African Union



African Space Strategy

For Social, Political and Economic Integration



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Foreword

Africa is facing serious challenges in ensuring adequate provision of basic necessities, such as food, shelter, a clean and healthy environment, and proper education, for its growing population. Howbeit, Africa is slowly awakening to the benefits that space science and technology provides in addressing these challenges. If Africa is to leapfrog towards "An integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena", then bold steps must be taken towards building the indigenous capability and skills required for self-sufficiency and sustained progress. Many of the technological developments required to address the multitude of socio-economic challenges holding this continent back cannot be outsourced. Africa has significant potential for growth compared to the developed world, and this potential should be used to create a prosperous future for all. The commitments and investments we make now will set future generations free if we show real political, economic and social ambition.

The convenient lifestyle and high standard of living in the developed world are supported by the instant access to information and space-based applications, such as instantaneous television coverage and navigation services. Even the provision of basic commodities such as food and energy resources is facilitated by space-based technology. In addition, space-based solutions are necessary for the effective management of resources such as water, forests, marine ecosystems and agriculture. Given this reality, it is inconceivable that so many of Africa's space-derived services and products are outsourced. This strategy has been developed to advance an indigenous space sector and provides direction for a formal African space programme. The strategy is aligned to Africa's aspirations and is premised upon the following core principles:

i. Development of the services and products required to respond effectively to the socio-economic needs of the continent.
ii. Development of indigenous capacity to operate and maintain core space capabilities.
iii. Development of an industrial capability that is able to translate innovative ideas from research and development into the public and commercial sectors.
iv. Coordination of space activities across member states and regions to minimize duplication, but maintaining sufficient critical mass.
v. Fostering international cooperation within Africa and with the rest of the world as a means of realizing the full value proposition of the space sector.

The implementation of this strategy is important if we are to transform Africa's resource-based economies into the 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.

H.E. Prof. Sarah Anyang Agbor
Commissioner for Human Resources Science and Technology

GLOSSARY

Africa	The World's second largest continent made up of 55 member countries, occupying about 30.3 million square kilometers and covering 6% of Earth's total surface area and 20% of its land area
African Space Programme	An African-led, well-coordinated and integrated space programme (system of space projects or services) that is responsive to the social, economic, political and environmental needs of the continent, as well as being globally competitive, and one that ensures that Africa is a responsible and peaceful user of outer space
Space Science	A holistic study in all scientific disciplines that involve space exploration, natural phenomena and physical bodies occurring in outer space, e.g. astrobiology, astrochemistry, astronautics, astrophysics, space medicine, among others
Earth Observation	Gathering of data and information about Earth's physical, chemical, meteorological and biological systems using in situ, aerial and space-borne platforms to monitor and assess the status of, and changes in, the natural and built environment
Satellite Comunication	Artificial satellites placed in space for the purpose of telecommunications
Navigation and Positioning	The determination of position and direction in space and time through triangulation
Space Sector	Distinct areas in the space industry. The African space Strategy focuses on Civilian and Commercial Space
Products and Services	Products are tangible benefits derived from space activities, while services are intangible value-added and re-packaged resources that benefit end-users in their day-to-day life with their minimum interventions
Governance Structure	The anatomy and inter-relationship of administrative and managerial processes that guide the decision-making chains of the African Space Programme
International Partnerships	Strategic engagement, cooperation or collaboration of African entities with any other associates outside the continent



INTRODUCTION

Highlights

- *Many policy frameworks have been developed to address Africa's socio-economic challenges*
- *Successful implementation of these frameworks is highly dependent on space technologies and applications.*

