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PLA Aerospace Force Base 37: An Open-Source Case Study in Integrating Geospatial Data

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Summary

Base 37 is the PLA's base for early warning and space situational awareness, likely now under the command of the PLA's new Aerospace Force (PLAASF). Observable elements of Base 37 appear to be engaged in research on a wide array of space situational awareness (SSA) topics, and units directly reporting to Base 37 operate at least some of the Large-Phased Radar Array (LPAR) stations previously belonging to the PLA Air Force (PLAAF). Continued tensions between the PLAAF and the PLAASF on LPAR ownership may produce two networks of LPAR stations with overlapping roles, but different command structures, and potentially different data management systems that may complicate the PLA's SSA capabilities.

In addition, Base 37 is engaged in research related to optical space detection, but there is little indication as of yet that Base 37 directly operates optical SSA assets. If Base 37 is going to take over foreign space object tracking, one would assume they would also absorb or build optical assets. Additional research is needed to determine if: (1) there will soon be a buildout of new optical facilities for Base 37; (2) Base 37 will rely on other organizations for tracking geosynchronous Earth orbit (GEO) and other high orbits; (3) the PLA prioritizes military space preparation in low Earth orbit over GEO. Base 37 units in Qinghai and Yunnan near known optical facilities are the best places to track.

Introduction

To demonstrate a workflow that incorporates geospatial intelligence into other data streams, this paper will conduct a brief study of the People's Liberation Army's (PLA) base for space object tracking and early warning, Base 37. Recent advances in the revisit rate, availability, and resolution of commercial satellite imagery have allowed researchers operating with open-sources to study foreign military forces in a level of detail that was previously only available to state intelligence organizations. Imagery intelligence allows us to not only draw conclusions about specific capabilities, but also draw conclusions about the operating procedures of the organizations overseeing the military assets that are the subject of the analysis. These visual signatures of the operation of military units can not only allow researchers to identify additional military units based on their infrastructure, but also inform researchers on budgetary and other organizational bottlenecks and problems the broader military network may be facing. In depth geospatial study of various military sites, combined with textual data collection using open-source methods, represents a new way of knowing about military forces that allows researchers to come to more specific conclusions by integrating multiple data streams.

A Mindset for Geospatial Analysis

Geospatial intelligence studies of military organizations are more than simply an effort to know where a target or a set of targets are located, or even a study of capabilities. Of course, centering the locations as your primary data input is necessary for any in-depth geospatial study, but the geolocation alone tells the analyst little of particular importance about the military forces themselves. Military order of battle analysis is fundamentally the study of organizations, and geospatial data should be examined with that in mind. Patterns in the construction of military bases, the movement of assets, and the interactions between different military units all reveal certain bureaucratic quirks that help the analyst better understand how the military organization operates. To fully identify and comprehend these patterns in the data, geospatial analysts should first ensure that they bring the proper mindset to the study, one that envisions the locations themselves as nodes of data in a network of sites that shift and move over time. Not only may the units themselves move geographically, but organizational changes may change the unit's relationship with other units in the network. Because of these considerations, the analyst should conduct their study with a healthy respect for two important aspects of geospatial study – time and network.

"Time" simply refers to the idea that the analyst should collect and analyze geospatial data of the set of sites related to the organization being examined over a certain timeframe. When certain changes occur at a site, it can reveal important information about organizational changes, but understanding those changes must be rooted in the broader context of the site's history. To identify and analyze unusual changes in a site's infrastructure or operations, one must first understand what is *normal*. Without fully contextualizing changes in a site, the analyst may draw incorrect conclusions or deem certain activity well within a site's normal operating procedures as unusual.

A good example of this problem occurred in December of 2022, after *Der Spiegel* reported that satellite images taken of Engels Air Force Base, one of Russia's largest strategic bomber bases, showed an uptick of bombers on the tarmac, possibly signaling preparations for a major attack.[1] Follow-up analysis that examined bomber activity over a much broader timeline, however, revealed that there was not much unusual about the number of bombers and the base was operating well within long-established procedures.[2] Establishing what normal looks like is critical for picking apart what activity at a site may constitute a major change from normal.

Analyzing sites over time also helps reveal what specific infrastructure signatures are related to specific systems. For example, if a PLA Rocket Force (PLARF) base transitions from an older system to a newer missile system, and during this time period builds new infrastructure to support that new system, an analyst can conclude that the infrastructure is likely related to either a change in how the new system operates or a change in the size of the missile brigade itself. For example, DF-26 brigades commonly replace older missile systems like the DF-21A. However, DF-26 brigades are three times as large as DF-21A brigades, and supporting this new size requires new garages, new barracks, and other infrastructure expansions.[3] Merely seeing this new expansion can give the analyst a clue that the brigade is likely transitioning systems without the analyst ever actually seeing a missile.

The second aspect, "networking," refers to the geospatial analyst understanding that they must examine sites as nodes within an organizational network. Changes at one site may be mirrored at another. If there are cases where one site shows construction that others lack, or if one site lacks construction, that should be noted and an effort made to deduce why the sites differ, without forcing a conclusion. One military unit acquiring technology or infrastructure before another may reveal organizational preferences to one type of unit or favoritism.

Alternatively, there could be congestion in the procurement system. A good example of this phenomenon is how the PLARF has gone about the expansion of their force structure. The PLARF has almost doubled the number of combat missile brigades in operation over the last decade, and notably, the way they have expanded reveals a particular bias within the PLARF.[4] When a new brigade is stood up, they do not receive a new brigade base – rather, they are given an older brigade base, while the older brigade that once inhabited that base is moved to a new base. This hand me down system possibly reveals the importance of pedigree of brigades within the PLARF's hierarchy.

The Open-Source Geospatial Toolset

With that mindset established, the analyst can begin working with their tools. This toolset extends beyond simply utilizing satellite imagery. Analysts will find the most success in combining satellite imagery with textual and ground truth imagery so that the satellite imagery may be used to contextualize other important pieces of data.

It is important that the analyst understand the benefits and drawbacks of certain tools in their toolkit, including the advantages and disadvantages of different types of commercial

satellite imagery. It is a common, but misplaced belief, that the quality of satellite imagery, in terms of its resolution, is the primary bottleneck to making conclusions about a target site. Satellite imagery resolutions are denoted by how many square meters a single pixel of the image represents. High-resolution imagery is generally 0.5 meters per pixel or lower. Medium-resolution imagery may be between 2-3 meters in resolution. Low-resolution imagery generally refers to anything beyond that.

As a general rule of thumb, large amounts of low-resolution imagery are easier to acquire than high-resolution imagery. This is due to two factors: lower resolution space sensors are commonly passive, meaning that they are continually scanning the Earth. Low-resolution sensors also generally have a much bigger area they can image. High-resolution sensors, on the other hand, generally can only image smaller images in a single shot and are not passive. They must be tasked to image specific areas. Because of this, a single low-resolution sensor is going to produce more raw data than a single high-resolution sensor. A set of low-resolution sensors are going to have a much higher revisit rate (the rate at which the satellite or constellation of satellites can visit a target over a specific time period) than high-resolution satellites. The analyst will, therefore, generally have access to more low-resolution imagery data than high-resolution data of the target. While resolution is important for making some conclusions, it is important to remember the aspect of time in geospatial study. In order to conclude that specific activities are unusual, the practitioner must have enough data to conclude what is normal. This, in most cases, requires relying on low and medium resolution imagery.

