NASA in the Second Space Age: Exploration, Partnering, and Security

The launch of Sputnik in 1957 and the dawn of the space age set off a frenetic competition between the Soviet Union and the United States. In the years that followed, both nations developed and orbited military satellites with increasingly sophisticated capabilities for intelligence collection, communications, and missile warning—capabilities largely intended to support strategic nuclear forces.[1] For more than three decades the competition between these two superpowers was relatively stable, marked by notable periods of cooperation and engagement. Since the end of the Cold War, however, a gradual change has been under way, driven in part by advances in technology and the proliferation of space capabilities. This transformation has ushered in what the National Aeronautics and Space Administration's (NASA) Tom Cremins has termed the "second space age."[2]

The second space age arguably began with the 1991 Gulf War. This conflict demonstrated, for the first time, the distinct advantages space-based capabilities can provide in conventional war fighting. The collapse of the Soviet Union also changed the geopolitical landscape and weakened the superpower duopoly in space. The 2011 National Security Space Strategy (NSSS) defines this new era by what has become known as the three Cs: congested, competitive, and contested.[3] Space has become congested as more nations and private companies are launching and operating satellites for a variety of missions and increasingly competitive as they vie for economic and strategic advantage. According to the Space Foundation, global space activities generated some $330 billion in economic activity in 2014, more than three-quarters of which came from commercial space products, services, infrastructure, and support.[4] A robust group of space startup companies has also emerged in recent years, injecting a fresh wave of innovation and competition in the space industry.

Perhaps the most disturbing attribute of the second space age is that space has become an increasingly contested domain. The United States is not alone in its use of space for military applications; more than 20 nations currently operate military satellites, making space a critical domain in modern warfare.[5] Because of the many military advantages

space offers, potential adversaries have made advances in antisatellite technologies—both kinetic and non-kinetic—to deny the United States and its allies the benefits of space-based capabilities. And as the 2007 Chinese antisatellite missile test demonstrated, widely accepted norms of behavior in space remain lacking.[6]

At the same time, NASA's role in space exploration is at an inflection point. The International Space Station (ISS) and human spaceflight to low Earth orbit (LEO) have been the centerpieces of NASA's mission for decades. Since the retirement of the space shuttle in 2011, however, NASA no longer has the ability to launch astronauts. Servicing of the ISS for both cargo and crew has transitioned to commercial companies and the Russian Federation. With the ISS currently scheduled for retirement in 2024 and work on the new Space Launch System (SLS) and the multipurpose crew vehicle known as Orion still in progress, NASA is shifting its attention to human exploration beyond LEO.

The 2011 NSSS states that, "Our strategy requires active U.S. leadership enabled by an approach that updates, balances, and integrates all of the tools of U.S. power."[7] But one of the most powerful tools available to the United States is not mentioned in this strategy. NASA and its vast network of commercial and foreign government partners are a key component of US national power and influence in the space domain. Virtually every nation that aspires to play a significant role in space wants to partner with NASA due to its technological expertise and powerful brand image. For many, it is an important symbol of prestige and power to join the club of responsible, spacefaring nations led by NASA.

This confluence of circumstances—the increasingly congested, competitive, and contested nature of the second space age and NASA's shift in mission focus beyond LEO—presents a once-in-a-generation opportunity to define the terms by which the second space age will operate. Will the space domain be a wild frontier where nations go it alone? Or will it be a more cooperative domain where norms are respected and the United States retains its leadership position? The next administration should seize this opportunity to set a new space exploration strategy for NASA that advances US interests in space by pushing the boundaries of human knowledge, bringing new partners into the club of responsible, spacefaring nations, and extending US leadership in this vital domain.

A Space Exploration Strategy

A new strategy for space exploration beyond LEO must include long-term exploration objectives that excite and inspire public support and near-term milestones that are technologically and fiscally achievable. In April 2010 Pres. Barack Obama gave a major address on space exploration at Kennedy Space Center. In his address, the president laid out a series of incremental improvements in capabilities, including: a new space telescope to replace Hubble; increased Earth-based observation for climate monitoring; extending the life of the ISS and working with private companies to deliver cargo and crew to the ISS; increased robotic exploration of the solar system, including scouting missions to Mars and other celestial bodies; continuing the Orion space vehicle program; and building SLS to provide a heavy lift launch capability for future missions. But the president only briefly mentioned his long-term objectives for where these space-exploration capabilities would take the United States. He called for sending humans to an asteroid sometime in the mid–2020s, to orbit around Mars in the mid–2030s, and eventually to land on Mars without any specific timeframe mentioned.[8] In the NASA Authorization Act of 2010, the most recent policy bill enacted for the agency, Congress stipulated that future missions beyond LEO should be designed to incorporate international contributions and that SLS and a multipurpose crew vehicle should be the building blocks for these future missions.[9]

