OPEN PUBLICATIONS

External Actors' Evolving Role in Space and the Impact on African Countries

Volume 10, Number 2, 2025

ISSN 2957-7160 (Online)
ISSN 2957-7799 (Print)

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ABSTRACT

The advent of space exploration and satellite technology has marked a pivotal shift in global dynamics, with significant implications for countries worldwide, including those in Africa. The involvement of external actors in space, encompassing a broad range of stakeholders from government agencies to private corporations, has increasingly become a focal point of interest due to its multifaceted impact on economic development, security, and technological advancement. This essay explores the evolving role of these external actors in space and assesses its implications for African nations, highlighting both the opportunities and challenges that arise from this global endeavor.

EXECUTIVE SUMMARY

This article examines how external actors, particularly NATO Member States and their ideological competitors such as China and Russia, impact African space development. Furthermore, it will address how these relationships influence regional and global geopolitics.

External actors seek to influence, shape, or grow the African space sector; this includes international space agencies and private corporations. Whilst the ideological disposition of the associated organization(s) needs to be carefully considered, the sharing of knowledge from more mature space actors will enable Africa to leapfrog traditional developmental stages, thus accelerating the continent's space capabilities and enabling it to reap a plethora of geopolitical benefits. If structured appropriately, these relational benefits would encourage the alignment of African countries to NATO's established standards, rules, and behavioral norms - the Rules-based International Order. Secondly, it will ensure collaboration opportunities with participant African nations for space domain research and activity. On the contrary, alignment with non-NATO Member States removes both of these benefits. This divergence highlights that NATO's diplomatic endeavors on the African continent are instrumental in shaping responsible behavior in space.

NATO's space strategy demonstrates a commitment to ensuring Alliance security and prosperity. While Africa's space strategy focuses on socio-economic development opportunities, there is considerable opportunity for NATO to enhance and extend its services and support to Africa and, in doing so, shape regional geopolitics in favor of a development model beneficial to Africa's ambitions. NATO's focus on amplifying existing space support rather than developing independent capabilities highlights the potential opportunities and threats the African continent presents. Addressing Africa's divergent political environment is essential for NATO's growing influence as well as its collective defense and cooperation.

NATO must emphasize peaceful cooperation and shared benefits and facilitate knowledge exchange, technological advancements, and capacity-building initiatives. This approach will promote global development and underscore a commitment to use space as a peaceful domain for the betterment of humanity. Secondly, NATO must support Africa in delivering carefully calibrated strategies to maximize meaningful engagement across external actors. These strategies must intersect strategic competition, diplomatic alliances, and commercial interests. Critically, both NATO and the African nations must navigate political rivalries and competitive dynamics to establish standards and equitable governance that are mutually reinforcing and beneficial to all parties.

INTRODUCTION – THE EVOLVING ROLE OF SPACE AND THE IMPACT ON AFRICAN COUNTRIES

THE ROLE OF EXTERNAL ACTORS IN SPACE

External actors in the space domain include countries with advanced space capabilities, such as the United States, Russia, China, and the European Union, along with emerging private sector players like SpaceX, Blue Origin, and OneWeb. These entities have expanded their role from mere exploration and scientific research to encompass satellite communication, Earth observation, and even space tourism. The democratization of space technology, driven by reduced launch costs and innovative business models, has allowed a broader array of actors to participate in space activities, fundamentally altering the landscape of space exploration and utilization (Kreps et al., 2022; World Economic Forum, 2022).

IMPACT ON AFRICAN COUNTRIES

OPPORTUNITIES FOR DEVELOPMENT AND CONNECTIVITY

For African countries, the engagement of external actors in space presents an array of opportunities. Satellite technology can play a critical role in bridging the digital divide by providing widespread internet connectivity, particularly in remote and underserved areas. Projects like Starlink by SpaceX aim to deliver high-speed internet across the globe, which could revolutionize access to information, education, and economic opportunities in African regions.

Moreover, Earth observation satellites offer invaluable data for environmental monitoring, agriculture, and disaster management (Chuvieco et al., 2019; Willige, 2024). For example, satellite imagery can be used to predict droughts, monitor crop health, and manage water resources more effectively, directly contributing to food security and resilience against climate change.

CAPACITY BUILDING AND TECHNOLOGICAL TRANSFER

Collaborations with external actors in space initiatives can lead to significant capacity building in African countries. Partnerships for launching satellites, developing ground infrastructure, and training local personnel not only build technical capabilities but also stimulate the growth of a domestic space industry. South Africa's collaboration with the European Space Agency (ESA) and Nigeria's engagement with foreign partners to develop its communications satellites are examples of how such collaborations can enhance technological proficiency and foster innovation.