Africa has an opportunity to exploit its geographic position and natural resources to promote economic growth, improve the quality of life of its people, and contribute to scientific knowledge. At the same time, Africa is facing major challenges in food security, rapid urbanisation, the sustainable use of the environment, and the need to educate a growing population. Economic, political, environmental and social reforms can make an impact only if there is concerted effort to build indigenous skills and technological capabilities that provide effective solutions to the challenges. These challenges have long been recognised and many policy frameworks (see Table 1) have been developed in response. Active participation in the development of space-related applications and services will enable the continent to address them, meet the objectives of the African Union (AU) Agenda 2063, make a significant contribution to the implementation of the Science, Technology and Innovation Strategy for Africa (STISA), take advantage of new opportunities offered by our geographic advantages, and become a global space player. The successful implementation of these frameworks is highly dependent on space technologies and applications. Access to sound, secure spatial data for decision-making will require an indigenous space programme and local capabilities. Africa cannot afford to remain a net importer of space technologies, as in the long term this will limit socio-economic development and negate the African Union vision of "An integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena".

Developing an adequate regional space capability has been hampered by the capital-intensive nature of the space sector and the lack of a formal governance structure to advance a collective effort. These difficulties must be overcome given the strategic value of a regional space sector in advancing the economic, political, environmental and social agenda of the continent. Space applications are needed to achieve over 90% of the strategic objectives across the eight departments of the African Union Commission (AUC). The use of space-based products and services to provide critical spatial information for decision-making purposes would have contributed to achieving the Millennium Development Goals, and will be valuable in our efforts to achieving the Sustainable Development Goals.

Societal needs	Policy framework	Information and products
Food security	Comprehensive Africa Agriculture Development Programme (CAADP)	Rainfall, yield, production, crops distribution, soil and land suitability
Water resources	African Water Vision 2025	Hydrography, aquifers, water bodies, quality, waste water
Marine and coastal zones	2050 Africa's Integrated Maritime Strategy (AIMS)	Coastal zone degradation and fishing potential
Environment	NEPAD Environment Action Plan	Ecosystems, biodiversity, vegetation and land cover
Weather and climate	Climate for Development in Africa (ClimDev Africa) and the Integrated African Strategy on Meteorology	Rainfall, temperature, wind, aerosol and climate trends and extremes
Security and disaster response	Africa Regional Strategy on Disaster Risk Reduction and the Convention on Cyber Security and Personal Data Protection	Risk and vulnerability data
Health planning	Africa Health Strategy	Disease vectors, environmental factors, population distribution
Governance and commerce	E-Government Strategy	Location-based mobile services, mapping of government information and communication technology (ICT) infrastructure
Infrastructure	Programme for Infrastructure Development in Africa (PIDA)	Spatial information on key infrastructure, such as transport infrastructure, energy sources and power systems, and distribution networks
Information and Communications	Reference Framework for Harmonization of Telecom/ICT Polices and Regulations in Africa	Telecommunications, Internet, television broadcasting, mobile communications, e-commerce, e-government and e-learning
Innovation	Science, Technology and Innovation Strategy for Africa (STISA)	Food security, disease prevention, communications and security

Africa represents 20% of the Earth's land surface area, more than the USA, India, China and Europe put together, yet these countries/region invested more than $50 billion on space activities in 2013, while Africa injected only under $100 million (translating to less than 0.2% of the global space budget) in the same period. In terms of performance in the space sector, only one country on the African continent, namely South Africa, ranked in the top thirty countries globally in 2013 – ranking 23rd in terms of its space budget ($41 million) and 30th in terms of scientific production in satellite technology (accounting for 0.87% of global publications in the domain). These comparisons highlight significant under-investment and suboptimal activities in the space sector, which limit Africa's potential in a fast-growing sector that can make a vital contribution to addressing the continent's challenges.

Hence, overcoming Africa's economic, political, environmental and social challenges is contingent upon a collective effort to formalise and sustain an indigenous space sector that is responsive to these challenges. Such efforts will promote commercial activities, ensure productivity and efficiency gains in diverse sectors, and facilitate cost avoidance measures that support the broader public good. This Strategy provides a strategic framework for developing and operationalising continental-level space initiatives. It clearly spells out the strategic goals and objectives of a long-term collective space vision for the continent. The Strategy hinges on the African Space Policy, which provides a guiding framework, for both the African public and private sectors, on the underlying principles to be adopted en route to a formal African space programme.



