航空 航天

CHINA AEROSPACE STUDIES INSTITUTE

In Their Own Words:

Lectures on the Science of Space Operations

Foreign Military Thought

PROJECT EVEREST

Printed in the United States of America
by the China Aerospace Studies Institute

To request additional copies, please direct inquiries to
Director, China Aerospace Studies Institute,
Air University, 55 Lemay Plaza, Montgomery, AL 36112

E-mail: Director@CASI-Research.ORG
Web: http://www.airuniversity.af.mil/CASI
https://twitter.com/CASI_Research @CASI_Research
https://www.facebook.com/CASI.Research.Org
https://www.linkedin.com/company/11049011

China Aerospace Studies Institute

CASI's mission is to advance the understanding of the strategy, doctrine, operating concepts, capabilities, personnel, training, organization, of China's aerospace forces and the civilian and commercial infrastructure that supports them.

CASI supports the Secretary, Chief of Staff of the Air Force, the Chief of Space Operations, and other senior Air and Space leaders. CASI provides expert research and analysis supporting decision and policy makers in the Department of Defense and across the U.S. government. CASI can support the full range of units and organizations across the USAF, USSF, and the DoD. CASI accomplishes its mission through conducting the following activities:

- CASI primarily conducts open-source native-language research supporting its five main topic areas.
- CASI conducts conferences, workshops, roundtables, subject matter expert panels, and senior leader discussions to further its mission. CASI personnel attend such events, government, academic, and public, in support of its research and outreach efforts.
- CASI publishes research findings and papers, journal articles, monographs, and edited volumes for both public and government-only distribution as appropriate.
- CASI establishes and maintains institutional relationships with organizations and institutions in the PLA, the PRC writ large, and with partners and allies involved in the region.
- CASI maintains the ability to support senior leaders and policy decision makers across the full spectrum of topics and projects at all levels, related to Chinese aerospace.

CASI supports the U.S. Defense Department and the China research community writ-large by providing high quality, unclassified research on Chinese aerospace developments in the context of U.S. strategic imperatives in the Asia-Pacific region. Primarily focused on China's Military Air, Space, and Missile Forces, CASI capitalizes on publicly available native language resources to gain insights as to how the Chinese speak to and among one another on these topics.

PROJECT EVEREST

The Department of Defense epicenter for human-centered strategic art

Project Everest is a strategy design start-up inspired by Andrew Marshall's call to cultivate comprehensive understanding of U.S. competitors in pursuit of national security. Project Everest contributes to this vision in two fundamental ways: by recurrently educating defense professionals on adversaries' ways of war and by facilitating the development of novel strategies that achieve competitive advantage over potential adversaries. Founded in 2013, Project Everest has grown its membership to hundreds, and shaped policy and education campaigns at the national level.

Project Everest tackles two significant national security problems for our nation. First, Project Everest seeks to invigorate the Chairman of the Joint Chiefs' 2013 charge to develop an officer cadre with deep regional expertise and to answer the 2018 National Defense Strategy's charge to "prioritize developing the intellectual firepower of our warfighters and workforce via education and training".

Second, we seek to inject creativity into stale strategy development methods for the Department of Defense, inspiring novel approaches to competition and warfighting and answering the charge of the 2021 Interim National Security Strategic Guidance to employ our "full diversity of talents [to] address today's complex challenges" and "prevail in strategic competition." Traditional approaches to strategy development overlook opportunities to understand how a potential adversary thinks about and plans for competition and war.

We bring together motivated individuals with subject-matter expertise in their primary specialty to interrogate key strategic issues throughout their careers. Over time, this develops a cadre of high-caliber officers who have a deepened appreciation of near-peers' ways of war and are experienced in thinking through the toughest operational and strategic challenges. We believe human-centered design and unconventional problem-solving methodologies enable members to assimilate new knowledge and develop novel warfighting concepts and recommendations to address strategic challenges.

Project Everest was founded by six graduates of the School of Advanced Air and Space Studies, who range in gender, expertise, rank, status, ethnicity, and personality, and who have a shared vision to inspire change in the way our nation prepares to compete and fight.

In Their Own Words

The "In Their Own Words" series is dedicated to translations of Chinese documents in order to help non-Mandarin speaking audiences access and understand Chinese thinking. CASI would like to thank all of those involved in this effort.

In the "In Their Own Words" series, CASI and its collaborators aim to provide Chinese texts that illustrate thoughtful, clearly articulated, authoritative foreign perspectives on approaches to warfare at the strategic, operational, and tactical levels.

Project Everest Comments

The *Lectures on the Science of Space Operations* (2012) is one of the featured "Military Academic Works of the Academy of Military Sciences (AMS)." This text presents a topic that is within the PLA Military Science Studies Plan. The text is a fundamental reference and teaching document written by AMS faculty, with help from the former General Staff Department, from all Services and Arms, and from key academies. This is a classical teaching material for the science of military affairs post-graduate education, and it is the first of its kind for the discipline building and comprehensive study of PLA space operations theory.

In the "Foreign Military Thought" series, the U.S. editors aim to provide foreign texts that illustrate thoughtful, clearly articulated, authoritative foreign perspectives on approaches to warfare at the strategic, operational, and tactical levels. The U.S. editors apply a stringent vetting process to select foreign texts. Selected texts will help build a deep understanding of different approaches to warfare and clarify details of foreign perspectives that may have both commonalities and asymmetries to U.S. approaches. This series will stimulate thought on both the core elements of military strategy and operational concepts for force application during war. The editors believe that cultivating a holistic understanding of foreign perspectives by learning from high-quality original material articulated from a foreign perspective offers an invaluable starting point for the exchange of ideas and the development of military thought.

.

Translators' Notes

This translation of the original text aims to accurately capture the technical meanings, in both English and Chinese. This will ensure that the reader will not inadvertently draw the wrong substantive understanding based on inaccurate translations.

Note on Trouble Terms:

Throughout the text are certain terms that are translated with the Chinese pinyin modifying the terms. This convention allows the reader to distinguish nuances that exist in the Chinese terms.

Jihua and *guihua* plans. The *jihua* plan is a more specific plan, a plan that is meant to be carried out to the letter, whereas the *guihua* plan is a more general plan that is macroscopically focused. In order to retain the intended Chinese distinction, plans will be rendered as *jihua* plan and *guihua* plan.

Bushi and *bushu* dispositions. *Bushi* disposition is the *mission differentiation*, *organized grouping,* and *positioning* [deployment] accomplished for strengths within the campaign task-based organization. *Bushi* denotes the relationship between one's own military forces, the opponent's military forces, and the combat environment (e.g., terrain). *Bushu* disposition is the positioning of participating force-strengths for a fixed time and space on the basis of *mission differentiation* and the *organized grouping of campaign* and in accordance with operational conditions and the enemy's possible activities.

Xitong, tixi, tizhi, and *zhidu* systems. The *xitong* system is an elemental system, one that can operate on its own. The *tixi* system is similar conceptually to a *System of Systems* as often seen in systems engineering; in Chinese, a *tixi* system is understood to be composed of elemental *xitong* systems acting together as a larger whole. The *tizhi* system is a large-scale system, typically a national-scale system and understood to be formalized embodiment of a *zhidu* system. The *zhidu* system describes a conformance system, one where all elements of that system conform to how that system is defined.

Note on Table of Contents:

The double pagination shown in the Table of Contents represents: 1) the original page numbers from *Lectures on the Science of Campaigns (2012)* followed by 2) the actual page number of this translation. Additionally, the headings throughout the document also reference original page numbers from the original-language text.

Academy of Military Science Master's Postgraduate Series Teaching Materials (2nd Ed.)

Lectures on the Science of Space Operations

空间作战学教程

{*kongjian zuozhan xue jiaocheng*}

Chief Editor: Jiang Lianju {姜连举}
Assistant Editor: Wang Liwen {王立文}

Military Science Press

.

Cataloguing in Publication (CIP) Data

Lectures on Science of Space Operations /Jiang Lianju {姜连举} Chief Ed. – Beijing: Military Science Press, January 2013.
AMS Master's Postgraduate Series Teaching Materials
ISBN 978-7-80237-581-9

1) Space {空 *kong*}… II. 1) Jiang {姜}… III. 1) Outer Space Warfare – Graduate Student {外层空间战-研究生-教材 *waiceng kongjianzhan - yanjiusheng - jiaocai*} IV. 1) E869

Archival Library of Chinese Publications CIP Data Approval Number (2013) Nr. 023785

Book Name: *Lectures on Science of Space Operations*
Author: Jiang Lianju {姜连举}, etc.
Editor in Charge: Fang Ning {方宁}
Sleeve Design: Ni Chunhao {倪春昊}
Publication and Issue: Military Science Press (Beijing City, Haidian District, Qinglong Bridge 100091)
Standard Book Number: ISBN 978-7-80237-581-9
Seller: Nationwide Xinhua Bookstore
Printer: Beijing Xinhaida Printing Co.
Book Size: 880 mm x 1230 mm A5
Print Sheet: 7.375
Word Count: 198,000
Edition: January 2013 Beijing 1st Edition
Print: April 2013 1st Print
Print Count: 1-2500
Set Price: 15.00 Yuan

Seller Hotline: (010) 62882626 66768547 (doubles as fax)
URL: http://www.jskxcbs.com
Email: jskxcbs@163.com

[End of page]

Lectures on Science of Space Operations Writers

Chief Editor: Jiang Lianju {姜连举}
Asst Editors: Wang Liwen {王立文}
Writers:

Jiang Lianju   Wang Liwen   Ni Tianyou {倪天友}
Ruan Guangfeng {阮光峰}   Chen Aiyuan {陈爱元}   Zhao Baoxian {赵宝献}
Yang Yilin {杨艺霖}   Huang Yong {黄勇}   Su Wei {苏伟}
Li Xianrui {李先瑞}

[End of page]

2nd Edition Explanatory Notes…1

In postgraduate education, talent is fundamental and teaching materials are the foundation. In 1998, when our academy released the First Edition Military Science Master's Postgraduate Series Teaching Materials (55 volumes), not only was it to play an active promoting role for strengthening the academy's postgraduate education and improving the quality of talent cultivation, but it was also to produce a positive effect in the domains of PLA-wide and national postgraduate education. In December 2008, on the basis of summarizing 20 years of experience in postgraduate education, our Academy established the objective of cultivating "high quality advanced research model talent and advanced staff officer model talent with basic theoretical skill training and improved thinking capabilities" (also called "dual-advanced talent {*lianggao rencai*}," putting forth an even higher requirement of Academy postgraduate education. In order to satisfy the needs-requirements of "dual-advanced talent" and adapt to the new discipline catalogue promulgated by the Ministry of Education and the curriculum setup after our Academy made its adjustments, the Academy decided to perform a revision of the Postgraduate Series Teaching Materials (1st Ed.), and in 2012, it completed the work on the 2nd Edition.

The 2nd Edition totals 65 volumes. Amongst them, 25 are revised volumes, and 40 are new volumes touching upon 10 first-order disciplines and 23 second-order. During the revision work, each discipline from start to finish persisted in Marxist military theory, and especially under the guidance of Chairman Hu Jintao's important discourses on defense and armed forces building with the military strategic concept of the new era as the reliance and with the pull of lively practices of recent years in in defense and armed forces modernization building, we tightly combined the development realities of the Academy's postgraduate education and military sciences; and while closely centered on the goal of cultivating the "dual-advanced talents," we paid close attention to bringing into play **[end of page 1]** scientific superiority and giving expression to military characteristics and achieved an organic combination of postgraduate education and military scientific research. First, we carried forward the outstanding achievements of the 1st Edition Teaching Materials. We compared and stabilized the thought, viewpoints and methods in the 1st Edition; we further refined and improved the more mature of the teaching materials in the theoretical *tixi* system; and we vigorously enabled it to become the classical teaching materials in the science of military affairs postgraduate education. Secondly, we made known the new knowledge, new achievements, new methods and the new *tixi* system of the science of military affairs disciplines {*junshi xue xueke*}. We fully assimilated the leading edge achievements of each discipline and we gave prominence to the innovative theoretical achievements in aspects such as the scientific development view, armed forces informationization theory, military transformation with Chinese characteristics and military struggle preparations, etc. We also adapted to circumstances development and gave expression to the features of the period. Thirdly, we adhered to the teaching characteristics and laws of the discipline specialties of the science of military affairs {*junshi xue xueke zhuanye*}. With the Academy Postgraduate Education Discipline Building *Guihua* Plan as the basis, and both in conformity with the Academy Postgraduate Education "12th Five-Year" *Guihua* Plan and in adjusting-coordination with adjustments to the Postgraduate Curriculum *Tixi* System, we gave expression to knowledge structure {*zhishi jiegou*} requirement of the "dual-advanced" objective. Fourthly, we correctly handled the relationship of teaching materials, lecture notes and outlines. We placed the fairly stable and theoretically mature courses into a Teaching Material Publication Plan {*jiaocai chuban jihua*}, and for some courses with contents still not quite mature but strong in farsightedness and urgently needed, we first organized the writing of lesson outlines, and after the outlines were mature, we wrote the lecture notes, and only after the lecture notes were mature did we write the teaching materials. Fifth, we accelerated science building through writing of the teaching materials and improved the teaching *tixi* system of each discipline; we strengthened the basic theoretical research and toughened the ranks of scientific research; we formed academic echelons {*xueshu tidui*} and spurred and aroused scientific research innovations.

The revision and publication of this set of teaching materials coalesces the large quantity of blood and sweat of the leadership, experts, advisors and associated workers at each level. Academy Superintendent Liu Chengjun {刘成军} personally assumed the position of Chairman of the Academy Teaching Material Editorial Review Committee. Political Commissar Sun Sijing {孙思敬} was extremely concerned with the teaching materials revision work and putting forth the requirement for writing and publishing a high quality postgraduate education teaching material that reflects the features of the period and military characteristics. Deputy Superintendents Liu Jixian {刘继贤} and Xu Lili {徐莉莉} assumed the positions of Vice-Chairmen of the Editorial Review Committee and personally organized the revision work. Experts and advisors participating in writing the teaching materials committed themselves to the work with an abundance of enthusiasm **[end of page 2]** and a high level of responsibility as they extensively investigated, researched, and worked extra hours to complete the writing task on schedule. The Scientific Research Guidance Dept. on multiple occasions organized the solicitation of ideas from research departments, institutes and advisors, and carefully studied the teaching material revision proposal; they promptly grasped the writing progress, earnestly coordinated the finalization of the publication, and accomplished a great amount of arduous and detailed work. The Military Science Press treated the publication of the teaching materials as a major task as they meticulously organized, designed edited, and proofread to ensure the quality of publication.

Due to the limits of writing time and levels, the *tixi* system of the 2nd Edition teaching materials is insufficiently complete, and some content is still inadequate; we solicit all concerned experts and the broad mass of postgraduate students to put forth revision ideas in order to facilitate further improvements.

Academy of Military Science
Master's Postgraduate Teaching
Material Editorial Review Committee
June 2011

[End of page 3]

This page intentionally left blank.

Table of Contents

Lecture 1
Introduction...1

History makes it clear to us that at the same time that the footprints of mankind's activities enter a brand-new space, [mankind] often carries genes for games of confrontation, and in the process of [mankind's] development forward, [these genes] are constantly interpreted as an intense military competition.

In the latter half of the 20th century, the rapid development of space technology led mankind to enter into a completely new Space Age, and struggles centered on the initiative in space have followed along with this. Early on, in the beginning of the 1960s, US President [John F.] Kennedy clearly pointed out that "A struggle for dominance in space will be the main detail in the coming ten years. Whichever country can control space, can control the world." For several decades after this, the major powers of the world launched the study and exploration of such major issues as the exploitation and use of space resources, military space technology, military theory of space, and the use of space operations, [all] centered on the strategic core that is "space." As the pace of the militarization of space has continually accelerated, competition has become increasingly intense, and the curtain of space confrontations has been drawn open. The several local wars that have recently occurred before our eyes have shown that whoever is strong in military spaceflight will rule the battlefield, that he in whose hands lies space superiority will master the initiative in warfare, and that with the support of "space," it is possible to win victory, but without the support of "space," this is impossible.

A great many details, such as space operations strengths, space weapons and equipment, the command of space operations, and space information systems, are incrementally being interpreted as basic key factors that are indispensable in informationized warfare. At the same time, they are becoming important basic supports for operations under informationized conditions. Although the peaceful use of space has become an international consensus, steps centered on the struggle for space military superiority have never stopped. The world's military powers and space powers, headed by the United States, have listed space operations as a main sphere of study for future warfare, and have used this to pull along the rapid buildup and innovative development of operational strengths, weapons and equipment, forms of operations, and theories of operations. Space operations have developed up until now, and they no longer are a "new fairy tale" being quietly performed on the stage of warfare, but rather have become a "normal drama" that is frequently performed in modern warfare. Space operations have strode to the foreground, and they permeate the entire process of operations; they are now developing from a single form of space information support to complex operations in space confrontations, and are continually penetrating each important link of operations, playing a decisive role in victory or defeat in warfare.

The importance of space operations for modern warfare has taken the lead in the study of military theory. Innovations in the study of space military theory and promoting practices in space operations are the subject of this course. This lecture primarily explores issues in such aspects as the basic concepts of space operations and the science of space operations, categories of study, methods of study, principles of study, the development process of space operations, and their impact on modern warfare, and it aims at clearly outlining the basic outline of the science of space operations and at clarifying the logical starting point in the science of space operations, and starting with recognizing and understanding the basic connotations of space operations and the science of space operations, it will gradually develop in-depth into a fairly comprehensive systematic study, and will carry out a general explanation of space operations and the science of space operations.

Section 1: An Outline of Space Operations...2

In studying the science of space operations, it is first necessary to clarify the basic connotations of space operations, their formation and development, and their role in modern warfare.

I. The definition of space operations...2

Clausewitz made this statement in his *On War*: "Any theory must first clarify disorderly, or one could say confused, notions and concepts. Only by having a common understanding of terms and concepts is it possible to clearly and smoothly study issues, and possible to stand together with the reader on the same standpoint. If we do not accurately determine the concepts [of a theory], we will then be unable to thoroughly understand its innate laws and interrelationships."[1] Therefore, in studying the science of space operations, it is necessary to first clarify the concepts of space operations, and to use this in order to unify our understanding and prompt a more in-depth study of space operations.

In clarifying the concepts of space operations, it is first necessary to clarify [the concept of] space and its interrelated concepts. Usually, "the sailing activities of manned and unmanned spacecraft beyond the earth's atmosphere" are called spaceflight. It can be

---

[1] (German) Clausewitz, *On War*, Liberation Army Publishing House, 1964, p. 143.

seen that the "space" in spaceflight refers to cosmic space beyond the earth's atmosphere. Space within the earth's atmosphere is called "air;" aircraft can only fly within the atmosphere, so this is called aeronautics. Early on, when the International Aeronautical Federation held a meeting in Barcelona in the 1960s, it specified that an altitude of 100 kilometers would be the upper boundary of the atmosphere, and this was widely accepted as the boundary of spaceflight and boundary of aeronautics. Therefore, people refer to the broad cosmic spaces beyond the atmosphere at more than 100 kilometers above the earth's sea level as "space," and it is also commonly called "outer space." They differentiate it into three types: 100 kilometers to 40,000 kilometers above the earth's surface is called near-earth space, 40,000 kilometers to 384,000 kilometers is called far-earth space, and more than 384,000 kilometers is called interplanetary space. Currently, human use of space, and particularly military use, is still primarily in near-earth space.

In recent years, the concept of near space is often seen in academic journals and various media. Near space is also called near outer-space or the air-space transitional zone, and it usually refers to the airspace between the highest altitude at which existing aircraft fly (about twenty kilometers) and the lowest altitude (about 100 kilometers) at which satellites move in orbit; it primarily includes most of the atmosphere's stratosphere region, all of the atmosphere's mesosphere region, and part of its thermosphere region (see Figure 1-1).

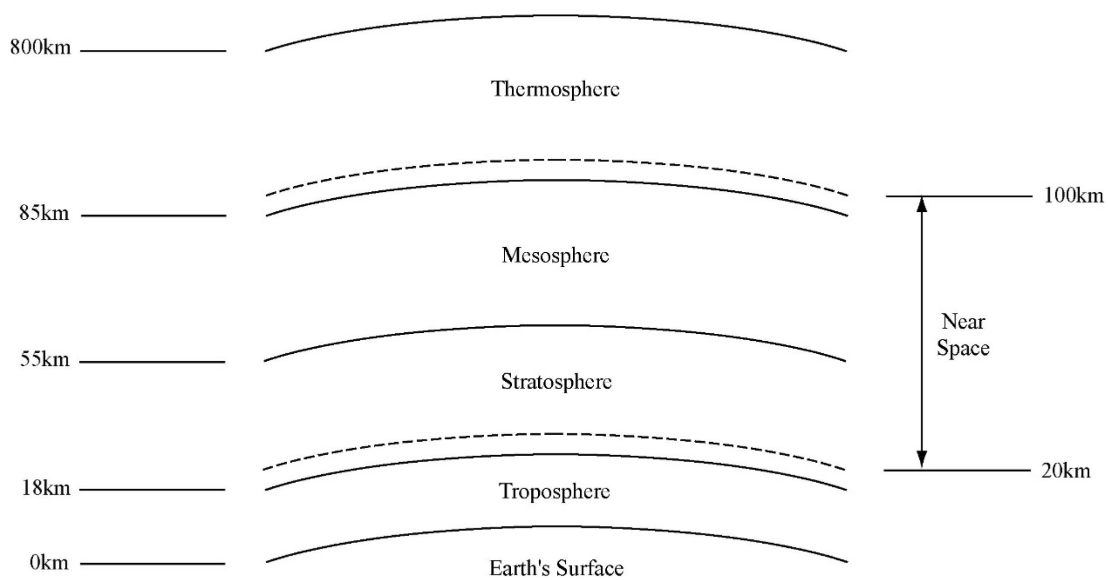

Figure 1-1: The Relations between the Various Near-space and Atmospheric Layers

The concept of space operations first appeared in the AFM1-1 doctrine published by the US Air Force in 1971. This doctrine considered that "Space operations refer to a series of operational actions that include space command, force enhancement, and space support."

Following this, the various countries of the world have launched wide-ranging studies into the issue of space operations, and explained space operations from differing angles.

The US military for the most part defines the concept of space operations from the angle of operational missions. The *Space Operations* doctrine that the US Air Force issued in August 1998 and the *Joint Doctrine: Tactics, Techniques, and Procedures for Space Operations* (draft) drafted by the Joint Chiefs of Staff in January 2000 define space operations as "a series of operational actions or military activities, including space combat (including space control and force applications), combat support (primarily referring to force enhancement), and space support (including spacecraft launches and protection in orbit)." Official documents from the US Department of Defense define four categories of operations in space operations. The first is offensive anti-space operations, that is, actively attacking the enemy by weakening, damaging, or destroying the enemy's space strengths. Offensive anti-space operations use two means, soft kill and hard kill, to achieve the five goals of deception, interruption, denial, deprivation, and destruction. The second is defensive anti-space operations, that is, adopting forms of active defense and passive defense to ensure that US space strengths avoid enemy attack or jamming. In this, active defense refers to detecting, tracking, identifying, and intercepting enemy space strengths and ballistic missiles; passive defense refers to the use of such measures as camouflage, concealment, deception, mobility, and dispersal to ensure the security of space strengths. The third is operations to attack the earth, that is, the use of spaceflight equipment to attack the enemy's important airborne or surface targets. The fourth is force enhancement operations, that is, operational actions whose goal is the use of space reconnaissance and surveillance, missile early warning, navigation and positioning, and space communications systems to reinforce land, sea, and air operational strengths.

The Soviet military believed that space operations were the sum total of operational actions that used space weapons and space military systems to resist enemy space weapons and space military systems, under the leadership of the state's supreme military command organ, with the goals of weakening the enemy's space strengths and seizing command of space. After the Soviet Union collapsed, the Russian military continued to treat space strengths as crucial factors for determining its status as a great power, and it never interrupted its studies of space operations theory. Based on the *Operations and Applications of Spacecraft* that Russia published in 1995 and on *Russian Military Doctrine* (draft) and *Methods of Space Activities*, Russia's military defines space operations as a series of military actions that use space strengths to support their own side's armed units in smoothly carrying out their operational mission, and that engage in offensive and defensive confrontations in space with the enemy. The missions of space operations primarily consist of fourteen basic tasks: attacks (against ground targets), interception (against spacecraft), reconnaissance, communications, electronic warfare, early warning, geodesy, weather, search and rescue, control, detection of nuclear explosions, navigation, radiation forecasts, and transportation. Space strengths not only can independently carry out their operational missions, but they can also participate in joint operations, closely cooperating with other services, in order to jointly complete operational missions.

The *Chinese Military Encyclopedia – Volume on War and Strategy* that the PRC military published in 1993 considers that "Space warfare is military confrontations carried out by hostile nations in outer space. It is also called space warfare or outer space warfare. It includes military offensive and defensive actions in outer space, actions from outer space to attack airborne or ground targets, as well as actions carried out from the ground or the air with the goal of damaging space systems or rendering them ineffective."[2] The *Chinese People's Liberation Army Military Terminology*, published in 1997, considers that "Outer space warfare, also called space warfare, is military confrontational activities that two hostile sides primarily carry out in outer space. It includes offensive and defensive actions against each other in outer space as well as offensive and defensive actions against each other that are carried out between outer space and the air or ground."[3] The *Chinese People's Liberation Army Military Terminology* (complete version), published in 2011, believes that "Outer space warfare is also called space warfare. It is confrontational activities that are carried out in outer space, primarily using military spaceflight strengths. It includes offensive and defensive actions in outer space as well as offensive and defensive actions that are carried out between outer space and the air, ground, or sea."[4]

To summarize the above, space operations are military confrontational activities that two hostile sides engage in primarily in space. Their essence is that they are a series of operational actions where two hostile sides use their space strengths as their main operational strengths and space as their main battlefield in order to seize, hold, and use command of space. They directly serve a certain part of the war or even the entire war situation, and they play an irreplaceable and unique role in gaining victory in warfare. For example, the use of reconnaissance satellites can track and monitor the enemy's military activities, in real-time and continuously, so that joint units' commanders continuously stay abreast of how the enemy's troop strengths are deployed, how his firepower is deployed, and how his positions are deployed, so that [the commanders] adopt corresponding measures in a focused manner. [Another example is that] by using

---

[2] Chinese People's Liberation Army National Defense University, *Chinese Military Encyclopedia – Volume on War and Strategy*, Military Science Publishing House, 1993, p. 96.
[3] *Chinese People's Liberation Army Military Terminology*, Military Science Publishing House, 1997, p. 17.
[4] *Chinese People's Liberation Army Military Terminology* (complete version), Military Science Publishing House, 2011, p. 75.

communications satellites, it is possible to achieve global and continuous communications in all weathers, that are strongly encrypted and highly reliable, so that the commanders can exercise flexible and effective command and control over their subordinate units. [A final example is that] navigation satellites not only can ensure that units at each echelon move rapidly and accurately, but they can also ensure that the various types of precision-guided munitions overcome the impact of unfavorable factors like climate and weather, in order to carry out long-distance precision attacks against the enemy.

In coming to an understanding of these definitions, we should have a grasp on the following several points.

First is to have space strengths be the main body in operations. Space strengths are the physical basis for organizing and carrying out space operations. Based on their missions, they can be divided into space information support strengths, space offensive and defensive strengths, space service and support strengths, and space operations command strengths. Space information support strengths refer to strengths that provide information support such as reconnaissance and surveillance, missile early warning, communications relay, navigation and positioning, meteorological observation, and battlefield mapping, from space, for land, sea, air, and space operational strengths. Space offensive and defensive strengths include space attack strengths and space defense strengths. Of these, space offensive strengths refer to strengths that carry out space attacks against important enemy space, air, naval, and land military targets, while space defensive strengths refer to strengths that block the space reconnaissance and attacks carried out by the enemy against your own side and that ensure your own side's space security. Space service and support strengths refer to strengths that provide space transportation, operations materiel supplies, base engineering support, and technical maintenance of equipment in order to ensure that control of space and use of space are carried out smoothly. Space operations command strengths refer to command and control strengths that ensure that the various space operations actions are smoothly carried out. The US military believes that the integration of space operations strengths with air, land, sea, and special operations units means stronger operational capabilities of various kinds. By fully bringing into play the roles of space operations strengths, it is not only possible to greatly strengthen the operational capabilities of joint units and to speed up the reactions of joint units, but at the same time it is also possible to greatly improve the defense capabilities of joint units, thus ensuring gaining maximum combat results at a maximum speed and minimal cost. Without effective assistance and support from space strengths, it will be difficult for the various services and service arms to smoothly launch and carry out various types of operational actions.

Second is to have space as the main battlefield. The battlefields of space operations include space, the air, the sea, and the land, but space is the main battlefield, and the main operations platforms are spacecraft. Spacecraft not only are platforms equipped with various types of lethal weapons and information devices, and transportation tools with various types of operational materials and personnel, for both sides in operations, but at the same time they are also targets whereby the two hostile sides attack each other. Regardless of what kinds of space operations actions are carried out, their operational activities mainly center on ensuring that spacecraft smoothly provide information support, that they transport personnel and materials, that they attack important enemy air, sea, and land targets, and that they are done to destroy enemy spacecraft that are performing these tasks; these operational activities are primarily performed in space. Although the land, sea, and air battlefields are also important battlefields for space operations, they only are bases for launching and recovering spacecraft and sites for reconnaissance and attacks against space.

Third is to have seizing, holding, and using command of space as the mission of their operations. The mission in future space operations will be mainly reflected in two areas. On the one hand, they will seize and hold command of space, that is, at the same time that they ensure that their own side's space strengths fully bring their effectiveness into play, they will limit, weaken, and destroy the enemy's space strengths. This will not only include carrying out offensive and defensive actions in space against the enemy's space strengths, but they will also include offensive actions carried out against the various kinds of installations of the enemy's space strengths, situated on the land, at sea, and in the air, by using such means as long-range firepower attacks, information warfare, and in-depth assaults by special units of the land, sea, and air operational strengths, as well as defensive actions that are adopted against such attacks by the enemy. On the other hand, they will use command of space, that is, they will use space strengths not only to provide reconnaissance and surveillance, missile early warning, and communications relay, and such battlefield information support for their own side's land, sea, and air operational strengths as navigation and positioning, weather observations, and battlefield mapping, but they will also engage in firepower attacks against important enemy targets in the air, at sea, and on land.

II. The developmental process of space operations...7

With the emergence of space technology and equipment and their application in war practices, the practice and theory of space operations began to appear and has continually developed; in general, it has undergone a seminal stage, a formative stage, and a developmental stage.

1. Seminal stage

From the mid- and late 1950s to the early 1980s was the seminal stage in the development of space operations. This stage was precisely the Cold War period of intense US-Soviet confrontation, and the development of space strengths was deeply branded by the "Cold War." The space strengths of the United States and the Soviet Union primarily served each [country's] nuclear deterrence strategies. First, they provided early warning for strategic nuclear defense, and [the countries] conceived of intercepting enemy ballistic missiles from space. For example, the United States in 1983 proposed the Strategic Defense Initiative (commonly called the Star Wars program), and it intended to establish a defensive shield in space, following several decades of efforts (this initiative later never materialized, for political, economic, and scientific and technological reasons). Second, [the space strengths] provided reconnaissance, navigational, communications, and weather information support for strategic nuclear attacks, ensuring the accuracy and effectiveness of strategic nuclear attacks. Third, they provided surveillance and detection means for international nuclear weapons inspections and effectively controlled nuclear proliferation, thus maintaining world-wide nuclear stability. It can be seen that space strengths in reality became an extension of nuclear deterrence strengths. At the same time, space strengths were also used in various major political crises and local wars, like the Berlin Crisis, the Cuban missile crisis, the Fourth Middle East War, and the British-Argentine Malvinas Islands War. Because of the restrictions of historical conditions, space strengths were primarily used at the strategic level, in order to serve the major powers' nuclear deterrence strategies, and to a certain extent partially met the needs of conventional wars for battlefield information; they reinforced the operational effectiveness of combat units, and thus the prototype of space operations made its initial appearance.

During this stage, the theory of space operations saw its initial generation. As various types of military satellite systems rapidly appeared and were applied to the military sphere, the various nations' research and development of anti-satellite weapons also became something that space powers like the United States and the Soviet Union became passionate about, and the idea of confrontational activities in space began to appear. In 1958, the US Department of Defense set about research on such issues as turning near-earth outer space into a possible battlefield and determining forms of weapons and technological weapons systems, the characteristics of combat actions that would be carried out in near-earth outer space, the ways of seizing command of space in near-earth outer space, and the impact that this would have on carrying out armed conflict. *The United States Air Force Basic Doctrine*, in 1959, for the first time used the term "aerospace," and replaced the word "air;" at the same time, it defined the Air Force's battlefield as the "entire space above the earth's surface," that is, "aerospace" space. A

1962 book, *Military Strategy,* [*Soviet Doctrine and Concepts*], whose chief editor was Marshal of the Soviet Union [Vasily D.] Sokolovsky, believed that the scope of space for future wars was huge, the cosmos would become the battlefield, and military actions could engulf the cosmos. As the types and scales of military satellites rapidly expanded, their technical functions that could serve warfare were a focus of development. The United States and the Soviet Union formed relative complete systems of military space equipment that included reconnaissance satellites, communications satellites, navigational satellites, weather satellites, and geodetic satellites, and carried out a number of anti-satellite tests, so that they preliminarily had the ability for anti-satellite operations. With the birth of practices in space operations, theories of space operations initially emerged. The 1971 *US Air Force Operational Doctrine*[5] for the first time specified the tasks of the Air Force in outer space, clearly indicating that the US Air Force had the responsibility for military activities related to spacecraft and for "ensuring that other nations cannot use space to explore and seize interests strategically." This marked the birth of the US Air Force's theory of space operations. The 1979 edition of this doctrine further clarified the Air Force's space missions as: spaceflight support, combat power enhancement, and outer space defense. The *Soviet Military Encyclopedia* that was published in the late 1970s pointed out that "In order to resist assaults that the enemy carries out from aerospace, various types of weapons should be used to carry out campaigns of a strategic nature to resist aerospace assaults." Given the restrictions of space military technical equipment levels, the theory of space operations had yet to be merged with overall theories of operations and was still in the seminal stage, without achieving organic "interface" with the operational theories, operational systems, and operational equipment of that time.

2. Formative stage

From the early 1980s to the late 1990s was the formative stage of space operations' development. During this stage, not only did space operations strengths achieve fairly great developments in their types and scale, but the technical and tactical performance of space operations equipment was also enhanced to a fairly great degree, they had fairly strong battlefield information assistance and support capabilities, and they came into fairly large-scale use in the several local wars. In particular, during the 1991 Gulf War, the multinational forces headed by the United States mobilized more than seventy satellites to carry out information assistance and support in many areas, such as space reconnaissance and surveillance, missile early warning, navigation and positioning, communications relay, and weather observations, and this made huge contributions to the

---

[5] Translator's note: Possibly *United States Air Force Basic Doctrine* (AFM 1-1).

multinational forces' victory. The Gulf War was called the "first space war," showing the vast magic and fascination of space operations, but it also revealed a series of problems as space operations expanded from an emphasis on serving nations' nuclear strategy to serving modern local wars. These problems primarily included: first, the process of deployment of space operations strengths as they reacted to emergencies took too long; second, systems compatibility was not strong; third, the technical and tactical norms of spaceflight equipment were not high, and it was difficult for them to adapt to battlefield environments that changed in the twinkling of an eye; and fourth, the command system of space operations was rigid, its information flow was not rational, and command and combat personnel at the various echelons lacked sufficient understanding of space operations strengths, so that they had no way to effectively use these in operations. After the Gulf War, the US military summarized its experiences and lessons involving space operations, and further strengthened its buildup of space strengths. In the 1999 Kosovo Campaign, the space operations strengths of the NATO units, in which the US military predominated, were greatly expanded over the Gulf War, both in support to operational actions and in their scale and quality. A former commander of the US military's Space Command, General [Richard] Myers, pointed out that "The Kosovo Campaign was indeed a war that was launched from space. In the Kosovo Campaign, our space information support reached completely new heights. As everyone knows, in Operation Desert Storm, many people complained that space support did not reach the campaign and tactical levels, but this operation of ours saw great progress in this area."

In this stage, the theory of space operations took shape incrementally. The "joint space-land operations" and "greatly in-depth three dimensional operations" theories that the United States and the Soviet Union put forward, in turn, advocated the need to aim at the new characteristics of modern warfare, to be "global, fully in-depth, full-spectrum, and highly three-dimensional" as they prepared for war, and to pay more attention in their operations to the support role of outer space information systems for the battlefield. Against this background, the space commands of the three US services and the Joint Space Command were established, one after the other. The US Air Force Space Command formally published the first work on space operations in October 1982, *Military Space Doctrine*, which marked the initial formation of the US military's space operations theory. *Space Operations*, which was completed in 1990 [sic], provided a complete systematic exposition on space operations theory, and the US military's theory on space operations was formally established by this. The mission of the US Air Force was further clarified as control of space, use of strengths, reinforcement of strengths, and spaceflight support, and spaceflight operations gradually began to stress the deployment of space strengths; there was an emphasis on using the space environment to reinforce ground strengths. Since 1992, the US military has published a series of doctrinal documents on space operations, such as *The Basic Aerospace Doctrine of the United*

States Air Force, *Military Space Doctrine*, the United States' Air Force Doctrine Document 2-2, *Space Operations*, and the United States' *Air Force Counterspace Operations Doctrine*, proposed the concept of "space campaigns," clarifying the command and control and the guiding principles of defensive space confrontational actions and offensive space confrontational actions, as well as the requirements and procedures for carrying out joint space campaigns. The Soviet military's senior-level generals, based on how space-based reconnaissance, surveillance, navigation, and early warning systems were developing, proposed the "information warfare" concept and theory, with a focus on space operations. In June 1995, Russia published the *Applications in Operations of Spacecraft*, which fully discussed basic theoretical and actual operating issues for how the armed forces, and particularly the air force, were to use spacecraft and resist enemy spacecraft, when drafting plans of operations and when carrying out operational missions. At the same time, they focused on analyzing the United States' space strengths and pointed out the basic methods for confronting them. Space operations theory moved from the strategic command level to the tactical operating level, gradually forming a system of space operations theory that was commensurate with space operations strengths.

3. Developmental stage

From the late 1990s until now is the stage where space operations have rapidly developed. The several modern local wars of the 1990s highlighted the status and role of space operations, setting off an upsurge among the various countries of the world, and especially military powers, to develop space operation strengths. Some countries introduced plans for the military development of space, one after another, and sped up the pace in the construction of space operations strengths, while the theory of space operations also entered overall into a preparatory stage for actual warfare applications. In April 1998, the US military's Joint Space Command released a *Long-Range Plan – Vision for 2020* [sic], in which it proposed four major concepts in space operations: control of space, global engagement, full-force integration, and global partnership. This theory especially emphasized that integrated space strengths should be fully utilized, that ballistic missile defense [should] be carried out using space as a base, and that various types of spacecraft, ballistic missiles, aircraft, ships, and land high-value targets [should] be attacked from space. In order to meet the needs of future space operations, the United States combined a space operations command center [sic] and a bureau of space command and control [sic] into a space command, control, communications, intelligence, surveillance, and reconnaissance center at the end of 1999, directly led by Space Command. At the same time, the United States withdrew in 2001 from the Anti-Ballistic Missile Treaty that the United States and the Soviet Union had signed in 1972, in order to clear away obstacles for the National Missile Defense System and space operations, and it formally deployed a missile defense system and comprehensively started a space warfare plan. In order to enhance its abilities for actual warfare in space operations, the US military organized and launched a Schriever system of war games, every two years, and from 22 to 26 January 2001 held the first Schriever I simulated war game in space operations. Up until this year, it has organized seven Schriever war games. The seventh Schriever war game, which the US military held from 19 to 26 April 2012, differed very much from previous war games, and was called the Schriever-2012 International war game (SW-2012 International). This war game focused on carrying out drills on "how to use outer space and network strengths in future conflicts" and it examined the US Air Force Space Command's operations command system and spaceflight systems, as well as coordination between spaceflight and ground systems; it was an important means by which the US military strengthened its space-network deterrence capabilities. This war game incorporated NATO and Australia, and it used even more space resources, in order to improve the ability of the US military's and its allies' outer space and network spaces operations; this resulted in the US military's space operations again making a great stride forward. Russia treats space superiority as an important foundation for ensuring national security; in order to ensure that it gets space superiority in future wars, at the same time that the Russian military has vigorously developed space offensive weapons and improved its theory of space operations, it also formally organized its Space Forces on 1 June 2001, on the basis of its former Strategic Rocket Forces space units and anti-missile space units, directly subordinate to the Russian military's General Staff. Russian President [Vladimir] Putin has also promised that, given the situation where the United States insists on having a missile defense system, "No matter how impoverished Russia is, it cannot impoverish its space operations units;" national defense expenditures will focus in the future on spaceflight enterprises, in order to ensure that "space operations units get rational and sufficient funding support."

In this stage, space operations theory continually developed and improved, which was primarily reflected in the developmental aspects of the US military's and Russian military's space operations theories. The US Air Force published its AFDD 2-2 *Space Operations* doctrine in 1998, and it revised this and reissued it in 2001, 2004, and 2006; of these, the 2004 revised edition had its name changed to *Counterspace Operations*. These doctrines stipulated in fairly great detail the forms by which the US Air Force would carry out command and control and deployment and execution in space operations. In August 2002, the US military's Joint Chiefs of Staff issued its *Joint Space Operations Doctrine* [sic] (JP3-14), and in January 2009 it issued a revised version, *Space Operations Joint Doctrine* [sic] (JP3-14). These doctrines were aimed at providing guidance plans for planning and carrying out joint space operations, and to provide a basic foundation for space operations by all operational personnel, in the air, on land, at sea, in space, and in special forces, as well as basic principles for space operations, in order to establish a guiding framework for the use of space strengths and space capabilities. The Russian military's theory of space operations also made breakthroughs. In 2001, Russia proposed a comprehensively improved theory of space operations in its National Space Plan Prior to 2010, and it systemically defined the principles of space operations, the division of areas of operations, the targets of operations, operations weapons systems, and main forms of operations. It envisaged three operational forms for dealing with future space operations: space offensive operations, space defensive operations, and space support operations. It divided space operations weapons systems into two major parts: space offensive and defensive operations weapons systems and space support operations weapons systems. [Finally,] it revisited a series of research concepts, such as land-based high-powered anti-satellite laser weapons, orbital bombers, manned space battle stations, and spaceplanes.

The competitive developments by the two space military powers – the United States and Russia – in the areas of space operations strengths and space operations theory also promoted developments by some other countries and regions in the buildup of space operations strengths and in the development of space operations theory.

III. The impact of space operations on modern warfare...12

Historically, every time a new space has become an important battlefield for military confrontations, this has had an intense impact on the state of warfare and on world military developments. The naval operations of the 19th century and the air operations of the 20th century dominated warfare, one after the other, and greatly changed the military face of the world. The space operations of the 21st century have already skyrocketed, and have generated a decisive and basic impact on modern warfare and on the world's military development.

1. They have changed people's concepts of time and space in warfare

The emergence of space operations again extended the footprint of warfare, and brought about new changes in the concepts of time and space in warfare; warfare extended beyond the atmosphere and was carried out in multi-dimensional spaces. In the Gulf War, the command post of the multinational force was set up in the front lines of the Gulf, but by Operation Desert Fox and the Kosovo Campaign, the US military's command post, relying upon space command and communications systems, was changed to the US homeland, and the distance between the command organization and the battlefield reached more than 10,000 kilometers. Operational platforms were also like this; cruise missiles launched from submarines and aircraft, by relying upon space positioning systems, could attack targets more than 1,000 kilometers away. As space military information systems developed and improved, the scope of the battlefield expanded further, and the boundaries between forward and rear areas gradually disappeared; the age of the "global battlefield" incrementally became reality. Space operations also sped up the rhythm of warfare to an unprecedented extent; prior to the emergence of the space operations form, the speed at which operational platforms moved did not exceed several dozen meters to several hundred meters per second, and the speed of munitions' flight also did not exceed several hundred meters to several kilometers per second. In space operations, operational strengths' movement and the speed of firing also were greatly increased; the speed of spacecraft's flight could reach several kilometers per second, and the speed of attack by directed energy weapons and laser weapons could reach 300,000 kilometers a second, several dozen times and up to ten thousand times the speed of movement and of firing in the air, respectively. They could launch instantaneous attacks against global targets. Surprise in warfare increased to an unprecedented extent, the time period for early warning was reduced, battlefield situations changed in the twinkling of an eye, and "blitzkrieg warfare" could truly be conducted at the speed of lightning; warfare at the level of hours, at the level of minutes, and even at the level of seconds was an emerging trend. The emergence of space operations has constantly sped up the rhythm of warfare, and the interrelationship between time and space has undergone major changes. Time in warfare has increased in value, while the size of national territory and how deep or shallow depths are basically are no longer an important limiting factor in the age of space operations, and it is difficult to achieve goals by exchanging space for time, while using time to struggle for space will become the new strategic choice.

2. They have given new connotations to initiative in warfare

As the state of war has evolved, the focus of the initiative in warfare has been transformed from dominating the land to command of the sea, and then to command of the air; it now has switched toward command of space, which is daily manifesting its huge value in dominating victory or defeat in war. Space has already replaced the air as the new high ground of war; whoever seizes command of space will be able to look down on and control the other battlefields from on high, and will be able to use space information systems in an effective manner to ensure that weapons systems on land, at sea, and in the air are able to operate in a stable manner; if it is the opposite, then without command of space or local command of space, it will be very difficult to seize and hold command of the air and command of the sea,; you probably will be put on the defensive in war, and it will be difficult for your space information systems to operate effectively, and it will be even less use to talk about support to weapons systems on land, at sea, and in the air. The basic goal in seizing command of the air is to damage the enemy's space systems and to limit the enemy's freedom to act in space, while protecting your own side's space systems and ensuring your own side's freedom to act in space. The fragility of space systems and the ease with which they are destroyed, as well as the complexity of space defensive technology, makes it quite possible that space attacks will become a primary means for seizing command of space, becoming an important detail in seizing the initiative in warfare.

3. They have sped up the integration of air and space defense

The emergence of space operations has brought about new changes in the threat of warfare, and attacks carried out from space have increasingly become a new form of warfare; merged with air attacks, they have become a primary threat in informationized warfare and have thus sped up the pace of integrated air-space defense. Air-space defense is characterized by its breadth and complexity; strategic reconnaissance and strategic air raids not only come from the air but also from space, requiring the establishment of an integrated air defense and space defense command organization and the implementation of integrated command, so that air defense and space defense operations cooperate with each other, support each other, and are closely coordinated, thus carrying out integrated confrontations. Air-space defense has the characteristics of [covering] all directions, having multiple levels, having great depth, and diversity, and there is no way to achieve the goals of defense against strategic air raids by relying upon a single strength. Therefore, establishing an integrated system of strengths in which space strengths (or space forces) and the air force predominate and in which relevant ground forces, navy, and civil air defense strengths jointly participate has become an important objective in the current world military buildup. The characteristics of air and space raid weapons, with their diverse forms of attack, their lethality and damage effects that differ from each other, their great suddenness, and their strong ability to penetrate defenses, require that space defense weapons be integrated militarily with air defense weapons on the land, at sea, and in the air; that means of active defense and means of passive defense be integrated; that means of hard kill and means of soft kill be integrated; and that resistance, counterattack, and defense systems be integrated. Not only does this fully bring into play the roles of the various means of operations, but it also keeps them from throwing each other out of balance and resulting in losses from internal strife, thus forming overall effects of operations where “one plus one is greater than two.”

4. They give birth to a new focus of attack in warfare

[Major General John F.C.] Fuller pointed out that “The combat power of a military exists in its organization. Killing the enemy is a war of the body; making its command authority ineffective is a war of the mind.” The rapid development of information technology and its widespread use in the military sphere have brought mankind truly into the age of the “war of the mind.” Killing using swords and spears and destruction using firearms became the main forms for achieving the goals of warfare in the age of the "war of the body." In the age of the "war of the mind," attacking the enemy's command and control systems and his psychological knowledge has become the main form for achieving the goals of warfare, which has greatly replaced the previous bloody forms of warfare. Changes in the form of warfare have brought about a transformation in the focus of attack. Command and control systems have become crucial targets of attack, while space information systems have become the most crucial thing in the age of "warfare of the mind," directly determining whether or not command and control systems operate effectively. Thus, destruction of the opponent's space-based systems and damage to his command and control systems have become the new focus of attack in warfare.

Section 2: Outline of the Science of Space Operations...14

With the rapid development of the practices of space operations, knowledge and understanding of space operations has continually deepened, the results of studies into space operations have daily become richer, and knowledge of the theory of space operations has incrementally formed systems and given birth to a new discipline: the science of space operations.

The science of space operations is a discipline that studies the laws and laws for guiding space operations, and that is used to guide preparations for and execution of space operations; it is a systematized rational knowledge of the formation of space operations, on the basis of a refinement of the practices and theories of space operations that have been constantly accumulated, and on [the basis of] the broad-ranging absorption and scientific integration of the theories of space operations. Currently, the science of space operations basically has all the main conditions that a comprehensive and independent discipline should have: the target of study is explicit, the structure of knowledge is systematic, the context of its formation and development is clear, and it has a set of scientific methods and means that are needed for obtaining the knowledge and materials for this discipline. The science of space operations primarily includes foundational theoretical knowledge for space operations, such as its basic concepts, basic laws, basic principles, and basic rules. It is a theoretical result that is basic, long-lasting, systematic, and relatively stable, and it plays the role of basic theoretical guidance for the laws, courses of study, and teaching materials of space operations. The laws, courses of study, and teaching materials for space operations, with the science of space operations as the guide for basic theory, have launched and refined any given aspect and any given level of the science of space operations; its relevance, applicability, and operability are relatively strong, and there are specific, realistic, near-term, and local theoretical results.

I. The objects, tasks, and contents of study in the science of space operations...15

An in-depth study of the science of space operations requires being clear about the targets of study, the tasks being studied, the details being studied, and the system of theories of the science of space operations.

1. The objects of study in the science of space operations

An important symbol and basic foundation for whether or not a given discipline can exist independently is whether it has targets of study or not. As an independent discipline, the targets of study in the science of space operations are space operations.

Space operations are the objects that the science of space operations studies, and they consist of two parts: space operations that have already occurred and space operations that could occur in the future. The science of space operations is a practical science, originating in practices and guiding practices. Investigating and studying battle examples of space operations that have already occurred are quite important for revealing the laws of space operations, for predicting developmental trends in space operations, and for guiding future space operations. The history of human warfare shows that it is on the basis of summarizing their experiences in past wars that people generally propose new theories of warfare to guide the practices of warfare, and it is through theories of warfare that have been revised and developed through war practices that they guide their preparations for the next war. If it is separated from the experiences of wars that have occurred in the past, the science of space operations becomes water without a source and a tree without roots. However, the science of space operations also cannot merely remain a summary of the experiences in space operations that have already occurred; what is more important is that even before the next space operations occur, that it scientifically predict future space operations and their developmental trends, and that it draft corresponding countermeasures. Therefore, space operations that could occur in the future are also an important detail in studying the science of space operations.

The science of space operations should conceive of, study, and resolve new situations and new issues that future space operations could encounter, based on developments in the equipment and technology of space operations, adjustments to [these operations'] organizational system and organizational structure, changes to the many factors of the future space battlefield, and innovations in operational concepts. Because space operations are a brutal confrontation between two hostile sides, it is impossible to carry out tests of future operations using real guns and live bullets. Therefore, all that we can do in peacetime is to simulate practices in space operations that could occur in the future, using training and exercises; it is also possible to learn from the experiences of foreign militaries, in order to stimulate our thinking, broaden our innovation, and thus take the initiative in responding to changes.

2. The tasks that the science of space operations studies

The tasks that the science of space operations studies generally mainly include revealing the laws and laws for guiding space operations, and predicting developmental trends in space operations.

First is revealing the laws of space operations. As an important component part and an objective phenomenon of human society's military activities, space operations have innate laws. The laws of space operations include laws that are generated and develop on their own and the laws of space operations actions. These laws are objective and inevitable; they do not rely upon human will to exist and transform, but they can be understood, mastered, and used by people. If people want to correctly understand and control space operations and guide them toward victory, then they have no choice but to study and abide by the laws of space operations. Just at Mao Zedong said, the laws of war are an issue that people guiding any war must study and must resolve. The laws of space operations are important issues that those people guiding warfare in the Information Age must have deep insight into; only by mastering the laws of space operations is it possible to gain freedom of action in the practices of space operations. Otherwise, you must suffer setbacks, leading to defeat. Therefore, the study of space operations treats revealing the laws of space operations as a primary task to be studied.

Second is to predict developmental trends in space operations. Space operations are a dynamically developing objective thing; the past, the present, and the future will not have two entirely identical space operations appear. The goal in studying space operations is to guide the practices of future space operations. Therefore, predicting developmental trends in space operations has become an important task in the science of space operations; it primarily explains the laws of development and change in space operations and makes a scientific judgment about developmental trends in future space operations, on the basis of analyzing and studying movement in the various inner key factors in space operations and the impact of exterior factors. Only in this way is it possible to be prepared in advance before future space operations occur and to seize the initiative and win victory when space operations occur.

Third is to explore the laws for guiding space operations. The laws for guiding space operations are innate laws within the process where the person guiding space operations commands the space operations. Speaking from an epistemological angle, they are laws where the person guiding space operations abides by objective laws of space operations and by which, on the basis of objective physical conditions, he dynamically resolves various contradictions and issues that appear during the process of space operations, in order to seize victory in space operations. They are specifically manifested as the principles and tenets for guiding space operations that correspond to the objective laws of space operations. Mao Zedong vividly referred to the laws for guiding war as the “art of swimming in the sea.” Therefore, the science of space operations treats revealing the laws for guiding space operations as an important task to be studied. The objective laws of space operations determine the laws for guiding space operations, and the laws for guiding space operations are a correct reflection of the objective laws of space operations and are expanded on by the person guiding space operations on the basis of understanding the objective laws of space operations. Revealing the objective laws of space operations is of course important, but the most commendable thing is to draft a series of countermeasures for defeating the enemy that correspond to the objective laws of space operations, that is, the laws for guiding space operations.

3. The details that are studied in the science of space operations

As a comprehensive discipline of military theory, the science of space operations touches on a great many of modern advanced theories and technologies, such as dynamics, systems science, aerospace science, cybernetics, information theory, new materials technology, information technology, artificial intelligence technology, and biotechnology, forming specific categories of research. The main details to be studied in the science of space operations are concepts and connotations related to space and space operations, and the status, nature, targets of study, methods of study, and system of scientific theories of the science of space operations; living conditions and developmental trends in space operations; the main characteristics, guiding thoughts, and basic principles of space operations, as well as the organization and execution, command and control, and overall support for space operations actions; the forms, means, and measures of space operations and the interrelationships and coordination and cooperation among these; the structure, buildup, and developmental trends of space operations strengths; the developmental trends and focus of development of space operations technology as well as the developmental principles of space operations weapons and equipment; the organization and carrying out of training and support for space operations; and the theory of space operations within joint operations.

II. The main characteristics of the science of space operations...17

The science of space operations emerged against the background of mankind’s stepping into the Space Age, of the widespread applications of space technology and equipment in the exploration of space, and of space confrontations becoming an important detail in military confrontations; thus it has the prominent characteristics of having a pioneering nature, of penetration, of having a composite nature, and of openness.

1. A pioneering nature

Although space operations have gone through the differing seminal, formative, and developmental stages, ascending the stage of warfare as a completely new form of operations, have displayed powerful fascination, and the theories of space operations regulations, doctrine, and scope have also continually been established and improved in the practices of space operations, still, looking at things from the angle of guiding overall space operations practices, the systemized research of the theory of space operations has yet to achieve breakthrough results. The establishment of the science of space operations not only absorbed in a widespread manner the "flowering" of studies into space operations in a theoretical manner and scientifically integrated these, so that it refined them and formed theoretical results that were systematic and integrated, but it also focused on the pressing needs of military conflict in space, actively exploring and carefully demonstrating things, thus creating theoretical precedents in the science of space operations, and it had milestone significance in the developmental process of space operations. Therefore, the science of space operations has combined theoretical innovations with academic innovation into one; this is a groundbreaking discipline that fills blanks in military theory. To be sure, it will be hard to avoid some immaturities in the science of space operations, as a newborn thing, but it has exuberant vitality, and as long as it has meticulous nurturing, it will inevitably gradually stride toward maturity.

2. Penetration

As a completely new form of operations, space operations are daily becoming fused into informationized operations, they are being combined and used with other forms of operations, linked together overall, and with their abilities improved and made more effective, thus bringing into play their increasingly important role. The extension of space operations to other forms of operations has resulted in the science of space operations penetrating other corresponding disciplines. The science of space operations not only needs to study the theories within the system of space operations, such as [the theories of] command, organizational systems, actions, and support, but it also needs to study the theories of command, organizational systems, actions, and support when space operations are combined and used with the other forms of operations, in order to meet the needs of fusing space operations into joint operations actions, and thus having the science of space operations exhibit fairly strong penetration.

3. A composite nature

Space operations are operational practices that touch on very broad areas and that require theoretical knowledge in many aspects as their support. As a refinement of space operations practices and experiences and a summary of theoretical knowledge, the science of space operations has a fairly strong composite nature. Not only does it have details from social sciences, but it also has elements of natural science. For example, space operations' operations technology and the quantified evaluation of the results of operations touch on the theories and methods of natural sciences; not only are the theories and methods of military history and military philosophy used to explain the laws of space operations, but the theories and methods of the science of strategy, the science of military logistics, and the science of operational command are used to study the command of space operations. [Also,] not only are the theories and methods of military geography, the science of the operational environment, and the science of military spaceflight used to study the operational environment, but the theories and methods of military management and military logistics are used to study support for space operations. These fully show that the science of space operations incorporates the theoretical knowledge of a number of disciplines and that it has a very strong composite nature.

4. Openness

The science of space operations' adaptation to dynamic developments in space operations and its organic interaction with other disciplines and results evince its characteristic of openness; it continually draws fresh nourishment from the practices of space operations, from other disciplines, and from foreign military's theories and practices, in order to enrich and develop the theory of space operations. The rapid development of space operations technology and the continual advances in the practices of space operations have caused activities in space operations to always be dynamically developing and to continually provide the science of space operations with a source of practices for innovative development. Updates to and developments in the theories of other, relevant disciplines have enabled the science of space operations to draw nourishment from them, to be digested and transformed into details of the science of space operations, and it is possible [for the science of space operations] to learn beneficial study methods from them. Beneficial experiences and advanced theories of foreign militaries' space operations have enabled the science of space operations to continually absorb valuable theoretical results. At the same time, the tendency in the science of space operations to be highly composite and to differentiate things will, on the one hand, impel people to have a more systematic and more in-depth overall knowledge of space operations, while on the other hand it will impel people to have more concrete and more professional studies of the branch areas of space operations, and the branch disciplines will be incrementally generated and continually added to. Thus, openness and drawing upon everyone's strong points has resulted in the science of space operations being always placed in a process of continual enrichment and improvement.

III. The system of theories of the science of space operations...19

One of the important marks of the existence of an independent discipline is that it has a complete system of theories. This system of theories usually consists of certain interrelated theory units, in accordance with a certain logical structure; these comprehensively reflect the essential characteristics of the target of study and cover all the details in the sphere of study. The system of theories in the science of space operations differentiates the basic details in the science of space operations in accordance with the knowledge structure made by their properties and innate relationships, in addition to which it arranges and combines by category the structure of systems and levels that is formed. Based on the targets of study in the science of space operations and the particularities of their details, it is possible to differentiate the system of theories of the science of space operations into three levels: basic theory, applied theory, and technical theory.

1. Basic theory

Basic theory in space operations is theory that involves the basic laws of space operations and the basic laws for guiding [these operations]. Its primary details include the targets, tasks, details, and methods of study in the science of space operations; the generation and development of space operations; the space operations environment; space operations strengths; space operations weapons and equipment; the guiding principles of space operations; command and control of space operations; combat methods in space operations; support for space operations; resource management for space operations; evaluation of the results of space operations; education and training for space operations; mobilization for space operations; the rules for space operations; and political work for space operations.

An in-depth study of the basic theory of space operations can fully recognize the phenomenon and form of this objective thing [that is] space operations; reveal the essential factors of its existence, its main contradictions, and its developmental laws; and thus form an extremely basic and comprehensive rational knowledge of space operations. Because what basic theory in space operations seeks for and reflects is the phenomena and laws that universally exist in the practices of space operations, and [because] it requires the manifestation of ordinarily principles related to space operations, in an accurate, complete, and in-depth manner, basic theory therefore has a high degree of abstractness and relative stability, and it has an important guiding role for applied theory and technical theory in space operations.

2. Applied theory

Applied theory in space operations turns basic theory into something concrete, in regard to the characteristics, laws, and laws for guiding space operations under differing types, differing levels, differing forms, and differing conditions of operations, and it directly guides the actions of space operations. Its primary contents include space operations theory for joint firepower attacks, space operations theory for joint blockade campaigns, space operations theory for joint island offensive campaigns, space operations theory for joint border counterattack campaigns, and space operations theory for joint anti-space raid campaigns.

An in-depth study of the applied theory of space operations can reveal laws that unify subjective guidance with objective reality in the process of space operations, forming a complete set of guiding tenets and measures for enhancing the benefits of operations and buildup, and thus closely combining theory and reality and better guiding space operations and their buildup. Because what applied theory in space operations studies and resolves is laws for guidance and methods of implementation that have a common nature in the practices of space operations and their buildup, with a focus on resolving current and developing actual problems, applied theory in space operations therefore has a clear purposefulness, a scientific predictability, a sharp relevance, and very strong operability.

3. Technical theory

Technical theory in space operations is the overall mechanisms and overall developmental laws related to space operations technology, with a focus on studying the principles and methods of the formation, use, building, and development of space operations technology, and it plays the role of a technical prop and assistance and support for space operations basic theory and applied theory. Its main contents include two parts: basic technology for space operations and applied technology for space operations.

The basic technology for space operations primarily includes: spacecraft technology, technology for the use and control of spacecraft, applied technology for spacecraft, technology for space launch vehicles, launch technology for spacecraft, space tracking technology, and manned spaceflight technology.

The applied technology for space operations primarily includes technology that is applied to carrying out and supporting space offensive and defensive operations, such as delivery into space, perception of the space situation, offensive space attack and defense, and defensive space attack and defense. Of these, offensive space attack and defense technology includes space weapons technology (including space weapons platforms technology and space weapons payload technology), anti-satellite technology (nuclear-powered anti-satellite technology, kinetic energy anti-satellite technology, laser anti-satellite technology, microwave anti-satellite technology, particle beam anti-satellite technology, direct ascent-type intercept technology, and rail-type intercept technology), space information confrontation technology, soft-kill technology, and hard-kill technology; defensive space attack and defense technology includes satellite-borne false target technology, spacecraft protection reinforcement technology, orbital movement technology, and rapid reconstruction technology.

IV. The relationship between the science of space operations and other disciplines...21

The science of space operations is not an isolated discipline; rather, it exists within the grand system of all military science, and it and the other disciplines in military science and even in natural science and social science affect one another, penetrate one another, and restrict one another, and [together] they continually advance forward. The study of the relationship between the science of space operations and related disciplines helps to clarify the position that the science of space operations holds within all of military science as well as the role that it plays there, and to have a clear idea of the impact that theories from relevant disciplines have on the science of space operations.

1. The relationships with the science of strategy, the science of campaigns, and the science of tactics

Space operations permeate each level of strategy, campaigns, and tactics; the science of space operations penetrates the sciences of strategy, campaigns, and tactics, while the sciences of strategy, campaigns, and tactics are reflected in the science of space operations. The science of strategy is science that relates to the overall war situation; it studies macroscopic issues in military theory, and it affects and restricts the building and development of other military disciplines. The science of strategy and the science of space operations form a relationship of guiding and being guided. The science of strategy provides the study of the science of space operations with a theoretical foundation that [covers] the entire situation and that is high-level, and brings into play the role of macroscopic guidance; the science of space operations determines the direction and tasks of relevant studies for its own discipline, based on the overall requirements of the academic theories of the science of strategy, thus deepening the theoretical studies of its own discipline and better serving the preparations for and execution of space operations.

Developments in the theory and practices of space operations will also further enrich the theories on military conflict and armed forces building in the science of strategy, thus promoting the development of academic theory in the science of strategy. The science of campaign and the science of tactics are disciplines affecting the laws of campaigns and combats and the laws for guiding these. The science of space operations is closely related to the science of campaigns and the science of tactics; they affect one another and supplement each other. On the one hand, changes and developments in the theories of campaigns and tactics directly affect and promote changes and developments in theories of space campaigns, filling out and improving the science of space operations; on the other hand, the theoretical results of the science of space operations and especially the results of combat methods that are generated in the practices of space operations, can enrich the theories of campaigns and tactics, and promote their further development.

2. The relationships with the science of joint operations, the science of operational command, and the science of the operational environment

The science of joint operations is the discipline that studies the laws of joint operations and the laws for guiding [joint operations]. The science of joint operations and the science of space operations respectively have joint operations and space operations as the targets of their studies. As regards their forms and methods, joint operations and space operations have similarities, and in looking at them in a certain sense, joint operations include space operations, while space operations reflect joint operations in a special form. Therefore, there is a clear overlap between the science of space operations and the science of joint operations, and the two can learn from each other, interact, and develop in a synchronized manner.

The science of operational command is the discipline that studies the laws of operational command and the practices that guide operational command. The science of operational command uses command activities for operations as the target of its studies in order to reveal the general laws for operational command, to explore and point out directions for theoretical studies and practices by space operations commanders and command organs, and to promote the development of command theory and practices for space operations, and the results of the command theory and practices in space operations also continually enrich and develop the theory of operational command.

The science of the operational environment is the discipline that studies the laws of the operational environment, which guides people in carrying out operational practices within differing environments. The science of the operational environment primarily studies the effect that the environment has on operational actions and guides people to correctly understand, master, and use various types of objective environments, in order to enhance the effectiveness of operations. The science of the operational environment is the study and revelation of the essence, characteristics, and laws of the environment, and it has a definite role in drawing lessons through theoretical studies of the space operations environment; the results of theoretical studies by the science of space operations of its special operational environment also will enrich and improve the science of the operational environment.

3. The relationships with the science of military information, the science of military spaceflight, the science of armed forces building, and the science of military equipment

The science of military information is the discipline that studies the laws of military information and the laws for using [this information], and that guides the military information building and its uses in actual combat. Looking at the details of this study, the science of military information merges with the details of the science of space operations, and they influence each other; moreover, there exists to a certain extent a relationship where they guide and are guided by [each other]. The science of military information has a universal significance for guiding the results of theoretical studies of the essence, characteristics, and laws of military information and of other disciplines, including the science of space operations, as well as value as something to learn from. The science of space operations has an important role in enriching and developing the results of studies of the essence, characteristics, and laws of space information and for theoretical studies of the science of military information.

The science of military spaceflight is the overall discipline that studies the laws of military spaceflight activities and that guides the buildup and use of military spaceflight strengths. The details that the science of military spaceflight studies primarily include the basis of space technology, space strengths, and operations; it forms a relationship with the science of space operations, where it includes [the science of space operations] and is included by it. Looking at it in general, the science of space operations basically overlaps with the theory of the use of spaceflight strengths within the science of military spaceflight. The results of theoretical studies of the science of military spaceflight have an important value in guiding the science of space operations and as a reference, while the results of theoretical studies of the science of space operations have a positive significance for enriching and developing the science of military spaceflight.

The science of armed forces building is the discipline that studies the laws for armed forces building and the laws for guiding [this buildup], and it is an up-and-coming discipline that has taken shape in order to meet the needs of the constant developments in military practices and the overall improvements in military science. The science of armed forces building resulted from studying the essence and characteristics of the armed forces building, and it has a role as something to learn from in the building of space operations strengths; the general laws for the armed forces building and the laws for guiding it that the science of armed forces building reveals has a role in guiding the theory of the building of space operations. The results of theoretical studies in the science of space operations has added new connotations for the science of armed forces building, and in particular, the theoretical results in the area of the building of space strengths will enrich and improve the theory of the armed forces building.

The science of military equipment is the discipline that studies the laws of military equipment's activities and the laws for guiding military equipment's work. Military equipment is the physical basis for space operations, and space operations are operational activities, under corresponding conditions of space military equipment, that people who have mastered this equipment carry out. The ordinary laws of military equipment activities and the laws for guiding the work of this equipment that are revealed by the science of military equipment have the role of guiding equipment activities and the work of equipment in space operations. The study results of the science of space operations regarding the special laws of equipment activities in space operations and regarding the special laws for guiding the equipment's work will promote enhancements and improvements in the theory of military equipment and enrich the theoretical contents of the science of military equipment.

In summary, as a comprehensive discipline, the science of space operations has a very close relationship with a great number of other military disciplines. Only by clearly recognizing the interrelationships among these various disciplines and by actively absorbing the academic nutrients of other military disciplines is it possible to continually enrich, improve, and ultimately form a system of theories of space operations that has the characteristics of the age.

Section 3: The Significance of the Creation of the Science of Space Operations, and Its Principles and Methods of Research...23

The science of space operations is a new discipline in the system of theories of military science. In order to ensure its healthy development and its moves toward maturity, it is necessary to accurately understand the major significance of the creation of the discipline and the important strategic position that it holds, to strengthen the sense of mission and sense of urgency in studying it, to have a grasp on the correct direction for studying it, to master scientific methods of study, to comprehensively improve the ability to study it, to better explore the laws of space operations and the laws for guiding space operations, and to continually deepen the study of the theory of space operations.

