'OUR MOST VITAL ASSETS': SPACE GROUND INFRASTRUCTURE AND U.S.–FOREIGN RELATIONS

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Executive Summary

Allies and partners are critical to achieve and maintain U.S. military and intelligence advantages in space. Although national security space experts often focus on satellites and launchers, satellite ground infrastructure hosted on foreign territories has been a core element of U.S. national security space partnerships since the Cold War. This infrastructure has been used to track satellites, carry out intelligence collection, and employ space-based nuclear command and control, among other functions.

During the Cold War, these missions required the United States to build relationships with states that possessed suitable territories for hosting ground infrastructure. But this need for land in specific locations abroad created significant foreign policy challenges for Washington. In the 1960s and 1970s, varied political issues, including apartheid in South Africa, unrest in Ethiopia, and a shift in Australia's domestic politics, all affected U.S. satellite infrastructure hosted in those locations. Fundamentally, these examples underscore that space operations are deeply embedded in terrestrial politics.

Securing access to real estate for hosting satellite ground infrastructure has emerged as a critical element of intensifying U.S.–China rivalry in space since both countries depend on overseas territories for projecting spacepower. This is a longstanding issue for the United States and an emergent one for China that stems from its growing investment in military space systems. The United States has the advantage in this arena as it did during the Cold War because its alliances and partnerships are global. Nevertheless, Beijing has been successful in cultivating space relationships, particularly with countries in the Global South, that have enabled its overseas satellite ground infrastructure to grow. In these circumstances, the United States should use diplomacy to frustrate Beijing's attempts to bolster its military capacity in orbit by establishing space partnerships with countries that are in prime locations to host satellite ground infrastructure.

Introduction

During the Cold War and today, analyses of spacepower tend to focus on systems in orbit, while overlooking the extensive ground infrastructure that is a critical component of space operations. Satellites allow the United States to overcome the tyranny of distance, but they are very much dependent on terrestrial hardware. Since the dawn of the Space Age, the United States has maintained a vast network of tracking stations for monitoring the spacecraft of friends and foes alike. Moreover, multiple countries around the globe host sites for sending and receiving data from U.S. satellites. This vast infrastructure on Earth that makes both civil and national security spaceflight possible underscores the importance of alliances and partnerships for American spacepower. During the Cold War, having allies in nearly every corner of the world that were willing to host U.S. space facilities helped tip the superpower space balance in favor of the United States.

James Webb, the head of NASA, told President John F. Kennedy in 1961 that "We feel there is no better means [than cooperative space efforts] to reinforce our old alliances and build new ones."[*] The placement of U.S. civilian and military space infrastructure in Australia, Zanzibar, Iran, Japan, Ethiopia, and South Africa (among many other places) underscores the international character of Cold War-era American space activities. Neil Armstrong's first steps on the Moon in 1969 became a symbol of resounding American technological achievement, but his famous statement, "…one giant leap for mankind" would not have been broadcast to the world without a communications dish located near Canberra, Australia. Around this same time, a base located in Asmara, Eritrea (then under Ethiopia's control), became the home of a large array of U.S. government antennas for collecting signals from Soviet spacecraft that provided U.S. intelligence agencies key insights into the Soviet space program. In return for hosting U.S. space infrastructure during the Cold War, foreign governments secured a stake in American space activities as well as bargaining leverage, in some cases.

The importance of satellite ground infrastructure has only grown in the post-Cold War era. The marked expansion of systems in orbit has precipitated the proliferation of space domain awareness (SDA) sensors across the globe as well as satellite ground systems, which creates opportunities for the United States. Certainly, having access to more data concerning what is taking place in orbit has both economic and security benefits. But the United States is not alone in seeking international partners to expand the reach of its terrestrial space infrastructure; China is also making inroads in Latin America and Africa for the very same reasons. But China's historic lack of expansive alliance relationships abroad limits its access to foreign territories, in stark contrast to the United States during and after the Cold War. To mitigate this problem, Beijing has used the promise of scientific and technological collaboration with countries, particularly in the Global South, to get access to territories that can house terrestrial space infrastructure. In these circumstances, it is vital that the United States continues to establish space partnerships with countries around the world as both a means of achieving its national objectives in orbit and frustrating China's attempts to do the same.

