Opportunities for US–Africa Space Cooperation and Development

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Abstract

The United States has a unique opportunity to establish enduring diplomatic, commercial, and security ties with African nations through space cooperation, with the potential to yield substantial development benefits. The African Union is preparing to open the African Space Agency. African nations are prioritizing the development of their own space infrastructure and applications—be it communications, remote sensing, or navigation/timing. The US space sector is robust, an area of comparative strength vis-à-vis Europe, Russia, and China. The US could work with African nations to reinforce a rules-based order in space, implement greater inclusivity in the space sector, and accelerate achievement of United Nations' Sustainable Development Goals.

A Space Development Program could include building and launching satellites, but its first objective should be to maximize the utility of space-based resources (e.g., orbits and frequency spectrum) and shared, publicly available, or commercial space applications, as an enabler of the Partner's national and economic interests.

To move forward, the US should develop a whole-of-government approach to US-Africa space cooperation and development, with a clear lead agency and a specific point of contact for foreign States. The US should expand bilateral and multilateral space cooperation and assistance, and specifically pilot a space development program in Africa. To support the most efficient and fair use of space resources, the US should increase support for African nations in managing their spectrum. Lastly, the US should raise internal and African awareness of US space-related support to the public good and clarify its intentions for the space ecosystem.

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Introduction

The United States, a leader in space exploration and innovation, has a unique opportunity to establish enduring diplomatic, commercial, and security ties with African nations through space cooperation—with the potential to yield substantial development benefits. This is contingent on understanding African agency in the space sector and African perceptions of US activity, both precursors for deliberate and productive US engagement.

African nations increasingly view space capabilities as basic infrastructure and essential to building a knowledge economy. Countries like South Africa, Nigeria and Egypt have well-established space agencies. Others, like Botswana and Rwanda, are just starting to build their space capabilities. Other actors, including China and Russia, recognize the value proposition posed by early partnership in space development with willing countries. There are, however, multiple challenges to effective U.S. engagement in Africa's nascent space sector. U.S. private sector activity and intentions in space are unclear, which makes it difficult for potential partners to initiate space-cooperation or to engage with private actors. Public sector support from abroad is likewise piecemeal: U.S. development and advising agencies, while they often leverage space applications, have not yet directly supported a whole-of-government space capability build.

U.S. policymakers have an opportunity to implement a collaborative approach with emerging African space actors both to grow a peaceful and law-abiding community in space and to benefit from Africa's contributions to the global space ecosystem. Space capability can also serve a crucial infrastructure role, yielding similar benefits to "traditional" infrastructure—including facilitating access to 5G connectivity and addressing clean water and food security needs through remote sensing and satellite communications.

The following organizations concerned with space-related development, diplomacy and defense coordination will benefit the most from considering opportunities for US-Africa space cooperation and development:

- The National Space Council
- US Department of State, Bureau of African Affairs, Bureau of Near Eastern Affairs and Office of Space Affairs
- US Agency for International Development, Development Innovation Ventures (DIV) and Innovation, Technology, and Research Hub
- Office of the US Trade Representative, Office of Africa Affairs, US Trade and Development Agency
- US Department of Commerce, National Oceanic and Atmospheric Administration, Office of Space Commerce
- Office of the Secretary of Defense for African Affairs, US Africa Command, US Space Command, US Space Force and the Secretary of the Air Force International Affairs, Defense Security Cooperation Agency
- National Aeronautics and Space Administration (NASA)

Key recommendations

- Develop a whole-of-government approach to US-Africa space cooperation and development, with a clear lead agency and a specific point of contact for foreign States
- Provide support for space as essential infrastructure through US development finance and assistance
- Increase support for African nations in managing their spectrum and developing national broadband plans
- Pilot a bilateral Space Development Program in Africa
- Expand bilateral and multilateral space-related security cooperation and assistance
- Improve awareness of US intentions in space and support to the public good in space

The value proposition of US–Africa space cooperation

The US space sector is robust, an area of comparative strength vis-à-vis Europe, Russia, and China. Engaging African states in the space sector will encourage international market growth, access, and trade, and inviting African states to participate in the space sector will build global understanding of and support for the rules-based order articulated in the Artemis Accords. The US Artemis Accords are a set of nonbinding commitments, aiming to operationalize the 1967 Outer Space Treaty for civil space actors, particularly in the areas of operational safety, debris mitigation and resource extraction, and has been signed by 16 countries, thus far.[1] Space cooperation, development and assistance could deepen and broaden ties in the digital economy and the security sector as well. Lastly, such efforts will help the African partners achieve the UN Sustainable Development Goals, which range from improving data-driven governance to closing the global digital gap.

Priorities of African nations in space development

Having decided that it is in their strategic interest to develop a space capability, many African nations are acting accordingly. Guided by Agenda 2063: The Africa We Want—a set of initiatives adopted by the African Union (AU) in 2015—and building on a policy that achieved consensus in 2017, the AU produced its African Space Strategy in 2019. That strategy articulates African interest in and determination to develop an endemic space capability.

AU Commissioner for Human Resources, Science, and Technology Sarah Anyang Agbor introduced the strategy as follows:

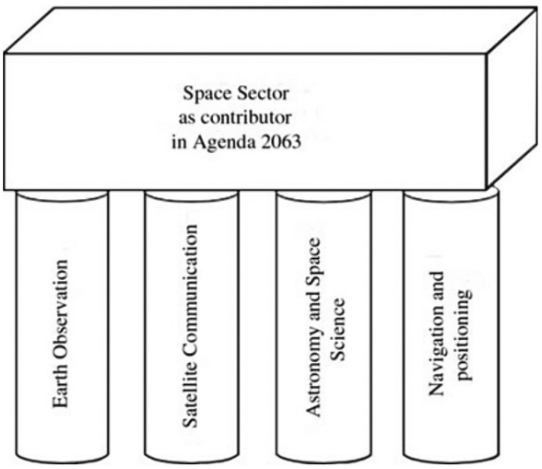
> The implementation of this strategy is important *if we are to transform Africa's resource-based economies into knowledge-based economies* to which we aspire. The space sector is not only a *high-end technology sector*, but also

> provides the *tools required* for effective decision making in the *management of our natural resources* and providing *essential communications links*, especially to our *rural communities*. We are therefore at an important juncture, where decisions pertaining to formalizing an African space programme *will have long-term sustainable benefits*, which will help this great continent realize its social and economic potential across public and private sectors.[1] [emphasis added]

All emerging space actors have their reasons for valuing investment in the space sector, but certain core themes persist. A study evaluating the rationales of 16 countries worldwide that established civil space agencies between 2014 and 2019—including the African Space Agency, the Kenya Space Agency, and the Zimbabwe Space Agency—found the following reasons:

- Economic: Growing the domestic sector to expand the domestic economy and boost gross domestic product.
- Socioeconomic: Improving the domestic welfare and using space data and applications to enhance existing governance activities, such as agriculture, mapping, and climate science.
- Coordination/centralization: Facilitating and integrating activities across the domestic space of academic, commercial, and government sectors.
- Geopolitical: Giving the government a platform to participate in the global space community, establishing the nation as a prominent space-faring nation, or benefiting the nations' national security.
- Regulatory: Developing a regulatory framework to manage the space sector and comply with international law.[1]

Figure 1. Space applications focus areas



Source: Figure created by Susanna Maria, Magdelena Engelbrecht, in Integrated Space for African Society (Springer, 2019).