I. The major significance of the creation of the science of space operations...23

Currently, the struggle that the major world powers have launched centered around dominance over space is increasingly intense, and they are all actively launching studies into the theory of space operations, energetically strengthening the building of space operations capabilities, and forming a new situation where they are trying to catch up with one another and competing for development. Given this kind of background, the creation of the science of space operations has a very major real significance and an important theoretical value.

1. It is a requirement for guiding the practices of space operations

Ever since mankind entered space, the curtain centered on the struggle for domination of space has been silently drawn back, and the tendency to develop space militarization has also continually intensified, directly giving birth to space operations. How to face the ascension onto the stage of war by space operations, this "newborn child," has become an urgent and real topic that future informationized operations faces. Since entering the 21st century, the major military powers of the world, and in particular the United States, have vigorously developed space operations strengths and equipment, and the pace at which [the United States] has enhanced the ability of its space operations for actual warfare has continually accelerated, continually widening the gap of its advantages over other nations; the situation is quite compelling. First, the United States withdrew from the Anti-Ballistic Missile Treaty in 2001, clearing away an obstacle to the National Missile Defense system and to space operations, and it formally deployed a missile defense system, thus comprehensively launching its space operations plans. It proposed a new strategic plan, announced a new national policy, and on the basis of summarizing its experiences in space operations in the several recent local wars, issued a number of space operations doctrines. Moreover, through simulated war games to test and improve its space operations theories, it strengthened the building of its space troops and actively invested huge funds in the research of space technology and equipment, putting these into material preparations for space operations. In the Information Age, victory or defeat in space operations has already become a decisive factor in the success or failure of warfare. If you want to be put in an unbeatable position in future wars and to win victory in space operations under informationized conditions, it will be necessary to strengthen your preparations for space operations and to comprehensively increase the abilities of your space operations. Therefore, the creation of the science of space operations in order to guide the buildup and use of space operations strengths, has become the only option in the development of space operations.

2. It is a requirement for improving and developing the theory of military science

Military science is a system of theories that is developing and is open; in general, it has continually developed alongside the development of science and technology and war practices. With the rapid development and in-depth use of space technology, the creation of a new and flourishing discipline that corresponds to the status and role of space operations in informationized warfare – the science of space operations – has become an urgent matter in the improvement and development of military science. First, the development of space technology and means has laid an objective foundation for the development of the discipline of space operations. The history of mankind's research of military science has shown that the establishment of any new and flourishing discipline must have the development of science and technology and means of operations as its basis. For example, the theory and discipline of air force operations were created only when air propulsion technology and combat aircraft had been developed, and the theory and discipline of nuclear warfare were created only with the development of modern nuclear technology and nuclear weapons. Today, the increasingly advanced technology and means of space have laid a firm foundation for the creation of the discipline of space operations. Second, the emergence and use of forms of space operations have levied pressing requirements on the discipline of space operations. In the local wars since the Gulf War, space operations have quietly mounted the stage of warfare, and have increasingly highlighted and displayed their enormous power, becoming an important form and action in informationized warfare; this has urgently required the creation of a military discipline corresponding to this that would provide it with a theoretical brace. Third, the creation of the discipline of space operations is an inevitable trend in the development of the system of military sciences. The system of theories for military science has had to undergo a process of incremental development and continual improvement. In this process of development and improvement, the existing system of military science theory is clearly lagging, in comparison with the rapidly developing technology of space operations and its forms of operations. If the system of the discipline of space operations is not added to the system [of military sciences theories], there will be no way to adapt to the needs of the development of informationized warfare, and it will also be difficult to form a complete system of military science theories.

3. It is an actual requirement for forging the ranks of space operations persons of talent

In operations under informationized conditions, how high or low the ability of space operations is determines how great the possibility for winning victory in war is. In these abilities, people are the core key factor. Therefore, building up the ranks of people of talent has become an important detail for the world's military powers as they strengthen the building of their space operations capabilities. If the scale and quality of space operations weapons and equipment is insufficient, these can be quickly developed within a short period of time, but if there is a serious lack of scientific and technological and military people of talent or if their overall quality is low, it will be very difficult to improve the abilities of space operations, and the gap that appears in this sphere will continually grow. In order to raise the abilities of space operations overall and to fully have the ability to win a future informationized war, it is necessary to incorporate the buildup of the ranks of space operations persons of talent into the new model of operational strengths, with a focus on their buildup and speeding up their development. Speaking basically, space operations are a high-end game of space operations persons of talent. Without a large batch of high-quality space operations persons of talent, it is impossible to have effective mastery of space operations weapons and equipment and to innovate combat methods in space operations in a timely manner, and it will also be very difficult to win victory in future space operations. Strengthening the buildup of space operations persons of talent inevitably requires launching studies into the theory of space operations, introducing a group of teaching materials on theory as represented by the science of space operations, giving shape to the discipline of space operations, and supporting the teaching of space operations theory. Currently, although there have been a number of results in studies on space operations theory, these are not systematic enough, and they have yet to form a complete system of space operations theory. Against this background, creating the science of space operations appears to be particularly urgent.

II. Principles of study in the science of space operations...25

As a groundbreaking theoretical discipline, the science of space operations not only needs to summarize and refine the theories and practices of space operations that it already has, but even more, it needs to combine these with what is real, so as to serve actual combat, and to correctly lead and guide theoretical studies and practical explorations in space operations. This places very heavy demands on the issue of studying space operations, and requires continually holding to the principles of holism, practicality, innovation, and rolling along with things.

1. The principle of holism

The principle of holism means keeping an eye on forming and completing systems of theories of space operations systems; proceeding from the overall situation, it not only carries out in-depth analysis of each part and each link in space operations, but it also carries out a systematic integration of the relations among the various parts and the various links. As theoretical knowledge of the systems of space operations, the science of space operations covers every aspect of space operations, from operations to support, from technology to tactics, from equipment to persons of talent, and from building up to use; it involves each level, from strategy to campaigns to tactics, and from setups to systems to key factors, and it is linked to a great amount of academic knowledge, such as the science of joint operations, the science of operational command, the science of military spaceflight, and the knowledge of information operations . Therefore, in the process of studying the science of space operations, it is necessary to hold fast to the principle of holism. In holding to this principle, it is necessary on the one hand to widely collect the results of relevant theoretical studies of space operations and practical explorations, in order to come to an understanding of the entire system of space operations; on the other hand, it is necessary to hold to an epistemological viewpoint, to adopt the method of overall analysis, and on the basis of in-depth analysis of each aspect and each link in space operations, to carry out systematic study and to strive to reveal the complete picture of space operations.

2. The principle of practicality

The principle of practicality means focusing on effective service to the development of space operations, with pragmatism as the criteria, in order to launch studies into space operations. Putting studies to use is a basic requirement in theoretical studies. Only by originating from practice, by serving practice, by being tested by practice, and by enriching practice, can any theoretical studies truly manifest their value and have a vigorous vitality. As a systematic theory that guides practices in space operations, the science of space operations must be close to practices and must strive to be pragmatic. Moreover, as a newborn thing, space operations' need for theoretical guidance by truly effective theory is particularly urgent. Given this background, studies in the theory of space operation have an even greater need to hold fast to the principle of practicality. In holding to this principle, it is necessary on the one hand to have an understanding and grasp of how foreign militaries' space operations are developing, in a comprehensive, systematic, and accurate manner, and to analyze and summarize their experience and lessons, and thus propose valuable theoretical viewpoints; on the other hand, it is necessary to go deep into the practices of space operations, and to combine these with reality, to pinpoint heavy difficulties in space operations, and to propose countermeasures that are truly effective.

3. The principle of innovation

The principle of innovation means focusing on developments in space operations that leap ahead, combining these with the specific requirements of operations, daring to break past results that have already been studied, and creating and forming a system of theories of space operations that have their own characteristics. The new characteristics of space operations have determined that theoretical studies of space operations must have innovation. In particular, the militaries of countries whose space operations started late, whose foundation is weak, whose scale is small, and whose abilities are weak, and that develop step by step in a way that follows after [those that are more advanced] will find it difficult to gain the initiative in space operations; they must exert themselves to bring into play the advantages of being the ones who are behind, and develop in a way where they leap ahead. For this reason, it is first necessary to dare to make breakthroughs in theoretical studies, and to continually use "new tactics," "unusual tactics," and "deadly tactics," thus forming theories that have their own characteristics and can effectively guide space operations, in order to guide the practices of space operations to develop in an extraordinary manner. In holding fast to this principle, it is necessary on the one hand to conscientiously study the current state of developments in space operations in today's world, in particular the strong points and weak points of the space operations of the main opponent in operations, and in accordance with the thinking of asymmetrical development, to propose relevant countermeasures; on the other hand, it is necessary to actively use advanced means of simulation technology in order to launch probes into practices in space operations that are done in advance, and to propose, test, and improve new theoretical viewpoints.

4. The principle of rolling along with things

The principle of rolling along with things means closely following developments in practices in space operations and continually enriching and improving the theory of space operations. Dialectical materialism believes that all things are perpetually in the midst of constant movement and changes, and that the laws for the movement of things and the laws for guiding [this movement] also must be constantly enriched and developed. Given that space operations are a completely new form of operations that has appeared under informationized conditions, their role is highlighted and their development is rapid, and the concomitant science of space operations has also became a new and flourishing discipline, which requires constant enrichment and development in its practices. Therefore, the study of the science of space operations requires holding fast to the principle of rolling along with things. Holding to this principle requires, on the one hand, closely following the newest dynamics in the development of space operations and combining this with your own realities in the development of space operations, thus finding and studying new issues and proposing new theories; on the other hand, it is necessary to systematically comb through, screen, and combine new theoretical results that are continually studied and proposed, and to supplement and improve the system of theories of space operations in a timely manner.

III. Study methods for the science of space operations...27

In the process of studying the science of space operations, it is necessary to hold fast to the methodology of historical materialism and dialectical materialism, and to adopt forms where theory is combined with practice and where quality is combined with quantity. Commonly used methods primarily consist of the systematic study method, the method of studying examples of battles, the comparative study method, the method of learning from others' theories, the simulation testing method, and the exercise and testing method.

1. The systematic study method

The science of space operations comes under the science of operations, it is restrained by and led by the science of strategy and the science of joint operations, and it is closely connected to other disciplines. Therefore, it is necessary to proceed overall from military science, to look at the overall situation, to penetrate from above downwards, and to carry out systematized study; the science of space operations cannot be studied in isolation. At the same time, given that the science of space operations is an independent discipline with a complete system, its various internal knowledge units are closely connected. In studying the science of space operations, it is also necessary to proceed in a holistic manner from the science of space operations, to use the method of systems theory, and to study the various parts in this system and their interrelationships, as well as their relations with external factors. These kinds of relations are regular. Even if you are studying a given specific issue in studying the science of space operations, you should also observe and study this issue within the grand system that is the science of space operations, before you are able to stand at a higher level and grasp the specific issue macroscopically, and to thus avoid studies that are one-sided, isolated, and dispersed.

2. The method of studying examples of battles

What is referred to as the method of studying examples of battles is the method of study that finds particular patterns in differing operations that have occurred in the past, by analyzing and studying their practices, and then afterwards abstracting general laws from out of these particular patterns. The 19th century capitalist military theoretician [Antoine-Henri] Jomini said, "The only rational basis in the theory of all skills in warfare is the study of history." Napoleon [Bonaparte] pointed out that a qualified military commander must conscientiously study eighty-three wars commanded by seven famous commanders-in-chief, such as Alexander, Hannibal, and [Julius] Caesar. In this way, he can write these into a complete study guide for the art of operations. Studying the science of space operations is no exception; in the same way, it requires using the method of analyzing examples of battles in order to systematically study the evolution and development of space operations as well as famous examples of battles, thus understanding and getting a grasp on the basic laws of space operations. When studying examples of battles, it is necessary to pay attention to using modern and advanced theory and methods, and to consider these from many angles and many levels, so as to seek to see what people of old did not see. However, any experience will have certain limitations, and it is necessary to follow the principle where what has been inherited from the past is united with innovation, and to combine this with the realities of units' organizational structure and equipment, in order to actively and courageously search for new theories; you cannot obsess over successful experiences of the past, but must always maintain a flourishing vitality in the science of space operations.

3. The comparative study method

Comparison is a logical method of thinking that carries out a comparative analysis of a given category of things, in order to determine the points of difference between things or their points in common. By using the comparative method in the study of the theory of space operations, it is possible to open up your field of vision through comparison. By means of an in-depth study of the theory of space operations, it is possible to seek a path for the development of space operations as well as future trends, through scanning history, and it is possible to reveal the objective laws of space operations and the laws for guiding these, against a broader strategic background. In using the comparative method to study the theory of space operations, the first thing is to carry out a horizontal comparison. For example, compare such key factors within the same period of time as the various countries' space operations weapons and equipment, their space operations exercises, their space operations combat methods, and their ability to guide space operations. The second thing is to carry out a vertical comparison. That is, launch a dynamic comparison of the same key factor in space operations in accordance with vertical sections of a time sequence. For example, when studying combat methods of space operations, you can reveal the laws of development of space operations combat methods by carrying out a vertical comparison of the combat methods that were used in the local wars that have taken place in the 20^{th} and 21^{st} centuries. The third thing is to carry out qualitative and quantitative comparisons. For example, when analyzing the space operations capabilities of the two hostile sides, it is not only necessary to quantitatively compare the various key factors that compose space operations, in order to accurately judge the differences in their numbers, but it is also necessary to carry out a qualitative analysis of their space operations capabilities, and to fully consider the many factors that cannot be quantitatively calculated, including the human factor, so as to reach accurate conclusions.

4. The method of learning from others' theories

What is referred to as the method of learning from others' theories is a method of study that learns from the beneficial parts of foreign militaries' theories of operations and of other neighboring or related disciplines, through studying and researching the details of [these theories], in order to enrich and improve the theory of space operations. Militaries are divided up according to countries, and the practices of space operations are differentiated by region or level, but the essence of space operations does not change because of this; this has also determined that the space operations theories of the various countries' militaries have identical or similar details. The advanced theories of space operations of foreign militaries have quite important roles in elevating the starting points for studies in their own countries' space operations theories and for speeding up innovations in their space operations theories. Therefore, in studying the science of space operations, you should pay attention to absorbing the quintessence of foreign militaries' space operations theories, in order to enrich and improve the PRC military's system of theories in the science of space operations. At the same time, although related and neighboring disciplines differ as regards their spheres of study, still, they in essence investigate the characteristics of operational practices from differing angles or aspects, and to a certain extent they reflect the essence and basic laws of operations, so that they play a certain positive role in studying the theory of the science of space operations. Of course, studying and learning from foreign militaries' theories of space operations and from the theories of neighboring and related disciplines must firmly hold to a Marxist position; use historical, comprehensive, and developmental viewpoints; and proceed from reality, learning from these and absorbing them with an attitude of seeking truth from facts and of discarding [what is not applicable].

5. The simulation testing method

What is referred to as the simulation testing method is a method of study that comprehensively utilizes such modern information technology means as distributed interactive modeling technology, virtual reality technology, and artificial intelligence technology to study the theory of space operations. By using this method, it is possible to merge generalizations of historical experiences and predictions of the future into one, and to combine qualitative analysis with quantitative analysis and [combine] analytic calculation with process simulation; moreover, it is also possible to create lifelike operational environments and battle laboratories that are close to actual warfare, through synthetic dynamic artificial simulated battlefields, so that the results of theoretical studies will be in even greater accord with the needs of actual warfare. Currently, the use of the simulation test method to study information operations theory primarily should do a good job of evaluating the effectiveness of space operations weapons systems, evaluating the effectiveness of space operations actions, and studying and using space operations simulations and emulations as well as intelligent decision-making systems. For example, when evaluating the effectiveness of space operations actions, it is possible to use computer systems to describe space operations strengths and plans of actions, and to carry out scientific calculations about the effectiveness of operational actions, and it is possible to use emulation technology to simulate battlefield environments and space operations actions in a lifelike manner, thus providing a support platform for evaluating the effectiveness of space operations. Through evaluations of space operations plans of action, [it is possible] to find problems and to seek methods for resolving [these problems], in order to further improve programs and plans for space operations actions.

6. The exercise and testing method

What is referred to as the exercise and testing method is a method that examines and tests the accuracy of space operations theory, through purposeful and planned practical activities for exercises, and that gets experiences and data that are similar to actual combat. Mature operational theory, forms and methods of using weapons and equipment, and ways to generate combat forces and bring their role into play, must all undergo corresponding practical activities in order to test their scientific nature and rationality. In particular, the applied theory part of the system of space operations theory must undergo practical activities that are basically consistent with corresponding subjective and objective conditions before it is possible to fairly accurately test the differences between [theories] and actual operations, in order to further improve and implement them. Although space operations practices are used to test corresponding theories, and their results are the most real, still, because the costs are too expensive and they are not controlled by subjective will, they do not help in studying and investigating the theory of space operations. Space operations exercises can overcome these shortcomings in an effective manner. Not only do they not require a fairly large investment, but they can also simulate the effectiveness of actual space operations, and thus they make it possible to test the newest results of studies of space operations theory, and they are one of the important methods for studying the science of space operations in peacetime.

Questions for Deliberation…30

1. What is the impact of space operations on modern warfare?

2. Describe the important significance of the establishment of the science of space operations.

3. Describe the system of theories of the science of space operations.

4. Describe the major characteristics of the science of space operations.

This page intentionallyleft blank.

Lecture 2
Characteristics, Guiding Thought, and Basic Principles of Space Operations...31

Characteristics are an external reflection of essence. Revealing the main characteristics of space operations is very important for an in-depth study of the essence of space operations and for exploring the general laws of space operations. And the guiding thought and principles of space operations are a product where subjective guidance of space operations abides by the objective laws of space operations and fully brings its dynamism into play, they are rational knowledge overall of the guiding laws for space operations, and they are the basic foundation and principles for preparing for and carrying out space operations. Studying the characteristics of space operations and establishing correct guiding thought and principles have an important significance for enriching the theory of space operations and for guiding the practices of space operations.

Section 1: The Main Characteristics of Space Operations...31

Space operations are a completely new form of operations, established on the basis of the high levels to which military space technology has developed. Their special battlefield situation, battlefield environment, weapons and equipment, forms of operations, and special operational goals give them distinct characteristics that differ from other forms of operations.

I. Battlefield spaces are broad, and confrontation is intense...31

Battlefield spaces of space operations refers to the spaces in which the two hostile sides engage in space operations activities. Space battlefields, in the narrow sense, are a hollow sphere whose lower interface is 100 kilometers above the surface of the earth and whose upper interface is 930,000 kilometers above the center of the earth; this is also called outer space. Space battlefields in the broad sense also include the atmospheric and land (or sea) areas and information spaces that are required for engaging in space operations activities. The battlefield spaces of space operations, compared to operations on land, at sea, and in the air, have a broader scope and a more intense level of confrontation.

Based on the current state and trends in the development of human space technology, as well as the distribution of orbits for military spacecraft, space operations platforms and their weapons and equipment will primarily be deployed and used in outer space, now and for a fairly long period of time in the future, and operational actions also will be launched centered on the control and use of this space; at the same time, [space operations] will deprive the opponent of freedom of action in this space, or weaken [this freedom]. Therefore, given that outer space is the main battlefield in space operations, the two hostile sides will inevitably make comprehensive use of both soft and hard means of attack to directly engage in offensive and defensive confrontations in space. The level of confrontation will be quite intense.

In space operations, the outer space battlefield will be closely linked to the traditional land and sea battlefields, by means of the atmosphere. It will be easy for space operations platforms to be intercepted and attacked by the opponent's space offensive weapons when transiting the atmosphere, and it will also be easy for radar, imaging, reconnaissance and other devices to be jammed and deceived by airborne radar jammers and fake targets. Therefore, given that the atmosphere will be an important channel for space operations and at the same time an important battlefield for engaging in space operations, the two hostile sides inevitably will adopt means for engaging in confrontations in order to ensure that their own side's passage through the atmosphere is secure and unimpeded.

The ground is the basic support for engaging in space operations, and it plays a crucially important role in the overall system of operations. The command and control organization, launch sites, control units, and service and support units for space operations are mainly located on the earth, and destroying the opponent's space ground facilities can greatly weaken or destroy his ability for space operations. At the same time, the locations of ground bases are relatively fixed and their defensive capabilities are fairly weak, so that it is easy for them to come under various kinds of attacks. Therefore, land battlefields are key battlefields for the two hostile sides' attack and defense, and the confrontation will inevitably be quite intense.

Information has become a crucial key factor for victory in warfare, and information spaces are places that space operations will inevitably fight over. Future space operations will be mainly manifested as space information support; also, they will control various kinds of spacecraft and release operations energy from various kinds of space weapons systems, by means of control over information flow, thus enhancing the overall effectiveness of operations in space operations systems. Struggling for dominance in space information will inevitably become a focus of operational actions, and the two hostile sides will inevitably mobilize all means to cut off information links between the opponent's space and other battlefield spaces. Therefore, the two combatants' powerful struggle for space information dominance will inevitably increase the level of intensity in information confrontations.

II. Weapons and equipment technology will be highly concentrated...32

The core of weapons and equipment technology in space operations is military space technology; it is integrated systems technology that delivers unmanned or manned spacecraft into outer space and uses the spacecraft to explore, exploit, and use outer space and the earth as well as celestial bodies beyond the globe. Military space technology also can be understood as military technology for studying, designing, creating, testing, launching, using, recovering, controlling, and using space systems.

Military space technology is an important symbol of the levels of a nation's science and technology and of the power of its national economy; it represents the highest level of a nation's military-industrial and scientific and technological development. At the same time, military space technology is complex and sophisticated science and technology; it contains humanity's huge abilities for wisdom and innovation; it comprehensively utilizes the results of mankind's research over the past several hundred years into a number of areas, such as military science, astronomy, physics, chemistry, mathematics, biology, and medicine, and it also has only been able to develop with the close support of the various related disciplines. Therefore, military science technology is a highly integrated technology; it concentrates the large number of today's basic sciences and advanced and new technologies, and it touches on almost all of the newest basic sciences and technologies. Military space technology includes the world's most sophisticated and advanced technologies today, such as design and manufacturing technology for such spacecraft and space vehicles as carrier rockets, satellites, spaceships, space stations, space shuttles, and space planes; carrier rocket and spacecraft experiments, rocket guidance and control, spacecraft launches, monitoring and control and recovery technology; spacecraft information gathering and processing and space science engineering technology; and new-concept weapons technology, microelectronics technology, new materials and new energy technology, and huge intelligent computers. Its main subject areas include aerodynamics, aerospace dynamics, spacecraft manufacturing technology, space thermodynamics, the science of space materials, the science of spaceflight, space systems engineering, and management science. This thus forms a huge and complex group of advanced technologies.

As physical achievements in the military sphere of space technology, space weapons and equipment systems make integrated use of such results of advanced and new technology as information technology, space technology, new materials, new energy sources, and artificial intelligence technology; the high levels of complexity, automation, and intelligence in their structures and the intensity of the demands that they place on operational and support personnel, are things that the weapons and equipment of other battlefields, like land, sea, and air, cannot compare with. Space weapons and equipment systems consist of military spacecraft, space transportation systems, spacecraft launch and recovery systems, space monitoring and control, communications systems, and applications systems, as well as space defense systems. As the heart of space weapons and equipment, military spacecraft generally consist of structural systems, thermal control systems, power systems, orbital and attitude control systems, tracking systems, remote telemetry systems, communications systems, and data management systems, as well as dedicated payload systems. Recovery-type spacecraft also need to be equipped with recovery and landing systems, and manned spacecraft also have environmental control, life support, and emergency rescue systems. The design and manufacture of military spacecraft touch on spacecraft design and manufacturing technology; carrier rocket design and manufacturing technology; rocket and spacecraft and flight environment simulation technology; jet propulsion technology; spacecraft thermal control technology; spacecraft power technology; rocket guidance and control technology; spacecraft launch, monitoring and control, and recovery technology; space sensor, communications, and navigation technology; and space-based new-concept weapons technology, thus concentrating the culmination of today's advanced and new technology results. The United States' Apollo moon landing project mobilized more than 20,000 businesses, over 200 universities, and more than thirty scientific research organizations, with over 300,000 personnel participating; the amount of its technological content, the intensity of its reliance on science and technology, and the greatness of its technological difficulties were something that other military projects could not compare with. Therefore, space operations strengths must include a group of scientists and experts who are well-versed in and adept at space technology, and a group of command personnel and combat personnel who have undergone special fostering and training, before they can be competent at the arduous missions of space operations.

III. Operations deployment will be highly dispersed...34

Space operations strengths not only consist of offensive and defensive strengths that are deployed in outer space, but they also consist of ground strengths that are provided for supporting the smooth execution of space operations; they consist of not only space operations strengths that have an organized structure, but they also consist of civilian strengths that are temporarily requisitioned; and they consist of "hard kill" strengths as well as "soft kill" strengths. The technical and tactical performance of space operations strengths and the patterns of their use cause deployments for space operations to exhibit characteristics that integrate multiple dimensions and are highly dispersed; this is something that other services' operational strengths do not have.

Looking at the requirements for building a system of space operations, space operations consist of three tasks: awareness of the space situation, defensive space operations, and offensive space operations. Systems for awareness of the space situation consist of ground-based detection equipment, space-based detection equipment, and command and control centers; the types of weapons are divided into kinetic energy weapons, laser weapons, microwave weapons, and particle beam weapons, and the entire space system is also divided into a space section, a linking section, and a ground section. The targets for space defense are not only orbiting satellites, but they also include linking satellites {*lianlu weixing*}, earth stations, and operational personnel. Because the functions and performance of all these systems, deployed over the broad space battlefield, differ and [because] they are deployed in a dispersed manner over the space battlefield, it is only through overall integration and being merged with each other that they can form a complete system of space operations.

Looking at space spacecraft, these are distributed in many levels of orbits; most orbits are circular orbits or near-circular orbits (with an orbital eccentricity of close to zero). Circular orbits usually are divided into three major types, in accordance with their altitude: low orbits (100 kilometers to 1,000 kilometers), medium orbits (1,000 kilometers to 20,000 kilometers), and high orbits (above 20,000 kilometers). Military or dual military-civilian manned spacecraft, such as manned spaceships, space stations, space shuttles, and space planes, generally operate in low orbits, below 500 kilometers.

Looking at the disposition of space [bases] and space defense bases on the ground, the special requirements for spacecraft launches, monitoring and control and recovery, and space defense operational actions have determined that the disposition of space [bases] and space defense bases on the ground is highly dispersed; space launch sites generally are selected in inland deserts and grasslands, or in coastal areas where the geographical latitude is relatively low, where the population is sparse, that are easy to defend, and where the geology, water sources, terrain, traffic, and weather conditions are appropriate. In order to ensure that there is effective measurements and control over spacecraft during the process of their launch, during their operations in orbit, and during the retrieval of recovery-type spacecraft, a number of monitoring and control stations are set up along the route for the launch section of the spacecraft, in the navigation area of the spacecraft, and in the landing area of recovery-type spacecraft, forming a space monitoring and control network over a broad scope and even across the entire globe. The long-range early warning radar network, anti-missile, and anti-spacecraft missile launch sites for space defense units on the ground generally are deployed in in-depth echelon along the main operational direction for incoming attacks by enemy ballistic missiles and space-based weapons platforms, in order to increase the chances of discovering [these] and the number of firepower in-depth interceptions, and they are also highly dispersed.

IV. Operational actions are rapid, precise, and highly effective...35

The extremely powerful operational capabilities that space military strengths have for detection and awareness, for rapid movement, for long-range attacks, and for surprise attacks have made it possible to concentrate and release space operations' effectiveness within a very short period of time. Therefore, compared to other operations, the rhythm of space operations has clearly accelerated, and their process has clearly been shortened. At the same time, the characteristic that space operations weapons and equipment have of being informationized and their powerful destructive capabilities, as well as the diversification of the means of space operations, have determined that space operations strengths can carry out their various operational tasks in a rapid, precision, and highly effective manner.

On land, sea, and air battlefields, the speed of movement of weapons and equipment is several dozen meters or several hundred meters a second, while the speed at which shells fired by firearms fly is several hundred meters or several kilometers per second. But in space warfare, the speed at which space operations strengths move and the speed at which they are projected is greatly increased; the flight speed of spacecraft can reach several kilometers a second and the speed at which directed energy weapons and laser weapons operate reaches 300,000 kilometers a second, which respectively are an increase of several dozen times to up to 10,000 times the speed of movement and projection in the air. They can instantaneously attack targets across the entire globe. This has increased surprise in space operations to an unprecedented extent, the strategic early warning time has been shortened, and battlefield situations change in the twinkling of an eye. When engaged in space warfare, only by reacting rapidly is it possible to have a grasp on fleeting opportunities for battle. The acceleration of the rhythm of space operations has consequently led to major changes in the interrelationship between time and space. In space operations, time has shown a tendency to increase in value, and the size of national territory and strategic depths has become unimportant as a restraining factor, so that it will be hard to achieve goals by trading space for time, while using time to struggle for space will become a new strategic choice. The characteristic of speed that space operations actions have covers the entire process of real-time discovery, real-time command and control, real-time actions, and real-time evaluation and feedback. In this, real-time discovery is the precondition, real-time command and control are the key, real-time action is the core, and real-time evaluation and feedback are the basis for follow-up actions. In space operations, the space information system, which is made up of reconnaissance satellites, communications satellites, navigational satellites, weather satellites, and geodetic satellites as well as earth-based systems, can provide information support at real-time speeds for the land, sea, and air battlefields of space operations, thus meeting the requirements for real-time actions in space operations.

In addition, microelectronic technology, computer technology, and precision guidance technology are used in space equipment, and they are particularly used in new-concept weapons, promoting a great degree of digitization in weapons guidance systems and further improving the precision of attack in space operations weapons. Success in the research and development of land-based, sea-based, and airborne anti-missile and anti-spaceship weapons, as well as space weapons and equipment like space-based directed energy and kinetic energy weapons, and putting these into use, has provided a number of precise and highly effective means of firepower attack for future space operations. In the area of anti-missile and anti-spaceship operations, land-based, sea-based, airborne, and space-based anti-missile and anti-spaceship weapons can precisely intercept the opponent's ballistic missiles and various kinds of orbiting spaceships that operate in outer space, by means of direct collisions or fragmentation. Experience in operations shows that the effectiveness of attacks by space-based high-energy laser weapons against satellites and ballistic missiles is extremely clear. In the areas of attack operations from space against the earth, orbiting bombs moving in earth orbit in peacetime can quickly leave orbit and reenter the atmosphere to attack ground targets in wartime just as soon as they receive an operational command, by relying upon reverse-thrust rockets. Some orbiting bomb weapons are stockpiled on the ground in peacetime, and are launched into orbit in wartime, based on operational requirements; after entering the target area, they use reverse thrust rockets to reenter the atmosphere to attack their targets. Space-based directed energy and kinetic energy weapons, like lasers, microwaves, particle beams, and kinetic energy interceptor missiles, can carry out precise and very strong attacks from outer space against various land, sea, air, and space targets, and can quickly change their targets of attack.

V. Support missions are arduous...36

Space operations are high-tech operations where there is a great deal of investment and a great deal of consumption. The two combatants emphasize attacks against their opponent's space operations systems, and the complexity and fragility of space operations systems themselves have determined that the task of support for space operations will be quite arduous and onerous.

On the one hand, technical support for space operations is complex. Because the construction of space equipment is extraordinarily strict and complex, its technical nature is strong, the rhythm of operational actions is rapid, and the rate of battle damage is fairly large, along with the special nature of the space battlefield, these [all] make technical support extremely difficult. First, space equipment is complicated and it is quite systemic in nature, so the task of technical support is heavy. Space strengths are operational strengths in which technology is concentrated, so technical support for them involves extremely broad areas. Second, the rhythm of operational actions is rapid, so technical support is very difficult. Future space operations will be very sudden, the time will be quite short, and there will be large amounts of technical equipment and many models, with heavy technical requirements and urgent deadlines for completion; thus support will be very difficult. Third, there will be heavy battle damage in space operations, and the task of repair will be arduous. In future space operations, because of precision guidance technology, information confrontation technology, and widespread use of new-concept weapons technology, and because combat methods such as long-range assaults and precision assaults will be fully developed, the rate of battle damage to weapons and equipment will be great, and the task of emergency combat repairs will be correspondingly arduous. Fourth, the special nature of the space environment will complicate technological support conditions. Two forms of maintenance will usually be used for space equipment that has been damaged: maintenance in orbit and maintenance on the ground. As regards repairs in orbit, it will be necessary to establish technological support strengths that are extremely mobile and that can enter space at any time and carry out concomitant support for space equipment; as regards ground maintenance, it will be necessary to adopt various measures to return the damaged equipment safely, before it is possible to repair it.

On the other hand, there will be a huge consumption of operational materiel. In future space operations, there will be enormous consumption of ammunition, fuel, weapons and equipment, and articles for daily use. The confrontations between the two hostile sides will be extraordinarily intense, and this will require that the space strengths carry out continuous and high-intensity mobile operations. This inevitably will lead to an increase in the amount of energy and fuel and weapons and ammunition that is consumed; as the accuracy of hits and the destructive power of space weapons systems continually grow, this will continually increase the rate of battle damage to space strengths; because the space battlefield will be in a situation where there is a high vacuum, microgravity, and strong radiation, this will require providing personnel who directly enter space to engage in operations with large amounts of daily supplies in order to maintain their existence. At the same time, the large amounts of operational materiel that is consumed will greatly increase the payloads for space transportation. In future space operations, the key to whether operational materiel can be carried into space in a steady stream, to whether damaged weapons and equipment and operations personnel can return to the surface in a timely manner, and to whether space strengths can carry out rapid movement, lies in space transportation. The great rapidity of space operations actions and the heavy consumption of operational materiel mean that space transportation will have to be characterized by having rapid reaction, by being large in scale, and by being low-cost, before it can meet the needs of future space operations.

VI. It will be greatly affected by the natural environment...37

The natural environment of space operations refers to the natural environment in which space operations activities exist. Space operations actions involve the land, sea, air, space, and electronic battlefields, and the omni-dimensional nature of battlefield spaces has determined the complex special nature of its natural environment. Space operations will include offensive and defensive actions in outer space as well as offensive and defensive actions between outer space [on the one hand] and the air, ground, and sea [on the other]. The factors of the outer space, atmospheric, land, and sea natural environments will unavoidably affect space operations actions to differing extents.

The atmospheric natural environment has a major impact on the deployment of space strengths, on gathering and transmitting space information, and on projections by weapons. First, it is easy for the launching and recovery of spacecraft to be affected and restricted by the atmospheric environment. The atmospheric environment factor in the areas where space launch sites are located has a very great role in affecting and restricting space launch activities. The explosion of the United States' space shuttle Challenger was primarily caused by atmospheric environmental factors (low temperatures). Second, the upward and downward transmission of space monitoring and control and of space remote sensing information must go through atmospheric spaces, and when electromagnetic waves are transmitted through atmospheric spaces, they are restrained by "atmospheric windows," which results in atmospheric attenuation. Third, weapons projections in space operations must pass through the atmosphere. When carrying out anti-missile, anti-spacecraft, and space-to-earth attack operations, projections from directed energy and kinetic energy weapons must pass through the atmosphere, and they will be affected quite a bit by the atmospheric environment. For example, when lasers, microwaves, and particle beams are disseminated through atmospheric spaces, they will lose part of their energy because of atmospheric attenuation, and when kinetic energy interception shells and electromagnetic cannon shells fly through atmospheric spaces, such environmental factors as wind and air resistance will have a fairly large impact on the distance of their operations and the precision of their attacks. Land and sea natural environments will directly affect the efficiency of space operations. The visible light imaging reconnaissance equipment of photoreconnaissance satellites cannot play their role under conditions where there is the dark of night, and it is not easy for infrared imaging reconnaissance equipment to find targets that are merged into the environmental background; moreover, they cannot find targets hidden in underground fortifications. Maritime surveillance satellites' ability to reconnoiter and monitor surface ships is somewhat decreased under complex weather and sea conditions, and it is fairly hard for [these satellites] to detect submarines sailing underwater. It is hard for space-based laser weapons to attack underground and underwater targets, and the attack accuracy of kinetic energy weapons is affected quite a bit by weather factors above the land and above the sea.

VII. There are many restraining factors in the international community...38

Outer space has become a high ground that each space power in the world is struggling for, and it is now becoming the main battlefield for carrying out space operations missions. As the various countries in the world continually explore and use outer space, and with the development of space technology, there is an ever-greater number of international factors restraining military actions in outer space, and these have a comprehensive effect on space operations.

On the one hand, outer space law and bilateral or multilateral international space conventions and agreements restrict space operations actions. Outer space law comes under international law, and it regulates relations among the various countries of the world in outer space activities and stipulates the legal status of outer space and the principles, stipulations, and rules and regulations that the various countries should abide by as they engage in space exploration and as they exploit and use [space] resources. In 1958, the UN established the Committee on the Peaceful Uses of Outer Space (abbreviated as the "Outer Space Committee"), under which were set up two subcommittees, the Legal [Subcommittee] and the Scientific and Technical [Subcommittee], which were separately responsible for deliberating on and researching the legal issues related to outer space. Since the 1960s, the UN has drafted a series of principles and stipulations for outer space activities, such as the *Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space*; the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*; and the *Convention on Registration of Objects Launched into Outer Space*. These international rules have a certain active role in ensuring that the various nations' space activities are conducted in an orderly manner, and they have a certain restrictive role for future space operations. In future space operations, it is necessary to be good at using outer space law, which is a weapon of law. For this reason, it is necessary to strengthen our awareness of outer space law and to comprehensively understand and master the relevant language of outer space law, and it is necessary to actively participate in the drafting of outer space law and to strive to draft laws that will benefit ourselves and will not benefit the enemy.

On the other hand, bilateral or multilateral international space conventions and agreements also are important factors that restrain future space operations. Combined military-civilian [missions] and international cooperation have become one of the important trends in the development of the world's space enterprises. The sphere and details of international space cooperation are extremely broad; there is not only civilian space cooperation, but there is also military space cooperation, and there is not only economic and technological cooperation, but there is also political cooperation. The International Space Station that sixteen countries, including the United States, Western Europe, Russia, and Japan, have joined to construct comes under economic and technological cooperation, whereas the military satellite system that the United States, the United Kingdom, France, and other countries jointly operated in the Gulf War and the Kosovo Campaign comes under military cooperation. By following the path of international cooperation in order to develop your own space strengths, and through signing bilateral or multilateral international space conventions and agreements, it is not only possible to quickly strengthen your own space military power, but it is also possible to restrain to a certain extent your opponent's actions for attacking your own spacecraft. Therefore, it is necessary to get a correct grasp on trends in international space cooperation, to pay close attention to trends in the international cooperation that major hostile nations engage in within the sphere of space, to actively launch "space diplomacy," and to constantly expand the scope of cooperation with friendly countries in the sphere of space, so as to create a favorable international political, diplomatic, and military environment for carrying out space operations in the future.

Section 2: Guiding Thought for Space Operations...39

Guiding thought for space operations is the core guiding viewpoints that are proposed based on a conscientious and comprehensive summary of the characteristics and laws of space operations and that have the nature of orientation, of guidance, and of the overall situation; they manifest in a concentrated manner strategic thinking for organizing space operations; they are the basic foundation for planning and carrying out space operations; and they are the overall requirements that are proposed for the various strengths that participate in space operations. The level at which space operations [operate] is high, and small campaign and tactical actions could be related to major strategic issues. Therefore, the guiding thought for space operations must have the military strategic guidelines as its basis, [it must] have the world's strategic setup and the situation of military development as its background, [it must] have the overall situation of preparations for military combat as the focus of its planning, [it must] keep an eye on major strategic opponents and the realities of the world's military combats, and it must suit the characteristics and laws of space operations; at the same time, it also must take into consideration the reaction that the international community may have to space operations actions.

Under the premise of corresponding to these requirements, studying and establishing guiding thought for space operations also requires giving full consideration to your own country's developmental requirements in preparing for future military combat; in accordance with the characteristics and requirements of space operations strengths, and [it requires] adapting to the existing levels and future developmental trends of space technology, focusing on the characteristics of the battlefield environment of space operations and on possible changes, adapting to actual combat capabilities and the state of space operations weapons and equipment, and comprehensively and systematically summarizing the experiences of space operations that have already occurred in the world. Based on these myriad actual requirements, space operations in future wars should abide by the basic guiding thought of "active defense, full-spectrum integration, and a focus on control of space."

I. Basic connotations...40

Active defense refers to the thinking of preemption as regards strategy and of taking the initiative to defeat the enemy as regards campaigns and combat, and of planning for and guiding the overall situation of space operations. The nature of the guiding thought of "active defense" in space operations is "defense," while the essence is "active." Defense refers to the defensive position of space operations as regards strategy, as well as to taking a self-defense position strategically and establishing a space operations posture that resists aggression, that protects the nation's security, and that defends your own interests; its goal is to maintain the initiative politically and diplomatically. Active refers to focusing on preparations for space operations and on space offensive actions as regards campaigns and combats, and to achieving the goals of strategic defense through campaigns and combats. This is manifested as an organic combination of defense as regards strategy and of attack as regards campaigns and tactics. That is, space operations overall are defensive, but in specifics, space operations actions are not confined to defense; instead, active space offensive actions are adopted during the process of strategic defense.

Full-spectrum integration refers to the integrated joint operations of the various services and service arms that integrate space offense and defense, that integrate space information support and firepower attack actions, and that integrate means of space hard kill and soft kill, within the spaces of all the dimensions of land, sea, air, space, and electronics, and centered on the goals of space operations; [this is done] through fusing command information systems with the various key factors of operations that are related to space operations, such as reconnaissance and early warning, command and control, communications, and weapons and equipment. The guiding thought in space operations of "full-spectrum integration" in essence is joint operations of an integrated nature in which the various services and service arms jointly participate within all dimensions of space; the main way to do this is to rely upon the command information system merging each of the various key factors in operations, while the mechanism for victory is comprehensive superiority that takes shape by forming space information superiority, firepower superiority, and actions superiority.

A focus on control of space refers to the overall use of various strengths and means for space operations, and primarily for seizing command of space. The focus is on jamming, blocking, damaging, and destroying key targets in the enemy's space operations system; on damaging the enemy's system of space operations; and on greatly weakening the enemy's ability to control space. The essence of the guiding thought of "focus on control of space" in space operations is "controlling space," and the core is "control of space in a focused manner." "Focus on controlling space" primarily stresses clarifying that the ultimate objective is seizing command of space, through damaging the enemy's space operations systems and greatly weakening the enemy's ability to control space. "Focus on controlling space" primarily includes such operational actions as space deterrence, space information support, space-to-space attacks, space-to-ground attacks, and ground-to-space attacks.

The three aspects of guiding thought for space operations are a closely connected organic whole. "Active defense" is the basic requirement for space operations, and it clarifies the nature of space operations; "full-spectrum integration" is the organizational form of space operations, and it clarifies the mechanism for victory in space operations and the basic means [for victory]; and "focus on control of space" is the ultimate goal of space operations, and it clarifies the core tasks and basic combat methods for space operations.

II. The basis for establishment...41

The guiding thought for space operations, as a rational understanding of the characteristics and laws of space operations under certain historical conditions, should have a scientific theoretical basis and a firm practical foundation. The guiding thought of "active defense, full-spectrum integration, and a focus on control of space" is proposed [based on] objective realities such as having the military strategic guidelines as the outline, combining the characteristics of space operations, focusing on the current state and possible developments of space strengths, and the conditions of the main strategic opponent.

1. The thought of military theoreticians is the theoretical source of "active defense"

The 19th-century Prussian military theoretician [Carl von] Clausewitz elaborated on the thought of active defense, at the tactical level, and he proposed that active defense "is defense whose goals are passive but whose means are active," and that "it is a shield composed of clever attacks." The Swiss military theoretician of the same period, [Antoine-Henri] Jomini, pointed out that active defense “is defense that needs to carry out surprise attacks.” [Karl] Marx carried out a revolutionary transformation and development of these viewpoints, and believed that “Defensive warfare by no means excludes offensive actions that ‘the process of events in warfare’ requires being taken;” [Friedrich] Engels pointed out that “Effective defense still is active defense that is accomplished through offensive;” and [Vladimir] Lenin pointed out that “In addition to mastering the offensive, it is also necessary to master the proper retreat.” Mao Zedong pointed out that “Active defense is also called offensive defense and is also called defense that is a decisive battle” and that “It is defense [that is done] for counterattacks and for offensives.” These important ideological discourses regarding active defense provide a theoretical source for the guiding thought of space operations, and they give vitality and vigor to the thinking in space operations of active defense, thus enriching the scientific connotations of space offensive operations and space defensive operations.

2. Space strategy has determined the defensive nature of space operations

Space strategy is planning and guidance done by a country or an alliance of countries for the sphere of outer space, which is overall in nature, in such aspects as politics, economics, science and technology, and the military It is an outer space political, economic, science and technology, and military program by a nation or alliance of nations within a certain historical period, and it has a long-term, comprehensive, and profound impact on the development and military struggle of space strengths. In the area of space strategy, the world has always advocated the peaceful use of outer space, opposed militarization of outer space, and prevented an arms race in outer space. Although the United States has ignored opposition from the international community and held to policies that deploy missile defense systems in order to control space, thus forming a comprehensive space threat against the various countries of the world, still, peace-loving countries have all consistently pursued a defensive-type space strategy that suits their own national situations and military situations, and have strongly opposed the United States’ policies for militarizing space. In order to break the United States’ monopoly on outer space, the various countries have actively and steadily promoted development of outer space strategies, and have treated active defense as the basic guide in developing their construction of outer space. Space operations strengths are an operational strength that is strategic in nature, and their use affects the entire situation. The United States and other military powers stress that an attack by any nation against their space systems is equivalent to launching a nuclear war. Based on these circumstances, when using space strengths, it will be necessary to stand at the vantage point of strategy and to comprehensively consider the various political, diplomatic, economic, and military factors, in order to make decisions cautiously and to strive not to “fire the first shot” at the strategic level. This kind of outer space strategy has determined that space operations will be defensive in nature.

3. The characteristics of the use and actions of space operations strengths have determined that they will be “full-spectrum integration”

The scope of the battlefield spaces of future space operations will cover the spaces of all the dimensions of land, sea, air, space, and electronics, and their operational actions will unfold in an integrated manner in the spaces of all these dimensions, so they will be full-spectrum integrated actions for joint operations. Space operations not only stress the integrated use of military with civilian and commercial spaces, but they also stress approaches where the use of space operations strengths is integrated with land, sea, and air operations strengths; [where there is] compatibility of science and technology; [where there is] heavy reliance by high-tech warfare on space information systems; and [where there is] an expansion of the use of civilian and commercial space strengths to participate in and support space operations. Because the number and scale of military space strengths are limited, and the development of civilian and commercial space strengths is quite rapid, therefore, only by adopting necessary measures is it possible to have these meet the needs of space operations. In future space operations, some civilian and commercial space strengths will become an important auxiliary strength. On the other hand, the integrated launch of space operations actions with other operational actions in the spaces of all dimensions has the typical characteristics of integrated joint operations’ actions. Space operations actions require that other operational actions cooperate with them to carry out operational tasks, and other operational tasks are inseparable from the support and cooperation of space operations actions. Space operations actions will be important actions in future space operations actions, and they will primarily involve collecting, transmitting, and processing space information and [involve] using space weapons against enemy space, air, sea, and land targets as they carry out attack missions. And in order to ensure that space operations are smoothly carried out, it will be necessary for land, sea, air, and other operational strengths to coordinate with space operations actions in destroying and damaging the surface installations of the enemy’s space operations systems; in jamming, deceiving, and suppressing the enemy’s space-surface data links; and in protecting the surface installations of your own space operations systems. Therefore, “full-spectrum integration” is something that is determined by the characteristics of the use and actions of space operations strengths.

4. The development of command information systems has laid a material foundation for "full-spectrum integration"

The possible developments of command information systems will lay an important material foundation for merging with the various key factors of operations that are related to space operations, such as reconnaissance and early warning, command and control, communications, and weapons and equipment, in order to carry out integrated joint operations of the various services and service arms that integrate space offense and defense, that integrate space information support with firepower attack actions, and that integrate means of space hard kills and soft kills. By relying on the networkization of space information links and on making space attack platforms intelligent, space information systems and space weapons systems will become important nodes in the reconnaissance intelligence and monitoring systems and attack systems within the operations system, and they will be further merged with command and control systems and with computer network systems, thus forming a command information system whose functions are more complete. Given the "multiplier" effect of space information systems, as the functions of command information systems are continually improved, they will form informationized operations systems that integrate the functions of command and control, communications, intelligence, monitoring, reconnaissance, and attack; they will strengthen the merging of space operations strengths with the operations functions of other services and service arms; and they will thus be able to meet the needs of space operations for full-spectrum integrated operations that are large in scope and greatly in-depth. In military practices, the United States has already researched and developed a global command and control system (GCCS), and has fully put it to use in operations. GCCS is a dispersed-style computer network that supports the United States' global joint operations; it closely integrates the four dimensions of land, sea, air, and space into one, and it has the functions of command and control over space information support and space offensive and defense operations actions. This system's lowest-level users include joint expeditionary units and the joint expeditionary units' elements and soldiers; its intermediate-level users are theater of war commands and services' units; and its highest-level users are the nation's command authorities, the national military command centers, and the services' headquarters. After this system was launched, it could ensure that there was smooth and unhindered exchanges of various types of aerospace information and data between the various services and service arms [on the one hand] and the commands [on the other], thus bringing into play the important core role for the US military as it carried out integrated space operations. It can be seen from this that the command information system has the possibility of developing and of laying a material foundation for full-spectrum integrated space operations.

5. Command of space is the premise for space strengths to carry out operational missions

In joint operations, providing space information assistance and support and carrying out offensive and defensive operations are important operational tasks for space strengths. Speaking of space operations strengths themselves, if they want to complete joint operations missions and achieve the goals of space operations, they must have command of space as a necessary condition and important premise. On the one hand, command of space is a necessary condition for space strengths to effectively provide information assistance and support. The reason is that space strengths' prominent advantages in getting information mean that the various operational actions that land, sea, and air operational strengths engage in during future informationized warfare will rely more and more upon the operational information support that is provided by the systems for getting and transmitting space information. This is primarily displayed as: the use of reconnaissance satellites makes it possible to collect the enemy's military intelligence in a comprehensive and accurate manner and in real-time, so that commanders can promptly get a grip on the enemy's deployments and his firepower distribution, and thus take corresponding measures in a focused manner; the use of communications satellites makes it possible to achieve global and continuous communications in all weathers, and its encryption is strong and it is highly reliable, so that commanders can carry out flexible and effective command and control over their units; and the use of navigation and positioning satellites not only makes it possible to allow your own units to carry out rapid and accurate movement, but also makes it possible to enhance the aiming precision of operations weapons, so as to carry out precision attacks against the enemy. Therefore, it will be necessary to do everything you can to seize and hold space dominance throughout the entire process of future warfare and to prevent the enemy from threatening your own space information systems, so as to ensure that your own space communications systems effectively carry out the operational task of information support. On the other hand, command of space is an important premise by which space strengths carry out effective offensive and defensive operations. The reason is that the high speed of spacecraft operation and the international nature and connectedness of space itself allow space strengths to quickly arrive at any region in space and to attack any region or target on the earth's surface. Moreover, space weapons have the characteristics where their launches are fast, their accuracy is high, and their power is great, so that space strengths can quickly and accurately destroy important political, economic, and military targets within the depths of the enemy's operations. It can be seen that space strengths will become important strengths for carrying out offensive and defensive operations in the future. In future wars, only by having command of space will it be possible to ensure that your own space strengths will not be affected by attacks by the enemy's space strengths and resistance by the enemy's surface space defense systems, or will suffer few [of these attacks] in the process of carrying out offensive and defensive operations missions. If you rashly use space strengths to carry out offensive and defensive operations actions under conditions where you have yet to win command of space, you will inevitably suffer major losses, and this could lead to loss of the initiative in war. To summarize the above, in carrying out operational missions, space operations strengths must first have command of space, and the core mission of space operations is therefore to control space.

6. "Focus on controlling space" is an objective requirement for space power

Space power includes the military, civilian, and commercial space strengths that a nation or alliance of nations currently have; they are an important material foundation for carrying out space missions; and they restrain the guiding thought, forms, means, and scale of space operations. Space battlefield strengths' greatest difference from land, sea, and air battlefield strengths is that their scale is limited and their costs are high. Even space powers whose economic strength is strong cannot carry out large-scale space confrontations, but instead treat comprehensive control of space as their objective in space warfare, and they use their space strengths in a concentrated manner to achieve this objective. Speaking of space nations, their investments in space are limited, the scale of their space military strengths is also limited, and even less can they be used on a wide scale. Therefore, focusing on the objective conditions of space power, it is necessary as regards command of operations to stress limited and effective goals in space operations. In the struggle for command of space, it is necessary to concentrate elite space strengths and to carry out focused actions to command space. As regards the effectiveness of operations, do not stress complete destruction of the enemy's space operations system, but pay attention to bringing into play [your space strengths'] "pinpoint" effect at decisive times, in order to cut off the enemy's space communications connections and damage the support of the enemy's space operations systems for his ground operations, which will lead to the enemy partially losing command of space at certain times.

III. The main issues that should be mastered in implementing guiding thought for space operations...45

An understanding and knowledge of the guiding thought for space operations is quite important; how to implement it and carry it out in actual operational practices is even more important. Centered on implementing the guiding thought for space operations, which is core, it is necessary to focus on getting a firm grasp on the following major issues.

1. Be based on the concept of taking the lead in bringing into play space operations actions

It is necessary to establish the guiding thought for space operations of "active defense, full-spectrum integration, and a focus on controlling space," in order to adapt to the new situation and new missions in space operations, and these are a result of innovations in the theory of outer space militarization. In implementing and using this guiding thought, it is necessary to be based on new concepts, to continually deepen your understanding of the important position and role of space operations, and to constantly strengthen your grasp on the characteristics of space operations. In the transitional period of the world's military development, new models of outer space weapons and equipment are being developed fairly rapidly; if thinking and concepts do not develop and are not renovated, but still stay with the previous model of thinking about space operations, it will then be impossible to leisurely adapt to the huge impact and profound changes that space operations will bring to modern warfare. Currently, the pressing need is to break the fetters of outmoded thinking and old concepts, and to be based on the concepts that space operations actions will initiate prior to other operational actions. The saying goes, arrange for forage and food before troops and horses move out. In the past there was a stress on "having information in advance" and on "information superiority," but without space operations, there is no "information superiority;" space operations are a concrete form for manifesting "information in advance" and are the basic condition for seizing "information superiority." Thus, space operations have already become the "forerunner" for modern local wars. In the advance preparations stage for operations involving a powerful enemy, the powerful enemy inevitably will first organize movements by his space operations strengths and carry out very powerful and continuous actions by his space information reconnaissance; space information reconnaissance actions of this scale and intensity differ from those of peacetime, and the enemy will begin to carry out his preemptive strategy. Strictly speaking, he will have already fired the "first shot" in space operations, and strategically, we should actively organize space defenses, engage in striking back, and struggle to take the initiative to defeat the enemy at the campaign and combat levels in space operations.

2. Comprehensively adopt multiple forms of operations

Actual warfare and deterrence are the two major forms of operations in space operations, they are an important form for manifesting the thought of "active defense," and they must be used in the practices of space operations in an integrated form. Just as with nuclear strengths, space military strengths have the role of strategic deterrence. But where they differ from nuclear strengths is that the threshold for using space strategic strengths is much lower than that for nuclear strengths. Speaking in this sense, the use of space strategic strengths not only needs to focus on deterrence, but it also needs to keep an eye on actual combat and to do a good job of handling the relationship between deterrence and actual warfare. When handling the relationship between these two, it is necessary to pay attention to differentiating between the "possession" of deterrence and the "use" of actual warfare. Some space weapons are similar to nuclear weapons; they have a strategic deterrence role, but they cannot be lightly used. Although the possibility that these space weapons will be used in actual warfare is not great, their value as strategic deterrence is quite big, and by bringing into play the benefits of their deterrence it is often possible to get the effects of "subduing the enemy without fighting." However, deterrence is not bluster; if you want to truly get the effects of deterrence, it is necessary to have a certain ability for actual warfare and to make solid preparations for actual warfare. Prior to a war breaking out, it is possible, by displaying necessary space strategic strengths that have deterrence as their goal, to restrain the outbreak of the war. At the start of the war's outbreak, it is possible to restrain the escalation of the war through space actions that are deterrent in nature, in an attempt to resolve the crisis under conditions that are favorable to yourself, and to end the war's conflict. During the process of the war, once it is necessary, you should firmly and resolutely use space operations strengths in order to retaliate and to actively create an operational situation that is favorable to yourself.

3. Pay attention to bringing into play the effectiveness of integrated operations

To ultimately implement the thinking in space operations of "full-spectrum integration," it is necessary to rely upon effectively bringing into play the overall effectiveness of the full-spectrum battlefield, the various strengths, the various means of operations, and the operational actions in space operations. To do this, you should earnestly do a thorough job of combining the following four aspects. The first is to combine specialized strengths with non-specialized strengths. The specialized strengths in space operations are the main body in space operations, which is responsible for major operational tasks and which bring the major effects into play. In addition to this, the non-specialized strengths in space operations are also an indispensably important component part in the overall strengths in space operations. The two each have their superiorities, and they should be organically combined in order to defeat the enemy as a whole. The second is to combine military strengths with local strengths. Space operations require energetic support and active participation by space personnel. This special field of operations provides a broad battlefield for local space and information strengths to participate in and to bring their roles into play. Space operations should fully utilize the rich local resources of talented personnel, technology, and installations, in order to carry out integrated operations by the various military and local strengths involved in space operations, within the differing spheres of space operations. The third is to combine space operations actions with other operational actions. Space operations are closely related to other operational actions; they are an organic whole. To combine space operations actions with other operational actions, it is necessary to be skilled at using the effects of other operational actions at the same time that you actively bring into play the effects of space operations actions themselves, in order to achieve the goals of space operations. The fourth is to combine the tangible battlefield with the intangible battlefield. Space operations, where networks and electronics predominate, are primarily carried out on intangible battlefields like network spaces and the sphere of the electromagnetic spectrum, and they differ greatly from the firepower confrontations on the traditional, tangible battlefield. Combining the tangible battlefield with the intangible battlefield requires merging cyber warfare, electronic warfare, and psychological operations, with firepower warfare and special operations, coordinating these in attacking the enemy and preserving themselves.

4. Be flexible in using means of operations

The integrated use of means of space operations is an important detail in the operational thinking of "full-spectrum integration and with a focus on controlling space;" it is also an effective means for weakening and disrupting the enemy's space operations capabilities and for seizing command of space. In the practices of operations, it is necessary to be skilled at flexibly using means of soft kills and of hard kills. The reason is that the various means of space operations each have their limitations, and thus it is necessary to flexibly use the two means of operations – "soft" and "hard" – based on the nature of the predetermined objective of operations and on the expected level of damage. On the one hand, soft kills are a single operational action, as well as an important support for carrying out hard kills. Only through coordination with soft kills is it possible to smoothly carry out hard kills; otherwise it will be quite difficult for it to succeed. On the other hand, soft kills have no way to get the effects of direct destruction and killing against the enemy's space-based operational platforms and surface bases and personnel. Hard kills can supplement the insufficiencies of the means of soft kills, and the results of their destruction and kills can have a long-term impact on the enemy's abilities for space operations, as well as make it easier to further organize soft-kill actions. However, it generally is not easy to take the lead in using the means of hard kills in space operations prior to the enemy using space hard-kill weapons or while your own side is still trapped in a situation where it is totally on the defensive in space operations in campaigns. But it is easy for means of soft kills in space operations to achieve surprise and concealment in space campaigns, and we should focus more on using them flexibly. The use of the means of soft kills, such as electromagnetic attacks, network attacks, and low-energy lasers, can paralyze or weaken the enemy's abilities for space systems operations, and can achieve the killing effects needed in operations without producing other collateral damage. Means of soft kills in space operations often are relatively sudden; they are not easy to discover, and it is hard to trace their source, so that it is possible to conceal operational intentions fairly well. They are an important means for seizing command of space.

5. Be cautious in using space hard-kill weapons

Outer space is shared by all mankind; the military, civilian, and commercial spacecraft of the various countries operate in differing orbits, forming an outer space battlefield situation in which the enemy, we, and friends are interwoven. This makes the international environment of space operations more complex than on other battlefields. Against this background, the use of hard-kill weapons to attack enemy space operations platforms would easily affect the normal operations of neutral parties' spacecraft or even cause "accidental damage;" attacking enemy space support installations that are located in third countries could also drag the third countries into the war, thus trapping [us] in putting us on the defense strategically and diplomatically. With the rapid increase in the number of outer space spacecraft, the continual shrinking of the relative spaces of the outer space battlefield will directly affect the placement and orbital maneuvering of outer space troop strengths and weapons; with the increase in density of spacecraft within the same scope of space, it will be more difficult to identify, monitor, and control targets on the outer space battlefield. These real problems will affect accuracy and precision in the use of hard-kill weapons; if there is an error in judgment, a tiny error in use will produce a serious strategic mistake. In addition, the destruction of land-based space operations targets will lead to an expansion in the scope of the war, and an attack on the enemy's homeland usually will be viewed as a move to escalate the war. In particular, as soon as an attack produces fragments in outer space, this will endanger all satellites in orbit, and will thus trigger diplomatic disputes. Moreover, the outer space fragments could also endanger your own country's satellite system. Therefore, it is necessary, focused on actual military actions against opponents in operations, to be cautious in using space hard-kill weapons.

Section 3: The Basic Principles of Space Operations...48

The basic principles of space operations are basic criteria that manifest the characteristics and laws of space operations and that guide space operations actions. In guiding the launch of space operations, you should firmly hold to the basic principles of "being fully prepared and carefully deploying; clarifying missions and unifying command; integrating joint actions and integrating offense and defense; being precise in selecting key points and the nodes for attack; having a grasp on opportunities for battle, and being concealed and sudden; and having mechanisms be smooth, with close coordination."

I. Being fully prepared and carefully deploying...49

Being fully prepared and carefully deploying refers to having a comprehensive and focused grasp of the enemy situation during the preparatory stage on the verge of war, based on the operational intentions of the commander, the space operations mission, and the task organization of the space operations strengths, and to carrying out overall operations research and careful planning, taking things into overall consideration, and making overall plans and arrangements for the various kinds of strengths in space operations and the various actions in space operations. In future space operations, conditions will be complex and changing, there will be a great deal of surprise and destructiveness, and weapons will be very complicated; it will be even more necessary to conscientiously and carefully engage in organization and preparations, in order to lay a firm foundation for winning in space operations. To carry out the operational principle of "being fully prepared and carefully deploying," you should comprehensively utilize the various means of information reconnaissance, have a comprehensive and focused grasp of relevant situations in enemy space operations, continually monitor actions by the enemy space operations strengths, and analyze and predict the intentions, objectives, forms, scale, and main directions of operation in enemy space operations, as well as the weapons and equipment that he could use and the tactical and technical measures that he could take. [You should] emphatically clarify the goals of our space operations, our important objectives, our basic combat methods, and our deployments for operations. [You should] carry out scientific allocation and combinations of space strengths, so as to form a system of space operations strengths where they are deployed correctly, linked together, and laid out rationally. [You should] correctly determine the objectives, occasions, areas of space, and frequency domains for space operations, and carefully draft plans for space operations. [Finally, you should] carefully organize support, based on the characteristics of space operations.

II. Clarifying missions and unifying command...49

Clarifying missions and unifying command refers to executing integrated command over the various combatant services and service arms and the ground space operations strengths, under the premise of clarifying the missions of operations. Space operational strengths are classified as strategic strengths; their structure is diverse and their deployment is dispersed, the methods and means of space operations are diverse, the effectiveness of space operations can cover all dimensions of space and a broad scope, space operations actions are closely combined with other operational actions, and the success or failure of space operations often directly affects the overall war situation. Therefore, only by clarifying the operational missions of the various combatant strengths and carrying out highly centralized and unified command is it possible to ensure that the various strengths in space operations act in a coordinated manner and to bring into play the maximum effectiveness of operations. In carrying out the operational principle of "clarifying missions and unifying command," it is necessary to use the guiding thought of space operations to unify the actions of the various space operations strengths, so that each space operations action is closely centered on the goals and missions of space operations as it is carried out. You should establish an integrated space operations command organization, clarify command relations and command jurisdictions, organize and use space operations strengths in a unified manner, and plan in a unified manner the actions of subordinate space operations strengths, based on the needs of space operations and in accordance with the need to be authoritative, highly capable, agile, and highly effective. Relying on the command information system, [you should] improve the space operations command network, in order to ensure that operational command is unimpeded and highly effective. [Finally, you should] flexibly adopt forms of command based on the battlefield situation.

III. Integrating joint actions and integrating offense and defense...50

Integrating joint actions and integrating offense and defense refer to the merging of mobility, firepower, defense capabilities, and information capabilities by the various kinds of operational strengths related to space operations, through a common understanding of full-spectrum spaces and synchronized planning, so that space offensive and defensive operational actions are seamless, form a system, and are coordinated. By comprehensively and rigorously forming a space defense, it is possible to reduce the effectiveness of enemy space attacks and to support your own side's effective use of space, and it is possible to facilitate the smooth execution of space offensive actions; this is an important condition for transforming being on the defensive into being on the attack. However, space defense has no way to basically weaken an enemy's space strengths, whereas an effective space offensive can damage and destroy the enemy's space strengths and lower his ability to use space. Space offense can strengthen space defense and correspondingly [can] strengthen your own side's ability for space defense and [can] support regularly bringing the effectiveness of your own side's space strengths into play. Space offense and space defense are two inseparable and important component parts in space operations; lopsidedly stressing either one while ignoring the other is unacceptable. At the same time that the two are used together, it should be stressed even more that only through unified space operations planning and by relying upon the merged functions of command information systems and the characteristics that space operations platforms have of being intelligent, is it possible to make space offensive and defensive operations actions seamless and coordinated, and to achieve "integrated joint actions and integrated offense and defense" in the true sense of the term. Therefore, "integrating joint actions and integrating offense and defense" are critical to the success of space operations and are an important principle in space operations. In implementing the operational principle of "integrating joint actions and integrating offense and defense," space operations offensive and defensive actions in differing dimensional spaces or operational directions must be closely coordinated, and the various operational strengths should take the initiative to coordinate and integrate their joint actions; the transformation of space operations offensive and defensive actions in the same dimensional space or operational direction or operation must be fast and the space for actions be kept in tight conjunction, so as to not give the enemy a gap that he can take advantage of, to seamlessly connect the transformation between offense and defense, and to thus quickly and effectively link [the process of] attack – defend – resume attack in space operations.

IV. Being precise in selecting key points and the nodes for attack...51

Precision selection of key points and the nodes for attack refers to seizing occasions that favor us, to meticulously selecting weak links and key nodes in the enemy's systems of operations, to concentrating and using elite space operations offensive strengths to carry out an attack, and to thus achieve the goal of damaging the enemy's system of operations and weakening the enemy's overall operational capabilities. Targets in space operations are widely dispersed over the space battlefield, and it is very hard to carry out attacks one by one against enemy space operations targets, due to technical and power limitations, so it is quite hard to carry out systemic confrontations with the enemy. In future operations to seize command of space, you should strive to control the core of operations, to concentrate and use elite space operations offensive strengths, and to form a superiority over the enemy in a particular time and space, [and you should] combine tactical and technical means to attack key parts in the enemy's system of operations, thus paralyzing the enemy's system of operations or greatly weakening the operational capabilities of the enemy system. Therefore, "precision selection of key points and the nodes for attack" is a major combat method in space operations and is an important principle in space operations. In implementing the operational principle of "precision selection of key points and the nodes for attack," you should combine the situations of your space operations strengths, based on the needs of space operations, and mobilize the important strengths that are capable of carrying out space operations missions, using them in an integrated manner and strengthening your space operations capabilities. [You should] concentrate assault operations strengths in major regions (or directions) of operations, major battlefields, major stages, and crucial seasons, thus forming a local superiority. [You should] meticulously select the enemy's key and crucial nodes and his weak links, form a powerful space operations offensive posture, flexibly use means and methods of soft and hard kills, carry out focused attacks, and thus paralyze, damage, and weaken the functions of the enemy's system of operations. [You should] summarize and consider the feasibility and effectiveness of attacks against targets, on the basis of a comprehensive grasp of the weak links and crucial nodes in the enemy's system of operations, and determine the key targets for a focused attack. [Finally,] you must track in a timely manner and find out about the situation for carrying out a space operations offensive attack, evaluate the damage effects of an attack, get real-time control, and adjust the various space operations offensive strengths and their intensity, as the situation warrants.

V. Having a grasp on opportunities for battle, and being concealed and sudden...51

Having a grasp on opportunities for battle, and being concealed and sudden, refer to the comprehensive use of various methods and means for concealing the intentions and actions of space operations, for deceiving and confusing the enemy, for striving to fully master opportunities for operations at a time and place and for objectives that the enemy does not imagine, and for concentrating space operations offensive strengths in carrying out sudden attacks, thus containing the enemy within circumstances where he is on the defensive. The features of space operations systems that are easily attacked are obvious, and having control over opportunities for battle and carrying out concealed and surprise attacks against [these features] can effectively strengthen your own side's space operations superiority, leave the enemy on the defensive, and achieve the effect of a space "blitzkrieg" operation. [These attacks] can speed up development of the process of space operations and heavy consumption of war potential. [Finally, these attacks] can prevent space operations actions from continually escalating and worsening, and effectively enhance your ability to control the scope and intensity of war. Therefore, "having a grasp on opportunities for battle, and being concealed and sudden" is a basic principle in space operations. In implementing the operational principle of "having a grasp on opportunities for battle, and being concealed and sudden," you should be fully prepared for space operations, draft a number of emergency response scenarios, and thus ensure that you [can] carry out space operations actions at any time. Based on the battlefield situation, [you should] select and create opportunities for battle, strive to launch attacks at the campaign and tactical level before the enemy does, and thus ensure that you have the initiative on the space battlefield. [You should] adopt strict measures for secrecy and strengthen strict management of space information systems and space operations equipment, thus concealing the intentions of your space operations. [Finally, you should] focus on using such means as feints in space orbits and deception in space information, and conceal what is real and reveal what is false about your own side's space operations intentions, deployments, and actions, so as to achieve the goals of confusing and out-maneuvering the enemy and of creating errors in the enemy's judgment and decision-making.

