
**Space and the Quad Powers**

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The ability to access space and utilize it in support of national security objectives has become a central consideration in modern conflict. Since the first Gulf War over a quarter century ago, space systems, including communications, weather, observation, and navigation satellite constellations have become essential elements of modern warfare, providing vital information for the movement of forces, guidance of weapons, provision of logistical support, and general coordination of high-intensity operations. The various conflicts since then, in the Balkans, Afghanistan, Iraq, and Syria, have only underscored the importance of space systems.

For the members of the Quad – the U.S, Japan, Australia, and India - national security space will be an area of growing concern in the coming decades. Information from space-based systems are assuming a central place in their respective defense planning efforts. At the same time, there is a growing threat to national space systems from the People's Republic of China (PRC). The Chinese People's Liberation Army (PLA) has determined that establishing "space dominance" (*zhitian quan*; 制天权) is a major element of establishing "information dominance" (*zhi xinxi quan*; 制信息权), which is vital for winning future wars.

***KEY SPACE MISSIONS***

The ability to conduct precision warfare as exhibited in recent conflicts such as the first Gulf War (Operation Desert Shield/Desert Storm), military operations in the Balkans, the toppling of the Taliban in Afghanistan, and the 2003 Iraq War is partly an outgrowth of space capabilities over the past half century.

Orbiting satellites do not have to pay attention to terrestrial borders. Depending on their payloads, they can also often operate without regard for terrestrial weather or geography;

synthetic aperture radars (SAR), for example, can penetrate cloud cover and still provide high-resolution radar images of various features. Because satellites operate high above the Earth, this also allows them to relay communications and data. Global communications depends, in part, on satellites (although submarine cables carry far more bandwidth).

### *Key Space Missions*

***Reconnaissance and surveillance.*** The ability to see "over the hill" has long been a desirable military feature. For both the U.S. and the Soviet Union, the space race was in part an effort to develop reconnaissance and surveillance capabilities in space. For the American intelligence community, this was partly a lesson from the Second World War. "Pearl Harbor was a warning of the dangers of not knowing what America's potential adversaries were planning and capable of doing."[1] Some of the earliest American satellites were therefore reconnaissance satellites, part of the CORONA program. Similarly, some of the earliest Soviet satellites were reconnaissance platforms (the ZENIT series, which began deployment in 1961). These were mainly electro-optical satellites, taking very high altitude photographs in order to detect developments in the inner reaches or secure military bases of the Soviet Union and United States.

Reconnaissance and surveillance satellites now collect a variety of additional information. While there are still imaging satellites, they now can not only operate in the visible light part of the spectrum, but also in other bands, including radar waves. SARs provide radar imaging through clouds and fog. Other types of intelligence gathered by space-based systems include signals intelligence (SIGINT) about various states' communications systems; electronic intelligence (ELINT) about various states' radars and other electronic systems; as well as detection of missile launches and nuclear detonations.

Earth observation satellites also provide important information, including measurements of the Earth's magnetic and gravitational fields, as well as changes in ground cover due to changes in the season. While these are mainly satellites serving civilian functions, their information is also often incorporated into maps and other military information databases.

***Communications.*** These were among the first commercial satellites developed, as they allowed for prompt transmission of information across oceans and continents. While most of the world's telecommunications bandwidth is provided by submarine cables, communications satellites provide additional coverage unaffected by accidental breaks. As important, in remote areas, far from cell towers and landlines, communication satellites remain an essential means of providing communications and data support.

***Meteorological support.*** Given the field of view from space, meteorological satellites play a vital role in predicting weather patterns, which in turn is essential for planning military operations. The ability of the Allied forces to predict a break in the weather in the English Channel, while denying the Germans a similar ability, was central to the success of D-Day, as it caught the Germans by surprise. There are typically weather satellites deployed in both low-earth orbit and geosynchronous orbit, providing different measurements of different atmospheric conditions.