Angola, Egypt, Ethiopia, Kenya, Morocco, Nigeria, Rwanda, and South Africa all have formal space policies, and many other African nations have recognized the importance of

space in some sort of strategic document. While African nations have their own priorities and approaches to space, the African Space Policy and the African Space Strategy function as umbrella documents. The African Space Policy calls for

- a well-coordinated and integrated African space program that is both responsive to the social, economic, political, and environmental needs of the continent and globally competitive; and
- a regulatory framework that supports an African space program and ensures that Africa is responsible and engages in the context of peaceful uses of outer space. [1]

As previously noted, the AU's 2019 African Space Strategy articulates African interest in and determination to develop an indigenous space capability. That strategy calls for

- space-derived products and services to use for decision making and addressing economic, political, social, and environmental challenges; and
- an indigenous space capability, in both the private and public sectors, that defines a coordinated, effective, and innovative African-led space program.[2]

A growing African space sector

Twelve African countries have already spent approximately US$4 billion to launch 44 satellites, with space-lift services provided by Russia, France, the United States, China, India, and Japan.[3] Twenty more African countries have established, or are in the process of establishing, a space program, and between them plan to outsource the launch of 114 more satellites by the end of 2025. The space budgets of African governments have grown significantly, from US$283 million in 2018 to $US503 million in 2020. Despite the COVID-19 pandemic, spending still rose by 9 percent to US$548.6 million in 2021.[4] Since 2020 alone, Botswana, Rwanda, Namibia, Burkina Faso, Djibouti, and Zambia have all initiated space programs. Besides investments in space-related services, such as purchasing satellites and data, and outsourcing space lift, market research expects further growth in African component manufacturing and equipment services.[5]

Although African nations have significantly increased their investment in space, taken as a whole, the majority of strides forward have been in "downstream" sectors that employ applications, products, and services that rely on satellite technology, signals, and data to function (e.g., satellite broadcasting, leveraging remote sensing data, and use of Global Navigation Satellite System–enabled devices or services).

Most "upstream" activity, to include space hardware manufacturing and ground systems, is based out of South Africa, but also originates, in order of capacity, out of Nigeria, Algeria, Egypt, Kenya, Sudan, and Tunisia. As of 2019, 60 percent of Africa's satellites were built by foreign entities, and as of 2022, all African satellites have been launched by other nations, namely, Russia (13), France (10), the United States (8), China (5), India (5), and Japan (2).[6] To date, no African nation has launched its own satellite, although Kenya, South Africa, and Nigeria are pursuing establishing spaceports. Of note, historically, between 1947 and 1990,

a total of 278 non-satellite-bearing rockets were launched from eight launch sites located in the Democratic Republic of Congo, Egypt, Libya, Mauritania, and South Africa, which suggests a successful history of space infrastructure on the continent and some endemic knowledge.[7]

In addition to national space programs, there are also several long-standing Pan-African initiatives, where several countries have pooled their resources. These include the Regional African Satellite Communication Organization (RASCOM), the African Resource Management Satellite Constellation, and the African Group on Earth Observations (AfriGEO) within the Global Earth Observation System of Systems. In addition, opportunities exist for emerging space actors within regional space-oriented organizations and nongovernmental organizations, such as the African Leadership Conference on Space Science and Technology for Sustainable Development and the African Centre of Meteorological Application for Development, among others.

Use Case: Launching the First Africa-Owned Communications Satellite

The Regional African Satellite Communication Organization (RASCOM) was established in 1992 as part of an International Telecommunication Union, United Nations Development Programme, and African Development Bank initiative. The initiative conducted feasibility studies, planning, and financing, and eventually contracted the development and 2007 launch of the first Pan-African communications satellite, RASCOM-QAF1. That satellite was replaced in 2010 with RASCOM-QAF1R, continuing to "ensure direct connectivity of African countries to support the consolidation of intra-African traffic, extend services (access) to remote and underserved rural areas and support all ICT services including TV and radio broadcasting services." A commercial company, RascomStar—owned by the Libyan Africa Investment Portfolio, RASCOM, and Thales Alenia Space (a Franco-Italian aerospace company)—operates the RASCOM satellite. Today, 45 African countries are RASCOM members. Satellite operating centers are located in Gharyan, Libya, and Fucino, Italy, with a network control center in Douala, Cameroon. The headquarters is currently in Dubai, but the possibility of transferring the headquarters to Cameroon, Libya, or Côte d'Ivoire is "being explored." In 2020, RASCOM's managing director, Mamadou Sarr, expressed interest in obtaining partners to support the launch of more communications satellites, the acquisition of additional orbital slots and frequencies, and expansion of terrestrial facilities.[8]

Use Case: NASA and USAID Space Applications Cooperation in Eastern, Southern, and Western Africa

In 2008, NASA and USAID partnered with the Regional Centre for Mapping of Resources for Development (RCMRD), based in Nairobi, Kenya, and together they began setting up SERVIR's eastern and southern Africa hub. RCMRD is an intergovernmental organization that currently has 20 contracting member states—Botswana, Burundi, Comoros, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Somali, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe—in the eastern

and southern Africa regions. RCMRD's aim is to promote sustainable development through generation, application, and dissemination of geo-information and allied ICT services and products in the member states and beyond. The SERVIR–eastern and southern Africa project builds on RCMRD's existing strengths and augments its data management and training capability. Efforts complement RCMRD's core mission and provide a springboard for the development of applications customized for member states.[9]

Figure 2. 2019 African space activities, capabilities, and infrastructure

Source: Space Supporting Africa, *vol. 1, by Annette Froehlich and Andre Siebrits.*[10]

Barriers to African space development

Barriers to space sector advancement in Africa include significant competing challenges for national resources and attention, nontechnical government bodies' general lack of understanding of space-related capabilities and benefits, inconsistent funding, a small workforce, and dependency on external support. A country interested in developing

upstream capabilities faces significant fixed costs, such as research and development, operations, equipment, and a specialized workforce. Lastly, there is a weak space "ecosystem," with the sufficient workforce, governance infrastructure, and business and civil society participation needed for sustainable growth in the space sector.