A good example of this workflow is Eli Hayes' analysis of China's laser development facility in Bohu, Xinjiang province.[5] The Bohu facility has multiple lasers housed in buildings with sliding roofs to cover and uncover the lasers. The movement of these roofs is visible on low and medium resolution imagery. Hayes collected a database of 1,700 days of imagery over a seven-year period and tracked how many times the sliding roofs were open, tracking a significant increase in the number of days the roofs were open beginning in 2020. From this analysis, Hayes concludes that certain technological breakthroughs may have occurred within the Chinese laser program.

This being said, the analyst may still run into problems with data availability, especially if the target has not yet been geolocated. For example, rural areas in China may go years between being visited by a high-resolution satellite and trying to find smaller targets simply based on their signature in three meter or worse imagery is difficult and, if done manually, time consuming. For larger facilities, the analyst can rely on three-meter imagery for the initial geolocation, as I did when I geolocated the Yumen silo field, one of China's new solid-fuel intercontinental ballistic missile facilities.[6] But for much smaller targets, the site may not be distinguishable on medium or low-resolution imagery.

When analyzing geospatial data, it is important to be mindful that geospatial study is a process that is susceptible to confirmation bias. If the analyst goes out looking for missiles, the analyst is going to find missiles, regardless of whether or not there are any missiles at the site in question, because everything they look at will appear to them as being missile-related. This is

why it is critical that the analyst make an effort to rule out certain sites that may have other functions. United States government geospatial analysts, for example, are not simply taught what a military site looks like. Instead, they are taught about the appearance of roads, mines, factories, and many other common civilian features, in order to ensure that false positives are not produced during geospatial study.[7] At the same time the analyst should not simply learn to identify these features so that they can be discarded. Sites providing dedicated military units with non-combat support or logistics may also tell the analyst important details on the operation of military organizations. In addition, militaries have a tendency to construct such support facilities in particular patterns. The PLARF, for example, has a particular standard pattern for their weather stations, and such stations appear at every dedicated combat missile brigade in the Rocket Force's order of battle.

In conjunction with the collection of satellite imagery data, a variety of different data sources collectable from the internet will invariably be of interest to the analyst. Contract records, patents, military propaganda, and local government documents all can contain information when attempting to make sense of military organizations. Analysts may also find it useful to try using different search engines from different countries as such engines will return different results. I regularly use Yandex Search, a Russian internet search engine, for tasks related to Russia, Baidu for tasks related to China, and Naver for tasks related to South Korea. If the situation allows, the analyst may also be interested in personnel information provided by sites like Linkedin.

There is no one process for conducting an open-source geospatial study. Each study should be tailored to the problem the analyst is looking at. If the analyst already has a good understanding of the geography and layout of the facilities in question, then the analyst can focus more on textual information to relate to the geospatial data they likely already have. The inverse is also true. What an analyst should always avoid, however, is collecting geospatial data and textual data but not making an effort to relate the two. The lynchpin of this process is to find ways to relate the geospatial and textual data to gain a clearer window in the operations of the organization. Data collected from one can inform the other, however. Knowing where units might possibly be located can introduce new keywords or specific methods for searching through the text and image data, and the text and image data can likewise give the analyst hints on where to look. Because of this, after initial collection of textual and geospatial data, the research workflow can occur much more organically as the analyst attempts to relate certain pieces of geospatial data to textual data.

Base 37

Now that we have established the basic mindset and the process an analyst must have before embarking on an open-source geospatial project, let's move on to our case study. China is rapidly expanding their ability to conduct missions in space and cyberspace. To support this, organizational changes have been made to the structure of the PLA with the creation of a new organization of the armed forces. In 2015, China established the People's Liberation Army

Strategic Support Force (SSF) as part of a much larger reorganization of the PLA. The SSF was a theater command-level organization responsible for space, cyberspace, electronic, information, communications, and psychological warfare missions, including space object tracking, missile early warning, and the collection and dissemination of intelligence.[8] The SSF was given control of many of the units related to these missions from across the branches of the PLA, which may have resolved several organizational fights previously fought by the branches of the PLA over responsibility of specific support tasks. For example, responsibility over missile early warning was previously disputed between the PLARF and the PLA Air Force (PLAAF), but is now merged under Base 37.[9]

The operational functions of the SSF were organized into two departments: the Space Systems Department and the Network System Department.[10] The Space Systems Department was responsible for operations in space, including space mission control, space-based communications, and space object tracking. The Network Systems Department was responsible for cyber and some electronic warfare operations. Like the services, the SSF created "bases" that oversaw multiple units across large territories. In some cases, these bases are analogous to how the United States armed forces would use the word "corps," like the Rocket Force bases that oversee multiple combat missile brigades. In other cases, they are closer to being analogous to unit organizations with specific tasks, like United States Space Force Deltas.

Recently, evidence has come to light that the SSF had established a new base, Base 37, responsible for foreign space object tracking and missile early warning.[11] This base was situated under the Space Systems Department. Previously many of these duties were split up between the Rocket Force (which at the time of the SSF's creation was called Second Artillery), the Air Force, and various General Armaments Department (GAD) and General Staff Department organizations. Because of the newness of the base and the fact that it draws units from across the PLA, discerning which units belong to this new base can be difficult to deduce utilizing solely textual methods. The addition of open-source imagery gives us the ability to directly compare and contrast differences and similarities between PLA units that may belong to Base 37.

In April 2024, China announced the disestablishment of the SSF and its replacement with three independent organizations that oversee the tasks previously overseen by the departments and organizations within the SSF.[12] These new organizations are the Aerospace Force (PLAASF), the Cyberspace Force (PLACSF), and the Information Support Force (PLAISF). Given that Base 37 is responsible for space-related tasks, it is very likely that the organization will be part of the new PLAASF.

Base 37 appears to have been given command of a myriad of different units across China to deepen expertise in, and data integration of, foreign space object tracking and missile early warning for the PLA's joint operations. Base 37 does not appear to have a monopoly on space tracking, however, and the PLAASF still maintains other bases for other space tracking tasks. PLAASF Base 26, for example, still provides telemetry, tracking, and control, mission control, and spacecraft anomaly resolution for the majority of Chinese national satellites, including military satellites. Base 37 includes units that belonged to a variety of different bases and

branches, including some from Base 26. This can make tracking their individual units a bit tricky as their military unit cover designators (MUCDs), numerical codes given to all military units of the PLA, are sometimes unchanged from the time those units belonged to different branches.