Allies, Partners, and U.S. Space Infrastructure During the Cold War

Even before the Soviet Union launched Sputnik in 1957, multiple U.S. efforts were underway to develop infrastructure for tracking artificial satellites. As part of the 1957 International Geophysical Year (IGY), the Smithsonian Astrophysical Observatory (SAO) began fielding Baker-Nunn optical cameras that could be used to determine the position of satellites in orbit. SAO built tracking sites in Argentina, Australia, Curacao, India, Iran, Japan, Peru, South Africa, Spain, and at three locations in the United States. In establishing agreements with foreign countries to host Baker-Nunn cameras, SAO leaders stressed the civilian nature of the program. Particularly in India and Japan, sensitivities arose concerning even the perception that the space tracking sites might be associated with U.S. military activities. Nevertheless, several foreign countries viewed their hosting of SAO cameras as a way to strengthen their ties with the United States. At the end of the

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[*] Presentation by the Administrator of the National Aeronautics and Space Administration (Webb) to President Kennedy, March 21, 1961, *Foreign Relations of the United States* (*FRUS* hereafter), 1961-1963, Vol. XXV, Organization of Foreign Policy; Information Policy; United Nationals; Scientific Matters.

1957 IGY, NASA began funding the SAO Baker-Nunn network and established data standardization across the different tracking sites to ensure the network acted as a unified whole rather than a loose confederation of independent stations.[†]

Around the same time that SAO was establishing its Baker-Nunn network, the Department of Defense and intelligence community were devising plans for a national security space tracking network. In a letter to the head of the Advanced Research Projects Agency, Central Intelligence Agency Director Allen Dulles stressed that the surveillance of foreign space vehicles "demands immediate and complete attention by the U.S. intelligence community."[‡] To address this issue, the U.S. Air Force erected its own Baker-Nunn cameras and the U.S. Navy created a radar system that could detect satellites transiting overhead. Combined, these resources formed the basis of the early U.S. Space Surveillance Network. In March 1964, the Pentagon established a Space Defense Center located in North American Aerospace Defense Command's (NORAD's) Cheyenne Mountain complex in Colorado to oversee the Department of Defense's space surveillance operations. The civilian Baker-Nunn camera network supplemented data from U.S. military space tracking sensors.[§]

Placing space tracking sensors on foreign territories created both opportunities and challenges for the U.S. government. The infrastructure served as a mechanism for more closely linking U.S. interests with the hosting nation, but dependence on foreign territories also created a liability when foreign policy agendas clashed. In 1960, the U.S. Air Force had established a space tracking facility in South Africa that created complications for the U.S. policy on apartheid. Shortly after the site became operational, officials in Washington considered reducing some military support for South Africa out of concern that not doing so might lead to an impression that the United States accepted apartheid. But the importance of the tracking station had a restraining effect on U.S. discussions about tempering engagement with South Africa. The State Department observed in a 1961 memorandum to the White House that maintaining the tracking station necessitated a cautious attitude toward Praetoria until an alternative site could be found.[**] This South African case study underscores the reality that the requirement to maintain space tracking infrastructure in particular locations had a spillover effect on broader U.S. foreign policy objectives. To mitigate this situation, the United States began looking for alternative space tracking locations.

The need to capture telemetry signals that contain valuable information about the performance of Soviet spacecraft drew unexpected countries into the superpower space competition. As the Soviet Union began launching deep space probes in the early 1960s, the U.S. intelligence community needed to fill its gap in technical collection on these satellites. Consequently, in 1965 the U.S. government established a covert space surveillance site at Kagnew Station (codenamed "Stonehouse") in Asmara, Eritrea, which was then under the control of Ethiopia. This location was perfect for intercepting telemetry from Soviet space probes because it was located on the same longitude as a Soviet spacecraft command and control facility in Crimea (present-day Ukraine). Fortuitously, the Pentagon already had a communications facility at Kagnew Station that could provide a cover for the clandestine intelligence activities taking place.[††]