Addressing African perceptions of the American space sector

The United States' private space sector has captured the world's imagination through truly rapid advances, as embodied by the substantial drop in space-lift costs and the promise of (comparably) affordable space-based broadband connectivity. However, it has also left the impression that tech billionaires are chasing a "techno-utopian vision" of space tourism, multiplanetary civilizations, and space colonization—goals that ignore more pressing, Earth-bound social, political, and economic challenges.[11] Emerging space actors worry that American billionaires are "filling up orbital slots" and associated radio frequencies, and thereby squeezing out developing countries' ability to participate.[12,13]

Old arguments endure, such as the 1976 Bogota Declaration. The signatories to that agreement—Colombia, the Republic of Congo, Ecuador, Indonesia, Kenya, Uganda and Zaire (now the Democratic Republic of Congo), Gabon, and Somalia, with Brazil as an observer, unsuccessfully attempted to claim exclusive rights over the geostationary orbit located above their territories.[14] As of the 2020s, the declaration has evolved to an appeal for "preferential rights." In parallel, regional forums have started to discuss more use of "band plans," the practice of reserving certain frequency bands for future satellite use.[15]

African countries are evidently exploring ways to push back. Rwanda, for example, "secured the possibility of future satellite launches"[16] by filing with the International Telecommunication Union (ITU) an intent to launch two constellations with a combined 327,230 satellites, despite only having previously launched a single satellite, a CubeSat called RwaSat-1, in 2019.[17] As one author put it, such efforts reflect the concern of developing countries in the face of perceived "saturation and seizure" of limited resources in space by developed countries, to include the United States.[18]

In contrast to the attention given to American tech billionaires, the US actually provides vast public goods in the space sector. Unfortunately, most US diplomats and policymakers seem to underestimate its value in strengthening US diplomatic, commercial, and security ties with African nations. For example, the US Global Positioning System provides free positioning, navigation, and timing (PNT) data that effectively underpins the world banking system and supports numerous mapping and applications services, a service estimated to have driven US$1.4 trillion in world economic growth since 1983.[19] NASA has cooperative agreements with 50 institutions in African countries, ranging from academic institutions to space agencies, and shares terabytes of Earth observation data and training through vehicles such as the SERVIR program.[20] The US National Oceanic and Atmospheric Administration routinely shares free weather and climate data. The Office of Space Commerce, with support from the US Space Command, provides space situational awareness to all governments and the public through space-track.org.[21] Additionally, the US Department of Defense (DoD)

often shares geospatial data in support of allied and regional operations against violent extremist organizations and to combat piracy and illegal, unreported, and unregulated fishing. For example, American satellites track automatic identification system transceivers on ships, and the United States processes and delivers said data to dozens of African maritime operations centers via Navy-owned software named SeaVision.

US policymakers lack of awareness can backfire, like what happened when Congress suddenly eliminated funding to several National Geospatial-Intelligence Agency data-sharing programs in early 2021. Several important regional partners were suddenly cut off from data they had come to rely on at the encouragement of the United States Africa Command, without warning or discussion of alternative commercial or government sources.[22] Such uncoordinated change to existing relationships plays into Chinese and Russian narratives that the United States is an unreliable partner. Even taking into account US contributions to the public good, and existing if unsung cooperation, the US faces a messaging challenge if it is to convince African space actors that it is "playing fair" in space. Current activity needs to be more coherently woven into overall country and regional engagements. New action, though, such as supporting African nations' space capability, would speak louder than words.

Where is the US "front door"?

From the perspective of African customers and partners, identifying points of contact through which to engage the United States for space cooperation and services is not easy. There are multiple US government offices to choose from, each of which has its own, often overlapping, mandate that is not always centered on space development.

For instance, although NASA provides extraordinary amounts of data and frequent training webinars to and has established relationships with African institutions, NASA is not in the business of supporting the holistic development of a foreign national space program. Similarly, the US Office of Space Commerce is primarily US-focused. That said, a new Bureau of Economic Analysis report on US space economy statistics is helping to establish global norms on what activity is included in the global, and African, "space economy."[23] The US Space Command is developing an engagement strategy but as of 2021 had decided to start in the realm of space situational awareness, not exactly a top priority for many African countries with comparatively few maneuverable satellites in orbit. NOAA is a global leader in supporting countries' ability to monitor and report on weather and climate change, and USAID does have projects that leverage space-based capabilities. Both agencies tend to be tied to providing or sharing geospatial data, developing space applications, and collaborating on specific projects rather than building an endemic space capability.

Although US space companies routinely make headlines in Africa, as of 2021 they had launched less than 19 percent of Africa's satellites.[24] An overly strict International Traffic in Arms Regulations (ITAR) regime and the difficulty in navigating contracts with African partners drive the gap between public image and commercial activities on the continent. Contracts in Africa are generally much smaller and more complex to manage than those with the US private sector's biggest customer, the US government. African countries may find it

difficult to navigate the sales teams of large US space companies, which often are not staffed to pursue numerous smaller contracts.

Use Case: Freetown's Experience Establishing an Innovative Tax System Using Satellite Imagery

In 2018, Yvonne Aki-Sawyerr, the newly elected mayor of Freetown, Sierra Leone, set out to improve property tax compliance under a progressive development plan called Transform Freetown, and requested international assistance.[25] The International Centre for Tax and Development and the International Growth Centre, in collaboration with the Freetown City Council, decided to begin by objectively mapping Freetown property values using satellite imagery (in addition to other sources of information). The new Freetown property tax system, built on data, is expected to quintuple revenue, providing a tangible return on investment for good analysis.[26] Projects such as this could spur an enduring demand for periodic updates of property assessments.[27] This project also speaks to an emerging market for smaller "parcels" of data to support similar work.

Framing US–Africa space cooperation

Most countries that have any sort of positive relationship with the United States would probably welcome the opportunity to establish or expand space cooperation. As discussed in the previous section, the United States currently does not have a whole-of-government approach to space cooperation, resulting in a haphazard collection of agency-specific projects that are not necessarily driving toward the development of a partner's space capability. This also speaks to the "invisibility" of space as a legitimate area of engagement. Education and active US leadership encouragement of the Department of State and USAID to include space in regional and country plans and of the DoD to include space as part of its theater strategy, command campaign plan, and country plans would enable US government mechanisms in charge of international cooperation to take action in the space sector.

"Come to us with the view that Africa is a partner in the business and not just a receiver of services," was advice offered to foreign companies looking to engage Africa by Dr. Tidiane Ouattara, a space science expert at the African Union Commission.[28] That advice works well for American efforts to engage as well. Each African country has its own interests, level of space capability, and vision. For example, Nigeria is working to expand its Earth observation capabilities and has invested significantly in a new arrangement with China to launch its next generation of communication satellites.[29] Ghana is working on building a "space hub" to bridge academia and its nascent tech sector. Egypt is pursuing an astronaut program, is preparing to open the African Space Agency in 2023, and is active in supporting African nations' development of their own space programs.[30] Although the US government is often motivated by great-power competition, most African nations are not interested in choosing between the United States, China, or other major space powers as a space cooperation partner.