VI. Having mechanisms be smooth, with close coordination...52

Having mechanisms be smooth, with close coordination, refers to forming mechanisms for smooth coordination among the various strengths in space operations and between space operations and other operational strengths, in order to carry out continuous and close coordination and to have the various strengths in space operations always [carry out] coordinated actions centered on the overall situation of operations. Space operations are both an independent form of operations as well as an important component part of joint operations, and they often are carried out against a background of joint operations. But regardless of whether space operations are independently carried out or they are operational actions against a background of a given type of operations, they do not exist in isolation. They must be closely coordinated with other operational actions, help each other in their actions, support one another, and have mechanisms for smooth support; only in this way is it possible to bring into play the integrated combined strength of space operations strengths and actions and to achieve the goals of space operations. In implementing the operational principle of "having mechanisms be smooth, with close coordination," you should establish complete mechanisms for coordinating space operations strengths with other operational strengths, use many methods of coordination, strengthen their support for one another, and strive to have this be smooth and continuous. You should rationally differentiate the missions of the main combat strengths and the support strengths and clarify the relationships for coordination and support, based on the operational decision and plans and focused on the differing stages of development for space operations actions. You should organize temporary coordination at appropriate times, strengthen coordination and support, maintain continuous coordination, and ensure that the various operational actions are coordinated, with an emphasis on planning and cooperation and based on developments and changes in the space battlefield situation. [Finally,] you should shorten the time for the transmission, flow, and delay of communications links for space information between outer space and the atmospheric layer, ensure that coordination of communications is unimpeded, and thus enhance the battlefield reaction capabilities of the various strengths in space operations.

Questions for Deliberation…53

1. What are the main features of space operations?

2. Describe the basic guiding thought for space operations and the basis for their establishment.

3. What are the basic principles in space operations?

4. Describe the main issues that implementation of the guiding thought for space operations should have a grasp of.

Lecture 3
Space Operations Strengths...54

Space operations strengths are operational strengths where space units are the main body, where military space systems are the backbone, where other space strengths are aids, and which engage in various military actions primarily in outer space. With the rapid development of space technology by the various countries of the world, the pace at which the various military powers are struggling for space resources and seeking space superiority has clearly accelerated, the trend toward militarization of space has become more and more evident, and missions in which space operations strengths carry out space support and space operations are becoming increasingly frequent, so that their role in future wars will become ever more important.

Section 1: The Structure and Characteristics of Space Operations Strengths...54

Space operations strengths primarily consist of space launch and recovery units, space tracking units, spaceflight combat units, strategic missile units, ground space defense units, and space service support units. Their personnel mainly consist of command personnel, operations staff, space experts and technical personnel, operations control personnel, and other ground service and support personnel.

I. The structure of units of space operations strengths...54

1. Space launch and recovery units

Space launch units refer to units that carry out spacecraft launch missions in order to deliver astronauts, weapons and equipment, and operations materiel; they generally are constructed on the basis of missile units and satellite launch units. Space launchings are the primary link and important premise for space strengths to access space and carry out operational missions, and space launch units' main work includes testing technical positions, transporting and lifting [space vehicles], inspecting and testing systems, filling [space vehicles] up with fuel, and carrying out launchings. After a space launch vehicle (carrier rockets, space shuttles, spaceplanes, and the like) and a spacecraft (such as satellites, spaceships, and space maneuvering vehicles) approach the site, testing elements immediately carry out [single] unit tests and composite tests while [the launch vehicle and spacecraft] are in a horizontal position. After the technical site tests are concluded, transport and lifting elements immediately move the launch vehicle and spacecraft from the technical site to the launch site, and lift and attach them. After the space launch vehicle and spacecraft are completely attached, the testing element carries out a subsystems test, a systems match, and an overall examination. After the launch site's testing work is completed, the space base commander should make the decision in a timely manner whether or not to launch, based on the technical state of the launch vehicle and spacecraft, the conditions of the site equipment, the state of the tracking system, and weather forecasts. After upper echelons approve of the decision for launch, the fueling element fuels [the launch vehicle] in accordance with the process of first the fuel and then the oxidant and first the first stage and then the second stage. After the propellant fueling is complete, the space base headquarters immediately organizes the launch in accordance with command coordination procedures, and launches the spacecraft to a predetermined orbit. Under ordinary conditions, the space launch uses the form of a ground fixed or mobile space launch base, in order to ensure that the space launch, flight, tracking, and support units have relatively ample time to carry out each task of preparation, so as to improve the chances for the spacecraft's launch and positioning. Under emergency conditions, in order to break through an enemy's space blockade and interception and to rapidly rebuild space strengths, it is possible to use concentrated launchings on land, at sea, and in the air at many points, in many directions, and in a short period of time, so as to improve the chances that space launches will break through [the enemy's] defenses. Therefore, space launch units must have a certain mobility and the capability for emergency launches.

Space retrieval units refer to units that carry out the missions of searching for and transporting return-type spacecraft and of ensuring that after astronauts complete their mission, they safely return to the earth base. For example, after return-type photographic reconnaissance satellites carry out their missions, their film canisters must be retrieved in a timely manner, in order to get the reconnaissance information as quickly as possible. After manned spacecraft, like spaceships and space shuttles, complete their missions, it is also necessary for them to quickly return to the earth base, so as to replace the astronauts, overhaul weapons and equipment, and add propellant.

2. Space tracking units

Space tracking units refer to units that carry out the mission of surveying and controlling spacecraft in orbit. Space tracking units consist of the space control center and certain space tracking stations (including tracking ships and tracking aircraft) that have equipment for tracking and measuring, remote control, and telemetry. The number, allocation, and distribution of tracking stations are determined by the flight path of the spacecraft and its need for tracking. The space control center forms a complex with the various tracking stations, by means of a tracking communications network; this [complex] is the space tracking network. Space tracking networks can in general be divided into three types, in accordance with the target being tracked and controlled: satellite tracking networks, which serve in the launch of various types of applications satellites and scientific testing satellites; manned space tracking networks, which serve in the launch of manned spacecraft, and which in addition to having greater requirements for tracking and surveying, telemetry reception, and remote control devices than the satellite tracking networks, also are equipped with devices for speaking with astronauts and for transmitting television; and deep space networks, which serve spacecraft that explore the moon and deep-space planets and which have large-diameter antennas and highly sensitive receiving systems, in order to reach extremely remote functioning distances.

By means of the space tracking network, the space tracking units first track and survey the flight path of the carrier rocket and the spacecraft, getting the working and environmental situation of the various subsystems, analyzing the data that they get, judging the correctness of the spacecraft flight path and the suitability of the spacecraft for the space environment, and providing a basis for controlling the spacecraft and for improving spacecraft design. Second, they complete real-time or programmed control, so that the spacecraft reaches its predetermined path and achieves the necessary attitude; as necessary, they change the spacecraft's path, flight procedures, and working attitude. Third, they receive the spacecraft's special information and recordings, such as some of its exploration data, telemetry information that reflects the astronauts' physiological state, and television images, and the space control center records, displays, and processes this information, and engages in communications contacts with the manned spacecraft's crew, thus providing real-time and subsequent analysis for use. Fourth, in regard to applications satellites that require highly precise positioning (such as navigation satellites, geodetic satellites, and high-resolution reconnaissance satellites), the satellite position (or path) data and corresponding time data that the tracking network provides users serves as basic information for applications data processing. Space tracking units must have the ability for multiple missions and to do real-time tracking.

3. Spaceflight combat units

Spaceflight combat units refer to units that carry out various kinds of space operations and relevant assistance and support missions in space, using space shuttles, spaceplanes, and space stations. The astronauts in spaceflight combat units have a great deal of subjective initiative and the ability to deal with emergencies, they can make timely and correct choices and react to urgent or unexpected incidents, and their role is something that is impossible to handle by relying only upon satellites and other unmanned space weapons. The main methods are first, carrying out space reconnaissance. By carrying out surveillance or photography in a purposeful manner against ground or sea military targets or adjustments to enemy deployments, astronauts can clearly improve the effectiveness of reconnaissance and can analyze materials in a timely manner, thus providing accurate information for military command. Second is space operations. In space, astronauts can more conveniently intercept, capture, damage, or jam enemy satellites or space weapons systems. For example, they [can] kill targets by launching high-energy laser beams, particle beams, or microwave beams; they [can] carry out suppressive or deceptive interference against enemy spacecraft's photoelectric reconnaissance and communications equipment, so that these cannot normally collect information or so that they get false information; and they [can] spread jamming chaff around enemy spacecraft or spray aerosols or other chemical substances on their exterior, masking or contaminating the enemy spacecraft's sensors so that these are temporarily or permanently ineffective. Third is attacks against the earth's surface. In using space-based directed energy and kinetic energy weapons to carry out offensive actions from outer space against the enemy's important targets on the earth's surface (to include land, sea, and atmospheric spaces), they have the characteristics of rapid reaction, global movement, precision attack, and powerful, instantaneous killing and damaging effects; this is an important symbol of the comprehensive maturing of space operations. Fourth is carrying out assistance and support for space operations. Examples are carrying out space transportation or trans-atmospheric transportation, in order to inspect and repair, and fuel other spacecraft, or to test and develop space weapons systems.

4. Strategic missile units

Strategic missile units generally refer to strategic ballistic missile units and strategic cruise missile units for missile launches in the medium range (1,000 kilometers to 5,000 kilometers), long range (5,000 kilometers to 8,000 kilometers) and intercontinental (more than 8,000 kilometers) and above. Strategic ballistic missiles' main trajectory is in outer space, and their warheads pass through outer space to reenter the atmosphere and attack targets. Strategic cruise missiles generally are supersonic cruise missiles that have a flight altitude in near space (more than twenty kilometers). The ones whose current development is relatively mature are surface-to-surface ballistic missile units.

Ballistic missile units use rockets to deliver their ammunition against enemy targets in order to carry out long-range attacks; they have two types of operational capabilities: nuclear attack and conventional attack. Examples are the United States' Minuteman III strategic ballistic missiles and the Russian Topol-M, RS-24, and Bulava, which have ranges that can reach 13,000 kilometers. Their characteristics are that units are widely dispersed, their operational actions are concealed, their preparation time is short, their flight is rapid, they have strong penetration capabilities against defenses, their destructive power is great, the precision of their operations is gradually being improved, and they can be used against fixed targets over a huge area, such as political and economic centers, strategic missile bases, and naval and air force bases. They are an important component part of the system of space operations strengths. Ballistic missile units normally are composed of missile bases, warhead bases, engineering technology units, and maintenance and management and other units. Of these, missile bases are responsible for the mission of missile operations, and they usually have missile launch units, warhead equipment inspection units, and various kinds of operations support units, with command installations, missile sites, and various types of operations support equipment. Warhead bases are responsible for the task of storing and supplying warheads, and they have warhead equipment inspection, storage, and transportation units, with a command organization, repositories, and various support facilities. Engineering technical units are responsible for such engineering support tasks as setting up missile sites and engineering and installation; they usually have transportation, engineering technology, and installation departments as well as corresponding stations and organizations and command organizations. Maintenance and management units are responsible for such tasks as maintaining and managing various types of equipment and devices and for training personnel; they usually have technical departments, training departments, and corresponding sites and facilities.

5. Ground space defense units

Ground space defense units primarily consist of space early warning and monitoring units and surface-to-space attack units as well as service and technical support units (or elements); their two main functions are early warning and attack. Space early warning and monitoring units have strategic early warning and surveillance centers, command and early warning satellites, and space surveillance long-range radar systems, forming a three-dimensional early warning network that is responsible for ocean surveillance and missile early warning and for finding and identifying space targets, tracking enemy spaceship paths, detecting incoming ballistic missiles, providing decision-making support for the commander to make decisions about counterattacks, and providing other services and service arms and relevant operational units with early warning information that is needed for operations. After surface-to-space attack units receive early warning information, they are responsible for carrying out precision positioning of enemy incoming space weapons, and for suppressing and destroying enemy orbiting spacecraft, weapons in near space, and incoming ballistic missiles, in order to protect the nation's important political, economic, and military strategic targets. For example, the National Missile Defense System (NMD) that the United States developed can intercept long-range ballistic missiles in the mid-flight stage, and the S-400 Triumf air defense missile weapons system can intercept mid-range ballistic missiles at ranges of 3,500 kilometers.

The main targets for attacks by ground space defense units are the enemy's spacecraft in low orbit and incoming ballistic missiles. The main methods [of attack] are first, the use of land-based, sea-based, and airborne anti-spacecraft missiles to attack enemy spacecraft, primarily by destroying enemy spacecraft in the form of a high-speed collision or destroying enemy spacecraft through explosions and fragments. On 13 September 1985, a US Air Force F-15 [Eagle] fighter launched an anti-satellite missile at an altitude of more than ten kilometers, successfully destroying a satellite orbiting at more than 500 kilometers. This was mankind's first use of missiles to destroy a satellite. Second is the use of land-based, sea-based, and airborne laser weapons to attack enemy spacecraft; not only is it possible to destroy enemy spacecraft by means of high-powered laser illumination, but it is also possible to illuminate the enemy spacecraft's sensors and electronic devices by means of low-powered laser weapons, leaving then unable to work normally. The installation of high-powered laser weapons on aircraft and other airborne platforms in order to attack enemy low-orbit spacecraft can greatly enhance the survival capabilities and operational effectiveness of the laser weapons, making it even harder for the enemy to protect against them. Third is to use information confrontation means to attack enemy spacecraft. Carrying out deception and jamming from the ground, the sea, and the air against enemy satellites and other spacecraft, and countering the use of [these spacecraft's] signals are effective methods for ground attacks against space.

6. Space service and support units

Space service and support units primarily consist of technical assistance support, logistics service support, and security support auxiliary organizations and units, composed of various types of service and support personnel.

Technical assistance support units primarily are responsible for providing space systems with relevant technical assistance support such as weather, mapping, communications, and information applications management. Because space engineering systems are quite complex, they require quite large technical assistance support units before it is possible to for them to complete arduous space operations missions, and command, control, communications, computer, and intelligence systems [sic] (C4ISR) are the most basic technical assistance support system.

Logistics service support units primarily are responsible for the maintenance and management of spacecraft; for the supply and support of materials and fuel; for the clothing, food, housing, and actions of operations personnel; and for the construction of relevant engineering facilities. This includes maintenance and repairs in the retrieval and return of spacecraft (they have corresponding maintenance centers and repair workshops); the construction, protection, and management of important military facilities like spacecraft launch sites, military airfields, and missile sites; and supporting and supplying the large number of necessities for space systems and the various kinds of complex materials and fuels. In particular, support for the lives of astronaut units and for their medical treatment and hygiene is much more complicated and difficult than for other services, requiring specialized knowledge and the setting up of special organizations.

Security support units are primarily responsible for the security of space systems' ground bases and for carrying out such support duties as security guards, defense, mobility, camouflage, and shelter. The ground systems in space operations are the basis for engaging in space operations, the ground control systems for space engineering have an extremely important role for spacecraft that carry out space missions, and whether they are secure or not has a direct impact on smoothly carrying out space operations.

II. The structure of personnel in space operations strengths...59

Space operations are confrontations between advanced and new technological space [weapons and equipment] and space defense weapons and equipment, but even more, they are contests between high-quality new types of military persons of talent. For this reason, only by fully utilizing the educational resources of military and local colleges; by increasing the intensity of training for military space persons of talent; by striving to foster and create large numbers of high-quality military space persons of talent who have mastered advanced theories of operations, who have fairly high levels of strategizing, and who are proficient in space technology and equipment; and by creating ranks of new types of space operations persons of talent, is it possible to meet the needs of the construction of space operations strengths and [the needs] of space operations. These strengths primarily consist of four types of personnel: command personnel, staff personnel, technical personnel, and operating personnel.

1. "Composite-type" command personnel of talent for space operations

"Composite-type" space operations command personnel of talent refers to those composite-type senior military personnel of talent who not only are proficient at the command and management of operations, but who also have fairly deep space technology knowledge and skill, and who in addition have an advanced sense of innovation and the ability for strategic thinking. With the rapid developments in space operations weapons and equipment, there has been a more widespread penetration and influence between command and management [on the one hand] and engineering technology [on the other], and qualified space operations command personnel must not only be proficient at military command, but they must also have a solid basic knowledge of science and culture, a [solid] knowledge of engineering technology, and a [solid] knowledge of related space technologies before it is possible to scientifically use space systems and informationized systems to carry out command of operations and to control new types of weapons and equipment for space operations; otherwise, no matter how advanced command and control are and [how advanced] weapons and equipment are, it will be difficult to bring into play the effect that they should have. Future space operations inevitably will be joint operations under informationized conditions, and they will place even higher demands upon the quality of commanders' command of joint operations, from the space of operations and the scope of coordination to the decision-making level and the span of command.

2. "Resourceful-type" staff personnel of talent for space operations

Battlefield situations in space operations change in the twinkling of an eye, and the amount of information is great; commanders at each echelon must quickly and resolutely make decisions, and this is inseparable from the vigorous help of "resourceful-type" staff personnel. Space operations often have a very powerful strategic nature, and integrated information network systems often become key targets for enemy attacks, requiring staff personnel to be "strategic" personnel of talent who are skilled at macroscopically organizing space operations support; space operations weapons and equipment are the crystallization of continual developments in advanced science and technology, requiring that staff personnel must be "composite-type" persons of talent who not only understand command and management but who also understand specialized technology. Space operations in joint operations under informationized conditions will be launched in three-dimensional spheres of space in such multiple dimensions as the land, sea, air, space, electromagnetics, the network, and knowledge, and operational command requires highly integrated operations by services and service arms as well as specialized knowledge of command and control, and this requires that staff personnel must be "composite-type" persons of talent with a broad knowledge. Science and technology are continually applied to space systems, and information technology and space technological support must be coordinated with space operations theory which is being constantly innovated, before it is possible to win victory, and this requires that staff personnel must be "innovative-type" persons of talent who have a powerful sense of innovation.

3. "Specialist-type" technological personnel of talent for space operations

Functions in space operations, such as monitoring, assistance, operations, and service support, are all done through military space engineering systems, and any link in military space engineering systems is inseparable from meticulous operations by scientists and engineering technical experts. In addition to space engineering technology itself, extremely complicated related support work is also required, such as electronic technology, automation technology, power technology, materials technology, remote sensing technology, computer science, chemistry, combustion, thermal physics, and manufacturing technology; these all require that relevant technical personnel carry out service support, and they require a huge, technologically superb cadre for equipment technology support.

4. "Knowledge-type" operating personnel of talent for space operations

Operating personnel of talent for space operations are the basic strengths by which space systems generate combat capabilities. If a single battle position in an operations system is in error, this could lead to the entire system being paralyzed. In particular, how qualified specialized backbone [cadres] are will directly affect [how and whether] the functions of operations systems will be brought into play in a normal manner. As regards astronauts, their selection and training is extremely complex and arduous; they generally are selected from among outstanding pilots, who not only need to have excellent physical and psychological qualities, but who also need to be skilled at and have mastered space technology and specialized operating skills. They must also have a grasp on necessary medical knowledge and on the technology for saving themselves, and the training time lasts four to five years. Therefore, only by striving to foster a group of specialized backbone [cadres] for technological operations, so that they have mastered new knowledge and new theories, are familiar with new equipment, and have attained excellent new skills, is it possible to achieve an optimal combination of man and weapons, and to thus bring into play the maximum operational effectiveness of space weapons and equipment.

III. The characteristics of space operations strengths...61

Space operations strengths are typical high-tech strengths; they have the outstanding characteristics of a complex structure, huge investment, great riskiness, and a high benefit-cost ratio.

1. Their structure is complex

Unlike other operational strengths, the structure of space operations strengths is quite complicated; as regards types of units, there are six types: space launch and recovery units, space tracking units, spaceflight combat units, strategic missile units, ground space defense units, and space service support units. As regards types of personnel, there are five types: command personnel, operations staff, space specialists and technical personnel, operational control personnel, and ground service support personnel. Specifically as regards every type of unit, they all include many subsystems, and the subsystems also can be further refined. For example, space tracking units include ground tracking stations and tracking ships at sea, and each tracking station and each survey ship also is a technologically complex subsystem. In addition, looking at the nature of the constituent components, although the main body in space operations strengths is military space strengths, still, large numbers of civilian space strengths inevitably will be requisitioned in wartime, thus forming an integrated military-civilian system of operational strengths. In actuality, the demarcation between the military and civilians in space operations strengths is quite vague; for example, most of the communications, navigational, weather, maritime, and geodetic satellites are used by both the military and civilians, and it is even more true that the various ground tracking strengths can be used by the military but can also be used by civilians. It is precisely for this reason that in the several recent local wars, the United States used large numbers of civilian space strengths, and a great many countries in the world have not strictly differentiated between the military and civilian nature of space strengths; the militaries of some countries, such as India and Japan, have even relied to a great extent upon the information provided in peacetime by civilian communications, navigation, weather, and geodetic satellites.

2. Investment is huge

Space operations strengths are the use of a nation’s comprehensive national power in the sphere of space, prominently reflecting its levels of manpower, materiel, finances, and scientific and technological strengths. The huge complexity of systems structures, the fairly long cycles of research and development, the high costs of testing and equipment, and the complexity of production have determined that research and development of spacecraft and their ground infrastructure are very costly. At the same time, spacecraft generally have a fairly short lifespan, and therefore their launch and recovery, tracking and management, and information use all require investing large amounts of manpower and materiel. In addition, the testing, repair, and maintenance of space weapons and equipment, as well as the supplementary materials that they consume, also require paying a very great economic price. According to estimates, constructing a large-scale space station costs $50 billion to $60 billion, constructing an aircraft carrying laser weapons costs about $900 million, research and development of a large-scale communications satellite costs $100 to $300 million, and research and development of a space robot also costs $150 million. A single flight of a space shuttle costs $1 billion, and maintaining it one time costs $74 million. Currently, delivery of a kilogram of effective payload into space costs up to $5,000 to $10,000. This then requires heavy funding and resources. Because of the high manufacturing costs of space technological equipment and the expensive maintenance costs, even military powers find it very difficult to maintain a huge, fully functional space equipment system in peacetime, and therefore what they basically have adopted is a “joint military-civilian use that combines peace and war” model of constructions.

3. High riskiness

The high-tech nature of space systems' development is strong, and the impact of the environment of their special physical space is great; moreover, as the levels of space confrontations have risen, this has led to an extremely large number of factors in the security issues of military space systems and especially of their weapons and equipment systems, so that the fragility of the system of space operations strengths is quite pronounced. First, the structure of space operations strengths is complex. Linkage in space systems is strong, and as soon as a given part is destroyed, this will affect how the functions of the entire system are brought into play. For example, just a single carrier rocket in a space system will consist of several hundred thousand or up to a million parts. From the research and development, testing, and production of spacecraft to their launching, tracking, and use, problems that appear in any link or any part or component will affect their operating efficiency in light cases, while in heavy cases, it will lead to failure of the entire mission and even create disastrous consequences. The loss in 1986 of the United States' Challenger space shuttle was because one rubber washer had poor quality, creating a major plane crash incident. Second is the threat of the space environment. Spacecraft that operate in space orbit not only are put into very powerful cosmic radiation, but they also are threatened by such factors as space fragments and intense changes in temperatures. For example, in July 1996, France's Cerise satellite's gravity gradient stabilization boom was bit by a fragment from its Ariane [carrier] rocket, and the upper part of this was cut off, so that the attitude control system was damaged, which led to there being no way for the satellite to operate normally. Third is that it is easy for the system of space operations strengths to come under enemy attack. Ground space infrastructure will be the focus of enemy long-range precision attack weapons' raids in warfare, and it will be difficult to conceal spacecraft deployed for extensive periods of time in space. Moreover, because of the restraints of the laws of physics, they operate in fixed orbits, so that their actions can be predicted; their ability for mobile response is limited, it is easy for the enemy to stay abreast of their operational intentions, and it is easy for them to be tracked and aimed at and to suffer interference and attack. Fourth is that spacecraft's self-defense measures are limited and their defense capabilities weak. Currently, the issue of space systems' own security has yet to be resolved; civilian spacecraft have yet to take measures for defense, while the defense measures of military spacecraft are also quite limited, so that their defense abilities are quite fragile. Even when spacecraft have an accident, it is very hard to judge whether this is man-made damage or natural damage; maintenance and resupply capabilities are even more insufficient, and even when astronauts are sent on space shuttles into space to carry out repairs in orbit, drawbacks exist where the amount of time consumed is long, costs are high, and risks are great.

4. High benefit-cost ratio

Although there is heavy consumption in the development of space operations strengths, the benefit-cost ratio is very high. This is because militarily, it is possible to engage in space confrontations and protect the nation’s sovereignty and rights and interests through strengthening and using space operations strengths. As regards science and technology, use of the exploratory nature and traction of military space development impels major advances in space, information, materials, and other related technologies. Economically, not only can it create an excellent platform for economic development and provide a secure environment, but space resources can also be put directly into civilian use. Politically and diplomatically, technological monopoly and cooperation in the development of space, as well as the space deterrence that is formed, not only can provide means for the diplomatic struggle, but they also help to enhance a nation’s status and prestige, and strengthen the nation’s overall national strength. What is even more important is that space technology has a dual military-civilian nature; its facilities, like space communications, satellite remote sensing, navigation and positioning, and mapping and weather, can be put directly into service for the nation’s economic and social development. Although the United States’ Apollo moon landing program consumed $25 billion, it produced $200 billion in economic benefits and spurred more than 500 high-tech inventions, and more than 3,000 technological results derived from it. These technologies ultimately were all put to civilian use and into the national defense military industry, thus establishing the United States’ superior scientific and technological position. The development of space operations strengths can vigorously promote the transformation of military and civilian space technologies into one another as well as [promote] their interactive development.

Section 2: The Main Missions of Space Operations Strengths...63

In joint operations under informationized conditions, given that space operations strengths are an important component part of the armed forces system, their main missions consist of deploying space strengths, space information assistance and support, trans-atmospheric transportation support, space assaults, space defense, and space blockades; their goal is to seize and hold command of space and to assist surface operations on the earth. These missions can be summarized into three grand missions: access to space, the use of space, and the control of space.

I. Access to space...64

Access to space refers to a series of space activities that are carried out for completing military missions: launching spacecraft into predetermined orbits, safely operating the spacecraft in orbit, and servicing and returning the spacecraft. It is one of the important missions of space operations strengths, it is a basic condition for building up space operations strengths, and it is a basic means for developing the deployment of space operations strengths. Access to space is a precondition and basis for using space and controlling space, and it is an issue that each country must first resolve in developing its space enterprises. The United States has already treated "ensuring access" as a crucial objective in the US military's development of space operations strengths. The US military's joint Space Command pointed out in its *Long-Term Planning – Vision for 2020* that "Ensuring access" means "the use as needed" of space traffic routes, and [it means] achieving unimpeded movement in and through space. This is extremely important for carrying out space operations missions. Various countries are developing their ability to access space, and this is primarily done through three areas.

The first is space launches. This primarily means launching spacecraft into predetermined orbits and having them operate normally, and [it also means] the ability to retrieve spacecraft from space based on need. This kind of space launch not only requires transporting an effective payload to mission orbit, but it also requires ensuring that the access transport is inexpensive, that its response is timely, and that it can access [space] at any time. For this reason, completing space launch missions not only requires having many ways and means of space launch during peacetime, but what is even more important is having the ability during wartime to quickly launch into space under conditions where [the launches] suffer jamming, blocking, and attacks. Only in this way is it possible to quickly replenish lost or damaged spacecraft under various conditions, and to deploy equipment or operational personnel as needed. In order to improve rapid emergency-response capabilities in wartime, the various space powers in the world all are vigorously developing the ability to quickly access space. This ability includes many aspects: carrier tools must be ready-made as well as modularized and systematized, and be able to adjust to the needs of differing payloads and orbits; the interface between spacecraft and carrier tools must be versatile; the carrier tools must be mobile and be able to move to nearby suitable launch points within a short period of time; the launch preparation time is short; and there must be a complete mobile tracking system for carrier tools.

Second is secure control in orbit of spacecraft. This primarily means providing global telemetry, tracking, and command of spacecraft in orbit, and the ability to adjust the orbit and position of an orbiting satellite in a timely manner, based on the needs of military operations. Secure control over a space[craft] in orbit requires having the ability to analyze the situation without any hindrance and without interruption, especially under conditions of wartime where the enemy is carrying out powerful electromagnetic jamming, and while you are quickly correcting mission data. In order to have secure control in orbit on a global scale, the two space powers – the United States and Russia – have both come up with ways to set up space tracking stations around the entire globe, with the goal of enhancing the secure reliability of space tracking. Given the restraints of its national characteristics, the PRC in addition to setting up overseas tracking stations by leasing them, primarily uses the method of overseas tracking ships to resolve the issue of global secure control over spacecraft in orbit.

Third is servicing and recovering spacecraft. This primarily means replacing parts and refueling spacecraft in orbit, and recovering valuable and important effective payloads. Because of the cost issue, servicing in orbit is restricted to high-value systems, such as expansive and lightweight tracking sensors and materials that are politically sensitive; most of them are deployed to deal with crises or military needs, and they are not necessary in peacetime. Most of the spacecraft that need to be retrieved in peacetime are spaceships and space shuttles; they are important means by which mankind explores outer space, as well as basic tools by which humans live in outer space.

II. Use of space...65

The use of space refers to bringing into play the role that space operations strengths have for assisting and supporting land, sea, and air joint operations. This is a direct goal in access to space, as well as the most important operational mission that space operations strengths currently have. Practices in the several local wars since the 1990s have shown that the information assistance and support that space operations strengths have provided, such as reconnaissance and surveillance, missile early warning, communications relay, navigation and positioning, weather observations, and earth surveying, have played a "multiplier" effect in improving the process of operational capabilities, and are crucial, valuable, and indispensable factors in integrated joint operations under informationized conditions. For example, in the Kosovo Campaign, the US military mobilized nearly twenty types of satellites, for a total of over fifty of them, and together with early warning aircraft, unmanned aerial vehicles, and various types of sensors and special operations intelligence personnel on the ground, they formed an integrated information network system at the strategic, campaign, and tactical levels, which carried out real-time monitoring and control throughout Kosovo and on the various battlefields, in all times and spaces and in all directions. In this, space strengths undertook more than seventy percent of battlefield communications tasks, more than eighty percent of battlefield reconnaissance and surveillance tasks, and 100 percent of weather support tasks, providing guidance information for ninety-eight percent of the precision attack weapons and twenty-four-hour continuous monitoring of theater of war communications signals. It can be said that fully utilizing space made indispensable contributions to the United States winning victory in the Kosovo Campaign.

Looking at current technological conditions, the major missions in the use of space are first, reconnaissance and surveillance missions. These include dynamic surveillance of the battlefield; this primarily means finding and identifying how enemy troop strengths and weapons are deployed, such as transfers and deployment of various kinds of high-tech weapons and equipment and the construction of major military fortifications, while at the same time monitoring how the enemy is preparing the battlefield and changes in his posture. [They also include] carrying out electronic reconnaissance; this primarily means determining the various kinds of enemy ground radars, the precision placement of radio stations, and signals characteristics and operating distances, through tracking and collecting enemy electromagnetic signals, and verifying the intelligence acquired by visible-light and infrared imaging reconnaissance. [Finally, they include] carrying out maritime surveillance. This primarily is done though target imagery and intercepting signals emitted by shipborne radars, communications, and other radio equipment, and through integrated processing to detect and track surface ships and floating bases, while at the same time measuring coastal terrain, the rise and fall in sea levels, ocean temperatures, the formation of typhoons, wind strength and wind direction, currents, and the distribution of sea ice. Second is the mission of missile early warning. This primarily means tracking and monitoring enemy missile sites, aircraft, and ships; having a real-time grasp of their missile launch situation; and providing prompt missile early warning intelligence so as to win as much time as possible for your side to organize missile interception and to protect your important targets. Third is communications relay missions. These primarily are the forwarding or emissions of radio signals, in order to carry out communications among surface communications devices, between surface communications devices and spacecraft, and between one spacecraft and another; providing transmission of voice, images, and data over long distances, in great volumes, and at high speeds; and ensuring delivery of rapid, reliable, and encrypted battlefield information among the supreme command, joint operations command, command of the various services and service arms, and their subordinate units. Fourth is the mission of missile positioning. This primarily means providing navigational and positioning assistance for precision-guided weapons, in order to enhance the precision of their aim, and providing accurate three-dimensional position, speed, and time information for the various services' and service arms' units, operational platforms, and weapons systems. This thus ensures that troop strengths and firepower can overcome the effects of an adverse natural environment; that they move accurately, quickly, and in a timely manner; and that they thus form a decisive superiority over the enemy at the most appropriate times and places. Fifth is weather observation missions. These primarily obtain weather information for the entire globe or for a specific region and predict developments and changes in the weather situation, by means of weather observations for the earth and its atmosphere, thus providing weather support for units at each echelon. Sixth is earth surveying missions. These primarily provide such materials as how the shape of the earth, the earth's gravity field, and the earth's magnetic field are distributed, which are used to improve the technical performance of the various kinds of precision-guided weapons, and they measure the positions, altitudes, and landforms of the various targets on a ground battlefield, in order to draft detailed and precise military maps.

II. Control of space...66

Looking at its essence, control of space means seizing and keeping command of space; it is an important guarantee for using space. What is referred to as command of space means dominance over a certain regions of space at a specific period of time. Under informationized conditions, once you hold command of space, and have won superiority where the high dimensions of space (information and [outer] space) restrain the low dimensions of space (the land, sea, and air), you are then able to effectively support your own combatant troop strengths' freedom of movement; to provide information, firepower, and trans-atmospheric transportation support for land, sea, and air domains; to restrain the assistance and support roles of your opponent's space operations strengths; and even to directly carry out intense firepower attacks against the earth's surface, thus greatly weakening your opponent's overall operational capabilities. Therefore, whether or not you are able to control space and to seize and keep command of space directly affects victory or defeat in war, and so its status is quite important.

There are primarily three missions in the control of space. The first is to enhance the survival capability of spacecraft, so that when they encounter jamming, damaging, or destructive attacks, they can perceive these in a timely manner and strengthen their protection. The second is that, when necessary, they will jam, damage, or destroy hostile nation's orbiting spacecraft or other applications systems that [pose] a threat. The third is direct support to ground operations by means of space-based weapons, particularly in attacking the enemy's in-depth nodal targets of a strategic nature.

There are many methods for fulfilling the mission of control of space, but looking at them overall, there are [just] three: space blockades, space attacks, and space defense. Space blockades use offensive weapons to form a screen between space and the ground, preventing enemy space strengths from accessing the space battlefield or moving in orbit, and from exchanging information with ground systems; it includes four types: blockades of space bases, orbit blockades, blockades of transmission channels, and information blockades. Space attacks are the comprehensive use of the means of soft and hard kill (destruction, denial, weakening, jamming, and deception) to attack enemy space targets or targets on the earth's surface (on land, at sea, or in the air), with the goal of reducing or depriving the enemy's right to use space, and to assist your own side's land, sea, and air operations. Space defense is the adoption of various active and passive measures and actions to defend against assaults by enemy space strengths and attacks by ballistic missiles; its goal is to keep your own country's space systems and its important land, sea, and air targets from coming under attack by enemy space systems or ground-based weapons systems. It includes three types: anti-missile, defense against spacecraft, and defense against space bases. The most effective method for achieving the goal of controlling space is direct destruction of the enemy's orbiting spacecraft. For this reason, the United States, Russia, and other countries have developed large numbers of anti-satellite weapons, such as anti-satellite satellites, laser weapons, and microwave weapons. The United States has even proposed deploying space-based laser weapons systems before 2020, and to deploy space fighter units in space in 2025, in order to hunt enemy nations' spacecraft at any time. It can be affirmed that as space technology develops, the struggle among the major space nations of the world over control of space inevitably will intensify.

Section 3: The Status and Role of Space Operations Strengths...68

Space operations strengths hold the high ground on the informationized battlefield, and they exert a major impact on operational actions on the earth's surface. They are strategic strengths for protecting national security, they are important strengths for carrying out strategic deterrence, they are crucial strengths in struggling for the initiative, and they are key factors and links for shaping the ability for systemic operations.

I. Strategic strengths for protecting national security...68

As humanity has entered the Space Age, the categories of national interests have gradually transcended the traditional [ones of] land, territorial seas, and the air, and they have continually expanded and been extended toward space. The nation's security boundaries have also accordingly been extended from geographical frontiers that are bounded to the vast [reaches of] space, which have no bounds, and the ranges have been greatly expanded. Threats to space security have become a completely new threat that national security faces. Because the development of space will have a comprehensive role in promoting development and transformation in each sphere of the nation, the impact of space security will therefore not be limited merely to outer space, but will penetrate and radiate to almost every aspect of the nation's political security, economic security, information security, maritime security, environmental security, financial security, energy security, production security, and cultural security, becoming a support for every sphere of national security; its impact on national development and on the expansion of interests will become increasingly important. It can be said that without space security, it will be difficult to get effective guarantees for other [types of] security. As the "high frontier" and "security umbrella" of national security, space security has become an important component part of national security. As major strengths for protecting national space security, space operations strengths are a new type of and crucially important strategic strength, as well as the symbolic strength of the status of a great power in the twenty-first century. Historically, naval military strengths and nuclear strengths have one after the other been the symbolic strengths of a world power. The sea covers seventy percent of the earth's surface area and is a major channel for mankind's exchanges and an important support for his existence; after market economies replaced natural economies to become the dominant form of mankind's production, naval military strengths became an important symbol of a powerful country's domination. Nuclear weapons pushed mankind's violence to the extreme, and they had an extremely great deterrent role against opponents; they therefore became the symbol of the status of a great power in the twentieth century and even today they are still a stick than a number of countries chase after. But in the twenty-first century, if you do not have space operations strengths or if your space operations strengths are not strong, and if you cannot effectively use outer space and protect your own space interests, you will be unable to become a world power in the true sense of the term.

II. Important strengths for carrying out strategic deterrence...69

Military deterrence has existed since ancient times, and as people's understanding of military deterrence has continually deepened and as practices of military deterrence have constantly developed, military deterrence, with its increasingly diversified methods and means, has become an important component part of operational actions and has played a role that is ever more important. Threatening the use or limited use of space operations strengths often can have a major deterrent effect on the enemy, producing psychological fear and forcing him to abandon his operational intentions or controlling the scale and intensity of [his] operations and means of operations, thus creating a beneficial environment and situation for your own side's joint operations. Space deterrence, compared to nuclear deterrence, information deterrence, and conventional deterrence, is flexible in its use, has a high degree of credibility, and is characterized by its global, rapid, and highly effective nature. Spacecraft flying at high speeds in space can threaten any target in the spheres of land, sea, air, and space, and truly have the ability for "global reach and global operations;" space operations strengths are not limited by any political or geographical conditions and can quickly arrive at any assault region in the world, attack any region or target within the enemy's borders, and force the enemy to submit. Space weapons and equipment are characterized by high precision and great power, and this not only ensures that space attacks are highly effective, but it also reduces collateral damage to a maximum extent. Therefore, space deterrence has increasingly become an important form of deterrence, and this has been an emerging trend in recent local wars.

III. Crucial strengths in seizing the initiative in warfare...69

Practices in the world's several recent wars have shown that seizing command of space has become a prerequisite condition for seizing information dominance, command of the air, and command of the sea, and has become crucial in seizing and holding the initiative in warfare; it directly affects the course and outcome of the war. If we say that the core of mechanized warfare is command of the air, then the core of informationized warfare is command of space. No matter whether it is the buildup of space operations strengths or it is space operations, the heart of it is for seizing command of space. Without control over space, there is no use talking about control over land, sea, and the air; command of space has become a new focus that the two sides struggle for, following [their focus on] control over the land, command of the sea, and command of the air. In carrying out integrated joint operations under informationized conditions, these often do not commence on land, at sea, or in the air, but they begin first from space and they begin with command of space. Control of space and seizing command of space has continually been listed by such military powers as the United States and Russia as important strategic objectives for taking the initiative and for seizing superiority on the battlefield in future wars. Early on in the 1960s, former US President [John F.] Kennedy believed that whoever controlled space would control the initiative in warfare. The United States has emphasized that by the 21st century, its reliance on space capabilities will be just like the reliance that the survival and development of industry in the nineteenth and twentieth century had on electrical power and petroleum, and that space will become even more the focus of the United States' national security and national interests. Starting in 2001, the United States has held a space operations simulation exercise almost every two years; its goal is to explore the characteristics and laws of space operations and to test the feasibility of theory for the command of space. As the main strengths in space operations, space strengths can create extremely favorable prerequisite conditions for seizing control over the land, command of the air, and command of the sea, through seizing command of space, and they will thus seize the initiative in war. Speaking in this sense, space operations strengths will be crucial strengths for seizing the initiative in warfare.

IV. Key factors and links in shaping the capabilities of systemic operations...70

Joint operations under informationized conditions are integrated operations by strengths in multidimensional spaces, such as the land, sea, air, space, electromagnetics, the network, and knowledge; space operations strengths have unique advantages in collecting, processing, and transmitting information as well as the ability to carry out space offensive and defensive operations. They have already become an important component part of the system of joint operations under informationized conditions, and play the role of an "adhesive" link as the capability for systemic operations takes shape.

In other words, the buildup of space operations strengths is an important link in a healthy system of joint operations strengths, and is an effective way to rapidly enhance joint operations capabilities under informationized conditions and for shaping the abilities for systemic operations. First, space information systems are the foundation that military command information systems rely on for their operating. Space information systems can have the function of an information center and link, forming an integrated overall information network system, and organically combine reconnaissance, surveillance, early warning, communications, navigation, positioning, and mapping, thus forming an integrated overall information network system. Moreover, it links land, sea, air, space, and electronic offensive and defensive strengths into a multi-dimensional integrated system of operations, carrying out precise, rapid, and highly effective command, control, and attacks, and thus joining the various combatant strengths into an organic whole, by means of a network. They are interlinked, they supplement each other, and they support one another, to achieve victory in their joint operations in a coordinated manner. Just as the US military points out in its *Vision for Space 2020*,[6] military satellite systems are able to bring into play the operational potential of traditional military strengths to a maximum degree, and play a role in combining and multiplying traditional military strengths. Second, ground forces, naval, and air force operational strengths have extended the distance of their operations and the accuracy of their hits, with the information assistance and support of space operations strengths. Using the information superiority of space-based information systems, it is possible to provide precise target information, navigation and positioning, and communications relay for the various types of weapons platforms and equipment, thus clearly improving their ability for long-distance precision movement, adding to the forms of deployment for weapons and equipment, and increasing the distance of operations, accuracy of hits, and destructive effectiveness of ground forces, naval, and air force weapons platforms and equipment to an unprecedented degree. At the same time, the precision reconnaissance and rapid communications through satellites help in passive protection and active defense, and also help in evaluating and [providing] feedback about the results of attacks. Third, the mobile superiority of the rapid flight of space offensive operations strengths and the firepower superiority of long-range attacks by space weapons and equipment are also an important foundation for carrying out long-range precision attacks.

Section 4: The Use of Space Operations Strengths...71

Based on the characteristics of space operations strengths, their operational goals, and the laws of space operations, scientific and accurate use of space operations strengths are a

[6]Translator's note: Probably the US Space Command's *Vision for 2020*.

primary condition for seizing the initiative in space operations and for winning victory in space operations.

I. Unified command and prudent use...71

As an operational strength of a strategic nature, space operations strengths' use affects the overall situation of operations and national security, and it is necessary to stand at the vantage point of strategy; to give comprehensive consideration to the various political, economic, diplomatic, and military factors; and to make prudent decisions. In particular, hard kill actions against enemy satellites, spacecraft, and other space systems have a major impact on the overall situation, and it is even more necessary to be extremely prudent and to make thorough preparations, so as to prevent enemy retaliation. The US military has already declared that an attack by any country against its space systems is equivalent to a nuclear war against the United States. As the number of spacecraft in outer space has rapidly increased, the various nations' military and civilian spacecraft operating in differing orbits have formed an interwoven situation, directly affecting the deployment and orbital movements of your own side's space operations strengths, as well as the identification and tracking of enemy spacecraft. Once you take action in space operations, it is extremely possible that [these actions] will affect the normal work of neutral parties' spacecraft and even create "accidental damage;" particularly under current conditions where we lack the basis of effective and standard space laws, it will be easy for this to lead to intense international contradictions and disputes. Therefore, given that space operations strengths are one of the strategic strengths of the nation, the sensitivity in using them is extremely strong, and their use must be subordinate to and serve the needs of the overall national security situation. Under normal conditions, space operations should involve unified planning and unified decision-making by the supreme command organization of a joint operation, and they may even require the supreme leader of a nation or the supreme headquarters of the military to directly give an operational order, and command authority has the feature of being highly centralized and unified. Unified command is a guarantee for achieving optimal combinations of the various types of operational resources and for carrying out highly effective and stable space operations, and it is the foundation for a unified will to fight, for unified operational actions, for strengthening operational capabilities, and for achieving the goals of operations.

To exercise unified command over the operations of space operations strengths, it is first necessary to centralize control over space [strengths] and space defense strengths. Centralized control, as reflected in the objectives of the operation, requires determining the objectives in the use of space operations strengths, in accordance with the overall intentions of joint operations; as reflected in organization and planning, it is necessary to keep an eye on the overall situation and overall course of joint operations, and to make overall plans for the operational actions of space operations strengths. [Finally,] as reflected in the use of troop strengths and weapons, it is necessary to carry out integrated mastery and unified use of space-based directed energy, kinetic energy, and other powerful weapons and of such elite strengths as spaceflight units. Second, you should fully bring into play the role of networked information systems, in order to organically combine strategic decision-making, campaign command, and tactical actions. Networked information systems not only are the spiritual center of the joint operations system, but they also are a basic means for unifying command over space operations strengths. Through the networked information system, it is not only necessary to have space launch units, tracking units, spaceflight combat units, ground space defense units, support units, and defensive units share information and have information flow among them, but it is also necessary to closely coordinate and cooperate with the various services' and service arms' strengths of the ground forces, navy, and air force, and to strengthen close coordination with relevant local departments, fully utilizing all civilian space strengths that can be used.

II. Joint use and integrated operations...72

In future operations, only by joining together the diversified operational strengths that participate in space operations, forming an organic whole, is it possible to bring into play the maximum effectiveness of operations, using overall combined strengths to win victory in space operations. On the one hand, it is necessary to bring about the joint use of the various services' and service arms' strengths. Space operations are joint operations carried out in common by the various services and service arms, and given that space operations strengths are the main body in space operations, they primarily undertake such operational missions as deterrence, command of space, information confrontations, space assaults, and support, while other operational strengths, such as the ground forces, Navy, Air Force, and Second Artillery not only can use such operational means as long-range precision attacks, special operations, electronic warfare, and cyber warfare to jam, damage, and paralyze the enemy's space operations system and to assist their own side's space operations strengths in seizing command of space, but they also can provide effective protection for land-based, sea-based, and air-based space operations strengths, thus ensuring their survival. Therefore, organically combining the strengths of the various services and service arms that participate in space operations, in order to carry out overall operations, can make up for deficiencies in your own side's space operations strengths and weapons and equipment, strengthening the overall capabilities of space operations. On the other hand, it is necessary to break through the boundaries between the military and civilians, thus achieving the joint use of military and civilian space strengths. Space technology has military and civilian compatibility, and while the number and scale of military space operations strengths are limited, the development of civilian space systems has been quite rapid, with certain of its performance metrics already approaching or even surpassing those of military space systems, so they can undertake some of the support to operational missions. As long as civilian space systems keep an "interface" with military space systems, they will be able to become important component parts of combatant strength systems within space operations, and meet the needs of space operations. During the Gulf War and the Kosovo Campaign, civilian communications satellites were responsible for forty percent and sixty percent, respectively, of the US military's communications duties. In future informationized wars, with the unified planning, coordination, and use of military and civilian space systems in order to achieve the integrated operations of many types of space strengths, it will be possible to fully bring into play the roles of civilian space strengths, to make up for insufficiencies in the number and scale of military space strengths. In addition, you should also pay attention to using the space strengths and resources of friendly countries or allies in order to strengthen your own side's space operational capabilities. Through drafting relevant space treaties and agreements with friendly countries or allies, and establishing cooperation mechanisms of mutual trust, it is possible to use third parties' space strengths to assist your own side's space operations actions in wartime, under conditions where your own side's space operations systems have been jammed, damaged, or destroyed by the enemy.

III. With a focus on attack, have both offense and defense...73

An active offense is the only means to gain victory in warfare. On the one hand, space operations strengths have powerful information support capabilities, global mobility capabilities, and the ability to attack in all spheres; on the other hand, military spacecraft sailing and operations in space follow relatively fixed orbital movements, and their self-defense capabilities are not strong, while their ground space assistance and support systems are large targets, with fixed positions, spread over a broad area, with obvious characteristics, and with a weak ability to resist attacks, so it is not easy to organize their defense. Therefore, space operations strengths have the attributes where they are strong on offense and weak on defense, and as military space technology rapidly develops and is constantly turned into space weapons and equipment, the imbalance where space operations strengths are strong on offense and weak on defense will become more pronounced. In addition, space operations strengths also are a double-edged sword; not only is it possible to construct a "shield" for defense, but it is also possible to forge them into a "sharp sword" for offense. For example, missile defense systems where space operations strengths are the main body not only promptly and accurately find and effectively intercept long-range offensive weapons that the enemy has launched, ensuring that their own side will avoid the enemy's attack, but they also can use military space systems to conduct reconnaissance and positioning and can use ballistic missiles, cruise missiles, and combat aircraft to directly and precisely attack the enemy's long-range weapons systems and important targets, thus weakening, damaging, and even destroying the enemy's operations system.

When space operations strengths are in use, they should seize the initiative, based on their attributes as strengths that are long on offense, using sudden and violent firepower to carry out suppressive attacks against such targets as the enemy's orbiting spacecraft, space launch sites, integrated information systems, and command and control centers, seizing command of space at one blow and gaining information superiority. On this basis, they should again concentrate their space operations strengths and the other services' and services arms' operational strengths to carry out long-range precision attacks against the enemy's key economic, political, and military targets, weakening the enemy's potential operational strengths, attacking the enemy's system of operations, and weakening the enemy people's morale, up until they win victory in the operations. At the same time that they carry out active space offensive operational actions, they should thoroughly organize space defense operations. It is necessary to adopt vigorous defensive measures for their own orbiting spacecraft, space launch centers, and systems of operations and their key economic and political targets; to defeat the enemy's counterattack actions that he carries out against their own side; and to pay attention to achieving the goal of defense through such active offensive actions as anti-missile and anti-spacecraft operations, thus avoiding a negative and passive defense.

IV. Rapid reaction, with a focus on attack...74

Although space strengths have powerful offensive capabilities, space systems themselves are quite fragile, and once they come under a preemptive attack by the enemy, it is easy for them to become paralyzed and to become totally passive. In addition, space operations' own characteristics of fast speeds, rapid rhythm, and heavy consumption also require that operational actions must have a quick fight and a quick resolution, striving to avoid protracted indecision. Therefore, space operations strengths must fully bring into play the subjective dynamism of commanders at each echelon and the rapid reaction capabilities of operational units, and pay attention to carrying out focused attacks against the opponent's space operations systems and to paralyzing his organizational systems, in order to seize and hold the initiative in space operations.

First, it is necessary to be fully prepared. Comprehensive and complete preparations for operations are an important premise for quick reaction. The commander of space operations strengths and his command organ must command and monitor space [units] and space defense units in making thorough preparations of all kinds in a timely and concealed manner, based on the enemy's space operations intentions and his possible operational actions, as well as their own side's space operations missions and operations capabilities and on possible developments and changes in the battlefield situation, thus ensuring that as soon as a command is given it will be possible to deploy [space strengths] for operations. Only in this way will it be possible to be faster than the enemy's operational rhythm and speed, and to quickly achieve the goals of space operations.

Second, it is necessary to seize the initiative and to have focused attacks. The commander of space operations strengths and his command organ must accurately ascertain the intentions of the enemy's space operations and the time, form, and scale of the first attack that [the enemy] might carry out, and command his units to seize the favorable opportunity where the enemy has basically completed his preparations for operations but not yet launched his attack, and to adopt the form of a sudden raid to carry out a destructive attack against the enemy's important orbiting spacecraft and the key installations of his space [bases] and space defense bases, in order to try to quickly paralyze the enemy's entire system of space operations, so that it will be hard for the enemy's space [strengths] and space defense strengths to recover their operational capabilities for a fairly long period of time, and thus you will achieve your own side's goal of a quick fight and a quick resolution.

Third, it is necessary to base yourself on repeated struggles. Superiority and inferiority, having the initiative and being on the defensive are relative postures in operations that the two combatant sides are placed in, and [these postures] can be switched under certain circumstances. In operations under informationized conditions, the struggle between the two sides' space operations strengths for superiority and the initiative will permeate the entire process of space operations, and it is quite possible that your own side's space operations strengths will only be able to finally gain superiority and the initiative in space operations through complicated and protracted struggles with the enemy. For this reason, it is necessary to exert prolonged pressure in space against the enemy, through continuous blockades and suppressive actions, and not giving his space operations strengths an opportunity to adjust and recover, thus maintaining your own side's superiority and the initiative. When your own side's space operations strengths come under enemy attack and temporarily are trapped in passivity, you should adopt such measures as emergency launches, adjusting your deployments, or enabling backup systems, in order to strive to recover your operational capabilities within the shortest period of time possible. Through gradually changing the ratio of space [strengths] and space defense strengths between the two sides, [you can] switch superiority and inferiority, and again take back the initiative in space operations.

Questions for Deliberation…75

1. What differences are there between space operations strengths' unit structures and personnel structures?

2. What are the main missions of space operations strengths?

3. What are the status and role of space operations strengths?

4. What principles should space operations strengths follow in their use?

Lecture 4
Space Equipment for Space Operations...76

Space equipment for space operations is a new type of weapon and equipment that emerged when science and technology developed to a certain stage, and it is the physical foundation for future space operations as well as an important technological guarantee for them. It is an important component part of modern high-tech weapons and equipment and an important symbol of national defense modernization and composite national strength, and it plays a crucially important role in seizing superiority in warfare and victory in operations.

Currently, there is as yet no unified and clear definition of space equipment for space operations, either within the PRC or abroad. The US military rather broadly utilizes the wording "military space systems," but it has not made any clear-cut definitions; although the Russian military has mentioned the term military spacecraft equipment, it has not put forward a conceptual explanation. The theoretical monographs that the PRC military has published over the past few years have understood [the term] spacecraft equipment for space operations mostly from two areas, a narrow sense and a broad sense. Speaking in the narrow sense, space equipment refers to various kinds of remote-sensing devices and monitoring equipment, communications equipment, and weapons systems that are deployed in space and that are used to carry out such military missions as reconnaissance and surveillance, ballistic missile early warning, military communications, navigation and target positioning, meteorological monitoring, geodesy, anti-satellite and anti-ballistic missile, and space offense and defense. Speaking in the broad sense, space equipment is a general term that refers to weapons and weapons systems that are used in peacetime or wartime to seize command of space and to carry out the missions of space operations, as well as the military technological equipment and materials that are ancillary to these [weapons and weapons systems]. These not only include the space equipment and ground applications systems that are referred to in the narrow sense, as well as the various weapons and equipment that use these as platforms, but they also include ballistic missiles and the weapons and equipment systems that carry out space operations missions using the land, sea, and air as their support.

Looking at developmental trends, future warfare inevitably will be integrated joint operations that are carried out in the multidimensional spaces of land, sea, air, space, and electronics. Based on this situation, the concept that defines space equipment for space operations in the broad sense is more accurate, that is, space equipment for space operations is a general term that refers to the spacecraft and space-based weapons systems that are used in peacetime or wartime to carry out and support space operations missions, as well as their applications systems, carrier tools, and relevant devices and installations. Looking at their military applications, they can be specifically divided into three categories. The first is satellite systems that are already used in large numbers for supporting ground military strengths, such as reconnaissance satellites, early warning satellites, military communications satellites, navigation satellites, meteorological satellites, and geodetic satellites. The second is space-based or partially space-based weapons that are undergoing research and development; this primarily refers to anti-satellite systems used by attack spacecraft, including anti-satellite missiles and various types of space-based directed energy weapons (laser and particle beam weapons). The third is manned spacecraft that theoretically could carry out military missions but that have only done individual exploratory tests; these include manned spaceships, space stations, space shuttles, and space planes.

To make it easy to understand, this lecture will focus on the functional roles of space systems, with an emphasis on five areas: space information collection, space navigation and positioning, space information transmission, space operations weapons, and ground applications of space resources, as it carries out a systematic explanation and description of spacecraft equipment.

Section 1: Space Information Collection Systems...77

Space information collection systems refer to satellite-borne systems that use such reconnaissance devices as optoelectronic equipment or radio receivers to engage in reconnaissance, surveillance, or tracking from earth orbit against predetermined targets on the ground, at sea, or in the air, in order to collect the targets' intelligence information. Based on differences in their effective payloads and missions, space information collection systems generally can be divided into satellite imaging reconnaissance systems, satellite electronic reconnaissance systems, satellite missile early warning and nuclear explosion detection systems, satellite cartographic mapping systems, satellite ocean monitoring systems, satellite meteorological monitoring and early warning systems, and satellite earth resources survey systems.

I. Satellite imagery reconnaissance systems...77

1. Overview

Satellite imagery reconnaissance systems are also called satellite photoreconnaissance systems; they refer to satellite-borne systems that obtain images from the reflected light of the targets being collected against, by means of visible light and microwave remote-sensing devices; they are primarily used to reconnoiter intelligence on airfields, seaports, missile bases, communications hubs, urban fortifications, industrial layouts, troop strengths assemblies, and military deployments. Among the various types of satellite reconnaissance systems, imaging reconnaissance systems were the earliest to develop, and they are the ones that undertake most of the space reconnaissance and surveillance mission. Their reconnaissance devices usually include visible light cameras, infrared cameras, multispectral cameras, synthetic aperture radar, and television cameras. Of these, visible light cameras can get the best ground resolution, and their image data are directly seen and easy to interpret; multispectral and infrared cameras can identify camouflage, and monitor military actions at night; synthetic aperture radar can carry out reconnaissance in all weathers and at all times; and television cameras can carry out near-real-time reconnaissance, thus shortening the time for collecting intelligence. Because the form in which synthetic aperture radar works is to emit electromagnetic waves and receive electromagnetic echoes from the target, it has a certain ability to display moving targets, and it can reconnoiter, track, and monitor dynamic military targets and military activities. Imaging reconnaissance satellites usually use nearly circular low earth orbits for their activities, at an altitude of less than 1,000 kilometers; sometimes, in order to get higher surface resolution, their altitude will drop to 150 to 160 kilometers while photographing [targets].

2. Classification of satellite imaging reconnaissance systems

In accordance with differences in the form of their information transmission, satellite imaging reconnaissance systems can be divided into two types: return types and transmission types. The reconnaissance information in return-type reconnaissance systems is stored on film or magnetic tape carriers; after the satellite has completed its reconnaissance mission, the return capsule in which the information carrier is deposited returns to the surface. The transmission-type reconnaissance system, on the other hand, is not equipped with a return capsule; the reconnaissance information uses real-time or extended-time radio transmission methods for transmission to an earth station. In accordance with differences in their uses, satellite imaging reconnaissance systems can also be divided into two types: general survey types and detailed survey types. The general survey-type reconnaissance system is equipped with low-resolution wide-angle cameras; it scans and photographs a defined country or region, and it can find potential military and economic targets. Detailed survey-type reconnaissance systems use high-resolution cameras with fairly narrow fields of vision; they repeatedly reconnoiter and photograph regions of particular interest that they find during general survey flights, and they can get clearer photographs. Currently, reconnaissance satellites that are "both general survey and detailed survey types" have appeared; this kind of satellite has a certain ability to move and change orbit and the satellite's lifespan is also fairly long, so it not only can be used for general survey missions, but it also can carry out detailed survey missions.

3. Sample satellite imaging reconnaissance systems

(1) US return-type satellite imaging reconnaissance systems

Fifty-odd years ago, the United States launched the world's first return-type imaging reconnaissance satellite, Discoverer 1. Starting in the spring of 1962, the United States' imaging reconnaissance satellites entered into the stage of actual applications, and up until now it has developed six generations [of this satellite type]. The first generation was the Discoverer series, which used visible-light cameras and return film canisters as its form of work; it had a relatively low resolution (detailed surveys had two to three meters, general surveys had three meters), and its work life was fairly short. The Discoverer reconnaissance satellite program's codename was the Corona program, and it had KH as its serial number. "KH" was an English-language abbreviation for Keyhole, with the meaning of a camera peeping at the surface as though through a keyhole on the satellite. Therefore, its follow-up models were also directly referred to as "keyhole" reconnaissance satellites. The photoreconnaissance satellites with differing KH serial numbers used differing cameras, and their reconnaissance capabilities also differed. The Discoverer satellites were divided into three types, in accordance with their serial numbers: KH-1, KH-2, and KH-3. The second generation began to be used in 1963; it took shape on the basis of improvements to the first generation, and its performance was somewhat improved. The third generation began to be used in 1966, as the Samos series. Its detailed survey performance was much greater than that of the second generation; its orbiting altitude could be lowered to 110 kilometers, and its resolution could reach about 0.15 meter. The fourth generation began to be used in 1971; it was a type that combined general and detailed [surveys], and its name was Big Bird. This was a world-famous satellite imaging reconnaissance system, as well as the last generation of return-type photoreconnaissance satellite; its code name was KH-9. It not only could enter the atmosphere for surveillance, but it could also carry out "point-blank observation;" it not only could transmit reconnaissance results by radio, but it also could get information by returning [canisters]. It had a resolution that could be up to 0.3 meter, but the surface scenery it photographed had a width that was rather small. The Big Bird reconnaissance satellite could carry a number of film cartridges, its working time in orbit was relatively long, and every time that war occurred someplace on earth, the United States used [this satellite] to monitor the battlefield. The sixteenth Big Bird satellite, which was launched in the early 1980s, worked for 261 days in orbit, and it monitored the battlefield situation of the Iran-Iraq War.

Although return-type photoreconnaissance satellites in the latter period used a number of forms for film cartridges, still, when all was said and done, it took several days to retrieve, interpret, and process them, while photographs from detailed surveys required several weeks before they could provide information on the battlefields. This easily bungled opportunities for battle in high-tech wars, and was unable to satisfy the needs of modern operations, so the United States later no longer used this type of reconnaissance satellite.

(2) Russia's return-type satellite photoreconnaissance system

Zenit was the Soviet Union's return-type satellite photoreconnaissance system in the early period; it was divided into two models: Zenit-2 and its improved model, Zenit-4. Zenit satellites consisted of two parts: a spherical return canister and a service module; their exterior appearance was very similar to the Soviet Union's first-generation manned spaceship, Vostok. What Russia currently uses is the high-resolution detailed survey-type Antar series of satellite photoreconnaissance system, including Antar-2K and Antar-4K; of these, the main model is the Antar-4K. The Antar-2K satellite consists of a composite compartment, an instrument compartment, and a special equipment compartment. The composite compartment primarily has a propulsion system, while the special equipment compartment has a camera and return system. The focal length of the camera is more than three meters, its surface resolution is fifty centimeters, and [the satellite's] working time in orbit is thirty days. Antar-4K is divided into two models: Antar-4K1's time in orbit has been extended to forty-five days, while Antar-4K2's time in orbit has been extended to 60 to 114 days, and it has several film return cartridges.

Russia's photoreconnaissance satellites all are serialized, and can satisfy reconnaissance requirements for differing precision and differing periods of time. Zenit-2 was also equipped with electronic reconnaissance devices and had multi-functional reconnaissance capabilities. The Antar-4K2, which had multiple film return cartridges, improved the time-effectiveness of outer space reconnaissance to a certain extent, and it was possible to select differing models and differing working times in orbit, based on the mission, thus strengthening flexibility in its uses.

(3) US transmission-type satellite photoreconnaissance systems

The United States' transmission-type satellite photoreconnaissance systems were developed on the basis of return-type [systems]; its fifth-generation photoreconnaissance satellite was also its first-generation transmission-type photoreconnaissance satellite, called Kennan/Crystal, and codenamed KH-11 (that is, Keyhole-11). A total of eight of this type of satellite were launched, and they have all stopped working. The KH-12 (that is, Keyhole-12) (see Figure 4-1) was the United States' sixth generation of photoreconnaissance satellite and was also the transmission-type photoreconnaissance satellite with the world's highest resolution at that time. It was improved and manufactured on the basis of the KH-11, and was also called an “advanced Keyhole-11;” it was first launched in August 1989. The KH-12 satellite’s working orbit and exterior were similar to those of the KH-11, its cylindrical structure (or camera lens) was similar to that of the Hubble space telescope, and its diameter was 4.5 meters; a large rocket engine was added to its exterior to provide mobility and [the ability] to change orbits; and its total length was more than fifteen meters (the Hubble telescope was only thirteen meters long). The greatest differences between it and the KH-11 were that it could carry more fuel, it had a greater ability to move and change orbit, and its lifespan was longer. The KH-12 used digital imaging transmission technology, that is, a satellite-borne analog-to-digital converter transformed analog signals into digital signals, and these were directly transmitted by a relay satellite to a surface interpreting center. [There,] they were converted into images and displayed on a large screen; this thus digitized information transmission, greatly enhanced the time-effectiveness of intelligence collection, and extended the working life of the satellite. Because the most sophisticated electronic equipment was used, its imaging quality could rival that of return-type satellites’ photographs, and its resolution was close to ten centimeters. Although the performance of the KH-11 and KH-12 was advanced, the effectiveness of the visible-light and infrared cameras that they used was not optimal when the weather was bad (for example, when there were clouds and rain); moreover, the visible-light equipment had no way to work at night, thus affecting their real-time nature to a certain extent. During the Kosovo Campaign, the KH-11 and KH-12 were affected by the weather a number of times, so that they could not carry out their reconnaissance missions.

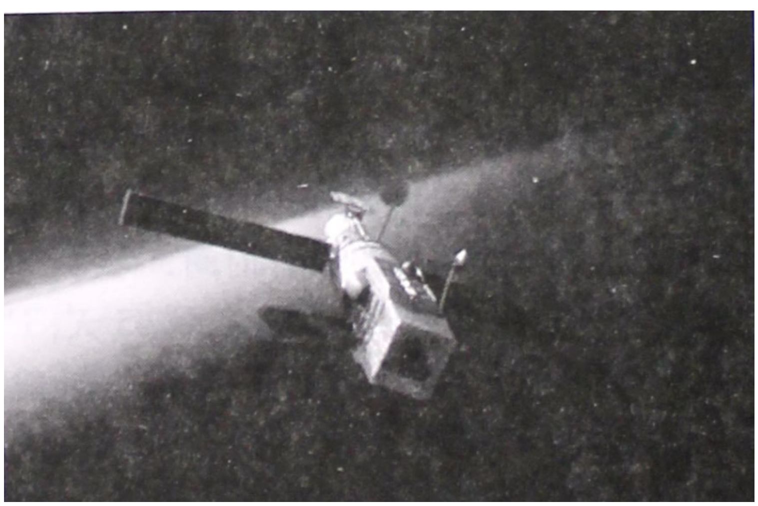

Figure 4-1: The United States’ KH-12 Imaging Reconnaissance Satellite

In order to make up for the inadequacies of the KH system satellites, in that their reconnaissance effectiveness was greatly affected by weather conditions, the United

States for the first time, in December 1988, used the space shuttle to launch a Lacrosse synthetic aperture radar imaging reconnaissance satellite. The Lacrosse satellite is equipped with a fairly large radar antenna and emitter, its resolution mode is three meters, and its fine sweep mode is one meter. The solar energy battery wings along its two sides are symmetrically vertical to the satellite's body; after unfolding, the "wing span" reaches fifty meters, with power of up to ten to twenty kilowatts, exceeding that of any other satellite. In order to improve the satellite's reconnaissance capabilities, the United States' National Reconnaissance Office also made improvements to it, so that the resolution of its fine sweep mode has been raised to ten centimeters, almost the same as that of the KH-12. Because the radar depends upon its own irradiation, that is, it emits electromagnetic waves, therefore no matter whether the weather is good or bad and no matter whether or not there is sunlight, it can image targets. Moreover, the wavelength of its radar waves is much longer than the wavelengths of visible light and infrared, so it can "pass through clouds and fog" and carry out reconnaissance in all weathers and at all times. In particular, it is much more real-time in nature. During the Gulf War, Lacrosse radar imaging reconnaissance satellites were used to reconnoiter and evaluate the results of attacks by US cruise missiles and to track the actions of Iraqi armored units. In the Kosovo Campaign, they were used to reconnoiter weapons and equipment that the Yugoslav military had camouflaged. In these military actions, the Lacrosse satellite played a very good role.