RELATED WORK - CHALLENGES AND CONCERNS

However, the involvement of external actors in Africa's space sector is not without its challenges. Stein and Uddhammar (2021) highlight concerns about dependency on foreign technology, services, and investment which could have negative long-term economic consequences for the continent. Additionally, the strategic and military implications

of space technology, such as satellite surveillance and communication interception, raise security concerns for African nations, necessitating careful management of international partnerships (Oyewole, 2020; Faboade, 2024). Moreover, the digital divide within countries could be exacerbated if space-based services primarily benefit urban and economically advantaged areas, leaving rural and impoverished regions further behind.

Amidst these global developments, African countries have increasingly sought to participate in space exploration and utilize space technology for sustainable development. The establishment of space agencies and programs across the continent reflects this growing engagement.

South Africa has been a leader in Africa's space endeavors, establishing the South African National Space Agency (SANSA) in 2010. South Africa's contribution to astronomy and space science, including hosting the Square Kilometre Array[1] (SKA) project, highlights its significant role in the global space community. In addition, the Nigerian Space Research and Development Agency (NASRDA), established in 1999, has focused on satellite communications to enhance socio-economic facilities such as internet access, education, and health services across the country (International Astronautical Federation, n.d.). Nigeria has successfully launched several satellites, demonstrating the practical applications of space technology for development.

Notably, Kenya, Egypt, Algeria, and Ghana have embarked on space-related initiatives, ranging from satellite development to space science education (Ngcofe & Gottschalk, 2013). These efforts aim to leverage space technology for environmental monitoring, disaster management, and agricultural optimization.

The African Union has recognized the importance of space technology for the continent's development, leading to initiatives like the African Space Policy and Strategy. This framework aims to foster regional cooperation in space activities, emphasizing space as a tool for addressing continental challenges (African Union Commission, n.d.). The distribution of space-related capability across African nations is clear, and it is apparent certain nations are benefitting from space significantly more than others. Africa must recognize the opportunity for regional advancement through space-capabilities and work to mitigate the inter-national competition and regional challenges facing the fractious region.

The African Union (AU) introduced its space strategy and policy in 2016 and first socialized the idea of the African Space Agency (AfSA) in 2017 (Kazeem, 2019). Despite its characterization as an unstable and disjointed region, awash with local and regional competition (Cilliers, 2017), Africa pursues a space strategy of common benefit and cooperation (African Union, 2019; AfSA, 2018). This African space renaissance and cooperative leadership ecosystem may set the conditions for continental standardization, yet only twenty-two of the countries on the continent have a space program (Santodomingo, 2023). These conditions would establish mutually beneficial opportunities for Africa and external factors, including commercial activity, advantageous launch positions, as well as the progression of AU aspirations[2] and UN Sustainable Development Goals[3] (SDGs) (Croshier, 2022). Critically, the AU presents the opportunity for pan-Africa collaboration and the use of space capabilities for advancement across many areas.

[1] The Square Kilometre Array is the world's largest international project in radio astronomy. Its first phase began in 2021 and will consist of two separate arrays of antennas: 197 large dish antennas in South Africa, and c.131,000 low-frequency wire antennas in Western Australia (University of Oxford, n.d.).

[2] The African Union has a series of seven aspirations that each have a set of goals that inform its roadmap for success in achieving its vision by 2063.

[3] The UN's SDGs are a series of 17 aspirational goals that will support national decision-making in pursuit of global prosperity and development (United Nations, 2015).

ANALYSIS SECTION: INTERNATIONAL COLLABORATION, OPPORTUNITIES, STANDARDIZATION, PROCESSES, AND CHALLENGES

The AfSA aspires to leverage space-derived benefits to address political, economic, social, and environmental challenges (African Union, 2019). Of note, these challenges also represent the critical areas of national, economic, human, and environmental security (Sharpe et al., 2023). This macro-level perspective of security is fundamental to the analysis outlined in this paper. Space is considered a domain common to all nations (Pečujlić, 2021). Thus, there is both a collective responsibility for its sustainability and an expectation of equitable opportunity across actors (Mather, 2017). These ideals are paramount. While the Outer Space Treaty (OST) of 1967 governs the activities of states in space and provides the foundational framework for international space law, it is yet to be updated (UNOOSA, 2021). The U.S. Artemis Accords seek to do so. The Artemis Accords are a series of US-led bilateral agreements focused on cooperation and the guiding principles of the OST (NASA, 2020). At present, Nigeria and Rwanda are the only participating African nations. The benefits Nigeria and Rwanda will receive from their participation in the Artemis Accords community are likely to set them ahead of other African nations seeking to further their own aspirations in space (Foust, 2022). More recently, Angola became the thirty-third signatory of the Artemis Accords and illustrates that African nations are recognizing the benefits (NASA, 2023). Accessing and leveraging global planetary environmental data insights can put data at the heart of decision-making and environmental management and can drive socio-economic change. While the overall benefits are innumerable, this benefit aligns with the AU's 206 Aspirations and the UN's SDGs. A significant challenge will be the degree to which the African continent invests in the Artemis Accords and becomes greater than the sum of its parts through unity of purpose and mutually beneficial endeavors.