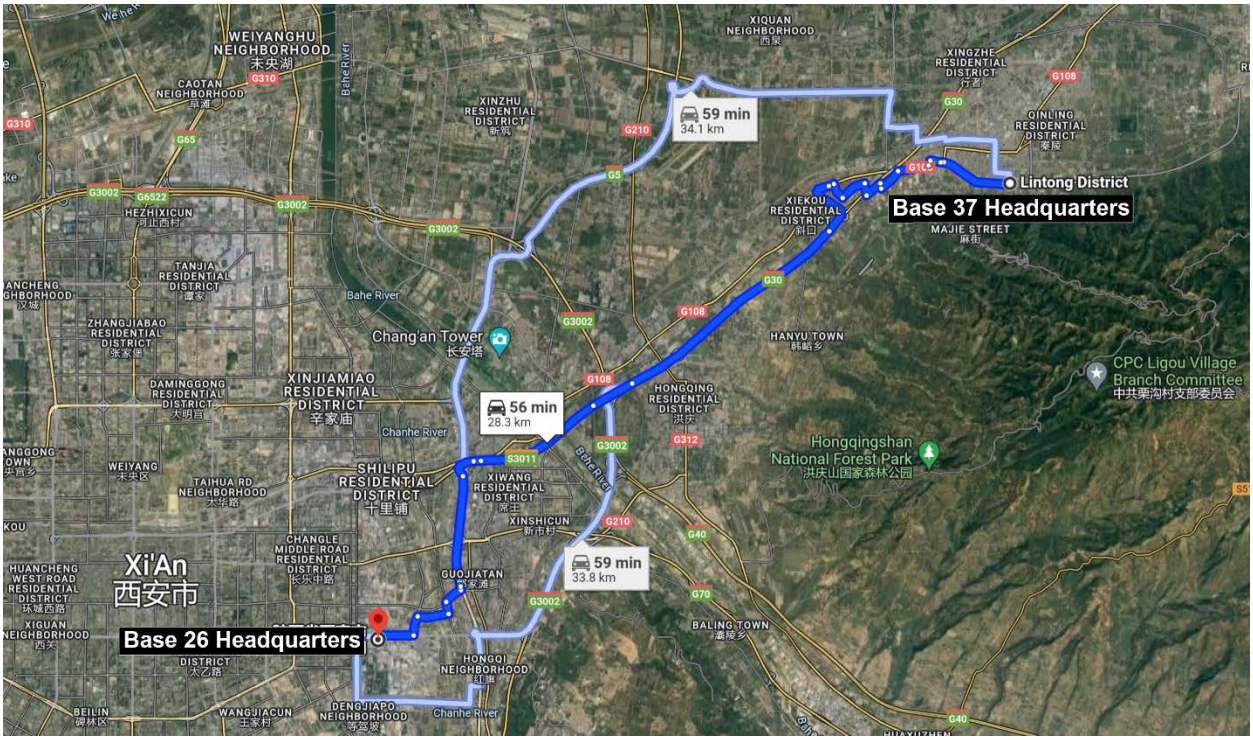

Figure 1: Distance Between Base 26 And Base 37 Headquarters

Base 37 operates a variety of different systems for tracking space assets. Some number of Large-Phased Radar Array (LPAR) stations formally belonging to the PLAAF have been transferred to Base 37. Base 37 also operates some number of optical tracking facilities for tracking space objects. These assets have slightly different purposes. LPAR radar stations can track ballistic missiles and other high-flying objects, including satellites in low-Earth orbit (LEO) from beyond visual range. This makes LPAR stations essential for any missile early warning system as well as their role in assisting with space situational awareness (SSA). Optical sensors for tracking space objects like satellites also have unique advantages, as they allow the user to image and characterize satellites in higher orbits like geosynchronous Earth orbit (GEO). The size and shape of a satellite reflects its purpose, meaning that a state with advanced optical capabilities can categorize space objects of interest and likely make some limited conclusions about their role and capabilities.

For PLA studies, the starting point is usually collecting data that refers to the MUCDs of the units involved in the organization of interest. CASI has published several of these MUCDs, and their research notes that the headquarters unit of Base 37 likely has the MUCD 32035, with various other units under Base 37 extending up through to MUCD 32039.[13] In addition to its headquarters duties, MUCD 32035 appears repeatedly in SSF recruiting material and also

appears to be in control of several financial aspects of military units reporting to it, as this MUCD appears in contract documents for military units across the country.[14] The areas of interest to us are the areas where we know the PLA operates LPAR and optical ground stations. There are a variety of strategies for finding data specific to those locations. Because we know the MUCDs of the units overseeing this new base, we can combine these MUCDs with the names of the cities and counties that our sites of interest are in to generate a more specific textual search of data related to units potentially subordinate to Base 37.

We must note that with Base 37 units involved in the operation of radar and optical ground stations, the headquarters of units may be far from the actual radars they own. This is not unusual for China. The PLA has a habit of placing brigade and regiment level military unit installations in major cities, apparently for improving recruitment and morale.[15] This means that a brigade or regiment may be headquartered hundreds of kilometers from the infrastructure that the unit actually owns or operates. This problem is compounded by the fact that a city government in China may be responsible for tens of thousands of square kilometers of territory. The fact that a military unit appears in propaganda on the website of a local city in China in some cases does not actually narrow the amount of territory the analyst may need to search through to find the unit's infrastructure. Another problem is that many PLA units are responsible for assets across the country, which makes tracking them down a complicated task that sometimes requires searching thousands of square kilometers of territory. Lastly, commercial imagery and textual data linking to the PLA is imperative when identifying SSA and missile early warning facilities because since 2014, the PRC has approved universities and companies with private finance to enter the ground station and SSA sectors.