International cooperation works best when both partners are committed and have a clear sense of what the return on investment will be. Like any complex system, such a capability requires a clear strategy, multiple lines of effort, steady funding, and engaged stakeholders. A space capability build should first focus on the downstream segment of space activities—products and services that are primarily Earth-oriented. That includes leveraging satellites to expand, reinforce, or "densify" telecommunications infrastructure and applying geospatial information services and global navigation satellite systems data to support a range of national priorities (such as disaster risk reduction, maritime security, and climate change). Investments in the upstream segment of space activities, to include research, satellite and ground systems manufacturing, should be staggered behind the downstream line of effort.

A general program for national space capability development

Establishing an initial space capability doesn't necessarily mean building satellites and spaceports. The goal of any early space program should be to maximize the utility of space-based resources (orbits and frequency spectrum) and shared, publicly available, or commercial space applications, from imagery to satellite communications, as an enabler of national and economic interests. The first and primary purpose of establishing a national space program is to consolidate existing capability and make such capability available to the government. It must be first acknowledged that any given country likely has some degree of space-related capacity already. It may be found in the ministry of communications or in academia, or it may be buried in a military mapmaking office. What any given country needs in its space program depends on its overall national strategy and objectives. It is worth repeating that a nation does not need to have a satellite in space or a launch capability to be space proficient.[31] Most countries just now considering a national space program are also balancing pressing requirements in security, civil services, and "traditional" infrastructure. Our recommendation in the next section for a "foundational space proficiency" serves as a pragmatic objective designed to maximize the utility of space applications and services using as few new resources as possible and limiting premature bureaucratic expansion (also see Figure 3).

Building foundational space proficiency

Foundational space proficiency could be housed within a relatively small team—for example, consisting of an adviser and his or her support staff. It may manifest as an office within an existing bureau, ideally one that best aligns with national priorities—for example, the ministry of communications for space-based telecommunications infrastructure, or the ministry of defense for security sector applications. Regardless, the office should be charged with proactively working with multiple ministries to apply space in support of discrete projects in order to provide said benefit, and also to grow familiarity with space infrastructure and benefits within government offices in general.

Figure 3. Proposed foundational space proficiency for all states

- Advises government on space applications and operations:
  - Remote sensing and positioning, navigation, and timing data: geospatial information systems data acquisition and management for governance, land use, tracking, security, and transportation
  - Telecommunications: broadband/mobile frequency management and regulation, emergency/security communications
- Advises on space-related versus alternative technical solutions to national data or infrastructure requirements.
- Acts as government/academic/private industry "connective tissue." Coordinates government activity, provides input to science, technology, and innovation-related efforts.
- Advises space-related program management: leadership, advocacy, planning, budgeting, executing, reporting. Leads domestic space development.
- Represents and advances national and collective interests at regional/world forums, e.g., International Telecommunication Union/World Radiocommunications Conferences, the UN Committee on the Peaceful Uses of Outer Space, Group on Earth Observations for Cooperation in Earth Observation.

Deepening state space capability

Moving beyond foundational space proficiency to develop both upstream and downstream capabilities requires the involvement of government, academia, civil society and the private sector. Examples of upstream competencies are satellite systems design and operations; satellite and payload testing and qualification; aerospace and rocket engineering; and mission control. In addition to establishing a space policy, strategy, and office, an emerging space actor also needs to deliberately grow the local "space and data ecosystem." That ecosystem roughly describes the pool of skilled manpower and the academic and private activity leveraging said manpower. A strong ecosystem will set up a positive feedback loop with government space-related activity. A weak ecosystem will either drain talent from government programs or result in an export of talent abroad. The Space Technology Ladder (Table 1) is a widely referenced model for the sequencing of space capabilities. A space development program should focus first on levels 0 to 4 of the ladder.

Table 1. The space technology ladder

Launch capability	15	Launch capability: Satellite to GEO
	14	Launch capability: Satellite to MEO
	13	Launch capability: Satellite to LEO
MEO/GEO satellite	12	MEO/GEO satellite: Build and operate locally
	11	MEO/GEO satellite: Build through mutual international collaboration
	10	MEO/GEO satellite: Build locally with outside assistance
	9	MEO/GEO satellite: Procure, with training services
LEO satellite	8	LEO satellite: Build and operate locally
	7	LEO satellite: Build through mutual international collaboration
	6	LEO satellite: Build with support in partner's facility
	5	LEO satellite: Procure, with training services
Establish space policy, strategy, office, and ecosystem	4	Establish space and data ecosystem
	3	Establish foundational space proficiency
	2	Establish government office responsible for space (assign staff, budget, objectives, and work plan)
	1	Establish national space policy and strategy
Preparation	0	Map existing space applications use (e.g., weather and climate, telecommunications) and stakeholders (e.g., government offices, university programs, businesses, civil society/clubs)

Source: Adapted from Danielle Wood and Annalisa Weigel, "Charting the Evolution of Satellite Programs in Developing Countries: The Space Technology Ladder," *Space Policy* 28 (2012).
Note: Terms include low Earth orbit (LEO), mid-Earth orbit (MEO), and geosynchronous Earth orbit (GEO), and represent increasingly complex objectives. This version places an emphasis on first "mapping" existing, organic space applications and stakeholders, developing a "foundational proficiency," including training services with procurements, and development of a "space and data ecosystem."

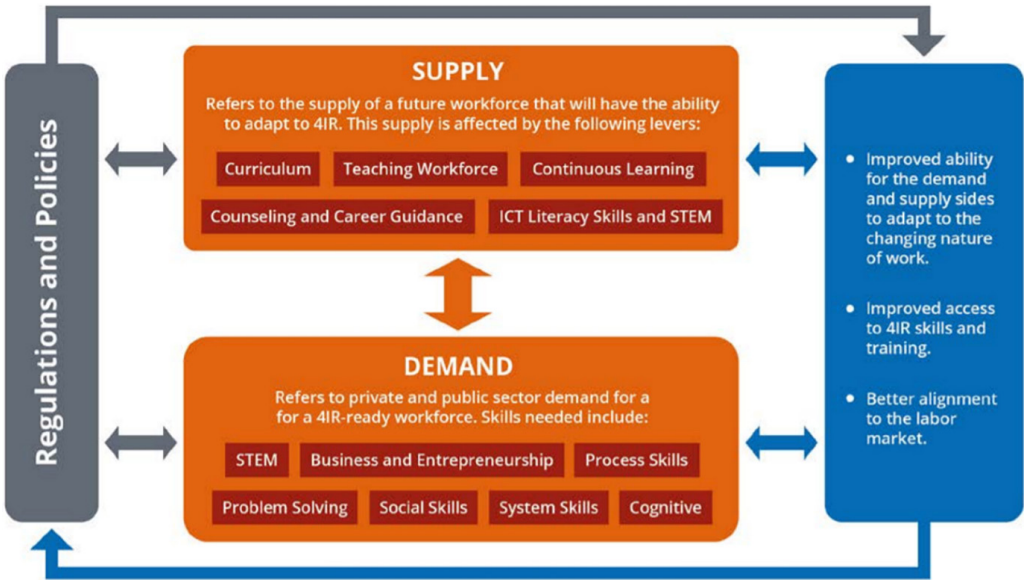
A space capability development effort would need to be deliberate and pragmatic. Spending limited government funds on a space development effort will always compete with other national priorities, so any program must be able to show near-term tangible returns on investment, in addition to the long-term benefits of developing a space capability as ascribed in Agenda 2063. For this reason, and as a method to sustainably grow a country's capability, a country should select a series of modest projects over time (about every two years) that also address a tangible national priority, be it agriculture, security, communications infrastructure, or other focus area. Such an approach provides immediate benefits to the public, deepening understanding by engaging various offices of government, increasing demand for products, and growing a workforce through experience in localized projects. It also provides a path to develop foundational capabilities (e.g., flood studies, extending satellite broadband) and progress to more complicated upstream efforts (e.g., CubeSats, sounding rockets, and so on).