The ideological and technological asymmetry that exists amongst space actors risks reinforcing existing power imbalances globally and regionally. As new space actors navigate the space frontier, calibrated strategies are required to ensure equitable participation and optimal employment of space-derived benefits, irrespective of the cultural or political views of the actor. The nuance required to deliver balanced, non-discriminatory participation in space endeavors will become increasingly complex. Crucially, African nations can remain non-partisan by engaging across all space actors. Helpfully, the African political ecosystem creates opportunities for engagement and advancement alongside many diverse partner nations.

As African countries continue to chart their courses in space exploration, the engagement of external actors adds depth and dimension to this journey. It underscores the interconnectedness of global space endeavors, reinforcing the position that space is not solely a frontier to exploit or conquer but a realm that unites diverse nations pursuing knowledge, development, and the expansion of human horizons. The evolving space initiatives across the African continent offer substantial benefits intertwined with complex challenges, thus forming a dynamic landscape where technological progress intersects with regional aspirations and global partnerships.

The Artemis Accords exemplify this progress. However, despite the growing number of Artemis

Accords participants, China and Russia continue to pursue a divergent discourse through the United Nation's Prevention of an Arms Race in Outer Space (PAROS) and the Prevention of the Placement of Weapons in Outer Space (PPWT) (Sharpe et al., 2023). Whilst this disparity may not directly affect African space actors in the immediate term, the polarized views of prominent space actors will have political ramifications on Earth. Divergent aspirations for the use of space must be reconciled quickly, or prevailing norms of behavior that lie outside of global median lawful and ethical behaviors will be established.

African nations stand to gain immensely from their space initiatives. These endeavors hold the potential to accelerate socioeconomic development by enabling informed decision-making through Earth observation satellites. By monitoring agriculture, natural resources, and urban planning, countries can formulate sustainable development strategies that align with their unique needs (Alberts, 2019; Munsami, 2022). AfSA's aims are to promote and coordinate the implementation of policy and strategy to exploit space technologies for sustainable development and the welfare of its citizens (Froehlich et al., 2020). In doing so, AfSA can address other security-related issues not previously mentioned, such as international crime and terrorism, hostile state threats, and climate security.

Furthermore, the integration of space technologies bolsters disaster management capabilities. Accurate, reliable satellite data would prove integral to the establishment of early warning systems that could be used to identify potential floods, droughts, and other natural disasters. Thereby facilitating timely interventions and reducing human and economic tolls. Likewise, robust connectivity will advance opportunities for remote and underserved areas through satellite-based communication infrastructure. This advancement opens doors to education, healthcare, e-commerce, and digital services, thus, driving economic growth and inclusivity across diverse populations.

Moreover, space technologies contribute to environmental monitoring and climate change mitigation. Satellite data assists in tracking deforestation, assessing pollution levels, and understanding climate patterns, empowering nations to devise effective strategies for environmental conservation and sustainable practices. There are many climate issues across Africa, particularly in West Africa, where increases in temperature and precipitation are changing the local climate, natural resource availability, and agriculture (Tarif, 2023). Climate issues are manifesting political tensions, conflict, and humanitarian emergencies (Stockholm International Peaceful Research Institute, 2023). Where isolated initiatives are of limited effect in addressing the root causes of human-centric challenges, systemization between African and external actors will be key to maximizing their effectiveness, scaling for efficiency, and avoiding duplication.

Scientific research and technological innovation also receive a significant boost from space activities. African countries gain the capacity to engage in space-based experiments, study celestial phenomena, and collaborate on international research projects. As a result, these countries can contribute to advancements across various scientific disciplines. In this regard, global partnerships emerge as a powerful avenue for progress. Collaboration with external entities, such as established space agencies and corporations, would afford African nations access to expertise, technology transfer, and funding. These opportunities accelerate the development of indigenous space capabilities, propelling countries further along their cosmic journey.