II. Satellite electronic reconnaissance systems...81

1. Overview

Satellite electronic reconnaissance systems are also called signals intelligence (SIGINT) systems; they refer to satellite-borne systems that use electronic signals receiving apparatus to analyze radio signals transmitted and radiated by various targets on land and at sea, to roughly position the signals radiation sources, and to determine their frequency bands and form of scanning. They are primarily used to acquire the configuration and performance parameters of enemy early warning and air defense radars, the telemetry data of strategic missile tests, and how electronic equipment like military radio stations are configured. The frequency reconnaissance scope of satellite electronic reconnaissance systems is primarily between 30 megahertz and 200 gigahertz, the systems are configured with many reconnaissance means, and their work forms are also flexible and variable. They no longer detect radio signals in the simple sense [of the term]; for example, they combine visible light and infrared imaging reconnaissance devices to reconnoiter targets, and they form a network with multiple satellites for their work. These have all greatly improved the working capabilities of satellite electronic reconnaissance systems. The effective payload of satellite electronic reconnaissance systems consists of the detection and receiving antennas, receiver system, recording system, information processing system, communications system, propellant receptacle, and orbit and attitude control system. After a satellite electronic reconnaissance system detects and receives signals, it records and stores them and does initial processing; afterwards, it sends the reconnaissance data through a downlink communications link to the earth station for further processing and distribution.

Electronic reconnaissance satellites ordinarily operate in near-circular orbits at altitudes of 300 kilometers to 1,000 kilometers, with a period of about 90 to 105 minutes. At these altitudes, satellite antennas cover a large area, they have a broad reconnaissance scope, their duration lasts for long periods of time, they can pass through the air over a single point for more than ten minutes, and they are superior to and more secure than other means of electronic reconnaissance. As electronic intelligence relies more and more on satellites, electronic devices have continually improved, especially in the United States, and the height of electronic reconnaissance satellites' orbits has already developed to altitudes of more than 800 kilometers. The higher the location of a satellite, the broader the area of land it will cover. If [satellites] are placed in geostationary orbits, only three satellites are required to cover the entire globe; this greatly enhances the time-effectiveness for monitoring electronic targets. At the same time, in order to improve the time resolution and space resolution, the form in which satellite electronic reconnaissance systems work has developed from a single satellite working [by itself] to a network made up of multiple satellites. In order to improve the timeliness of information, information processing functions, which previously were on the ground, have incrementally developed toward satellites, and with the development and application of large-scale integrated and microprocessing technology, terminal equipment on satellites will shoulder more and more of the information processing tasks; this will lay the foundation for direct use of satellites to transmit information on future battlefields.

In May 1962, the United States launched the first detailed survey-type electronic reconnaissance satellite; following this, it also launched a general survey-type electronic reconnaissance satellite. In the early 1970s, after the United States had determined the basic deployment of its opponent's electromagnetic radiation sources, it no longer launched detailed survey-type electronic reconnaissance satellites, and as the life of satellites grew and as electronic reconnaissance technology progressed, the number of launches of general survey-type satellites also was greatly reduced. After 1971, United States launched the high elliptical orbit-type Jumpseat electronic reconnaissance satellite and the geosynchronous orbit-type Rhyolite electronic reconnaissance satellite, one after the other, as well as its follow-up Magnum electronic reconnaissance satellite. Currently, the US satellite electronic reconnaissance system has developed a total of six types, and what it is now using is general survey types, synchronous types, high elliptical orbit types, and new types of extreme orbit types. During the Gulf War, the United States' satellite electronic reconnaissance system listened in on and reconnoitered Iraq's radio and microwave communication day and night, as well as the telemetry signals [Iraq] was testing; after this electronic intelligence was transmitted to the National Security Agency for processing and analysis, the Iraqi military's assemblies and movements, the locations and functional parameters of its military radars and radio stations, and information about new types of weapons and equipment were derived from it.

Because the lifespan of Russia's electronic reconnaissance satellites was relatively short, [Russia] launched fairly large numbers of these. Russian electronic reconnaissance satellites can roughly be divided into four generations, and currently the third and fourth generations predominate. Of these, the fourth generation is one of several types of satellites that Russia has researched, developed, and launched, whose structure is the most complex and whose manufacturing is the most expensive. Its primary mission is to intercept communications and electronic signals, and to track the ship activities of the United States and NATO. The satellite has fairly strong satellite-borne processing abilities, and can relay data in real-time to earth stations within Russia, using Potok satellites in geosynchronous orbit.

2. Categories of satellite electronic reconnaissance systems

Just like satellite photoreconnaissance systems, satellite electronic reconnaissance systems are divided into two types – general survey models and detailed survey models – and they can operate in a number of types of orbits. Satellites operating in nearly circular orbits at altitudes of 300 kilometers to 1,000 kilometers have periods of 90 to 105 minutes; their antennas cover large areas, their scope of reconnaissance is broad, their duration lasts for fairly long periods of time, they pass through the air above a single area for more than ten minutes, and they are primarily used for general surveys. Satellites that operate in high elliptical orbits pass through the air over a given area for up to ten hours and can carry out prolonged monitoring of this area. This makes detailed surveys easy; that is, they accurately confirm targets of interest discovered during the process of a general survey, and they obtain the characteristics and specific parameters of radio station and radar signals, which makes it easy to derive valuable intelligence. And with electronic reconnaissance satellites moving in geostationary orbit, only three can then cover the entire earth; if they are used together with electronic reconnaissance satellites in other orbits, it is possible to form a system with a number of functions, such as general surveys and detailed surveys.

3. Typical satellite electronic reconnaissance systems

(1) The United States' Jumpseat electronic reconnaissance satellite

The Jumpseat is a first-generation electronic reconnaissance satellite that the United Sates began launching in the 1970s; the number that was launched was fairly large, and now there are still two of them working in orbit. The Jumpseat satellite uses a high elliptical orbit with a period of twelve hours and an angle of inclination of 63.4 degrees; its apogee is at an altitude of 37,000 kilometers, similar to the orbit of Russia's Molniya satellite, and it can carry out long-term surveillance of key areas in Russia (particularly of its northern parts). It is primarily used to reconnoiter military radio station and radar signals. Two to three of these satellites work in a network, that is, they can carry out continuous reconnaissance at all times and in all weathers. They use such advanced technologies as large antenna structures and satellite-borne information processing, they have fairly high reconnaissance precision and satellite-borne data processing capabilities, and they can quickly identify and transmit target information. The weight of the upgraded model of Jumpseat satellite was increased from the original 680 kilograms to about 8,000 kilograms, the diameter of the parabolic receiving antenna was 18.3 meters, while the parabolic downlink communications antenna had a diameter of 3.05 meters. The newest Jumpseat satellite, on the other hand, uses a broadband phased array eavesdropping antenna; after this deploys, it has a diameter of up to 91.4 meters and can simultaneously listen in on up to a thousand ground signal sources.

(2) The United States' Magnum electronic reconnaissance satellite

The Magnum is a new type of US geostationary electronic reconnaissance satellite, as well as the main force in the United States' current space electronic reconnaissance system; there currently are three operating in orbit, and they can cover the entire globe. After the satellite-borne reconnaissance system on the Magnum satellite listens in on signals, these undergo simple processing on the satellite; they then are first sent to a US military ground base situated in Australia, and they are then sent back to the US homeland. The Magnum satellite carries two antennas: the forward-facing parabolic antenna's maximum diameter is 152.5 meters, and it is used to intercept all radio signals from 0.1 gigahertz to 20 gigahertz, including radar signals, missile telemetry and remote control signals, radio station communications signals, and microwave signals; the rear-facing antenna is used to forward signals to the ground. The Magnum satellite is designed to have a long lifespan, and the signals processing capabilities on the satellite are quite strong; they can carry out real-time and continuous reconnaissance and listening.

(3) Russia's Tselina electronic reconnaissance satellite

Russia started using Cosmos-3M rockets to launch Tselina satellites at the end of the 1960s. Most of these satellites operated at an orbit 540 kilometers high, with an inclination of seventy-four degrees; they used the gravity gradient stabilization method. Although a fairly large number of types of electronic reconnaissance satellites were launched during the time of the Soviet Union, Russia currently only uses two of these, that is, the Tselina-D and the Tselina-2. The Tselina-2 electronic reconnaissance satellite began to be used in 1990 and it currently is still being launched, with one to two satellites launched yearly on average. The Tselina satellite uses the form of a number of satellites intersecting to form a network, with low earth orbits. Their probes are very flexible and their monitoring capabilities are strong, but the number of satellites that are needed is large. The satellite structure is simple and easy to control, and its directional capabilities are strong.

III. Satellite missile early warning and nuclear explosion detection systems...84

1. Satellite early warning and detection systems

Satellite missile early warning systems refer to satellite-borne systems that use infrared probes on satellites in order to monitor, find, and track strategic ballistic missiles launched by specific targets and to issue early warnings. Satellites that are loaded with this kind of system usually are deployed in geostationary orbit or in high elliptical orbits with a period of about twelve hours, and they generally work in networks with multiple satellites. Missile early warning satellite networks normally network with space-based probe networks and ground early warning radar networks in order to form early warning and detections platforms that integrate the land, sea, air, and space, striving to find [missiles] in a timely manner and trying to track enemy-launched ballistic missiles and space flight vehicles throughout the entire process of the boost phase, flight phase, and reentry phase, in order to provide air defense anti-missile operations with necessary early warning time and interception parameters. Early warning satellites have high orbits, cover a broad scope, and are able to overcome the drawbacks that ground air defense radars have, where they are unable to find targets as early as possible because electronic wave signals spread along straight lines and are affected by the earth's curvature. Based on the distance of the opponent's missile launch site, [missile early warning satellites] can give fifteen to thirty minutes of early warning time, and thus make it easy for your own side to catch opportunities for battle and to organize strategic defense or carry out a counterattack in a timely manner. Some countries also have X-ray probes, gamma ray probes, and neutron counters on their early warning satellites, in order to also carry out the task of detecting nuclear explosions.

2. Satellite nuclear explosion detection systems

Satellite nuclear explosion detection systems refer to satellite reconnaissance systems that are used to monitor and detect nuclear explosions in the atmosphere and in outer space. In peacetime, this system is primarily used to monitor how the various countries are implementing the [Comprehensive] Nuclear Test Ban Treaty; in wartime, they are used to collect the parameters of nuclear explosions, such as the nuclear explosions' coordinates, time, power, and altitude data, in order to appraise the effects of the nuclear explosion. Satellite nuclear explosion detection systems have advantages in that there is little background interference and the distance of detection is long, and they can detect the X-rays, gamma rays, neutrons, electromagnetic pulses, and nuclear explosion fireballs that are produced alongside nuclear explosions. The Vela nuclear explosion detection satellite system that the United States first launched in the early 1960s adopted the paired launch form, and [these satellites] operated in a nearly circular orbit at an altitude of 90,000 to 120,000 kilometers, with an inclination of 320 degrees to 40 degrees and a period of 85 to 112 hours; they were designed to have a lifespan of three years. By the early 1970s, a total of six had been launched; afterwards, this kind of special satellite was no longer launched. Instead, nuclear explosion probes with similar functions were installed in early warning satellites or navigation satellites, in order to also carry out the task of detecting nuclear explosions.

3. Typical missile early warning and nuclear explosion detection systems

(1) The United States' Defense Support Program satellite system

The Defense Support Program was a program that the US Air Force designed in the late 1960s that used satellites to carry out missile early warning. The Defense Support Program (DSP) satellite system could provide twenty-four hours [daily] of global monitoring, and was used to detect ballistic missile launches and nuclear explosions. The US Air Force's DSP early warning satellite network was composed of five satellites in geostationary orbit, consisting of three working satellites and two backup satellites. This system usually could provide a total of twenty to thirty minutes of early warning time against intercontinental ballistic missiles, five to ten minutes of early warning time against submarine-launched ballistic missiles, and five minutes of early warning time against tactical ballistic missiles. A new generation of DSP satellite systems has a very high level of automation, its abilities to change orbits and move are markedly increased, and it has a certain ability to prevent collisions. At the same time, it also has data retransmission functions; that is, after enemy jamming or data relay, it can quickly repeat its transmissions. Moreover, it can use satellite-borne laser transmission links to transmit data to other satellites, ensuring that the ground reliably receives them.

Starting in the 1970s, DSP early warning satellites became a component part of the United States' North American Air Defense Command (NORAD) tactical early warning and offensive evaluation system. The data downlinked from early warning satellites were transmitted to NORAD via communications links and to the Space Command's early warning center for processing; the processed data were directly delivered to various bureaus and distributed among the various areas of operations throughout the globe. The United States' overseas units or allies could also directly receive DSP satellites' data through the Joint Tactical Ground Stations (JTAGS). In the Gulf War, the United States' DSP satellite system played an important role in Patriot missiles' interception of Scud missiles. However, DSP satellites themselves also have weak points; for example, their satellite scanning speed is slow, their ability to identify targets is poor, they have problems with false alarms, and their ability to detect theater of war missiles is quite limited. Therefore, the United States decided to research and develop a new type of Space-Based Infrared System (SBIRS) with stronger deployment capabilities, in order to replace the DSP system

(2) The United States' Space-Based Infrared System

In the early 1990s, the United States began to research and develop a new generation of missile early warning satellite, under the Space-Based Infrared System. The Space-Based Infrared System was a comprehensive system that included a number of satellite constellations and ground installations, composed of high-orbit satellites, low-orbit satellites, and ground installations. The high-orbit part of the Space-Based Infrared System will provide US supreme command authorities and operations departments with infrared data related to the launch, boost, and flight phases and landing point regions of global and theater of war missiles or other infrared incidents. The high-orbiting satellites include four geosynchronous satellites (GEO) and two high-elliptical orbit satellites (HEO). The scanning speed and flexibility of the high orbit satellites of the Space-Based Infrared System are greater than those of the DSP satellites, and they can transmit early warning information to ground units ten to twenty seconds after a missile launch. The geosynchronous satellites are primarily used to detect and find ballistic missiles in the boost phase; they have two types of infrared probes: staring and scanning. The scanning probe uses a small-scale phased array to scan the entire region in order to construct a complete image of the entire region. The low-orbit part is made up of four to twelve low-earth orbit satellites (SBIRS-LEO). The low-orbit satellites' missions primarily are to provide precision tracking and identification in the trajectory's mid-flight phase; they will track ballistic missiles world-wide, from their launch to their reentry, and will provide guidance data to missile interception missiles. The low-orbit satellites and high-orbit satellites jointly provide the ability to cover the entire world. The SBIRS system not only can complete its strategic missile early warning mission better than the DSP system was able to, but it also can carry out effective early warning and tracking against attacks by tactical ballistic missiles, and it thus can meet the needs of the US military in the 21st century for early warning against strategic and tactical ballistic missiles.

IV. Satellite cartographic systems...87

1. Overview

Satellite cartographic systems are also called satellite geodetic and mapping systems; they refer to satellite geodetic systems that are used to determine the shape of the earth, the distribution of the earth's gravity field and geomagnetic field, and the precise geographic coordinates of various points on the earth's surface, as well as such geophysical information as movements of the earth's tectonic plates and polar motion. They are the main component part of geodetic survey systems. Because the distribution of the earth's gravity field is not uniform and because of errors in measurement, the various geographic locations shown on existing maps often do not correspond with actual sites; it is possible, by means of geodetic satellites, to calibrate errors in data related to calculations for missile trajectories, [related to] inertial guidance for aircraft and missiles, and [related to] matching cruise missiles' guidance to maps, thus improving the accuracy of hits and greatly enhancing the operational effectiveness of strategic weapons. Geodetic satellites have value militarily in their broad-ranging applications, and the US and Russian geodetic satellites are launched especially for military use. In addition, it is possible to equip geodetic satellites with other special equipment (such as multispectral cameras), in order to survey earth resources, thus turning them into earth resources satellites, to be used in ascertaining and getting a grasp on the reserves of the various nations' strategic resources.

Currently, the nations that have launched satellites especially for geodesy consist of the United States, Russia, and France. Of these, the United States' geodetic satellites consist of Geos-3, the Laser Geodynamics Satellite and others; Russia's geodetic satellites are mixed in with its Cosmos series; and France's geodetic satellites consist of the Diaposon, Diadem, Peole, and others. The US Department of Defense in February 2000 carried out three-dimensional, highly accurate digital terrain mapping of seventy percent of the entire globe's land area, using a synthetic aperture radar carried on the space shuttle; these data have an important value militarily and especially for precision-guided weapons.

2. Categories of satellite cartographic systems

In accordance with whether or not a satellite carries special active geodetic systems, satellite geodetic systems can be divided into two types: active and passive. Currently, most are active geodetic-type satellites. In accordance with the differing geodetic missions and methods, satellite geodetic systems can also be divided into geometric satellite geodetic systems and dynamic satellite geodetic systems. Satellite geometric geodesy uses satellites as reference points or control points to engage in geodetic surveys. Based on the role of satellites in geodesy, satellite geometric geodesy can also be divided into two types. The first is data for precision predictions of satellite orbits, using the satellites as positioning benchmarks, in order to determine the precise coordinates of anchor points. By using this method, navigation satellites and reconnaissance satellites can also serve as geodetic satellites; their accuracy is determined by the accuracy of predictions about the satellites' orbits. The second is to treat satellites as intermediary control points for the various observation stations, and to carry out trans-continental and transoceanic global geodetic conjunction through simultaneous observations and spatial triangulation, in accordance with unified global geodetic data, in order to build a high-precision global network of geodetic control points. Satellite dynamic geodesy uses already-known satellite orbital parameter or the instantaneous positions of satellites to obtain the earth's gravity parameters, based on orbital perturbation theory, and to thus determine the geocentric coordinates of the locations of observation points.

3. Typical satellite cartographic systems

(1) The United States' Anna satellite geodetic system

The US Army, Navy, Air Force, and National Aeronautics and Space Administration cooperated in 1962 to launch the first geodetic satellite, the Anna-1B. The Anna-1B's effective payload consisted of a mapping camera, electronic ranging, and a Doppler tachometer. In consideration that the Anna-1B would be equipped with a laser ranging system, the US Army developed a Sequential Collation of Range (SECOR) transponder for the ANNA-1B in orbit. A ground-transmitted phase modulated signal would be received in the SECOR transponder installed on the ANNA-1B, and then sent back to earth. The ANNA-1B could transmit continuous wave signals to the surface on unmodulated fixed frequencies, and the continuous wave signals received on the surface would produce a shift in the frequency (the Doppler effect). The size of the frequency shift was compared to the rate of change in the oblique distance between the earth station and the satellite, that is, the radial velocity. By installing a laser rangefinder on a telescope on the surface, this could be used to simultaneously measure angles and distances.

(2) The United States' Laser Geodynamics Satellite Geodetic system

A total of two of the United States' Laser Geodynamics satellites were launched. The satellite was a sphere made of aluminum; it was sixty centimeters in diameter and weighed 410 kilograms, and it used a circular orbit. One [of the satellites] had an altitude of 5,800 kilometers, with an inclination of 110 degrees; the other had an altitude of 5,843 kilometers, with an inclination of fifty-two degrees. The surface of the satellite had 426 laser mirrors, used to verify the laser satellite's tracking technology, and to accurately measure the movement of the earth's crust and its ability to move in a rotating manner; it measured fault movements, the scope of local changes, tectonic plate movement, the rotation of the earth, terrestrial tides, and the location of observation points; and it carried out precise global measurements, thus establishing a fairly precise system of geocoordinates.

V. Satellite maritime surveillance systems...88

1. Overview

Satellite maritime surveillance systems refer to satellite-borne reconnaissance systems that can do real-time or near-real-time surveillance, listen in on shipborne radar signals and radio communications signals, and be used to detect and monitor the activities of ships and submarines at sea. Satellite maritime reconnaissance systems can monitor the ocean's surface in all weather conditions, such as dark nights and clouds; they can differentiate enemy ship formations and the direction and speed of their sailing, in an effective manner; they can detect missile nuclear submarines that are submerged underwater and track cruise missiles that are flying at low altitudes; they can provide important intelligence for launching anti-ship missiles or other weapons to destroy enemy ships; and they can also provide important data such as sea surface conditions and maritime characteristics such as the speed of ocean currents, the temperature of seawater, sea surface wind speeds, the height of sea level, and dangerous objects in shallow waters, [in order to ensure] safe sailing by their own country's ships.

Because sea areas are broad and [because] the targets being probed are mostly in the midst of dynamic changes, the orbits in which satellites move are all fairly high; they usually use near-circular orbits at altitudes of around 1,000 kilometers and with inclinations of sixty-three degrees (the critical inclination). In order to be able to carry out continuous monitoring of the broad oceans, it is generally necessary to have multiple satellites form a network of surveillance satellites, in order to achieve the goals of continuous surveillance, increased probability of detection, and precise location.

2. The classifications of satellite maritime surveillance systems

Satellite maritime surveillance systems can be divided into electronic reconnaissance-type satellite maritime surveillance systems and radar-type satellite maritime surveillance systems, in accordance with differences in the reconnaissance and surveillance equipment that they have and the differences in the reconnaissance means that they employ. The former are also called passive-type satellite maritime surveillance systems and the latter are also called active-type satellite maritime surveillance systems; the two work in cooperation and coordination with each other. Passive-type satellite maritime surveillance systems use electronic reconnaissance equipment to intercept radio communications and radar signals that are emitted by targets on the ocean surface, in order to determine target locations, or they use millimeter wave radiometers and infrared scanners to probe submerged nuclear submarines. Active-type satellite maritime surveillance systems, on the other hand, are used to provide intelligence such as ship dimensions. Because active-type maritime surveillance satellites have nuclear power sources on the satellites, they are also called nuclear-powered maritime surveillance satellites; the satellites generally have high-powered, large-aperture, nuclear-powered radar, and by emitting radar wave pulses against the ocean surface, they scan and collect echo signals reflected from the target.

3. Typical satellite maritime surveillance systems

(1) The United States' White Cloud maritime surveillance satellites

White Cloud was a US electronic reconnaissance-type maritime surveillance satellite, which was also called the Naval Ocean Surveillance System (NOSS). Its primary mission was to judge the quality, position, speed, and direction of targets, through intercepting the radar, radio, and other communications signals of ships on the ocean and of underwater submarines, in order to track and locate targets and to transmit the location information at set times to naval ships. White Cloud satellites were the main force in the United States' space maritime surveillance.

White Cloud satellites used a mother satellite structure; after the main satellite (the mother satellite) entered orbit, it shot out three sub-satellites, with a gap between them of several dozen kilometers, that is, each group had four satellites. The White Cloud system generally worked as a cluster made up of four groups, for a total of sixteen satellites, in order to carry out surveillance and location. The newest type of White Cloud used a means whereby four satellites (one main and three sub-satellites) were launched together; onboard the satellites were large numbers of advanced devices, such as passive radiofrequency receivers, omni-directional electronic information antenna arrays, multi-passband filters, multiplier detectors, and data forwarding devices. The satellites operated in medium and low orbits, and every group of satellites could monitor signals within a scope of 7,000 kilometers. Every group of three sub-satellites formed a triangular configuration for its work, it used the principle of time differences in receiving information to do its locating, and after the location information was processed by the main satellite, it was transmitted back to the surface. A certain distance was maintained between each group, and they assisted one another in their work. The White Cloud satellites orbited at an inclination of 63.4 degrees, and they could monitor all maritime areas between 63.4 degrees south latitude to 63.4 degrees north latitude. The four groups of satellites in a constellation alternated in monitoring the same maritime area, and they repeated it more than thirty times a day, so they had the ability for continuous surveillance. The information that the satellites obtained, after processing by the main satellite, could be promptly transmitted back to the surface and to ships at sea. The main satellite had four transmitters, three of which were used to transmit reconnaissance data, so it was possible to carry out real-time or near-real-time surveillance.

White Cloud satellites came into widespread use in a number of local wars. In the British-Argentine Falkland Islands War, they provided the British fleet with intelligence on the Argentine navy's ships. In the Gulf War, they intercepted radio and radar signals emitted by Iraqi ships, to determine [the ships'] position, direction, and speed, and continuously tracked them, while at the same time pointing out targets for the multinational force to attack at sea, with excellent results. During the Kosovo Campaign, they surveilled the activities at sea of Yugoslav and Russian ships; this prevented naval assistance that Russia could have provided to Yugoslavia.

(2) Russia's maritime surveillance satellites

The working orbit of Russia's maritime surveillance satellites is fairly low, and the orbital inclination is high; they can monitor broad sea areas between sixty-five degrees south latitude to sixty-five degrees north latitude. They are divided into two types: the electronic reconnaissance type and the radar reconnaissance type. Russia's electronic maritime surveillance satellites are all located in a nearly circular orbit of 450 kilometers, with an inclination of sixty-five degrees; they weigh 4,000 kilograms and have a lifespan of eight to twelve months. The satellites have passive-type electronic receivers, with frequencies of 166 megahertz; they determine the location of surface ships and monitor the ships' activities by probing their communications and radar signals. The satellites also can probe shore-based radar and communications signals, in order to ascertain how the shore-based radars are deployed. Currently, one to two satellites are launched each year, on average. Russian radar maritime surveillance satellites use active forms for their work; they use satellite-borne radars to probe and monitor the activities of ships at sea, and they send back to earth stations the information they have reconnoitered, thus determining the location, direction, and speed of ships. The satellites are cylindrical in shape, about 7.8 meters tall, with a diameter of 1.8 meters, weighing around 4,500 kilograms, with an orbital altitude of 250 kilometers and an inclination of sixty-five degrees. They use nuclear-powered equipment, thus meeting the needs of their high-powered radars, and they have a strong probe capability. During the Falkland Islands War, the Argentine navy's Super Etendard attack aircraft used Exocet air-to-ship missiles to sink the British Navy's missile destroyer *Sheffield*. According to reports, the position of the British warship was reported to the Argentine navy by the Soviet Union, after this had been obtained by maritime surveillance satellites. However, there are risks with this kind of satellite, and the Soviet Union had incidents where nuclear-powered satellites crashed.

(3) The US Navy's Space-Based Wide Area Surveillance System (SBWASS)

In the early 1990s, the United States replaced the Navy maritime surveillance system White Cloud with the Navy's Space-Based Wide Area Surveillance System (SBWASS–Navy) Ranger. At the same time as this, the US Air Force also was developing a Space-Based Wide Area Surveillance System (SBWASS–Air Army), primarily for monitoring aircraft. The Ranger SBWASS–Navy had three satellites in each cluster, predominantly using infrared imaging. A total of four of these were successfully launched, with the last one, on 12 May 1996, using an Atlas-4 to launch a cluster of three satellites. The perigee altitudes were respectively 1,050 kilometers, 1,050 kilometers, and 1,053 kilometers, while the apogee altitudes were respectively 1,166 kilometers, 1,160 kilometers, and 1,163 kilometers, with an orbital inclination of 63.4 degrees. The US Air Force's SBWASS – Air Army was a radar imaging satellite; inside it was a synthetic aperture radar and electronic reconnaissance equipment. Two of them were successfully launched, the last one using an Atlas-2 for a 25 April 1992 launch. The perigee altitude was 784 kilometers, while the apogee altitude was 805 kilometers, with an orbital inclination of 85.14 degrees.

Covering the globe required a number of clusters or a number of satellites, regardless of whether it was the Navy's Ranger SBWASS–Navy or the Air Force's SBWASS – Air Army; these were constructed in a duplicate manner, and the expenses were huge. Therefore, the US Department of Defense decided in the early 1990s not to separately construct the Navy's and the Air Force's Space-Based Wide Area Surveillance Systems, but to have the Department of Defense construct a Space-Based Wide Area Surveillance System–Consolidated in a unified manner, and it considered having space-based radar results be used in a system, so that the SBWASS–Consolidated became a component part of a space-based radar system.

VI. Satellite meteorological monitoring and forecasting systems...91

1. Overview

Satellite meteorological monitoring and forecasting systems refer to satellite-borne systems that obtain military meteorological situations from space and that provide ground force, naval, and air force operations with real-time meteorological materials for strategic regions on a global scale, as well as for the air above any battlefield. They usually consist of special systems for monitoring and of support systems. The special systems are the effective payload of the meteorological satellites, while the support systems support the satellite's normal work. Satellite meteorological monitoring and forecasting systems have various types of scanning radiometers, visible light and infrared television cameras, temperature and humidity probes, and automated image transmission devices. After computer processing, these devices change the various meteorological data that have been collected into photographic images or transform them into electrical signals, and record them on magnetic tape; afterwards, [this tape] is sent back to the surface. After meteorological personnel on the surface carry out comprehensive analysis of the meteorological materials that have been collected through the satellites, in combination with meteorological materials that have been obtained by other methods, they can accurately predict the weather. Military satellite meteorological and forecasting systems have the features of strong encryption and high imaging resolution; when used together with photoreconnaissance satellite systems, they can more effectively get clear photographs of important military targets, and the data they obtain can also be used to correct other satellites' orbital measurements and the trajectories of intercontinental missiles, thus improving the accuracy of satellites' measurements of orbits and strikes by missiles.

Because meteorological satellites have very high social and economic benefits as well as military benefits, they have developed quite quickly; currently, the breadth of their applications is second only to that of communications satellites. Internationally, a world meteorological satellites organization[7] has also been established, allowing the various countries to share meteorological satellite information resources. The United States, Russia, China, the European Union, and Japan all have their own meteorological satellites. Of these, the United States, Russia, and China are countries that simultaneously have two types of meteorological satellites: geostationary and sun-synchronous [satellites]. Some countries, such as the United States and Russia, in order to improve the

[7]Translator's note: Probably the World Meteorological Organization.

timeliness, accuracy, and confidentiality of their forecasting, also have especially launched military meteorological satellites.

Since the United States launched Tyros-1, the first meteorological satellites, in 1960, many types of meteorological satellites have been launched in the world. Up until now, the United States and Russia (including the Soviet Union) have launched more than 100 meteorological satellites. The US Department of Defense began to research and develop special military meteorological satellites in the 1960s. These satellites were polar orbiting meteorological satellites; they went through numerous upgrades, and have developed from Block 4A, 4B, SA, SB, and SC into Block SD-1 and 5L-2 [sic]. Of these, the Block SD-2 was the most advanced. The Block SI-2 [sic] is an upgraded model; it is characterized by a long lifespan of use and great flexibility. The satellite not only has microwave temperature probes, microwave imagers, atmospheric density probes, and multispectral infrared probes, but it also has redundant sensors, new forms of sensors, and an expanded sensor area.

2. Classifications of satellite meteorological monitoring and forecasting systems

Based on differences in satellites' orbits, satellite meteorological monitoring and forecasting systems can be divided into two types: polar orbiting types and synchronous-orbiting types. The two types of satellite systems mostly combine military and civilian uses, but there are also meteorological satellite systems that are especially for military use, and they generally operate in networks of several satellites. Meteorological satellites can be divided into two types, in accordance with where their orbits are: sun-synchronous orbiting meteorological satellites (or polar orbiting meteorological satellites) and geostationary meteorological satellites. Sun-synchronous orbiting meteorological satellites patrol the surface of the globe twice each day and can obtain global meteorological materials; they can thus repeatedly compare meteorological materials for the same area. Geostationary meteorological satellites operate in space above the equator, and can cover close to one-third of the globe's area. They can carry out continuous monitoring of the same area, and send data back to the surface in real-time. By evenly spacing four of this kind of satellite, they can continuously monitor the formation and development of weather situations for the entire globe and for low-latitude regions, but their ability for meteorological monitoring in regions at latitudes higher than fifty-five degrees is somewhat lacking. These two types of meteorological satellites supplement each other and can get complete global meteorological materials. In accordance with their uses, meteorological satellites can be divided into civilian meteorological satellites, military meteorological satellites, and combined military-civilian meteorological satellites. Civilian meteorological satellites primarily are used in meteorological forecasting, in order to support the building of the national economy. Military meteorological satellites collect meteorological information, globally or for a specific region, and forecast weather situations, in accordance with special needs militarily; they are characterized by strong encryption and high image resolution, they can provide real-time meteorological materials for the various global strategic regions, battlefields, and the various services and service arms, and they provide necessary meteorological support for drafting military plans of action. Combined military-civilian meteorological satellites not only can be used by the military, but also by civilians.

3. Typical satellite meteorological monitoring and forecasting systems

(1) China's Fengyun meteorological satellites

China has successfully researched and developed the Fengyun series of meteorological satellites; this includes two types of satellite: stationary-orbiting and polar orbiting. These two types of satellite comprise China's meteorological satellite operational monitoring system, and have already entered into a stable phase of business operations. They continuously gather information about the world's atmospheric environment, and play an important role in such areas as weather forecasting, climate predictions, and weather studies. In particular, they have conspicuously enhanced the time-effectiveness and accuracy of weather forecasting. The second-generation polar orbiting meteorological satellites (Fengyun-3) have been successfully launched and are operating in orbit, and research and development is currently underway for the second generation of stationary orbit meteorological satellites (Fengyun-4). The Fengyun-2A (FY-2A) that was launched on 10 June 1997 was China's first geostationary meteorological satellite. It operates together with Fengyun-1, and ended the history where China's meteorological forecasting for a long time depended upon foreign meteorological satellites, turning China into the third country, after the United States and Russia, to simultaneously have two series of meteorological satellites: polar orbiting and geostationary orbiting. This provided technological support for China to participate in international cooperation and meteorological information exchanges and to carry out studies on global climate change. On 25 June 2000, China launched the Fengyun-2B (FY-2B), which is its second geostationary meteorological satellite. This satellite has a number of communications scanning radiometers, which could get three types of meteorological cloud maps – visible-light, infrared, and water conditions – and can get observational data from meteorological, maritime, and hydrological data collection platforms distributed over a broad area. It can also broadcast materials for widened digital images broadcasts, low-resolution cloud broadcasts, and S-waveband weather map broadcasts, and can collect and send back monitoring data on the space environment. However, the radiometer can only align with the earth half of the time, and the utilization of its cloud maps is relatively low.

(2) The United States' Defense Meteorological Satellite

The full name of the United States' Defense Meteorological Satellite is the Defense Meteorological Satellite Program (DMSP). Under ordinary conditions, this system has two satellites positioned in the same orbit; as the satellites travel around the earth in their orbit, they can cover and scan the surface of the earth 2,965 kilometers wide every circuit; in twelve hours they can cover the entire globe once. The selection of this orbit can allow the satellites to provide military departments with cloud maps and meteorological materials twice each day for a specific region. The new generation of Defense Meteorological Satellites can carry out global observations under all weathers and at all times, and the resolution of their materials is high. The visible-light systems imaging capabilities on the satellites are quite strong, and various types of measuring devices, such as infrared and microwave, can provide comprehensive meteorological materials with fairly high resolution. Because they are military meteorological satellites, they use encrypted communications; only the US military can use the materials. During the Gulf War, the US military had three Defense Meteorological Satellites providing services, and six terminal stations were set up in the theater of war to receive meteorological materials. The US military used the data from the Defense Meteorological Satellites to forecast the rapidly changing weather situation and to monitor the situation of oil wells' burning. In its drafting of plans for air raids, [the US military] also used meteorological information to deduce wind directions and to determine whether or not it was possible [for Iraq] to spread chemical warfare agents, and to issue sandstorm and other weather alerts to the multinational force. The multinational force's use of the newest meteorological data fully brought into play the functions of infrared and night-vision sighting devices. In the process of drafting plans of operations, preparing weapons systems, preparing defenses, and maneuvering units, meteorological satellites could also provide important support. Because fogs and sandstorms in desert regions along the coast could reduce visibility to zero, meteorological data was even more important in these coastal desert regions. The selection of targets for attack and the types of aircraft and ammunition also required meteorological data.

(3) Russia's Meteor meteorological satellite

The Meteor meteorological satellite was a type of combined military-civilian meteorological satellite that the Soviet Union developed on the basis of its Cosmos meteorological satellites; its satellite-borne probes primarily consisted of visible-light cameras that were used to monitor cloud- and snow-covered conditions, infrared television cameras that were used to monitor how clouds and snow were distributed, and scanning radiometers that were used to collect solar radiation data reflected from the earth. The Meteor-2 model was equipped with a visible light/infrared scanning radiometer, a vertical temperature probe, and automated image transmission equipment, as well as two multispectral scanners of an experimental nature. The first Meteor meteorological satellite was launched on 23 March 1969. Currently, the polar orbiting meteorological satellite that Russia uses is still the Meteor series, but after 1995 it also had a new Meteor-3 type. The Meteor meteorological satellite uses a non-sun-synchronous nearly circular quasi-polar orbit, but the altitudes of the three types of satellites are not quite the same: the Meteor-1 [altitude] is 600 kilometers, the Meteor-2 [altitude] is 900 kilometers, and the Meteor-3 [altitude] is 1,230 kilometers.

The early-period Meteor meteorological satellites recorded the images they photographed on magnetic tape, and then returned them to the surface based on commands from the surface. The later-period satellites use the form of automated imaging transmission; they not only can transmit images in real-time, but can also store images on the satellite and then later send them back to the surface in playback form, based on commands from the surface. The uniqueness of the Meteor meteorological satellite is that it is equipped with eight to twelve micrometer infrared cameras and multispectral probes, and therefore can also be used as a resources satellite. In addition, it is also equipped with fairly advanced synthetic aperture radars and other microwave remote sensors. Because [Russia] is situated in areas with high latitudes, it mainly relies upon data provided by polar orbiting meteorological satellites.

VII. Satellite earth resources surveying systems...95

Satellite earth resources surveying systems refer to civilian satellites that are used to survey and study earth resources but that also have very great military value. Earth resources satellites can carry multispectral remote sensing devices, in order to capture multispectral electromagnetic information radiated and reflected by surface targets, and send this information to ground collection stations. The ground stations process and interpret this information, based on the spectral characteristics of the various materials that they have gotten a grasp on in advance, and they thus receive information on the characteristics, distribution, and state of the various resources. Earth resources satellites can be divided into land resources satellites and maritime resources satellites. In order to ensure that the satellites can get images of surface targets under basically the same lighting conditions, and to carry out cyclical repeat photography, earth resources satellites mostly use sun-synchronous return orbits, with orbital altitudes of 500 kilometers to 900 kilometers and inclinations of ninety-seven degrees to ninety-nine degrees. Earth resources satellites generally use a three-axis stabilization form of control.

The technical characteristics of satellite earth resources surveying systems [are as follows]. First, they can adapt to many working environments and have many forms of work. In order to get sufficient earth data, earth resources satellites need to work in such environments as strong light, weak light, and even dark nights. In order to meet remote sensing needs under differing lighting conditions, the satellites use many forms of work such as spectroscopic imaging and synthetic aperture radar imaging. Second, they are able to carry out multispectral and multi-perspective surveys. Earth resources satellites carry visible-light, infrared, ultraviolet, and multispectral remote sensors, and can obtain multispectral information, and they can use multiple perspectives to get three-dimensional images that cover the entire globe, thus meeting differing needs. Third, they can [do] repeat monitoring a number of times, in order to obtain dynamic information. The satellites use sun-synchronous return orbits, and can do repeat monitoring a number of times for a given region on the earth in a single day, getting dynamic materials and information for this region. Fourth, they have powerful information transmission capabilities. The satellites operate in a sun-synchronous orbit, and receiving all of the satellites' information in real-time requires stations that are distributed globally, but this is neither possible nor is it necessary. Therefore, the satellites are able to transmit data in a timely manner, using data transmission devices with wide bandwidth and high speeds; in places where there are no surface collection stations, they can use data storage devices on the satellite to store data, and wait until the satellite flies in space over the collection station and then use high-speed transmission devices to quickly transmit the data. Earth resources satellites make broad use of advanced remote sensing technology. Even though their resolution is slightly lower than that of military reconnaissance satellites, they display great advantages in their uses.

Section 2: Space Satellite Navigation and Positioning Systems...96

Space satellite navigation and positioning systems refer to satellite-borne systems that use navigation and positioning satellites (abbreviated as navigation satellites) to provide navigation and positioning services for users on land, at sea, in the air, and in space; they are navigation satellite networks (or constellations) composed of a number of navigation satellites operating in differing orbital planes.

I. Overview...96

Space satellite navigation and positioning systems are a space-based radio navigation positioning and time transfer system for all weathers and all times, and that is highly precise. They can provide three-dimensional location, speed, and time information for land vehicles and personnel as well as for aircraft, ships, submarines, and satellites in such spheres as the air, the sea, and space. They can act as supplements to inertial guidance systems for mid-flight stage guidance for intercontinental missiles, thus improving the accuracy of the missiles. They can also be used in geodetic surveys, mid-air refueling, air transport, air traffic control, and command. The satellite navigation and positioning system [sic] (GNSS) is similar to other long-range radio navigation systems; its greatest advantage is that the scope of its effects is great (it can reach the entire globe) and the accuracy of its positioning is high (it can go from several hundred meters to several dozen meters and even to several meters, and it can get even greater positioning accuracy by differentiations).

Satellite navigation and positioning play an indispensably important role in the modern military and economic spheres, they are an important component part of the foundation of a nation's economy, and they are an important symbol that shows the nation's overall strength; the world's powers are racing to compete in this sphere. The satellite navigation and positioning systems that are currently already operating in orbit and have been put to use primarily consist of the United States' GPS satellite positioning system, Russia's GLONASS satellite navigation system, and China's Beidou satellite navigation system (COMPASS), as well as the Galileo satellite navigation system that the European Union has developed and is about to put into use. In addition, Japan is working to build a Quasi-Zenith Satellite System (QZSS) made up of three satellites; the first satellite in this regional navigation system was launched in 2009. India has not only formally participated in Russia's GLONASS system and the European Union's Galileo program, but it also announced, in 2006, that it would research and develop a satellite navigation system for the India region, and that it would place a constellation made up of seven satellites [into space] prior to 2011.

II. Categories of satellite navigation and positioning systems...97

Satellite navigation and positioning systems have differing categories and methods in accordance with the different forms in which they work and with their technological characteristics. In accordance with the principles of their work, they can be divided into two types. The first is Doppler velocimetric navigation satellites; they measure the navigation signal's Doppler frequency shifts for users, and from this they seek the rate of change in distances, in order to derive navigation and positioning. The other type is time and ranging navigation satellites; they measure the time of the navigation signals propagation for users, in order to find distance, and thus derive navigation and positioning. Doppler measurement of speed and position was the satellite navigation method that was used earliest. What the United States' GPS and Russia's GLONASS adopted was the time and ranging positioning method. According to whether the user needed to propagate a signal to the satellite, this could be divided into active-type navigation and passive-type navigation satellites. GPS and GLONASS both are passive-type navigation satellites; they have the advantages of being simple and inexpensive, and having good confidentiality. China's Beidou satellite navigation system is an active-type satellite navigation system. In accordance with the altitude of the orbit, [satellites] can be divided into low earth orbit satellites, medium earth orbit satellites, and geostationary satellites. Of these, active-type navigation satellites currently do not include any medium earth orbit satellites, and passive-type navigation satellites currently do not include any geostationary satellites. In accordance with the scope of their applications, they can also be divided into global navigational systems and regional navigational systems.

III. Typical satellite navigation and positioning systems...98

1. GPS satellite navigation system

The GPS satellite navigation system (Figure 4-2) was the first global satellite navigation and positioning system in the world; it took the United States twenty years and cost more than $30 billion to establish it. It was also called the Navstar system. It was a US joint military-civilian satellite navigation and positioning system. Its military applications were quite broad; it was the only highly precise global and all-weather navigation and positioning and time transfer system that operated in a long-term and stable manner in all weathers and at all times. The GPS system was completed in 1993, and was dominated and controlled by the US military. The system began to be carried out by the US Department of Defense in 1973, and for a fairly long period of time it monopolized the global military and civilian satellite navigation market. Starting in the [Bill] Clinton era, the system began to be used in civilian areas, and it was opened to the entire world free of charge. The GPS system is an all-weather, real-time global navigation and positioning system, and it can continuously provide three-dimensional positioning, three-dimensional speed, and precision time information twenty-four hours a day, without interruption. Its positioning accuracy can reach ten meters, its velocimetric precision is less than 0.1 meter/second, and its timing accuracy can reach 100 nanoseconds.

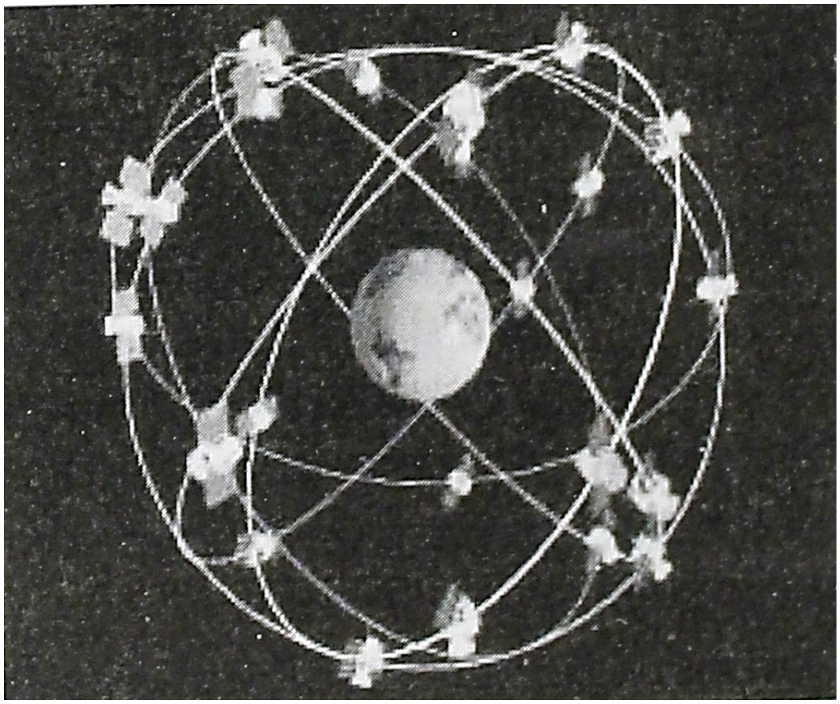

Figure 4-2: GPS Satellite Navigation System

The GPS system consists of three parts: a space segment, a control segment, and a user segment. The space segment is the main part of the system, and it consists of twenty-four working satellites and three backup satellites distributed within six orbital planes. The altitude of the satellite orbits is about 20,000 kilometers, the orbital inclination is fifty-five degrees, and all users in each area of the globe can simultaneously receive signals from at least four navigation satellites at any time. The control segment consists of a tracking station network spread over the globe, as well as a master control station (MCS) located in Colorado Springs in the United States. The tracking stations are used to determine and predict satellite positions, and to monitor their automated clocks and system integrity. This information is sent to the MCS, and the MCS regularly generates updated messages for each GPS satellite. Based on these updated messages, the satellites will automatically synchronize their atomic clocks and adjust their internal orbital model. The user segment consists of military and civilian devices. These satellites and ground support systems form a network, and users' GPS receivers broadcast the users' position (longitude and latitude), speed, altitude, and time information to [the users] every one to three seconds, based on positioning information that antennas simultaneously receive from four to eight satellites and applying the principle of differential positioning.

In order to promote the development of GPS applications, the United States issued orders three times in the form of presidential directives, standardizing the use and management of the system. Prior to 2004, the United States' highest-level GPS management organization was the interagency GPS Executive Board, which was jointly composed of the Department of Defense, representing the military, and the Department of Transportation, representing the civilian side. Now, it is the newly organized Space-based Positioning, Navigation, and Timing (PNT) committee. In the military sphere, the US military makes heavy use of GPS in the areas of command and control, weapons guidance, and personnel positioning; in the civilian sphere, it is primarily concentrated in automobile navigation (monitoring), individuals' navigation, and civilian aviation navigation, and in areas of application related to precision monitoring of positioning parameters. Because GPS signals do not broadcast information with integrity, safety and reliability are affected when they are used.

The United States' GPS positioning system provides two services, that is, a standard service (SPS) and a precise positioning service (PPS). The SPS is provided for civilian use, while the PPS is used by military users who have been approved by the United States and by selected government department users, and it is strictly controlled. For a long period of time, the United States' GPS system only provided encrypted precision positioning information (with a positioning accuracy of within three meters) to its own country's military, in order to monopolize the global satellite navigation market; for civilian users, including for other nations, it provided low-precision signals that had jamming (with a positioning accuracy of about 100 meters).

GPS played a fairly major role in the several most recent wars, and it improved the navigation and positioning precision of personnel, vehicles, ships, and aircraft to a fairly great degree. But some problems were also found; for example, it was easily jammed electronically, GPS signals were weak in some regions, and positioning accuracy still needed to be improved. In order to ensure its ability to control things in the military sphere and its monopoly position in the civilian market, the United States has been energetically promoting a GPS modernization program since 1996, and it intends to carry out a GPS III program after 2013, again greatly improving the accuracy, reliability, and security [of GPS] as well as its anti-jamming ability, and getting maximum political, military, economic, and social benefits. At the beginning of 2011, the US Department of Defense decided that in the construction of its GPS III system, it would abandon its existing twenty-four satellites in medium earth orbit (MEO) and adopt a completely new [program of] thirty-three "high earth orbit (HEO) plus geostationary orbit (GEO) satellites." All of the satellites for the GPS III program will be operating in orbit between 2015 and 2020.

2. The GLONASS satellite navigation system

In the 1970s, in reaction to the US announcement that it would establish and develop the GPS system, the Soviet Union's Ministry of Defense conceived of and constructed the GLONASS dual military-civilian navigation and positioning satellite system (Figure 4-3). This was the Soviet Union's second-generation satellite navigation system. The GLONASS project began in 1976, and it was continued and carried out by Russia after the Soviet Union collapsed. In 1996, this system momentarily achieved a model where twenty-four satellites were in orbit, providing global coverage. But later, because of Russian economic difficulties, and because the working lifespan of the satellites was relatively brief, the number of satellites in orbit was clearly insufficient, and this system collapsed and did not form a network. Starting in 2002, Russia began strengthening the building of the GLONASS system. As [Russia's] investment continued to grow, the process of supplementing the GLONASS system's network gradually accelerated.

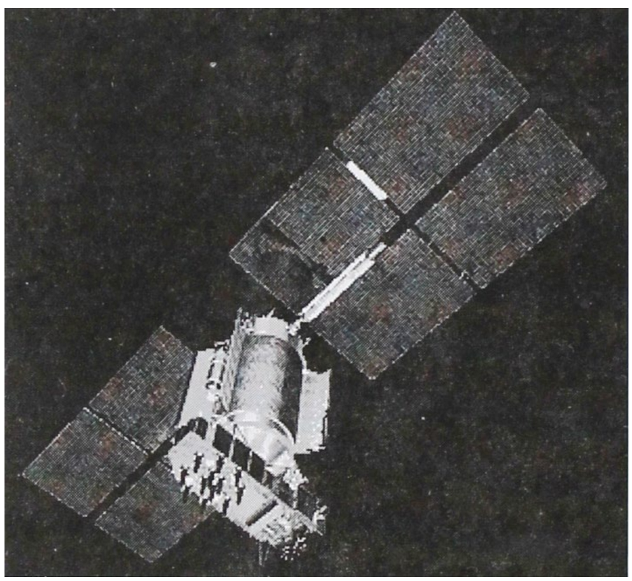

Figure 4-3: GLONASS Navigation Satellite

The GLONASS system can provide all-weather, continuous, real-time, and high-precision three-dimensional positioning and velocimetrics for ships at sea, aircraft in the air, users on the ground, and spacecraft in near-earth space; it can also be used for geodetic surveys and high-precision satellite timing. Compared to the United States' GPS system, GLONASS uses differing orbits and signal frequencies, it pays more attention to covering areas at high latitudes, and it has a stronger anti-jamming ability. The positioning accuracy of the GLONASS system is between thirty and 100 meters, its velocimetric precision is 0.15 meter/second, and its timing accuracy is one microsecond. This system consists of a space segment, a ground applications segment, and a user segment. The design of the space segment of the GLONASS system is a constellation consisting of twenty-four satellites; the twenty-four satellites are evenly distributed in three orbital planes at angles of 120 degrees, and each orbit has eight satellites. The orbiting altitude for GLONASS satellites is 18,840 kilometers to 19,440 kilometers (the nominal value is 19,100 kilometers, MEO), the orbital inclination is 64.8 plus or minus 0.3 degrees, and the operating cycle is 11 hours 15 minutes 44 seconds plus or minus 5 seconds.

GLONASS is managed by the Russian Air Force, and the Russian Federation Ministry of Defense's Coordination Scientific Information Center is responsible for its operations. Because of the short lifespan of GLONASS satellites, and because of the impact of the Soviet Union's collapse and Russia's economic slide, this system was unable to provide comprehensive and regular service for a long period of time; it could only be used together with GPS, and its applications and popularity were far less than those of GPS. In recent years, as Russia's economic situation has improved and the satellite navigation and positioning market has flourished and developed, Russia has begun rebuilding the GLONASS system; it has drafted and implemented a program for promoting the modernized building of GLONASS and has actively recommended this system for the global civilian market. On 8 December 2011, Russia deployed the GLONASS-744 satellite, which it had most recently launched into space, as a regularly working satellite; this marked the first time in fifteen years that Russia's GLONASS global navigation satellite system had entered into comprehensive operations. The twenty-four working satellites are all placed in predetermined orbits, their working state is excellent, and they can provide global coverage service. In the next few years, Russia will incrementally adopt a new type of GLONASS-K satellite to replace the existing GLONASS-M satellites; the first GLONASS-K satellite was launched into orbit in February 2011. Russia also plans to launch a GLONASS-KM satellite in 2015, whose performance will be even more advanced. At that time, the GLONASS system's navigation and positioning error range will be reduced from the current five to six meters to around one meter.

The GLONASS system's return to global coverage has not only broken the United States' monopoly position in the sphere of global satellite navigation and can provide continuous, real-time, and precision navigation and positioning services for global users, but what is even more important, it has laid a foundation for the Russian military to carry out joint operations and precision attacks, and has enhanced its strategic deterrence capabilities; this has important significance for Russia's national security and economic development.

3. The Galileo Satellite Navigation System

In order to break out of the situation where the United States' Global Positioning System dominated the world, and to create a new stage for the European Union's geodetic surveys and space industries, the European Union's fifteen member states on 27 March 2002 began to launch the Galileo satellite navigation and positioning system program (Figure 4-4). Currently, it has established an entity called the Galileo Joint Undertaking (GJU), which is responsible for managing the research and development of the Galileo project. At the end of December 2005, the first Galileo satellite, GLOVEA,[8] was launched into space; this marked the formal entry of the Galileo satellite positioning system into its construction stage.

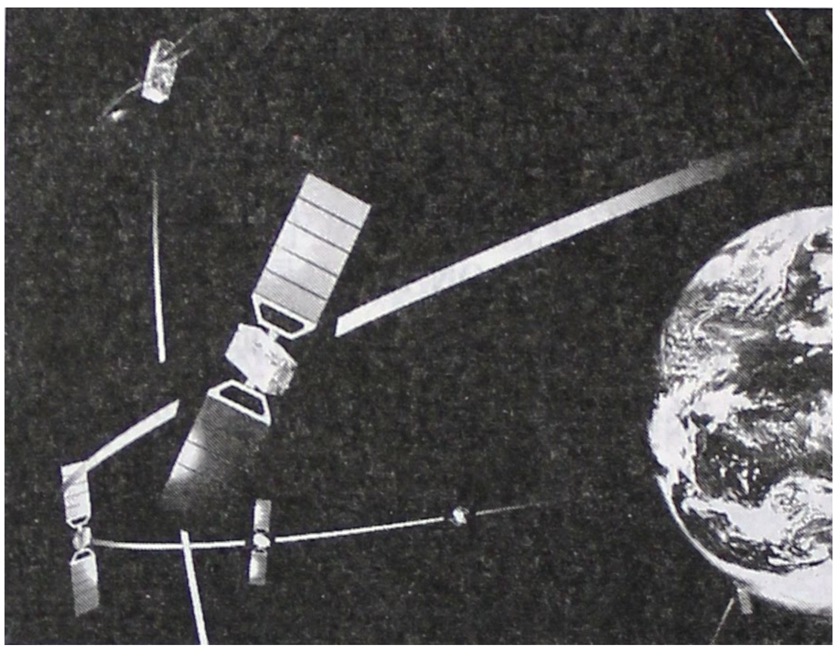

Figure 4-4: Galileo Navigation Satellite

The Galileo system is certainly not a duplication of the GPS or GLONASS systems; it is controlled by a civilian organization, and at the same time also has participation from other, non-European Union countries, like China and India, as well as involvement by private organizations. The Galileo system has a better constellation design, its service coverage and positioning accuracy are higher, and it can provide information like system completeness parameters and system error warnings. This system not only provides meter-level real-time navigation and precision accuracy, but it also [is] effective in

[8]Translator's note: This probably is a mistake in the Chinese text for GIOVE-A.

issuing real-time signals and provides commercial navigation services, thus further improving the accuracy and reliability of navigation and positioning, and it provides guarantees for applications for trains and automobiles that have fairly high requirements for positioning services as well as for aircraft landings. The Galileo system can be compatible with the GPS and GLONASS systems, and it provides diverse services for users. Galileo can primarily provide services with five differing levels of accuracy, completeness, and reliability.

Just like the other satellite navigation and positioning systems, the Galileo system is also composed of three parts: a space segment, a control segment, and a user segment. Of these, the space segment includes thirty MEO satellites evenly distributed in three medium earth orbital planes (with three backup satellites); each plane includes one backup satellite in order to protect against the working satellites having an accident. It takes about fourteen hours for the satellites to revolve around the earth one time, and the satellites have a designed lifespan of twenty years. Galileo's control segment includes one sensor station network, two control centers, and multiple uplink stations. The sensor network, which is distributed around the globe, continually monitors the constellation, and sends its precisely measured navigation signals to the two control centers situated in Europe. The orbital and clock data produced by the control centers is sent to the uplink stations, and transmitted to the satellites once every two hours. At the same time, the control centers forecast the integrity of the constellation and provide these data to users in the life {*shengming*} security industry. When fault signals appear, the system can warn users after a delay of six to ten seconds.

Although the Galileo satellite navigation system was designed and planned in accordance with first-rate standards, as regards its construction requirements and technical performance, the Galileo system has still not been completely built because of funding, technical, and other reasons; the program has been continually delayed, and building of the entire completed system still remains to be seen.

4. The Beidou satellite navigation system

The first-generation Beidou satellite navigation system (Figure 4-5) is a two-satellite navigation and positioning system that China itself designed; this system ended China's history of entirely relying on ground navigation and foreign satellite navigation systems, and preliminarily established its own regional satellite navigation system; together with the United States' GPS system, Russia's GLONASS system, and Europe's Galileo system, it forms the globe's four great satellite navigation systems. In October and December 2000 and in May 2003, Beidou navigation test satellites were successfully launched, forming the first-generation Beidou satellite navigation system, and the system formally began operating in 2005.

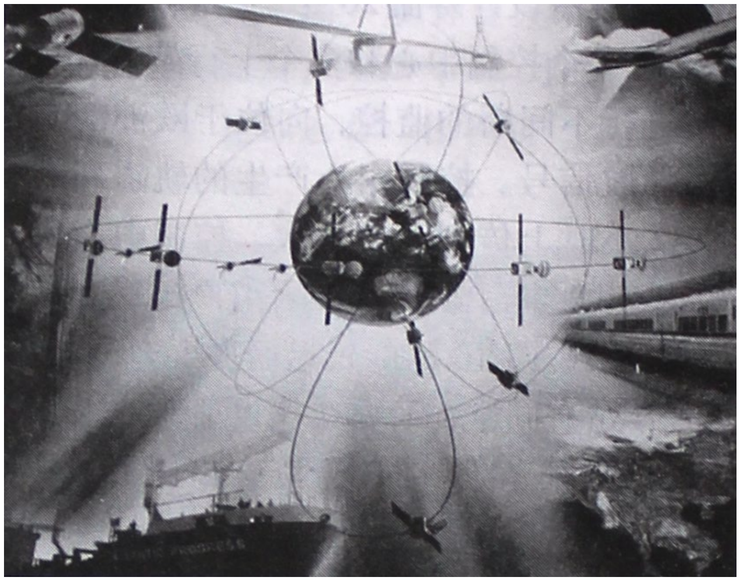

Figure 4-5: Beidou Satellite Navigation System

The first-generation Beidou navigation system combines the three great functions of satellite positioning, short message service messages, and high-precision timing into one; it is an all-weather, highly precise, and quick real-time regional two-dimensional navigation and positioning system that can provide rapid positioning, short digital message communications, and timing services for medium and low dynamic and static users in part of the Asia-Pacific sea regions and part of the peripheral regions, and that can provide two forms of services: open services and authorized services. Open services provide positioning, velocimetric, and timing services free of charge in the service area, the accuracy of positioning is ten to twenty meters, the timing accuracy is fifty nanoseconds, and the velocimetric accuracy is 0.2 meters/second. The characteristics of the first-generation Beidou system primarily include [the following]. First, it has a number of functions: positioning, timing, and short message communications. Second, it can be used to issue wide-area differential information. Third, it has dual military-civilian use, with the military predominating. Fourth, it uses the RDSS work system; at the same time that it [provides] positioning, it can report locations. Fifth, there is no need to accumulate navigation messages, so first-time positioning is fast. Sixth, it broadcasts users' locations through communications links, and can [provide] positioning as well as be monitored.

The first-generation Beidou system uses a two-satellite positioning system; the basic principle of its positioning is the measurement principle where three spheres intersect: the surface center broadcasts a querying signal (the outbound signal) toward the user, by means of two satellites, then based on the answering signal (the inbound signal) of the user's response, it measures and calculates the distance from the user to the two satellites. Afterwards, based on a digital map stored at the center or on the elevation measured by an altimeter carried by the user himself, it calculates the distance from the user to the center of the earth, and based on these three distances, it can determine the location of the user, and inform the user of the results of the location by means of the outbound signal. The timing and short message communications functions also are simultaneously achieved through the transmission process of these outbound and inbound signals.

The first-generation Beidou system consists of a satellite system and a ground applications system. The space segment consists of three geosynchronous satellites at an altitude of approximately 36,000 kilometers, of which two are working satellites and one is an orbiting backup satellite. The first-generation Beidou's ground applications system includes a central control system, a calibration system, and various types of users' machines. Because the first-generation Beidou system uses a passive positioning system, the system has certain restrictions in such areas as user capacity, the precision of positioning, concealment, and positioning frequency, and the system has no velocimetric function and so cannot meet the high-precision guidance needs of long-range precision attack weapons. However, compared to other satellite navigation systems, this system's investment is much smaller, and it also has positioning reporting and communications functions that the other systems lack. Therefore, it can be said that the first-generation Beidou system is a satellite navigation system that is fairly cost-effective and that has its own characteristics.

Ever since the first-generation Beidou was put into operation in 2005, it has made comprehensive breakthroughs in the national economy's key industries in such spheres as the transportation of hazardous chemicals, the ocean fishing industry, and timing for the national grid, which has pulled and promoted developments in relevant production such as electronics, communications, machinery manufacturing, and geographical information. It has produced notable economic and social benefits and become a new point of growth for the national economic and social development. In the next few years, Beidou will also launch a series of satellites, one after the other, and network and test the system, incrementally expanding it into a global satellite navigation system, that is, the second-generation Beidou satellite navigation system. The second-generation Beidou satellite navigation system will be built in accordance with the overall thinking of "first regional and then global," and will be implemented step by step.

5. Other satellite navigation and positioning systems

In addition to these four major satellite navigation and positioning systems, many countries also are actively developing their own satellite navigation and positioning systems, such as Japan's Quasi-Zenith Satellite System, India's regional satellite navigation system, Canada's Active Control System (CACS) and Germany's Satellite Positioning and Navigation Service System (SAPOS).

(1) Japan's Quasi-Zenith system

In recent years, the Japanese Government has cooperated with industrial circles (the Japan Federation of Economic Organization), and is now establishing a Japanese satellite navigation and positioning system based on GPS – the Quasi-Zenith Satellite System (QZSS), to serve as a new generation of Japanese satellite navigation and positioning system. The Quasi-Zenith system can be used together with the twenty-four satellites of the United States' GPS, enhancing the precision of positioning and strengthening the ability to resist jamming. Because the orbits of the Quasi-Zenith satellites differ from each other, then even though they use the same frequencies, they will not interfere with each other, and in this way it is possible to greatly enhance the utilization of the Quasi-Zenith system's frequencies. In addition, the Quasi-Zenith also can supplement blind spots in Japan's satellite reconnaissance. Currently, Japan's reconnaissance satellites still have no way to reconnoiter the globe's north and south polar regions, but the Quasi-Zenith satellite system can supplement these deficiencies.

The Quasi-Zenith satellite system consists of three navigation satellites; the three satellites are in a circular orbit about 36,000 kilometers from the earth and move at a speed of one circuit each day. Where they differ from geosynchronous satellites is that each satellite has a different orbit, and these three orbits are on a plane that forms an angle of forty-five degrees from the earth's equator. Therefore, looking at them from Japan's homeland, there always is one satellite remaining in a place close to the apex of the sky, so the Japanese call this a "quasi-zenith" satellite system. In this way, all of Japan can enjoy a greater scope of coverage and more precise positioning services. Its characteristics [are as follows]. First, the Quasi-Zenith system only has navigational functions; it does not have mobile communications and broadcasting functions. Second, the satellites' angle of elevation is more than sixty degrees, which helps in resolving the blind spots in "urban canyon" coverage, so the rate of coverage can reach 100 percent. Third, it will help in carrying out more accurate global positioning. Fourth, it can improve the utilization of high frequency bands. Fifth, it can monitor the north and south polar regions, which synchronous orbiting satellites cannot monitor, thus providing additional valuable materials for scientific research.

(2) India's regional navigation satellite system

India's regional navigation satellite system is a regional dual military-civilian satellite navigation system research and development project that India has focused on promoting in recent years and that has autonomous intellectual property rights and independent operating capabilities. This project can provide India with the ability for independent regional navigation and positioning, and the system's design also fully takes into consideration its future compatibility and interoperability with GPS, Galileo, and other systems. After the Indian regional navigation satellite system is built, it will be able to help India's military monitor the border regions of the Indian subcontinent, regions with complex terrain, and the Indian Ocean region. The Indian Government in May 2006 formally approved the launching of the research and development program, and proposed the establishment of a regional navigation and positioning system with a network of seven satellites. This program also required the ability to provide navigation and positioning services for all of India's territory and for regions within a scope of 2,000 kilometers along its periphery, with a positioning accuracy within twenty meters. In September 2007, then-chairman of the Indian space research organization, Madhavan Nair, publicly announced at an international space conference that India planned to launch seven navigation satellites over the next six years, one after another, and to create an Indian version of GPS in outer space. Based on its design, the Indian regional navigation satellite system's satellites will be visible at all times, and the system will be able to provide standard positioning services, accurate positioning services, and services to users having special permission from the Indian Government. In addition to providing navigation and positioning services, the system will also provide such services as ground monitoring, long-range communications, information transmission, evaluations of disaster situations, and public safety.

In addition to the Indian regional navigation satellite system having a space-based satellite constellation, the system will also include a master control center and some ground installations that will be responsible for satellite tracking and control, in order to ensure the system's integrity. It will include a space satellite control center, monitoring stations, tracking and injection stations {*cekong zhuru zhan*}, time centers, ranging stations, CDMA ranging stations, laser ranging stations, navigation control centers, and data links. Of these, the tracking stations' primary function will be to receive data from the geostationary satellites and inclined geosynchronous satellites, and at the same time to correct the ranging values of these satellites, and to directly transmit the original data and ranging corrected values to the navigation control center. The primary function of the navigation control center will be to calculate satellite ephemeris, parameters for correcting satellite clock errors, the ionospheric delay error numbers, and corresponding integrity information, and to transmit the results of the calculations to the upload injection stations; afterwards, this will pass through the global satellite control center, which will be responsible for managing, controlling, and safeguarding the regular work of the orbiting satellites. The CDMA ranging stations and laser ranging stations will be responsible for collecting the satellite ranging information, and after they correct this, for sending it to the satellite control center. The user segment primarily will include specially designed single-frequency user receivers and dual-frequency user receivers. All the receivers will, in addition to receiving signals from the Indian regional navigation satellite system, also be able to receive signals from the space GPS and GLONASS; at the same time, the single-frequency receiver users will be able to receive corresponding ionospheric error correction information.

This first satellite navigation system that India will independently build still has a great deal of crucial technology that has yet to be perfected, including atomic time standards, building the ground stations and master control center, users' receivers, and time conversion technology; these are all pending completion of technological research. Particularly as regards the research and development of crucial miniature precision positioning payloads, India still needs to rely upon international cooperation with the United States, Russia, and the European Union. For example, India currently still has no way to produce crucial technological parts and satellite-borne atomic clocks for satellite positioning. For this reason, India has signed a contract worth four million euros with the SpectraTime Company, which belongs to France's Orolia Group, requiring that [SpectraTime] provide the satellite system with rubidium atomic clocks.

Section 3: Space Information Transmission Systems...107

Space information transmission systems refer to such things as satellite communications and tracking and data relay satellite systems. Space information transmission systems will be completely fused digitized battlefield command and control network systems at the strategic, campaign, and tactical levels. Their main function and mission will be to complete the transmission and distribution of strategic, tactical, and battlefield information (to include sounds, image, data, and numbers), and to deliver to the ultimate user information products from the ground comprehensive processing and management center, in order to meet the needs that informationized operations have for command and control coordinated operations, firepower attack, and information and communication support.

I. Satellite communications systems...107

1. Overview

Satellite communications systems refer to radio communications systems that have satellites as their relay stations and that can transmit telephone calls, television, cables, faxes, and data; their main equipment includes communications antennas, signal processors, and signal repeaters. Satellite communications systems achieve communications links between earth stations, between earth stations and spacecraft, and between spacecraft, through forwarding or emitting radio signals. Satellite communications systems are the main means of long-distance strategic communication, and they have a pivotal role in military communications; more than ninety percent of the long-distance military communications tasks of the United States, Russia, and other countries are shouldered by satellite communications systems. Currently, ninety percent of intercontinental communications services throughout the world and 100 percent of intercontinental television broadcasts, as well as a great deal of the regional communications, are undertaken by satellites, and there are more than 300 communications satellites working in orbit. In the 1991 Gulf War, the multinational force headed by the United States established a huge satellite communications system; the US and British militaries mobilized a total of six communications satellites to form a comprehensive communications system, which provided communications support for the multinational force's operations, from the strategic level to the tactical level. In addition, they also used field satellite communications systems in order to provide communications support for command activities [carried out] by basic-level units (or combat units).