Avoiding failure

The field is littered with failed attempts by states and development agencies to establish and sustain new capabilities, even more so for complex capabilities, such as space applications and operations, that require a skilled, innovative workforce. Even if significant resources are poured into recruiting and/or training a skilled workforce (i.e., basic education through industry and professional competencies), if the surrounding "ecosystem" is unbalanced in a way that those skills are too much in demand, or not enough in demand, the workforce will not remain stable. Personnel will be poached by the private sector, nonprofits, or academic institutions, or they will move to areas where their skills are valued, and they have an opportunity to advance. Both contribute to chronic brain drain, where a program can't seem to keep its workforce, and therefore its capability, stable. The AU recognizes that its growing youth population is outpacing job creation on the continent, spurring global skills-based immigration abroad.[32] Case in point, over the past five years, the number of Nigerian immigrants moving to Canada has tripled.[33] It is important, therefore, to foster conditions that will grow a local space and data ecosystem if a space program hopes to attract and retain talent. As a state climbs the Space Technology Ladder, the mix of its workforce, and of its broader ecosystem, will need to adapt as well.

The African Center for Economic Transformation report *Strengthening Education and Learning Systems to Deliver a 4IR-Ready Workforce* highlights the need for balance between the "supply" of personnel from academia and the "demand" for a skilled workforce. Governments and development and finance institutions play a vital role in spurring the formation of such an ecosystem (Figure 4). *USAID's Principles for Digital Development* provides a complimentary primer on designing and implementing technology-enabled programs.[34]

Figure 4. Graphic from an AECT youth employment and skills multi-country study



Source: African Center for Economic Transformation, Strengthening Education and Learning Systems to Deliver a 4IR-Ready Workforce, *February 2022, https://acetforafrica.org/acet/wp-content/uploads/publications/2022/02/Strengthening-Education-and-Learning-Systems-to-Deliver-a-4IR-Ready-Workforce_REPORT-2022_14Feb2022.pdf.*

A note on space applications

Many resources explore the various ways space applications can support African governments, economies, and overall development goals. A good starting point is the United Nations Office for Outer Space's Space for Sustainable Development Goals (Space4SDGs) directory that maps each SDG to relevant space technologies and applications.[35] See Figure 5 for an example.

Space agencies such as NASA and the European Space Agency go into more detail, linking SDGs to recommended data sources and processing and analysis methodologies. NASA, for example, publishes "Data Pathfinders" such as the one illustrated in Figure 6[36] and supports the use of space applications through the SERVIR program. The Asian Development Bank, World Bank, and European Space Agency collaborate on the Earth Observation for Sustainable Development (EO4SD) initiative.[37] Lastly, a multitude of research papers are published regularly that explore various use cases.

Figure 5. Sample mapping of an SDG to space technologies

SDG 10: Reduced Inequalities. Space technologies can contribute in various, for example through:

- Connectivity in remote and isolated areas
- Remote participation in democratic processes
- Reliable access to information
- Connectivity in remote and isolated areas
- Remote participation in democratic processes
- Reliable access to information

Source: NASA Earthdata, https://earthdata.nasa.gov/learn/pathfinders/sdg-data-pathfinders/sdg-2-data-pathfinder/.

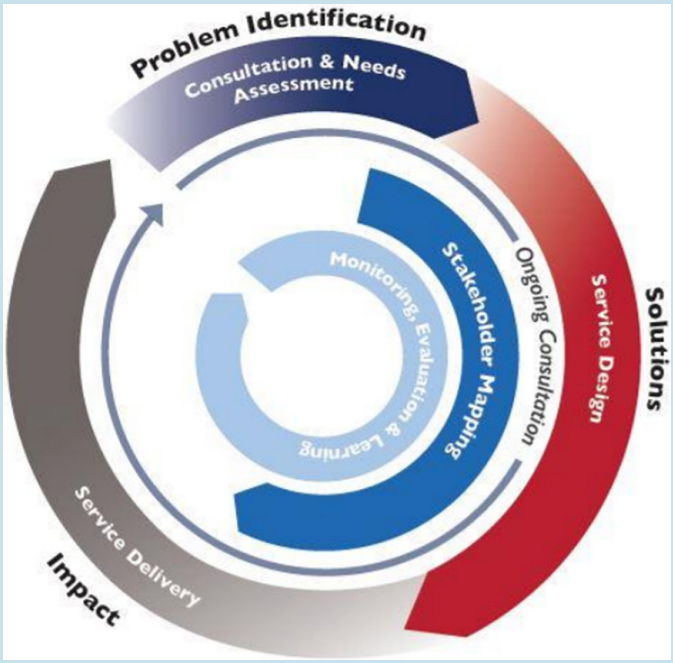
Figure 6. Example of a NASA data pathfinder

Source: NASA Earthdata, https://earthdata.nasa.gov/learn/pathfinders/sdg-data-pathfinders/sdg-2-data-pathfinder/.