At the most basic level, strategy is about bringing ends, ways, and means into alignment. For NASA, the desired "ends" are its exploration objectives, whether to cislunar space, an asteroid, Mars, or beyond. The "ways" are how NASA plans to achieve its objectives—the specific programs and activities it undertakes and the ways it engages with partners. But having a desired end state in mind and a plan to get there is not sufficient. The "ends" and "ways" of a strategy may be constrained by the "means." NASA's means include the people it employs, the labs and facilities it maintains, the annual budget it receives from Congress, and the many industry and international partnerships it sustains. An exploration strategy set without regard for the means required risks being un-executable in practice. Furthermore, the heart of an effective strategy is not just determining what one *will* do but also what one *will not* do.[10]

In his 2010 speech, President Obama proposed increasing NASA's budget by $6 billion over the next five years. Due to budget constraints imposed by the Budget Control Act (BCA), however, NASA's budget

declined by 12 percent in real terms from FY10 to FY15.[11] The BCA budget caps are set to remain in effect through FY21, meaning that without a broader budget deal NASA is unlikely to receive a significant increase in funding in the near future. Moreover, because NASA's budget falls within the nondefense side of the budget caps, it competes directly with other domestic programs which are projected to continue growing for the foreseeable future. That means any increase in funding required for new exploration missions must be offset in part by reductions in legacy missions or the reallocation of science and technology investments to more directly support the exploration challenges ahead.

Challenges That Are NASA-Hard

When setting its exploration objectives, NASA should focus squarely on challenging missions where there are significant risks that only NASA can or should assume—challenges that are truly "NASA-hard." For example, in space exploration there is always the possibility that a mission may fail to achieve its objectives or discover anything of value. The risks of mission failure are often highest when pushing the outer limits of human knowledge—looking beyond where humans have explored—because there may be nothing of interest. When the mission risk-reward imbalance is too great, commercial firms and other government agencies are often reluctant to engage in this type of exploration. Yet these are exactly the type of high-risk ventures an agency like NASA ought to undertake to expand the boundaries of human knowledge.

Another type of risk only NASA should assume is extreme risk to human life. While sending humans into LEO remains risky, the safety of human spaceflight has improved to the point that NASA has begun the process of ceding human spaceflight in LEO to commercial companies, and numerous commercial ventures are on the verge of creating a space tourism industry. The technological advancements that made this possible are the result of billions of dollars invested in research and development and real-world experience by NASA over the course of nearly six decades. Human spaceflight beyond LEO, however, is less well understood, and further research and development remain to be done. Only nine manned missions flew beyond Earth orbit as part of the Apollo program, six of which landed on the moon, while there have been hundreds of manned missions to LEO. The risks to humans for missions to the moon, Mars, and beyond remain high—perhaps too high for

nongovernment entities to undertake at this point, notwithstanding statements by SpaceX's Elon Musk, who, regardless of ambition, must continue to rely on NASA's help and expertise.[12] With groundbreaking investments in exploration by NASA, however, human missions beyond LEO could one day be opened to commercial ventures at a more acceptable level of risk.

A final type of risk that NASA is uniquely positioned to assume is the risk associated with large capital public goods projects. The ISS, for example, is effectively a massive infrastructure project in space that provides a public good for humanity: a zero-gravity laboratory that serves as a platform for many other missions and scientific experiments. It does not make economic sense for a private company to fund projects like the ISS, with its price tag of over $100 billion. Even if a company were so inclined, it is unlikely that it could raise the capital required for such a project or ensure a healthy return on investment. Some space missions, like the ISS, are so large that they can only be undertaken by NASA. However, once these investments are made, they can be leveraged by private companies for commercial purposes, such as testing new drug-manufacturing technologies or as a destination for space tourism.[13] NASA's investments in space infrastructure, like the ISS, may also serve as an impetus for private companies to invest in the development of smaller human platforms to retain these capabilities once the ISS is retired.