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[1]Dwayne A. Day, John M. Logsdon, and Brian Latell, "Introduction," in Day et al., eds., *Eye in the sky: The Story of the Corona Spy Satellites* (Washington, DC: Smithsonian Press, 1998), p. 3.

***Position, navigation, and timing (PNT).*** The development of navigation satellites began in the 1970s, as the United States and Soviet Union both began to deploy radio beacons into space. Initially supplementing terrestrial systems such as LORAN (LOng RAnge Navigation), space-based systems could also provide altitude information, making them much more useful to pilots. The incorporation of highly accurate atomic clocks further enhanced the role of navigation satellites, as it now could also fulfill a timing function. Since the 1970s, Global Positioning System (GPS) signals have now been incorporated into financial transactions, cell phone operations, and electrical power grids. Military frequency-hopping radios often employ GPS timing signals to ensure the synchronization of their shifts in frequency.

## *The Importance of Space for Indo-Pacific Security*

While these satellite services are important for military operations around the globe, they are especially important given the geographic realities of the Indo-Pacific region. Because of the "tyranny of distance," military activities by the Quad states are often likely to occur at significant distances from one or more of them. This is especially true for the United States, which must travel halfway around the world to operate in the Indian Ocean, and almost as far in order to operate in the western Pacific. Without space-based systems to provide and transmit information, American forces would find it hard to undertake surveillance of a potential adversary, share information among various components, coordinate their operation, or operate many of their most advanced weapons.

But Australian, Indian, and Japanese forces would also find it much more difficult to operate away from their bases, or with each other, if they were deprived of ready access to space systems. As important, American space-based systems often provide important information to supplement local resources and capabilities. Indeed, without space-based telecommunications or intelligence, surveillance, and reconnaissance systems, many forces would be much less able to exploit the full capacity of range and sensors. But because of the high cost of these platforms (advanced satellites typically cost over $1 billion apiece), few states can afford constellations in the aforementioned mission areas, much less all of them.

### *DIVERGENT CAPABILITIES*

For the members of the Quad, there are widely divergent sets of capabilities that each state can bring to bear in space. This, in turn, will make coordinating space policies, especially in the national security realm, more difficult.

### *The United States*

By a large margin, the United States has the most capable space program of the four Quad states. The United States fields constellations in each of the key mission areas. In some, such as communications and intelligence, it is believed to have several. The U.S. Air Force, for example, operates the Global Positioning System (GPS) constellation of PNT satellites, and provides its services for free. For a number of years, it was the only satellite navigation system, as the collapse of the Soviet Union led to the degradation of the Russian GLONASS system.

The extensive American space network is due, in part, to the American ability to afford multiple space systems. In addition, however, it is a function of bureaucratic competition and the division of civilian and military authorities that has led to separate space efforts. Indeed, the United States may be said to have ***four*** space programs.

1. ***NASA.*** The National Aeronautics and Space Administration is probably the best known space agency. It is responsible for scientific exploration of space, including missions to the sun, the Moon, and other planets. It is also responsible for undertaking manned space missions and supporting associated programs such as the now retired Space Shuttle and the International Space Station (ISS).
2. ***NOAA.*** The National Oceanic and Atmospheric Administration is part of the Department of Commerce. It is responsible for managing a number of satellites, including the American weather satellite constellation. After protracted delays, the newest U.S. weather satellite, GOES-16 (Geostationary Operational Environmental Satellite), has entered service.
3. ***Department of Defense.*** The U.S. Department of Defense runs a large number of military satellites in support of various military operations. Many of these are the responsibility of the U.S. Air Force, which is the primary agent responsible for U.S. Department of Defense satellite activities. Among the various DOD satellite constellations are the Space-Based Infrared System (SBIRS) responsible for detecting missile launches; the GPS network, which provides global PNT support; and the Wideband Global SATCOM system (WGS) and Advanced Extremely High Frequency (AEHF) satellites, which provide worldwide communications and data support.
4. ***Intelligence community.*** The United States intelligence agencies also field a variety of satellites in support of intelligence-collection activities. These include satellites dedicated to ELINT, SIGINT, and measurement and signature intelligence (MASINT), as well as electro-optical imaging satellites capable of photographing most of the globe.