Satellite communications systems have the following advantages. First, the scope of their coverage is great, and communications distances are far. One geostationary communications satellite can cover forty percent of the earth's surface, and three communications satellites equally spaced in geostationary orbit can carry out global communications, apart from some of the south and north polar regions. Second, the capacity of communications is great. Currently, the capacity of one satellite can reach tens of thousands to hundreds of thousands of circuits, and can forward high-resolution photographs and other information. Third, the quality of transmission is great. Communications satellites are not affected by natural conditions like terrain and surface features, and they are not easily affected by natural or manmade jamming and changes in communications distances, so communications are stable and reliable. Fourth, they have good mobility. Communications satellites can act as long-distance communications trunk lines between large-scale ground stations, and can also provide communications for small-scale mobile terminals in aircraft, on ships, and in vehicles; they can quickly establish communications links with various directions, based on need. The confidentiality of military communications satellites is even better, and their ability to resist jamming is even stronger.

The main developmental trends in satellite communications systems are that confidentiality in satellite communications, resisting jamming, and the mobility of ground terminal stations are being comprehensively improved, as is survival capabilities under the conditions of nuclear warfare. The focus is on enlarging communications capacity and permitting large numbers of tactical users to communicate, and on enhancing the ability to resist attacks and resist destruction. For example, satellite systems in high earth orbit, medium earth orbit, and low earth orbit are developing in parallel, and they are launching the use of multibeam antenna and ultra-precision antenna technology, optical communications technology, high-speed satellite-borne signal processing and switching technology, technology for military applications of direct-broadcasting satellites, and high temperature superconducting transponder technology.

2. Classifications of satellite communications systems

There are many methods for classifying satellite communications systems. For example, in differentiating them in accordance with their operating orbits, satellite communications systems can be divided into geostationary orbit, high elliptical orbit, and medium and low earth orbit satellite communications systems; in differentiating them in accordance with the scope of their services, they can be divided into international, domestic, and regional satellite communications systems; and in differentiating them in accordance with their services, they can be divided into fixed service and mobile service satellite communications systems. Looking at their military applications, satellite communications systems usually are divided into two main types of satellite communications systems: strategic communications and tactical communications. Strategic satellite communications systems are primarily used in global strategic communications; they usually operate in geosynchronous orbits and use superhigh frequencies (SHF, three gigahertz to thirty gigahertz) and extremely high frequencies (EHF, thirty gigahertz to 300 gigahertz) frequency bands, and provide services for the transmission of strategic commands, control, communications, and intelligence over long distances up to a global scope. Tactical communications satellites, on the other hand, provide regional tactical communications, including mobile communications for terminals in military aircraft, ships, vehicles, and even small detachments or for ones that are carried on individual soldiers' backs. Tactical satellite communication systems generally operate in elliptical orbits with periods of twelve hours, and primarily provide communications service for the movements of military aircraft and surface ships. Since the 1980s, as communications satellite technology has developed, and especially as high-powered communications transponders have come into use, satellite communications systems are developing in the direction of large platforms and being multi-functional; the differentiations between strategic and tactical communications satellites are no longer distinct, and multiple-use and joint military-civilian communications satellites have become a new direction of development.

3. Typical satellite communications systems

Currently, apart from the United States and Russia, NATO has the NATO series of military satellite communications system, the United Kingdom has the Skynet series of military satellite communications system, and France has the Syracuse military satellite communications system. The US military has researched and established a global satellite communications system with multiple uses and has begun transformative construction of its satellite communications system.

(1) The United States' Defense Satellite Communications System

The Defense Satellite Communications System is a global strategic satellite communications system that the US Department of Defense constructed in order to adapt to the needs of modernized operations; the system undertakes most of the Department of Defense's satellite communications affairs. This system began to be built in May 1962; [the construction] was carried out in three stages, and development now has reached the third generation. The first-generation Defense Satellite Communications System (DSCS-1) satellites were small and functioned poorly, and their communications capabilities were extremely limited. The second generation (DSCS-2) was a global communications network consisting of four satellites in geostationary orbit and was the main communications system for the military prior to the 1980s. Research and development of the third generation (DSCS-3) began in 1972; it not only was suitable for large-scale fixed earth stations and ship-borne terminals, but it also was suitable for small-scale mobile terminals, and could simultaneously satisfy strategic and tactical communications needs; it is currently the main satellite communications system used by the US military. The Defense Satellite Communications System (DSCS) can provide global communications for all of the US military's services and service arms.

On the eve of the 1991 Gulf War, [the number of] DSCS-3 satellite terminals that the US military deployed in the Gulf region increased from four to more than 120, and they were used to complete combat, combat support, combat logistics support, and other communications missions. The multinational force's air force headquarters used Defense Satellite Communications System every day to send air raid mission orders to the various operational units, making air attacks timely and effective. The antennas for ground mobile unit users' terminals were installed on flatbed trucks and followed units' movements; when the units halted, [the terminals] established contact with command posts. In all, there were thirty-three mobile terminals serving combat units, providing prompt command, control, communications, and intelligence information. In the initial period of the war, the Defense Satellite Communications System undertook seventy-five percent of theater of war communications; in particular, it played a major support role for units that were fairly far from the theater of war and that had no ground communications systems support.

(2) Russia's Molniya satellite communications system

The Soviet Union was the earliest country in the world to launch a satellite, and its satellite communication system also developed fairly early. In 1965, not only did it launch the first Molniya communications experimental satellite, but it also began establishing a satellite communications system. Currently, the Molniya-3 communications satellite system used by Russia is its third generation, and it primarily provides strategic communications service for the military.

The Molniya satellite communications system has the following characteristics. First, the satellites have a high elliptical orbit with a twelve-hour period, their perigee is at about 500 kilometers in the southern hemisphere, and their orbital inclination is sixty-five degrees. This is because most of Russia's territory is located in the high latitude regions of the northern hemisphere, and some of its territory is in the north polar region; if a geostationary orbit were used, the communications effects would not be good, and moreover there would be no way to have communications in the north polar region. But by using a high elliptical orbit and having the apogee adjusted to the space above the northern hemisphere, it is possible to have the satellites' longest flight time be in the space above [Russia's] own territory. The Molniya satellites usually work in a network of eight satellites, operating in four orbital planes separated ninety degrees from each other in a dual mode. In this way, it is possible to ensure continual global communications twenty-four hours [a day]. Second, the communications capacity is limited. A Molniya satellite only has three transponders and can provide only 200 circuits for telephone calls or three circuits for television, so it has a certain disparity with the large capacity requirements of strategic communications. Third, [the satellites] have great need for ground systems; their ground applications systems consist of eighty-five ground stations. Because Molniya satellites operate in a high elliptical orbit, the antennas of their ground systems need to continually track the satellites, so the technology is more complex.

(3) The United States' Milstar system

The United States' Milstar system, whose full name is the Military Strategic and Tactical Relay system and which uses extremely high frequency (EHG) wavebands, is the most advanced satellite communications system in today's world. This system combines strategic communications, tactical communications, and data relay functions into one. The Milstar satellite communications system began undergoing research and development in the 1980s and by now has already had two generations develop, respectively Milstar 1 and Milstar 2. Milstar 1's reinforcement against nuclear [explosions] was fairly strong, and it was primarily used for strategic communications. Milstar 2 has no reinforcement against nuclear [explosions], and it is primarily used for tactical communications. The constellation consists of two Milstar 1 and three Milstar 2 satellites, for a total of five [satellites]. The system's main characteristics [are as follows]. First, its communications capacity is great and its processing capabilities are strong. The satellites have fifteen secondary antennas and use such autonomous processing systems as signals code processing, capturing and processing of timing and signals, processing of links between satellites, and overall processing, and they have signal modulation and demodulation [functions] and beam switching functions. They use three frequency bands: ultrahigh frequency, superhigh frequency, and extremely high frequency, simultaneously supporting strategic and tactical communications. They use sixty gigahertz broadband links to carry out communications among satellites, linking a number of satellites in orbit to form a constellation. Second, they use adaptive nulling antenna technology to improve their ability to resist jamming. What is called adaptive nulling antennas means that the antenna's main beams are always aligned with the signals direction, and the signals null point is always aligned with the source of jamming. Because jamming is random, adaptive nulling antennas can automatically adjust to changes in the antenna direction pattern, and always track the direction of jamming. In addition, because the beam length is quite short and the beams are quite narrow, it is possible [to have] highly directional emissions, making it quite hard to eavesdrop on and jam [signals]. In addition, satellites' regenerative processing technology limits the accumulation of noise and jamming, thus further enhancing the system's anti-jamming ability. At the same time, the extensive use of narrowband and broadband spread spectrum and frequency modulated technology also makes it very difficult for the enemy to intercept their communication. Third, it works using the form of networks whose orbits intersect, thus enhancing resistance to destruction and survival capabilities. Some satellites' orbits are higher than geostationary orbits, for fairly long periods of time, and anti-satellite means cannot reach this altitude. Satellites in geostationary orbit also adopt preventive measures, taking along sufficient fuel, so that as soon as they come under attack, they can immediately ignite their engines and engage in flexible dodging and mobile shifts. Backup satellites that are placed in orbit do not work in peacetime and are put in a secret status; they can move, based on orders, and reinforce the system's work capabilities from a suitable location. Therefore, the Milstar system also can provide regular communications services in a complex battlefield environment and has quite strong survival capabilities.

II. Tracking and data relay satellite systems...111

1. Overview

Tracking and data relay satellite systems are space relay stations that can track earth orbit flight vehicles, including space shuttles, and can return data to earth stations. They are one of the important means for carrying out global reconnaissance and surveillance and for providing real-time information delivery for strategic early warning, as well as an indispensably important component part in establishing a global space-based comprehensive information network. They are primarily used for real-time relay transmission of information for various types of low earth orbit spacecraft users, and for expanding the scope of coverage for low earth orbit spacecraft tracking. Tracking and data relay satellite systems not only are hubs by which medium and near earth orbit spacecraft transmit information in real-time, but they also are important platforms for forming space-based tracking networks. They also have a very important role in manned spaceflight and deep-space probes. Because the amount of data that imaging reconnaissance satellites transmit is quite large, and because it is necessary to prevent data interception by other nations, it is therefore necessary to rely upon data relay satellites to carry out high-capacity, high-speed data relay in real-time.

Currently, the United States, the European Union, and Japan are developing new generations of tracking and data relay satellite systems; data transmission speeds are getting faster and faster, and communications frequency bands are developing towards the Ka band and optical frequency bands.

2. Typical satellite relay systems

(1) The United States' "Tracking and Data Relay Satellites"

In 1975, the United States began research and development of "Tracking and Data Relay Satellites" (TDRS). From 1983 to 1995, it launched a total of seven first-generation TDRS satellites; the satellites had seven differing types of antennas and could simultaneous use S, C, and Ku bands, while their data transmission speeds reached 300 megabits per second. These satellites and a ground station set up in White Sands, New Mexico, formed the United States' first-generation TDRS network, and its coverage in near earth orbit reached eighty-five percent. Starting in 1995, the United States planned to research second-generation TDRS satellites, whose working frequency bands would be S, Ku, and Ka, and that would develop toward the Ka band, so that the space-based tracking network would have coverage of 85 percent to 100 percent. This system can transmit in real-time various types of data information from earth-monitoring satellites, such as Lacrosse reconnaissance satellites forwarding SAR imaging data, and transmitting information services for a new generation of the Earth Observing System (EOS).

(2) Russia's tracking and data relay satellite system

Russia's tracking and data relay satellite system is divided into two main categories: civilian and military. The civilian tracking and data relay satellite system is divided into three independent networks – eastern, central, and western – and is called the Luch system. This system's primarily direction of service was to provide communications and control for low earth orbit satellites and to provide two-way data exchanges with earth stations for the Mir space station, the Salyut space station, Soyuz spaceships, and the Almaz [satellite's] synthetic aperture radar. The Potok military tracking and data relay satellite system, which was launched in 1982, used the C band, and the satellite antenna was a phased array antenna; it was primarily used for optical imaging reconnaissance, ocean monitoring, and other military satellites.

Section 4: Space Operations Weapons Systems...113

The huge role in warfare of satellites and other spacecraft has resulted in an ever-increasing number of countries fully realizing the necessity and importance of developing space weapons. At the same time that they are actively developing satellites, space shuttles, space stations, and other military spacecraft, the issue of how to prevent an enemy from using space or how to carry out a counterattack when the enemy launches an assault against your own spacecraft, of how to bring the altitude advantage of space into play, of how to seize and hold command of space, and of how to attack ground, aerial, and maritime targets from space, have all impelled the applications of space weapons.

Space operations weapons systems conceptually are divided into a narrow sense and a broad sense. Space operations weapons systems in the narrow sense refer especially to weapons systems deployed on space-based platforms and directly used to kill the opponent's outer space, aerial, maritime, and land operations targets. Space operations weapons systems in the broad sense refer to weapons systems deployed in outer space, on land, at sea, and in the air that are used to attack and destroy enemy targets flying in outer space and to attack from outer space important targets on land, at sea, and in the air. Looking at functions, space operations weapons systems can be divided into two categories: hard kill and soft kill. Speaking specifically, they primarily include anti-satellite weapons, anti-ballistic missile weapons, and orbital bombardment weapons. Anti-satellite weapons refer to weapons systems used to jam or damage satellites operating in outer space; these are currently a relatively mature type of space operations weapons system. Currently, anti-satellite weapons largely can be divided into three types. The first is kinetic energy weapons, including anti-satellite missiles with nuclear warheads or conventional warheads and kinetic energy interceptors that rely upon direct collisions to kill the [enemy] satellite. The second is directed energy weapons, including laser weapons, particle beam weapons, and high-powered microwave weapons. The third is electronic warfare weapons, which are used to jam satellites' communications and data transmissions.

I. Hard kill weapons systems in space operations...113

Hard kill weapons systems in space operations refer to space-based weapons systems that use various kinds of weapons systems to directly destroy spacecraft themselves. According to differences in the means of hard kill, they normally can be divided into two kinds: nuclear energy and non-nuclear energy. Nuclear energy space weapons refer to weapons that use the thermal radiation, nuclear radiation, and electromagnetic pulse effects produced by explosions of nuclear devices to damage the structures of targets or to render them ineffective. They primarily include nuclear electromagnetic pulse bombs, enhanced x-ray bombs {*zengqiang x shexian dan*}, and gamma ray bombs. The lethal scope of nuclear energy space weapons is large, and so they do not have very high requirements for precision in guidance; any long-range ballistic missile that can carry nuclear warheads can act as an anti-satellite weapon. However, space nuclear explosions will indiscriminately damage all satellites within their killing scope, including the enemy's, your own, and allied nations' satellites. In the 1970s, when levels of guidance technology were relatively poor, this scheme was the only choice, but now the various nations all have abandoned it. Non-nuclear energy space weapons refer to weapons and equipment that use the offensive killing effects produced by non-nuclear devices to carry out space offensives. Non-nuclear energy space weapons can be divided into two types – kinetic energy and directed energy – and they are the space operations weapons and equipment that the various nations are currently researching and using on a broad scale.

1. Kinetic energy weapons

Kinetic energy weapons refer to weapons that rely upon launching interceptor warheads that move at high speeds and that are trajectory, homing, and guided [types], and that use their entire body or fragments from an explosion to directly collide with and kill targets. The term kinetic energy weapons first appeared in United States' Strategic Defense

Initiative of the early 1980s (that is, the Star Wars program). Kinetic energy weapons primarily are composed of two large sections, an interception warhead and a high-speed launching apparatus. The interceptor warhead usually uses a homing guidance type, but can also [use] a trajectory type, and it is primarily composed of an infrared or radar probe, computer, guidance and communications systems, and a killing mechanism, as well as propulsion and control systems; the high-speed launch apparatus primarily uses booster rockets but can also use an electromagnetic launch apparatus. In accordance with differences in the form of deployment, kinetic energy weapons are divided into four types: space-based kinetic energy weapons, ground-based kinetic energy weapons, airborne kinetic energy weapons, and sea-launched kinetic energy weapons; in accordance with their mechanisms of action, they can be divided into kinetic energy interceptors, electromagnetic cannon, and the like. Currently, kinetic energy weapons that have a certain ability for actual combat consist of the United States' airborne anti-satellite missiles, land-based kinetic energy anti-satellite weapons systems, and space-based anti-satellite systems, and Russia's kinetic energy anti-satellite systems.

Compared to traditional weapons and directed energy weapons, kinetic energy weapons have their own advantages. First, land-based kinetic energy weapons are not affected by the weather, and so can operate in all weathers. Second, their destructive capabilities are strong, and it is easy to determine the effects of operations. And third, their forms of deployment are flexible and their survival capabilities are strong, and it is hard for opponents to take precautions against them when they attack. These are major reasons why kinetic energy weapons can continually and rapidly develop. Compared to directed energy weapons, the drawbacks to kinetic energy weapons are that they are slow, they operate only over short distances, they cannot be repeatedly used, and they currently still have difficulties in dealing with fast targets that are far away and with multiple targets. The most crucial technology in kinetic energy weapons is precision homing guidance; the more precise they are, the less quality and speed their interception warheads will need, and the better the results of their operations will be. In order to improve the success rate of interception, some kinetic energy interceptors have some apparatus added to their warhead parts, such as large high-speed projectiles or umbrella-shaped steel rods.

In the 1980s, the United States and the Soviet Union energetically developed kinetic energy weapons technology. The United States made some major progress in the area of such crucial technologies as probes and guidance, and it often demonstrated the anti-missile and anti-satellite abilities of its rocket-propelled kinetic energy weapons. In 1990, the US Department of Defense's Strategic Defense Initiative Organization also carried out the first suborbital flight tests of the Bright Pebbles [project], as well as the first atmospheric flight tests of the High Endoatmospheric Defense Interceptor (HEDI).

(1) Space-based kinetic energy interceptors

Space-based kinetic energy weapons are a space killer with totally new concepts and that are completely different from conventional warheads or nuclear warheads. They are primarily composed of several parts, such as a supersonic launch mechanism (that is, a propulsion system), a probe system, a guidance system, and a projectile. Space-based kinetic energy weapons that have been developed or are currently under development primarily include space-based kinetic energy interceptors, outer space railguns, and Brilliant Pebbles. Space-based kinetic energy interceptors are mainly used to intercept intercontinental ballistic missiles (these can also be used against satellites). They are space-based weapons that accelerate "projectiles" to a very high speed, using supersonic launching apparatus installed on spacecraft and that use guidance systems to destroy targets that the probe system has found, such as aircraft, spacecraft, or enemy space-based weapons.

(2) Railguns

Electromagnetic orbiting cannon are also called coilguns; they consist of a series of fixed accelerator coils along with projectile-mounted moving coils wrapped around a miniature sabot. When these coils power up in accordance with procedures, they produce a moving magnetic field, which thus impels the miniature sabot that is in the magnetic field to accelerate and then fire. Railguns use multiple magnetic fields to again combine and produce new magnetic field structure with even greater capacity, accelerating and firing the miniature sabots in multiple stages. The main technical difficulty of railguns is in enhancing the quality and speed of the sabot.

2. Directed energy weapons

Directed energy weapons refer to weapons systems that directly illuminate and damage targets by means of firing high-energy laser beams, particle beams, and microwave beams. In accordance with the form that the energy effects take, directed energy weapons can be divided into conventional directed energy weapons and nuclear directed energy weapons. Conventional directed energy weapons include high-energy laser weapons and high-energy particle beams (neutral hydrogen atomic beams and electron beams) weapons. Nuclear directed energy weapons include nuclear-pumped X-ray lasers, directed electromagnetic pulse shells, and directed plasma weapons. In accordance with the way they are deployed, directed energy weapons can be divided into three types: space-based, land-based, and sea-based. In accordance with their operating mechanisms, they can also be divided into high-energy laser weapons, particle beam weapons, microwave weapons, and the like. Directed energy weapons can carry out soft kills against satellites and missiles (such as using lasers to temporarily blind satellite and missile optical probes), but they can also carry out hard kills (such as destroying certain critical parts of satellites and missiles), so their operational uses are very flexible. Not only are they suitable against satellites orbiting in low earth orbit, but they are also suitable against satellites orbiting in high earth orbit and against ballistic missiles, and they can repeatedly fire. However, their drawback is that it is easy for targets to adopt measures to strengthen their countermeasures, and it is not easy to judge the effects of the kills. Ground-based directed energy weapons are easily limited by meteorological and other conditions when they are being used in operations.

Directed energy weapons usually consist of such parts as the directed energy pulse source, the firing transmission system, target acquisition tracking and identification, and the kill evaluation system. They can instantaneously attack rapidly moving targets thousands of kilometers away (such as intercontinental ballistic missiles' boosters, post-boost vehicles, decoys, and military satellites), so that these are destroyed or identified and can be quickly be targeted again. The use of means of directed energy kills to destroy space targets is characterized by quick speed and broad areas of attack, but technologically, it is fairly difficult to achieve. Currently, the United States, Russia, and other military powers are actively researching and testing these, and it is estimated that in the near future, they will be able to research and develop directed energy hard kill weapons that can meet the needs of actual warfare.

(1) High-energy laser weapons

High-energy laser weapons (also called powerful laser weapons and laser cannons) refer to directed energy weapons that use the excited materials of such external energy sources as light energy, thermal energy, chemical energy, or nuclear energy to have these emit special high-energy light beams produced by stimulated radiation, so that they blind or destroy enemy targets. They generally consist of a high-energy laser, a precision aiming and tracking system, and a light beam controlled-firing system. Lasers are a directed energy weapon that has many functions and uses; by mounting laser weapons on spacecraft such as satellites, spaceships, and space stations, it is possible to use them to destroy various types of enemy military satellites, missiles, and other weapons. This kind of laser weapon can intercept [targets] head on, and they can also pursue and attack from the side or the tail. Because the carrier spacecraft for these weapons are very steady, without interference issues from airflows and shaking, the energy from lasers mounted on spacecraft can be fully brought into play.

Currently, there are primarily three types of laser weapons that have a certain amount of capability in operations. The first are US land-based anti-satellite laser weapons. US land-based anti-satellite laser weapons are fairly mature and have already undergone numerous tests. They mainly consist of the Mid-Infrared Advanced Chemical Laser (MIRACL) and Sea-stone light beam director (SLED)[9]. A second is the United States' airborne laser weapons system (ABL). The United States' airborne laser weapons system uses a Boeing 747-400F aircraft as the platform, and consists of an oxygen-iodine chemical high energy laser, a passive infrared sensor, and an aiming and tracking system. It can counter ballistic missiles, [enemy] satellites, and [enemy] aircraft. Its primary advantages are its excellent mobility and the large scope of its operations; its drawbacks are that the system is complex, it is very difficult to support, and every theater of war needs to have seven combat aircraft, in groups of two, to carry out missions. The third are space-based laser weapons systems (SBL). Space-based laser weapons concentrate high-energy laser weapons centers on a satellite platform, which can counter satellites and counter ballistic missiles. Their advantage is that there is no impact from the atmosphere on laser transmission and they are steadier that airborne laser weapons and easier to operate; their drawbacks are that the scope of operations is restricted, and their difficulty is that they need to have the lasers be small in size but very powerful, and this is a contradiction technologically.

(2) High-powered microwave weapons

High-powered microwave weapons are also called radio frequency weapons; they refer to directed energy weapons that use the energy of powerful microwave beams to destroy the electronic devices or personnel in targets like aircraft, missiles, and spacecraft. They are a weapon that uses radio wave energy to attack targets. High-powered microwave weapons are characterized by their radiation microwaves (radio waves with a wavelength of one meter to one millimeter), and therefore they are also called radio wave weapons and radio frequency weapons. High-powered microwave weapons generally consist of a super-high powered microwave emitter, a large-scale antenna, a power source, and other sets of equipment; their structure is similar to the transmitting section of a radar, but the energy of their radiation must be a hundred times or up to 10,000 times greater than that of a radar. The radiation frequency of the microwaves is often in the one gigahertz to thirty gigahertz range, and the pulse power that is transmitted reaches the gigawatt level. Based on the strength of the microwave energy, high-powered microwave weapons not only can carry out soft kills but also can carry out hard kills.

High-powered microwave weapons have the following characteristics. First, they can attack in all weathers. Microwave weapons are not affected by any weather conditions,

---

[9]Translator's note: Probably a typo for SLBD, "Sealite Beam Director."

and can attack enemy electronic devices at the speed of light. Second, they can carry out attacks at differing levels. They can carry out surgical strikes at specific degrees of operations, and based on the nature of the target and the operational mission, they engage in destruction and interruption [of targets], or degrading of [the target's] capabilities. Third, they have excellent directionality and a definite scope of coverage. They can carry out attacks against targets on a broad scope, but they can also deal with a given specific target, that is, the radiation scope of microwaves can be changed. Fourth, the scope of operations is broad. High-tech weapons and equipment universally use electronic or optoelectronic parts, and therefore, high-powered microwave weapons can attack virtually all [of these] weapons and equipment; attacks are particularly effective against the large numbers of satellites and missiles that use electronic parts.

The mechanism of operations for high-powered microwave weapons is that they concentrate very powerful microwave energy produced by the microwave generator into a narrow beam by means of very narrow pulses through an antenna; this is directed and projected at targets in space and in the air or on land and at sea, damaging the sensors and receptor portions of the enemy's electronic system, burning out [the system's] electronic components, and disrupting its digital circuits, and even directly destroying equipment. Compared to particle beam weapons and powerful laser weapons, microwave weapons have fairly broad beams, and thus a relatively large scope of illumination and killing. In addition, they are not affected very much by the weather and smoke and other battlefield environments, so they are fairly suitable for operations. However, concentrating the energy of microwave weapons requires using large-scale antennas, and it is very difficult to immediately judge their killing effects against targets.

Currently, the developed countries of the world, such as the United States, Russia, France, the United Kingdom, Germany, and Japan, are all paying a great deal of attention to the development of high-powered microwave weapons. Of these, the United States' and Russia's high-powered microwave weapons have developed fairly fast and have undergone major improvements. Early on in 1987, high-powered microwave weapons technology was listed as one of five key technical projects in the US Department of Defense's Balanced Technology Initiative (BTI) program. The space-based High-Power Microwave (HPM) weapon that the United States is currently researching and developing is a weapon that kills targets on the surface, in the air, and in space. It consists of a low earth orbit satellite constellation, and it can direct ultra-wideband microwave energy at targets on the earth's surface, in the air, and in space. Its effect is to produce a high magnetic field over a scope of several dozen to up to a hundred meters in the target area, thereby destroying or damaging any electronic components.

(3) Particle beam weapons

Particle beam weapons refer to directed energy weapons that use powerful, high-current subatomic beams to destroy targets like aircraft, missiles, and satellites, or to render them ineffective. They are usually divided into two types: charged particle beam weapons that are used in the atmosphere and neutral particle beams weapons that are used in outer space. Particle beam weapons usually consist of a particle source, a particle accelerator, probes and aiming and tracking, and a command and communications device.

The working principles of particle beam weapons are to use a powerful high-current accelerator that accelerates electrons, protons, and ions produced by a particle source to near-light speeds and to use a magnetic field to focus these into a dense particle beam flow that is shot toward the target. [The weapons] rely upon the many effects of the particle beam flow to destroy the target or render it ineffective. There are largely three mechanisms by which particle beams destroy targets or render them ineffective: the first is to damage their structure, the second is to cause ammunition to explode early, and the third is to render electronic devices ineffective.

Particle beam weapons have the following distinct characteristics. First, their energy is highly concentrated, their penetrating ability is strong, their firing power is great, and they can damage the internal structure of targets just as kinetic energy weapons do, leading to an explosion in the ammunition of the target's warhead and causing pulse currents that leave electronic devices ineffective. Second, they can quickly change the direction of their firing and can thus deal with multiple targets. Third, they can identify real and false targets. Neutral particle beams can identify real and fake targets; this has an extremely important role in operations against missiles and against satellites. Fourth, they are not affected by weather and the environment. Particle beams are not distorted by the atmosphere nor are they affected by such things as clouds, so they are convenient to use.

Because particle beam weapons have great advantages and developmental prospects, some military powers are competing to research and develop them, but they currently are still in an experimental stage. Early on in 1944, British scientists conceived of using particle beams as weapons. As relevant technology developed, and given military needs, this research work has still been ongoing since the 1990s. If the problem of the equipment's excessive bulk is resolved, particle beam weapons may in the future become an important space-based weapon.

II. Soft kill weapons systems in space operations...119

Soft kill weapons systems in space operations refer to weapons and equipment systems that damage the optoelectronic instruments in enemy space-based weapons systems, rendering them ineffective, or that use some other no-destructive means to cause enemy space-based weapons system to lose their effectiveness in operations. In future space operations, silent "soft confrontations" that leave no mark will make up an ever-growing proportion; soft kills cost less than hard kills, they are relatively simple to carry out technologically, and they have the advantages where the scope of their use is broad, the effectiveness of their operations is great, and they can avoid contaminating the outer environment that is outer space. The weapons systems that are used in soft kills primarily consist of three types: low-powered directed energy weapons, electronic warfare weapons, and network warfare weapons.

1. Low-powered directed energy weapons

Low-powered directed energy weapons are a type of directed energy weapon. They damage the fragile sensors and optoelectronic systems of satellites, through firing low-powered microwave beams, laser beams, and ion beams, thus jamming and suppressing the ability of space-based weapons systems to work. For example low-energy laser and microwave weapons and particle beam weapons are used to illuminate the enemy's space operations weapons and equipment, damaging their optoelectronic devices; although their entire structure is not damaged, they still lose their effectiveness in operations.

Currently, space platforms primarily have two measures to resist attacks by low-powered directed energy weapons. The first is to use new-materials technology to reinforce space platforms' resistance to directed energy. This primarily is the research and development of materials or paints that absorb, reflect, or disrupt directed energy beams; these materials are used to manufacture certain parts that would be damaged by directed energy. Or a layer of paint that covers the outer surface of space platforms can reduce in an effective way the destructive effects of beam energy weapons. Currently, electromagnetic protective materials and laser protective materials have already been researched and developed and have become relatively mature. Electromagnetic protective materials primarily consist of electromagnetic shielding fabrics, electromagnetic shielding paints, electromagnetic wave-absorbent paints, nanometer-level metallic powders, and the like; these kinds of electromagnetic protective materials have become widely used in the military sphere. Laser protective materials primarily consist of two types: wavelength protection types and light intensity protection types. The wavelength-type protective materials use multiple layers of dielectric film, which have fairly good reflective effects against lasers with certain wavelengths; light intensity-type protective materials use third-order non-linear optical effects or heat-induced phased transformation mechanisms to protect against lasers. Laser protective materials have already been applied in certain space-based weapons systems; for example, heat-induced phased transformation materials that were successfully researched and developed by the United States' Westinghouse Electric Company have been used to protect infrared probes on satellites from being damaged by lasers. The second [measure] is to use innovative technology to convert various kinds of sensors on space platforms; this kind of technology is represented by the "eyelid" system developed by the United States' MCNC Company. This kind of "eyelid" is manufactured from a piece of thin glass; the upper part covers two transparent electrodes made of indium oxide and tin, and the electrodes are connected by a non-transparent electrode similar to a hinge. By adding reverse voltage between the two electrodes, the non-transparent electrode is pulled down under the effect of electrostatic attraction, so that the "eyelid" closes; by changing the direction of this voltage, the "eyelid" opens. This "eyelid's" opening and closing can reach 4,000 times a second. This technology's application to satellites' optoelectronic sensors can prevent optical sensors being blinded by lasers.

2. Electronic warfare weapons

Electronic warfare weapons are the sum total of the various types of weapons and equipment that jam and deceive space-based platforms. In order to carry out electronic jamming against space-based weapons systems, electronic warfare weapons primarily use a suppressive form of jamming, that is, they use very powerful jamming signals to push the traveling-wave tube amplifiers or the solid state power amplifiers in space platforms transponders into power saturation, so that they produce the so-called "power robbing" phenomenon. The jamming signal produces effective suppression of normal signals, thus affecting and even blocking normal communications. For example, jamming of the global satellite navigation and positioning system causes the opponent to have no way to correctly receive navigation and positioning information, and jamming of communications satellites interrupts the opponent's communications links, keeping him from transmitting information. In addition, it is also possible to send deceptive signals to navigation and positioning systems, so that the opponent mistakenly treats false information as correct navigation signals; this similarly can achieve the goal of damaging the system's operational effectiveness.

With regard to suppressive-style jamming by electronic warfare weapons, the combat methods that can be adopted consist of improving space platform transponders and using nulling antenna technology and spread spectrum technology. Improvements to transponders primarily consist of installing hard/soft limiters to the transponders or adopting automatic gain control. Limiters and gain control technology can restrain high-powered jamming signals fired at space platforms, reducing the power that passes through the transponders, but simultaneously without affecting the passage of useful signals. Currently, the US military's military satellite transponders basically have limit controls {*xianfu kongzhi*}. Nulling antenna technology is technology for resisting jamming that is based on spatial filtering; this technology goes through a combination of multiple antennas, and the received signal goes through adaptive weighing, forming a null point for beams, and it can automatically align the null point with the direction of the jamming source. This anti-jamming technology can be used to resist any type of electronic jamming; at the same time, it can also achieve a fairly low signals interception rate. Spread spectrum is the most important technology for resisting jamming in military communications; and it is also widely applied in satellite communications resistance to jamming. After using spread spectrum technology, the power of regular signals will be several dozen times greater than that of jamming signals under conditions where they are at the same distance; in order for the ground receiver's output terminal to get a jamming-to-signal ratio of 1:1, the jamming signal's power must be thousands or up to ten thousand times greater than the signal power. It is very evident that using spread spectrum technology to enhance the anti-jamming capabilities of space-based weapons systems is extremely effective.

3. Network warfare weapons

Network warfare weapons refer to the sum total of the various types of weapons and equipment that are used to carry out network reconnoitering and damage to enemy space-based weapons' information systems. There are primarily two kinds of network attacks against space-based weapons systems. The first is to get data chaining parameters and communications protocols by deciphering satellite signals and to inject viruses, logic bombs, and false information signals into the opponent's information system by means of his data chaining, thus creating malfunctions in the satellite information system or thoroughly paralyzing it. The second is to conceal computer viruses in computers in the opponent's satellite information system in advance by means of covert channels and to activate the viruses when necessary, thus damaging the opponent's information system. This means of soft attack is not limited by time, area, or weather conditions, and it has the nature of being random, covert, sudden, long-term, extensive, and calamitous; it not only can steal important information in the enemy's space operations weapons and equipment system, but it also can "paralyze" the opponent's entire spaceflight system.

There are primarily four methods for resisting attacks by network warfare weapons. The first is to carefully monitor signals from the space platforms. By means of comprehensive monitoring and a monitoring system, monitor uploaded and downloaded signals for the space platforms at all times, so as to promptly find and track suspicious signals and to analyze the direction, power, and contents of the suspicious signals, and to launch a counterattack when necessary. The second [method] is adopt information identification technology within the satellite information system, in order to automatically distinguish illegal information, information containing viruses, and false information, and to carry out prompts [about these], refuse to transmit them, and refuse to process them. The third is to carry out careful and detailed examination of information systems on the satellite prior to the satellite's launch. It is particularly necessary to examine the security and reliability of parts, [to see] whether there are leaks and back doors. The fourth is to use legal means for an effective attack against "satellite hackers." The main thing is to draft and stringently execute laws related to satellite information security, and to carry out prevention, deterrence, and punishment against "satellite hackers," while at the same time strengthening international cooperation and joining international strengths in attacks against international organizations' or individuals' network attacks against satellites.

Section 5: Ground Systems for Applications and Management of Space Resources...122

Ground systems for applications and management of space resources usually refer to various types of command and control systems that have been established on the ground and that are responsible for receiving, processing, and distributing information. Ground systems for applications and management of space resources are linked with other subsystems by means of the satellite operations control network, and they quickly provide users with the data and information products that the spacecraft and ground receiving and processing systems collect and produce, so as to manage and share space resources in an effective manner and to improve the applications effectiveness of space strengths' support to joint operations command systems. Here we will focus on explaining the ground applications system for satellite reconnaissance, the ground applications system for satellite communications, and the ground system for satellite meteorological monitoring and forecasting.

I. Ground applications system for satellite reconnaissance...122

There are a fairly large number of types of reconnaissance satellites; their ground applications systems vary, but in general, they can be divided into two categories, that is, geostationary satellite ground applications systems and near earth orbit satellite ground applications systems. Because the effective payloads that reconnaissance satellites carry differ, the missions of their ground applications systems also vary.

Geostationary reconnaissance satellites' ground applications systems are similar in form to those of satellite communications earth stations; where they differ is that what they receive is satellite remote sensing data. The amount of data is great, and its transmission rate requirements are high. The ground applications systems of satellites in near earth orbit require setting up a certain number of ground collection stations, because the satellites' locations are constantly changing, in order to get as much data as possible, and [these stations] subsequently transmit the data to a data processing center. Of course, countries with relay satellites can transfer the reconnaissance data to ground stations via geostationary relay satellites; in this way, there is no difference between their ground applications systems and the ground applications systems of geostationary reconnaissance satellites. Return-type reconnaissance satellites do not have ground receiving systems. Another important function of ground applications systems is professional control over satellites. Control management of satellites also can be divided into two categories. One category is engineering control, which primarily does orbital control and attitudinal control for satellites, with the goal of ensuring that satellites work normally. The other category is professional control, which mainly controls the working status of satellites, that is, it manages the effective payloads that satellites carry, such as control over the times and places that cameras on photoreconnaissance satellites will photograph. These two types of control can be carried out in tandem, done in a unified manner by a single ground control center of control station; they can also be carried out separately by a ground control center and a satellite users' ground applications system.

Satellite reconnaissance ground applications systems largely include the following subsystems: satellite ground stations systems, satellite applications management centers, and satellite data applications systems. Satellite ground stations primarily are composed of receiving antennas, remote control antennas, terminal equipment, computers, and power systems. Their main tasks include precision tracking and monitoring of satellites; receiving the remote sensing and telemetry data sent by satellites; processing to a certain extent the data that they receive and then transmitting these to the management center; in accordance with the center's instructions, exercising professional control over the satellites, sending remote control instructions and examining how these are being carried out; and completing other tasks as assigned by the control center. The satellite applications management centers are the command hubs for reconnaissance satellites; they control the satellites in completing their various designated tasks. They primarily consist of computer systems; imagery data processing systems; data transmission systems; analysis, decision-making, and control systems; communications systems; and power systems. Their primary tasks are to summarize the remote sensing data sent by ground stations and to process these; to display task requirements, calculate control data for satellites, and transmit the control commands to ground stations; and to analyze satellite data, provide opinions and proposals to decision-making departments, and coordinate engineering control over satellites with the control centers and control stations that are responsible for engineering control over satellites, so as to ensure that satellites operate normally. The main tasks of satellite data applications systems are to transform satellite data into the final results, such as imagery, photography, and maps; to transmit the final results of the satellites to relevant users; to set up satellite information and data and to collect and sort out satellite data; and to produce products to be attached to the satellite data.

II. Satellite communications ground applications systems...123

Ground applications systems are an important component part of satellite communications systems. There are slight differences among the ground applications systems of satellite communications that have various uses, but their basic facilities are similar. Their main equipment is ground station devices that are used to transmit and receive communications signals; they customarily are also called satellite communications earth stations, ground stations, or terminal stations.

Satellite communications earth stations' equipment generally can be broken down into six subsystems. The first is the antenna subsystem. Earth stations generally use parabolic antennas; in addition to the antennas themselves, they also include feeder devices (that deliver antenna signals to the tracking part) and tracking and driving devices (that control the direction the antenna faces). Earth station antennas in the early period had apertures of ten to thirty meters; because satellite technology has developed and ground systems have improved, antenna apertures have now been greatly reduced. The second is the transmitting subsystem. This modulates the audio-frequency and video-frequency signals to a carrier with a working waveband, and after a power amplifier amplifies them, they are transmitted to the satellite through the antenna. The third is the receiving subsystem. This receives signals coming from the satellite, and after it amplifies the detected wave, it retransmits it to the terminal system. The fourth is the terminal subsystem. This consists of a carrier telephone terminal device, a television terminal device, a fax terminal device, and a data terminal device. The fifth is the communications control subsystem. This is responsible for monitoring, controlling, and periodic testing of the various devices within the earth station. The sixth is the power subsystem. This is used to provide power for all of the earth station's devices.

Based on work requirements, satellite communications earth stations can use differing frequencies and antenna apertures. In order to facilitate production, use, management, and maintenance, the International Communications Satellite Organization has stipulated six types of earth station planning standards. Standard A stations' working frequencies are to be 6/4 gigahertz (uploading/downloading), their antenna apertures are to be twenty-seven to thirty meters, and they are to be suitable for transmitting high-density trunk-line telephone calls on more than 100 to 1,000 channels. Standard B stations' working frequencies are to be 6/4, their antenna apertures are to be eleven to thirteen meters, and they are to be suitable for transmitting telephone calls on less than 100 channels. Standard C stations' functions are similar to Standard A stations', but their working frequencies are to be 14/11 gigahertz and their antenna apertures are to be sixteen to eighteen meters. Standard D stations' working frequencies are to be 6/4 gigahertz, the antenna apertures are to be 4.5 to 5 meters, they are to be inexpensive and easy to use, and they are to be suitable for communications lines requirements for less than ten channels. Standard E stations' working frequencies are to be 14/11 gigahertz, their antenna apertures are to be 3.5 to 8 meters, and they are to be used for digitized communications with a channel rate of sixty-four kilobits per second. Standard F stations are similar to Standard E stations, but their working frequencies are to be 6/4 gigahertz and their antenna apertures are to be five to seven meters. In accordance with the form in which they are used, satellite communications earth stations can be divided into fixed stations, portable stations, and mobile stations; their working frequencies and antenna apertures also can be differentiated in reference to international standards.

III. Ground systems for satellite meteorological monitoring and forecasting...124

Meteorological satellites' ground applications systems are used to measure and control meteorological satellites, and to receive and process their meteorological information. They consist of a data collection and control station {*shuju jieshou yu cekong zhan*}, a data processing center, a data collection system {*shuju souji xitong*}, and a data use station {*shuju liyong zhan*}.

The data collection and control station includes a receiving system, a control system, and communications devices. Polar orbit meteorological satellite systems have many data collection and control stations, while geostationary meteorological satellites only have one station. These primarily receive information measured by the meteorological satellite's remote sensors, the data that are transmitted via satellite are collected into platform remote sensing data, along with the satellite's own remote sensing data, after which this information is sent via communications equipment to the data processing center. It also transmits to the meteorological satellite the remote control commands that are sent by the satellite control center. In addition, geostationary meteorological satellites' data collection and control stations transmit to the meteorological satellites cloud images and weather facsimile images that have been sent from the data processing center, based on the orders from the satellite control center for the satellites to carry out tracking and measurements, and to send the data that have been measured to the data processing center.

The data control center consists of computers, peripherals, and corresponding software. It records and processes the information sent from the data collection and control station, extracts various kinds of useful information, turns these into various kinds of weather maps, and changes various kinds of observation data into meteorological data and distributes these to users. In addition, this center also exercises monitoring and command and control over the entire meteorological satellite system.

The data receiving system includes large numbers of automated environmental data collection stations set up on land, at sea, and in the air. They are configured with differing sensors and can collect differing environmental data; after these undergo sampling, encoding, and amplification, they are sent to the meteorological satellites. Each meteorological satellite can collect data from a number of stations, and afterwards transfer these [data] to the data collection station, and after these are again processed by the processing center, they are distributed to users.

The data use station is responsible for receiving the various cloud maps that the meteorological satellites send in real-time, and provides them to relevant regions for their use. The data use stations that are normally used consist of automated image transmission cloud map stations, which are used to receive the real-time low resolution virtual cloud maps; high-resolution image transmission cloud map stations, which are used to receive high-resolution digitized cloud maps sent from polar orbiting satellites; small-scale data stations, used to receive low-resolution virtual cloud maps sent by geostationary satellites; and medium-scale data stations, used to receive high-resolution digitized cloud maps or virtual facsimile cloud maps {*moni chuanzhen yun tu*} sent by geostationary satellites.

Questions for Deliberation…125

1. What are the main systems for obtaining space information?

2. Describe the categories of satellite imaging reconnaissance systems.

3. Describe the types of satellite communications system.

4. What are the basic types of space operations weapons systems?

Lecture 5
The Main Patterns of Space Operations…126

Space operations have a special operational space and weapons and equipment *xitong* systems, and their operational patterns similarly have an extremely special quality. In the current phase, space operations mainly include two form-states: the first involves providing military assisting support {*zhiyuan*} from outer space for land, naval, and air operations; the second involves conducting attack activities from the land, sea surface, underwater, and air against enemy spacecraft. Along with the further development of space technology, direct confrontations of spacecraft unfolding in outer space will become a possibility. Current methods for classification of space operations patterns are quite numerous, but fairly typical are the following: partitioned per the engagement space, they include the "space-to-space confrontation battle," "space-to-ground confrontation battle," and "integrated space-land battle" {*tiandi yitizhan*}; partitioned per the nature of attack and defense, they include space assisting support operations, space offensive operations, and space defensive operations; partitioned per the weapons employed, they include missile battles, satellite battles, and spacecraft battles; partitioned per the application level, they include strategic space battles, campaign space battles, and tactical space battles; and so on. From the standpoint of operational missions and goals, space operations can be partitioned into five patterns: space deterrence, space blockade operations, space strike operations, space defensive operations, and space information assisting support operations.

Section 1: Space Deterrence…126

Space deterrence signifies having powerful space forces as backing and threatening to use or actually using limited space forces to awe and contain the opponent's military activities. The goal of this activities pattern is to make a show of strength combining deterrence and combat and conduct activity {*huodong*} to create a favorable posture, thus showing the real strength and resolve of the friendly space operations; generate doubt, fear, and wavering in the enemy; force him to abandon his operational intention; control the operational scale and intensity, plus the operational means; and thus achieve the goal of breaking the enemy's resistance without fighting or with minimal fighting. Space deterrence is like nuclear deterrence or conventional forces deterrence: they all are a form of military deterrence. Since space deterrence in terms of use has a strategic quality, convenience, and controllability, it thus will become the main form of military deterrence, and the frequency of its use will grow increasingly frequent. **[end of page 126]**

I. Main activities of space deterrence…127

In order to enhance the deterrent effects, space deterrence when applied usually adopts the method of gradual escalation, to constantly increase the degree of force in deterrence of the enemy. According to the sequence of activities intensity from weak to strong, 4 types of activities can be differentiated: show of space strength, space military exercises, disposition of space forces, and overawing space strike. These four types of activities are not at all mutually exclusive; they can be simultaneously employed, or can be conducted without a strict priority, and must be flexibly applied based on the current situation.

1. Show of space strength

In peaceful times and in the early stages of "crises," since the status of enemy and friendly confrontation is not clear or not present, the goal of space deterrence is only prevention, so it usually only requires a display of the presence of friendly space strength in order to achieve the goal of deterrence. Show of space strength can exploit public media such as TV stations, radio, computers, and newspapers and magazines to carry out public opinion propaganda and display to a potential enemy the powerful strength possessed by the friendly space forces, so that the enemy dares not take a risk in political respects, or take rash action in military respects. Show of space strength belongs to low-intensity deterrent activities, generally is carried out to complement political and diplomatic struggle, and is mainly expressed by conducting various types of space equipment tests. Advanced space equipment is the main embodiment of real strength in space operations, and open or semi-open tests of certain important space equipment will employ the form of media propaganda, display at exhibitions, and invitations to foreign military officers to be observers. These will comprehensively reveal the achievements of friendly space strength building, display the powerful space operations capabilities they possess, and thus deter a potential enemy. In the process of displaying space strength, [the friendly side] should differentiate the situations and adopt different open methods. This means either thorough openness, so as to fully display real strength to deter the enemy, or semi-openness, so that the enemy cannot size up the exact details of the friendly forces, and thus has misgivings and does not dare to conduct rash activities.

2. Space military exercises

When a "crisis" escalates, and a show of space strength is no longer sufficient to deter the enemy, it will be necessary to conduct space military exercises. Space military exercises are quasi-real-combat [quality] space deterrent activities set against an imaginary enemy and real combat backdrop, and adopting computer simulation and live fire modes to carry out mutual attack and defense. These activities have a clear goal and a strong directed [focused] quality; they have a sharp confrontational quality and quasi-real-combat quality and thus are suitable to be carried out in "crisis" times and in the preparation phase for military activities. According to the development of military struggle circumstances, this will require conducting space military exercises of appropriate scale and diversity of form, and having a real-combat backdrop. The goals lie in boosting the attack and defense and assisting-support operational capabilities of the space forces, and in displaying to the enemy the current posture and operational resolution of the friendly space forces, as well as transmitting to the enemy information on the war preparations we already properly carried out, **[end of page 127]** and on our capability and resolve for gaining victory in war — all to force the enemy to beat a retreat in the face of difficulties. Space military exercises have multiple forms, including the following: organizing anti-ballistic-missile and anti-spacecraft exercises, sufficient to display the real strength of the friendly side's space and counter-space units, and make clear that we have the capability and means to seize space dominance; organizing space strike exercises, sufficient to display the powerful strike might of friendly space weapons and equipment, and make clear that we have the capability and means to directly strike at targets in the enemy's strategic depth; and organizing space information assisting support exercises, sufficient to display the real-time or near-real-time battlefield-posture awareness capability possessed by the friendly space information systems, and make clear the ability to effectively provide battlefield information assisting support to other operational strengths.

3. Disposition of space forces

Once a crisis intensifies, when the possible enemy takes clear action in terms of real combat preparations, [we] should immediately speed up readjustment of the disposition of the space forces, to boost the deterrent intensity. The disposition of space forces is the force-strength differentiation and deployment carried out for the space operational strengths, based on the missions and activities nature of the space operations. This activity belongs to medium- to high-intensity deterrence; it is an effective method for enhancing the deterrent effects and also can create a favorable posture for the friendly side to enter real combat within days. Setting the disposition of space forces requires regarding them as an important part of the integrated-whole operational disposition of the next military activities, and an important link in working out an approach in planning using mathematical and scientific methods, so as to correctly deploy the friendly space forces, form local superiority over the enemy, create a posture for strategic attack, and thus cause the enemy to abandon his war intention out of a sense of a "large enemy force bearing down on the border." This activity mainly has two forms: projection of space forces and readjustment of the space forces' disposition. Of these, projection of space forces signifies activities to send spacecraft into outer space and recover spacecraft from outer space, so as to transport astronauts, weapons and equipment, and operational materiel. This is the most important link in establishing the space operational disposition, and also is an important prerequisite for the space forces' entry into outer space and carrying out of the operational missions. The activities for projection of space forces are specifically jointly conducted by the space launch, space flight, space telemetry, tracking and control [TT&C], space equipment technical support, and base defense units; and based on the differences in the projection goal and endpoint, they can be divided into upward projection and downward projection. Upward projection signifies the space launch activity conducted by the space launch units and space flight units, under close complementation by the TT&C units and support units, as well as the defense units. Its goal is to transport astronauts, weapons and equipment, and operational materiel into outer space. Today, the world's space-faring nations mainly employ space launch vehicles [SLVs] as the means of space delivery, while the U.S. also uses space shuttles to implement projection. Downward projection signifies the activity of retrieval of recoverable spacecraft — photoreconnaissance satellites, space ships, space shuttles, and aerospace planes — carried out by the space flight units and TT&C units, under complementation by the support units. Its goal is to see that the recoverable spacecraft, after fulfilling its mission, safely returns to **[end of page 128]** the ground base. Readjustment of the disposition of space forces signifies, on the basis of the space forces' peacetime disposition, the use of contingency space launch, orbital maneuver, and land, sea, and/or air maneuver, to swiftly readjust the structure and arrangement of the space-based information net, space-based firepower net, and ground base net, so that they are adapted to the needs and requirements of space operations.

4. Overawing space strike

When the above 3 nonviolent deterrent modes are not sufficient to halt the enemy's war intention, [we] should adopt punitive strikes, to warn the enemy that we have already properly carried out all-around war preparations, and will spare no costs to safeguard the interests of the state. Overawing space strike is the highest form and final means of space deterrence, and is the final effort made to realize the goal of deterrence when other means of space deterrence are ineffective. It belongs to the real-combat [quality] space deterrence activities. The execution of overawing space strike can adopt two forms: "soft strike" and "hard strike." "Soft strike" signifies employing the space forces to execute information attacks on the enemy, and in the electromagnetic [EM]-spectrum field, to jam and suppress or deceive and confuse the enemy's information acquisition, transmission, and command and control [C2] systems, so as to cause radar blindness, communication interrupts, and C2 dysfunction on the enemy side. In the information network field, the space forces will execute cyber attacks on the enemy, sabotage various types of enemy military-civilian information networks, render various types of networks unable to normally operate, make the enemy fully feel our powerful cyber operational capability, and thus add to the enemy's doubts about adopting military activities. "Hard strike" signifies employing the space forces to execute surprise, swift, limited-scale, overawing strikes against susceptible positions in the enemy operational system of systems [SoS], to shake the enemy decision-makers psychologically, and force them to dare not adopt large-scale military activities, or force them to sign a "[peace] treaty made under coercion," in view of the might of our space forces.

II. Basic requirements for space deterrence…129

Space deterrence serves as a relatively flexible activities pattern. Within military struggle, it has a special position and role, and its proper application will bring into play special effects which other activities patterns do not have. [We] should tightly center on the links of employing deterrent forces, unfolding deterrent activities, displaying deterrent resolve, transmitting deterrent information, and realizing the objectives of deterrence; accurately grasp the key points of deterrence; control the intensity and tempo of the deterrence; synthetically apply the 4 deterrent activities; and carefully organize and conduct the space deterrence, to achieve the optimum deterrent effects.

1. Focusing on the overall situation, for cautious decision-making

This is the most important principle in carrying out space deterrence, and is a fundamental assurance of achieving the fixed military and political goals. Space deterrence is important content in the state's military deterrence; it must focus on the strategic overall situation, **[end of page 129]** comprehensively consider the state's needs and requirements in political, economic, and diplomatic respects, and adopt the appropriate activities, in order to deter the enemy, and achieve the goal of gaining victory without a battle or with only a small battle. At the same time, space deterrence is a relatively complex military activity. In the face of a sharp conflict of interests between the opposing sides, various contradictions are woven together in an intricate and complex manner, and within this, besides the known and quantifiable factors, there are also a good many unknown and unquantifiable factors. For example, the psychological effects and degree of influence brought about by deterrent activities, the subjective dynamic quality of the men, the fortuity in the deterrence process, and in particular the intangible factor of the ruses and stratagems applied by the opposing sides — all these cause the deterrent activities to involve extremely complex situations. If these situations are not well grasped, it could lead to failure of the deterrence, and then set off a war or an escalation of war. Hence, in carrying out space deterrence, [we] must occupy the high ground of the overall situation in respect to the formulation of tactics, the commitment of forces, the selection of the object [of deterrence], the establishment of the scope, the achievement of the objectives, and the employment of means and modes — and thus carefully use mathematical and scientific methods, act with caution, and strive to bring into play to the maximum extent the effectiveness of deterrence, and thus achieve the anticipated goal. [We] should comprehensively consider needs and requirements plus possibilities, and on the basis of all-around analysis and weighing of the advantages and disadvantages, carry out cautious decision-making. The needs and requirements of space deterrence are mainly expressed in three respects: first are the needs and requirements of military struggle. Relative to real combat, deterrence is a military activity of both lower risk and lower cost. Only when the deterrence fails or in situations where there is no alternative can real combat means be employed. Next are the needs and requirements of political struggle. Space deterrence similarly is in the service of political struggle and is one of the means for achieving political goals. The more pressing the needs and requirements of politics for space deterrence, the clearer will be its objectives, and the more distinct will be its role. Third are the needs and requirements of diplomatic and economic struggle. Within economic and diplomatic struggle bearing on the immediate or vital interests of the state and the nation, when diplomatic avenues cannot achieve or have difficulty achieving a certain goal, conducting military deterrence, including space deterrence, often is an important choice for decision-makers. On the basis of needs and requirements, the conduct of space deterrence always must consider what is possible, mainly in 3 respects: first is the need to have certain convincing space deterrent strength. This is because in any situation, if [we] ourselves do not have real strength, or if the strength is insufficient, we will never be capable of deterring the enemy. Second is the need to have the resolve to "intimidate the enemy." If [we] lack firm resolve and strong will, the role of deterrence will be a pale and weak one. Third is the need to have a good environment for achieving the goal of space deterrence. The talent of the decision-makers and the morale of the officers both are important factors deciding the success or failure of space deterrence.

2. Controlling the tempo, and striving for the initiative

Space deterrence serves as one means of military struggle, and it requires altering the adversary's psychological mindset in order to play its role. Compared to operational activities, it requires an even stricter grasp of the tempo of the activities; otherwise, the activities could lead to failure of the deterrence and loss of the initiative. To this end, in the course of carrying out space deterrence, **[end of page 130]** [we] must be able to examine the time to measure the circumstances, act according to the circumstances, be flexible and changeable, and from start to finish seize the initiative in the struggle with the enemy. This mainly involves fully grasping 4 points: first is rational determination of the intensity of space deterrence. If the deterrent intensity is too high, the adversary will have difficulty accepting it, and may rush ahead into danger; and if the deterrent intensity is too low, [we] cannot make the adversary feel the pressure, so it will be difficult to play a deterrent role. Hence, the intensity of the deterrence must be moderate; the key points will be leaving the adversary leeway to come to terms and make concessions, to prevent an escalation of the confrontation caused by the adversary not having an out. Second is a precise grasp of the timing for carrying out space deterrence. Deterrent activities which are too early will reveal the friendly side's strategic intent, and lead to passivity in strategic terms; deterrent activities which are too delayed may mean losing the optimum opportunity for combat and inability to achieve the deterrent effects. Third is a timely evaluation appraisal of the space deterrence effects, so as to adjust the deterrent tactics at the right time. After the friendly side conducts space deterrence, it should adopt a variety of means to timely collect and arrange intelligence on the enemy's reaction and evaluate the effects of the deterrence. If the adversary's reaction makes clear that the degree of force in the deterrence is insufficient, then the friendly side should in good time increase the degree of force in the deterrence; and if the adversary's reaction makes clear that the degree of force in the deterrence is too high, then the friendly side should consider suitably decreasing the degree of force in the deterrence. In situations where the adversary has already shown signs of launching space operations or where space operations have already escalated, clearly indicating that the deterrence has failed, the friendly side should immediately and fully carry out preparations for meeting the adversary head on. Fourth is flexible handling of the various situations over the course of space deterrence. In the process of application of deterrence, [the friendly side] must swiftly and resolutely handle all unexpected situations which temporarily arise, so as to maintain the initiative within the space deterrence activities.

3. Unified activities, for integrated-whole deterrence of the enemy

Space deterrence is an integrated-whole confrontation of the opposing sides' comprehensive real strength. Only via unified activities, and truly doing a good job of adjusting-coordination and complementation of multiple forms of deterrence, with synthetic application of a variety of deterrent means, can [we] realize an organic combination of deterrent strength, resolve, and information; form integrated-whole effects with the space deterrence; and achieve control while not being controlled. First are unified activities. All forces which participate in space deterrence should be cohesively joined in all respects at the periphery of the supreme decision-making level, which should put into effect centralized unified leadership, to ensure in fundamental terms the consistent adjusting-coordination of operational activities. Next is the adjusting-coordination and complementation of multiple forms of deterrence. Under informationized conditions, the diversity and complexity of threats and conflicts have decided that military deterrence by a single means or a single avenue will have increasing difficulty in forming effective deterrence of the enemy. Only when space deterrence is combined with deterrent forms such as nuclear deterrence and conventional forces deterrence, and at the same time complemented by struggle in the political, economic, and diplomatic fields, so that all forms of deterrence benefit by mutual association, can the effectiveness of deterrence be brought into play to the maximum extent. Third is the tight combination of all means of deterrence. In view of the different environments and different objects [of deterrence], [we] should combine attack with defense and see that the false and the true aid one another, to form integrated-whole deterrent effects, and thus firmly seize the initiative in space deterrence, so that the enemy cannot but believe in our operational resolution, real strength, and capability, **[end of page 131]** and so must believe in them and dares not believe otherwise.

4. Having preparations in advance and keeping grounded in real combat

Preparedness ensures success, and unpreparedness spells failure. Due to the complex and changeable situations facing space deterrence, the possibility of failure is present from start to finish. Only by moving up and fully carrying out all preparations for meeting the enemy head on, can [we] swiftly shift into space operations status once the deterrence fails, or deal with an escalating situation in space operations, and fight and defeat the enemy. At the same time, deterrence is something having real combat as its basis. Speaking in fundamental terms, precisely because the real combat application of space forces can force the adversary to pay a huge price, it thus can play a role in deterrence. The stronger the real combat capability, the larger will be its role in deterrence. Hence, when carrying out space deterrence, the fuller the preparations for meeting the enemy head on, the higher will be the dependability in defeating the adversary, the more effective will be the deterrent activities, and the higher will be the possibility of success in the deterrence. By contrast, that kind of deterrence or intimidation which is purely an empty show of strength not only will have difficulty playing a deterrent role, but sometimes even may produce just the opposite result. In properly carrying out the preparations for space operations, the key points are to set out from the most complex and most difficult situations, and formulate a variety of contingency courses of action [COAs], to ensure that when needed, [we] will be able to swiftly shift from a deterrent status to real combat status.

Section 2: Space Blockade Operations…132

Space blockade operations signify operational activities conducted by space forces alone, or under assisting support and complementation by other services and arms, in order to stop enemy space forces from entering outer space and orbital maneuver, as well as to exchange information with ground systems. Entering outer space and carrying out orbital maneuver plus effective transmission of information are basic prerequisites for the space forces to carry out their missions, and space blockade can make the enemy partially or completely lose this capability. Hence, in operations under future informationized conditions, space blockade operations will serve as one of the basic patterns for seizure of space dominance and will penetrate space operations from start to finish.

I. Main activities of space blockade operations…132

Based on the differences in the blockade area (zone), space blockade operations can be divided into 4 types of operations: blockade of a space base, orbital blockade, launch path blockade, and information blockade. The activities of these types of blockades not only can be independently adopted, but also synthetically adopted, to enhance the blockade effects.

1. Blockade of a space base

This signifies operational activities in which space forces, under assisting support and complementation by other services and arms, apply various types of firepower and information weapons to attack or jam an enemy ground space launch base. Space bases are **[end of page 132]** fundamental supports {*yituo*} for space forces, and even though spacecraft autonomous operating capability will be constantly enhanced along with the full-speed development of space technology, operations by space forces nonetheless still will highly rely on ground bases to provide them with various types of assisting support. Strikes to sabotage enemy space bases, so that they cannot operate normally, thus will be able to effectively stop the enemy's transportation of personnel, equipment, weapons, munitions, and energy fuel into outer space, and thus maximally weaken and even disintegrate the enemy space forces' capability for sustained operations. At the same time, since space bases and their subsidiary installations usually occupy large surface areas, have relatively fixed locations, involve huge complex systems, have distinct target features and weaker protection capability, and moreover are difficult to restore within a short time after suffering a strike, blockading an enemy space base thus not only enables sabotage of the enemy space launch capability, but also enables destruction of the enemy's various types of spacecraft situated on the ground and produces the effects of ripping up the ground from under the enemy's feet and yielding twice the result with half the effort. In order to boost the effects of blockade of an enemy space base, [we] should synthetically apply the fighting methods of force-strength harassing attack, fire strike, and information jamming. Force-strength harassing attack means dispatching special operations forces [SOF] to infiltrate from the air or ground into an enemy space base, and adopt the surprise-raid mode to sabotage the base's critical-quality space installations such as its C2 center, launch towers, and TT&C radar, as well as infrastructure, such as the electric power support {*baozhang*},[10] fuel injection, and communication support systems, in order to delay or sabotage the enemy space launch activity within a fairly short time. Fire strike means the application of space forces, as well as the long-range precision strike forces of other services and arms, to execute continuous, fierce fire strikes against an enemy space base. The key points are on sabotaging the spacecraft, SLVs, launchers, and various auxiliary installations situated within the base; killing the base's effective strength; and thus within a fairly short time paralyzing the enemy space base, and stripping away its space launch capability. Information jamming means the application of cyber warfare and electronic warfare [EW] means to sabotage the enemy space base's C2 net, and suppress and jam the enemy space measurement and control signals, so that the enemy space base cannot effectively fulfill its launch missions.

2. Orbital blockade

This signifies operational activities to lay obstacles in the enemy spacecraft's operating orbit and its adjacent areas (zones), so as to block or sabotage the enemy spacecraft's in-orbit operation and orbital maneuver. Each and every spacecraft executing a mission in outer space has its relatively stable operating orbit. Since this orbit's parameters are fairly easily acquired via technical means, added to which is that outer space is an open space, the outcome is that implementation of orbital blockade is convenient and fast. Two methods can be adopted to implement the orbital blockade: orbital interception and orbital obstacle setup. Orbital interception is the use of anti-spacecraft weapons, in entity destruction mode, to directly destroy enemy spacecraft operating in orbit, or in incapacitating mode, to cause them to partially or even completely lose operating capability. Due to the differences in operational capability of various types of anti-satellite [ASAT] weapons, and the mutual differences in the classes and nature of the strike objectives, [we] thus should thoroughly adjust-coordinate the interception activities of the various ASAT weapons, to boost **[end of page 133]** the interception effectiveness, and as much as possible reduce the accidental damage to friendly spacecraft. Orbital obstacle setup is the laying of obstacles — space mines and space debris — in the operating orbits and adjacent areas (zones) of enemy spacecraft, so as to threaten the spacecraft in collision or blocking/blast mode, and thus limit its normal operation and orbital maneuver. Laying obstacles in space orbits is simple and easy to realize, and has fairly low cost, with fairly good blockade effects. However, the presence of large quantities of space obstacles, and in particular the inability to distinguish friend from foe with some obstacles (such as space debris), not only can constitute threats to enemy spacecraft, but also may imperil the security of our side's spacecraft and those of neutral

[10] Translator's note: unless otherwise indicated, all "support" in this chapter is safeguarding support {*baozhang*}.

states. Hence, when organizing and implementing an orbital obstacle blockade, [we] must analyze the space battlefield posture in an all-around and careful way, and as much as possible reduce the blockade area (zone), so as to boost the directed [focused] quality. In order to avoid “self-blockade” or setting off an international dispute, the obstacles are usually only laid in an enemy space orbit or in a 3rd-party space orbit used by the enemy, and are generally not laid in orbital areas (zones) shared by the enemy and friendly sides and neutral states.

3. Launch path blockade

This signifies the use of a space-based anti-spacecraft weapon or meteorological weapon to control an enemy space launch path, intercept an enemy SLV taking off from the ground but not yet entering orbit, and stop the enemy space forces' operational activities involved in entering a mission orbit. Due to the restrictions of a space base's geographic conditions and the SLVs, as well as the spacecraft mission orbit, a spacecraft's launch into orbit must use a specific launch path. Hence, controlling an enemy spacecraft's launch path enables effectively stopping the enemy space forces from entering the predetermined orbit. Blockade of a launch path can adopt two modes: closing of a “launch window” and exoatmospheric interception. On one hand, space launch activity is fairly highly influenced by meteorological conditions, and if the minimum meteorological conditions permitting a launch are exceeded, successful launch of the spacecraft cannot be ensured. Hence, via thorough space reconnaissance, accurate grasp of the situation of progress in the enemy space launch preparations work and of the meteorological situation in the launch area (zone), timely employment of meteorological weapons to alter the local meteorological conditions present in the area of the space base, and closing of the enemy's “launch window,” [we] can block or sabotage the enemy space launch activity. On the other hand, before an SLV has risen into the atmosphere to insert the spacecraft into orbit, since the spacecraft has still not separated from the SLV, the SLV thus will have a fairly slow speed and form a fairly large target, with distinct features; it will be extremely susceptible to interception by an anti-spacecraft weapon. At such a time, the use of space-based directed energy weapons [DEWs] and kinetic energy weapons [KEWs] to effect interception of an enemy spacecraft before insertion into orbit can effectively stop its entry into the predetermined orbit or lower its orbital-entry precision. Organizing of exoatmospheric interception is extremely complex; it not only requires timely detection of enemy space launch activity, and thus accurate interception data provided to the anti-spacecraft weapon system, but also requires adopting flexible orbital disposition modes to realize multilevel coverage of the enemy space launch path.
[end of page 134]

4. Information blockade

This signifies synthetic application of a variety of information warfare [IW] means, to jam and sabotage the signal communication among enemy spacecraft and between the spacecraft and the ground, blind electro-optic [E-O] reconnaissance facilities equipment, jam navigation positioning signals, and thus isolate the operational activities of the information contacts between the enemy ground [stations] and outer space. Information blockade mainly includes 3 modes: the first is electronic jamming: i.e., the use of electronic and E-O jamming equipment and instrument equipment with a disposition on the land, sea, air, and space battlefields, and adoption of nonlethal modes to disrupt the normal operation of the electronic facilities equipment in the enemy space system, and sever the signal communication between the enemy's in-orbit spacecraft and the ground assisting support and safeguarding support systems {*zhiyuan baozhang xitong*} and various types of user systems, as well as the signal communication among various spacecraft. By conducting electronic jamming of the enemy space system's space TT&C and command systems, as well as space-based information platforms and spacecraft sensors, and severing their communication links, [we] not only can render the enemy spacecraft unable to operate normally, but also can render the enemy spacecraft unable to provide effective information assisting support for operational activities on the land, sea, and air battlefields. The second mode is cyber attack: i.e., the use of computer virus and "hacker" intrusion modes to sabotage and even paralyze the enemy space system's computer network. The computer network is the core of the entire space system, and the acquisition, transmission, processing, storage, and dissemination of various types of information all rely on this network. [This means] applying cyber attack forces and adopting virus attack and "hacker" attack modes to conduct attack activities — information theft, tampering, deletion, deception, and congestion — against the enemy space system's computer network, so that it cannot normally operate, and thus render the enemy's space control system, weapons systems, and communication systems unable to operate normally. The third mode is low-energy damage: i.e., the use of low-energy lasers, microwaves, and particle beams to attack the enemy space system and damage it or cause it to fail, so that it loses the capability for providing information assisting support to the land, sea, and air battlefields. Use of the low-energy damage mode produces direct and clear effects and enables within a short time swiftly degrading and even stripping away the enemy's capabilities for space information acquisition and transmission; but the scope of destruction and sabotage is not easy to control, and this mode easily causes sabotage to friendly or neutral-state information platforms operating in the same orbital area (zone). Hence, attacks on enemy space-based platforms must be extremely careful, to avoid "fratricidal fighting" or triggering of an international dispute.