Use Case: NASA and USAID's SERVIR Program

In 2017, the SERVIR program published SERVIR Service Planning Toolkit to articulate a "use-centric, consultative and collaborative approach for applying Earth observations, geospatial science and technology to an array of development challenges related to climate change." The toolkit provides a structured way to identify and prioritize development challenges, and design and implement a space application "service," as Figure 7 illustrates.[38]

Figure 7. SERVIR service planning lifecycle



Source: USAID and NASA, SERVIR Service Planning Toolkit, https://www.servirglobal.net/Portals/0/Toolkit/ServicePlanningToolkit_2021%20revision_%20clean%20v1.pdf

Other actors in the African space sector

China

African nations will likely continue to increase their investment in space infrastructure, and China is interested in being the primary enabler of that expansion. In so doing, China hopes to gain support for its vision of governance in space and votes in the UN, expand the global space market and demand for Chinese space exports, and vertically integrate its "sovereign Internet" and "smart city" models. In addition to hard infrastructure like railroads, power stations, and ground-based communication networks, China's space component of the Belt and Road Initiative, called the Belt and Road Space Information Corridor, aims to connect Eurasia and Africa with Earth observation, communications, and PNT satellites; ground stations; data centers; and other ground application systems. For China's Ministry of Foreign

Affairs, space cooperation is generally reserved for those governments with which it has signed "strategic partnerships" or "comprehensive strategic cooperative partnerships." As of 2020, that included Algeria, Angola, Cameroon, Ethiopia, Kenya, Nigeria, Senegal, and Tanzania. It was China that Nigeria turned to in 2007 to finance, build, launch, and train to operate NigComSat-1 and subsequent communications satellites. Nigeria also works with other countries; NigeriaSat-X was built in collaboration with the UK company Surrey Satellite Technology Ltd. The China National Space Administration recently published a white paper, "China's Space Program: A 2021 Perspective," that dedicated an entire section to international cooperation. In it, China tied its space services to UN millennial goals and outlined steps to lower barriers to using People's Republic of China space services. China highlighted the use of its meteorological satellites for disaster prevention and mitigation, the construction of satellite-data-receiving stations in Namibia and South Africa, and various training programs, and committed to supporting the development of Egypt's "Space City" (the future home of the African Space Agency).[39,40] US policy, such as the "Wolf Amendment," disallowing NASA cooperation with Chinese or Chinese-owned companies, as well as the United States' ITAR regime, tends to restrict nations' ability to work with both the United States and China in the space sector.[41]

Russia

Although its space sector has many challenges, Russia made several successful overtures to African nations during the October 2019 Russia–Africa Summit, resulting in proposed bilateral space cooperation between Russia and Uganda (via Aksioma) and Russia and Algeria (via Glavcosmos, a Russian launch service provider and subsidiary of the state corporation Roscosmos).[42] This effort built on previous engagements in the space security realm. In 2014 and 2015, for example, Russia established joint overhead surveillance programs with both South Africa and Egypt (Project Condor and EgyptSat-A, respectively).[43] More recently, the Roscosmos State Corporation for Space Activities and the South African National Space Agency agreed to install a space situational awareness facility in Hartebeesthoek, South Africa, to support the detection of space debris.[44] Overall, Russia's space cooperation falls below that of China and Europe in Africa. Russia's February 2022 attack on Ukraine continues to damage its reputation as a potential space partner. The AU has strongly condemned Russia's invasion of Ukraine, citing Russia's lack of respect for international law.[45]

Policy recommendations

Potential African partners, faced with multiple US government offices with varying mandates and goals, struggle to identify points of contact to engage the United States for space cooperation and services. **In the near term, policymakers should clarify a point of entry and take initial steps to expand US tools for space development:**

> ***Establish a point of contact for potential space partners.*** The State Department Office of Space Affairs mandate sould be expanded to include space development,

or alternative office identified. This should include a high-level expert to coordinate US space development efforts with emerging space actors. An executive order, or mandate from Congress, could establish this position as a point of contact for parties interested in US space cooperation.

Provide support for space as essential infrastructure through US development finance and assistance. As a major contributor to international financial institutions such as the World Bank and African Development Bank, the U.S. could use its voice and influence to support an increased focus on space development in addition to "traditional" infrastructure such as roads and power. Both the AfDB and ADB have supported the development and launch of large geosynchronous communications satellites in the past, akin to the installation of undersea cables, but not the development of indigenous space capability more broadly. Millennium Challenge Corporation programs, ranging from the Innovation and Technology Program to the Infrastructure Accelerator Program, have a mandate that could more directly consider the growth of space applications and infrastructure in supporting the development of partners' economies. Tools such as the U.S. Export-Import Bank (EXIM), US International Development Finance Corporation (DFC), and US Trade and Development Agency's "Access America" initiative could reduce the perceived risk for US space companies and accelerate private sector engagement with emerging space actors in Africa. EXIM and DFC should explore the space investment sector and—through congressionally-mandated report or otherwise—identify barriers, whether regulatory, legislative, or financial, that currently prevent the agencies from making financing available to such projects.

Use Case: The Africa development bank and space

The president of the Africa Development Bank (AfDB) visited the Center for Global Development in Washington, DC, in late 2021 for an informal discussion regarding AfDB's 2022 strategy. During the discussion, the topic of leveraging space-based capabilities—such as remote sensing, communications, and positioning, navigation, and timing—to address long-standing capability gaps was raised. AfDB president Akinwumi Adesina took a few moments to tell his own story of how he had used publicly available satellite data to support crucial decisions concerning flood zones when working as an economist in the Nigerian government. Animated, the discussion moved on to emerging technology and the impact of putting good data in the hands of African decision makers. The AfDB representatives didn't need to be convinced regarding the relevance of space. Rather, like many African institutions, they're open to opportunities to partner, and pragmatically develop, domestic space-based capabilities. The AfDB is in the business of funding infrastructure development. As space-based infrastructure such as communications satellites, ground stations, and observation satellites and the ability to process geospatial data becomes normalized as "basic state infrastructure," the more development institutions and their members should be postured to fund space-focused projects.

Increase support to African nations in managing their spectrum and developing national broadband plans. Satellites require designated frequency ranges (called bands) on the radio spectrum to move data and operate. More satellites mean more competition for key bands, thus boosting the importance of, and African participation in, international coordinating and arbitration organizations such as the ITU and the UN Office for Outer Space Affairs. Developing countries rarely have a robust support agency to manage what is, essentially, a limited natural resource. We recommend that the United States expand the capacity of the United States Telecommunications Training Institute (USTTI), a nonprofit focused on training partners to manage their spectrum, deploy wireless technologies, develop national broadband plans, implement national cybersecurity strategies, support Internet deployment, launch cloud services, and ensure sound emergency communications plans. The USTTI, the Federal Communications Commission International Bureau, and organizations such as the ITU Telecommunication Development Sector should be tapped to advise US–Africa space cooperation and development programs.

Pilot a Space Development Program in Africa. The US approach to a space development program will naturally be shaped by mutual national interests, political will, and a partner's space readiness, as well as by a mosaic of other factors in common with other major development endeavors. For those emerging African space actors in the "preparation" and "establish" levels of the Space Technology Ladder (Figure 4), a US-supported space development program should begin with the initial objective of ensuring a national, self-reliant, foundational space proficiency (Figure 3). That said, no national space program has ever proceeded in a strict, linear manner up the ladder, nor is every space program pursuing launches to geostationary orbit. No country is strictly limited to the top of today's space ladder, as more rungs will surely be added for all nations in the coming decades.