In addition to these government programs, there are also a host of commercial satellite operators, including communications but also imagery constellations, which provide vital space-based information support to a variety of government and private customers. These include American companies such as Intelsat and Digital Globe, as well as European and Asian companies such as Eutelsat and Asiasat. It is important to note here that long-haul military communications cannot rely solely on satellites, much less only military communications satellites. Submarine cables and landlines account for perhaps 99% of global bandwidth for communications and data relay.[2]

As one of the two original space powers, the United States has the most extensive history in space, and most well-developed supporting infrastructure among the various members of the Quad. In particular, the United States has some of the most extensive space situational awareness (SSA) capabilities. "SSA seeks to determine the position, function, and current status of every object in space."[3] The SSA task includes determining who owns a particular asset, which may or

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[2]Douglas Main, "Undersea Cables Transport 99 Percent of International Data," *Newsweek*, April 2, 2015, http://www.newsweek.com/undersea-cables-transport-99-percent-international-communications-319072 (accessed October 6, 2017).

[3]Gene H. McCall and John Darrah, "Space Situational Awareness: Difficult, Expensive—and Necessary," *Air and Space Power Journal* (November-December 2014), p. 9.

may not be distinct from who launched it, and where that item might be at any given time. While space systems typically remain in the same orbit, military and intelligence satellites may change their orbits, either to fulfill their mission or to avoid being tracked. In addition, SSA increasingly entails assessing the capabilities of various objects in space; this has become of increasing importance as various states develop co-orbital anti-satellite capabilities, or mount multiple payloads on the same satellite bus. SSA capabilities can also provide information regarding the overall space environment, such as space weather, which in turn can be used to assess reasons for satellite failures.[4]

### *Japan*

Japan was one of the first Asian nations to deploy its own satellite, lofting the Osumi satellite in 1970. Japan's space program has been largely focused on non-military roles, due to the restricted interpretation of what was allowed under the "Peace Constitution." This has included weather satellites and earth resource satellites. Another major program has been the Quasi-Zenith Satellite System (QZSS), designed to supplement the GPS network in high northern latitudes, as well as provide telecommunications services.

Since the late 1990s, however, when North Korea began to conduct nuclear tests, the Japanese space effort has slowly assumed more national security roles. Japan first deployed dedicated national security surveillance satellites in 2000 under its Information Gathering Satellite (IGS) program. This entailed the launch of an electro-optical satellite and an SAR satellite (IGS-1a and IGS-1b, respectively). These were operated by the Cabinet Satellite Information Center.

The IGS network has been a priority for the Japanese government, insulated from pressures that have affected other parts of Japan's space efforts. This is significant, as the IGS has been "the single biggest [cost] for a satellite program in Japan's entire space budget."[5] That Japan should prove reluctant to rely either on commercial space imagery or the United States reflects a common attitude among emerging space powers, i.e., a desire to develop reconnaissance satellites in order to support national information-gathering capabilities.

This shift was embodied in the 2008 Basic Space Law, where the Japanese government reoriented its space program from focusing on scientific research towards a greater focus on potential applications—including in the national security domain. Japanese space activities would remain primarily managed by the Japanese Aerospace Exploration Agency (JAXA), an entity subordinate to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Internal Affairs and Communications (MIC).

JAXA itself was the result of the merger of the main Japanese space-related agencies in 2003: the National Space Development Agency (NASDA), the Institute of Space and Astronautical Science (ISAS), and the National Aerospace Laboratory (NAL). While it would continue to emphasize peaceful and scientific uses of space, it was expected that JAXA would expand its

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[4]U.S. General Accountability Office, *Space Situational Awareness Efforts and Planned Budgets*, GAO–16–6R (Washington, DC: GAO, October 8, 2015), http://www.gao.gov/assets/680/672987.pdf (accessed October 6, 2017).