When civil war broke out in the vicinity of Asmara in the mid-1970s, the site's future was called into question. At one point, insurgents attacked the facility and heavily damaged communications equipment located on the base, thereby degrading all U.S. defense communications in the Middle East, Africa, and South Asia. The deteriorating security situation in Ethiopia ultimately prompted the Carter administration to close down operations at Kagnew Station and evacuate the site.[‡‡] Some U.S. officials feared that an American withdrawal from Kagnew might result in an increased Soviet presence

[†] Teasel Muir-Harmony, "Tracking Diplomacy: The International Geophysical Year and American Scientific and Technical exchange with East Asia," in *Globalizing Polar Science: Reconsidering the International Polar and Geophysical Years*, ed. Roger Launius et al (New York: Palgrave Macmillan, 2011), 74.
[‡] Brief for DCI, "briefing memorandum on space vehicle surveillance," undated, CREST, CIA-RDP80B01676R003800100005-7.
[§] Rick Sturdevant, "From Satellite Tracking to Space Situational Awareness: The USAF and Space Surveillance, 1957-2007, *Air Power History*, vol. 55, no. 4 (winter 2008).
[**] Letter from the Under Secretary of State (Bowles) to McGeorge Bundy," September 21, 1961, *FRUS*, 1961-1963, Vol. XXI, Africa.
[††] Mark Nixon, "The Stonehouse of East Africa," *Cryptologic Quarterly*, vol. 38 (2019), 29-39.
[‡‡] Aaron Bateman, "The Weakest Link: The Vulnerability of U.S. and Allied Global Information Networks in the Nuclear Age," *Journal of Strategic Studies* (2024), https://www.tandfonline.com/doi/abs/10.1080/01402390.2024.2360724.

in the Horn of Africa. Emperor of Ethiopia, Haile Selassie, worried that a U.S. exit from Ethiopia would reduce American military aid to his country and thus looked for alternative partners, including Moscow.[§§] In the end, however, U.S. officials maintained that the risks of keeping the site outweighed the potential benefits.

Even before the White House decided to close Kagnew Station, defense and intelligence officials were already looking for an alternate location due to the instability in the region. U.S. leaders considered moving some of the hardware at Kagnew to U.S. sites in Iran, but access to those facilities would be cut off in the wake of the 1979 revolution.[***] The Kagnew Station closure created greater momentum in favor of placing vital terrestrial infrastructure only in countries that were deemed politically stable and reliable U.S. partners. However, international political shifts that might affect U.S. access to vital foreign territories were very difficult to predict.

American policymakers worried how changing political agendas could affect their overseas bases even among their closest allies. In 1966, the U.S. and Australia governments signed an agreement to establish a Joint Defense Space Research Facility at Pine Gap near Alice Springs, Australia, which both governments acknowledged was home to national security activities that were critical for the defense of their mutual interests.[†††] In 1971, as the United States began launching Defense Support Program (DSP) satellites that are designed to detect missile and space launches, Australian leadership agreed to host one of the DSP ground sites near Woomera (which was moved to Pine Gap in the 1990s) for processing DSP data collected in the Pacific region. This ground facility made Australia a key node in the American space-based nuclear command and control infrastructure.

U.S. anxieties about the future of the sites in Australia were aroused when Australian Labour Party leader Gough Whitlam came to power in December 1972. In the lead up to the election, Whitlam signaled his intent to take Australian foreign policy in a more independent direction and he expressed overt hostility toward American bases in Australia. Pine Gap had become a topic of significant domestic political controversy in Australia due to the public perception that the Australian government exercised only limited control over activities at the site, further fueling animosity toward the United States. Complicating matters even more was the growing fear among a section of Australian society that the presence of American bases could make Australia a target for Soviet nuclear weapons.

All these factors prompted U.S. officials to assuage Australian anxieties about the U.S. defense presence in their country. A 1974 National Security Council staff memorandum stressed that the White House needed to take whatever action necessary to "prolong the life of our most vital assets (like Pine Gap)."[‡‡‡] Ultimately, the governor general of Australia sacked Whitlam in 1975, which cooled U.S. concerns about the tenure of the American sites. But tensions resurfaced in the late 1980s concerning the lack of Australian control over operations at the DSP ground site. To calm Australian leadership, senior U.S. officials modified longstanding policy that restricted the management of strategic systems to U.S. personnel only and permitted the DSP ground site deputy commander, an Australian national, to take control in the absence of the U.S. commander. Air Force Space Command supported this shift in light of what it described as a "special relationship" between Washington and Canberra.[§§§] Although these episodes never became a serious threat to the U.S. space presence in Australia, they reminded policymakers that U.S. space hardware situated in foreign territories, even in allied countries, was subject to domestic political whims outside of Washington's control.