However, this journey is not devoid of challenges. The financial constraints of establishing and sustaining space programs pose a significant hurdle. Countries exhibiting lower than average outputs across the range of economic growth measures must allocate limited resources across competing developmental priorities and balance immediate needs with long-term aspirations or geopolitical alignment. Although foreign direct investment may reduce immediate economic burdens relative to the 'original' mission, they may also carry many associated geopolitical costs. To highlight this, it is apparent that Africa is increasingly the nexus of strategic competition between the U.S. (including its Western allies), Russia, and China (Mabera, 2019). As this competition intensifies, Africa can pursue political and behavioral paths commensurate with the UN's and AU's development goals without alienating either side (Alden, 2019). Acknowledging a rising

trend in global multipolarity, Africa can embrace numerous geopolitical development models. The African Union can support and coordinate its members towards achieving the UN's SDGs instead of promoting national interests. In this context, Africa holds the potential to influence strategic competition through balanced engagement with global superpowers (Rudd, 2022). Africa can 'set the political tone' for engagement with ideologically opposed external agents, thereby enhancing global stability and, in turn, reaping the benefits for its space program and general socioeconomic development.

Africa's strategic geographical advantages, combined with its potential as an emerging market for space technology, offer unique opportunities for NATO to establish myriad international partnerships. It would, almost certainly, prove advantageous for NATO to cooperate with Africa on space exploration and technology for several compelling reasons. In this regard, standardization plays a crucial role in facilitating effective and sustainable partnerships.

REASONS FOR COOPERATION WITH AFRICA ON SPACE

Diverse Geographical Advantage: Africa's vast, varied geography offers unique locations for space launches and ground stations. Its equatorial position is especially advantageous for launching satellites into geostationary orbits with lower fuel consumption and costs.

Emerging Market Potential: Africa's growing interest in space technology represents an emerging market for satellite communications, Earth observation, and space exploration technologies. This presents opportunities for technological exchange, commercial partnerships, and the expansion of the global space economy.

Global Challenges, Global Solutions: Many African nations are particularly vulnerable to climate change, environmental degradation, and natural disasters. Space technology can play a crucial role in monitoring and managing these challenges. International cooperation can leverage space assets for disaster preparedness, agricultural optimization, water management, and climate monitoring, offering benefits that extend beyond Africa's borders.

Capacity Building and Education: Collaborating with African nations on space projects can contribute to capacity building, education, and the development of a skilled workforce in the region. This not only aids local development, but also contributes to the global pool of knowledge and expertise in space science and technology.

Enhanced Global Security: Space technology is pivotal for global security and surveillance. Collaborating with African nations can enhance global efforts in areas such as maritime security, anti-piracy operations, and border surveillance, thereby contributing to overall global peace and stability.

To ensure seamless cooperation and interoperability, international standards can be developed. It is advisable that these standards encompass various aspects of space activities, including spacecraft design, communication protocols, data exchange formats, safety procedures, and environmental protection. While this is not purely an Africa concern, Africa is ideally positioned to benefit from seamless cooperation in the pursuit of its space-based interests.

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TECHNOLOGICAL EVOLUTION

The contemporary space domain underscores a transformative shift catalyzed by public and private organizations collaborating in space endeavors and extending humanity's reach throughout the solar system (Chaben, 2023). It elucidates how SpaceX, Blue Origin, Virgin Galactic, and other commercial space programs have transitioned from niche players to entities democratizing space (Trichas et al., 2023; Davis, 2019). The shift has engendered innovative business models, low-cost reusable launch systems, and a previously inconceivable software-defined era (Sharpe et al., 2023; Cross, 2019). Likewise, rapid technological advancement has driven unprecedented growth; however, governance has failed to keep pace with the intensifying complexity space demonstrates (MacDonald et al., 2023). As a corollary, the interplay between commercial forces, technological innovation, and strategic competition is higher now than ever.

Technological advancement delineates seminal milestones: the planned ARTEMIS moon landings, robotic missions across the solar system, and the International Space Station (ISS) offer robust evidence that ideological competitors can collaborate. This narrative highlights the epochal significance of each advancement in propulsion systems, spacecraft design, communication technology, and remote sensing instruments. Contrary to the views of Kuhn (1962), these circumstances demonstrate the incremental evolution of humanity's technological prowess and illustrate how each breakthrough redefined the boundaries of space exploration.

As the cyber domain previously did, space has introduced new dynamics in competition between state and commercial actors who are principally limited by technological prowess as well as political will, bureaucracy, and financial constraints. Given the multiple layers of diplomatic uncertainty currently affecting global stability, it is essential to consider the possibility that space may become a direct vector for conflict. Space is not openly weaponized; however, Zwart and Henderson (2021) argue that, following decades of employment in support of military operations

and intelligence activity, it has become so. The criticality of space as the ultimate military high ground, a crucial infrastructure enabler, and a clandestine domain of dual-use systems elicits its complexity and strategic significance. These considerations are synonymous with increasing geopolitical tensions and the risk of deliberate attack or accidental damage to assets (Peperkamp, 2020). For example, the technological advantages in robotics and proximity operations currently being pursued by the People's Republic of China (PRC) space program can easily be exploited by removing adversary systems from orbit (Mowthorpe & Trichas, 2022).