[5]Saadia M. Pekkanen and Paul Kallender-Umezu, *In Defense of Japan: From the Market to the Military in Space Policy* (Stanford, CA: Stanford University Press, 2010), p. 130.

dialogue with the Japanese Ministry of Defense and Ministry of Foreign Affairs. The Strategic Headquarters for Space Policy (SHSP) was also established, which was responsible for helping to manage Japanese space activities. The SHSP helped draft the Basic Space Plan, promulgated in 2009.

In 2012, a further bureaucratic reorganization saw JAXA placed under the political control of the Prime Minister's Cabinet Office. Under the Law for Partial Amendment of the Law for Establishment of the Cabinet Office, the Cabinet Office was given broad oversight of Japan's space capabilities and policies, and now plays a central role for determining space policy. The office coordinates among the various other space-related agencies, including JAXA, the Japanese Ministry of Defense (JMOD), and the Ministry of Economy, Trade, and Industry (METI), which promotes Japanese industrial development (including its space-industrial complex). It exercises its responsibilities through the National Space Policy Secretariat (NSPS), the successor to the SHSP. The head of the NSPS is a member of the Cabinet Office.

***India***

India's space program is mainly managed via the Indian Space Research Organization (ISRO), which is subordinate to the Department of Space and reports to the Indian Prime Minister and the Space Commission.[6] The space portfolio was originally assigned to the Department of Atomic Energy in 1961, which in turn established the Indian National Committee for Space Research to help plan for a national space development program. The Committee gave way to the ISRO in 1969, and later established the Space Commission, and then the Department of Space in 1972, which was assigned to the ISRO that same year.

In addition to the ISRO, the Indian Defence Research and Development Organization (DRDO) also plays a role in India's space efforts, with a more specific military focus.

India's first satellite, the Aryabhata, was launched by the USSR in 1975. Since then, it has placed about 100 satellites in orbit, using both indigenous and foreign launch services. India currently has about 30 operational satellites in orbit. These include a regional navigation satellite system, meteorological satellites, and communications satellites. The centerpiece of India's satellite constellation is the Indian National Satellite System (INSAT) series. INSAT was planned in 1976, and involves several satellites in geosynchronous orbit. The satellites combine certain communications and meteorological functions, including incorporating television broadcasting and telephone switching services, in order to maximize cost-efficiency.

India has also developed reconnaissance satellites, including both SAR and electro-optical sensors. The Cartosat-2C, part of the Indian Remote Sensing satellite constellation, is an electro-optical system with a 0.6-meter resolution. Other Indian satellites include the Radar Imaging

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[6]This section draws upon Brian Harvey, *The Japanese and Indian Space Programmes: Two Roads into Space* (NY: Springer Publishing, 2000), pp. 127–189; Adrija Roychowdhury, "From Aryabhata to RLV-TD," *Indian Express*, May 23, 2016, http://indianexpress.com/article/research/isro-rlv-td-history-of-indias-space-research-space-activities-space-journeys-isro-launches-reusable-launch-vehicle-spacecraft-2815247/ (accessed October 6, 2017); and Lonnie Schechtman, "How India Is Quietly Becoming a Space Exploration Powerhouse," *Christian Science Monitor*, May 24, 2016, http://www.csmonitor.com/Science/2016/0524/How-India-is-quietly-becoming-a-space-exploration-power-house (accessed October 6, 2017).

Satellite (RISAT) with a SAR system onboard. It has also launched a lunar probe (the Chandrayaan-1), which included an American instrument package, as well as tested a reusable spacecraft (the Reusable Launch Vehicle-Technology Demonstrator).