Strategic Partnering

Armed with a space-exploration strategy that has long-term objectives, near-term milestones, and a focus on challenges that are NASA-hard, the next challenge is to build a coalition of industry and international partners with a shared interest in the mission. Partners are a critical component of any future space exploration strategy because NASA is not likely to have the resources or capabilities to pursue its ambitions alone. One of the key challenges for NASA in executing a new space-exploration strategy is determining what capabilities it should keep internally and what it should outsource to others. While the exploration objectives may be things that are truly NASA-hard, the capabilities required to pursue these objectives may not be the exclusive domain of NASA. Capabilities that once were core to NASA's identity, such as human spaceflight to LEO, are quickly becoming the domain of commercial firms. The ISS, for example, may soon be approaching the point where it can transition

to commercial operations, either partially or in full, which would free up resources within NASA that could be applied to new missions. As NASA shifts its focus to new objectives, it will need to refocus its internal capabilities—including science and technology investments—on areas in which no commercial market exists and ruthlessly divest itself of internal capabilities that can be more effectively provided by industry. However, when leveraging the innovation and expertise of industry, NASA must also be careful not to become overly dependent on companies with untested business models or objectives that may diverge from NASA's interests.

An ambitious space-exploration agenda also presents an opportunity to extend and expand NASA's network of international partners to advance broader US foreign policy and national security objectives. The 2011 National Security Space Strategy states that the United States "will encourage responsible behavior in space and lead by the power of our example."[14] NASA is perhaps the best example the United States has to offer for the peaceful and responsible use of space. Moreover, NASA's vast network of international partners is a source of strategic advantage for the United States that can be leveraged to help promote stabilizing norms of behavior in space.

Since many other nations do not maintain a clear separation between military and civil space activities, decisions on whom to partner with on civil space programs must take into account potential security implications. However, geopolitical competition and even antagonism between nations do not necessarily preclude the possibility of cooperation in civil space exploration. History has shown that cooperation in civil space programs that is mission focused and mutually beneficial can proceed largely independent of competition in other areas.

Perhaps the best example of this is the cooperation between the United States and the Soviet Union that took place throughout the Cold War. Beginning with the Kennedy administration, the two superpowers engaged in a series of cooperative ventures that included sharing weather satellite data, mapping the Earth's geomagnetic field, and experimenting with communication relays in space. In the 1970s, the two rivals embarked on a joint human spaceflight program known as the Apollo-Soyuz Test Project. While US cooperation was through NASA, the Soviet civil space program was secretive and intermixed with the military's space command. As Russian physicist (and former science advisor to Soviet

Pres. Mikhail Gorbachev) Roald Sagdeev and international security and space policy expert Susan Eisenhower have noted, this cooperation gave the United States valuable insight into the largely shrouded Soviet space enterprise.[15] Following the breakup of the Soviet Union, cooperation and insight into Russian space programs continued first with visits of the US space shuttle to the Russian Mir space station and then with the Russian Federation joining the ISS consortium—a partnership that continues today. Perhaps the longest-running example of international partnership in space is the US-Russian Joint Working Group on Space Biology and Medicine, which has been active since 1971 and has spanned the Apollo-Soyuz, Shuttle-Mir, and ISS programs.[16]

As this example demonstrates, partners do not have to like each other to cooperate successfully if the basis of their partnership is a shared interest in the mission. Despite a marked decline in the US-Russian relationship in recent years, cooperation on civil space programs has so far not been affected. Both the United States and Russia have a shared interest in continuing to cooperate because neither can maintain the ISS or a robust human spaceflight program on its own. Nevertheless, one must be mindful of the geopolitical risks and opportunities involved in partnerships that create an interdependence with other nations.

Partnerships can also be beneficial for strategic reasons beyond just the mission at hand. For example, the United States could partner with another nation to influence the direction of that country's space activities and encourage norms of behavior ranging from limiting the production of space debris to sharing scientific data. The United States can also use the enticement of partnering on civil space programs to discourage other countries from engaging in activities that would be detrimental to US interests.

Partnerships on civil space programs can also provide valuable insight into the organizations and space activities of other countries. For example, China does not make the same distinctions between civil and military space programs as the United States. This comingling of programs leads to great uncertainty and mistrust on the part of the United States, which has been noted by the US-China Economic and Security Review Commission. In its 2015 report, the commission quotes one expert as saying, "China's space program does not have structures in place that make meaningful divisions between military and civil programs, and those technologies acquired and systems developed for ostensibly civil

purposes can be applied—and most frequently are—for military purposes."[17] The lack of separation between military and civilian programs invites suspicion and should not be ignored. But just as the United States partnered with the Soviet Union during the Cold War, partnering with China on select civil space programs could provide greater insight into an otherwise opaque system. This kind of partnership can reduce uncertainty regarding China's space activities and help encourage investment in more peaceful and stabilizing space capabilities. It could also lay the groundwork for military-to-military contacts between the US and Chinese militaries' space commands, something that is sorely needed and is vital to stability and mutual understanding in a crisis situation.