The development of advanced satellite systems aids global communication and navigation. High-speed internet connectivity, remote sensing, and precise GPS positioning have become integral enablers of contemporary society. Innovative Earth observation satellites equipped with sophisticated sensors provide data on environmental changes, weather patterns, and natural disasters. These data aid disaster response, resource management, climate research, and the mitigation of ecological challenges. Similarly, studies conducted aboard the ISS have yielded valuable insights into the effects of microgravity on human health (Linck et al., 2019). According to Linck et al. (2019) these findings have implications for addressing health conditions on Earth, including musculoskeletal, immune system and cardiovascular disorders, to highlight a few. Furthermore, space exploration has spurred advancements in materials science and manufacturing techniques. The quest for lightweight, durable, and heat-resistant materials has led to innovations across aerospace engineering to everyday consumer products (Van Manen et al., 2020).

THE NEED FOR STANDARDIZATION

Interoperability: Standardization ensures that systems, procedures, and technologies from different countries and companies can work together seamlessly (Salmeri, 2020). This is crucial for multinational projects like satellite constellations, space stations, and exploration missions where assets and data need to be shared efficiently.

Safety and Reliability: Common standards help ensure that all space operations meet safety and reliability benchmarks, reducing the risk of accidents, misunderstandings, and failures. This is especially important in collaborative ventures, where diverse technologies and practices converge.

Integrating third-party technology requires a delicate balance between innovation and adherence to mission protocols. Ensuring compatibility and preventing vulnerabilities becomes paramount, especially in cybersecurity, where protecting the 'C3IA2'[4] of mission-critical data is essential for minimizing project risk. Paralleling this view, economic considerations are also highly pertinent. The involvement of IT companies in space projects can optimize resource allocation, expedite timelines, and potentially reduce costs (Croshier, 2023). However, the commercial nature of these

[4]*Confidentiality, contagion, culture, integrity, attribution, and availability (Sharpe et al., 2023).*

partnerships necessitates a judicious assessment of proprietary interests, equitable benefit-sharing, and long-term sustainability.

Cost Efficiency: Standardized components and procedures can significantly reduce costs associated with design, manufacturing, and operations. This makes space technology more accessible to emerging space nations, including those in Africa, and fosters broader participation in space exploration.

Sustainability: Standardization is key to addressing space debris management and the long-term sustainability of space activities. Common guidelines and practices for the end-of-life disposal of satellites, debris mitigation, and space traffic management are essential to preserve the space environment for future generations.