32035 Troop Headquarters, Likely Base 37 Command Unit
34.369173°, 109.213239°

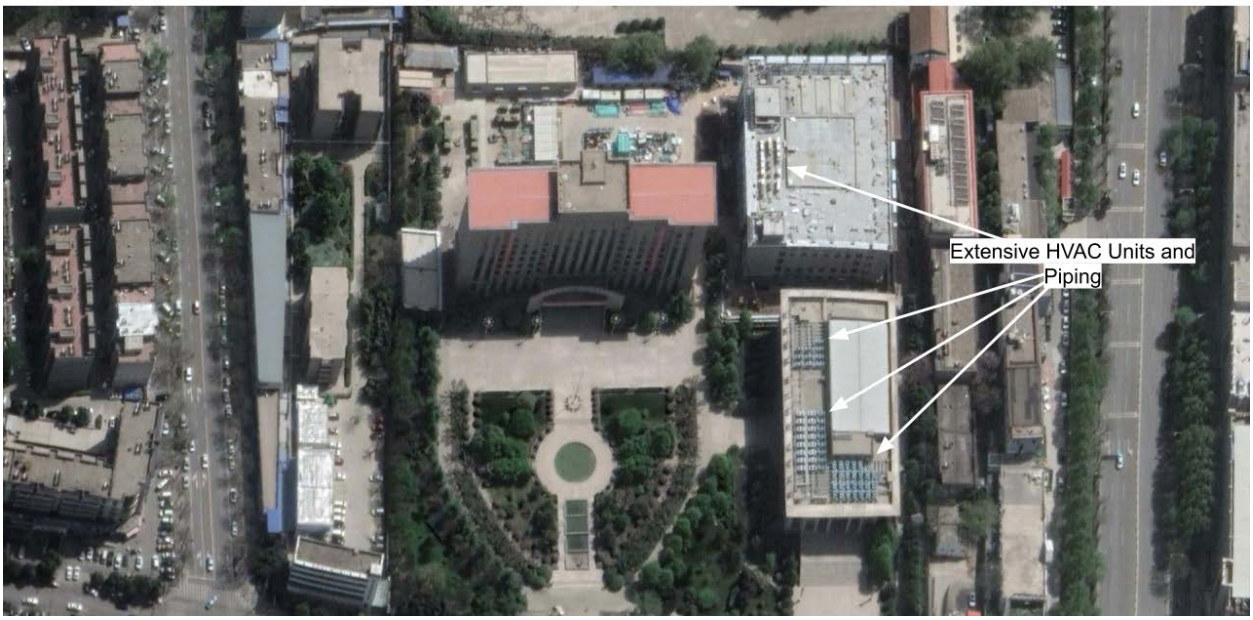

Figure 2: Unit 32035 headquarters

Focusing on the headquarters of Base 37, the address listed in patent information for Unit 32035 leads us to an address in Litong District, Xi'an City.[16] A military administration complex is in the area, and notably this complex has seen comprehensive expansion and modernization beginning in 2020. An existing building was renovated with an unusually large number of rooftop heating, ventilation, and air conditioning (HVAC) units and extensive piping for refrigerant gases while a new building was constructed on site that also displayed an anomalously large number of the same sorts of system. This rooftop setup suggests that whatever is inside of the building requires the regulation of large amounts of heat. It is common to see similar setups at chemical and radiological laboratories, because such laboratories also have extensive venting systems. A similar set up to this HVAC system can be found in buildings that house large amounts of electrical equipment that are expected to be continuously running like a data center. Given that Unit 32035 is responsible for various SSA tasks, it is likely that the anomalous number of HVAC features we see in geospatial imagery is due to the construction of a data center within the buildings for continually processing large amounts of orbital data. This is an important datapoint as it suggests that the headquarters of Unit 32035 is responsible for much more than administrative tasks, and, in fact, is actually the location of one of China's monitoring centers for orbital activity.

Unit 32035 is still only a single piece of the larger organization, however. Base 37 has numerous units under its control and those units appear to have stations positioned across China. Recruiting material for Unit 32035 explains that individuals recruited to the unit may be assigned to garrisons across the country, in places such as Urumqi, Hangzhou, Shandong, Yunnan, Qinghai, Hubei, Jiamusi, and Beijing and Chongqing Municipalities.[17] These locations are notable because they are near other known deep space and LPAR stations.

Figure 3: Chinese Space Launch, SSA, Satellite Control Centers, Command and Control, and Data Reception Stations.[18]

The other units with MUCDs falling between 32035 and 32039 have headquarters scattered across China and may operate stationary data downlink stations or mobile data tracking equipment. While the city or district that each unit is located in is known, some units have not been fully characterized with the method used here, due to lack of available satellite imagery. In addition, it is difficult to say with certainty which units transferred from other branches or organizations, like the PLAAF or GAD, are overseen by Base 37 due to those units keeping their old MUCDs. Only in special cases, like when the headquarters unit of Base 37 directly finances the facilities of one of these bases and leaves a paper trail, can we say that such units are under Base 37.

It is possible – but not confirmed at this point – that each of the subordinate units of Base 37 within the MUCD block 32035-32039 are engaged in specific tasks, similar to how USSF Deltas operate (See Table 1). However, much is still unknown about how the other units transferred to Base 37 operate within this structure. It is possible that such units directly report to the headquarters unit of Base 37, or it is possible that the units within block 32035-32039 operate within their structure similar to how USSF Deltas operate oversee subordinate squadrons, with each unit within the block overseeing the research and execution of a specific task.

MUCD	Location	Notes
32035	Xi'an, Shaanxi Province	Base 37 Headquarters Unit. Has conducted research into a variety of topics related to space object tracking.
32036	Nan'an District, Chongqing Municipality[19]	Purpose of the unit is unknown. Has conducted research into airborne early warning radar design.[20]
32037	Yao'an County, Yunnan Province[21]	Members of this unit publish on topics related to optical space tracking topics.[22]
32038	Nanchuan District, Chongqing Municipality[23]	Head of this unit is described as a "station chief." Lack of available imagery over the district makes characterization difficult.
32039	As of May 2023, Unit 32039 had multiple locations in Henan Province (Sanmenxia, Xuchang, and Jiaozuo cities) and Beijing (Haidian and Mengtougou districts). A Base 37 component called the SSF Base 37 Third Monitoring and Early Warning Station is located in Lichuan City, Hubei Province[24]	Composed of units managing the national satellite communications network.[25]

Table 1: Base 37 units

Base 37's LPAR Stations

As missile early warning is a key part of Base 37's mandate, it is possible that at least some units operating China's network of LPAR stations will be placed under the command of this base. China has an expanding network of LPAR stations to provide early warning against incoming aircraft and missile threats. The locations of many of these radar stations are well known, as such radar are very large and impossible to hide.[26] Knowing their locations alone, however, does not tell us who operates them, let alone their specific use, and as such we must discover this using the methods outlined. By utilizing and incorporating geospatial data into our open-source portfolio, we can identify signatures shared between bases that may hint at the operators of each unit.

The issue of the LPARs came to my attention after I discovered a contract document in my initial sweep for documents related to Unit 32035 for the construction of a new base for Unit 95921 in Jinan, Shandong.[27] The contract has precise directions to the plot of land the new base was to be built on, and satellite imagery confirms that a new military base is being built at the location. Unit 95921's MUCD would theoretically place it with the PLAAF, but many units that

transferred to the SSF have retained their old unit numbers. The fact that this unit, formally belonging to the PLAAF and located in the middle of a city away from any airfield, suggests that this unit is responsible for a support function, like electronic intelligence or radar operations. There are no radar on the unit's new base, which is not unusual, and the nearest LPAR is 120 kilometers away. As previously explained, it is not unusual in the PLA for a headquarters unit to be placed a long distance away from the sites the unit operates.

When the researcher encounters an MUCD and it may be unclear what service the unit belongs to, an easy way to confirm their identity is to see if the unit appears in any pictures made available by Chinese propaganda sites or local governments. Given that 32035 is paying for Unit 95921's new headquarters, it is almost certain that Unit 95921 is an ASF unit under Base 37. Thankfully, this is usually surprisingly easy to do in China. Local governments are eager to show that they work closely with and support local military units in their area, and there are usually pictures of the military unit meeting with local government officials or participating in some sort of charity event available for collection online. In this case, Unit 95921 appears in a recent photoshoot wearing SSF uniforms, confirming that they have been transferred to the SSF.[28]

Another piece of critical evidence comes from an article published in the *Journal of Radar and Science Technology* (雷达科学与技术) titled "Research on Optimal Configuration of Large Phased-Array Radar Antenna Array Spare Parts" (大型相控阵雷达天线阵面备件优化配置研究) that was coauthored by a member of Unit 95921 in 2017.[29] Given that Unit 95921 is a member of Base 37, is physically located near a radar, and is engaged in the maintenance of LPAR stations, it is likely that this unit operates or at least uses the data from the LPAR station in Jinan.