[§§] Information memorandum, "Ethiopia-US Relations," November 1, 1973, CREST, CIA-RDP85T00875R001100160069-4.
[***] Letter from the Deputy Secretary of Defense (Nitze) to the Under Secretary of State (Katzenbach), September 6, 1968, *FRUS*, 1964-1968, Vol. XXIV, Africa.
[†††] Statement by the Hon. Richard Marles, "Securing Australia's Sovereignty," February 9, 2023, https://www.minister.defence.gov.au/statements/2023-02-09/securing-australias-sovereignty.
[‡‡‡] Memorandum from W. R. Smyser to Henry Kissinger, "Where do We Stand in Asia," July 18, 1974, *FRUS*, 1969-1976, Vol. E-12, Documents on East and Southeast Asia, 1973-1976.
[§§§] "Missile Warning," Air Force Space Command, 1990, National Security Archive, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB235/21.pdf.

Improvements to U.S. space surveillance infrastructure were urgently needed in the 1970s due to the massive growth of space objects. Between 1967 and 1970, the number of objects in orbit more than doubled from 1,200 to just over 2,400. Monitoring Soviet satellites took on even greater importance as Moscow reinvigorated testing of its anti-satellite (ASAT) weapon designed to attack satellites in low Earth orbit. Senior NORAD officials stressed that better sensors were required for timely detection of a Soviet ASAT attack against U.S. reconnaissance satellites that provided the majority of American and allied intelligence on the Soviet Union and China. More sophisticated sensors for tracking Soviet satellites were also needed to transmit targeting data to the U.S. ASAT program initiated in 1977.

To remedy the inadequacies of the U.S. space monitoring network, in 1978 the Pentagon contracted TRW to develop a new optical surveillance capability called the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) system. TRW used advances in solid-state electronics to design an electro-optical telescope that could transmit data nearly instantaneously, rather than rely on the slow film processing method associated with Baker-Nunn cameras. In addition to speed, GEODSS would allow the U.S. space surveillance network to more accurately monitor satellites in geostationary orbit.[****]

To be effective, GEODSS required a global footprint. Two sites would be situated in U.S. territory, in Hawaii and New Mexico. A third site would be placed in South Korea, though the Pentagon closed it in 1993 due to financial considerations.[††††] Finding a place for the fourth site would become a complicated diplomatic exercise. In the summer of 1976, U.S. Air Force technical experts concluded that Morocco would be an ideal location for a GEODSS site. The U.S. Navy already had two communications facilities in the country that could host the telescope, but the Air Force insisted that a new facility be built farther inland solely for the space tracking facility.[‡‡‡‡]

King Hassan of Morocco initially approved the U.S. request to place GEODSS on Moroccan territory in exchange for arms sales, but deteriorating U.S. relations with government officials in Rabat stalled construction. After three years, the U.S. embassy in Rabat described the GEODSS deal as "effectively shelved" due to Hassan's frustration with a lack of U.S. support for his fight against the Polisario Front in the Western Sahara.[§§§§] Once again, broader U.S. foreign policy considerations were affecting the placement of critical space tracking infrastructure abroad. With the failure of the Moroccan GEODSS site, the United States turned to its British ally and struck an agreement to place the space tracking facility on the island of Diego Garcia in the Indian Ocean.

To mitigate some of the difficulties associated with securing access to foreign territories for space surveillance, Air Force leaders have long considered the development of a *space-based* system for tracking satellites. In fact, a 1967 Air Force study advocated moving all surveillance and warning sensors into space, thereby replacing the ground-based systems,[*****] but moving all this infrastructure into space turned out to be impractical. In 1982 Air Force Systems Command laid down the requirements for a Space-Based Surveillance System (SBSS) that could detect and track foreign space objects and warn of attacks on U.S. and friendly space systems. Though it was slated to be operational in 1993, multiple programmatic delays would prevent SBSS from reaching orbit until 2010. Thus, through the end of the Cold War and for years afterward, the United States continued to depend on radar and optical surveillance sites spread across the world to surveil objects in space.