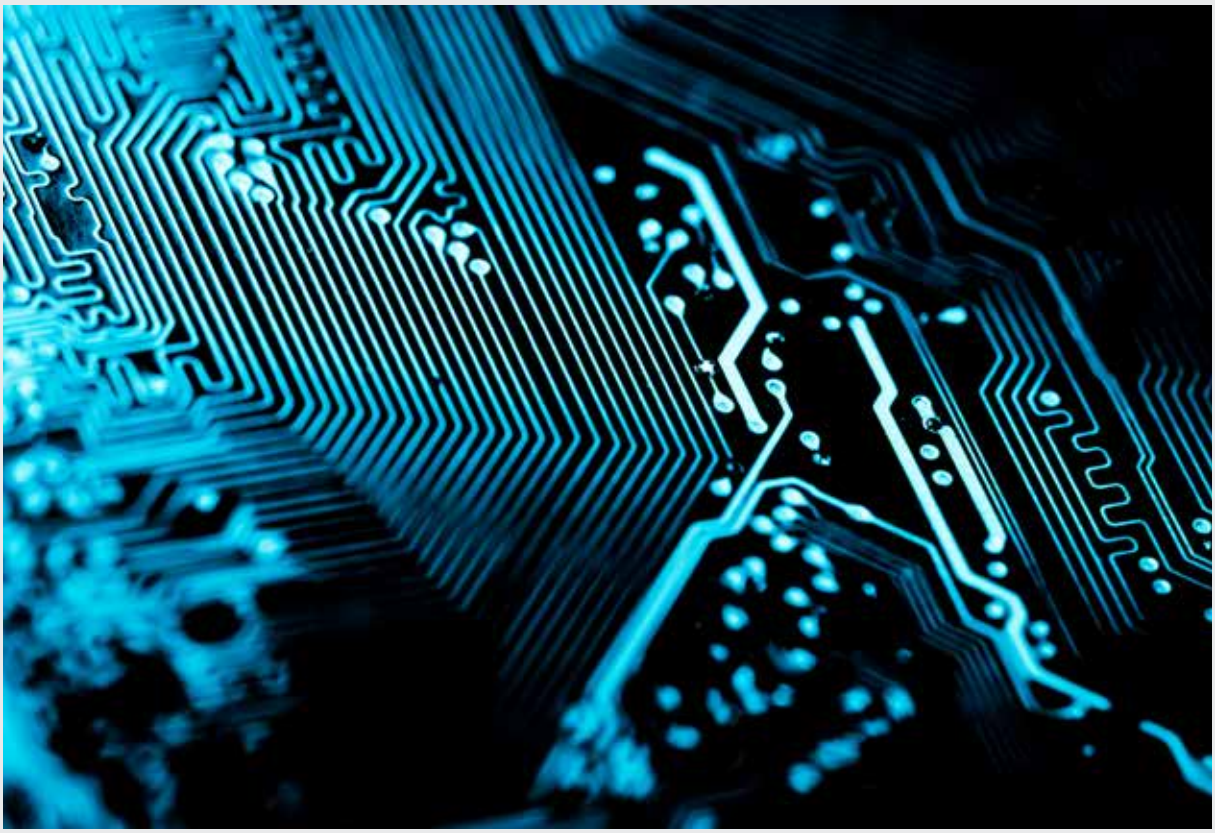
NATO's involvement in space security and standardization efforts emerges as a strategic bypass, where international security imperatives intersect with space exploration and technological cooperation. A history of exploitation and the traditionally paternalistic behavior the West has demonstrated across the African continent creates a barrier to contemporary and future engagement (Arezki, 2023; Fox, 2022; Maunganidze, 2022). NATO must, therefore, approach strategic competition on the African continent with deeper cultural awareness and a comprehensive appreciation of the ways in which its activities are likely to be perceived by African nations. A failure to establish this position may inadvertently espouse preferential engagement between certain African nations and potential strategic partners that the West deems less compliant or adversarial. It is imperative, therefore, to consider the layers of nuance that NATO must apply in navigating space security, cultivating collaborative initiatives, and championing standardization throughout pan-African space endeavors.

Data Sharing and Utilization: Standardized data formats and protocols enable easier sharing and analysis of space-derived data, enhancing its value for scientific research, environmental monitoring, and commercial applications. This is particularly relevant for Earth observation missions, where data can contribute to addressing global challenges such as climate change, natural disaster response, and sustainable development.
NATO is a conduit for the exchange of space-related information among its member states. Contemporaneously, it facilitates comprehensive situational awareness of the celestial environment across its Partner Nations (NATO, 2023a; 2023b). This domain awareness is instrumental in ensuring security and prosperity, identifying nascent threats, monitoring satellite movements, and tracking space debris. The insight gained therein enhances NATO's ability to respond effectively to emerging challenges by elevating the collective preparedness to address space security concerns and ensuring operational success. NATO's focus on security is clear. This focus is, nevertheless, at odds with the prevailing sentiment of the African Union's Space Strategy that focuses on development and socioeconomic benefit (African Union, 2022).
This diplomatic dimension reinforces NATO's commitment to preserving a secure and stable space environment. Furthermore, it accentuates the importance of NATO cooperating with inter-governmental institutions such as the UN, AU, and supranational organizations such as the European Union (Rose, 2020). In doing so, NATO will develop commonality with countries uncomfortable or opposed to the further militarization or weaponization of space (Mills, 2021; Hitchens, 2019).

HANDLING IN THE IT INDUSTRY

The IT industry is critical for space technologies and is a pivotal nexus where technological prowess converges with hardware and software engineering. This intersection will reshape how humanity envisions, implements, and benefits from our ventures beyond Earth's confines. The IT industry catalyzes a transformation in how space missions are conceptualized, executed, and analyzed. According to Morris (2022) and Katz (2020), innovative computing technologies amplify the capacity to process vast volumes of data, enabling scientists to be more ambitious than ever. Katz (2020) asserts that this computational muscle lends itself to tasks such as trajectory analysis, complex simulations, and the intricate calculations that underpin the success of space missions.

Moreover, the IT industry amplifies the efficiency and efficacy of satellite technologies. Advanced software simulations can model space operations and orbit pathways whilst developing robust communication strategies for satellite design and deployment. These simulations refine satellite



functionality, enhance reliability, and reduce potential risks, thus epitomizing the constructive collaboration between IT, engineering, manufacturing, and celestial exploration (ESA, 2023). Data management and AI are critical concepts that highlight the IT industry's impact on space activity. The torrents of data streaming from satellites, rovers, and telescopes exploit sophisticated data analytics and AI algorithms. These analytical tools extract actionable insights, thereby fostering breakthroughs in a range of fields from climate modelling to astronomical observations (Frackiewicz, 2023). It follows that the IT industry's hand in turning raw data into knowledge is instrumental in advancing humankind's understanding of the Earth and the cosmos.