The United States could provide programmatic structure, strategic-level advice, technical assistance (space law, frequency management, satellite development), capital investment (loans, grants), human capital development (scholarships, exchanges, internships, partnerships with civil society organizations), and other tools such as modeling public–private partnerships and start-up incubators. Countries that recently have signaled strong political will by initiating space programs include Botswana, Rwanda, Namibia, Burkina Faso, Djibouti, and Zambia. Taking into consideration only their space-related activity and capability as of 2019, candidates also include, but are not restricted to, Cameroon, Côte d'Ivoire, Ethiopia, Guinea Bissau, Mali, Mauritius, Niger, the Republic of the Congo, Senegal, Sudan, Uganda, and Zimbabwe.[46]

Use Case: Botswana

In December 2020, Botswana president Mokgweetsi Masisi announced an effort to develop a space program as part of an overall agenda to "harness a knowledge-based economy." Space in Africa reported that the state was "emboldened" by the adverse effects of the COVID-19 pandemic to commit "to investing in the satellite project and harnessing it." President Masisi continued, "It will take three years, will require full commitment and selfless dedication. It will be demanding as it is the first time the nation will be launching a satellite into space. However, if we capitalise on the data and apply it in various industries [current focus is on agriculture], it would contribute to the growth and development of the nation."[47] Botswana has expressed political will, garnered popular support, established a "home office" (the Botswana International University of Science and Technology), and set a timeline with clear, progressive objectives.

More broadly, the US should establish a whole-of-government approach to space cooperation, and communicate more fully with lawmakers when expansion is needed, including:

Develop a whole-of-government approach to US–Africa space cooperation, with a clear lead agency. Create an executive order that clarifies the US president's and US senior leadership's support for whole-of-government international engagement and cooperation in the space sector, to guide and empower Africa-oriented US agencies and departments, in accordance with the White House's December 2021 *United States Space Priorities Framework*.[48] Recommend that the Department of State appoint a specific office and person to lead US efforts to develop a space development program, using technical experts drawn from various US agencies and departments, to include NASA, the DoD, and the US Department of Space Commerce. Encourage incorporating the pragmatic use of space capabilities and applications in US development, cooperation, and assistance programs, in general.

Expand Space-Related Security Cooperation and Assistance. As part of a comprehensive approach to space-related security cooperation and assistance, the United States should foster long-term, strategic relationships in Africa by enabling endemic security of African telecommunications and data infrastructure. The US Space Command, the Secretary of the Air Force International Affairs, USAID and the Defense Security Cooperation University should develop and "roadshow" guidelines for space-related security cooperation for the US Africa Command headquarters and embassy-based offices of security cooperation. Security cooperation and assistance (U.S.C. Titles 10 and 22) and a revalidated National Geospatial-Intelligence Agency pro-cooperation posture should be applied to support space applications and space development in the security sector.

Increase US space cooperation and commerce with more advanced emerging African space actors. For more advanced emerging African space actors, the United

States should increase collaboration for mutual benefit. Broadly speaking, such counties offer wide open spaces, potential equatorial launch positions, natural resources, a growing workforce, and a desire to transform their economies and are committed to developing their space capability. Ideally an US Embassy-based Department of State lead would coordinate a blend of engagements from the US Trade and Development Office, Office of Space Commerce (and private-sector space actors), NASA, USAID, and the DoD (US Africa Command, Space Command and the US Space Force), to encourage cooperation and space-related commerce. Countries that are good candidates for such engagement, if we take into consideration only their current space-related activity and capability, include Algeria, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tanzania, and Tunisia.[49]

Use Case: South Africa

South Africa is arguably the most advanced space actor in Sub-Saharan Africa, and is thus able to leverage closer parity in capability for (near-term) mutual benefit. Having achieved foundational space proficiency, South Africa is working on developing its space ecosystem and is continuing to climb the Space Technology Ladder. South Africa's space sector includes upstream manufacturing (satellite components) and promotes research and development and commercial activity (i.e. incubator and accelerator programs, tax incentives), as well as respected universities and research laboratories. The majority of Africa's space companies are headquartered in South Africa, including Dragonfly Aerospace, SES Space, and GeoSmart, among others.[50] South Africa also houses one of two UN-supported institutions focused on space education, the Pan African University Institute for Space Sciences. Its sister school is the African Regional Centre for Space Science and Technology Education in English in Nigeria.

Looking at ongoing US–South Africa space cooperation, in 2020 the South African National Space Agency (SANSA) partnered with NASA to establish a new Deep Space Ground Station that will enable deep space communications needed for spaceflight missions to the moon and Mars, to be operated and managed by SANSA. This project has deep roots. NASA built a tracking station in Hartbeestfontein, South Africa, in 1961 to track NASA probes moving beyond Earth orbit. The original venture was suspended due to international opposition to the apartheid government in 1974. This example of space cooperation provides significant mutual advantages. NASA is able to situate its 20-story tall antenna in the southern hemisphere. South Africa will use this project to feed its "space ecosystem" and increase national research output in space science and technology.[51] Of note, South Africa's first satellite, SUNSAT, was launched in 1999 from Vandenberg Air Force Base (now Vandenberg Space Force Base) in California.

Looking forward, South Africa has continued to express interest in deepening US–South Africa space cooperation. At a November 2021 US–Africa Space Cooperation Webinar, Martin Snow, the South African panel speaker, noted South Africa's investment of US$297 million in its space economy and its commitment to establish a new space infrastructure "hub" focused on the development of satellite infrastructure, satellite-based augmentation systems, and Earth observation satellites.[52] Interest in (re)establishing a space port in Arniston, located on the Cape South Coast, continues at a low simmer.[53]

Figure 8. SKA site in Narnarvon, South Afria

Source: Provided by the SKA Organization website, skatelescope.org.

Increase multilateral space cooperation in Africa. Working with the more mature space actors in Africa, to include Kenya, Nigeria, Algeria, South Africa, and Egypt, the United States could also build bridges to regional or subregional space-related efforts, since those key countries have significant regional leadership roles. The European Space Agency and allies such as Italy and France have been working with African nations for decades. Italy and Kenya, for example, signed their first space agreement in 1964 founded on common interests and mutual advantages, and it is still active today. Through a partnership between the Sapienza University of Rome and NASA, Kenya allocated land to Italy (the Luigi Broglio Space Centre in Ngomeni, Kenya) to launch rockets from its fuel-efficient equatorial position, in exchange for the development of Kenyan human capacity in space science and technology.[54] The United States could both enrich its current space cooperation with Italy (a signatory to the Artemis Accords) and boost an emerging African space actor (Kenya) through multilateral cooperation. There is already a foundation to build upon- the USAID/NASA environmental data program SERVIR partners with the Regional Centre for Mapping of Resources for Development in Nairobi, Kenya. (There is also a SERVIR partnership with the Agrometeorology, Hydrology,

and Meteorology Regional Center in Niamey, Niger.) Additionally, the United States could lend its support to projects such as the Square Kilometre Array (SKA), an effort to build the world's largest radio telescope with an eventual collecting area of over one square kilometer. The KSA has facilities in Botswana, Ghana, Madagascar, Mauritius, Mozambique, Namibia, and Zambia, in addition to Kenya and South Africa, spurring industry, academia, and intra-Africa space cooperation. Lastly, interest in space cooperation and development across the board is expected to grow with the projected launch of the African Space Agency, with Egypt to host its headquarters, in 2023. The United States could provide space attachés or liaisons, sponsor projects, workshops, and regional training, and expand scientific research and exchanges.