II. Basic requirements for space blockade operations…135

Space blockade operations generally are offensive operational activities carried out by the side whose space forces hold superiority. Their focus of attention does not lie in initiative-based wiping out of the enemy space forces, but rather in completely cutting off the enemy contacts with outer space. Those organizing and conducting space blockade operations should — based on this focus of attention — grasp the requirements in 4 respects. **[end of page 135]**

1. Subordination to the overall situation, with thorough operations-research-based planning

The main activities of space blockade operations are all conducted in outer space. Since outer space belongs to the common space of all humankind, in situations of abiding by international space law and bilateral or multilateral international space conventions and agreements, any nation or organization having space flight capability always can enter outer space; while the military and civilian spacecraft of various nations are all given a disposition in outer space, only with differences in their operating orbits. This then has formed a space battlefield posture with the interweaving of all parties: the enemy, the friendly side, friendly neighbors, and neutral states. Conducting blockade operational activities in this complex battlespace extremely easily causes “accidental damage” to non-enemy spacecraft, and thus triggers international conflicts and disputes over outer space. Hence, conducting space blockade requires subordination and service to the strategic overall situation; this not only means abiding by the associated international laws and regulations, but also means making choices based on the current international circumstances and the developing situation of war. [We] should occupy the high ground of the strategic overall situation, carry out thorough operations-research-based planning, conscientiously do a good job in the application of operational means and in the control of time and space, and fully grasp the operational progress, so that all operational activities will have an active influence on the strategic overall situation.

2. Integrated-whole operations, with key point blockade

The forces for conducting space blockade operations not only include the space forces themselves, but also include other land, sea, and air units having space blockade capability. Since the blockade means and blockade methods applied by the various operational strengths differ from one another, and since the blockade capabilities they possess similarly have their strong points and shortcomings, it is thus necessary to develop the strong points and avoid the shortcomings, rationally apply [the various strengths], see that all operational strengths are closely coordinated, and form integrated-whole might for the blockade. At the same time, due to the hugeness and complexity of a space system, and to the large number and wide-ranging distribution of space installations, an all-around blockade is not only unrealistic but also impossible. Only by focusing on the enemy space system's compositional characteristics and the position and role of its various components, and by selecting their vital sites for implementing key point blockade and control, can the optimal blockade effects be obtained.

3. Flexible use of troops, with combination blockade and strike

In space blockade operations, the main goal lies in blocking the enemy space forces from entering the space battlefield or conducting orbital maneuver, and not in seeking to thoroughly wipe out the enemy. As long as the enemy cannot timely and effectively carry out space launch and orbital maneuver, the blockade operations will directly achieve their goal. Hence, during space blockade operational activities, [we] should take realizing the blockade as the basic focus of attention, combine blockade with strike, blockade when we can do so, strike when we cannot blockade, and after striking return to blockading. The two means are flexibly applied and promote one another. Concretely speaking, we should flexibly use troops based on the degree of threat posed to us by the enemy space forces and on our capability for blockade operations. Under ordinary circumstances, against an enemy having powerful space forces, [we] should employ strike as primary, carry out key point strikes at the enemy's critical-quality ground space installations and in-orbit spacecraft, **[end of page 136]** and swiftly degrade the enemy space launch and orbital maneuver capabilities, to create the conditions for follow-on blockade operations. Against an enemy with weaker space forces, [we] should combine blockade with strike, use fire strikes to paralyze the enemy space system and via orbital obstacle setup limit the enemy's in-orbit spacecraft from carrying out orbital maneuver. Against 3rd-party space forces who provide assisting support to the enemy, [we] should adopt blockade as primary, and mainly via orbital obstacle setup blockade and limit their normal operation or orbital maneuver in order to achieve the blockade goal. Unless the 3rd-party space forces constitute a serious threat to us, we usually will not carry out fire strikes against them, so as to avoid expansion of the conflict.

4. Full preparations, for continuous blockade

The goal and characteristics of space blockade operations have decided that their duration is generally fairly long; moreover, the blockade effects similarly will have difficulty being manifested within a short time. In particular, when implementing a blockade against a space power or against an enemy obtaining assisting support from 3rd-party space forces, the situation is even more like this. Long-lasting space blockade operations inevitably attrite large quantities of manpower, material resources, and financial resources, and once the support {*zhichi*} is of no use, it will directly lead to failure of the activities. To this end, [we] must do a good job of full preparations in regard to the application of strength and the preparations for materiel in order to maintain a sustained blockade capability. This then requires that commanders must profoundly understand the protracted quality of space blockade operations and, while reinforcing the preparations, scientifically and rationally apply the operational strengths and blockade modes, so as to seize the initiative in the space blockade versus counter-blockade struggle.

Section 3: Space Strike Operations…137

Space strike operations signify operational activities which apply space forces, under assisting support and complementation by other services and arms, to execute strikes on enemy land, sea, air, and outer space targets. Offensive quality is the fundamental attribute of space strike operations. This has determined that the participating main body in space strike operations is the strike force-strength within the space forces, and that the basic activities include wiping out, sabotaging, suppressing, or destroying the enemy's important strategic and campaign targets. Along with the full-speed development of space technology, and the successful development and large-scale commitment and use of various types of space weapons and equipment, new concept weaponry such as DEWs and KEWs will become the most important "trump cards" {*sashoujian*} in future operations, and are certain to greatly boost the might of space strike operations. This weaponry thus makes the position and role of space strike operations even more important.

I. Main activities of space strike operations…137

According to the level, space strike operations can be divided into strategic space strike operations and campaign space **[end of page 137]** strike operations, and according to the participating strengths, they can be divided into independent space strike operations and joint space strike operations. Based on the differences in the engagement space, space strike operations usually can be divided into two types of activities: attack against enemy spacecraft and space-to-ground strike.

1. Operations to attack enemy spacecraft

The various types of spacecraft are the core of the space forces, and executing strikes against them in fundamental terms will strip away the enemy's space operations capability. Hence, attack on enemy spacecraft is the main activity in space strike operations, and also is where the center of gravity [COG] lies in seizing and maintaining space dominance. Attack on enemy spacecraft can adopt multiple methods.

First is the use of DEWs to carry out the attack. DEWs mainly include laser weapons, particle-beam weapons, and microwave weapons, each having their respective merits. Of these, laser weapons mainly use laser beams to irradiate the spacecraft for a certain time, and to form high temperatures after which the spacecraft will be damaged. This type of weapon is not affected by EM jamming, and has a long operating range and high hit precision; it is a space attack weapon with outstanding performance. Particle-beam weapons use a high-energy, high-current accelerator to accelerate a particle beam, and thus form a high-energy, high-current particle beam which is fired at near-light speed toward the target and destroys the spacecraft via kinetic energy. This type of weapon has high attack speed, high destruction capability, and flexibility in use and control; it can be employed in all types of weather, and is an ideal anti-spacecraft weapon. Microwave weapons exploit intense microwave-beam energy to kill the target, and have very strong kill power. When using DEWs to execute an attack, based on the characteristics of the different types of weapons, they can be given an echelon disposition in a zone which the enemy spacecraft crosses. Once the enemy spacecraft crosses this zone, the attack can be swiftly launched from many directions. At the same time, DEWs also can be installed in airborne platforms or space-based platforms, to realize multi-domain attack against the enemy spacecraft.

Second is the use of KEWs to carry out the attack. KEWs mainly include high-speed interceptor missiles and EM guns (railguns); these have quite high lethal might, and can directly kill a spacecraft. The use of KEWs usually exploits the modes of rocket propulsion or EM-force drive, to accelerate the payload to a sufficient speed for direct collision with the target spacecraft, so as to destroy it. Alternatively, the payload can carry a high-energy explosive; this can be detonated near the target, to form dense metal fragments which will destroy a satellite.

Third is the use of a space shuttle, manned space ship, or space station to capture an enemy spacecraft. A space shuttle or aerospace plane can be used to disposition, maintain, or recover various types of spacecraft, and can exploit its own detection facilities equipment to detect an enemy spacecraft and carry out tracking and jamming of it, as well as being able to capture it. Moreover, this type of spacecraft can conveniently carry out space maneuver, has a rapid reaction speed, and can execute multimode attack and sabotage of an enemy spacecraft. Manned space ships and space stations operate in outer space for long periods, **[end of page 138]** and have strong independent operational capability; moreover, the astronauts they carry not only can operate their weapons systems to execute attacks on enemy spacecraft, but also can directly capture enemy spacecraft.

Fourth is the use of space mines or ASAT satellites to execute the attack. In peacetime, [we] can use the space observation net to conduct uninterrupted observation and positioning of the enemy's various types of spacecraft, and store [the data] in a target database. Prior to combat, in advance [we can] launch space mines or ASAT satellites into space, and put them in standby status in a certain orbit. In wartime, once there is a need to execute an attack on a target, the space mine or ASAT satellite can be maneuvered in orbit to the target orbit, and the space mine can be detonated to destroy the target, or [the ASAT satellite] can directly collide with the target.

Fifth is the use of soft-kill means to cause a spacecraft to fail. This can exploit a laser weapon emitting a low-power laser beam to irradiate an enemy spacecraft's visible-light and infrared [IR] sensors and radar antenna, thus blinding them; it also can release metal fragments and jamming substances such as particles and aerosols in an enemy spacecraft's orbit, to obscure the enemy spacecraft's sensors, so that they lose normal operating capability. This furthermore can involve electronic jamming of an enemy spacecraft's electronic facilities equipment and sensors, to sabotage their normal operation or cause their functions to not work; or it can involve sabotage of the enemy space system's computer network, so that the entire space system falls into paralysis, thus creating favorable conditions for us to conduct fire strikes.

2. Space-to-ground strike activities

The superior spatial location possessed by outer space has made it become the commanding heights of operations under informationized conditions. By having seized space dominance, [we] will have freedom of activities on the land, sea, and air battlefields. The execution of strikes from outer space against targets on the ground, at sea, and in the air has superiority unmatchable by other operational activities. Some examples are a battlespace which covers the whole globe, participating strengths which are few but streamlined, operational activities which are swift and sudden, and operational effects which are high in shocking power. In executing space-to-ground strike, the main goal is to coordinate with and provide assisting support to Army, Navy, and Air Force operations, and the key point is to strike at the critical strategic and campaign targets in the enemy's operational SoS. These targets mainly are as follows: C2 type targets, including reconnaissance and early warning systems, communication hubs, and command centers; war potential type targets, including logistics and replenishment systems, military-industrial bases, electric power and energy systems, and infrastructure within the strategic and campaign depth; counter-preemptive operational capability type targets, including missile positions, Air Force airfields, naval bases, nuclear bases, and all types of IW installations.

Due to the differences in the operating spaces of the strike weapons, space-to-ground strike activities come in two modes: “space-to-ground” style strikes and “ground-to-space-to-ground” style strikes. “Space-to-ground” style strikes signify operational activities using space-based weapons to attack enemy ground targets from outer space. The weapons used for “space-to-ground” style strikes mainly include space-based DEWs and KEWs; these have characteristics such as rapid reaction, **[end of page 139]** global maneuver and precision strike capability, and strong instantaneous destruction effects. At present, space-based DEWs and KEWs are still in the experimental research phase, and although in several respects this research has already achieved breakthrough progress, nonetheless due to the technical complexity and the stringent requirements on space-based platforms, these weapons are still quite far from real combat disposition and application. In this research, the space powers — the U.S. and Russia — have taken the leading positions worldwide in terms of studies on the technologies correlated to space-based laser and microwave weapons, and have realized phased-nature achievements. Once the US and Russian space-based weapons begin to be applied in real combat, they will induce revolutionary changes in space operations. At that time, [the two nations] will be able to directly strike from space against important targets on the land, sea, and air battlefields, to fulfill the strategic and campaign missions. “Ground-to-space-to-ground” style strikes signify operational activities which employ orbital bombing weapons and weapons carried aboard manned space ships, space shuttles, or aerospace planes, to effect destruction from space of enemy ground targets. Orbital bombing weapons in peacetime are prepositioned on the ground and in wartime are launched into orbit; then, they use their reverse-thrust rockets to reenter the atmosphere and execute strikes on [ground] targets. Since orbital bombing weapons have low trajectories and high speeds, they can attack a target from two opposing directions, and thus are more difficult to defend against than ballistic missiles. Manned space ships, space shuttles, and aerospace planes all have powerful orbital maneuverability and ultrahigh-altitude and ultrahigh-speed flight capability; and based on operational needs and requirements, they can flexibly strike at a variety of high-value targets within the enemy’s strategic full depth. Under current space technical and equipment conditions, in terms relative to space-based DEWs and KEWs, the technology for orbital bombing weapons and for manned space ships, space shuttles, and aerospace planes is basically mature, so “ground-to-space-to-ground” style strikes will be the main mode of space-to-ground strike.

II. Basic requirements for space strike operations…140

Space strike operations are a type of strategic [quality] offensive activities and must occupy the high ground of the strategic overall situation, including fully preparing and thoroughly working out an approach in planning. The key points are on fully grasping the requirements in 4 respects: “integrated-whole operations, concealment and surprise, key point strikes, and fighting a quick battle to force a quick decision." They are an organic integrated whole with mutual contacts. Of these, integrated-whole operations are the basis for space strike operations; concealment and surprise are objective requirements for all operational activities, and in particular for first-strike activities; key point strikes are an important avenue for ensuring fighting a quick battle to force a quick decision, and for realizing the operational intention within a short time; and fighting a quick battle to force a quick decision is the starting point and ending point of space strike operations.

1. Integrated-whole operations

This requirement signifies synthetic application of the various strengths participating in space strike operations and proper handling of the adjusting-coordination among various operational patterns and operational means, to form an organic integrated whole, **[end of page 140]** and with integrated-whole composite strength seize success in the operations. Operations under informationized conditions are warfare of system versus system and of SoS versus SoS, and the success of such operations to a very great extent is dependent on fully bringing into play the integrated-whole might of the operational SoS. To this end, space operations commanders should rigorously organize operational coordination, realize integrated-whole adjusting-coordination, and see that all operational strengths are highly centralized and unified, so as to achieve the maximum operational effectiveness. They not only must concentrate on the adjusting-coordination of the operational activities of the various partial strengths participating in space strike operations and undertaking different missions — so that the operational activities of the space forces are combined with the operational activities of the Army, Navy, and Air Force strengths, to fully bring into play the integrated-whole might of all participating strengths — but also must carry out scientific organizational grouping of the space-based and ground-based strength possessed by the space forces themselves and of their various weapons systems, according to mission needs and requirements, to form a powerful, multifunctional operational system. In addition, all participating strengths should establish the sense of the integrated whole, set out from the overall situation, trust and support {*zhichi*} one another, maintain strong combat unity, resolutely execute the *jihua* plans, take initiative for assisting support to friendly neighbors, and consistently adjust-coordinate the fulfillment of space strike operational missions.

2. Concealment and surprise

This requirement means fully exploiting favorable conditions where offensive activities hold the initiative, selecting times and spatial areas (zones) to catch the enemy unaware, adopting means and fighting methods unimaginable to the enemy, and conducting swift and concealed activities to execute surprise strikes at the enemy, to shake the enemy in mental terms. At the same time, [it means] degrading the operational effectiveness of the enemy's space-defense operational SoS, reducing the losses to friendly force-strengths, and increasing the strike effects. Concealment and surprise is an important guiding principle for organizing and conducting space strike operations and is the main means for achieving a surprise raid. In particular, this is even truer in situations where the enemy space defense forces are stronger while the friendly space strike forces are inadequate and their means limited. Even in situations where the quality of the weapons and equipment holds superiority, the organizing and conducting of space strike operations still should enforce the requirements for concealment and surprise, to expand the friendly superiority, reduce the degree of difficulty in penetration, and achieve greater effects. From the viewpoint of the space forces' own traits, since spacecraft operation has a global quality and high-speed quality, with space-based weapons having characteristics such as long range and rapid speed, and moreover since the operation of spacecraft in space is not limited by any political, weather, or geographic factors, the result is that the space strike forces themselves are the best operational strengths for achieving the element of surprise. In order to achieve concealment and surprise, first of all, [commanders] should implement strict secrecy and effective camouflage, carry out active struggle with the enemy in all reconnaissance activities, see that all friendly operational activities are conducted in a state of secrecy, and do everything possible to avoid perception by the enemy. They should strictly limit the number of personnel having contact with operations plans, as much as possible shorten the operational preparations time, properly seize time opportunities for adjustment and transfer of friendly space forces, and enforce strict limits on EM-spectrum information and computer network information in the space system, to guard against revealing the intention. Next, they should adopt a variety of methods and means to deceive, paralyze, and confuse the enemy, **[end of page 141]** and create "time gaps" and "space gaps" in the enemy's assessments, so that friendly forces can exploit enemy loopholes. In peacetime, [commanders] should take care to study and analyze the enemy's space operations theory and space operations SoS, find their theoretical defects and operational SoS weak points, and exploit them. They should formulate lifelike space operations diversion and deception plans, exploit the news media and all other exploitable methods and means to issue true and false space launch and spacecraft orbit information, and thus create misconceptions in the enemy's thinking and psychology, to achieve the goal of concealing the friendly side's true intention.

3. Key point strikes

This requirement in essence stresses tightly centering on the space operations' intention, concentrating the space forces in the main direction and important time segments, and executing key point strikes on the critical targets and vital site positions in the enemy operational SoS, to carry out structural sabotage of the enemy, weaken and paralyze the integrated-whole functioning of the enemy operational SoS, and strive for gaining the optimal strike effects. From the viewpoint of the space forces' possible development situation within the future period, their quantitative scale will be very limited, and they will not have the capability to simultaneously execute strikes on the numerous strategic and campaign targets within the enemy's depth. At the same time, in view of the enemy's numerous targets, if [commanders] do not distinguish the primary from the secondary, decentralize the force-strengths, and strike everywhere, it will still be difficult to achieve the anticipated effects. Hence, only when they execute key point strikes can they bring into play to the maximum extent the might of the limited space forces. In implementing the requirement for key point strikes, the key points are on fully grasping the content in 3 respects: rational selection of the strike objectives, concentrated use of force-strength, and committing the main forces in the important operational phases. Selection of the strike objectives is a very important but also complex item of work. Whether the strike objectives are selected correctly not only will decide whether the operational intention can be realized, but also will influence the number of force-strengths which need to be committed and the length of time needed to achieve the goal. Space operations commanders must focus on the strategic overall situation, and on the basis of carrying out all-around analyses of the enemy operational momentum disposition and important targets, select the critical targets and vital site positions which play a structural sabotage role in the enemy's entire operational SoS, and execute the key point strikes against them. In the course of space strike operations, [commanders] must concentrate use of the limited space forces in the first strike and main operational direction, and for the operational activities of the critical operational time segments — and via concentrated and fierce strikes at the main targets, gain the maximum strike effects within a short time, to swiftly realize the operational intention.

4. Fighting a quick battle to force a quick decision

This requirement signifies fully exploiting favorable conditions to seize the initiative during space strike operations, accurately and timely grasping time opportunities for the launch of operations, concentrating superior force-strength in a rapid and concealed manner, and executing a decisive and powerful first strike to swiftly seize the operational initiative. It also signifies execution of high-intensity, continuous strikes to swiftly exploit the combat results, not give the enemy an opportunity to catch his breath, and strive within a fairly short time to achieve **[end of page 142]** the operational goals. Fighting a quick battle to force a quick decision is something decided by the special quality of space operations. Its biggest differences from other operational patterns are that the scale of space operational strengths tends to be small, the attrition in operational activities is enormous, and the logistics and equipment support is extremely difficult. This has determined that space operations must not and also cannot be sustained over too long of a period. At the same time, the objectives of space strike operations mostly lie in the enemy's strategic and campaign depth, and their political sensitivity is very high. If [commanders] cannot resolve this problem within a fairly short time, and are trapped in a situation of prolonged indecisiveness, they not only may aggravate the operational strength losses, but also will be detrimental to political and diplomatic struggle, and will very easily fall into a passive position. In order to realize fighting a quick battle to force a quick decision, first, when organizing and conducting space strike operations, [commanders] should attach high importance to executing a powerful first strike. This is because the first strike is most convenient to fully exploiting a position of initiative in offensive operations, so as to achieve the element of surprise. Moreover, the first strike's preparation time is longer, the support conditions are better, and the various operations plans are complete, making it easy to achieve bigger combat results. Execution of the first strike should concentrate use of space forces to strike at critical targets, so as to gain the position of initiative in the strategic overall situation. Next, when preparing and conducting space strike operations, [commanders] should fully grasp the linkup and complementation among all strike activities, so that the next strike activity can fully exploit the combat results of the previous strike activity. At the same time, the activities of all classes and types of strike weapons must be mutually coordinated, to boost the integrated-whole operational effectiveness, accelerate the course of the space strike operations, and shorten the operational time.

Section 4: Space Defensive Operations…143

Space defensive operations signify the sum of various active and passive measures and activities adopted in order to prevent strikes by enemy space forces and attacks by ballistic missiles. Their operational goal is to support the security of friendly space forces and of important strategic and campaign targets (including important political, economic, and military targets). Along with the rapid improvements in space strike capability among nations around the world, the threats coming from outer space are growing ever greater. Whether [we] will be able to effectively defend against the enemy space forces' strikes and ballistic missile attacks not only will have a bearing on the survival of the space forces, but also will directly bear on the stability of the entire operational SoS. Hence, organizing and conducting space defensive operations will become an important mission undertaken by the space forces.

I. Main activities of space defensive operations…143

Based on the differences in the objects of operations and on the composition of the space system, space defensive operations mainly include 3 types of operations: anti-missile operations, spacecraft defensive operations, and space base defensive operations. **[end of page 143]**

1. Anti-missile operations

Along with the rapid proliferation of missile technology, whether the threat of ballistic missiles can be effectively resisted has become a common problem facing all nations. Anti-missile operations are operational activities which use land-based, sea-based, and/or air-based anti-missile weapons systems to intercept and destroy enemy incoming strategic, operational, or tactical missiles, and thus enable friendly important targets to avoid enemy missile strikes. At present, the U.S., Russia, Japan, and Israel all have built anti-missile systems of differing scale; and in particular, America's "National Missile Defense (NMD) System" has already entered real-combat disposition. Since the entire flight process of a ballistic missile from launch to target hit on the whole can be differentiated into 3 phases — boost phase, intermediate phase, and reentry phase — and since their main trajectories are in outer space, with their payloads crossing through space and reentering the atmosphere to attack the targets, anti-missile operations thus can focus on the structural and kinematic features of the ballistic missiles' different flight phases, to realize segment-by-segment and layer-by-layer interception of the missiles, so as to boost the interception's probability of success.

First is boost-phase interception. The flight phase of a ballistic missile from launch to the final-stage booster rocket engine shutoff and separation is called the boost phase. In this phase, a ballistic missile has still not completed payload-rocket separation; and with its slow flight speed, large target area, and distinct IR signature, the missile is easy to detect and track, so this is the optimum timing for interception. The process of interception is as follows: when a missile early warning system detects the launch of an enemy missile, it immediately performs measurements on and tracking of the missile and transmits the missile's coarse ballistic parameters via the C2 center to all anti-missile weapons systems. Airborne laser [ABL] weapons use their own precision tracking and aiming systems to perform precision measurements on and stable tracking of ballistic missiles still in boost-phase flight, and to lock the laser-beam light spot on a weak position on the missile body (such as a point on the fuel tank or guidance system), after which the ballistic missile is destroyed by the effects of buildup of high-power laser energy. Land-based and sea-based anti-missile systems, based on the target ballistic parameters provided by the missile early warning system, will swiftly calculate the contact point and launch an anti-missile missile(s), to destroy the target missile before it has completed payload-rocket separation.

Next is mid-phase interception. The flight phase of a ballistic missile from payload-rocket separation to reentry of the payload and false targets into the atmosphere along a forward predetermined trajectory to begin unpowered flight is called the mid phase. In this phase, the ballistic missile's flight time is the longest (an ICBM requires approximately 20 minutes, while a short-range ballistic missile still needs several minutes), which is beneficial to conducting continuous interception of it. At the same time, the high vacuum and microgravity environment in outer space are similarly beneficial to interception of payloads traveling through this space by laser weapons, EM guns, and kinetic-energy interceptors. The process of interception is as follows: a space-based detector net and ground early warning radar net are used to perform detection of all targets released by the ballistic missile's main module, and to identify and continuously track the true payload hiding among **[end of page 144]** a false target grouping; then these nets swiftly provide the payload's precise orbital parameters to the C2 center. The C2 center, based on the information on the number of incoming enemy missiles and their orbital parameters, will carry out firepower distribution and control of the anti-missile weapons systems to intercept the incoming payloads.

Finally there is reentry-phase interception. The flight phase of a ballistic missile from payload reentry into the atmosphere to target hit is called the reentry phase. In this phase, various types of light and heavy decoys will be burned up when entering the atmosphere, and the true payload will be completely exposed; but since the payload during this phase has a flight time of only around 1 minute, the requirement on the reaction speed of the interception activities is extremely strict, and there is only one interception opportunity for each payload. The process of interception is as follows: land-based X-band radar is used to swiftly lock onto the true payload on the basis of a mid-phase, early-stage identification, and to vector land-based or sea-based anti-missile missiles to destroy the payload before it hits its target, at a relatively safe altitude, via the warhead fragmentation mode.

The interception activities in the above 3 phases are mutually connected link-by-link, and have formed a layer-upon-layer interception posture against ballistic missiles. The previous phase creates the conditions for the next phase, while the next phase fully exploits the detection and tracking results of the previous phase; each interception phase, while having its advantages and disadvantages, nonetheless cannot replace another phase. In order to boost the operational efficiency of interception, [commanders] must establish a multilevel anti-missile defensive system, to implement full-course interception of enemy ballistic missiles.

2. Spacecraft defensive operations

Spacecraft are the core of the space forces, so [commanders] must adopt a variety of defensive measures and activities to ensure their safe and stable operation. Based on the differences in the structural and operating characteristics of spacecraft, spacecraft defensive operations can synthetically apply multiple modes, including concealment and camouflage, multi-satellite networking, structural ruggedizing, evasive maneuver, and orbital confrontation.

Concealment and camouflage is the application of advanced stealth and transformational camouflage techniques to conceal a spacecraft's nature, reduce the spacecraft's detectability, and thus boost its survivability. Of these, transformational camouflage mainly employs exterior design, so that our side's spacecraft in external respects resemble the spacecraft of the enemy or a third party, to increase the degree of difficulty in the enemy's detection and identification. Stealth camouflage, then, mainly employs energy-diffusion design, energy absorption, refractive materials, and similar low-detectability [low-observables] techniques and materials, to design and manufacture spacecraft; reduce their radar, IR, and optical signatures; and perform technical processing of the signals transmitted by the spacecraft, so that it is difficult for the enemy to detect, identify, track, and attack them.

Multi-satellite networking signifies the use of many structurally simple, single-function, low-cost small satellites to replace large satellites with complex single structures, functional diversity, and high manufacturing costs. Compared to large satellites, small satellites have many merits, including lighter weight, lower cost, and shorter development cycles; **[end of page 145]** they can be mass produced; they can be mobile launched or piggybacked, and adapt to rapid networking requirements, while involving low launch expense; and they can be operated in constellation formation mode, for high entire-system performance, high redundancy, and high destruction resistance. Taking small satellites as the basis, and adopting the constellation and satellite-grouping modes for networked operation, on one hand enables boosting the integrated-whole functioning of the satellite applications network SoS and saving on large amounts of funds. On the other hand, they enable effective resistance to enemy ASAT weapons attacks, so that even if a single satellite or even some satellites encounter an attack or experience a fault and fail, the remaining satellites still can continue to execute the missions by re-networking and may not lead to the thorough paralysis of the entire satellite net.

Structural ruggedizing signifies carrying out ruggedizing of a spacecraft's external structure and surfaces, to resist attacks by anti-spacecraft DEWs and KEWs. Examples include covering a spacecraft's surface with reactive armor, which can partially absorb or dissipate the inertial energy of ultrahigh-speed projectiles, so that the spacecraft can to a certain extent resist a KEW attack; mounting shields on a spacecraft's sensors, so that when the sensors suffer an attack by a laser or particle-beam weapon, the shields can be swiftly closed to protect the sensors; and using nuclear energy instead of solar energy to provide a spacecraft's power supply, which can greatly reduce the probability of spacecraft failure caused by the solar cell array being damaged.

Evasive maneuver signifies altering a spacecraft's operating orbit in a timely and swift manner, so as to evade attack by an enemy anti-spacecraft weapon(s). When the spacecraft warning system detects information on encountering enemy attack, it swiftly ascertains the nature of the threat, and timely transmits a warning to a ground C2 center or autonomous navigation system, and under control by that center or system it effects orbital maneuver, to evade the enemy's anti-spacecraft attack.

Orbital confrontation signifies the use of space-based DEWs or KEWs to execute strikes against targets which threaten the safety of our spacecraft. Orbital confrontation is the most active and effective means within spacecraft defensive operations and it mainly employs attack with initiative against enemy anti-spacecraft weapons, to achieve the goal of protecting friendly spacecraft in orbit. In order to effectively carry out orbital confrontation, [commanders] must have an all-around grasp of the situation of the enemy anti-spacecraft weapons classes and quantities, as well as their disposition and locations, and conduct rigorous surveillance of the movement of enemy anti-spacecraft operational units. Once the enemy executes an attack, [commanders] should timely issue a warning, and do everything possible to destroy the enemy anti-spacecraft weapons before they are launched or before they hit friendly target spacecraft.

3. Space base defensive operations

Space bases serve as basic parts of the space system, and their security is of the utmost importance in preserving the stability of the entire space system and the continuity of space operational capability. Space bases and their installations are widely distributed over the nation's strategic depth and on the seas, and all of these targets can encounter enemy attacks coming from the land, sea, air, and outer space. Hence, space base defensive operations are **[end of page 146]** a type of synthetic operational activities, which include surface-to-air and surface-to-space defense, plus ground and naval defensive operations. In the current period and for a while to come, surface-to-air defense and ground and naval defensive operations will still form the main content of space base defensive operations. Of these, in terms of surface-to-air defense, since cruise missiles, high-performance operational aircraft, and similar long-range air raid force-strength and weapons already have the capability to strike at targets in the enemy's strategic full depth, they thus constitute grave threats to space bases. However, from the viewpoint of the space bases themselves, they do not at all have air defense operational capability. This then requires [commanders] to disposition sufficient air defense strengths on land, at sea, and in the air in the areas (sea areas) where space bases are situated, and adopt the area (zone) screening mode to support the surface-to-air security of the space bases. In terms of ground and naval defense, along with the constant enhancement of the operational capability of SOF, the threats to space bases are growing more severe every day; so [commanders] must disposition certain ground (naval) defensive force-strengths, to guard against harassing attacks and sabotage by enemy SOF.

II. Basic requirements for space defensive operations…147

Space defensive operations in terms of attributes are a type of defensive, passive operational activities. Their COG lies in ensuring the security of friendly space forces and of important strategic and campaign targets. To this end, in the organizing and implementation process, according to these attributes, and on the basis of carrying out full preparations, [commanders] must implement unified command of all space defensive forces, form integrated-whole defensive capability, and thus achieve the fixed defensive goals.

1. Full preparations, for rapid reaction

Clearly unlike other operations, the enemy strike forces faced in space defensive operations are either dispositioned in the vast outer space, or come from enemy PGM or long-range raids by SOF; the degree of difficulty in defense is extremely high, and enemy ballistic missiles are even more difficult to detect, track, and intercept. This then causes extremely high passivity in space defensive operations, and often the early warning and imminent battle preparations time is extremely brief; sometimes there is not even enough time for early warning and carrying out imminent battle preparations, so that in situations of being caught off guard, [commanders] are forced to commit to operations. Hence, full preparations for rapid reaction is a prerequisite for gaining the initiative in space defensive operations and is an objective requirement for focusing on the space defensive operations' own characteristics. Full preparations are the basis for rapid reaction, and rapid reaction is an important focus of attention in the preparations for space defensive operations. Full preparations signify the need to properly perform all items of preparatory work before an imminent battle in space defensive operations, so as to lay the foundation for boosting wartime rapid reaction capability. All preparatory work for space defensive operations should begin in peacetime, lay stress on grasping and accumulating data, and reinforce studies on the objects of operations — in particular, the situation of the enemy's readjustment of the disposition of space forces, weapons and equipment development, and studies on space operations theory. **[end of page 147]** The preparatory work also [requires] establishing a sound *zhidu* system for all items of readiness, properly handling readiness thought and education, strengthening the idea of readiness, and upholding the concept of being prepared at all times; and keeping grounded in the difficult and complex situations when formulating multiple operations plans and COAs, and, based on developing changes in the situation of the objects of operations and the operational environment, at the right time revising and perfecting those plans and COAs. This also means building a perfected space defensive reconnaissance and early warning system, and, based on the technical characteristics of the reconnaissance satellites, early warning aircraft, and ground radar composing this system, setting echelon deployment and rational disposition, to form a full-dimensional {*quanfangwei*}, full-depth, 3-D reconnaissance and early warning net, so as to realize early detection, early identification, and early decision-making, and gain reaction time. This further means organizing space defensive operations drills at the right time, to boost the units' rapid reaction capability and the organizing and command capability of commanders and command organs. Rapid reaction is a requirement for the units undertaking space defensive operational missions to strive to achieve the ability to rapidly carry out space defensive operational missions in situations where the imminent battle preparations time is brief, or even where there is no imminent battle preparations time. All operational strengths participating in space defensive operations, based on the missions they themselves can undertake, should from start to finish maintain a state of readiness adapted to the enemy-situation threat. The reconnaissance and early warning system should broadly open up the intelligence sources, and reinforce reconnaissance of the enemy space strike and ballistic missile attack situation, to timely detect signs of an enemy attack, gain even more early warning time, and achieve rapid detection, rapid identification, and rapid interception. [Commanders] should build a rapid and agile command information network, to boost command efficiency and achieve rapid transmission of intelligence information, plus accurate and decisive command decision-making.

2. Integrated-whole operations, with protection and counterattack combined

Within space defensive operations, the participating strengths not only include the space forces, but also include the correlated strengths of the Army, Navy, and Air Force; the composition is fairly complex, and at the same time the battlespace involves the entire globe, so that the scope is extremely vast. Only by forming an integrated whole in regard to the operational strengths and spaces, and by realizing integration {*yiti*} of protection, resistance, and counterattack in regard to the operational activities, can success be seized in space defensive operations. Integrated-whole operations signify the need to synthetically apply the space forces participating in space defensive operations, plus the land, sea, and air correlated strengths, and synthetically employ air defense, anti-missile, and ASAT weapons and EW equipment, so that they have scientific organizational grouping, leverage one another's strong points and offset one another's shortcomings, and form a powerful synthetic space defensive capability. In accord with the principle of not only giving consideration to the overall situation, but also laying stress on key points, [commanders] should implement unified disposition of the space defensive forces, to form an integrated-whole defensive operational momentum disposition with a mutual combination of land, sea, surface-to-air, and surface-to-space defense. Thus, the integrated-whole composite strength of the aviation and space units, plus the air defense and space defense units, as well as the ground and sea defense units, will screen the space system and other strategic targets. [Commanders] should conduct anti-missile operations and spacecraft and space base defensive operations as the principal line; combine the operational activities in the land, sea, air, space, and information fields; and combine the protection, resistance, and counterattack operational activities, so that all operational activities adopted by the various operational strengths in the different operational spaces **[end of page 148]** form an organic integrated whole. [Commanders also] should fully consider the contradiction between the many targets which need to be protected and the small number of defensive strengths, and employ the space defensive forces in a concentrated manner which also has key points. In terms of time, the key point is on resisting the enemy's first large-scale raid against the friendly space system; in terms of space, the key point is on screening the areas occupied by friendly large-scale integrated {*zonghexing*} space bases and the orbits occupied by important spacecraft; and in terms of the objects of defense, the key point is on striking at the enemy targets posing the maximum threats to the friendly space system (such as nuclear-tipped ICBMs, space-based DEWs and KEWs, and operational platforms like space shuttles and aerospace planes). Combination of protection and counterattack signifies that over the entire course and in all fields of space defensive operations, [commanders will] organize all participating strengths in synthetically applying a variety of defensive measures to implement rigorous protection for spacecraft, space bases, and important strategic and campaign targets, to preserve their space operational capability and potential. On the basis of all-around protection, [commanders also] should implement unified organizing and adjusting-coordination of all strengths participating in space defensive operations, and concentrate the force-strength and weapons in the main direction and important time segments, to execute active and key point based strikes at the enemy's space strike forces and incoming ballistic missiles, to ensure the stability of the friendly space defense SoS. Simultaneously with this, [commanders should] in good time organize the space strike forces and the ground and sea long-range weaponry, as well as SOF, in conducting active offensive operations and sabotage-raid operations behind enemy lines, and executing counterattacks on the enemy space system, to weaken the enemy space strike capability and realize an organic combination of protection, resistance, and counterattack.

3. Unified command, with close coordination

Space defensive operations involve operational missions jointly carried out by the participating space forces along with the land, sea, and air correlated strengths; so only when there is unified command and close coordination can the various defensive strengths be formed into an organic integrated whole. Unified command signifies the need to establish a sound command SoS for space defensive operations, and straighten out the command relationships, so that all participating strengths can conduct the activities under unified command by the space operations commanders and command organs. On one hand, this requires that all levels of participating strengths must set out from the overall situation, and thus firmly execute the instructions and orders of the space operations commanders and command organs. On the other hand, space operations commanders should flexibly apply the command modes, in advance make clear to the lower levels their authority limits for handling of critical situations, and implement a mutual combination of centralized command and delegation mode of command, to ensure that the lower levels in situations where they have lost higher-level command can act promptly at their own discretion, based on the general operational intent and actual needs and requirements. [Space operations commanders] should achieve the following: unified formulation of space defensive operations plans; unified disposition of all defensive force-strength and weapons; unified intelligence support; and unified adjusting-coordination of all operational directions and of the operational activities of all participating strengths, so that all strengths can adjust-coordinate their activities under a unified intent. Close coordination signifies the requirement for all participating strengths to complement with initiative the formation of integrated-whole might in space defensive operations. Space operations commanders and their command organs should implement unified operational thought, and clarify for all participating strengths their operational missions, operational patterns, **[end of page 149]** and activities timing and methods, so that the various strengths can adjust-coordinate their activities under the unified intent. They also should thoroughly formulate coordination plans, and according to the predetermined operational progress and the operational missions of all space defensive forces, clarify the principles and methods for coordination among the various strengths, to provide a basis for coordinated operations. In the implementation process for space defensive operations, commanders and their command organs must focus on the characteristic of rapid changes in battlefield situations, at all times grasp the operational progress, and maintain uninterrupted coordination, to ensure that all participating strengths from start to finish consistently adjust-coordinate their activities.

Section 5: Space Information Assisting Support Operations…150

Space information assisting support operations signify operational activities which use space information support strengths to provide land, sea, and air operational strengths with information assisting support and safeguarding support from space, including reconnaissance and surveillance [R&S], missile early warning, communication relay, navigation positioning, meteorological observation, and geodetic surveying and mapping. Due to restrictions by the objective conditions of space technology development, space information assisting support operations are the main operational pattern for space operations today. The practice of war since the 1990s, the Persian Gulf War, the Kosovo War, the War in Afghanistan, and the Iraq War, has shown that space information assisting support has become a "multiplier" for boosting operational capability, and an important backing for gaining the battlefield initiative.

I. Main activities of space information assisting support operations…150

Based on the differences in missions, space information assisting support operations mainly include 6 types of activities: space R&S, space missile early warning, space communication relay, space navigation positioning, space meteorological observation, and space geodetic surveying and mapping.

1. Space R&S

This signifies operational activities which employ space reconnaissance satellites and target surveillance systems to carry out reconnaissance, surveillance, and tracking of all types of targets on the battlefield, so as to acquire information on the enemy's important operations. Since space R&S systems have characteristics such as high speed, broad scope, few limitations (and no limitations from territorial air space or from geographic and weather conditions), full content (both imagery and EM information can be reconnoitered), and either regular or continuous surveillance of the same area, they are thus the main sources for strategic, campaign, and even tactical intelligence within operations under informationized conditions. At present, 70% of the strategic intelligence of the world's military powers comes from space reconnaissance, while in the U.S. the proportion of all types of military intelligence provided by space reconnaissance is as high as 90% or more. Space R&S mainly includes remote sensing reconnaissance and electronic reconnaissance. Of these, **[end of page 150]** remote sensing reconnaissance is the use of satellite-mounted visible-light, IR, and microwave remote sensing devices to carry out photography or observation of ground targets, so as to acquire imagery intelligence; and electronic reconnaissance is the use of facilities equipment such as satellite-mounted radio receivers and antennas, for reconnaissance and interception of enemy radio/wireless signals, so as to acquire EM intelligence.

2. Space missile early warning

This signifies operational activities which use the space missile early warning system to detect, find, and track the launch and flight of missiles, so as to issue a missile incoming alert as early as possible and to forecast the missile's trajectory and landing point. Space missile early warning overcomes the drawbacks of ground early warning radar in wartime, such as susceptibility to attack, short operating range, and short early warning time; and it is an important component of a strategic defense system within operations under informationized conditions. During the Persian Gulf War, the US military precisely via the early warning intelligence provided by use of its missile early warning satellites was able to acquire the targets of Iraqi "Scud" missiles within 90-120 seconds after launch and ascertain their impact areas, thus providing 4-5 minutes of early warning time, which ensured timely interception by "Patriot" missiles.

3. Space communication relay

This signifies operational activities which employ communication satellites as "relay stations" for communications, to provide information transmission and relay for a variety of fixed or mobile communication terminals. Compared to other means of communication, space communication relay has a very clear superiority: the communication relay platforms are situated in outer space, have a broad scope of coverage, and can overcome the influence of all terrain obstacles; the communication frequency is high and the capacity high, enabling the communication needs of large numbers of users to be simultaneously met; the communication bandwidth is broad, enabling spread spectrum communication, with good security and jam resistance; the use of natural channels means excellent communication quality, with minimal influence by weather or other natural conditions; and true multi-address communication with flexible networking, good network reconfigurability, and high destruction resistance can be realized. Hence, space communication relay will become the foremost communication relay mode in operations under informationized conditions.

4. Space navigation positioning

This signifies operational activities which use a space navigation positioning system to transmit navigation signals and navigation messages, so as to provide all-weather, real-time precision navigation, positioning, and timing service for the units and weapons systems of all services and arms, as well as for spacecraft operating in low Earth orbit

[LEO]. Space navigation positioning has synthesized the merits of traditional astronomical navigation and ground radio navigation, and has overcome their shortcomings: its positioning precision is high, enabling passive dynamic positioning; the user space is large, so that the number of passive users in theory is unlimited; it can provide all-weather, all-climate navigation positioning services; and it can provide real-time or **[end of page 151]** near-real-time navigation positioning information. At present, the space navigation positioning systems operating around the world mainly include America's GPS System, Russia's "GLONASS" [Global Navigation Satellite] System, Europe's "Galileo" System, and China's "Beidou" (COMPASS) System. These will be the backbone of navigation positioning within operations under future informationized conditions.

5. Space meteorological observation

This signifies operational activities which use satellite meteorological monitoring and forecasting systems to perform meteorological observation of the earth's surface from outer space. Meteorological satellites have characteristics such as long observation time, a broad coverage zone, a short data compilation time, and high security and image resolution; they can provide real-time meteorological intelligence over a global scope, and have an important role in supporting the smooth conduct of various military activities. According to operating orbit, space meteorological observation systems can be divided into the following: sun-synchronous-orbit [SSO] meteorological observation systems, which can perform two meteorological observations of the same area every day and acquire global meteorological data; and geostationary-orbit [GSO] meteorological observation systems, which can perform continuous meteorological observation of 25% of the areas (zones) of the entire globe, and mainly provide services to high-tech weapons and equipment and operational activities with stricter requirements on the meteorological environment.

6. Space geodetic surveying and mapping

This signifies operational activities which employ satellite surveying and mapping systems to perform surveying and mapping of the earth's gravity distribution, the earth's magnetic field distribution, and the earth's shape, as well as geographic information on the earth's surface. Geodetic surveying and mapping satellites have high operating orbits and rapid speed, and in particular are not restricted by a nation's territorial airspace or territorial waters. Thus, they not only can provide geodetic information not obtainable by other means of surveying and mapping, but also have high precision and a strong time effectiveness quality. All this is of the utmost importance in boosting the preciseness of command and the hit precision of long-range ballistic missiles.

II. Basic requirements for space information assisting support operations…152

In operations under informationized conditions, the position and role of space information assisting support operations are extremely important and have determined that the confrontation centering on space information assisting support will also be very sharp. When organizing and conducting space information assisting support operations, [commanders] must, under the premise of reinforcing protection to ensure safety, synthetically apply a variety of space information assisting support forces, and lay stress on the support key points, to provide forceful support {*zhichi*} for all fields — land, sea, air, and space.

1. Synthetic adjusting-coordination {*zonghe xietiao*}, with integrated-whole application

The space forces participating in space information assisting support operations come in numerous classes, but each class of forces has its specific superiority and limitations. In order to fully bring into play the superiority of each class of forces and make up for their limitations, **[end of page 152]** [commanders] must carry out synthetic adjusting-coordination and realize integrated-whole application. So-called synthetic adjusting-coordination with integrated-whole application means centering on a unified objective; synthetically applying space information assisting support forces for R&S, missile early warning, communication relay, navigation positioning, meteorological observation, and geodetic surveying and mapping; forming a good relationship for mutual assisting support, mutual enhancement, and mutual complementation, with no conflict or friction; and thus achieving the optimal space information assisting support effects. This is mainly embodied in two respects: on one hand, it means adjusting-coordination and complementation among all space information assisting support forces. To give some examples, in the complementation between the R&S system and the communication relay system, the raw observation data acquired by the R&S system can be transmitted over the communication relay system in real-time to a ground information processing center, and the processing results then can be swiftly transmitted over the communication relay system to all operational units {*danwei*}, thus maximally boosting the exploitation value of the acquired information; or in the complementation between the navigation positioning system and the communication relay system, the navigation positioning system can be used to precisely fix the geographic location of a ground communication terminal, thus boosting the communication quality of the communication relay system; or in the complementation between the meteorological observation system and the R&S system, the meteorological observation system can be used to timely grasp the meteorological situation in target areas (zones), thus enabling selection of good meteorological conditions to conduct reconnaissance and boosting the R&S system's reconnaissance effects. On the other hand, there is the adjusting-coordination and complementation internal to all space information assisting support forces. For example, in the complementation between the general survey type satellites and detailed survey type satellites internal to the R&S system, the general survey type satellites will perform large-scope, low-precision posture observation, but once they detect a suspected target, they will immediately provide the target vector to the detailed survey type satellites, to assist the latter in performing high-precision identification of the target, and thus boost the utilization ratio of the reconnaissance system; or, in the complementation between electronic reconnaissance satellites and photoreconnaissance satellites, the electronic reconnaissance satellites can be employed over a vast sea zone to acquire EM signals from the enemy's heavy ships, roughly determine their locations, then vector the photoreconnaissance satellites in carrying out precision positioning of the heavy ships, and thus provide information assisting support for the friendly side's execution of long-range precision strike.

2. Concentration of forces, for key point support

Due to the limitations of technological conditions and restrictions of economic real strength, for the foreseeable very long time to come, the quantitative scale of space information assisting support forces will be unusually limited, but the position and role of space information assisting support will grow ever more important, so that the contradiction between the needs and requirements and the possibilities will be very prominent. If [commanders] adopt the mode of casting a large-area net for decentralized use of the space information assisting support forces, they not only will be unable to effectively bring into play the effectiveness of the existing forces, but also could generate disorder due to a lack of stress on the support key points. To this end, they must concentrate use of limited space information assisting support forces to provide key point support. So-called concentration of forces for key point support involves unified planning and unified organizing for concentrating considerable-scale space **[end of page 153]** information assisting support forces in the important operational phases, critical time segments, main direction, and key point areas (zones), to provide powerful information support for the important objects, so as to ensure the success of the operations. Concentration of forces not only requires emphasizing concentration in quantitative terms, but also emphasizing the formation of qualitative superiority; and it not only requires ensuring concentration in a certain space, but also requires taking care to realize concentration at a certain time. At the same time, concentration of forces should uphold the principle of being "reasonable and sufficient;" this not only requires ensuring the needs and requirements for fulfilling the missions, but also requires detailed calculations for precision strike, economizing on use [of forces], and absolutely avoiding blind concentration. In key point support, the most important thing is to capture the key points. Generally speaking, these mainly include the following: higher-level C2 centers, units which execute important operational missions, high-tech weapons platforms, and units situated in harsh environments and unable to be supported by other information support forces. Of course, in different operational patterns or different phases of operations, along with the changes in the battlefield situation and operational missions, the operational COG will regularly undergo change, and thus will require that the key points in use of the space information assisting support forces also should correspondingly be adjusted and transfer-shifted.

3. Rigorous protection, to ensure safety

In operations under informationized conditions, the prominent superiority of space information assisting support forces in regard to information acquisition and transmission has made them become absolutely indispensable “operational partners” for the land, sea, and air operational strengths in carrying out operational missions, and thus they are certain to become the targets of key point strikes by the opposing sides. Moreover, along with the acceleration of the course of space weaponization, various types of counter-space forces weapons are emerging in an endless stream, and this also will sharply increase the threats faced by the space information assisting support forces. Once the space information assisting support forces sustain severe damage, they will not be able to provide timely and effective information assisting support; this will cause lethal strikes to the operational SoS increasingly based on networked information systems and even lead to loss of operational capability in this SoS. Hence, reinforcing protection for space information assisting support forces, to ensure their safe and stable operation, is a major problem which must be closely heeded by space operations commanders and their command organs. When the space information assisting support forces are carrying out operational missions, [commanders and their command organs] should apply a variety of technical means to provide concealment and camouflage, enhance the orbital maneuverability of spacecraft, reinforce the defensive strengths for the ground stations, and rigorously organize electronic defense, so as to boost the destruction-resistance capability and survivability of space information systems and ensure the smooth conduct of the space information assisting support operations, as well as an uninterrupted flow of space information assisting support and safeguarding support.

Questions for Deliberation…154

1. Which are the main patterns of space operations?

2. Which are the main activities of space strike operations? What are their basic requirements?

3. Which are the main activities of space information assisting support operations? What are their basic requirements? **[end of page 154; end of lecture]**

This page intentionally left blank.

Lecture 6
Command of Space Operations…155

Command of space operations is command by space operations commanders and their command organs over the space operations activities of their subordinate units. According to the operational pattern, it is divided into command of space deterrence operations, command of space blockade operations, command of space strike operations, command of space defensive operations, and command of space information assisting support {*zhiyuan*} operations. According to participating strengths, it is divided into command of space launch and recovery units, command of space telemetry, tracking and control [TT&C] units, command of space flight combat units, command of strategic missile forces, command of ground space defense units, and command of space service and support troops {*qinwu baozhang budui*}.[11] According to the weapons employed, it is divided into command of missile operations, command of spacecraft operations, and command of new concept weaponry operations. According to the confrontation area (zone), it is divided into command of "space-to-space" operations, command of "space-to-ground" operations, command of "ground-to-space" operations, and so on. Command of space operations mainly involves content such as the characteristics and laws of space operations, command principles, the command system of systems [SoS] {*tixi*}, the command structure, command modes, command means, and command activity {*huodong*}. Its basic missions are as follows: to analyze, study, and correctly assess the enemy space operations situation, to rationally disposition the friendly space operational forces, to implement unified *jihua* planning and organizing and control and adjusting-coordination of the space operations activities, and to flexibly apply space operations fighting methods, so as to boost the integrated-whole effectiveness of the space operational SoS and seize success in space operations. Whether command of space operations is correct directly influences the progress and outcome of space operations activity. In-depth study of command of space operations can reveal the laws of command of space operations, benefit the boosting of command effectiveness in space operations, and bring into play the major role of space operational forces within joint operations.

Section 1: Characteristics and Principles of Command of Space Operations…155

Command of space operations has its intrinsic characteristics and laws. By following the objective laws, command of space operations can be highly effective. In-depth study of the correlated problems in command of space operations requires first having a clear idea

[11] Translator's note: unless otherwise indicated, all "support" in this lecture is safeguarding support {*baozhang*}.

of the characteristics and laws of command of space operations, and correctly grasping the basic principles of command of space operations. **[end of page 155]**

I. Main characteristics of command of space operations…156

Space operations have a very strong special quality in many respects, such as weapons and equipment, the battlefield environment, the task organization of strength, and the operational patterns. The result is that command of space operations is clearly distinguished from command of other operations. Based on the actual application of space operational forces in several recent local wars, as well as predictions of the development trends for future space operations, command of space operations mainly assumes characteristics in the following 5 respects.

1. Space operations involve the strategic overall situation; the command decision-making level is high.

Along with the swift development of the militarization of space, the battlefield will expand from the land, sea, and air further into space. Future wars are certain to be informationized wars with integration {*yiti*} of the land, sea, air, space, and electromagnetic [EM] multidimensional battlefield, and space operations will be an important component of future informationized wars. In space, space equipment serves as the space information platforms of modern war. This equipment has the capabilities for real-time precision navigation positioning, high-resolution remote sensing imagery, high-precision weather data, timely missile early warning, and reliable high-capacity communication. This has maximally enhanced the "degree of transparency" of modern battlefields, and has expanded the "channels" for battlefield information. The use of satellites to conduct reconnaissance, surveillance, communication, navigation, and early warning will become the main operational support mode in joint operations. The high-speed operation of space weapons in space orbits is not limited by national borders, territorial waters, or territorial airspace, and is not restricted by terrain conditions and atmospheric environments; the degrees of freedom in operational activities thus have greatly increased, and the battlefield scope and space are vast. The use of space operations platforms, employing lasers, kinetic energy weapons [KEWs], and new concept weaponry and munitions to attack the adversary's spacecraft from outer space, and attack the adversary's land, sea, and air targets, similarly will become an important operational mode. It is quite clear that once the space battlefield falls, space assisting support *xitong* systems, space offensive systems, and space defensive systems all will no longer play role. This can be compared to having lost eyes and ears and having lost space protective shields; seizing information dominance, command of the air, and command of the sea similarly would become empty phrases, and this would also mean loss of the initiative in war. Hence, space operations involve the strategic overall situation, and their position and role is very important. The command decision-making levels must be raised in space operations, so that unified disposition and unified command and control [C2] are from a high level, to ensure the smooth conduct of space operations according to the intent of the Supreme Command and the correct direction.

2. High speed, rapid tempo, and short command cycle in space activities

One distinct characteristic of space operations distinguishing them from other battlefield operations is the high speed of the operational activities, with a great acceleration of the operational tempo. On one hand, spacecraft and space weapons operate with extremely high speed **[end of page 156]** and ultra-long range. For a spacecraft to move in circular movement around the earth, become an artificial satellite within the solar system, and leave the solar system to enter deep space, it must respectively achieve the First Cosmic Speed of 7.91 km/s, the Second Cosmic Speed of 11.18 km/s, and the Third Cosmic Speed of 16.63 km/s; i.e., it must cover an operating distance of at least 400 km – 1000 km every minute. Space weapons and laser and KEWs plus particle-beam weapons all operate at the speed of light and only need a time of 0.0014 second to strike a target on the earth's surface. Operations employing such a high speed and such a long range are actions which cannot be compared with other battlefield operational activities. Added to this, the wide-ranging application of various types of stealth technology and electronic warfare [EW] technology has greatly enhanced the element of surprise and the rapidity in space operations. On the other hand, the wide-ranging application of advanced information acquisition, transmission, and processing technology in the future space battlefield also will provide technical brace-support {*zhicheng*} for rapid command of operations. During the Persian Gulf War, the full-course flight time of a "Scud" missile was only 7 minutes. The US military applied early warning satellites with a disposition above the Indian Ocean to detect the launch flames of these "Scud" missiles of the Iraqi military and then automatically transmit the relevant data to a US Air Force [USAF] ground station situated in Australia. This ground station then used a communication satellite to transmit the data to the command center of the North American Air Defense Command [NORAD] situated in the US homeland; the command center then performed processing of the data and rapidly transmitted the processing results to the Central Command [CENTCOM] command center situated in Riyadh and to the "Patriot" Air Defense Missile Center. The air defense missile center timely and accurately commanded and vectored the "Patriot" missiles in realizing interception and destruction of the "Scuds," with the entire process not exceeding 5 minutes, so that command was implemented under near-real-time circumstances. Practice has demonstrated that command of space operations requires energetically shortening the command cycle. To this end, only when space operations commanders and their command organs fully apply a variety of command means to timely detect the enemy situation, rapidly assess it, make rapid decisions, complete the planning and organizing work before the enemy does, and greatly boost the organizing and command effectiveness and the rapid reaction capability, can they adapt to the needs and requirements of space operations.

3. Multidimensionality {*duoyuan*} of space operational forces, making command coordination very complex

In local war under informationized conditions, in order to gain success in space operations, and thus gain space dominance, both opposing sides will use all their forces and try all possible methods to participate in space operations. Space operations assume the important characteristic of multidimensionality in the participating strengths, and this makes the content of command coordination in space operations wide-ranging and the missions strenuous. First is the internal coordination of space operations. Generally speaking, space operations mainly are an integrated whole composed of numerous activities, such as reconnaissance and surveillance [R&S], communication relay, C2, firepower and information attack, and service and technical support. Within this integrated-whole structure, a small mistake in any single operational activity always could lead to failure of the entire course of operations. **[end of page 157]** Next is the coordination between space operational activities and other operational activities. This type of coordination not only includes the information and fire assisting support provided by the space operational forces for the land, sea, and air operational strengths, to assist in seizing information dominance, command of the sea, and command of the air, as well as executing continuous strikes against war potential targets in the enemy depth, but also includes the information and fire assisting support provided by the land, sea, and air operational strengths to the space operational forces, to assist in seizing and maintaining space dominance; and it not only includes hard destruction, but also includes soft kill. Finally, there is the coordination between the space operational activities and civilian space activity. Along with the constant growth in China's economic and science and technology [S&T] real strength, the participation by civilian forces in space activity may grow ever greater and broader. During space operations, civilian forces also will be an important participating strength. Operational coordination not only includes the information and means assisting support provided by civilian space activity for space operational activities, such as the urgent and backup information assisting support provided to the armed forces by communication satellites, meteorological satellites, and maritime satellites; it also includes the protection provided by space operational activities to civilian space activity. Hence, space operational coordination is very complex, and objective situations will levy pressing needs and requirements to adopt a variety of measures and methods. In particular, this means fully applying advanced command information systems, to reinforce the timeliness and accuracy of command coordination in space operations, and to ensure the consistent adjusting-coordination of space operational activities.

4. Advanced means of space engagement, making for sharpness in command warfare

Due to the wide-ranging application of space technology and information technology [IT], space weapons and equipment will constantly see new breakthroughs. This will provide even more choices for directly attacking the adversary's command institutions and command information systems, and achieving the goal of subduing the enemy troops with minimal use of friendly troops. On one hand, the reconnaissance means are advanced, so that command institutions are extremely easily positioned by reconnaissance. Today, [commanders] not only can employ electronic reconnaissance satellites to conduct full-spectrum, full-dimensional {*quanfangwei*}, full-depth surveillance, monitoring, and positioning of the enemy's C2 systems; they also can exploit a variety of imaging satellites to conduct all-around, careful reconnaissance of the entire battlefield. For example, satellite-borne synthetic aperture radar [SAR] has a certain penetration ability and can detect command institutions concealed underground; and multispectral imaging reconnaissance has a certain capability for revealing camouflage and can detect installations and personnel concealed in the woods. This type of superstrong battlefield reconnaissance capability makes concealment of command institutions and command installations very difficult. On the other hand, space weapons are not subject to any political, geographic, or weather limitations, and have characteristics such as rapid firing speed, high precision, and high yield; they can at extremely high speeds penetrate into the enemy's far reaching rear areas, and in regard to severe threats posed by enemy command institutions situated in the strategic and campaign depth, they not only can carry out hard destruction of them, but also can carry out soft kill of them. Hence, the opposing sides' struggle centering on reconnaissance versus counter-reconnaissance of command institutions, and the corresponding strike versus protection, will grow increasingly sharp. **[end of page 158]**

5. Strangeness of the space battlefield field {*lingyu*}, with stringent requirements on command quality

In terms of most commanders and their command organs in armed forces around the world, due to their long involvement and operations in the land, sea, and air battlefield fields, they are unusually familiar with the land, sea, and air battlefield fields; but their understanding of the space environment, space technology, spacecraft, and space weapons and equipment is not good, and their grasp of these even less. Added to this is that a small error can lead to a miss by a thousand miles, so it is very difficult to realize skillful command. Concretely speaking, in technological terms, space technology mainly includes spacecraft technology, spacecraft delivery technology, spacecraft launch technology, spacecraft TT&C technology, and manned space technology; and each of these technologies also includes a good many specific technologies and tenets. All of this content is the quintessence of current high-tech fields, so general personnel cannot learn and grasp it within a short time. In terms of the content of space command, due to the differences in the objects of command, the command means, and the command modes, the space command procedures and command methods thus show fairly great differences from command of other battlefield operations. For example, the space battlefield is vast and boundless, so how is early warning surveillance of all space targets to be conducted; or how is C2 to be implemented for spacecraft and space weapons after they reach outer space; or how is rapid reaction to be realized for space weapons as heavy as tens of tons or as small as a particle beam? These special situations raise all-new challenges in terms of commanders and their command organs without practice in space operations. In international law respects, the UN to date has formulated a good many international space laws. These mainly include the following: several conventions — the *Outer Space Treaty* (1967), the *Rescue Agreement* (1968), the *Liability Convention* (1972), and the *Registration Convention* (1976) — plus a certain number of principles and declarations, such as the *Declaration on Outer Space* (1963) and the *Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting* (1982). These conventions, principles, and declarations not only must be thoroughly known and understood, but even more importantly require skill in one's use of them, to avoid during space operations the triggering of disputes between the UN or non-participating states and the friendly side, and even the unfavorable situation of the opening of hostilities against the friendly side. Evidently, due to the strangeness of the field and the lack of practice in it, the capability and quality of commanders and their command organs in subjective terms universally exhibit fairly big gaps from the objective needs and requirements of space operations. To this end, multiple measures must be adopted to reinforce studies on command of space operations; explore content, procedures, and methods conforming to the command of space operations having [our] own characteristics; and reinforce cultivation and training and drills, in order to as rapidly as possible boost the integrated-whole quality of the personnel in command of space operations.

II. Basic principles of command of space operations…159

The principles of command of space operations are the criteria which must be followed by space operations commanders and their command organs **[end of page 159]** when carrying out command activity. They are the concrete embodiment of the operational command laws within space operations command activity. By implementing command of space operations according to these principles, [commanders and their command organs] can boost command efficiency, reduce shortsightedness, and avoid making major mistakes.

1. Full-zone monitoring, with foresight in good time

This principle signifies, during command activity for organizing and conducting space operations, a real-time grasp of the battlefield postures in space, the air zones, the sea zones, and the land zones; detecting the enemy first; and swiftly making the correct forecast, so as to lay a firm foundation for ultimately determining decision-making which conforms to battlefield realities. Full-zone monitoring means the need to employ a variety of technologies and special reconnaissance means for a comprehensive, accurate, real-time grasp of information on the entire battlefield in all respects, including the enemy, our side, and friendly neighbors, as well as the battlefield's natural environment, with space as primary, and with the correlated air zones, sea zones, and land zones as auxiliary. This mainly includes static information, such as the enemy's space operations thought, operational characteristics, operational intention, personnel quality, and weapons and equipment performance; the enemy's main spacecraft launch positions and space energy and equipment production bases; the orbital locations and operational uses of the enemy's in-orbit spacecraft in peacetime; and the integrated-whole levels of the enemy's space S&T — as well as fairly rapidly changing information, such as the enemy's current space operational disposition and main operational direction, newly committed space force-strength and weapons, and operational loss situation. During monitoring, [commanders and their command organs] must use multiple reconnaissance means in parallel, mutually confirm all acquired information, discard the dross and reject the false, and thus boost the accuracy and continuity of battlefield information. Foresight in good time means that on the basis of effectively obtaining space battlefield information, they will apply the method of a mutual combination of the quantitative and the qualitative to rapidly synthesize, compare, and analyze the battlefield information; clearly state the respective superiorities and inferiorities of the enemy and friendly sides, plus the favorable and unfavorable conditions; see any potential threats, and in good time foresee the operational development trends and favorable timing for operations; and make correct decisions which conform to reality, so as to realize unification of the subjective and objective in the understanding of space operations.

2. Scientific decision-making, with rapid reaction

This principle is a basic requirement for commanders in setting the operational resolution. Within it, rapid reaction also is a basic requirement for command organs in their activity on collecting the situation [information], planning and organizing, and control and adjusting-coordination. All of these are prerequisites and critical factors in ensuring success in operations. Command of future space operations will be faced with ever more complex situations; the battlespace will be unprecedentedly expanded, weapons and equipment will be highly informationized, the operational missions will be interwoven in fulfillment, the information quantity will sharply rise, the course of operations will accelerate, and operational support will be abnormally complex—all leading to ever shorter command cycles, and great increases in the degree of difficulty in command control and adjusting-coordination. These factors have raised severe challenges to operational decision-making. Hence, only relying on the command experience of individuals, and adopting simple, direct, qualitative decision methods to form the operational resolution, are by far no longer able to adapt to **[end of page 160]** the needs and requirements of command of future space operations. Taking scientific decision-making theory as the foundation, [commanders and their command organs] must grasp scientific methodology, apply high- and new-tech means, and focus on the strategic overall situation and the integrated whole of space operations, in order to ensure the accuracy, real-time quality, and effectiveness of the space operational resolution. During decision-making, it is not only necessary to uphold the core role of the commanders, but is also necessary to fully bring into play the brain-trust role of the staff personnel and relevant experts, combine "collective working-out-an-approach in planning" with "decision by the main officers," achieve collective wisdom and effort, and thus boost decision quality. [Commanders and command organs] not only must lay stress on qualitative analysis in theory, but also must excel at applying mathematical methods to perform quantitative analysis, combine the two analysis methods, and select resolution courses of action [COAs] strictly according to scientific decision procedures. They must fully exploit advanced IT and tightly combine staff personnel and technical personnel with technical facilities equipment based on high-performance computers, to compose a man-machine-integrated interactive intelligent computer-aided [decision-making] system, for meticulous design of operational COAs, and for seeking sound strategies to subdue the enemy. At the same time, along with the swift development of high and new technologies, especially IT, and their wide-ranging application in the military field, the role of operational command speed in future war will be more prominent than at any time in the past. Today, military powers around the world attach high importance to boosting operational command speed. Specifically, the US military has put forth the "Observe – Orient – Decide – Act" operational command cycle theory (i.e., the "OODA Loop" theory). This theory holds that during operations, if one side has shortened its own operational command cycle, and launches activities before the enemy has mounted a reaction to that side's previous activities, then the enemy very rapidly may fall into disorder due to being too busy to handle all matters; and even if the enemy's real strength is substantial, that side will still be able to avoid the misfortune of being in a passive situation and taking a beating, or even the misfortune of a crushing defeat. In the future, space operations will be faced with expanded operational spaces and compressed operational times, operational platforms moving at high speeds, and operational patterns with frequent transitions; these have put forth even stricter requirements on rapid reaction in the command of space operations. Hence, [commanders and their command organs] must focus on the future, approach [the problem] from a variety of standpoints — intelligent functioning in command decision-making, simplification of command procedures, flexible adoption of command modes, and real-time flow of command support — and exert effort toward boosting the rapid reaction capability in command of space operations.