When selecting partners, one must also be mindful to avoid incentivizing others to develop or mature dual-use technologies with national security implications. In 1996, the failed launch of a Chinese Long March rocket carrying a US commercial satellite led to a US company transferring technical data to the Chinese that helped improve their launch capabilities. Since this technical data was also relevant to China's long-range missile programs—a key national security concern for the United States—it led to strict controls being put in place to prevent future technology transfers.[18] Technology transfers such as this are clearly prohibited by law, and partnerships for civil space programs should go one step further and avoid partnering in any way that could incentivize or assist a rival power in the development of military space capabilities. Instead, partnerships with military rivals should be focused on missions that have little if any direct military applications, such as human spaceflight and deep space missions.

Guiding Principles for International Partnerships

International partnership decisions should be informed by a fundamental set of guiding principles. These principles must be consistent with NASA's exploration strategy and considerate of geopolitical factors and domestic politics in the United States and its partner countries. Based on the past experiences of NASA, the European Space Agency (ESA), and other space agencies as well as best practices gleaned from other international organizations, four fundamental guiding principles for international partnerships stand out for consideration.

1. **International partnerships should be based on areas of mutual interest and benefit**. As Dr. Jean-Jacques Dordain, the former director general of ESA, has noted, when it comes to building strong relationships, mutual interest is in many ways more powerful than love. Partners do not need to love each other or even like each other—they merely need to have a shared interest in the mission.[19] Partnerships should be structured in a way that each partner is better off in net from partnering than from not partnering. The benefits each partner derives from cooperation, however, do not need to be symmetrical. For example, a smaller space agency may benefit from the prestige and resources of partnering with NASA, while NASA may benefit from getting access to facilities, geographical locations, or specific technical expertise.

2. **New partners should not come at the expense of existing partners**. For multinational endeavors, all parties should be consulted and should consent to adding new partners, and new partners should bring value that benefits each of the existing partners. Moreover, NASA must be careful to consider how new bilateral agreements—even if they involve separate and distinct mission areas—could affect existing partnerships in other areas. When reaching out to new partners, careful coordination and open communication can help prevent existing partners from feeling isolated or undermined.

3. **Each international partner should self-fund its part of the project**. While not an absolute rule, this structure helps prevent the need for complex contracting and fund-transfer agreements and is one of the guidelines for international cooperation NASA already follows.[20] It also helps alleviate negative competition or resistance from each country's industrial base, where fears of commercial loss often result in resistance to international partnerships. Moreover, self-funding avoids putting partner governments in the sometimes awkward position of appropriating funds for another government's agency and industrial base. When each partner funds its own contribution to the project, it keeps the partnership focused on the mission rather than on the financial details. In the no-exchange-of-funds model, each partner also assumes the risk of cost overruns for its part of the project, creating a strong incentive for each partner to manage and control the cost of work under its direction.

4. **International partnerships should be structured so that they do not rely on the exchange of technology**. The transfer of technology, particularly in the area of space systems and launch vehicles, is a sensitive issue even among close allies. In the no-exchange-of-technology model, each partner is responsible for developing and applying its own technology for its part of the project. The exchange of technical information can then be limited to the minimum level of information needed for technical interfaces between mission modules—another guideline for international cooperation NASA already employs.[21]

Conclusion

NASA is at an inflection point. With the impending retirement of the ISS and the opportunity for human exploration beyond LEO, NASA is well positioned to continue its leadership role in the second space age. But to make this transition a success, it needs two things. First and foremost, it needs a space exploration strategy with clear, long-term objectives that are truly NASA-hard to excite and inspire public support. Just as important, it also needs a robust network of industry and international partners that shares its exploration objectives and has meaningful capabilities to contribute.

In many ways, NASA's challenge is to make a dime out of 10 pennies. It must bring together a network of industry and international partners—including new and nontraditional partners—in a cohesive and coherent manner to advance its exploration objectives. With a clear strategy that sets long-term objectives that excite and near-term milestones that are achievable, NASA can reorient itself to work with new partners in more innovative and effective ways. Without such a strategy, however, NASA risks spending a penny here and a penny there and not having a dime to show for it.

NASA's leadership still has no equal or substitute in the second space age to foster international cooperation, to push the technological envelope, and to promote responsible and stabilizing norms of behavior. While the hard power of NASA's technical prowess has long been held in high regard, the soft power of NASA's influence through agreements with industry and foreign governments has yet to be fully realized. US national security relies on commercial and military space-based capabilities that are

increasingly at risk, and other nations, private companies, and the rest of the US government look to NASA to promote cooperation and the peaceful use of space. While NASA was the indispensable partner of the first space age, NASA's network of partnerships is the indispensable ingredient for security and continued US leadership in the second space age. SSQ

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Notes

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