Use Case: Kenya

Only recently established in 2017, the Kenya Space Agency (KSA) has made great progress in consolidating decades-long space activity and in coordinating, regulating, and promoting the development of the Kenyan space sector. In a succinct justification, the new KSA national coordinator, John Njoroge Kimani, noted that India, China, and Brazil were able to "leapfrog" their social economic development by embracing space science and technology. Kimani said that KSA's effort was "technology commercialization . . . not a capability transferred from developed to developing nations," and that it would be pursued in cooperation with Kenya's academic institutions.[55]

That is not to say that Kenya is not open to cooperation with the United States. In late 2021, Charles Mwangi, KSA's research, education, and outreach lead, expressed interest in cooperating with the United States in establishing a spaceport in Kenya, partnering to manufacture satellites and launch vehicles in Kenya, and developing ground facilities, as well as garnering US support for general human capacity development.[56]

Today, Kenya anchors the NASA/USAID joint project in the Regional Centre for Mapping of Resources for Development, based in Nairobi. KSA's Malindi ground station's 10-meter transmitter, based at the Luigi Broglio Space Center, was the first Earth station to receive a signal from the United States' new James Webb Space Telescope launched by NASA on December 25, 2021.

Improve awareness of US intentions in space and support to the public good in space. The United States should socialize the public good it provides that underpin the African, and global, space economy and support governance and development goals. This includes the provision of free PNT data (via GPS) and remote sensing (i.e., NASA's SERVIR program), among other services. Whenever possible support and collaborate with established African programs—such as the AfriGEO Initiative, consisting of the African community in the Group on Earth Observations,[57] and Digital Earth Africa programs.[58] Provide background papers on US space

contribution to the public good to inform US policymakers and diplomats. Feature in Voice of America, and proactively engage African media. Engage African and/or space-oriented organizations like the AU, youth organizations such as the Space Generation Youth Council, and members of the UN Committee on the Peaceful Uses of Outer Space. The US should more widely discuss US intent and reasoning for the Artemis Accords and their utility to emerging space actors and encourage African participation.

Promote geospatial data platforms, tools, and education that empower African space applications. Space-derived geospatial data is one facet of a greater digital ecosystem, and should be included as a line of effort while implementing USAID's Digital Strategy.[59] To encourage the uptake of free and commercial data, and to spur market competition, the US should also support the development of geospatial data marketplaces.

Expand Space-Related Security Cooperation. Security cooperation and assistance (U.S.C. Title 10/22) and a revalidated National Geospatial-Intelligence Agency pro-cooperation posture should be applied to support space applications and space development in the security sector. As the US Africa Command frequently reminds the US government, Africa is big. Many states are challenged by having to govern vast spaces using limited security forces. Commercially available remote sensing, to include infrared, radar, and electro-optical, could be better leveraged by African nations to increase situational awareness on land (boarders, conflict zones, disasters) and sea (illegal, unreported, and unregulated fishing; piracy; pollution). Satellite imagery and data are valid evidence in international courts, bolstering the rule of law.[60] Satellite-enabled communications, becoming increasingly affordable and portable, could improve communications between remote military units or prompt a faster, more precise response to threatened remote civilian populations. The United States should foster long-term, strategic relationships in Africa by enabling endemic security of African telecommunications and data infrastructure. The US Space Command, the Secretary of the Air Force International Affairs, and the Defense Security Cooperation University should develop and "roadshow" guidelines for space-related security cooperation for the US Africa Command headquarters and embassy-based offices of security cooperation.

Promote geospatial data platforms, tools, and education that empower African space applications. Because data storage and data processing are available via the cloud, the basic hardware for a geospatial capability can be reduced to a decent laptop and a fast Internet connection. Small teams are capable of bringing pragmatic geospatial technology to any country on the map by leveraging application-oriented programming such as Python and SQL, free data such as is available from UN-SPIDER, NASA's SERVIR program, or Norway's International Climate and Forests project, among others, and powerful application programming interfaces such as Google Earth Engine and Microsoft's Planetary Computer.[61] Space-derived geospatial data is one facet of a greater digital ecosystem, and should be included as a line of effort while implementing USAID's Digital Strategy.[62] To encourage the

uptake of free and commercial data, and to spur market competition, the US should support the development of geospatial data marketplaces.

Conclusion

African nations writ large are interested in pragmatically leveraging space-based capabilities to support an array of national objectives. All have accepted the role ascribed to space in Agenda 2063 and all desire an active role in the space sector so as to participate fully in an evolving world economy. The United States has an opportunity to collaborate with emerging African space actors both to grow a peaceful and law-abiding community in space and to benefit from Africa's contributions to the global space ecosystem.

Appendix: Key US space actors in Africa

The **National Space Council** within the Executive Office of the President is charged with providing objective advice to the President on the formulation and implementation of space policy and strategy.

The **Department of State Office of Space Affairs** advances American space leadership by pursing and maintaining a rules-based international framework for space commercialization and use. It also leads the U.S. delegation to the United Nations Committee on the Peaceful Uses of Outer Space.

NASA has cooperative agreements with 50 institutions in African countries, ranging from academic institutions to space agencies, and shares terabytes of Earth observation data and training through vehicles such as the SERVIR program.[i] NASA, however, is not in the business of supporting the holistic development of a foreign national space program.

The US National Oceanic and Atmospheric Administration routinely shares free weather and climate data. It is considered a global leader in supporting countries' ability to monitor and report on weather and climate change.

The US Global Positioning System provides free positioning, navigation, and timing (PNT) data that effectively underpin the world banking system and support numerous mapping and applications services, a service estimated to have driven US$1.4 trillion in world economic growth.[63]

The **Department of Commerce's Office of Space Commerce**, with support from the US Space Command, provides space situational awareness to the public through space-track.org.[64] Its mission is to foster the conditions for the economic growth and technological advancement of the U.S. commercial space industry.

The **US Department of Defense (DoD)** often shares geospatial data in support of allied and regional operations against violent extremist organizations and to combat piracy and illegal, unreported, and unregulated fishing. For example, American satellites track automatic identification system transceivers on ships, and the United States processes and delivers said data to dozens of African maritime operations centers via Navy-owned software named SeaVision. **US Space Command** is developing an engagement strategy but as of 2021 had decided to start in the realm of space situational awareness, which is not a priority for African countries with comparatively few maneuverable satellites in orbit.

The **US Agency for International Development (USAID)** does have projects that leverage space-based capabilities, though those tend to be tied to providing geospatial data, developing space applications, and collaborating on specific projects rather than building an endemic space capability.

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