[****] Chapter III, "Space Defense," in Military Uses of Space, 1945-1991, National Security Archive.

[††††] "Space Surveillance Sensors: GEODSS (Ground-based Electro-Optical Deep Space Surveillance) System," August 20, 2012, https://mostlymissiledefense.com/2012/08/20/space-surveillance-sensors-geodss-ground-based-electro-optical-deep-space-surveillance-system-august-20-2012/

[‡‡‡‡] Memorandum from Poor to Clements, "U.S. Military Facilities in Morocco," March 8, 1977, *FRUS*, 1969-1976, Vol. E-9, Part I, Documents on North Africa, 1973-1976.

[§§§§] Telegram from U.S. Embassy in Morocco to the Department of State, "Long-Term Planning for US Military Access and Overflights in a Southwest Asian Contingency," January 31, 1980, FRUS, 1977-1980, Vol. XII, Part III, North Africa.

[*****] "Surveillance and Warning: A Master Plan," in Military Uses of Space, 1945-1991, National Security Archive.

Space Infrastructure and Alliances After the Cold War

In the post-Cold War era, alliances remain a critical element in U.S. space strategy. Although anxieties about superpower military space competition receded with the dissolution of the Soviet Union and the so-called peace dividend of the 1990s, space quickly reemerged in the 21st century as a domain of potential conflict. The 2007 Chinese ASAT test was a watershed moment in post-Cold War space security that reminded U.S. and allied defense planners that space systems were attractive targets because of their role as enablers of global power projection. Concurrently, the growing number of government and non-government space operators was making space increasingly congested. In this rapidly changing space environment, enhancing space monitoring capabilities around the world took on even greater importance.

Even before anxieties about space security heightened with the 2007 Chinese ASAT test, the Department of Defense was already establishing mechanisms for international cooperation in SDA. In 2004, then-President George W. Bush designated U.S. Strategic Command as the lead agency for administering the Commercial and Foreign Entities (CFE) program aimed at bolstering U.S. SDA partnerships. The Pentagon intended for CFE to "encourage international cooperation and transparency with foreign nations and/or consortia on space activities that are of mutual benefit."[†††††] CFE entailed the United States sharing SDA data with foreign participants. As of September 2024,more than 100 SDA sharing agreements have been established with countries around the world.[‡‡‡‡‡] It is important to note that, until recently, the limited number of sensors owned by other countries has made CFE a primarily one-way information stream, with the U.S. government acting as the main SDA data provider.

Today, allied countries around the world possess sophisticated SDA sensors. Germany, Japan, Australia, France, and the United Kingdom have all established military space units that operate space tracking systems that enhance the United States' ability to monitor satellites. As such, hosting infrastructure is no longer the primary mechanism for U.S. military space cooperation with allies and partners—but this situation also creates challenges. The United States is rapidly adopting a coalition approach to outer space, meaning that allies and partners are playing a more prominent role. The Pentagon and key allies established the Combined Space Operations Initiative (CSpO) to ease coordination of space activities.[§§§§§] This shift toward combined operations requires data standardization and systems interoperability to ensure that SDA information can be quickly disseminated to end users. However, linking disparate SDA sensors spread across the world that were not designed to communicate with each other is a significant challenge.

Space-based sensors greatly enhance the U.S. ability to detect and monitor threats in orbit as well. In the past two decades, the United States has deployed SBSS in low Earth orbit as well as multiple Geosynchronous Space Situational Awareness Program (GSSAP) satellites that perform a "neighborhood watch" function in the geosynchronous orbital regime.[******] The United States is not alone in developing sophisticated sensors for in-orbit monitoring. Japan has announced its intention to launch a space-based surveillance capability to supplement its existing ground-based optical and radar space surveillance systems.[††††††] The growth of space-based SDA will enhance, but not replace, terrestrial sensors for monitoring the space environment.