We now know that Base 37 operates at least one of China's LPAR stations. The question now is how many of these LPAR stations are under Base 37. Geospatial analysis can assist in attempting to answer this question. The task is now comparing the LPAR station at Jinan to all the other LPAR stations in China and collecting data on who may own each radar (See Table 2). The locations of many of China's LPAR stations are well known and have been tracked for quite some time.[30] China currently operates at least seven large LPAR stations across the country. China's experience with such stations stretches back decades. Beginning in the 1970s, China has operated a fixed LPAR station pointed towards the Soviet Union (now Russia) outside Xuanhua, Hebei, near Beijing.[31] Over the last 30 years, China has expanded the number of LPAR stations in operation, but this progress happened slowly and was overseen by different organizations. Before the establishment of the SSF, some of these stations were operated by the Second Artillery or the PLAAF.

Even after the reorganization of the PLA and establishment of Base 37, it appears not all LPAR stations are under Base 37. A new LPAR station, built on the coast of China in Sheyang County, Jiangsu Province, is almost certainly operated by PLAAF Unit 94535. A publication from the Sheyang Country Veterans Affairs Bureau refers to this unit as the "Air Force Liuduo Radar Station 94535 Unit 72 Detachment" (空军六垛雷达站 94535 部队 72 分队), and the radar unit in question is located only 10 kilometers from Liuduo Township (六垛乡) in Sheyang

County.[32] This radar was constructed in late 2020 through 2021 and appears to have been operational by early 2022. The radar is pointed in the direction of the Korean Peninsula and is likely used to track U.S. and South Korean air operations.

Name		MUCD	Location	Notes
Xuanhua, Hebei LPAR			40.446830°, 115.116479°	First LPAR operated by Second Artillery. Current status unclear, support buildings in state of disrepair.
Korla, Xinjiang LPAR			41.641194°, 86.236749°	Second LPAR, likely used to support missile testing.
Jinan, Shandong LPAR		95921	36.025000°, 118.091944°	Likely Base 37. Extensive underground facilities.
Hangzhou, Zhejiang LPAR			30.286567°, 119.128608°	
Pingliang, Gansu LPAR		63726[33]	35.483008°, 106.571892°	
Jiamusi, Heilongjiang LPAR			46.527581°, 130.756423°	
Sheyang, Jiangsu LPAR		94535	34.056541°, 120.357448°	PLAAF Unit

Table 2: Known LPAR stations in the PRC

It is notable that the radar sites listed in the table have some overlap with the list of sites provided in Unit 32035's recruitment material and the locations of LPAR stations. Hangzhou and Jiamusi both host LPAR sites, but the connection is not as strong as Jiamusi also hosts a Chinese Academy of Sciences deep space radar.[34] Jiamusi was host to at least one SSF unit, but it is unknown if this unit operates a part of the facility, like the LPAR, or is a guest at the Chinese Academy of Sciences facility.[35]

Taking a closer look at each radar in question, I first looked at each location and noted when they were constructed and the time of any important changes in the infrastructure of the location. Even supporting infrastructure that may seem innocuous or of no interest to a capabilities-based assessment may yield important clues about the operation of the organization.

The level of supporting infrastructure varies at each location, which is not all that surprising (See Table 3). Locations will require different levels of supporting infrastructure depending on different factors like difficulty of maintenance and how close they are to a nearby city. Of note is the fact that some of the sites have been recently renovated in very similar ways. At several sites, they have built next to or nearby the LPAR what appears to be a garage and a small gas station. Historical imagery of the sites reveals that the gas station sites were constructed by first digging a shallow hole in the ground, likely for the installation of gasoline

tanks. Once this hole is filled and covered with a concrete pad we see several small features at each site, likely ports for the extraction of gasoline.

An alternative hypothesis that these sites were for either communications or weather monitoring was also considered, but was discarded as one of the sites is covered by a permanent fixture and the inability to explain why a communications or weather monitoring station would require significant ground excavation. The fact that these facilities were constructed at the same time as a garage increases the confidence that these installations are for gasoline. Not only are the gas stations of similar construction, so are the garages. At two sites, the garages are both about 50 meters in length and are of similar design. The fact that these facilities are likely garages and gasoline stations is notable in its own right, as it suggests that SSF/ASF vehicles are transiting back and forth from the LPAR stations from long distances away.

Name	Dates of Construction	Dates of Renovations	Notes
Xuanhua LPAR	1980s	No significant renovations detected.	Decaying state of support building suggests this facility may not be operational.
Korla LPAR	Under construction in 2004. Complete by 2009.	No significant renovations detected.	
Jinan LPAR	Under construction in 2012. Operational 2013.	Second LPAR added late 2020. Finished mid-2021.	
Hangzhou LPAR	Built sometime before 2014.	Currently, beginning in 2023, site is under expansion with the addition of an additional facility with at least one large radome and the addition of a garage and gas station. LPAR currently being overhauled.	
Pingliang LPAR	Site clearing began late 2016. Site finished by late 2018.	Garage and gas station added fall of 2022. Renovation finished early 2023.	Referred to as an “XL-3203” type radar.[36]
Jiamusi LPAR	Built before 2011.	Garage and gas station added late 2020. Renovations finished early 2021.	
Sheyang LPAR	Site clearing begins early 2020. Finished mid-2022.	No significant renovations detected.	PLAAF Unit

Table 3: LPAR construction details[37]