3. Unified command, with key point control

Unified command is a basic principle of operational command to which strategists in ancient and modern times both in China and abroad have attached high importance. Its fundamental goal lies in implementing unified command in order to achieve unified thought, unified planning, and unified activities, so as to boost the integrated-whole effectiveness of operations. Within future space operations, space operational forces will be distributed very widely, with forces dispositioned on the land, at sea, in the air, and in space; moreover, their mutual spacing will usually be quite far, making coordinated activities difficult. Space technology is very complex, and a problem occurring in any one link — early warning, launch, or TT&C — always can lead to situations where space operations cannot perform measurements, **[end of page 161]** cannot realize interception, or cannot carry out destruction. Added to this, space operations often will not be present in isolation and usually will accompany land, naval, and air operations. If C2 is not properly implemented, it could lead to a scene of utter disorder in land, sea, air, and space operations, and even could cause major losses to the friendly side. Space resources belong to the common resources of all humankind, and all nations around the world are entitled to start out from the goal of peaceful use of space, launch a variety of spacecraft into space, and freely operate them in various orbits. In the future, more and more spacecraft will be launched into space by many nations, no matter whether they are space powers or ordinary states. If space operations are not meticulously organized and precisely calculated, they very likely could harm other nations' spacecraft and set off a war between these nations. To this end, in order to fully bring into play the role of the limited space operational forces, [commanders and their command organs] must firmly implement centralized command, unified operations-research-based planning, and unified organizing, and to the maximum extent form integrated-whole composite strength. This will be important support for gaining success in future space operations. At the same time, the space battlefield is vast, and involves all kinds of factors. In particular, space operations are fast changing, so conducting all-around surveillance and all-around control of all targets in all phases and all time segments is not only unnecessary, but also impossible. To this end, [commanders and their command organs] must lay stress on the key points, and in particular conduct full-course surveillance of the important phases and important time segments, and key point strikes at the important targets. For the other phases, the other time segments, and the other targets, based on the unified operations plan and the detailed operational specifications, they can delegate authority and implement decentralized control. In particular, for various types of outbreak situations, they all the more should implement decentralized control to seize the initiative in space operations.

4. Total effort on support, for stability and continuity

Command of space operations cannot do without all-around and careful command support. If command support is forceful, command of space operations can then be stable and continuous, and also can then create good prerequisite conditions for seizing success in space operations. [Commanders and their command organs] need to unify the organizing of the various forces, to properly conduct reconnaissance intelligence, early warning and detection, targeting, communication, cryptographic, surveying and mapping and navigation, meteorological, and operational data support. In particular, they must focus on the needs and requirements for commanding space operations and on the characteristics and difficult points of command support, work hard to achieve real-time monitoring of the space environment and space targets, and realize uninterrupted flow of space communication, as well as stable and high-efficiency operation of the command information system. They also must earnestly provide good protection for command of space operations. In view of the situation where the space operations command institutions and command information system are the most important objectives of enemy destruction and sabotage, [commanders and their command organs] must in a directed [focused] manner adopt a variety of protective measures. For example, when formulating plans for resistance operations, they not only need to consider resisting the enemy's space attacks, but also need to consider resisting enemy attacks on land, at sea, and in the air; and they not only need to consider defense of ground command institutions, but also need to consider defense of future space command institutions (such as space command posts set up in medium- and large-scale space stations), and thus rationally disposition **[end of page 162]** multiple forces — land, sea, air, and space — to form an effective resistance capability against all incoming targets. They should also synthetically consider multiple factors for protective measures and take care to see that they complement the resistance measures; carry out general operations-research-based planning from the standpoints of counter-reconnaissance, counter-jamming, and counter-fire strike; and perform the necessary engineering work, including construction, hardening, and camouflage. In particular, they should set up several anti-laser-guidance and counter-IR-reconnaissance measurement devices such as smoke screens, water sprayers, and false-IR sources, and mutually combine them with other deception means as well as means of command concealment, to constitute a "shield" which can effectively ensure the security of the friendly space operations command institutions. When organizing command communication support, they should perform forecasts and analyses of the missions undertaken by space operations command institutions at all levels and of situations which can be encountered when signal communication is jammed and sabotaged by the enemy; study and formulate handling COAs for different special situations; lay stress on the key points and rationally deploy communication facilities equipment and technical strengths; and adopt multiple effective means to construct multipath bypassing communication circuits, to ensure the smooth and unblocked flow of signal communication among all command institutions on the ground and in space, and between the command institutions and the units.

Section 2: The Command SoS for Space Operations…163

The command SoS for space operations signifies the organic integrated whole of all levels and all types of space operations command institutions, according to the composition of command relationships. It is an important foundation on which all levels of commanders and their command organs implement organized command of the space operations activities of their subordinate units. A scientific and rational command SoS for space operations enables shortening of the command flow path and is beneficial to command coordination and to boosting of command efficiency.

I. Basic requirements for constructing the command SoS for space operations…163

Construction of the command SoS for space operations has its own special requirements. [Commanders and their command organs] must abide by the characteristics and laws of space operations, adapt to the general requirements of the operational command SoS, and bring them into the command SoS for joint operations, for synchronous building and perfection of the space operational forces.

1. Abiding by the laws of command of space operations

Command of space operations, besides abiding by general operational characteristics and laws, also should be organized and implemented according to the unique characteristics and requirements of space operations. First is [a need] to abide by the laws of high-level command. In space operations, unlike other operations, the participating strengths mostly are strategic forces, and the operational objectives mostly are enemy strategic targets; moreover, the success or failure of operations will have a bearing on success or failure in other battlefield operations and even on victory or defeat in an entire war. Hence, command of space operations must be by the Supreme Command or by a theater's joint operations commander [JOC] and his **[end of page 163]** command organs and must conscientiously realize unified command according to the supreme commander's intent; it cannot permit the least bit of error. Next is [the need] to abide by the laws of precision and high efficiency. Due to the universal application of IT, the informationized degree of all spacecraft, weapons and equipment, and ground launch and TT&C installations and facilities equipment within space operations is growing ever higher, and the capabilities for precision control and long-range strike have greatly improved. For operations under informationized conditions, this causes an acceleration of the tempo, greater preciseness, and unprecedented increases in operational efficiency. Given the pressing needs and requirements of real situations, the command SoS for space operations must be streamlined and smooth, in order to realize precision and high efficiency in command. Third is [the need] to abide by the laws of integrated linkage {*yiti liandong*}. The wide-ranging application of IT enables a variety of operational strengths to be employed in parallel, and enables the operational effectiveness of various types of weapons to be interlinked, so that operational capabilities are accumulated and released within a short time, thus leading to great increases in operational efficiency and acceleration of the course of operations. This feature has increased the degree of difficulty in command of space operations, and in particular has increased the degree of difficulty in scheduling of space operational forces, adjusting of operational objectives, and adjusting-coordinating of operational activities. This in turn has put forth requirements, unprecedented in history, on command of space operations with integrated linkage.

2. Bringing [the space operational forces] into the Joint Operations Command SoS

Space operational forces are a new type of operational strength and one whose position and role is very important. They must be brought into the joint operations SoS, and their command SoS similarly must be brought into the Joint Operations Command SoS. First of all are the needs and requirements for centralized unified command. Centralized unified command is a military rule particularly stressed by strategists in ancient and modern days both in China and abroad and one which has been repeatedly proven in military practice. It requires that all operational strengths must be under unified command by one commander and his command organ. In local war under informationized conditions, the classes of operational strengths are more numerous, which similarly requires abiding by the principle of centralized unified command. Space operational forces serve as an important component of the joint operational forces; they not only can be independently employed, but also can be employed as complementation to other forces. While concentrating the space operational forces to seize space dominance, [their commanders and command organs must] coordinate with other forces seizing information dominance, command of the sea, and command of the air, and inflict heavy strikes on the enemy's effective strength, to seize victory in campaign combat. Objective reality requires that the command SoS in space operations must be brought into the Joint Operations Command SoS and come under unified command by the JOC and his command organ. Otherwise, it could result in [situations where] each department acts on its own, and too many heads issue commands; the units thus could not know what course to take, their operational effectiveness would be lower, and they could even be disorganized and defeated in battle. Next are the needs and requirements for interconnection and intercommunication in the command information system. The space operational forces and other operational strengths are not mutually isolated or mutually unconnected; instead, they are mutually supplementary and mutually promoting, with natural close ties between them. During operations, the other operational activities and the space operations activities will all need mutual assisting support and close complementation. Objective reality requires that the command information system for space operations and the command information system for other operational activities **[end of page 164]** are interconnected and interoperable, even to the point where the needs, activities planning, and activities results of the space operational forces and of the other operational strengths can be timely transmitted from one side to another and mutually exploited, to jointly boost the operational effects of an entire campaign. Third are the needs and requirements for boosting the benefits of building. Although the space operations command SoS has its special quality, nonetheless in overall terms it belongs like other command SoS's to the operational command SoS's, and they all have common characteristics and laws to be observed. On one hand, all operational command SoS's must be treated as one integrated whole, with unified operations-research-based planning done by one institution, which will concentrate manpower, material resources, and financial resources; carry out unified building; lay stress on the key points; and invest the limited funds in the most urgently needed and most important building, to guard against causing unnecessary waste of materiel. At the same time, this can ensure that all command SoS's have the same form and the same *xitong* system, and ensure their mutual interconnection and intercommunication, to constitute one organic integrated whole. On the other hand, under the premise of unified building, [commanders and their command organs] also must appropriately give consideration to the special quality of the space operations command SoS, and guard against always following the same pattern, to boost the directed [focused] quality and practicality of command of space operations.

3. Adapting to the general requirements of operational command

The command SoS for space operations serves as one type of operational command SoS. Compared to the Joint Operations Command SoS and the service operations command SoS, it has a similar task organization and organizational grouping, performs similar functions, brings into play similar functions, and similarly also must conform to the requirements of general command SoS's.

The requirement for centralized unified command: "Centralized unified [command] is a basic requirement for operational command in terms of the principle of the goal-driven quality of war and of composite strength to gain victory, and was a basic principle of operational command in ancient times."[12] The space operational forces are very numerous, but mainly include space launch units, space TT&C units, space early warning units, space offensive operations units, and space defensive operations units. In order to have these forces form composite strength, [commanders and their command organs] must have scientific and rational command institutions, implement centralized unified organizing and command over them, and thus establish unified command authority with a high degree of authoritativeness. They must employ unified operational thought, operational objectives, and operational planning, to unify the activities of all these space units.

The requirement for layer-by-layer command: "The control of a large force is the same principle as the control of a few men: it is merely a question of dividing up their numbers."[13] The meaning here is that if one wants to properly manage armed forces numerous in numbers of men, just as if one wants to properly manage armed forces few in number of men, one must organize them well. The specific method is to partition the armed forces into a certain number of components and implement level-by-level and section-by-section management. Speaking from the standpoint of management science, management exhibits spans. Under present technical conditions, **[end of page 165]** when the objects of management are in the range of 5-10, [the span] is relatively rational; but when this number exceeds 10, management institutions often may not be able to withstand the heavy burden, so that the phenomenon of a decline in management efficiency is seen. Today, space operational forces are undergoing full-speed development, their scale is constantly expanding, the equipment comes in many types and varieties, and the scope of disposition and spaces employed are constantly being extended; moreover, the functions not only include tactical and campaign functions, but also strategic ones. Thus, layer-by-layer command must be implemented over this type of operational strength, with mutual supplementation and mutual linkup among the layers. In reality, this then has formed a command SoS for space operations.

The requirement for sustained stability: command which is unstable or interrupted will cause loss of contact with the units, and the resultant outcome naturally will be a collapse without even going into battle. Along with the development of modern reconnaissance technology and the application of precision strike weapons, and in particular the rise of information warfare [IW], command systems, acting as the armed forces' operational

---

[12] Ding Bangyu. *The Science of Operational Command*, p. 117, Military Science Press, 2004.
[13] *Connoisseur's Dictionary of the Ancient Art of War*, p. 76, Military Translations Press, 1995.

nerve centers, have become the main targets of reconnaissance, jamming, strike, and destruction by the enemy, so the stable, uninterrupted flow of command has been gravely challenged. Once the space operations command SoS is established, it must be kept relatively stable for a fairly long time, so that commanders at all levels [can] implement sustained, uninterrupted organizing and command of space operations. Here, what are needed are outstanding commanders and staff personnel; a command information system with perfected functions; a full set of operating procedures, content, methods, and a *zhidu* system for command of space operations; and a set of effective concealment and protection measures, so that there is a reliable assurance of sustained, stable operation of the command SoS for space operations. This command SoS not only cannot be weakened due to adjustments and changes of command personnel, but also cannot lead to disorder in the entire SoS, or even loss of its role, caused by a certain command institutions being jammed, sabotaged, or destroyed by the enemy.

The requirement for agility with high efficiency: agility with high efficiency has always been an important principle of operational command and also is an important requirement for an operational command SoS. Along with the high-speed development of space technology and IT and their wide-ranging application in the military, modern operations take on the trends of faster tempo and higher efficiency. Hence, in order to adapt to the development of circumstances, the space operations command SoS, like other command SoS's, also must abide by the requirement for agility with high efficiency. On one hand, the establishment of the space operations command SoS, and in particular the space operations command institutions at all levels, should be further optimized, so that the collection, processing, dissemination, and transmission of various types of information are even more rational and scientific, and even faster; but on the other hand, the establishment of the space operations command SoS, based on the situation of increasing advances in command information systems, as well as the requirement for command of space operations to be ever rapider, should be further simplified, develop in the direction of flattening, i.e., an increase in the objects of command laterally, with fewer command levels longitudinally.

II. Constructing a model for the space operations command SoS…166

Today, the US military has specialized space operations units and space operations command institutions; moreover, **[end of page 166]** it has formed a relatively perfected space operations command SoS, with the armed forces of other nations worldwide still basically in an exploratory phase [for establishing such a command SoS]. Based on the possible situations in future space operations, combined with the situation of construction of space operations command SoS's by foreign militaries and in particular the US military, and synthesizing the relevant situation of domestic and foreign theoretical studies, future space operations command SoS's will involve two construction models: a model in which the space operations command institution is merged with the Supreme Command and a model in which the space operations command institutions are independent of the Supreme Command.

1. Model in which the space operations command institution is merged with the Supreme Command

Restricted by factors such as progress in political democracy, economic globalization, mutual balance of military forces, the speed of media propagation, and the common people's pursuit of happiness, future war will undergo major changes: the number of wars will be fewer and fewer, the scale of forces will be smaller and smaller, and the joint activities will be relatively greater in proportion. These development trends inevitably will require the operational command SoS to be further joint, flatter, multifunctional, and smaller in scale. The specific changes very likely will include transformation of the service operational commands {*zhihuibu*} and special-project operational commands, with their merging into the Supreme Command, so that the Supreme Command becomes a true Joint Operations Command for all services and arms, and has supreme authority over all types of operational command PLA-wide; and transformation of the theater service operational commands, with their merging into theater joint operations commands, so that the theater joint operations commands have supreme authority over all types of operational command in the root theater. Command of space operations, from the strategic-level viewpoint, may — following upon the departments for land command, sea command, and air command — become a new department in the Supreme Command's C2 center, and be an important component of the Supreme Command. From a campaign-level viewpoint, command of space operations also may— following upon the departments for land command, sea command, and air command—become a new department in the C2 center of the theater joint operations command and be an important component of the theater joint operations command. Hence, in overall terms this involves constructing a 3-level Joint Operations Command SoS: "a Supreme Command space operations command department – the space operations command department of each theater joint operations command – the command institutions of the space operations units." In this 3-level SoS, the Supreme Command space operations command department will be responsible for strategic command of space operations, and will guide each theater joint operations command's space operations command department in organizing space campaign operations and space assisting support operations; each theater joint operations command's space operations command department will be responsible for campaign command in space operations and for space assisting support operations; and the space operations units' command institutions will be responsible for command of the operational activities of the root-level subordinate units.

2. Model in which space operations command institutions are independent of the Supreme Command

When the space forces are relatively large and their operational capability fairly strong, there is also the possibility to establish a specialized Space Joint Operations Command, an Air and Space Operations Command, and/or a "Space Corps" {*tianjun*} Operational Command. Relatively speaking, the Air and Space Operations Command is a united command for space and air operations; its essence **[end of page 167]** is the same as that of the "Space Corps" Operational Command, and it belongs to the service operational commands. Since the future will see even greater emphasis on joint operations command, the possibility of its establishment is fairly low. The specialized Space Joint Operations Command, then, will be a command bearing a joint nature; compared to the Air and Space Operations Command and the "Space Corps" Operations Command, it will have a greater possibility of establishment. The specialized Space Joint Operations Command is under the leadership of the Supreme Command, and is specially tasked with space operations command. Under it are the space operations command departments of the theater joint operations commands, hence forming a 4-level command SoS: "the Supreme Command – the Space Joint Operations Command – the space operations command departments of the theater joint operations commands – the command institutions of the space operational units."

The space operations command department serves as an important department of the Supreme Command, and compared to the specialized Space Joint Operations Command, it can fully rely on the functions of the modern command information system and has simple and clear hierarchy and smooth relationships. These facilitate operational coordination among the space operational forces and between the space operational forces and other operational strengths, and can to the maximum extent bring into play the command effectiveness of integrated joint operations and the strategic role of the space operational forces. From the long-term viewpoint, this is an unusually ideal command SoS model; but from the short-term viewpoint, it exhibits weak points such as being detrimental to the space operational forces' special-project building and rapid development, and placing overly heavy strategic command missions on the Supreme Command. By contrast, the specialized Space Joint Operations Command is convenient to the building and development of the space operational forces, is beneficial to operational coordination among the space operational forces, and can to the maximum extent bring into play the strategic role of the space operational forces; however, it too shows weak points such as an increase in the command levels and disadvantages in the coordination between the space operational forces and the other operational strengths.

III. Task organization and organizational grouping of space operations command institutions…168

Based on the above two construction models for the space operations command SoS, the space operations command institutions may carry out the corresponding task organization and organizational grouping, to meet the needs and requirements of command of future space operations. When command of space operations serves as an important department in a joint operations command institution, the task organization and organizational grouping of the space operations command institutions will be fixed by observing the task organization and organizational grouping of the Supreme Command and of each theater joint operations command. When establishing a specialized Space Operations Command [SOC], the task organization and organizational grouping of the space operations command institutions may involve establishing a basic command post [CP], a reserve CP, and a rear CP.

1. Organizational grouping of a space operations command department

A future space operations command department will be determined mainly based on the task organization and organizational grouping of the attached joint operations commands.

When a joint operations command establishes a basic CP, reserve CP, and rear CP, **[end of page 168]** command of space operations will respectively serve as an important department of the joint operations command's basic CP, reserve CP, and rear CP. Below this department, the specific organizational grouping will include positions for planning and adjusting-coordination, space attack, space defense, and space information operations [IO]. The department's main duties are as follows: to achieve an all-around grasp of the space operations situation, and put forth decision recommendations for strategic and theater space operations; to organize and formulate the space operations plan, and participate in formulating space information assisting support plans; and to organize and supervise-guide space operational activities and space logistics and equipment support activities, and adjust-coordinate the space operations units' participation in other operational activities.

2. Task organization and organizational grouping of an SOC

The task organization and organizational grouping of a future SOC will be set based on the specific situation of the needs and requirements for carrying out space operational missions, the task organization of space operational forces, and the environment and conditions permitted by command. From the viewpoint of task organization, the task organization can include an SOC basic CP, an SOC reserve CP, and an SOC rear CP.

(1) Organizational grouping of the SOC basic CP

The SOC basic CP by and large can be organizationally grouped into a space operations command center and departments for intelligence, communication, military affairs, political work, logistics support, and equipment support. This CP will usually be composed of a space operations commander, a chief of staff, and relevant department personnel from a headquarters [HQ] organ, as well as correlated department personnel transferred from other organs.

The space operations command center is the core of the space operations basic CP. Based on needs and requirements, this center by and large can set up departments or positions for operational planning, duty-shift control, and planning control support. The center's main duties are as follows: to achieve all-around grasp of space operational situation information and put forth the related reports and recommendations; to draft and transmit space operational orders and instructions; to draft space operations general plans and sub-plans; to assume examinational work for space logistics support planning, equipment support planning, and lower-level operations planning; along with related departments, to organize forecast and evaluation of space operations effects; and to organize and guide the space operational support activities.

The space operations intelligence department can set up reconnaissance command, intelligence collection, and intelligence analysis positions. Its main duties are as follows: to put forth space reconnaissance intelligence support recommendations; to draft space reconnaissance intelligence support plans and instructions; to organize space reconnaissance intelligence support activities, and guide and adjust-coordinate the related activities of other reconnaissance intelligence strengths; to grasp, reorganize, and evaluate space intelligence information, report and release intelligence information, and provide intelligence sharing service; and to assist the space operations command center in organizing space counter-reconnaissance, and forecast and evaluation of space operational effects.

The space operations communication department can set up planning and adjusting-coordination, communication support, and command information system **[end of page 169]** support positions. Its main duties are as follows: to put forth space communication support and command information system support recommendations; to draft space communication support and command information system support plans and instructions, and assume examinational work for the lower-level related space communication support plans; to organize space communication and command information system support activities, and guide and adjust-coordinate the related activities of other communication and command information system support strengths; and to organize and adjust-coordinate space information system protection.

The space operations military affairs department can set up planning and adjusting-coordination, military manpower work, resources mobilization, and space battlefield control positions. Its main duties are as follows: to put forth space military affairs, mobilization, and space battlefield control work recommendations; to draft plans and orders or space operational unit augmentation and military manpower mobilization; and to organize space battlefield control.

The space operations political work department can set up organizational work, cadre work, propaganda and public opinion, and security and discipline inspection positions. Its main duties are as follows: to put forth space operations political work recommendations; to draft space operations political work plans and instructions; to organize political mobilization, agitprop, and news release and control; to assume Party and [Communist Youth] League work in organizing, adjustment, and replenishment of cadres; and to adjust-coordinate and launch space public opinion warfare, psychological warfare [PSYWAR/PSYOP], and legal warfare.

The space operations logistics support department can set up planning and adjusting-coordination, finance, medical, and materiel and fuel positions. Its main duties are as follows: to put forth space operations logistics support reports and recommendations; to draft space operations logistics support plans, issue support instructions, and organize and conduct space operations logistics support activities; and to coordinate with relevant departments in organizing space operations logistics mobilization and defense.

The space operations equipment support department can set up planning and adjusting-coordination, equipment support, and technical support positions. Its main duties are as follows: to put forth space operations equipment support reports and recommendations; to draft space operations equipment support plans, issue support instructions, and organize and conduct space operations equipment support activities; and to coordinate with relevant departments in organizing space operations equipment mobilization and defense.

(2) Organizational grouping of the SOC reserve CP

The SOC reserve CP by and large can be organizationally grouped into space operations command, political work, logistics support, and equipment support departments. It is usually composed of a space operations deputy commander, and relevant organ personnel. Its main duties are as follows: to collect and grasp space operations-related situation information; to link up and maintain signal communication with other CPs; to properly perform all the preparatory work for taking over command of space operations; and, based on the commander's instructions, to take over command from the basic CP.

(3) Organizational grouping of the SOC rear CP

The SOC rear CP by and large can be organizationally grouped into a rear command center and **[end of page 170]** logistics support, equipment support, and mobilization and support-the-front departments. It is usually composed of a space operations deputy commander, the main personnel from the logistics (joint logistics) and equipment organs, and relevant personnel from the HQ and political organs and the local support-the-front institution. The rear command center usually sets up integrated planning {*zonghe jihua*}, control and adjusting-coordination, communication support and command information system support, rear defense, and political work positions. It is mainly responsible for adjusting-coordinating space operations logistics support, equipment support, and support-the-front mobilization work, and commanding the rear defense activities. The logistics support department usually sets up planning and adjusting-coordination, quartermaster materials, finance, medical, transport, and barracks positions, and is mainly responsible for logistics support in space operations. The equipment support department usually sets up planning and adjusting-coordination, general-purpose equipment support, and special-purpose equipment support positions, and is mainly responsible for equipment support in space operations. The mobilization and support-the-front department usually sets up planning and adjusting-coordination, mobilization, and support-the-front positions, and is mainly responsible for mobilization and support-the-front work in space operations.

Section 3: Space Operations Command Activity…171

Space operations command activity is the organizational and leadership activity carried out by space operations commanders and their command organs over the space operations activities of their subordinate units, in order to achieve certain operational goals. It mainly includes understanding and grasping and analyzing and assessing the space operations situation, setting the space operational resolution, formulating the space operations plan, organizing space operations preparations, organizing space operations coordination, commanding space operations activities, and organizing space operations comprehensive support. Of these, the core of space operations command activity is the setting of the resolution and realization of the resolution; these restrict and govern the units' space operations activities, influence and even decide the progress and outcome of space operations, and influence the smooth conduct of war. Conducting in-depth study of space operations command activity has extremely important significance.

I. Basic requirements for space operations command activity…171

In view of the very great influence of space operations on local war under informationized conditions, and their very important position and role, ever stricter requirements have thus been put forth for space operations command activity.

1. Laying even more stress on efficiency

The pursuit of high efficiency is a universal law and basic requirement of operational command activity in ancient and modern times both in China and abroad. Along with the constant evolution of the form-state of war, space operations already have become an important operational pattern in modern war, and in particular within local war under informationized conditions. Moreover, operations now assume the characteristics of short time segments and dangerous situations, **[end of page 171]** requiring that space operations command activity should lay even more stress on high efficiency. This stress is embodied in 3 respects: first is that space operations command decision-making must be timely. During space operations, operational information propagates at the speed of light; space weapons exhibit advanced performance, operate at extremely high speeds, have long operating ranges, and are not limited by national boundaries, territorial waters, or territorial airspace. In particular, space weapons are not restricted by terrain conditions or the atmospheric environment, so the operational tempo is accelerated. Hence, there is an urgent requirement for command of space operations to be timely; this means focusing on the enemy space operations' characteristics, rapidly assessing the situation, rapidly setting the operational resolution, changing when the enemy changes, and even changing before the enemy does, to strive for the initiative. Next, the organizing and planning of space operations must be rapid. The participating strengths in space operations are multidimensional {*duoyuan*}, with mutual exploitation of other activities and alternation in their conduct; so organizing and planning are very complex, inevitably leading to long planning cycles. However, objective reality with equal urgency requires that the organizing and planning of space operations must be rapid and highly efficient. To this end, [commanders and command organs] should draw upon research and development [R&D] of integrated {*yitihua*} command platforms and the opportunity to use the command information system, lay stress on the organizing and planning functions of space operations, and exert effort toward R&D of an advanced space operations organizing and planning subsystem. In particular, they should strengthen the force-strength calculations for space operations, with timely and accurate simulation evaluation appraisal, thus greatly boosting the efficiency and scientific quality of organizing and planning, and thoroughly changing the outdated status of manual drafting of plans. Finally, the control and adjusting-coordination of space operations activities must be efficient. Good decision-making and good planning alone are insufficient: if the execution of space operations in the course of implementation is not forceful, good effects similarly cannot be achieved. Hence, [commanders and their command organs] must reinforce control and adjusting-coordination of space operations activities. [This involves] a timely grasp of the dynamic situation of space operations, and when detecting that the enemy situation has undergone a major change and the battlefield posture differs from the original plan, with major deviations in the units' execution of the plan, they then must fully bring into play the roles of the command information system and modern command means, to timely readjust and adjust-coordinate the space operations activities, so that they are conducted according to the intent of our commanders.

2. Laying even more stress on a directed [focused] quality

Space operations are operational activities for seizing and maintaining space dominance, their goal being to sabotage and strike at the enemy space operations objectives. Thus, command of space operations has a very strong directed [focused] quality. This is mainly embodied in 3 respects: first, target selection in space operations must have a directed [focused] quality. In order to see that space operations attain the optimal effects, space operations commanders and their command organs must meticulously select the space operations objectives, and in particular must select targets which have a huge influence on space operations, such as strategic early warning satellites, communication satellites, navigation satellites, and space attack systems. By striking at these objectives, space operations can achieve very great success. Second, selection of the methods and means in space operations must have a directed [focused] quality. The targets of space operations mainly are concentrated among the early warning satellites, communication satellites, navigation satellites, and space stations; and since their technical quality and professional quality are very high, the means and measures often adopted **[end of page 172]** are relatively limited, so selection of these means and measures is very important. Several means can be selected for one target, and even a single means can be selected for one target. If the directed [focused] quality of the methods and means is not strong, the operational effects are certain to be poor, and will not be able to play much of a role. Third, the selection of the timing of space operations must have a directed [focused] quality. In terms of the space operations themselves, proper selection of the timing can increase the operational benefit and reduce the operational losses. In terms of other operations, since space operations often can lead to failure of the enemy command systems and precision guidance systems, and most effectively screen and assist-support the other operational activities, the selection of their timing becomes even more important. If the timing is either too early or too late, it could influence the smooth conduct of other operations.

3. Being even more particular about the combination of technology and tactics

Space operations are a new type of battlefield operations and high-technology-intensive operations which emerged and developed along with the emergence and development of high technologies, especially space technology and IT, and their wide application in the military. Space operations also have catalyzed command of space operations, so that a technological quality and a professional quality are natural traits of space operations command activity. In addition, command of space operations is an important component of operational command, and, like other operational command activity, it has a very strong stratagem quality and tactical quality. Hence, command of space operations also similarly has the characteristics of a technological quality, a professional quality, a stratagem quality, and a tactical quality. In particular, this has put forth a requirement for even stronger emphasis in its command content on the tight combination of the technical and the tactical. On one hand, space operations need and require the brute-force brace-support of technology. Space operations are dependent on the technical performance and tactical performance of space operations weapons and equipment, and the better the technical performance, the better will be the tactical performance. This also means that compared to command of other operations, command of space operations even more requires technical knowledge, and requires having the participation of a large group of personnel who understand space operational equipment and space operational knowledge. On the other hand, new technologies can generate new tactics in space operations. Today, a grouping of new technologies with space technology and IT as the core is rapidly developing, and regularly bringing about new changes. Once these technologies are used for military goals, they could immediately generate very many new weapons and new types of equipment. If these new weapons and new types of equipment are employed rationally, they could also generate very many new tactics, and thus achieve taking the enemy by surprise within the course of space operations. Hence, those serving as space operations command personnel and operating personnel for new weapons and equipment must, on the basis of a skillful grasp of the related equipment's performance, reinforce studies of tactics, to fully bring into play the operational performance of the equipment. At the same time, in peacetime they also must take care to track developments in space technology and IT, and, based on the possibility of technical development, study and forecast the various tactics which can be generated. In this way, they not only can pull the development of the technologies, but also can lay the foundation for tactical applications after the technologies are formed into equipment. **[end of page 173]**

4. Paying even more attention to mutual correlation

Space operational forces not only can independently contend for space dominance or do so under assisting support and complementation by other operational strengths, and thus seize success in space operations; they also can serve as operational support strengths and fire assisting support strengths, to create good prerequisite conditions to contend for information dominance, command of the air, and command of the sea, and to provide assisting support and safeguarding support {*zhiyuan baozhang*} to other operational strengths for executing continuous strikes at the enemy's deep targets or war potential targets, right up to seizing success in land, naval, and air operations. Hence, space operations activities have extremely high relevance to other operational activities. Space operations command personnel must comprehensively consider the various situations within the full-dimensional {*quanwei*} battlefield, and attach high importance to complementation and adjusting-coordination between space operations activities and other operational activities. If a certain frequency, a certain time, or a certain activity in the course of space operations undergoes change, [command personnel] should timely brief the associated unit(s), and correspondingly readjust the force-strengths and plans, so that the operational effects are interlinked and rely on one another for support, thus achieving integrated joint effects. If they do not pay attention to the relevance of space operations to other operations, that very likely could lead to a reduction in the operational effects, and even lead to the severe aftermaths of mistaken strikes and accidental injuries.

II. Main content of space operations command activity…174

Space operations command activity is the tensest, sharpest, most important, most brilliant activity within space operations. Its content is wide-ranging, its coordination is complex, and its requirements on standards are strict. Only by comprehensively understanding all content of space operations command activity, and accurately grasping the critical links and important problems within it, can [space operations command personnel] steer the space operations toward success.

1. Understanding and grasping and analyzing and assessing the space operations situation

Understanding and assessing the space operations situation are prerequisites and the basis for setting the space operational resolution, planning and organizing the space operations, and controlling and adjusting-coordinating the space operations activities. Space operations commanders and their command organs must employ all space reconnaissance and early warning strengths; construct a space reconnaissance and early warning and surveillance SoS; and adopt a variety of reconnaissance intelligence and early warning and surveillance measures, to comprehensively collect and grasp the space operations situation, including the enemy situation, the friendly situation, and the battlefield environment. Moreover, on the basis of fully understanding the space operations missions and profoundly understanding the higher-level general intent, they should join with related departments to carry out synthetic [comprehensive] analysis and assessment of the acquired space operations situation, and in overall situation respects, grasp the developing changes in the enemy and friendly sides' space operations situations to lay the foundation for correctly setting the space operational resolution.

The content here mainly includes the following: first is the enemy situation. [This involves] the enemy space operations intention, space operational forces' task organization and disposition, the missions of all space operational units and the correlated missions of other units, the possible **[end of page 174]** space operational modes, the command of space operations, the main space attack means and key point objectives, the main space defensive means, the activity laws of space operations, the complementation of space operations for other operational activities, and the current activity situation of the space operational forces; the enemy space operational forces' strong points and weak points, the technical weak points of the space operations equipment, and the time opportunities and intermediate links we can exploit; the structure, distribution, critical nodes or links, and technical weak points of the enemy information system and its infrastructure; and the degree of reliance of the enemy information system on the reconnaissance and early warning, navigation positioning, and communication satellite information infrastructure, plus its repair capability. Second is the friendly situation. [This includes] the space operations requirements of the higher-level operations' general intention, the space operational forces' task organization and disposition, the main space weapons and equipment and their performance, the space operational activities which can be adopted, the organizing of command of space operations, the space attack fighting methods and defense fighting methods, the space operational support capability, the situation of progress in current space operations, and the civilian personnel and equipment exploitable for space operations, as well as their technical levels. Third is the battlefield environment. [This includes] the atmospheric environment, the EM environment, the vacuum and microgravity environment, the space debris, and the solar and geomagnetospheric activity, as well as their influence on space operations and the factors we can exploit.

When collecting and grasping and analyzing and assessing the space operations situation, the space operations command department, besides abiding by the requirements for speed, objectivity, and accuracy, also must take special care to grasp the following several points: first is the need to adopt multiple means to grasp the situation. [This means] as much as possible mobilizing the reconnaissance strengths of all services and arms and giving them a rational disposition; constructing a space reconnaissance intelligence and early warning and surveillance SoS; and adopting a variety of advanced R&S means — in particular, full exploitation of advanced means for space reconnaissance and early warning and surveillance, ground long-range early warning and surveillance, and technical reconnaissance — to comprehensively collect the situation related to enemy space operations, in order to provide the prerequisites for correctly analyzing and assessing the enemy space operations intention, unit operational capability, main operational direction, main operational phase, and main operational activities, as well as their main strong points and weak points. Second is the need for a mutual combination of macroscopic analysis and microscopic analysis. On one hand, [the space operations command department] must set out from the microscopic and technical standpoints; reinforce analysis of specific problems such as the technical tactical characteristics, launch, rendezvous, and recovery of space operations platforms and space weapons and equipment; and thus create favorable conditions for precision command and precision strike. On the other hand, it also must set out from the macroscopic and strategic and campaign standpoints; reinforce in-depth analyses of the space operations' integrated-whole posture and of the influence of space operations on land, sea, and air battlefield operations and even the entire war; and thus lay the foundation for formulating space strategy and space operational guidance. It must lay stress on organically combining macroscopic analysis with microscopic analysis, to ensure correct assessment of the space operations situation. In particular, it must guard against attaching too much importance to the microscopic while ignoring assessment of space operations in macroscopic respects, which would diminish the commander's macroscopic guidance over space operations and thus reduce the effects of the space operations. Third is the need **[end of page 175]** to consider the influence of the battlefield environment on space operations. Compared to the traditional battlefield environments, the space battlefield environment has a great many special qualities and has different influences on space operations. To give several examples, space radiation and space debris may influence the detection, identification, and tracking of missiles by a space missile early warning system; perturbations in the ionosphere may influence the measurement accuracy for a target's azimuth, speed, and range by a space R&S system, and could seriously influence the quality of satellite communications; solar flare radiation can immediately produce interference with all types of EM signals and persist for several hours or more; sunspot eruptions will lead to the occurrence of sharp changes in the density of the upper atmosphere, in turn leading to spacecraft seriously deviating from their predetermined orbits; lower atmospheric phenomena have a fairly high radiating influence on spacecraft; intense solar activity can induce magnetic storms, causing greater inhomogeneity in the ionosphere, thus leading to the occurrence of sharp changes in the intensity and phase of communication and navigation signals; and factors such as the earth's magnetic field will influence the employment effects of certain new concept weaponry. Hence, only when space operations command personnel accurately grasp and synthetically [comprehensively] analyze the space battlefield environment can they dynamically exploit the battlefield environment within future space operations, and achieve the goal of pursuing the advantage while avoiding harm.

2. Setting the space operational resolution

Setting of the space operational resolution is the operations-research-based planning and decision process carried out by space operations commanders and their command organs for the content of the space operations objectives, the space operational forces, the space operations direction, the space operational activities, the basic fighting methods of space operations, and all items of space support. It is the critical link and core content in space operations command activity, and is the basis for organizing and command of space operational activities. It mainly includes two parts: the chief of staff's putting forth of space operational resolution recommendations, and the commander's setting of the space operational resolution. Whether the content of the space operational resolution is scientific and whether the process of setting the resolution is timely and resolute are of the utmost importance, and will influence and even decide the success or failure of the space operational activities.

The main content of space operational resolution recommendations includes the following: the situation assessment conclusions; the goals of the space operations; the main direction of space attack and the important objectives and timing; the main direction of space defense and the targets defended; the disposition and mission differentiation for all units; the space offensive fighting methods and defensive fighting methods; the organizing of command coordination; and the time limit for completing the space operational preparations.

The putting forth of space operational resolution recommendations is done on the basis of the space operations department's systematic study of the situation associated with the space operations, and the recommendations are then put forth to the commander by the chief of staff after his further induction and summary. When studying and putting forth space operational resolution recommendations, [the space operations department] must grasp 3 points: first is the need to tightly center on the higher-level intent in putting forth the space operational resolution recommendations. The higher-level intent is the basis and foundation for the participating units' unified thought, unified planning, unified command, and unified activities. Only when [the department] tightly centers on the higher-level intent, **[end of page 176]** studies the problems of the root-level space operations, and launches the space operational activities, can it have the situation of the root unit's activities conform to the higher-level intent and the higher level's space operations plan, and thus more easily achieve the general goal of the campaign activities. Second is the need to put forth the space operational resolution recommendations from the standpoint of the strategic and campaign overall situation. Space operations not only can be independent operational activities, but also more often are important components in joint operations; they are guided and restricted by the overall situation of joint operations, and conversely influence and even decide success or failure in the overall situation of joint operations. To this end, [the space operations department] must keep grounded in the overall situation; center on the main operational goal, direction, phases, and activities during operations-research-based planning for the space operations; and unify the space activities' main force-strengths, main direction, and main activities into the joint operations, so that space operations are consistently adjusted-coordinated with the overall situation of joint operations, to form integrated-whole composite strength. Third is the need to relentlessly put forth effort to study the space operations COAs. It must set out from the most complex and most difficult situations, have many preparations made in advance, formulate multiple COAs, and guard against hastily meeting the enemy head on — and even collapsing without a fight — due to inadequate preparations. From the technical and tactical standpoints, on the basis of fully analyzing the enemy space operations' strong points and weak points, it must be able to deliberate in depth, innovate in fighting methods, and work hard to find various COAs to vanquish the enemy.

3. Formulating the space operations plan

The space operations plan is the plan for organizing the units in conducting space operational activities. It is the specific embodiment of the space commander's operational resolution, and is the basic foundation for the space units' operational activities. The formulation of a thorough, detailed space operations plan plays an important role of decisive significance in ensuring the smooth fulfillment of the space operations missions. The space operations plan usually is formulated by the space operations command organ, based on the higher-level intent and on the root-level commander's resolution and instructions, combined with the actual situation of the space operations.

Formulation of the space operations plan involves two situations: in one situation, only a space war breaks out, and space operations serve as an independent operational pattern; at such time, there is a requirement to formulate a space operations general plan, sub-plans, and support plans. In the other situation, a space war breaks out in parallel with another type of war, so that space operations are not the only operational pattern; at such time, the space operations plan needing to be formulated will be a sub-plan for the joint operations plan. The content of the space operations plan usually includes the following: the situation assessment conclusions, with the key point being the enemy space operations intention; the enemy force-strength task organization and disposition, plus its activity laws; the enemy operational capability, plus its strong points and weak points; the enemy's main direction and key point objectives; the types, quantities, and deployment of the enemy's space main battle equipment; and the timing and modes which he can employ, as well as their harm to and influence on us; our space units' operational capability; the quantities, performance, and deployment of our main battle equipment; the time needed for operational preparations; the operational strength comparison with the enemy; the favorable conditions and unfavorable factors for fulfilling the operational missions; **[end of page 177]** and the influence of the space environment on the enemy and friendly sides' operational activities. In the higher-level intent, the key points are the higher level's strategic intention, the guiding concept and principles relating to all space operations, the operational goals which must be achieved, and the assisting support strengths and resources which can be provided. In the root-level missions, the key points are the task organization, deployment, and mission differentiation for all space units; the operational phase partitioning and the situation expectations, plus the handling COAs for these situations; the main operational direction and the key point objectives; the space operations assisting support missions which can be undertaken by other operational strengths; the times, areas (zones), and modes for operational coordination; the organizing of and support measures for command of space operations; the time limit for completing the space operations preparations; and the time(s) for launching the space operations. When the space operations plan serves as a sub-plan, the complementation between the space operational activities and the other operational activities also should be included.

The space operations plan involves the success or failure of the space operations. Hence, formulation of the space operations plan should include a grasp of 3 problems: first is reinforcing the directed [focused] quality. This means a need to focus on the goals and missions of the space operations, so that the operations plan to the maximum extent adheres closely to operational reality. This not only requires understanding the higher-level intent in an all-around and systematic manner, and achieving an all-around understanding of the operations' overall situation goal, operational guidance, task organization of strength, and activities methods, but also requires carrying out an objective analysis and accurate assessment of the enemy's situation, such as his intention, force-strength task organization, and operational capability. On the basis of knowing oneself and knowing the enemy, [the space operations command organ will] analyze the advantageous and disadvantageous conditions for space operations, and in particular focus on the enemy's vital site targets, vital site systems, and vital site nodes, and formulate a space operations plan to produce precision, fierce, relentless strike effects against the enemy, in order to trick and subdue the enemy. Second is properly combining precision with leaving adequate leeway. Space operations are long in range, with strict requirements on precision. Hence, when formulating the plan, the precise time for completing the preparations, the precise time for launching [spacecraft], the precision time for rendezvous, the precise time for orbital [entry], and the precise time for attack all must be calculated with unusual accuracy. Otherwise, even a tiny error could lead to a large discrepancy. At the same time, in terms of the quantity of units employed, the linkup of all activities, and the preparations for support materiel and munitions, [command organ personnel] must leave adequate leeway to guard against a change in one factor causing other activity to fall into a disordered and passive situation. Third is paying attention to the interface with other operations plans. No matter whether in formulating an independent space operations plan, or in formulating a space operations sub-plan within joint operations, [command organ personnel] always must take care with the interfaces among the general plan, the sub-plan, and the various support plans. The key points are on clarifying for all operations plans the main mission, the force-strength composition, the operational disposition, the main activities, the command coordination, and the comprehensive support; conducting careful inspections in regard to times, spaces, and resource allocation, as well as mission arrangements; seeing whether there are points of contradiction such as inconsistency in missions, overlap in the arrangements, and unconnected activities; and correcting those points of contradiction, to guard against the occurrence of undue errors. **[end of page 178]**

4. Organizing the space operational preparations

Space operational preparations signify the preparations carried out for the space operations units in regard to their personnel, thought, materiel, organizing, and activities, in order for them to carry out the space operational missions. In space operations, the time is short and the tempo is rapid, and the level of quality in the pre-combat preparations will have a direct bearing on the success or failure of the space operations and even of all operations. Hence, preparations for space operations must be firmly and closely grasped.

The main content of the preparations for space operations includes the following: drawing in personnel and launching the pre-combat mobilization; determining the task organization and organizational grouping for command of, operations by, and support for the space operational forces, and rationally arranging the backbone strengths; readjusting the current operational disposition to form a favorable momentum disposition for the space operational forces; maintaining and rush repairing the existing equipment and information systems, including replenishing the ground space operations equipment, instrument equipment, munitions, and related materiel, and adjusting-coordinating the relevant departments in resolving problems present in the space operational preparations; focusing on the possible enemy situation, friendly situation, and battlefield conditions when launching the tactical and technical preparations for space operations; focusing on unknown areas (zones) and the main enemy situation to carry out emergency launch of reconnaissance satellites and relevant space operations platforms, for reconnaissance, early warning, and surveillance of the enemy space operations activity situation; when time permits, organizing operational simulation and emulation, to test the feasibility of the space operations plans and COAs; organizing the space operational forces' imminent battle training, so that the units become intimately familiar with the related plans and COAs; organizing the maneuver and unfolding of the space operational forces; focusing on the enemy situation when organizing space testing and carrying out space deterrence; and inspecting the space operation preparations situation in all units.

Space operational preparations are directly organized and conducted by the chief of staff-led space operations command department, based on the commander's instructions and according to the space operational resolution and the space operations plan. During the organizing, [command department personnel] should take care to grasp the following several points: first is the need for high standards and strict requirements. Space operations have characteristics such as rapid attack speed, a long operating range, and platforms far from the support bases. Unlike the situations on the land battlefield, sea battlefield, and air battlefield, once the platforms leave the ground and enter deep space, they cannot be replenished or repaired within a short time. Sometimes, problems arising in the components and parts of a certain platform also can cause space disasters. Hence, when organizing space operational preparations, [command department personnel] always must be hard and strict with the requirements, reinforce inspections and supervision-promotion, and see that all preparatory work is solidly and carefully performed. Second is the need to reinforce tactical and technical studies. Tactics and technology are the magic weapons for vanquishing the enemy. In terms of the opposing sides, besides the current large-scale application of space reconnaissance and early warning surveillance, all other operational means in space have not yet undergone real-combat testing. In order to gain superiority in space operations, [command department personnel] not only must rely on advanced weapons and equipment, but also must rely on brilliant fighting methods for space attack and space defense. The side which conducts in-depth tactical and technical studies is bound to summarize, conclude, and innovate a great many fighting methods, and within future space operations also will certainly **[end of page 179]** hold the initiative. Therefore, while conducting R&D of new space operations platforms and weapons and equipment, [command department personnel] certainly must set out from the technical standpoint, reinforce studies of fighting methods in space operations, and constantly find tricky moves to send the enemy to his doom. At the same time, focusing on the changing situations which can arise during real combat, they must study and formulate responsive measures to ensure the smooth conduct of space operations. Third is the need to rigorously organize protection. Since space operations have the characteristics of global reach and global deep strike, the result is that any space infrastructure situated in the strategic depth always will be revealed under those threats. At the same time, various types of space platforms, due to the peacetime constraints of international space laws, basically stay in an undefended status. To this end, in peacetime [command department personnel] must earnestly reinforce operations-research-based planning for space defense, and make preparations early. Prior to combat, then, they should adopt measures such as emergency launch of backup satellites, initial use of backup frequencies, and transportation of urgently needed materiel toward space stations, to further reinforce the preparations for space operations.

5. Organizing space operational coordination

Space operational coordination signifies the mutual assistance and mutual complementation of all operational strengths in space operations, and thus the consistent adjusting-coordination of space operational activities, to form an organic integrated whole. The organizing of space operational coordination is an important component of space operations command activity. Its goal is to achieve complementation of superiorities among all operational strengths, mutual linkup of the operational times, and mutual exploitation of operational effects, and thus bring into play the integrated whole might of our space operations, to create good conditions for seizing space dominance and smoothly launching the other operational activities.

The main content of space operational coordination includes the following: the overall mission and general objectives of the space operations; the partitioning of all phases and all time segments of the space operations; the missions of all units participating in the space operations; the objectives, areas (zones), times, methods, and avenues for carrying out the missions; the items for coordination among all internal space forces; the items for coordination between the space operational forces and the land, sea, and air operational strengths, as well as the conventional missile operational strengths; the items of coordination between the space operational forces and the civilian space forces; the recovery measures when space operational coordination is sabotaged or misadjusted; and the requirements and related specifications for coordination.

The organizing of space operational coordination is under the leadership of the space operations commander, with the coordination specifically organized and implemented by the chief of staff-led space operations command department, according to the joint operations plan and the space operations plan. When the circumstances are grave or during organizing of major space operational coordination, this coordination will be personally organized by the commander. While organizing space operational coordination, [command department personnel] should take care to grasp the following several points: first is the need to formulate a space operational coordination plan or issue space operational coordination instructions. In future space operations, the participating strengths could be concentrated, or could be administratively subordinate to different services and arms, and have a decentralized disposition; but during space operations, the activities **[end of page 180]** will be very brief, making for difficulty in command coordination. All levels of space operations command departments should, according to the joint operations plan and the commander's intent, timely formulate a space operational coordination plan or issue space operational coordination instructions, so as to provide a basis for the subordinate units to organize coordinated actions in space operations, so that these subordinate units according to a unified plan and unified required activities will form integrated-whole composite strength. Second is the need to lay stress on the key points of space operational coordination. Space operational coordination must clearly distinguish primary from secondary. This mainly includes the following: during internal coordination of the space operational forces, [command department personnel] should center on launching coordination for the units executing the main mission; when carrying out space operational missions, the coordination between the space operational forces and the other services' strengths should center on the unfolding of the space operational forces' activities, and the coordination between the space operational forces and the civilian strengths should center on the unfolding of the space operational forces' activities; and when carrying out space assisting support to operational missions on other battlefields, the space operational forces should center on launching coordination with the activities of the other services and arms. In this way, space operations then can form an organic integrated whole. Third is a need to organize operational coordination in an uninterrupted manner. Future space operations can accompany IO, be conducted before other operational activities, and penetrate the entire course of war. The opposing sides inevitably will carry out sharp contention centering on space dominance, so occasional interruptions of space operational coordination can hardly be avoided; but if coordination is interrupted and not timely restored, and [the situation] left to develop, then the aftermath will be too dreadful to imagine. To this end, prior to combat, the space operations command department must study all methods of space operational coordination, and formulate recovery methods and measures when the various types of coordination encounter sabotage. When the situation permits, it also must organize testing and training, so that the units become thoroughly familiar with the methods and skilled in the procedures. During combat, it [must] focus on situations of interruption in space operational coordination, draw upon peacetime studies to formulate the coordination recovery measures, and immediately adopt the corresponding countermeasures, to ensure an uninterrupted flow of space operational coordination.

6. Controlling and adjusting-coordinating the space operational activities

The control and adjusting-coordination of space operational activities signifies a series of activities — issuing of instructions, tracking of feedback, posture analysis, and error correction and adjustment control — conducted for the participating units by the space operations commander and his command organ, according to the space operational resolution and space operations plan. The control and adjusting-coordination of space operational activities is the core of space operations command activity. Its goal is to see that the activities of the units participating in space operations are conducted and consistently adjusted-coordinated according to the fixed plan, thus to the maximum extent bringing into play integrated-whole operational effectiveness. Control and adjusting-coordination of the space operational activities has maximally important roles in seizing space dominance and in providing assisting support and screening for other operational activities.

The main content in control and adjusting-coordination of space operational activities includes the following: in a timely and accurate way, grasping the enemy and friendly space operational postures, the enemy space operations' main posture and its influence on our space operational activities, and the main activities and main fighting methods of our space operations, plus their operational effects; according to the space operations plan, **[end of page 181]** supervising-promoting the activities of all forces; according to the space operational coordination plan (instructions), adjusting-coordinating the activities for complementation between the main direction and secondary direction, among the space operational forces and between the space operational forces and other assisting support and safeguarding support strengths, between the space operational forces executing the current missions and those executing follow-up missions, and between the space operational forces executing special missions and those executing general missions; and based on the development of space operations or on the situation when space operations encounter a major setback, readjusting the space operational forces' disposition and resources deployment, adjusting the space operational missions, establishing new space operational centers of gravity [COGs] and critical links, adjusting the coordination relationships among the space operational forces and between them and other operational strengths, and adjusting the space operations command relationships and command modes.

The control and adjusting-coordination of space operations is specifically organized and implemented by the space operations commander and his space operations department, according to the space operational resolution and the space operations plan. In the control and adjusting-coordination of space operations, they must take care to grasp the following several points: first is the need to carry out the control and adjusting-coordination by centering on the space operational resolution and the space operations plan (instructions). The space operational resolution and space operations plan (instructions) are the foundation and basis for the space operational activities. When conducting the space operations, they certainly must implement C2 of the activities according to the space operational resolution and operations plan (instructions). When the enemy and friendly situations and the battlefield situation have not undergone big changes, they must not be disturbed by some unimportant small details or small changes, but should supervise-promote the units in continuing to conduct their activities according to the original plan. When the enemy and friendly situations and the battlefield situation have undergone fairly big changes and the units cannot fulfill their missions according to the original plan, they must adjust the unit activities under conditions of upholding the space operations general intent unchanged and based on the changing situation. Second is the need to flexibly carry out the control and adjusting-coordination. "Just as water retains no constant shape, so in warfare there are no constant conditions."[14] Operations are always in a process of constant change, and situations where space operational activities C2 is implemented completely according to the space operational resolution and the space operations plan (instructions) almost do not exist. Hence, when the space operations commander and his command organ are in command of space operations and find that the situation has somewhat changed, they must not copy [methods] mechanically and apply them indiscriminately, but must — based on contingency preliminary COAs and COAs formulated in advance, combined with the new changes and new situation — flexibly adopt new command modes and new fighting methods, and implement new control and adjusting-coordination of the space operational activities, so that the space operational activities from start to finish are adapted to the needs and requirements of the new circumstances. Third is the need to scientifically carry out the control and adjusting-coordination. The space operational activities times are brief, and their technical quality and professional quality are strong; space operations C2 must be very particular about the scientific quality. On one hand, [the commander and his command organ] must fully apply the new command means, and in particular the command information system, to carry out aided decision-making; timely readjust the force-strength, disposition, and fighting methods of the space operations; and rapidly disseminate the space operational instructions and related information, so as to boost the rationalness and timeliness of C2. On the other hand, they must focus on the performance of the enemy's space operations weapons and equipment and their application characteristics, from the technical standpoint select appropriate **[end of page 182]** confrontational modes and methods, and constantly innovate the confrontational modes and methods, so as to boost the directed [focused] quality and effectiveness of the space operations.

7. Organizing comprehensive support for space operations

Comprehensive support for space operations is the general term for all ensuring measures adopted by, and corresponding activity conducted by, the units to carry out their space operational missions. According to the differences in mission, it is divided into operational support, logistics support, equipment technical support, and political work

---

[14] Translator's note: this is a quote from Ch. VI ("Weak Points and Strong") of *Sunzi: The Art of War*.

support for space operations; and according to the differences in level, it is divided into space strategic operational support and space campaign operational support. The organizing of comprehensive support for space operations is an important component of space operations command activity. Well provided comprehensive support for space operations similarly has extremely important significance for seizing space dominance and for assisting support and screening of other operational activities.

The content of comprehensive support for space operations includes the following: operational support, mainly consisting of space reconnaissance, space early warning, space communication, navigation positioning, camouflage and protection, meteorological, engineering, and geodetic support; logistics support, mainly consisting of materiel, transport, medical, and information support; and equipment support, mainly consisting of weapons and equipment, technical equipment, and base duty support.

The organizing of comprehensive support for space operations is jointly handled and implemented by command HQ, the logistics (joint logistics) department, the equipment department, and related departments, based on the commander's instructions and the space operational resolution, and according to the space operational support plan (instructions). When organizing comprehensive support for space operations, [these departments] should take care to grasp the following several points: first is the need to lay stress on the key points of comprehensive support for space operations. Space operational support has many classes and complex content, so when organizing support they should never evenly divide the force-strengths and resources, but must lay stress on the key points. This means laying stress on the main mission, main direction, main phase, and main activities of the space operations, to achieve the maximum support benefit. For example, during space offensive operations, they must place the key points on anti-satellite [ASAT] operations and on operations to attack space ground targets within the enemy depth; or during space assisting support to other operations, they must place the key points on properly providing space reconnaissance, space early warning, space communication, and navigation positioning support. Second is the need to reinforce the organizing and adjusting-coordination of comprehensive support for space operations. The units, personnel, and equipment participating in space operational support are numerous, and the organizing of the command procedures, content, and methods is very complex. To this end, the relevant departments involved in space operational support must strengthen the consciousness of initiative-based support and active adjusting-coordination, and reinforce the unified operations-research-based planning {*tongchou guihua*} and organizing and adjusting-coordination. This means centering on the space operational resolution and the comprehensive support plan (instructions) for space operations; leveraging success in space operations for success in comprehensive support for space operations; correctly handling the support relationships between the main mission and the secondary mission, between the main direction and the secondary direction, between the main phase and the secondary phases, and between the main activities and the secondary activities, as well as between the current missions and later missions; **[end of page 183]** and ensuring the adjusted-coordinated development in all respects of comprehensive support for space operations. Third is the need to innovate the modes and methods of comprehensive support for space operations. Space operations are a new type of operations, and not only are there few nations with experience in providing such support, the support installations are universally not fully complemented. Hence, in peacetime [the relevant departments] must earnestly study the modes and methods of comprehensive support for space operations; and in wartime, based on the actual situation of the space operations, they must break with the conventional and innovate several new support modes and methods, to gain the initiative in comprehensive support for space operations.

Questions for Deliberation…184

1. Which are the main characteristics of command of space operations?

2. Which are the basic principles of command of space operations?

3. How is the space operations command SoS composed?

4. How are the space operations command institutions task organized and organizationally grouped?

5. Which are the main contents of space operations command activity? **[end of page 184; end of lecture]**

Lecture 7
The Practical Applications and Developmental Trends of Space Operations...185

In the more than half a century from the birth of the various kinds of spacecraft, primarily satellites, until today, although the various kinds of military spacecraft spread all over outer space have yet to fight one another face to face, their support and assistance have reached a point where these are pervasive and ubiquitous on the land, sea, air, and electromagnetic battlefields; they greatly affect the course and outcome of warfare, and their status and role are increasing daily. In today's age, competition among space military strengths has developed and led to a new service – the birth of "space forces." Information support operations and anti-missile operations that are based on space already exist and have increasingly presented certain characteristics of future space operations. However, in the final analysis, no large-scale actual war has yet to occur in outer space, similar to those on land, at sea, or in the air. In other words, a new form of operations – "space wars" – has yet to appear side by side with land wars, naval wars, and air wars. Therefore, this lecture does not refer to some actions in which military spaceflight (or confrontations) has been used, which have occurred in history, and which have the characteristics of space operations, as "examples of space operations;" this differs from the fairly universal appellations in current academic circles, such as *The Science of Military Spaceflight*,[15] and we hope the reader will draw this distinction. Based on this, this lecture is entitled "The Practical Applications and Developmental Trends of Space Operations," and it aims at investigating the process by which space operations have occurred and developed, at helping to deepen an understanding of the importance of space operations, and at promoting the in-depth study of space operations theory.

Section 1: The Practical Applications of Space Operations...185

Based on the development of space weapons and equipment and their use in modern local wars, it is possible to divide the practical applications of space operations into three periods: the initial period of practical applications of space operations (the 1950s to the late 1980s), the middle period of practical applications of space operations (the early 1990s to the late 1990s), and the recent period of practical applications of space operations (the late 1990s through today).

[15] Refer to Chang Xianqi et al., *The Science of Military Spaceflight*, National Defense Industries Press, 2005.

I. The initial period of practical applications of space operations...186

After the Second World War, at the same time that the two superpowers, the United States and the Soviet Union, engaged in large-scale research and development and deployment of strategic nuclear weapons, they also intensified their research and development of military and military-civilian spacecraft, in order to contain and defeat their opponent; they launched an intense arms race in space, and as a result of this, the use of space operations that were characterized by space information assistance and support took the stage.

1. The use of space operations in the Berlin Crisis

The Berlin Crisis fell under the category of issues left over from the Second World War, and historically there were two of them. The first occurred at the end of the 1940s. With the thorough defeat of fascist Germany in the Second World War, Berlin was divided into East Berlin, which was occupied by the Soviet Union, and West Berlin, which was occupied by the United States, the United Kingdom, and France. West Berlin lay in the heart of an area occupied by the Soviet military, and had its own independent government and the Western allies' garrison units; the West viewed it as "the last 'bastion of democracy' existing in Communism under the Iron Curtain." The Soviet Union believed that Western forces' existence in West Berlin was dangerous and intolerable, and it needed to remove this nail from its eye, this thorn from its flesh. Therefore, East-West relations were extremely tense at that time, and both sides threatened each other with nuclear weapons, thus for a time forming a situation where daggers were drawn. The second crisis lasted for four years, from 1958 to 1963; looking at its causes, it was considered to be a historical continuation of the first crisis. Soviet leader [Nikita] Khrushchev demanded that the United States, the United Kingdom, and France end their occupation of West Berlin and that Berlin be made a free city; the Western countries refused to yield. Khrushchev made use of a "missile gap" at that time, which was rumored about in the United States, and sent a final ultimatum to the United States and its allies, announcing that in an emergency situation he would not hesitate to mobilize intercontinental missiles to launch a nuclear weapon with a hydrogen warhead; this was an attempt to force the United States to yield, and for a time it left the United States confused. During that time, the Soviet Union successfully launched the first artificial satellite, Sputnik 1, on 4 October 1957. The United States on 28 February 1959 launched the first military spy satellite, Discoverer 1; although [the launch] was not successful, in the following year or so, [the United States] successively launched twelve Discoverer spy satellites, and it ultimately on 10 August 1960 successfully launched the thirteenth spy satellite, Discoverer 13, and the next day successfully retrieved a film canister, marking the start of mankind's use of outer space to engage in military activities.

In 1961, the National Security Advisor to then-President Kennedy of the United States, based on the intelligence that had been collected, deduced that Khrushchev was only bluffing. In order to test the accuracy of this deduction, the United States on 7 July launched a Samos-2 photoreconnaissance satellite to carry out detailed reconnaissance photography of the Soviet Union's missile test site. Through analysis of the photography, [the United States] discovered that the Soviet Union's SS-7 and SS-8 intercontinental missiles were still in a test phase and did not have actual combat capabilities. At the same time, it also ascertained that the Soviet Union's intercontinental missiles did not number 400, as rumored, but only fourteen, similar to the United States; this entirely cleared up the so-called "missile gap." In October of that year, President Kennedy met with the Soviet Union's foreign minister and let him see the satellite photographs, debunking on the spot Khrushchev's bluff as well as the bottom line of the blackmail that he was carrying out. Faced with the United States' satellite photographs, Khrushchev had no choice but to soften his attitude, and he was forced to withdraw his "ultimatum" with its flavor of nuclear warfare. The second Berlin Crisis ultimately was "peacefully" resolved because of fairly major concessions by the Soviet Union.

The Berlin Crisis was a serious military crisis that erupted between the two camps of West and East, headed respectively by the United States and the Soviet Union. The defusing of the crisis benefited from the cutting edge of space military strengths in their first test, fully showing the enormous potential military power that space bore and its important status and role in warfare and crises.

2. The use of space operations in the Cuban Missile Crisis

The "Cuban Missile Crisis" was a bitter pill brought about by US hegemonism and the US-Soviet struggle to dominate the world. Cuba historically was a Spanish colony. After the 1898 Spanish-American War, the United States occupied Cuba. In 1901, the United States forced a Cuban constitutional convention to include an "amendment" proposed by US congressmen to the Cuban constitution, stipulating that the United States had the "right" to send troops to interfere in Cuban internal affairs. The Cuban Republic was established on 20 May 1902. In 1903, the United States forcibly leased two Cuban naval bases; of these, Guantanamo Base is still used by the United States. Subsequently, the United States sent troops to occupy Cuba, in 1906, 1912, and 1917, thereby interfering in Cuba's internal affairs. President [Fulgencio] Bautista relied upon US support to take office. Internally, he banned various political parties and democratic groups, brutally killed patriotic persons and progressive people, and carried out policies of white terror; externally, he obeyed the United States, followed its advice, and sold his country for glory. Under the leadership of Fidel Castro, who had been born in poverty, the Cuban people overthrew the Bautista dictatorship, which was supported by the United States, by means of an arduous revolution, and established a new revolutionary regime. Subsequently, Castro made his first visit to the United States and took the initiative to express [a desire] to improve relations between the two countries. However, the United States looked down on Castro and demanded that Cuba continue to be the United States' sugar cane colony. Castro defended Cuba's sovereignty without turning back, and this infuriated the United States even more. The youthful and arrogant Kennedy heard the news, and in an endless rage, he announced in 1960 that the United States would stop importing sugar from Cuba.

The United States' hegemonic behavior angered the Cuban people. The reason was that the sugar refining industry had always been Cuba's economic lifeline; sugar was the main source of income for the Cuban people, and they relied upon sugar to exchange for food and other goods. This prohibition by the United States was equivalent to cutting off Cuba's economic lifeline. In order to break through the United States' embargo and blockade, all that Castro could do was seek help from the Soviet Union. And the Soviet Union, out of its need to struggle for hegemony with the United States, was thinking about finding a foothold in the Americas. Cuba's request for aid was something that Khrushchev much desired. He immediately announced that the Soviet Union was willing to extend a hand in aid and to buy Cuba's sugar, and he promised to supply Cuba with industrial equipment, so that Cuba would obtain foreign exchange and other benefits. The Soviet Union's assistance to Castro alleviated Cuba's urgent needs, but it further infuriated the United States. Therefore, the United states trained 2,000 Cuban mercenaries, and these landed early in the morning of 17 April 1961 at Cuba's Giron Beach (or Bay of Pigs), in an attempt to use military force to overthrow the Cuban revolutionary regime. At this instance of life or death, Castro ordered the Cuban military and people to fight for seventy-two hours, and they completely destroyed the Cuban Brigade of US mercenary troops, composed of Cuban exiles, thus thoroughly pulverizing the United States' plan to overthrow Cuba. When one trick fails, try another; the United States decided to send a special agent to assassinate Castro, while at the same time intensifying its embargo and blockade against Cuba.

In order to resist the United States' military threat, Cuba urgently needed Soviet weapons and equipment, and Castro had no choice but to again seek help from the Soviet Union. Khrushchev took advantage of this opportunity to use Cuba as a chip for contending with the United States. On 2 July 1962, Cuba and the Soviet Union reached an agreement: the Soviet Union would secretly place nuclear missiles in Cuba. The frequency of contacts between Cuba and the Soviet Union as they engaged in military trade was discovered very quickly by the United States. In July 1962, the United States used reconnaissance satellites to promptly find that the Soviet Union had already delivered forty-two ballistic missiles to Cuba, and was engaged in constructing more than ten launch sites; the United

States was shocked. In the afternoon of 4 September 1962, Kennedy issued a warning: the United States would definitely not tolerate having offensive weapons enter the borders of Cuba. Afterwards, he again issued a solemn statement and took tit-for-tat measures to carry out a sea blockade and to quickly assembly the military in Florida and the Caribbean Sea, using 200 ships to form an interdiction line. This set off the Cuban Missile Crisis, which shocked the world. Faced with the United States' intense reaction, the Soviet Union launched two satellites, on 17 and 20 October 1962, in order to investigate what was actually going on; it was only after [Khrushchev] confirmed that the United States was completely prepared that he was forced on 29 October to order the withdrawal of his missiles.

It can be seen from the Cuban Missile Crisis, which lasted thirteen days and was on the brink of nuclear war, that the background to this crisis was still very closely tied to the US-Soviet competition in outer space. As for the Americans, it was precisely through reconnaissance satellites and reconnaissance aircraft that they discovered that the Soviet Union was secretly transporting missiles to Cuba, and it was also only through their reconnaissance satellites and reconnaissance aircraft, that that they knew the details of the Soviet Union's strategic missiles, strategic bombers, and missile bases like the palm of their hand, that they boldly chose the tough measures of an armed blockade. As for the Soviets, it also was only through ascertaining by their reconnaissance satellites the actual military deployments of the United States that they ultimately helplessly withdrew their missiles from Cuba, under the conditions that the United States promised not to use armed force to invade Cuba. Imagine, if there had not been reconnaissance satellite photographs at that time to serve as evidence, the Soviets possibly would not have honestly bowed their heads and obeyed the Americans orders, and a fearful nuclear war possibly would have come.

3. The use of space operations in the Indo-Pakistani War and the Middle East Wars

The South Asian subcontinent holds an important strategic location, and the Middle East region is known as a "powder keg;" they have always been focal points of interest for strategists. The United States and the Soviet Union, for the sake of their own interests in these regions, pulled out all the stops to ascertain and get a grip through various channels on military intelligence about these areas of conflicts between India and Pakistan, the Arab countries and Israel, and Israel and the Palestinians; most of this intelligence was obtained through reconnaissance satellites moving in outer space.

In the December 1971 India-Pakistan War, the Soviet Union continuously launched reconnaissance satellites to engage in "spy" activities, monitoring the military actions of US warships and the Pakistani air force. On 6 December, the Soviet Union launched the

Cosmos-463 satellite from its Tyuratam Base in order to carry out reconnaissance photography against Pakistan; on 10 and 16 December, the Soviet Union again launched two satellites, Cosmos-464 and Cosmos-466, respectively, from its Plesetsk base. Their goals were to spy on the military intelligence of both sides in the Indo-Pakistani War.

In October 1973, the Arab countries and Israel launched the Fourth Middle East War. During the war, the United States and the Soviet Union, each proceeding from its own strategic interests, launched nineteen and fifteen reconnaissance satellites, one after the other, in the direction of the theater of war, in order to carry out closer reconnaissance about the situations of the two sides in the war. Egypt and Syria made use of the intelligence regarding Israel that the Soviet reconnaissance satellites obtained, and adopted more than 200 measures to deceive US satellites, in order to launch an attack against Israel at lightning speed. And at the crucial moment, the United States provided Israel in a timely manner with battlefield intelligence that its Big Bird photoreconnaissance satellite had obtained, so that Israel turned defeat into victory and reversed at a single blow the position where it was on the defensive. This was the first time that military reconnaissance satellites were used in actual combat, and it set a precedent for strategic information assistance and support from outer space, thus raising the curtain on space operations.