Terrestrial space infrastructure has become a key element in recent U.S. efforts to strengthen its existing alliances in the Indo-Pacific and Europe. In 2023, the United States, Australia, and the United Kingdom announced a joint plan to field

[†††††] Report of the Commission to Assess United States National Security Space Management and Organization, January 11, 2001, https://aerospace.csis.org/wp-content/uploads/2018/09/RumsfeldCommission.pdf.
[‡‡‡‡‡] Karen Singer, "100th space sharing agreement signed, Romania Space Agency joins," April 26, 2019, U.S. Strategic Command Public Affairs, https://www.stratcom.mil/Media/News/News-Article-View/Article/1825882/100th-space-sharing-agreement-signed-romania-space-agency-joins/.
[§§§§§] David Vergun, "More Nationals Need to Address Space Security, DoD News, December 7, 2023, https://www.defense.gov/News/News-Stories/Article/Article/3610656/more-nations-meet-to-address-space-security/.
[******] "Geosynchronous Space Situational Awareness Program," U.S. Space Force, https://www.spaceforce.mil/About-Us/Fact-Sheets/Article/2197772/geosynchronous-space-situational-awareness-program/.
[††††††] "Japan to put space situational awareness satellites into orbit to track debris and threats," Space Watch Asia Pacific, https://spacewatch.global/2018/08/japan-to-put-space-situational-awareness-satellites-in-orbit-to-track-debris-and-threats/.

more capable deep space radars for monitoring threats in geostationary orbit.[‡‡‡‡‡‡] These new capabilities will strengthen preexisting space cooperative partnerships, since both Australia and the United Kingdom have long contributed to U.S. SDA and satellite ground infrastructure.

International partnerships concerning satellite ground sites and SDA infrastructure are important for China to achieve its military, commercial, and civil goals in orbit as well. Space cooperation is an important element of China's Belt and Road Initiative (BRI). Furthermore, Beijing is using BRI to expand its terrestrial infrastructure that supports both civil and military space missions because countries in Latin America and Africa (among other places) are eager to strengthen scientific and technological ties with China.[§§§§§§] Therefore, it is increasingly important for the United States to continue establishing space cooperation partnerships in the Global South as a counterbalance to China's efforts.

Conclusion

Space competition during the Cold War could be easily misconstrued as having been a bipolar, superpower affair. In reality, U.S. space capabilities—both civil and national security assets—heavily depended on infrastructure hosted by allies and partners across the world. Being able to place hardware in foreign territories extended the reach of U.S. space systems but also became a source of vulnerability. The United States could not be certain that its access to space infrastructure located on the real estate of allies, even the closest ones, would be indefinite. When changing political conditions necessitated moving space infrastructure out of a particular overseas location, the geographic expanse of U.S. alliances and partnerships generally provided suitable alternatives.

Today, the terrestrial imperatives of spacepower remains an important factor in shaping U.S. engagement with allies and partners. Resiliency in orbit requires a vast infrastructure on the ground to monitor the space environment, launch satellites into space, and to transmit data to and from space systems. Even countries with limited assets in orbit can enhance coalition space operations through hosting support infrastructure. This situation underscores that international partnerships are the foundation of U.S. space security.

The United States is not alone in its dependence on overseas satellite ground sites and terrestrial SDA sensors. China's fast-growing military and civil space programs have required an expansion of Beijing's terrestrial space infrastructure. This reality has prompted Chinese officials to cultivate closer ties with countries, especially in the Global South, that are willing to host SDA facilities and satellite ground systems, which are oftentimes dual use. It is therefore vital for the United States to continue forging space partnerships with countries around the world to achieve its own space goals, and to also strengthen ties with states outside of its alliances. In some cases, this approach can help to deny China access to specific overseas territories for hosting terrestrial space infrastructure, thereby impeding its national space objectives. Fundamentally, U.S.–China competition in orbit is shaping the terrestrial geography of superpower competition.

[‡‡‡‡‡‡] Rebecca Connolly, "Space Surveillance and AUKUS: The Power of Awareness," January 19, 2024, Lowy Institute, https://www.lowyinstitute.org/the-interpreter/space-surveillance-aukus-power-awareness.

[§§§§§§] R. Evan Ellis, "China-Latin America Space Cooperation: An Overview," February 16, 2024, U.S. Army War College Strategic Studies Institute, https://ssi.armywarcollege.edu/SSI-Media/Recent-Publications/Display/Article/3680615/china-latin-america-space-cooperation-an-overview/.

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