The IT industry affords a novel perspective on satellite communication by supporting data reach-back to Earth with astonishing efficiency. Advanced coding techniques and encryption protocols secure these transmissions, mitigating potential interference and safeguarding sensitive information (Tedeschi et al., 2022). This capability extends to satellite-based navigation, enhancing global positioning systems through refined algorithms and real-time updates. However, challenges emerge. The IT industry faces the daunting task of ensuring data integrity and cybersecurity across vast cosmic distances. Safeguarding satellites from potential cyber threats is paramount, as a breach could compromise sensitive information or disrupt critical mission functions. The capacity to strike an effective balance between the joint frontiers of innovation and security underscores the IT and security industry's pivotal role in the cosmic narrative.

The IT industry reshapes the cost dynamics of space endeavors. The infrastructure and mechanisms essential to national survivability are now increasingly integrated with the internet infrastructure of Earth. Consequently, direct access to cloud computing resources enables remote data processing, this, in turn, reduces the need for bulky onboard computing hardware and further reduces the costs of asset space launching, particularly when implemented alongside a multitude of smaller satellites (Odell et al., 2021). This efficiency streamlines mission designs and lowers costs, broadening the horizons of participation in space exploration. Access to cloud computing services also expands the ubiquity of the internet to forms of space hardware that were, historically, held discretely because of uncommon

protocols and operating systems (Pavur & Martinovic, 2022).

As tensions in space intensify, space actors will increasingly use the cyber domain to influence competitors and adversaries. The vulnerability of the space and cyber domains is their dependence on the electromagnetic environment. Data communicated through non-physical mediums are at risk of exploitation by adversaries who can undermine a system or service's confidentiality, integrity, or availability to facilitate a competitive advantage. Cybersecurity considerations are now fundamental to space activity. Security through obsolescence or novelty is insufficient as software-defined radios and amateur enthusiasts can target satellites. This raises myriad concerns around the capability and intentions of highly trained, well-equipped hostile state actors. Without robust, open, and standardized security protocols, attackers will continue engaging in sophisticated attacks on space systems (Pavur & Martinovic, 2022).

NATO'S APPROACH TO SPACE - STANDARDIZATION IN NATO

NATO is working towards the establishment of protocols that govern responsible behavior in space. These protocols encompass guidelines for conducting space activities, preventing debris creation, and avoiding actions that could degrade the security of space. By articulating these norms, NATO aims to foster an environment of transparency, trust, and mutual respect among space stakeholders. While this may be the case for NATO, the U.S. is at risk of adopting a 'do as I say, not as I do' approach to its space activity. The U.S. continues to pursue military advantage through the space domain, risking the further militarization and potential weaponization of space (Osborn, 2021). According to Retired Col. Charles Galbreath, "It's oxymoronic to establish a new military service charged with protecting interests in space without arming it with the weapons it must have to accomplish its mission" (Hadley, 2023). Furthermore, U.S. Air Force Secretary Frank Kendall III acknowledged that there are 'hard kill and soft kill' space capabilities funded by the U.S. Government (Hitchens, 2023; Kitfield, 2023). It is noteworthy that non-kinetic 'space weapons' are also discussed in U.S. and other NATO Member State's space doctrines. This inconsistent narrative between NATO and its most powerful members does not elicit the ideals NATO hopes to espouse in its members and Partner Nations (Haar, 2020). These circumstances may dissuade those countries seeking to employ space for peaceful purposes from aligning with NATO. Commentary from the Nigeria Minister Muhammed Zayyanu Bandiya highlights that a 'comprehensive and legally binding treaty' regarding the placement of weapons is necessary and condemns the placement of weapons in space for 'offensive or defensive purposes' (Bandiya, 2022). In response to this statement, it would be advantageous for NATO to categorically define what it regards as 'space weapons' and, thereafter, to set out associated governance principles.

NATO's approach to space encompasses the development of frameworks that promote space situational awareness. The organization facilitates the sharing of space-related data, tracking information about satellites and debris, and the provision of comprehensive space-based insight to its members and Partner Nations (SFET, n.d.). This collaborative approach enhances the ability to identify and mitigate potential threats to space assets. NATO's pursuit of space-related protocols and frameworks epitomizes a multifaceted commitment to the secure, responsible, and collaborative use of space. To what extent NATO is best suited to lead these initiatives remains in question as other non-military organizations, such as the Inter-Agency Space Debris Coordination Committee's (IADC), have proven successful (IADC, 2023). The IADC's successes in orbital debris environmental models and observation data exchange formats suggest that ideological competitors can work towards common interests for the betterment of humankind (Sharpe et al., 2023; IADC, 2023).