India has developed several indigenous launch vehicles to support its space program. These include the Polar Satellite Launch Vehicle (PSLV), which has been used over 20 times, and the Geosynchronous Launch Vehicle (GSLV), which has seen five launches. Because U.S. arms exports laws have generally not been applied against India, the Indian commercial space launch industry has more opportunities to operate than the PRC. India has launched over 75 foreign satellites aboard its rockets.[7]

Indian officials have also expressed interest in developing missile-defense capabilities. Much of this research is undertaken by the DRDO. The DRDO has also developed the Communications-Centric Intelligence Satellite (CCI-SAT), which apparently is part of India's missile-defense R&D effort.[8]

### *Australia*

Australia is unique among the Quad countries, and in the Organization for Economic Co-operation and Development (OECD), as the only state without a national space agency. Australia's space activities are managed through the Ministry for Industry, Innovation, and Science.[9] That ministry is responsible for Australian civil space activities.

Australia has owned or operated 14 satellites into orbit, all either communications or scientific satellites. Of these, six (one scientific, five communications) are still operational. The Australian communications satellites are part of the Optus network, which is operated by Singtel, a Singaporean company.

Although Australia does not have its own space agency, its close cooperation with other members of the Commonwealth, including the U.K. and Canada, as well as with the United States gives it access to a range of space-based systems. At the same time, it hosts a number of space facilities, including a C-Band space surveillance radar and a Space Surveillance Telescope in western Australia near Exmouth.[10]

## *SPACE THREATS IN THE ASIA-PACIFIC REGION*

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[7]Yogita Limaye, "Why India's Commercial Space Programme Is Thriving," BBC News, September 26, 2016, http://www.bbc.com/news/world-asia-india-37448629 (accessed October 6, 2017).

[8]Rajit Panditi, "India to Gear Up for 'Star Wars,'" *Times of India*, May 25, 2010, http://timesofindia.indiatimes.com/India/India-to-gear-up-for-star-wars/articleshow/5970384.cms (accessed October 6, 2017), and "India Making Strides in Satellite Technology," *Defense News*, November 10, 2010, https://web.archive.org/web/20130606194638/http://www.defencenews.in/defence-news-internal.asp?get=old&id=239 (accessed October 6, 2017).

[9]Government of Australia, "Industry," https://industry.gov.au/INDUSTRY/IndustrySectors/SPACE/Pages/default.aspx (accessed October 6, 2017).

[10]Lockheed Martin Australia, "Tracking Space Debris," http://lockheedmartin.com.au/au/what-we-do/space-systems/space-fence.html (accessed October 6, 2017).

The growing importance of space to modern warfighting has been recognized by not only the members of the Quad, but also other states as well. In particular, the PRC has been building its military space capabilities. The PLA has been paying especially close attention to the role of space in securing "information dominance," which the PLA sees as the essential prerequisite for fighting and winning future wars.

Indeed, for PLA writers, space and information are intimately and closely linked. The essential technologies for winning future "local wars under informationized conditions" are those associated with information, including space technologies. This is because, in the view of PLA analysts, information will be gathered, transmitted, and exploited via space systems.

PLA analyses focus on the same, key space-based systems and tasks as Western analysts have, including:

- **Communications satellites** (*tongxin weixing*; 通信卫星), which facilitate the transmission of information globally, and provide both secure and reliable information channels;
- **Meteorological satellites** (*qixiang weixing*; 气象卫星), which provide essential information regarding weather, which affects military operations;
- **Reconnaissance satellites** (*zhencha weixing*; 侦察卫星), which can collect information regarding an opponent round-the-clock and provide commanders with the early warning necessary to respond to enemy activities;
- **Earth observation satellites** (*cehui weixing*; 测绘卫星), which allow geodesy and general geographic information; and
- **Navigation satellites** (*daohang weixing*; 导航卫星), which facilitate friendly troop movements with greater certainty as to their own location, as well as provide guidance for modern weapons [11]

It is worth noting that each of these systems is currently part of the Chinese inventory of space assets. The dual-use nature of China's space systems has not prevented them from developing the systems that they believe are necessary to sustain military operations.