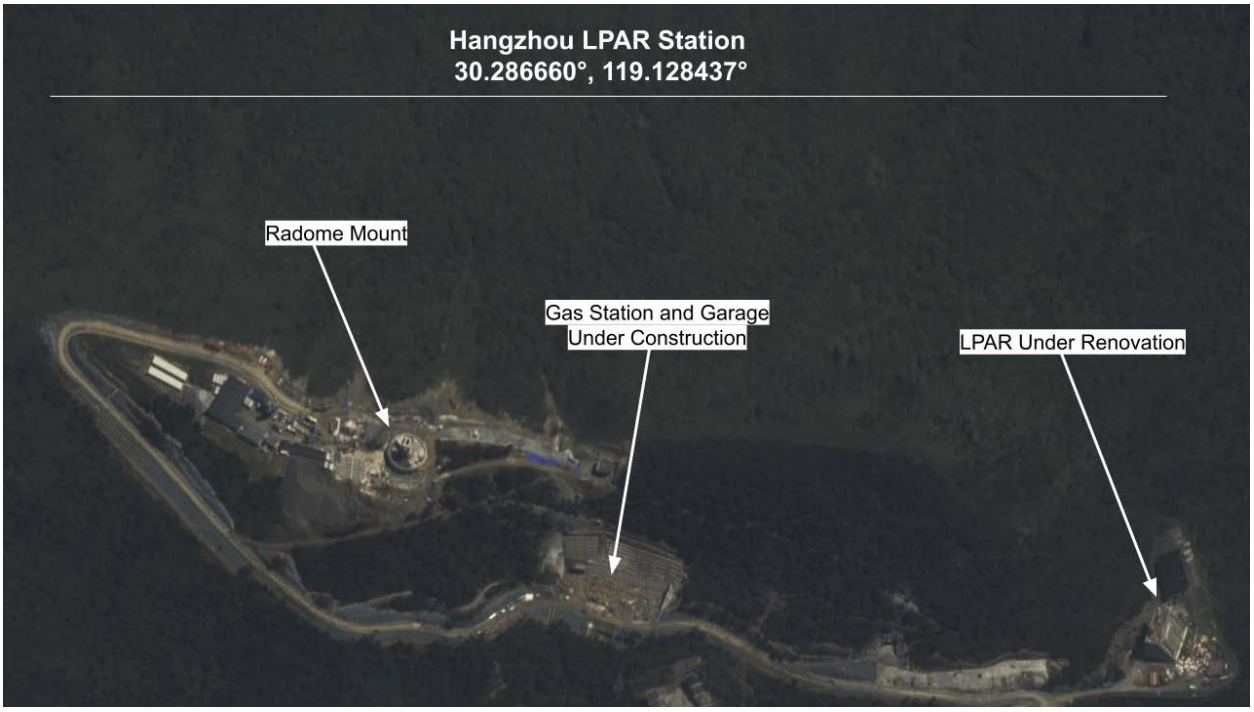

Figure 4: Hangzhou LPAR station

The gas stations and garages that are of similar design have been added to various LPAR stations over the past four years. The similarities between their construction and placement suggest that these facilities are built to a specific standard by a specific organization. It is also notable which LPARs have been renovated with these facilities. Xuanhua is possibly mothballed, and Korla, which may have a dedicated role tracking missile launches, is likely not dedicated to an early warning mission. Hangzhou and Jianmusi, however, appear to have been built as dedicated early warning assets. Their position and heading would not make them suitable for anything else. Pingliang appears to be the outlier, as that system appears to have been originally built by a GAD unit supporting missile testing. It is curious that we see the garages being built at LPAR units with different roles, but not built at others. If Jinan had a similar garage, we may have been able to more safely conclude that the LPAR stations purpose built for early warning were under the same organization while the LPAR stations built for missile tracking are not. Despite these problems, we can still say that given the geospatial evidence, it is possible that the LPAR stations at Hangzhou, Pingliang, and Jiamusi are all under the same organization. If a future link can conclusively prove that one of these units is under Base 37, we could say with much higher confidence that the other two are also Base 37 units.

Space Tracking

If Base 37 is going to take over foreign space object tracking, one would assume they would also absorb or build optical assets. However, at the time of writing, units under Base 37 do not appear to operate the vast majority of optical assets in China. As previously mentioned,

optical sensors are advantageous for high orbit SSA as it allows the user to image and characterize the size and shape of satellites passing above. This gives the user the ability to not only detect satellites operated by foreign states but deduce the likely mission of specific satellites. Generally speaking, PLA researchers have access to national assets for research, such as the Chinese Academy of Sciences (CAS) and the Purple Mountain Observatory, facility in Yao'an, Yunnan.[38]

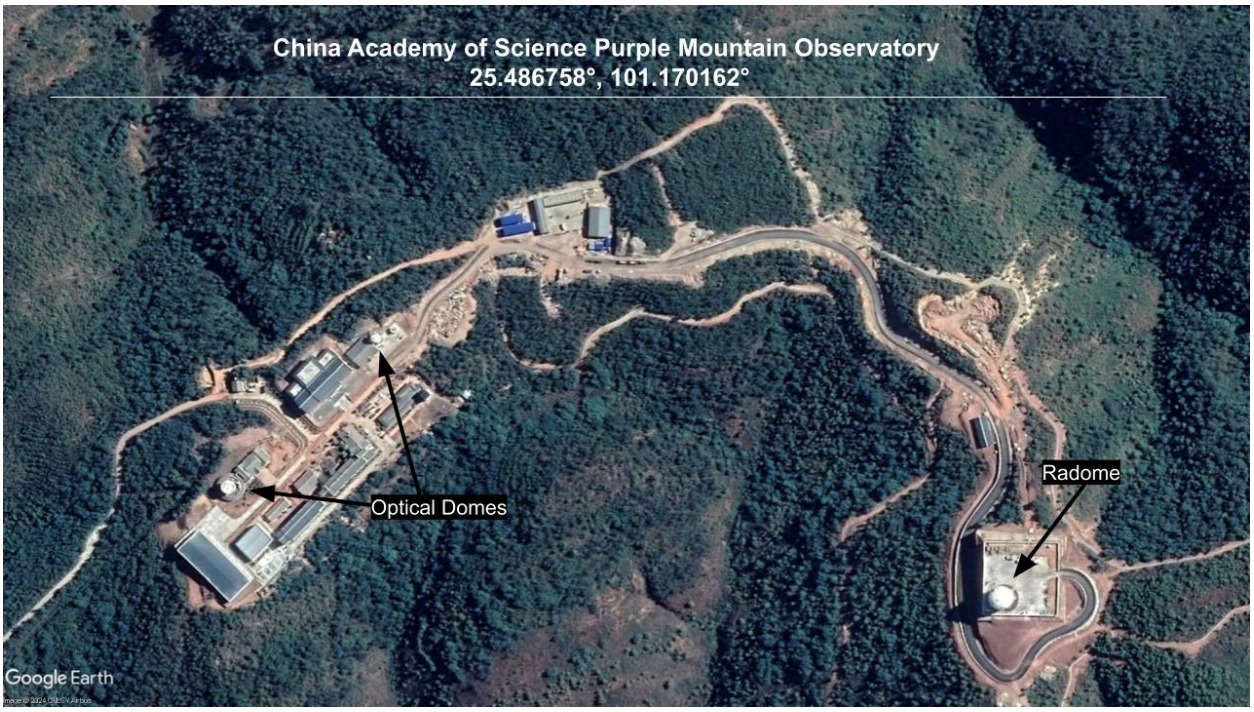

Figure 5: Chinese Academy of Sciences Purple Mountain Observatory

Unit 32037 is subordinate to Base 37 and is involved in research on ground-based optical sensors for SSA. Of particular interest to this unit is researching ways to increase the resolution of China's ground based optical assets. In one article, Huang Jian and Wang Gongchang, the latter a member of Unit 32037, published an article in the *Chinese Journal of Lasers* on utilizing laser guide stars to accommodate for the distortion of light that occurs when light travels from space through Earth's atmosphere.[39] This atmospheric disturbance greatly degrades the resolution of ground-based space sensors, but can be counteracted with systems such as laser guide stars.

This unit is located in Yao'an, Yunnan province, which is also home to optical installations operated by the CAS's Purple Mountain Observatory. Originally constructed in 2011, this facility was composed of two optical installations, one encased in a 12-meter diameter cover and the other inside a 6-meter diameter cover. Dramatic expansion of this facility was conducted beginning in 2020 when a 20-meter radome was added. In 2022, a third optical cover was added to the site. More research is needed to determine if the expansion was primarily

funded by CAS Purple Mountain Observatory, which does world renowned science but also regularly contracts with the PLA.

Similar to the U.S. Maui Optical Observatory, military and science organizations often share locations for optical equipment that is heavily reliant on weather and lighting. Even if tentative, this evidence is unique as it is the only indication of Base 37 having a connection with an optical facility. In fact, the number of optical assets at other SSF/ASF locations is surprisingly light, and those that do exist appear to be directly related to tracking domestic space launches under the launch bases and Base 26.[40] Further research cross-referencing SSF/ASF locations with facilities operated by the CAS may be necessary to further untangle this relationship.