On 16 June 1982, the Israeli military entered Lebanon. The Soviet Union's Cosmos-1370 satellite was adjusted two days later to a position where it could observe this gradually escalating war. Based on a similar goal, the Soviet Union's Cosmos-1377 satellite also flew through the space above the Middle East region from 12 to 16 June, and it transmitted the intelligence that it obtained to Syria and other countries, which had no way to conduct aerial and space reconnaissance, so that they could resist Israel.

On 1 November 1982, Iraq launched a new attack against Iran. Soviet spy satellites were quickly turned toward the space above this region. When Cosmos-1419 flew past the battlefield on 5 November, it slowed down, and for the next two days continued to reconnoiter. Cosmos-1421 also continually paid attention to every move and every action in the Persian Gulf, providing intelligence about the combatant countries.

4. The use of space operations in the British-Argentine Falkland Islands War

On 4 March 1982, the Falkland Islands War, which caught the world's attention, broke out between the United Kingdom and Argentina; the start of the war originated in Argentina's desire to take back the Falkland Islands from the hands of the British. The British, on the other hand, wanted to recover these islands, which had just been occupied by Argentina. In the background of this war, the United States and the Soviet Union staged an intense space intelligence battle. US relations with the United Kingdom were close, and intelligence from satellite reconnaissance naturally was provided to the United Kingdom. And when the United States sanctioned exports of cereals to the Soviet Union, Argentina sold cereals to the Soviet Union, so that it could be seen that the Soviet-Argentine relationship was not an ordinary one; in order to thank Argentina for its timely assistance, the Soviet Union used intelligence from satellite reconnaissance as a repayment.

After the Falkland Islands War broke out, the Soviet Union launched thirteen spy satellites, one after the other; eight of these were radar satellites and five were communications satellites. [The Soviets] primarily used the Cosmos-1347 satellite to carry out reconnaissance and to obtain military intelligence about the British forces. From the departure of the British task force from Portsmouth Harbor straight through to its arrival at the Falkland Islands, Soviet satellites continually closely tracked and monitored it. Afterwards, the Soviet Union also launched military satellites; among them, Cosmos-1352 was especially for use in the Falkland Islands War.

At the same time that it supplied the Argentine military with intelligence, the Soviets also did not forget their own country's interests. On 2 April 1982, the British forces were about to land on the Falkland Islands; that day, the Soviet Union launched the Cosmos-1347 satellite, in order to reconnoiter how the war was progressing. This satellite was a high-resolution reconnaissance satellite, and it twice flew past the area where the British task force was stationed – Portsmouth Harbor. After two days, when the main forces of the task force had already completed their preparations for war, and when they were going to put to sea the next morning, this satellite again flew over Portsmouth Harbor, with the goal of wanting to clarify whether or not, as many people at that time had guessed, there was a nuclear submarine in the fleet, and in order to make it easy to provide a military service to the Soviet military and the Warsaw Pact countries. In regard to this, the United States was unwilling to show weakness. At this time, the United States used twenty-four maritime surveillance satellites to provide intelligence support to the United Kingdom and to assist the United Kingdom in sinking Argentina's cruiser *General Belgrado*. The Soviet Union used thirty-seven reconnaissance satellites to provide information support for Argentina; the Argentine air force utilized intelligence information provided by Soviet reconnaissance satellites to use an Exocet missile to unexpectedly sink a fairly advanced British missile cruiser [sic], the *Sheffield*. The Falkland Islands War ultimately came to an end, with Argentina losing because of a great disparity in actual military strengths, but the US-Soviet space battle still continued.

II. The practical applications of space operations in the middle period...191

The several local wars since 1991 have exhibited a great many characteristics that differ from previous wars, so that the shape of war is silently undergoing fundamental and comprehensive changes. Of these, the change that has most caught people's attention is that military applications in the space sphere have already developed to a brand-new stage; space strengths have begun to comprehensively get involved in local wars, forming a new form of operations.

1. Applications of space operations in the Gulf War

The 1991 Gulf War was a classic example of high-tech local warfare, as well as a landmark example where space operations were used to initially form combat strengths. The multinational force headed by the United States, in order to gain victory in the war, made use of space strengths that had become rudimentarily mature in order to provide support-style operations throughout the entire course [of the war], using more than seventy satellites, 118 mobile satellite ground stations, twelve commercial satellite terminals, eighty-one satellite information switches, 329 telephone circuits, thirty message circuits, 30,000 radio frequencies, and 40,000 computers to establish a huge space information collection, transmission, processing, and distribution system. For the first time, it showed the world the powerful information support capability of space strengths, and it had an enormous impact on the course of the war and made important contributions to victory in the Gulf War. After the war, when the US military summarized its experience in the Gulf War, it believed that speaking in a certain sense, the Gulf War was "the first space war" in human history, and that "the Gulf War proved that space weapons systems have become an indispensable part of the system of modern operations, regardless of whether this is in strategic actions or in tactical actions." The various kinds of military satellites (see Table 7-1) that the United States used in the Gulf War provided information support for operations at all times and spaces, in all time domains, and in all directions, in a highly efficient manner. The four great systems that they formed, for space reconnaissance and surveillance, space communications support, space navigation and positioning, and space weather support, provided high-quality, urgently needed, and reliable information for operations; this was used on a large scale by the multinational force in the war, and it vigorously supported joint operations on the ground.

Table 7-1: Statistics for the Various Types of Military Satellites Used by the US Military in the Gulf War

Type of Satellite	Name	Number (of satellites)
Imaging Reconnaissance Satellite	Advanced Keyhole KH-11	4
	Keyhole KH-11	2
	Lacrosse	1
Navigation and Early Warning Satellite	DSP	2
Electronic Reconnaissance Satellite	Vortex	2
	Magnum	1
	Jumpseat	1
Ocean Surveillance Satellite	White Cloud	12 (4 clusters)
Communications Satellite	Defense Satellite Communications System (DSCS-2)	2
	Defense Satellite Communications System (DSCS-3)	4
	Fleet Satellite Communications System (Fltsatcom-5)	3
	Leasat-3	1
	Syncom	4
	Satellite data systems	14
Weather Satellite	Block 5D-3	3
	NOAA	Multiple satellites
Navigation and Positioning Satellite	GPS-2A	18
Geodetic Satellite	Landsat-4	2
	Landsat-5	2

In the war, in order to ensure communications needs, the United States felt that the two DSCS communications satellite strengths above the Indian Ocean were too insubstantial, so it also especially moved one of the DSCS satellites in the Defense Satellite Communications System above the Pacific Ocean to the Indian Ocean, in order to take over the task of communications for the US military in the Gulf region. It also had three Fleet Communications satellites and one Leasat-3 assume the task of naval communications. And the British military used the Skynet-4 satellite, and the French military used Syracuse military communications circuits on the Telecommunications-1A and the Telecommunications-1C. Satellite communications made up eighty-five percent of the total amount of internal and external communications in the theater of war.

In order to provide operational units with precise navigation and positioning information, the United States deployed eighteen GPS-2A global navigation and positioning system satellites in outer space. The ground operations units, aircraft, ships, and special operations units of the multinational force had approximately 5,500 military positioning and navigation receivers as well as 10,000 civilian receivers; these could receive highly precise three-dimensional navigation and positioning signals for more than twenty hours every day. GPS receivers were installed on precision-guided weapons, and these were effective in enhancing the accuracy of the weapons' strikes and their attack capabilities. Assisted by these accurate navigation and positioning signals, F-16 [Fighting Falcon] fighters, B-52 [Stratofortress] bombers, and RC-135 reconnaissance aircraft could carry out their military missions accurately and without error in all weathers; tank formations could carry out precision movements in the desert zones that had no landform characteristics; minesweeping units could safely pass through minefields and accurately determine the locations of mines in order to make it easy to destroy these; and supply transportation vehicles could find combat personnel in the desert and provide them with supplies. In naval operations and in supporting busy ocean shipping, GPS enabled naval ships and the large number of commercial vessels carrying supplies to get accurate navigation and positioning.

The multinational force used imagery reconnaissance satellites to carry out all-weather reconnaissance against important targets like Iraq's command centers, airfields, Scud missile launchers, air defense missile batteries, and communications nodes, and they used "land" satellites and two French SPOT satellites to do general surveys with rather low resolution over broad areas; the information that was obtained played an important role in large-scale air raids and ground operations. Imagery reconnaissance also had the task of evaluating and appraising the results of bombing and destruction against targets, and they provided a basis for determining the time when ground units would launch assaults.

The multinational force used electronic reconnaissance satellites and other land, sea, and air reconnaissance platforms together to create a three-dimensional reconnaissance intelligence system to closely reconnoiter Iraq's electromagnetic spectrum activities, to collect its signal characteristics and parameters, to ascertain the various frequency band signals, and to thus carry out support for electronic warfare operations. Electronic reconnaissance satellites listened in on the Iraqi military's most important radio communications channels, including the channels used by Iraqi President Saddam [Hussein] and senior commanders in the Republican Guard and the channels used by the

Iraqi military's military command organizations' communications network, so that the multinational force was able to stay abreast of any major military actions by the Iraqi military.

The United States used two Defense Support Program (NSP) [sic] early warning satellites to detect launch conditions for Iraqi Scud missiles and to provide four to five minutes of early warning to residents in Israel and to the units deployed in Saudi Arabia (Scud missiles' flight time was about seven minutes). At the same time, they provided crucially important early warning data for Patriot anti-missile systems to intercept [the Scuds], thus creating a precedent for ground interception weapons to carry out actual combat in missile interception.

The Gulf War made the US military become profoundly aware of the important role that space strengths have in assisting and supporting campaign and tactical actions. However, US military persons also realized that although the Gulf War could be called the "first space war," this was only a "space war for which there were no preparations." The reason was that all of the space systems that the US military used at that time had been designed for carrying out strategic missions during the Cold War and were unable to fully adapt to the military needs of local wars and regional conflicts. It was still necessary to carefully study and improve them, so that these space warfare systems would be able to better serve the high-tech local wars of then and the future.

2. The use of space operations in the Bosnian War

The Bosnian War that that broke out in 1995 was another high-tech local war following the Gulf War. The applications of military space strengths developed to an even deeper level; in particular, a major step was taken in handling the uncertainties and delays of battlefield information.

The US military established a set of mirror simulation equipment {*lingjing fangzhen shebei*} at Wei-ya-nuo Air Base[16] in Italy, using images captured by military reconnaissance satellites and civilian remote sensing satellites in order to create a three-dimensional visible model of the terrain in Bosnia-Herzegovina, so that the battlefield information that was obtained reached the level of real-time comprehensive integration and so that it was possible to extract detailed crucial information.

[16] Translator's note: Probably a typo for Aviano Air Base.

The United States also directly used broadcast satellites and communications satellites to form a new battlefield information transmission link, thus greatly improving the speed of information transmission and enhancing the effectiveness of main battle weapons and equipment in operations. So that combatant personnel would be able to receive crucial information in real-time, the US military deployed a Bosnian Command and Control Augmentation system (BC2A) at its European headquarters. This system consisted of two parts: a Joint Broadcasting Service system (JBS) and a Very Small Aperture Terminal (VSAT) network. The JBS received visible-light, infrared, or synthetic aperture radar images from Predator unmanned aerial vehicles or other reconnaissance aircraft and transmitted these through international communications satellites to a US military unmanned aerial vehicle base in Hungary, after which they were again transmitted through international communications satellites to a US military air force base in England, and were ultimately transmitted through a fiber optic cable to the Pentagon. After the Pentagon processed this information, it transmitted it via JBS to the US military commander in Bosnia. Television images taken in the air above Bosnia-Herzegovina by unmanned aerial vehicles were transmitted through the intelligence data links described above to the Pentagon in the United Sates, with a delay of about one second. The VSAT network of the BC2A system had two-way communications capabilities; it connected more than fifty headquarters in the theater of war, and every commander could receive information through the VSAT network and could also transmit information to the Pentagon. Sending a photograph to every user through the BC2A system generally took only five to ten seconds, whereas it required more than an hour during the Gulf War period. This shows that the US military had absorbed the experiences of the Gulf War and that it had done a great deal of work in the aspects of how to have space operations weapons and equipment meet the needs of high-tech local wars.

3. Applications of space operations to the Kosovo Campaign

The excellent displays of space information support in the previous several local wars caused the US military to pay more attention and to increase the intensity of its theoretical research and actual applications. During the Kosovo Campaign, which took place from 24 March to 9 June 1999, US and other NATO units jointly deployed seventy-eight satellites of various kinds in close to twenty spaceflight systems (see Table 7-2), providing NATO's multinational units with such important operations information support as comprehensive reconnaissance, surveillance, communications, early warning, navigation, positioning, and weather. Because the NATO units controlled command of space, they always held the initiative in this war.

During the entire course of the war, the United States' space systems provided information support to the NATO group, from beginning to end. In Operation Allied

Force, where NATO raided Yugoslavia by air, the United States alone mobilized more than fifty reconnaissance and other satellites, providing target information for the air raid actions and information for evaluating the effects of operations. NATO's battlefield intelligence systems were an integrated intelligence reconnaissance and surveillance system composed of sea, land, air, space, and electronic systems. In this system, the United States' space information systems played a decisive role, and they included photograph and radar reconnaissance satellites, missile early warning satellites, ocean surveillance satellites, weather satellites, global positioning satellites, and electronic reconnaissance satellites. Satellite performance reached unprecedented levels, and the resolution rate of space reconnaissance could reach 0.1 meter and could detect submarines forty meters below the surface of the water and tanks concealed below three to five meters of sand; the error of its positioning of electromagnetic radiation sources was within thirty meters. "Comprehensive missile early warning" systems satellites could provide twenty-five to thirty minutes of early warning time against land-based intercontinental ballistic missiles and fifteen minutes of early warning time against submarine-launched ballistic missiles.

Table 7-2: Statistics on the Satellites Used by the US military and its Allied

Militaries during the Kosovo Campaign

Type of Satellites	Name	Number (of satellites)
Reconnaissance Satellite	Lacrosse radar imaging satellite	2
	Advanced Keyhole KH-11 optoelectronic imaging satellite	3
	Helios-1A optical imaging satellite (France)	1
	Small-scale optoelectronic imaging reconnaissance satellite	3
	Signals intelligence satellite	Several
	Electronic reconnaissance satellite (Magnum, Vortex, Orion, Mercury, etc.)	Several
Communications Satellite	Fleet Satellite Communications System	1
	Defense Satellite Communications System (DSCS)	5
	UHF follow-on communications satellite (UFO-9)	3
	Leasat	1
	Tracking and data relay satellite	4
	Milstar communications satellite	Several
	Skynet 4A communications satellite (British)	1
	Syracuse communications satellite (France)	1
	NATO-4 communication satellite	1
Navigation Satellite	GPS global satellite navigation system	24
Meteorological Satellite	Defense Meteorological Satellite Program (DMSP)	4
	MOAA-10/12/14/15 meteorological satellite	4
	Meteosat (European)	2

In providing reconnaissance satellite information assistance and support, not only did the United States have the most reconnaissance satellites, but their quality was also best. Of them, there were two US Lacrosse radar imaging satellites costing $1 billion, three upgraded Keyhole-11 digital imaging transmission satellites costing more than $1 billion, and large numbers of meteorological and ocean monitoring satellites. These artificial satellites, especially used for information reconnaissance, were able to reconnoiter

Yugoslav radio communications and radar facilities, in order to intercept various kinds of radio signals and signal parameters and to determine the accurate locations of their radio broadcasting stations and radar stations. In particular, the US military's Lacrosse reconnaissance satellites were the only military radar imaging satellites in the world; the space resolution of their satellite-borne synthetic aperture radars reached 0.3 to 1 meter.

The electronic warfare that NATO units waged in the Kosovo Campaign went down to the bottom of the sea and up into outer space, filling up all of natural space. In outer space, the United States and the other European nations in NATO all had high-performance electronic reconnaissance satellites, which could carry out electronic offensive and defensive missions for their electronic warfare aircraft, as well as provide real-time accurate electronic intelligence for assault fleets to carry out bombing missions. Prior to the war, the United States' electronic reconnaissance satellites, in full-time domain, monitored changes in the Yugoslav electromagnetic environment, gaining large amounts of electronic warfare intelligence needed for operations against Yugoslavia. During the war, NATO electronic reconnaissance satellites with advanced performance were able to carry out reconnaissance missions night and day; in particular, the United States Lacrosse radar imaging reconnaissance satellites could carry out reconnaissance in all weathers and at all times, on average providing the allied forces with reconnaissance results of ground conditions once every 180 minutes, thus overcoming the drawback of visible light cameras where these were unable to take pictures on dark nights and cloudy days. This real-time electronic warfare intelligence support system for the NATO units, which integrated land, sea, air, and space, overcame the weak point of electronic warfare intelligence support where each link was disconnected, thus enhancing the timeliness, accuracy, and operational effectiveness of intelligence support.

III. The recent practical applications of space operations...197

After the Kosovo Campaign, people in the world more soberly realized the important position and role that space strengths would have in future wars. The various countries actively planned the development of space technology and the buildup of space strengths, closely centered on each of their strategic objectives, and space operations thereby entered a new period of rapid development.

1. The applications of space operations in the Afghanistan War

The Afghanistan counterterrorism war was the first war of the 21st century. On 5 October 2001, the United States launched a counterterrorism war [called] Operation Enduring Freedom, focused on [Osama] bin Laden and his al Qaeda organization as well as the Afghanistan Taliban armed forces that had sheltered and harbored them. During this local war, the US military again staged tricks where the world joined hands for the battle. In order to fight this asymmetric war, the United States deployed fifty military satellites, organized a space intelligence information network, and strove to confront an adversary who had no choice but to fight; it also needed to maintain its superiority in space information systems, thereby doing everything possible to support the ground units' operations. This thus resulted in the applications of space strengths again undergoing new developments. This was prominently manifested in [the following].

First, military and civilian space-based information resources were integrated into a space network. Although the Afghan forces were nowhere near as strong as those of Iraq, the US military still paid a great deal of attention to counterterrorism operations. On the one hand, just as in previous wars, it launched and adjusted the deployment of satellites before the war; on the other hand, it did all it could to requisition civilian and commercial satellites and to have them serve in common the ground units' operations. Two days before the war began, the United Sates launched an Advanced Keyhole KH-11 optical imaging reconnaissance satellite, which together with two similar satellites that had been launched earlier formed a constellation and which carried out reconnaissance that covered Afghanistan in all weathers. At the same time, these were linked with three low-resolution Lacrosse radar imaging satellites, forming a global satellite intelligence network, especially providing intelligence support services to operations in the Afghanistan theater of war. In addition, the Pentagon exclusively bought up mapping materials of the entire Afghan theater of war that Space Imaging Company's Ikonos commercial satellite had photographed, and it coordinated with the French Government through diplomatic channels to forbid that country's SPOT imaging company from selling satellite images associated with the Afghanistan theater of war with a resolution of close to ten meters that were photographed after 8 October 2001. In addition to using and controlling civilian and commercial satellites, the US Department of Defense also used the US National Aeronautics and Space Administration's Earth Observation-1 satellite to provide the US military with hyperspectral images of targets in the Afghanistan region before and after bombings in order to evaluate the battle results. The terrain image materials obtained by the Shuttle Radar Topography plan that NASA carried out in February also played a role in the Afghanistan operations, providing GPS-guided weapons with precise elevation data.

Second, having absorbed the lessons of the Gulf War and the Kosovo Campaign, it strengthened its measures for interfering with the global positioning system (GPS) and for countering interference. On 20 October 2001, a spokesman at the US Air Force's Schriever Base indicated that the US military possessed the ability to selectively jam GPS signals in certain regions, without affecting the accuracy of its own military GPS signals. As regards measures for countering GPS jamming, the US Department of Defense's

Advanced Research Projects Agency, in its research on a GPS virtual satellite program, was able to use a "simulator" installed on an unmanned aerial vehicle or on the ground to construct a virtual GPS constellation; the high-powered encrypted GPS signal that it transmitted suppressed the enemy's jammer signal.

Third, the precision-guided weapons with space-based navigation and positioning information support displayed their prowess. After the war, the US Department of Defense revealed that there were close to 1,500 various types of ammunition dropped in Afghanistan; about fifty-five percent of them were precision-guided weapons, whereas in the Kosovo Campaign, precision-guided weapons made up about thirty-five percent of the number dropped. Looking at things in general, in [the Afghanistan] War, the United States followed up on its successful experiences in the Gulf War and the Kosovo Campaign by fully utilizing space strengths to conduct a withering attack against the Taliban regime and bin Laden's terrorist forces. Although the United States' methods were suspected of overkill, still, from another aspect they fully proved that after entering the 21st century, no matter what scale a war had and regardless of the differences between the two sides' strengths, and regardless of the geographical environment of operations, the space battlefield would dominate the entire battlefield, and space strengths would play a crucially important role.

2. The applications of space operations in the Iraq War

On 20 March 2003, the United States adopted a dangerous "preemptive strike" strategy to carry out unilateral actions and again attacked a sovereign country, Iraq, ignoring the opposition that the people of the world had in common; it circumvented the UN and instigated a few followers like the United Kingdom. Within a short period of time it had overthrown the Saddam regime and had again put on a farce where it relied upon armed force to display its hegemonism.

In the Iraq War, there were many reasons why the US military was able to quickly win the war; among these, a complete system of satellites played an extremely important role. A relevant US military expert recently issued an article in which he pointed out that "The reason the United States has been able to successfully use armed force throughout the globe was that it has an unbeatable group of satellites, which is able to carry out immediate communications, powerful surveillance, and precise positioning. For close to ten years, the Pentagon has been able to completely merge these resources into its operational actions, and so every military conflict that the United States has launched nowadays has inevitably been an aerospace war; even wars conducted in the desolate and uninhabited wilds of Afghanistan and Iraq have been no exception." The words of the American have given away their hegemonistic mentality and their ambition to dominate outer space. In the Iraq War, just as in the Gulf War, Kosovo Campaign, and Afghanistan War that previously occurred, the US military mobilized almost all its military satellite systems, and it also requisitioned some orbiting commercial satellites to provide combatant units with important support to operations, like reconnaissance, surveillance, communications, early warning, navigation, positioning, and meteorology. There was a wall in the US Air Force's Joint Air Warfare Center in the Gulf that formed a huge screen with continuously flickering and constantly changing pictures, showing the precise location of every US warplane in the air above Iraq. Throughout the entire war, as soon as there was a confirmed enemy military target on the air warfare center's screen, the commander would immediately order warplanes to go bomb it, and the key reason for this [ability] was the important role that satellite intelligence played. In the Iraq War, the US military deployed more than 100 satellites; it could be said that this was the largest number of satellites that were used in any of the several recent high-tech local wars. Throughout the entire time of the war, more than ninety percent of information on the battlefield was provided by satellites. They were able to deliver positioning data to the GPS on ships, aircraft, tanks, and other platforms; they were able to deliver intelligence to units' portable computers; and they were able to deliver satellite images to weather stations along the lines furthest to the front, bringing into play their role of "clairvoyance and omniscience" in an effective manner. In the Iraq War, ninety percent of the bombs used by the joint US-British forces were so-called "smart bombs;" these bombs were guided either by lasers or by GPS signals sent by satellites. But in the Gulf War in 1991, only ten percent of weapons were precision guided; thus GPS had become part of the core of modern high-tech weapons. According to reports, the final tracking and attack that the US military's B-1B [Lancer] bomber did against Saddam [used] information provided by satellites and targets that [the satellites] displayed.

Section 2: The Main Characteristics of the Practical Applications of Space Operations...200

The practical applications of space operations have already followed a journey lasting several decades, and in every historical stage that they have gone through, each stage has presented differing characteristics of practical applications because of differences in military technology, operational needs, weapons and equipment, and the state of warfare. In general, the extensions and expansions of national interests, the powerful pull of the needs of warfare, and continuing innovations in science and technology have been major motivators pushing the applications of space operations to rapidly develop and quickly be put into practice. Through a comprehensive analysis of the practical applications of space operations in the various historical stages, it is not only possible to summarize the historical experiences of space operations, but it is also possible to provide lessons and guidance for the future development of space operations, which will have major significance for winning space operations under future informationized conditions.

I. Characteristics of the practical applications of space operations in the initial period...200

As regards the initial period of the practical applications of space operations, although people at a conscious level had a certain degree of understanding of the major impact that space operations would have on warfare, still, as regards specific practical activities in operations, they could not get more sophisticated weapons and equipment for space operations and so it was difficult for technical support to meet the needs of operations. Therefore, during this stage, space operations primarily were applied at the strategic level and were limited only to applications to the nuclear deterrence strategies of the two superpowers, the United States and the Soviet Union. They provided enormously important information support for the great powers in resolving major political crises; moreover, to a certain extent they partially met the needs of conventional warfare for battlefield information and strengthened the operational effectiveness of combatant units. So this was the period in which the prototype of space operations appeared. In the initial period, the main characteristics of the practical applications of space operations were [as follows].

1. An emphasis on applications at the strategic level

As people's understanding that outer space would be the "high ground" of future warfare incrementally deepened, the concept of command of space gradually became married to military strategy. Applications of military space technology to seize military superiority and victory in operations became important details for the various military powers as they planned for strategic issues. The two hegemons – the United States and the Soviet Union – played important military games during this period, treating the military applications of space as important chips to be played in the practical process of confrontation between the two great camps, and they engaged in overall planning of operational issues strategically. Although military space technology was still at a starting period "where it was just beginning to bud," and [although] it was still only limited to space reconnaissance information support applications as regards its specific applications, this application was entirely a consideration at the strategic level, and what it stressed was strategic applications in gaining victory.

2. A focus on the deterrence role

In the Cold War, the military powers that confronted each other treated space military deterrence as an important way to resolve the issue of how to implement the applications of space strategy and to prevent the appearance strategically of being "big but empty" and tactically of being "mysterious but imaginary." Therefore, space military deterrence also became a primary form of practical applications of space operations during this period. Because nuclear deterrence had become a major "trump card" for confrontations between the great powers at this time, given the premise that neither side dared to lightly take a shot, space deterrence had room in which to operate, becoming a means whose role was equivalent to nuclear deterrence. Therefore, the two opposing sides actively relied upon space technology and spared no effort to adopt real measures in order to deter their opponent. It was precisely because the great powers used nuclear deterrence and space deterrence together at this stage that the Cold War was prevented from [taking] steps that would slide into a "nuclear winter" and that a great many major international strategic crises were diffused.

3. A single means of use

During the initial stage of carrying out space operations, because the development of military space technology had just begun, the means that could be used in space operations were quite limited; basically, they were simply used for space reconnaissance and surveillance. The limitations of this single means meant that the needs of space operations involved "ideas but no ways of carrying them out." It was precisely because the means of space operations at that period were limited, [because] the needs of space operations were also quite pressing, and [because] meeting these needs also meant meeting the needs of nations' major strategies, that developing diverse means of space operations became inevitable in the rapid development of subsequent military space technology.

II. The characteristics of practical applications of space operations in the middle period...201

As the applications of space operations developed to the middle period, clear differences already existed with the initial period: the focus in the applications of space operations gradually switched from the strategic level to the campaign and tactical level, and the role of the space battlefield became extraordinarily evident. For example, getting information, carrying out information warfare, deploying troop strengths, and launching firepower all primarily relied upon space support, and space weapons systems became important pillars for precision attacks, precision engagements, and precision, real-time information support, and this resulted in a clear display of space confrontations. At the same time as this, a system of theories of space operations gradually took shape that corresponded to space operations strengths. Against this background, the three US services' space commands and the Joint Space Command were established, one after the other; the mission of the US Air Force was further clarified as space control, force application, force enhancement, and space [forces] support; and space operations gradually began to stress deployment of space strengths. There was a push to use the outer space environment to reinforce ground strengths. To sum things up, there were the following three main characteristics.

1. Strategic, campaign, and tactical applications tended to merge

As the shape of warfare evolved, modern operations' space military requirements continually grew, and space operations also were incrementally transformed from the strategic level toward a direction that covered each level: strategic, campaign, and tactical. The several recent local wars have shown that space operations weapons systems play an indispensably important role, from responding to sudden incidents and commanding joint operations by services and service arms to seizing battlefield information superiority, supporting land, sea, and air battlefield operations, and pushing the process of war forward, and then to transmitting command and control orders and evaluating the effects of operations; they have played the role of a "central nervous system" and a troop strengths multiplier. Space operations' widespread use at the strategic, campaign, and tactical levels as well as their unparalleled performance have highlighted the dominant role of information, and this has provided the most direct impetus for the transformation from the mechanized state of warfare to the informationized state of warfare.

2. The focus in the state of warfare developed toward holistic operations

The practical applications of space operations during this period show that using the battlefield reconnaissance, surveillance, navigation, early warning, and communications services provided by outer space's unique battlefield advantage of a bird's-eye view of the globe can effectively carry out real-time exchange and sharing of operations information by land-based, sea-based, airborne, and space-based operational platforms and by various types of personnel, thus providing highly effective and massive amounts of information support for the many services and service arms, multidimensional operations spaces, and multiple battlefield operations, so that overall operational capabilities in local wars under high-tech conditions are clearly strengthened. This led modern warfare to develop in the direction of joint operations with information systems as their support and where the five dimensions of land, sea, air, space, and electronics are integrated. Moreover, it became a primary developmental trend for then and for a period of time in the future.

3. Means tended toward diversification, and the scope of applications widened

We discover through a vertical comparison that the applications of space operations during this period incrementally expanded from the earliest time, where a single means dominated – strategic reconnaissance – to the integrated application of multiple means, including reconnaissance and surveillance, communications relay, navigation and positioning, meteorological observation, military mapping, missile early warning, and electronic warfare. The level of battlefield one-way transparency was greatly reinforced, and the side that had fairly strong space information capabilities possessed the information superiority environment to fully perceive battlefield spaces, to carry out an integrated "seamless link" for the many types of operational units and informationized weapons that were dispersed in differing spatial locations, and to thus ensure the accuracy, rapidity, great effectiveness, and interoperability of command and control, thereby greatly enhancing the effects of weapons and equipment and their integrated joint attack capabilities.

III. The characteristics of the practical applications of space operations in the recent period...203

Overall, this stage of space operations apparently still primarily consists of providing information support to the land, sea, and air battlefields, in order to get the effect of multiplying the ground forces', naval, and air force operational strengths, but the comprehensive seizing of command of space, the development of offensive space weapons systems, and the carrying out of global long-range rapid attacks against the earth are daily becoming a new direction of development for space operations. In particular, the United States' space military superiority, which is far ahead [of everyone else], is unrivaled by any other country in the world, but the United States still focuses on continually enhancing its effectiveness in actual warfare and does anything it can to seek innovative developments. One after another, it has organized a series of Schriever space operations war games, so that the theoretical studies and practical applications of military space technology have entered a healthy track of cyclical development. Now and for a period of time in the future, the main characteristics of the practical applications of space operations are [as follows].

1. Reliance on space-based information is stronger

The several recent local wars have shown that by providing information support and by being combined with traditional land, sea, and air operational strengths, space military systems have already displayed their incomparable strategic and tactical value. In other words, only by being closely combined with outer space and [only] through the joint actions of operational strengths and their information systems that are spread out on land, sea, air, and space battlefields, is it possible for military actions on land, at sea, and in the air to smoothly achieve their predetermined goals in operations and [to carry out] the missions of their operations. For a fairly long period of time in the future, the enormous military value of space-based systems will still be reflected in their reinforcement of surface military strengths. Regardless of whether it is land warfare, sea warfare, or air warfare, these will rely heavily on the assistance and support that space-based systems provide in the areas of early warning, surveillance, tracking, positioning, navigation, meteorology, mapping, and evaluating the results of attacks. As the state of integrated five-dimensional warfare on land, at sea, in the air, in space, and electronics develops, and particularly with the emergence of new means of space operations, the level of this reliance will only intensify; it definitely will not ease up.

2. The systems nature of operations will be distinctly increased

It can be discovered through the fog of the several recent wars that by using space military information systems to ascertain battlefield conditions in near-real-time, by obtaining and transmitting the various kinds of information for the entire battlefield, and by organically combining reconnaissance, command, control, communications, intelligence, attack, and support, it is possible to form an integrated comprehensive information network system, and to thus connect the multidimensional battlefields of land, sea, air, space, and electronics into an interrelated integrated complex, thereby turning the confrontation between the two combatants into a confrontation between systems. Victory or defeat in war no longer is determined by one or a certain number of systems, but rather is determined by the effectiveness of the entire system of operations. As space technology has continually developed and with its widespread applications in the military sphere, the two hostile sides and especially the side that is on the strategic attack will strive to seize command of space or partial command of space, so as to provide vigorous support to its military actions on the land, sea, and air battlefields; this will highlight even more [the fact that] future struggles to seize command of space will be along the nature of a confrontation between systems.

3. The development of equipment for space confrontations will accelerate

As future informationized warfare becomes increasingly reliant upon space systems, military confrontations in space with the goal of "ensuring your own side's use [of space] and preventing the enemy from using it" will be unavoidable, and this will impel the rapid development of equipment and technology for space confrontations. Despite limitations arising from research and development funding, crucial technology, and international treaties on arms controls, the main military space powers have already formed the ability for actual operations, through adopting stratagems that "blend anti-satellite [operations] with anti-missile [operations]" and developing "hard kill" weapons against low-orbiting satellites. They have adopted the stratagems of "mastering capabilities and having cautious deployment," and they have incrementally made breakthroughs in crucial anti-satellite for such new-concept weapons as lasers and high-powered microwaves, but they have not rushed to deploy these. At the same time that they have energetically developed and improved "hard kill" anti-satellite weapons, they have also spared no efforts to develop "soft kill" anti-satellite weapons for jamming satellite communications links, as well as ones like micro-satellite weapons, in order to form comprehensive capabilities for space confrontations.

Section 3: The Current State of Space Operations and Developmental Trends...204

Space operations are a new form of operations that has appeared in the process of protecting security in space and seizing the international strategic high ground; their goal is to get the ability to control space or the ability to damage the enemy's control of space. As reliance on space operations capabilities have continually grown, the world's major space nations in recent years have each drafted or adjusted developmental strategies, developmental plans, and developmental objectives for space, centered on the increasingly intense competition and confrontation for space. This clearly has accelerated the pace of building up space strengths, centered on [the fact that] there has been a continual increase in major incidents occurring in space security, as represented by the 2008 US earth-based kinetic energy interception of a satellite and by the 2009 collision between a US [satellite] and a Russian satellite (Figure 7-1). In future informationized wars, space operations will permeate each level – tactical, campaign, and strategic – of military action carried out by joint operations units. It can be foreseen that in the near future, the forms, scopes, and effects of actions in space operations will undergo major changes, and space strengths will become important strategic strengths for defending national security and winning future wars.

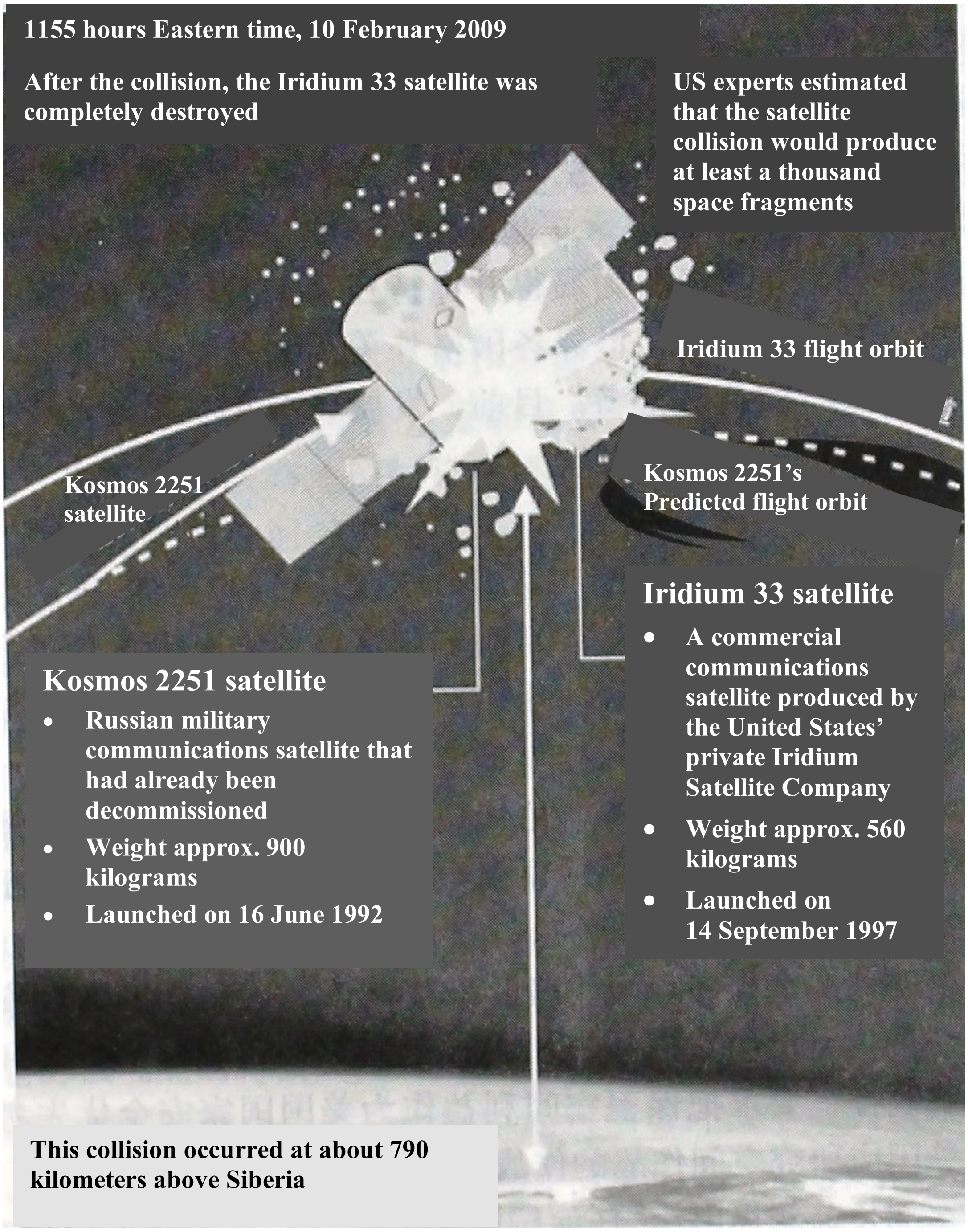

Figure 7-1: Schematic Diagram of Collision between a US [Satellite] and a Russian Satellite

I. The current state of space operations...206

During the Cold War, although the United States and the Soviet Union both realized the importance of outer space, their military activities in outer space remained highly restrained, and the international space setup generally existed in a relatively balanced state. After the Soviet Union collapsed, the United States consistently maintained its relative superiority in space, and the international space setup subsequently took shape before the world in the form of four powers – the United States, Russia, the European Union, and China – in a multipolar competition. Particularly in the past few years, practices in the several high-tech local wars have brought the various nations of the world to a full realization that outer space is the source of various kinds of information, and struggling for control of outer space turned into an important prerequisite condition for winning victory in informationized wars. Looking at things in general, this situation is relatively stable, but given the impact of the left-over legacy of hegemonism, of the rapidly expanding gap in technology, and of the gradual increase in confrontational factors, a new round of "enclosure movements" has appeared in the sphere of space, with the various space military powers, represented by the United States and Russia, investing large amounts of manpower, materiel, and finances to prepare their space strengths in order to lay a firm foundation for winning and holding absolute superiority in future space operations. Therefore, the various countries of the world are paying special attention to the struggle in outer space, and are hurrying to prepare for carrying out space operations. Currently, the development of space weapons and equipment has become an important detail as the various countries develop their military equipment.

1. The United States

Taking an overall view of the several local wars in recent years where the United States dominated, such as the 1991 Gulf War, the 1999 Kosovo Campaign, the 2001 Afghanistan War, and the 2003 Iraq War, the US military has always relied on its powerful space information support system to win rapid and decisive victories. Despite this, as a major power in the world and with first-rate military strengths, the United States has for many years sought military superiority in many spheres. In particular, it has always viewed the search for an ability to be far in advance of other countries in space as being an important national security interest. Therefore, the United States currently is preparing in all directions for space operations.

First, it has explicitly proposed a strategy for controlling space. In January 2001, the Commission to Assess United States National Security Space Management and Organization issued a report that pointed out that the United States' increasing reliance on space, and the fragility that this produces, require that US national security give priority consideration to focusing on upholding its space interests, and that the United States should study operational thoughts, concepts, and abilities for space operations. In June 2003, the US Secretary of the Air Force publicly proposed that "No country or organization (to include the United States' allies) can use space resources to develop military intelligence or other military goals without obtaining US approval." In August 2006, US President George W. Bush signed a new *National Space Policy* that stressed that the core of US space policy needed to switch from "peaceful uses of space" to "space security," that explicitly pointed out that "Strengthening US leadership in space ensures that space abilities can serve US national security, homeland security, and diplomatic policy when necessary," and that "The United States will prevent hostile forces from entering space." In February 2011, the US Department of Defense formally issued a *National Security Space Strategy* report that believed that as global science and technology continuously develop and as some other countries' space capabilities continually strengthen, the United States' space technology superiority will accordingly incrementally weaken. In order to maintain its superiority in space military forces, the United States should vigorously strengthen its construction and application of space intelligence capabilities. It can be clearly seen from a series of policy documents issued by the United States and from the words of US political notables, that the United States has explicitly proposed a strategy to control space and that it is trying to control the earth by controlling space and to maintain and strengthen its dominant position in the world. In other words, seizing command of space, seeking hegemony in space, and maintaining absolute superiority in space will always be a core idea as succeeding US administrations draft space policies.

Second, it has intensified its development of space operations technology and equipment. During the Cold War, the United States already treated space operations weapons as an important component part of its strategic nuclear deterrence strengths, and it energetically developed them. In recent years, as the status of space strategy has constantly risen, the United States has again intensified its development of space operations technology and equipment. On the one hand, it has devised ways to improve the survival and defensive capabilities of spacecraft systems; researched and developed stealth satellites, microsatellites, and even nanosatellites; and taken measures for satellites to resist jamming and to adjust their orbits, thus improving the survival capabilities of satellite systems. On the other hand, it had accelerated the pace of its research and development and testing of space operations weapons. Equipment that is being researched include land-based, air-based, and space-based laser weapons; land-based and space-based kinetic energy weapons; space-based weapons systems for attacking the ground; and space operations flight vehicles. On 22 April 2010 local time in the United States, the world's first space plane, the X-37B (Figure 7-2), ascended from Cape Canaveral in Florida for its first test flight. Looking at developments in spaceflight technology, this was another milestone development in mankind's conquest of outer space. Because no other country in the world today has mastered similarly mature technological equipment, the success of its test flight greatly enhanced the United States' military power and technological superiority for dominating space. Taking advantage of this technological high ground, the United States will firmly dominate command of space in outer space or outside of the atmosphere, and thus tightly lock down the "gates of life" for military defense and future operations by Russia and other nations – that is, satellite relay and secure transmission of information and data. Therefore, just as the former director of the Center for Defense Information's Space Security Project, Theresa Hitchens, said, "If the X-37B is used for military purposes, it will create a reason for other nations to research and develop dangerous anti-satellite weapons."

Figure 7-2: The US Air Force's X-37B space plane

Third, it uses units' task organizations to serve as preparations for establishing a space force. At the start of the 1980s, as US military spaceflight vigorously developed, the US Department of Defense began to organize military space strengths. One after another, it organized space commands for the Army, Navy, and Air Force, as well as a Joint Space Command for the three services; the total number of personnel in the space commands was about 40,000 men. In the area of building up space forces, the United States adopted a form of incremental transition. It first reinforced the functions of the Air Force Space Command and made it responsible for managing the military space activities of the three services; afterwards, it established a space service arm within the Air Force, and it will await a future opportunity, when this is mature, to make it independent of the Air Force and turn it into a space force. Currently, there has already been a focus on strengthening the US Air Force's space functions.

Fourth, it drafts doctrines for space operations and carries out space operations war games. Starting in 1998, the United States issued three versions of its *Space Operations* ([Air Force Defense Document] 2-2) doctrine document, one after the other (in 1998, 2001, and 2006), and its *Counterspace Operations* ([Air Force Defense Document] 2-2.1) (in 2004). Since 1997, the US Army, Navy, and Air Force have held operational exercises related to space operations. In particular, beginning in 2001, the US Air Force has held six space operations war games called "Schriever," one after another, to study and prove theories and operational doctrines for future space operations and has improved and innovated relevant technologies.

2. Russia

Russia was the primary inheritor of the Soviet Union's legacy and has always viewed space security as an emblem of the nation's overall power and its military power. [Russia] treats seeking space capabilities as an important way to restore its great-power status, and it is the second great space nation in today's world. Faced with the United States' aggressive developmental trends in the area of space control, Russia has adopted tit-for-tat response measures.

First, it has drafted a science of military strategy that has command of space as its core. On 4 February 2000, Russia's expanded National Security Council approved of and passed a *Draft Russian Federation Military Doctrine*, which considered that military actions in future wars would be space-based at their core, that one of the developmental trends in future military wars would be establishing and maintaining space superiority, and that seizing command of space would become one of the main conditions for seizing command of the air and naval superiority.

Second, it has established its new military space units. On 1 June 2001, Russia formally organized its Space Forces; these were the world's first independent space units, and were an armed forces entity that integrated the use of space, space operations, and missile defense into one.

Third, it has reorganized its military satellite system. Starting in 2006, it implemented a 10-Year Federal Space Program, and its investments in the area of space over ten years will reach close to 400 billion rubles; one of the focuses of its investment will be development of the military satellite system. Since 2000, Russia has launched a number of military satellites each year, in order to supplement and improve its military satellite systems, like GLONASS, and it has started to research and develop new types of reconnaissance, meteorological, and other satellite systems.

Fourth, it has vigorously developed its space operations weapons systems. Not only has Russia adopted various active and passive defense measures for its satellite systems, but it has also vigorously reinforced its research and development of space operations weapons systems, on the basis of the Soviet Union's anti-satellite satellites that had combat capabilities and on ground-based laser anti-satellite weapons that [the Soviet Union] had been testing. Russia is at an advanced world level in the areas of powerful lasers and high-powered microwaves, and this has laid an excellent foundation for Russia to develop corresponding space operations weapons.

3. The European Union and China's peripheral countries (or regions)

In recent years, the various countries of the European Union have treated development of an independent space capability as a focus of Europe's space security strategy, and they have carried out a series of new space security policies. First, they have clarified the important role of space for Europe's development, they have reevaluated the cooperation and divisions between Europe and the United States in the space sphere, they have emphasized the independence of Europe's ability to develop space, and they have vigorously pursued applying the principle that "matters in the European region are decided by Europeans" to the space sphere. For example, Europe took the lead over the United States in 2003 in successfully launching a Mercury [sic] probe into orbit, showing the great significance of their competition with the United States. Second, they have kept an eye on the overall European strategic situation, actively optimized their space functional organization, made highly effective plans for European space activities, and followed an integrated road of space development. Currently, nations are still the main bodies in Europe's space activities, but alliances at the supra-national level have gradually shown their strength, and the various member states of the European Union are now joining hands to establish mechanisms for space construction and use where there is joint management, a sharing of responsibilities, and a sharing of results. Third, they treat security and defense as the focus of Europe's future development of space, they are continually improving their various policies and regulations, which will provide guidance and a basis for comprehensive and integrated European space strengths, and they have begun to expand their alliance on space technology form a "civilian alliance" to a "military alliance."

Along the PRC's periphery, Japan in May 2009 [sic] passed the *Basic Law on Space*, which allowed the Japanese Space Self-Defense Force to use space resources; at the same time, Japan intensified its policies related to "research, development, and planning," laying a legal foundation for future space actions. In addition, Japan also spent a great deal of money on creating a reconnaissance satellite system, has actively built up its own military space strengths, and intends to make use of space development to seek the status of a military power. India has paid close attention to trends in space militarization, and in October 2003, it announced the establishment of an aerospace command, with its priority on research and development of a military space system that would have a supporting role for command and control; it is thus striving to improve its aerospace operations capabilities. South Korea and North Korea as well as the region of Taiwan have also adopted such means as borrowing rockets to launch satellites, leasing channels, and actively developing satellite confrontation measures as they compete to develop their own space military systems and seek to have a say in the use of space and in the area of [space] confrontation.

II. Developmental trends in space operations...210

As military space technology has rapidly developed and as the status of space strategy has continuously risen, and as military competition in space has increasingly intensified, the United States, Russia, and other military powers are giving more emphasis to the study of future forms of space operations and to the buildup and development of space operations strengths.

1. The mission of space operations is developing from the "information support form" toward the direction of the "command of space operations form," and ultimately will achieve "deployment of strategic strengths against the earth's surface"

Looking back on the history of the development of air operations in the 20th century, it can be found that air operations underwent three main stages: reconnaissance and communications support, seizing command of the air, and deployment of strategic strengths against the land and sea battlefields. Although the platforms and methods used by air operations and space operations differ, it is still possible to use the analogy of air operations' developmental process in order to predict future developmental trends in space operations; these inevitably will undergo three stages similar to those of air operations.

Currently, space operations are in the first stage, that is, the space information support stage. The main mission in this stage of space operations is to provide information assistance and support to the ground forces, the navy, and the air force, and operational actions primarily use the reconnaissance and surveillance, missile early warning, communications relay, navigation and positioning, meteorological observations, geodesy, and nuclear explosion detection carried out by space information systems. Given that space information systems play a huge role in information integration and in increasing the effectiveness of strengths in warfare, at the same time that the various space powers of the world are comprehensively improving and perfecting their space information systems, they are intensifying their development of anti-spacecraft weapons, in order to seek the ability in wartime to interfere with, damage, or destroy their opponent's orbiting spacecraft, thus paralyzing his space information systems. The development and use of anti-spacecraft weapons inevitably will push space operations to develop toward the stage of seizing command of space.

Seizing command of space will be the second stage in the future process of the development of space operations. The mission in this stage of space operations will primarily be to seize and hold command of space, and on this basis to provide information support to other services and service arms. Its operational actions will center on offensive and defensive confrontations and on the development of space systems, and will mainly include space defense early warning reconnaissance, anti-missile and anti-spacecraft, space blockades, and defense of space bases. In order to seize command of space, the two great space powers – the United States and the Soviet Union (or Russia) began in the early 1960s to research and develop anti-missile and anti-satellite weapons. In 1998, the United States' Aerospace Command explicitly pointed out in its *Long Range Plan – Vision for 2020* that space is becoming an extremely important area of national interest and an important basis for high-tech warfare, and the United States must energetically develop "integrated offense-defense" space strategic strengths, while at the same time having the ability to use strengths and to control the enemy's use of space, thus firmly grasping "command of space." After 2006, Russia had the ability to carry out space reconnaissance and surveillance, missile early warning, missile interception, and anti-satellite operations, under unified command. The functions of space strengths' missions will incrementally rise from the current emphasis on information support to an emphasis on attack missions, doing all they can to seize control over the sphere of space. Building a "space force" that has strategic deterrence and space offense and defense capabilities will be an inevitable choice in the 21st century as the major military powers struggle for the new strategic high ground.

After space operations have passed through the two stages of the "information support" and "operations to command space," deploying strategic strengths against the earth's surface will be the third stage of its future development. In this stage, space forces will not only be able to provide information support for the ground forces, navy, and air force, and to seize and hold command of space, but they will also be able to attack targets on the earth surface from space or through space; to provide the ground forces, navy, and air force with firepower support; and even to directly achieve strategic or campaign goals. In order to attack targets on the earth's surface from space or through space, the United States, the Soviet Union (or Russia), and other space powers have not only energetically developed ballistic missiles, but they have also invested huge sums in researching and developing orbital bombardment systems, fractional orbital bombardment systems, space-based directed energy and kinetic energy weapons, and other space-to-surface attack weapons, as well as carrier tools and launch platforms like manned spaceships, space stations, space shuttles, and space planes. Of these, the Soviet Union (or Russia) focused on researching and developing orbital bombardment systems, partial orbital bombardment systems, manned spaceships, and space stations; the United States, on the other hand, concentrated on research and development of space-based lasers, microwave and particle beam weapons, space shuttles, and space planes. Based on how the United States, Russia, and other countries have been researching and developing space-to-surface attack weapons and carrier tools as well as launch platforms, it is projected that around 2020, attacks from space or through space against targets on the ground (or underground), at sea (or underwater), and in the air that are on the earth's surface will become possible. At that time, space forces will possess the ability to launch strategic strengths against the earth's surface. At that point, space operations will have comprehensively moved toward maturity and will present the following forms of space operations.

First is space information support and countermeasures. Space information assistance and support and countermeasure actions will change the basic setup where there are no obstacles to the use of space information. Space information support primarily includes space navigation and positioning; space communications; space weather and geodetic support; space reconnaissance, surveillance, and identification; and space ballistic missile early warning. Countermeasures against the use of space information support include preventing satellites from entry, jamming and suppression, and soft and hard kills.

Second is missile battles. This primarily refers to ballistic missile battles. Ballistic missile battles are also divided into [the following]: for offensive missiles with a range of less than 3,500 kilometers, missile defense systems generally adopt offensive and defensive operations that intercept tactical missiles within the atmosphere at high and low altitudes; for offensive missiles with a range greater than 3,500 kilometers and speeds greater than five kilometers per second, missile defense systems generally adopt offensive and defensive operations that intercept strategic missiles during the powered stage and the mid-flight stage outside the atmosphere. With the development of near-space weapons, missile offensive and defensive operations will also include near-space offensive and defensive operations that attack cruise (or gliding) missiles flying at altitudes greater than twenty kilometers.

Third is anti-satellite operations. Anti-satellite weapons differ according to their carrier platforms; they can be divided into four types: land-based, sea-based, air-based, and space-based. Their means of killing primarily consist of three types: nuclear energy kills, kinetic energy kills, and directed energy kills. Currently, land-based kinetic energy anti-satellite weapons are relatively mature, while space-based kinetic energy anti-satellite weapons are in the technical demonstration stage.

Fourth is space-to-surface assaults. Space-to-surface assault actions refer to actions that carry out attacks from outer space against targets on land, sea, and air battlefields on the earth's surface, using space-based weapons. Attack operations that are carried out from outer space at [altitudes of] more than 120 kilometers above the earth's surface are not restricted by national boundaries, territorial waters, or territorial air, and so have a fairly great degree of freedom. The targets that they hit can be fixed strategic targets, but they can also be mobile targets on land, sea, and air battlefields, and they not only can be targets within a theater of war, but also targets anywhere on the globe.

Fifth is space-to-space battles. Space-to-space battle actions refer to the use of space-based weapons to carry out attacks in outer space against enemy space-based weapons, space stations, and space satellites, or defensive operational actions against attacks by space-based weapons; they are the highest form of space offensive and defensive confrontations.

2. Space operations equipment are developing from a "single type" in the direction of an "auxiliary systems type"

Up until now, because the primary mission of space strengths has been information support, the types and models of space weapons and equipment have been relatively unitary. The increasing maturity of military space technology and the escalation and expansion of space military actions will turn research and development of space weapons and equipment that have both offense and defense and that have auxiliary systems into a main focus of future space military competition. The United States will continue to develop main space battle equipment that will be marked by space operations platforms and attack weapons, and it will achieve major breakthroughs in the area of research and development of missile defense weapons, anti-satellite weapons, orbital bombardment weapons, kinetic energy interception weapons, space-based anti-missile weapons, and directed energy weapons. The US Department of Defense in 2010 launched research and development of the "next generation of long-range attack" systems, and intensified its tests of equipment like the X-37B space plane, the HTV-2 Falcon hypersonic flight vehicle, the X-51 supersonic cruise missile, and "advanced hypersonic weapons." The X-37B is the world's first space plane, researched and developed by the United States, and it has successfully been launched into the air a number of times since 2010. It not only can carry out hypersonic flights in the atmosphere, with a maximum speed that can reach twenty-five times the speed of sound, six to twelve times the speed of modern combat aircraft, but it also can enter outer space orbit and remain in operation [there] for 270 days. In addition, the cost of its launches is low, the rate at which it can be repeatedly used is high, and it has a number of military uses, so it will become one of the crucial weapons for the United States' future control of space and its struggle for command of space. The X-51 cruise missile's speed is five times the speed of sound, while the speed of the Falcon HTV-2 flight vehicle, which is launched using a carrier rocket, is twenty times the speed of sound, and it glides 3,700 kilometers in thirty minutes at supersonic speeds after separation from its rocket, meaning that it can reach anywhere on the globe in one to two hours. Russia is paying a great deal of attention to the research and development of advanced space weapons, and it will continually improve the combat capabilities of its anti-satellite satellites, its ground-based powerful laser weapons, and its high-powered microwave weapons. It is predicted that between 2020 and 2030, the weapons and equipment of space strengths will transition from the current emphasis on passive defense and unitary support in the direction of offense-defense integration, with an emphasis on offense and with auxiliary systems.

3. The structure of space operations strengths will develop from the "single structure model" in the direction of a "composite structure model"

As space strengths further develop, the organizational structure of US and Russian space strengths will become more composite and the functions of their systems will become more perfect. The buildup of future space strengths will develop in the direction of being "composite" and generally can be divided into four types of structures. [The first is] space tracking units, which are primarily responsible for monitoring intercontinental missiles launched from the air, from underwater, and from the ground; for tracking enemy military spacecraft in outer space; for finding situations and [issuing] early warnings; and for providing information support. [The second is] space offensive operations units, which primarily rely on space operations platforms to carry out offensive operations actions that attack targets in space, in the air, at sea, and on the ground. [The third is] space defensive operations units, which are primarily responsible for defensive operations actions that intercept enemy intercontinental ballistic missiles and military spacecraft. [The fourth is] space logistics support units, which are primarily responsible for space technological assistance and support, logistics support, and security support. The United States' space operations strengths consist of units for monitoring combat and units for military space combat. Their current organizational structure consists of four space wings and one space squadron. Of these, the 21st Space Wing is primarily responsible for strategic early warning, the 30th and 45th Wings are mainly responsible for space launches, and the 50th Space Wing is responsible for carrying out space tracking and for professional management. The space squadron is primarily responsible for space defense surveillance. In 2000, the United States established a space operations institute, especially to train space operations personnel for the US military. In

October of that same year, the United States also established the 527th Space Aggressor Squadron; this was the United States' first unit used for space operations. In addition, according to plans, the United States will establish and deploy seventeen aerospace expeditionary forces. Based on the differences in their operational tasks, the seventeen units will be divided into three types: a basic type, an emergency response type, and a mobile type, which will be responsible for differing tasks. Currently, the United States has ten basic space expeditionary units, two emergency response aerospace expeditionary forces, and five mobile aerospace expeditionary forces. On 25 January 2001, Russia separated its military space units and missile defense units from out of its Strategic Rocket Forces, and within a year it had reorganized a new service, on the basis of them: the Russian Space Forces, directly subordinate to the command of the General Staff. The newly organized Space Forces were primarily responsible for military space launches, space operations, and missile defense missions, and they were mainly equipped with such space attack weapons as anti-satellite satellites and space-based anti-satellite missiles.

4. Miniature satellites will become an important trend in the development of future military satellites

There is as yet no unified definition for the concept of miniature satellites, but a relatively uniform view is that they weigh less than 450 kilograms; their length, width, and height all do not exceed fifty centimeters, and their research and development costs are between several million US dollars and $25 million. Because their many "characteristics" are quite suitable for roles in the military sphere, their prospects are therefore unlimited, and they will become an important trend in the development of future military satellites.

Looking at this from a military angle, the miniaturization of satellites will bring about benefits in the following several areas. First is that small satellite systems have strong survival capabilities. It is very easy for large satellites to become the targets of attacks by anti-satellite weapons, and once they have been damaged they are then "completely annihilated." If multiple small satellites are used in a form that works to create a network where [the satellites] back each other up, then even if one or two are "sacrificed," this will not have a major impact on the entire system. Second is that launches of small satellites are flexible. They can be launched in a mobile manner using small-scale carrier rockets along railways and highways, and they can also be launched from the air, using aircraft; it will be very difficult for the enemy to be certain about the ins and outs of their launches. According to reports, the US military is currently bidding to research and develop several mobile carrier tools especially for launching small-scale satellites, in order to "not put all of the United States' eggs in one basket," and so that it could use any rocket among them to launch a small-scale special emergency-response military satellite in a timely manner at any time to carry out a single mission. Third is that it is easy to deploy and use small satellites to create a cluster-style network, in order to enhance the scope and timing of their outer space reconnaissance as well as the stability of their system. Fourth is that small satellites have a fairly high cost-benefit ratio. The characteristics of modern small satellites, where their research and development cycle is short and their costs are low, are very suited to the modern military "appetite," because modern warfare is developing in the direction more and more of a quick fight and a quick resolution; as long as tactical satellites can meet wartime needs, then even if they are discarded after the war, this will not create excessive losses. Looking at the costs of waging a high-intensity war, using small satellites to replace large satellites that have a fairly long lifespan but whose costs are expensive is still quite worthwhile. Fifth is that they are conducive to mass production and storage. Because of miniature satellites' characteristics where their technology and parts are standardized and universal, this not only makes it possible for them to use an assembly line for mass production, just as with commercial products, but it is also possible in peacetime to store some of them in advance, and once war breaks out, it is possible to launch them at any time for use.

Currently, the United States, Russia, the various European countries, and Japan are all energetically developing miniature satellites. The US Army, Navy, and Air Force have drafted plans for the research and development of miniature satellites and have begun to carry these out. For example, the "pipe" {*yandou*} ultrahigh frequency miniature satellite weighs less than twenty-two kilograms, and seven "pipe" satellites located in the same plane can form a communications satellite net. A concept by Englishmen is more advanced; a plan they have proposed is to launch several hundred "fiber cable-type" satellites the size of a softball; each satellite would weigh less than one kilogram, and they would form a chain of satellites for relaying information in an orbit 400 kilometers high, to be used for communication with remote units. The entire communications network would consist of sixty to 100 satellites, and according to estimates, each satellite would cost $17,000. As miniature [technology] and nanotechnology further develop, scientists' concepts are becoming even more daring; they have conceived of using several hundred satellites [each] weighing less than 100 grams to carry out surveillance and information forwarding missions.

The emergence of miniature satellites will bring about profound changes in the design, manufacture, and orbital control of future spacecraft; contention in outer space among the various countries will be even more intense, and outer space in the future will also be even less tranquil. This inevitably will push space technology to advance forward faster, better, and more economically, while at the same time it will also inevitably greatly promote the development of military spaceflight.

Questions for Deliberation…216

1. The process of development of space operations has largely gone through what stages?

2. Examining the goals, means, and scales of strengths for space operations, summarize the characteristics of space operations in each stage.

3. At the current stage, what measures have the two great space military powers, the United States and Russia, each taken to deal with competition in outer space?

4. Summarize the developmental trends for future space operations.

Main References…217

[1] Chang Xianqi {常显奇}, et al. *Science of Military Astronautics {junshi hangtian xue}*. Beijing: National Defense Industry Press, 2005.

[2] Wang Wanchun {王万春}. *Air and Space Operations, Theory and Practice {hangtian zuozhan lilun yu shijian}*. Beijing: Blue Sky Press, 2010.

[3] Jia Junming {贾俊明}. *Study of Space Operations {taikong zuozhan yanjiu}*. Beijing: NDU Press, 2002.

[4] GED Electronic Information Foundation Department. *Modern Weapons and Equipment Knowledge Series {xiandai wuqi zhuangbei zhishi zongshu}*. Beijing: Atomic Energy Press, 2003.

[5] *Chinese Military Encyclopedia: Military Space Technology {zhongguo junshi baike quanshu – junshi hangtian jishu}*. Beijing: China Encyclopedia Press, 2008.

[6] Wang Yonggang {王永刚} and Liu Yuwen {刘玉文}. *Introduction to Military Satellites and Applications {junshi weixing ji yingyong gailun}*. Beijing: National Defense Industry Press, 2003.

[7] Ding Bangyu {丁邦宇}. *Science of Operational Command {zuozhan zhihui xue}*. Beijing: Military Science Press, 2004.

[8] Xiong Wuyi {熊武一}. *Dictionary of Ancient Military Art Appreciation {gudai bingfa jianshang cidian}*. Beijing: Military Translations Press, 1995.

[9] Le Jingchun {勒敬纯}, et al. *Struggle for Supremacy in Space {zhengba taikong}*. Beijing: National Defense Industry Press, 2008.

[10] Xu Lisheng {徐立生} and Huang Wuyuan {黄武元}. *Modern Military Astronautics {xiandai junshi hangtian}*. Beijing: Starmap Press, 2008.

[11] Xiao Han {肖寒} and Zhu Chaowei {朱焯伟}. *Exploration of Space {taikong tansuo}*. Beijing: People's Armed Police Press, 2009.

[12] Pan Houren {潘厚任} and Wang Jingtao {王景涛}. *Introduction to Science of Astronautics {taikong xue gailun}*. Ha'erbin: Ha'erbin Institute of Technology Press, 2003.

[13] Shu Xing {蜀星}. *Pressing Forward in Space {tingjin taikong}*. Beijing: PLA Press, 2005.

[14] Yuan Gannan {袁赣南} and Zhou Weidong {周卫东}, et al. *Navigational Guidance and Positioning Systems Engineering {daohang dingwei xitong gongcheng}*. Ha'erbin: Ha'erbing: Ha'erbin Institute of Technology Press, 2008.

[15] Li Yue {李跃}. *Navigational Guidance and Positioning – The Beidou Star of Informationized War {daohang yu dingwei – xinxihua zhanzheng de beidou xing}*. Beijing: National Defense Industry Press, 2008.

[16] Ren Xuan {任萱} and Hu Xiaoping {胡小平}. *Military Space Technology {junshi hangtian jishu}*. Beijing: Military Translations Press, 1998. **[End of page 217]**

[17] Li Ruichen {李瑞晨}. *Operational Applications of Spacecrafts {hangtianqi de zuozhan yingyong}*. Beijing: China Defense Science and Technology Information Center, 1996.

[18] Hu Siyuan {胡思远} and Chen Hu {陈虎}. *US Space Warfare {meijun hangtianzhan}*. Beijing: NDU Press, 1995.

[19] Lin Huabao {林华宝}. *Current State and Trends of Foreign Satellite Technologies and Applications {waiguo weixing jishu ji yingyong xianzhuang yu qushi}*. Beijing: China Astronautics Press, 2001.

[20] Cao Fucheng {曹福成}. *Space Warfare in the 21st Century {21 shiji taikongzhan}*. Xi'an: Future Press, 1999.

[21] Su Enze {苏恩泽}. *Space Force Across the Heavens {tianjun hengkong}*. Beijing: Military Science Press, 2001.

[22] Hong Bing {洪兵} and Liang Xiaoqiu {梁晓秋}. *America Will Fight Space Warfare {meiguo yao da taikongzhan}*. Beijing: PLA Press, 2001.

[23] Xu Haiyu {徐海玉}. *Study on US Military Space Confrontation Theory and Technology {meijun kongtian duikang lilun yu jishu yanjiu}*. Ha'erbin: Ha'erbin Institute of Technology Press, 2002.

[End of page 218]

Postscript…219

The book, *Lectures on Science of Space Operations*, is one of the topics of the 2010 Academy of Military Science [AMS] Postgraduate Teaching Material Revised Plan. The revision of this lecture is the first of its kind for the discipline building and comprehensive study aspect of PLA space operations theory. Under the correct leadership and strong support of the senior officers and organs of the AMS, the *Lectures on Science of Space Operations* began its revision at the beginning of 2011, and it was completed in the latter half of 2012, coalescing the wisdom and painstaking care of the leadership, experts and topic team members of the Operational Theory and Regulations Study Department. During the revision period, AMS Deputy Director Xu Lili {徐莉莉} and AMS Scientific Research Guidance Dept. Chief He Lei {何雷} followed with interest the lectures' revision work and on multiple occasions made some instructive requirements; AMS Operational Theory and Regulations Study Department. Chief Zhang Shiping {张世平} and Deputy Chief Jiang Yamin {蒋亚民} conducted specific guidance on multiple occasions for the lectures revision work as well as approving the details of the lectures' framework. On the basis of the characteristics of the foundational quality of the lectures and the difficulty degree of revision, the Lectures Revision Topic Team broadly collected the theoretical and practice achievements of foreign military and PLA space operations, conscientiously sifted, thoroughly deliberated, meticulously proved, and boldly made breakthroughs; they strived to be complete and accurate and to innovatively reflect the features of space operations in terms of structure and content.

The topic team formed for lectures revision was headed by the team chief (Chief Editor) Jiang Lianju {姜连举} and Deputy Team Chief Wang Liwen {王立文} (Assistant Chief Editor) as they conducted the specific division of effort: Jiang Lianju designed the framework of the entire book and refined the main writing content of each lecture; the first lecture was written by Zhao Baoxian {赵宝献} and Li Xianrui {李先瑞}; the second lecture is by Yang Yilin {杨艺霖}; the third lecture is by Ruan Guangfeng {阮光峰}; the fourth lecture is by Huang Yong {黄勇} and Su Wei {苏伟}; the fifth lecture is by Wang Liwen, the sixth lecture is by Ni Tianyou {倪天友}; and the seventh lecture is by Chen Aiyuan {陈爱元}. During the course of research and writing, we cited and absorbed some study achievements of colleagues and experts; we obtained the strong support and concerned guidance of the Operational Theory and Regulations Studies Department's 4th Research Office leadership as well as the powerful support of colleagues across the PLA. For this we express our utmost appreciation!

Space operations are a completely new form appearing along with the accelerated evolution of informationized war. The study of space operations is still in an exploratory period, and especially because the PLA space operations practices and experience are insufficient, top quality work in theory is in short supply, adding to the degree of difficulty for study. At the same time, also constrained by our **[end of page 219]** field of view and levels, some oversights and inappropriate places were difficult to avoid in the lectures, so we earnestly request our broad readership to make corrections.

Editor
October 2012

[End of page 220]