For the PLA, the aspirational objective of space operations seems to be to establish space dominance, whereby it can both preserve friendly access to space, while denying it as much as possible to an opponent. Without control of space, at least at a local level, PLA authors suggest it is virtually impossible to gain or to maintain air or naval dominance. As one article notes, "the struggle to seize the strategic commanding height in future wars will first be unfolded in the outer space."[12]

Moreover, by denying an opponent the ability to use space freely, the PLA would effectively be denying them the ability to operate as they are accustomed to fighting. As one PLA article observed, it was U.S. space systems that allowed U.S. and NATO forces to wage war so

[11]Wang Yao and Shi Chunming, "Regarding 'Space Information Combat,'" *Jiefangjun Bao*, December 19, 2002.

[12]Zhao Shuanlong, "The Initial Battle Is the Decisive Battle, and Preparations for Military Struggle in the New Period," *Jiefangjun Bao*, August 18, 1998, p. 6, in FBIS-CHI-98-257 (September 14, 1998).

effectively in the case of Kosovo. Air-based and naval-based forces, connected by space systems, were able to engage in a form of integrated joint operations which were a major new form of warfare.

> ***We can conceptualize that, if there had been no space systems support, the US could only conduct a high-level mechanized war, and could not implement informationalized warfare.*** Therefore, we can reach the following conclusion: Without space technology breakthroughs and space technical preparations, the shape of warfare cannot move from mechanized combat towards informationalized combat.[13]

Recent reorganizations of the PLA underscore this emphasis on space and information capabilities. One of the new services created by the PLA is the PLA Strategic Support Force (PLASSF), which brings together China's space, electronic warfare, and network warfare capabilities. By bringing together these disparate, but information-oriented forces, it is clear that the focus of this new service is the securing of "information dominance."

### *RECOMMENDATIONS*

For the members of the Quad, it would be useful to create a dialogue on space-related issues that is both timely and useful. There is already a certain degree of cooperation, whether it is the mounting of an American instrument package aboard the Indian lunar probe Chandrayaan-1, or information sharing between the U.S. and Australia, and between the U.S. and Japan.

Given the importance of space to all four members of the Quad, however, it is in their mutual interest to enhance coordination, and even explore cooperation, among them on such issues as space situational awareness, space industrial policy, and perhaps even key space measures. It is arguably also in their mutual interest to expand information sharing. While there are likely to be limits, based on respective national security classification concerns, one possibility might be the creation of a common pool of commercial imaging data. Such a pool could be used by each state to support their respective national political and security policies, but with a common set of analytical methods. This could also help expand the body of photo-interpreters (and perhaps facilitate the development of automated analytical tools).

Another area where the various members of the Quad could benefit from greater information sharing would be the formulation of best practices, such as limiting debris in the course of space launches. Three of the four members of the Quad are already members of the Inter-Agency Space Debris Coordination Committee (IADC), which also includes the PRC, Russia, Canada, the U.K., Italy, France, Germany, Ukraine, and the European Space Agency, which strives to limit debris-generating activities. However, China's 2007 anti-satellite test, the worst debris-generating event in space history, underlines the limits of the IADC. Forging better practices

[13]Emphasis added. Zhu Wenhao, "An Exploration of the PLA's Military Equipment Construction Leapfrogging Development Concept," *Junshi Xueshu* (#2, 2004). At the time of this article, Zhu was with the PLA General Armaments Department.

among this smaller group could clarify the difference between responsible and less responsible space-faring nations.

This dialogue will have to overcome the serious challenge of widely disparate organizational imperatives and bureaucratic templates. Coordinating among just the American space programs is often a difficult matter, never mind with foreign partners. Given the sensitivity of intelligence and military space systems, coordinating interactions among the various agencies, determining what can be released to whom, and maintaining operational security all must also be taken into consideration. An informal mechanism, such as through the nongovernmental organizations represented by the Quad dialogue, and the ability to inform respective governments through Track 1.5 mechanisms, could help overcome some of these barriers.

At a minimum, enhanced discussion of space issues among the four members would help clarify the organizational structure of each nation, which is often opaque and almost always very confusing.