China has a growing number of optical facilities for deep space observation, however, many of the technologies involved in deep space observation, like laser guide stars, are also applicable to satellite tracking. For example, China is building a large complex of optical telescopes in Lenghu, Qinghai Province. Various Chinese state and civilian education institutes are building observatories at this site, some of whom have partnered with American universities.[41] As mentioned above, there is a Base 37 unit in Qinghai, and researchers should keep an eye out for any of its activity in Lenghu specifically.

Conclusions

This geospatial study conducted on Base 37 and its SSA and early warning radar systems reveals organizational issues that may affect the efficiency of China's space object tracking and early warning capabilities. First, we can say that at least one LPAR station has been transferred to Base 37 and that at least three other LPAR stations are possibly under the same organization due to common changes in their support infrastructure. Continued surveillance and data collection of the locations in question will be necessary to positively confirm the organization status of these units.

The fact that after many of the LPAR stations were transferred to Base 37 organizations like the PLAAF continued to construct LPAR stations of their own, may point to continued inter-service bureaucratic tensions between the PLAAF and the rest of the services. Continued tensions between the PLAAF and the ASF on this issue may produce two networks of LPAR stations with overlapping roles, but different command structures and potentially different data management systems that may complicate the PLA's space-situational awareness capabilities and inject confusion into their command-and-control systems. The fact that this may be an issue is supported by the fact that Base 37 appears to be responsible for data analysis of its LPAR stations. It is unknown if the PLAAF LPAR station will be integrated into this data management system.

Further research is required to deduce the precise structure of Base 37. It is possible that the majority of units report directly to Base 37's headquarters unit. It is also possible that the units directly reporting to Base 37are assigned specific subtasks and oversee their own small network of units that fulfill those subtasks. Further research is also needed to examine if the Base 37 units in Yunnan and Qinghai are the primary operators of any of the optical equipment there.

Sharing those facilities does not imply that military priorities would prevail, however. China is also substantially increasing support for space science and space exploration as a way to build its international influence and domestic innovation capacity.

One major aspect of geospatial study is that major conclusions about force structures can come from sources that an individual who was simply focusing on the weapon systems may miss entirely. We can say that it is likely that Unit 32035's headquarters includes a data center by examining its HVAC infrastructure and we can say that many of China's LPAR stations are likely under the same organization by examining its gas stations. Neither of these conclusions involve examining radar or offensive military systems. The supporting infrastructure tells its own story, and in many cases like this allows you to extract certain information that a different study that only examined weapon systems would not be able to.

This case study was intended to both further explore infrastructure changes at PLA space tracking and early warning sites and their relationship organizationally to each other and to give the reader an example of how a geospatial study is conducted and how such a geospatial study can be integrated with other data sources. In this case, our study of how the PLA organizationally oversees its LPAR stations has been illuminated by the addition of geospatial data and the recognition that similarities in infrastructure likely tell us that many of these sites share a common organization. While we have no hard data confirming this and, in many cases, we still have not confirmed if many of these radar systems are under the ASF, laying out similarities between the sites in question can help future analysis. Now that we have examined the similarities between the LPAR sites, further information confirming the organizational status of one site may unlock the others.

Endnotes

[1] Epp, Alexander. “Nachster russischer luftangriff steht offenbar kurz bevor.” Der Spiegel, November 30th, 2022. https://www.spiegel.de/ausland/ukraine-naechster-russischer-luftangriff-steht-offenbar-kurz-bevor-a-1b7ee87f-1c26-475c-81d2-3b516fa2f25e.
[2] Trevithick, Joseph, and Tack, Sim. “Surge In Russian Bombers At Air Base Not As Unusual As Reports Claim.” The Warzone, December 1st, 2022.
https://www.thedrive.com/the-war-zone/surge-in-bombers-at-russian-base-not-as-ominous-as-media-claims.
[3] Eveleth, Decker. “People Liberation Army Rocket Force order of Battle 2023.” Center for Nonproliferation Studies, July 3rd, 2023.
https://nonproliferation.org/peoples-liberation-army-rocket-force-order-of-battle-2023/.
[4] Ibid.
[5] Hayes, Eli. “The Bohu Laser Facility, Part 2: Operations.” Arms Control Wonk Blog, December 21st 2022.
https://www.armscontrolwonk.com/archive/1216867/the-bohu-laser-facility-part-2-operations/.
[6] Warrick, Joby. “China is Building More than 100 New Missile Silos in its Western Desert, Analysts Say.” The Washington Post, June 30th, 2021.
https://www.washingtonpost.com/national-security/china-nuclear-missile-silos/2021/06/30/0fa8debc-d9c2-11eb-bb9e-70fda8c37057_story.html.
[7] For an example of imagery analyst training texts utilized by government agencies, see the Hanham, Melissa, “Photo Interpretation Student Handbook,” Arms Control Wonk Blog, May 27th 2015.
https://www.armscontrolwonk.com/archive/605252/photo-interpretation-student-handbook/.
[8] “Military and Security Developments Involving the People’s Republic of China 2023.” U.S. Department of Defense, October 19th, 2023.
https://media.defense.gov/2023/Oct/19/2003323409/-1/-1/1/2023-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA.PDF
[9] Costello, John, and McReynolds, Joe. “China’s Strategic Support Force: A Force for a New Era.” Institute for National Strategic Studies, October 2nd 2018. Page 22.
https://ndupress.ndu.edu/Media/News/Article/1651760/chinas-strategic-support-force-a-force-for-a-new-era/.
[10] Ibid. Page 1.
[11] Burke, Kristin. “The PLA’s New Base for Space Situational Awareness – Opportunities and Challenges for the U.S.” China Aerospace Studies Institute, September 11th, 2023.
https://www.airuniversity.af.edu/CASI/Display/Article/3498588/the-plas-new-base-for-space-situational-awarenessopportunities-and-challenges-f/.
[12] Mulvaney, Brendan. “The PLA’s New Information Support Force.” China Aerospace Studies Institute, April 22nd, 2024. https://www.airuniversity.af.edu/CASI/Display/Article/3749754/the-plas-new-information-support-force/.
[13] Burke, Kristin. “PLA Counterspace Command and Control.” China Aerospace Studies Institute, December 2023.
https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLASSF/2023-12-11%20Counterspace-%20web%20version.pdf.
[14] University of Science of Technology of China. “中国人民解放军 32035 部队人才引进”September 21st, 2023.
https://ses.ustc.edu.cn/_t1596/2023/0921/c1616a612821/pagem.htm