It is important to note, however, that NATO's role in fostering a cohesive framework extends to crisis management and response. The characteristic of resilience is rooted in NATO's Article 3 and supports its means to deter and defend against its adversaries. The organization conducts exercises and simulations that replicate space-related contingencies, both military and natural, thereby honing member states' readiness to address emergent challenges and ensuring resilience across military and civil endeavors (NATO, 2023c).

A pivotal aspect of NATO's impact on international space governance lies in its role as a model of responsible behavior. The standardization efforts advocated by NATO are examples of global best practices in space activities. By adhering to established norms, member states reinforce the principles of transparency, sustainability, and non-militarization in their cosmic endeavors, thus signaling to the broader international space community that the adoption of similar standards is advantageous. Crucially, NATO's efforts to establish standardized protocols resonate beyond its member states. The organization's emphasis on cooperation, transparency, and predictability in space activities reverberates across the international landscape, influencing the norms and practices of Allies and Partner Nations (Tardy, 2022). The effects of this approach are especially beneficial in facilitating joint operations and collaboration between NATO and other non-member countries.

RECOMMENDATIONS FOR NATO AND NATIONS AND CONCLUSION

NATO should continue to advocate space security, champion robust and equitable policies, and encourage collaboration across African regional actors. Contemporaneously, NATO should carefully consider how it engages African nations regarding their space development roadmap by focusing on opportunities for socio-economic betterment that maximize positive engagement. This position will, thereby, minimize the likelihood of any potential geopolitical ramifications by focusing on non-contentious activities. Despite this observation, encouraging African nations to align with NATO's development and operational standards opens the opportunities for the Western technology market and future integration. These opportunities would be less numerous should Africa align with other great powers.

NATO should also continue highlighting the criticality of avoiding increasing tensions and geopolitical competition in space; particularly, between hegemonic nations. The prospect of space becoming increasingly militarized and weaponized is a symptom of the human condition of competition; as such, NATO should direct its influence towards prevention of space becoming a true domain of warfare.

Furthermore, NATO should support capability development within African nations, thus contributing to significant industry growth as related industries cluster around NATO space investment. These clusters will attract businesses, investment in infrastructure, research facilities, and talent, in the form of professionals and academic institutions. NATO investment in Africa will become increasingly sustainable as a regional cultural shift attracts young professionals, innovative businesses, and startups, establishing a closer link between academia and industry.

CONCLUSION

The evolving role of multiple actors in space exploration signifies a transformation from government-centric initiatives to a dynamic landscape involving private companies, international collaborations, and multilateral partnerships. Technological advancements, commercial interests, the pursuit of scientific discovery, and geopolitics are driving the shift. This paradigm has significant potential to impact Africa by offering participation, knowledge transfer, and technology sharing. With the correct positioning, African nations will benefit from increased access to space resources, collaboration on capacity-building programs, and the potential for economic growth through space-related industries. However, challenges such as technology disparities, geopolitical equity, and the implementation of equitable participation must be carefully considered.

Standardization and international cooperation are pivotal in ensuring the efficient, safe, and sustainable growth of space activity. Standardization establishes a common framework that streamlines operations, enhances interoperability, and mitigates risks. Likewise, the successful alignment of protocols, technologies, practices, and legal frameworks will facilitate collaboration among diverse stakeholders. International cooperation transcends boundaries and encourages sharing of resources, expertise, and knowledge. When delivered in a manner that is consistent with international legal statutes and established trade agreements, multinational cooperation frameworks pave the way for cost-effective endeavors, accelerate technological advancements, and foster a sense of collective responsibility. It follows that standardization and international cooperation form the bedrock of safe, prosperous, and collaborative space activity.

Efforts by NATO Member States to ensure equitable and sustainable space exploration for global development underscore the critical role that international collaboration plays in shaping the future of space activities. By prioritizing inclusivity, transparency, and responsible practices, NATO and its member states can foster a harmonious space environment that benefits all nations. Emphasizing peaceful cooperation and shared benefits will facilitate knowledge exchange, technological advancements, and capacity-building initiatives. This approach not only promotes global development but also underscores a commitment to the use of space as a peaceful domain for the betterment of humanity. Africa must exercise carefully calibrated strategies to maximize meaningful engagement across an array of external actors. These strategies must intersect strategic competition, diplomatic alliances, and commercial interests. Critically, they must navigate entrenched political rivalries and competitive dynamics to establish standards and equitable governance.

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