[15] For example, placing missile brigades near major towns and cities was the policy of the Second Artillery Corps, a policy that appears to have continued under the PLARF.
Wood, Peter, Stone, Alex, and Corbett, Thomas. “Chinese Nuclear Command, Control, and Communications.” BluePath Labs, published by the China Aeropsace Studies Institute, March 2024. Page 27.
https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLARF/2024-03-11%20Chinese%20Nuclear%20Command%20and%20Control.pdf
[16] The exact coordinates to this address were first provided to me by CASI. I have confirmed via my own research into Unit 32035’s patent data. For an example, see:
https://www.patentguru.com/CN220455984U.
[17] Huatu Education. “预公告！ 2024 年战略支援部队 32035 部队人才引进公告 (2).” July 6th 2023.
https://jzg.huatu.com/2023/0706/2665636_2.html and Burke, Kristin. “PLA Counterspace Command and Control.” China Aerospace Studies Institute, December 2023.

https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLASSF/2023-12-11%20Counterspace-%20web%20version.pdf.
[18] “2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion.” Department of Defense, Defense Intelligence Agency, 2022.
[19] Chongqing Nan’an District Veterans Affairs Bureau. “— 1 —重庆市南岸区退役军人事务局 2023 年部门预算情况说明.”
https://www.cqna.gov.cn/bm/qtyjrswj/zwgk_59968/fdzdgknr_59970/ysjs/czys_112716/202303/W020230307590551659742.pdf.
[20] Wanfeng Data Catalogue, search term “中国人民解放军 32036 部队."
https://s.wanfangdata.com.cn/paper?q=%E4%BD%9C%E8%80%85%E5%8D%95%E4%BD%8D%3A%20%22%E4%B8%AD%E5%9B%BD%E4%BA%BA%E6%B0%91%E8%A7%A3%E6%94%BE%E5%86%9B32036%E9%83%A8%E9%98%9F%22.
Li Yongwei, Xie Wenchong, and Wang Shaobo. “Range Fuzzy Clutter Suppression Method for End-Fire Array Airborne Radar.” Radar Science and Technology Journal, 2020,
http://radarst.cnjournals.com/html/2020/2/202002004.html.
[21] Yao’an County Government. “姚安县充分运用“三优”工作法，解决部队“三前三后”问题.”June 9th, 2023.
https://www.yaoan.gov.cn/Pages_9_81308.aspx.
[22] Huang Jian and Wang Gongchang. “Study on Tomography Performance of Multi-Conjugated Adaptive Optics Affected By Configuration of Sodium Laser Guide Star Constellation.” China Journal of Lasers, July 2023.
https://www.researching.cn/ArticlePdf/m00001/2023/50/13/1310004.pdf.
[23] The Paper. “我们的 2020丨不忘初心 不负韶华.” January 22nd, 2021.
https://m.thepaper.cn/newsDetail_forward_10908588.
[24] Burke, Kristin. “PLA Counterspace Command and Control.” China Aerospace Studies Institute. December 2023. Page 68-70.
https://www.airuniversity.af.edu/CASI/Display/Article/3612979/pla-counterspace-command-and-control/.
[25] Ibid.
[26] Wood, Peter, Stone, Alex, and Lee, Taylor A. “China’s Ground Segment: Building the Pillars of a Great Space Power.” BluePath Labs, Published by the China Aerospace Studies Institute. March 1st, 2021.
https://www.airuniversity.af.edu/CASI/Display/Article/2517757/chinas-ground-segment-building-the-pillars-of-a-great-space-power/.
[27] Biaozhaozhao. “槐荫区淄博路以东、德州路以南、青岛路以北、东营路以西.” August 27th 2023.
https://www.biaozhaozhao.com/land/c980772103e86d45ab212d9521155f5c.
[28] Shandong Provincial Cultural Center. “我为群众办实事——“癸卯贺新春 春联送祝福” 活动走进驻济 95921 部队.” January 13th 2023.
https://www.sdpcc.cn/document/3937.html
[29] Chang Chunhe, Wu Gaowei, Yu Xingwei, and Yao Xu. “大型相控阵雷达天线阵面备件优化配置研究.” Journal of Radar and Science Technology, 2017, 15(3), pages 334-338.
http://radarst.ijournal.cn/ldkxyjs/ch/reader/view_abstract.aspx?file_no=20170321&flag=1.
[30] Wood, Peter, Stone, Alex, and Lee, Taylor A. “China’s Ground Segment: Building the Pillars of a Great Space Power.” BluePath Labs, Published by the China Aerospace Studies Institute. March 1st, 2021.
https://www.airuniversity.af.edu/CASI/Display/Article/2517757/chinas-ground-segment-building-the-pillars-of-a-great-space-power/.
[31] Stokes, Mark. “China’s Strategic Modernization: Implications for the United States.” United States Army War College Press, September 1st, 1999.
https://press.armywarcollege.edu/monographs/149/.
[32] Xinhua Daily Media Group. “射阳县退役军人事务局：加大政策解读力度 送上服役 “定心丸.”” June 17th, 2022.
http://jres2023.xhby.net/yc/zx/202206/t20220617_7586181.shtml.
[33] Wood, Peter, Stone, Alex, and Lee, Taylor A. “China’s Ground Segment: Building the Pillars of a Great Space Power.” BluePath Labs, Published by the China Aerospace Studies Institute. March 1st, 2021.
https://www.airuniversity.af.edu/CASI/Display/Article/2517757/chinas-ground-segment-building-the-pillars-of-a-great-space-power/.
[34] Ibid.

[35] For references placing both the deep space radar station and the LPAR, see Wood, Peter, Alex Stone, and Taylor A. Lee. Also see the Chinese Academy of Sciences website for its locations. Just like in Maui, USSF and the National Science Foundation are collocated to leverage an excellent location.
Jiamusi was home to at least one SSF unit, as a spotlight featuring a former SSF soldier specifies he was stationed in the city. The Paper. “骄傲！贵州籍学子作为学生代表在中国人民大学毕业典礼演讲.” June 29th, 2022. https://m.thepaper.cn/newsDetail_forward_18792465.
[36] Wood, Peter, Stone, Alex, and Lee, Taylor A. “China’s Ground Segment: Building the Pillars of a Great Space Power.” BluePath Labs, Published by the China Aerospace Studies Institute. March 1st, 2021. https://www.airuniversity.af.edu/CASI/Display/Article/2517757/chinas-ground-segment-building-the-pillars-of-a-great-space-power/.
[37] Because many of these stations were constructed more than a decade ago, this table must rely heavily on archival Google Earth imagery and other archival sources, and these sources do not enjoy high revisit rates. Monthly or years may pass between available images, and this lack of data has significant effects on the data available.
[38] Yao'an Observation Station, PMO, CAS, http://english.pmo.cas.cn/resources/facilities/201911/t20191123_226178.html.
[39] Huang Jian and Wang Gongchang. “Study on Tomography Performance of Multi-Conjugated Adaptive Optics Affected By Configuration of Sodium Laser Guide Star Constellation.” Chinese Journal of Lasers, July 2023. https://www.researching.cn/ArticlePdf/m00001/2023/50/13/1310004.pdf.
[40] For example, 41.326057°, 100.365210° is the optical tracking facility for the Jiuquan Satellite Launch Center.
[41] The complex is located at 38.559971°, 93.689017°. Patel, Neel V. “Chinese Astronomers want to build an observatory in the Tibetan Plateau.” MIT Technology Review, August 19th, 2021. https://www.technologyreview.com/2021/08/19/1032320/chinese-astronomers-observatory-tibetan-plateau-lenghu/.