How space can address Africa's challenges

The Strategy focuses on these domains

• Earth Observation- Gathering of the earth's physical, chemical and biological information to improve management of resources

• Satellite Communication-Relaying, amplifying and broadcasting voice and video signals from a transmitter to a receiver at different locations on Earth

• Navigation and Positioning-Applicable in many areas such as the global air traffic management system

• Space Science and Astronomy- Study to understand the origin and evolution of the dynamic universe and its constituents.

Space science and technology has contributed to sustainable development efforts and many other societal benefits, and will continue to do so. Depending on their mission, satellites have different orbits. Weather and communication satellites are placed in geostationary orbits (at an altitude of 36,000 km) above the equator, from which they have a constant view of the same hemisphere of the Earth by completing one orbit around the Earth every 24 hours. Other satellites are placed in low earth orbits, which complete one orbit around the Earth every 100 minutes on average. Because the Earth rotates in the plane of the orbit, such a satellite eventually covers the whole of Earth's surface. Such orbits are used for remote sensing, and navigation and positioning applications. Space technology contributes to meeting society's challenges by making it possible to:

• Communicate anywhere in the world;

• Observe any spot on Earth very accurately; and

• Locate a fixed or moving object anywhere on the surface of the globe.

Below is an overview of the socio-economic value and benefits of four key areas of space science and technology, namely, (i) Earth observation, (ii) navigation and positioning, (iii) satellite communications, and (iv) space science and astronomy.

2.1 Earth observations

In countries where the failure of a harvest may mean the difference between bounty and starvation, satellites have helped planners manage scarce resources and head off potential disasters before insects could wipe out an entire crop. For example, in agricultural regions near the fringes of the Sahara desert, scientists used satellite images to predict where locust swarms were breeding and were able to prevent the locusts from swarming, thus saving large areas of cropland.

Remote sensing data helps with the management of scarce resources by showing the best places to drill for water or oil. From space, one can easily see fires burning in the rain forests as trees are cleared for farms and roads. Remote sensing satellites have become a formidable tool against the destruction of the environment because they can systematically monitor large areas to assess the spread of pollution and other damage. Such monitoring capabilities are critical for the long-term sustainable use of the continent's scarce resources.

Remote sensing technology has helped map makers. With satellite imagery, they can produce maps in a fraction of the time it would take using laborious ground surveys. The use of synthetic aperture radar (SAR) or stereoscopic imaging provides topographic maps of the landscape. This capability enables city planners to keep up with urban sprawl and gives deployed troops the latest maps of unfamiliar terrain. The latter is vitally important for peacekeeping missions in Africa.

Because remote-sensing satellites cover the entire globe, they are important for the study of large-scale phenomena like ocean circulations, climate change, desertification and deforestation. Satellites make it possible to monitor environmental change caused by human activity and natural processes. Because data is collected in a consistent manner, satellites can reveal subtle changes that might otherwise remain undetected. For example, the well-known Ozone Hole over Antarctica and the phenomena of atmospheric ozone depletion were discovered using satellites.

2.2 Navigation and Positioning Applications

The benefits from space infrastructure are becoming more evident in the management of long-term challenges faced by modern society. A case in point is the management of natural disasters like floods, for which navigation and positioning applications from space can provide data for the cycle of information for flood prevention and mitigation, pre-flood assessment, response (during the flood), recovery (after the flood) and accurate localised weather newscasts. In addition, timely satellite imagery and communication links in hard-to-reach places can help stem catastrophic economic and human losses.

Navigation and positioning is the main element of the international air traffic management system, providing worldwide navigation coverage to support all phases of flight. With appropriate augmentation systems, navigation and positioning satellites will enable gate-to-gate navigation and all-weather capabilities for suitably equipped aircraft. With more precise navigation tools and accurate landing systems, flying not only becomes safer, but also more efficient by reducing the delay, diversion and cancellation of flights. These interventions also assist in reducing carbon dioxide emissions in the aviation sector.

In general, mariners use the Global Positioning System (GPS) for navigation and positioning. GPS has also recently been applied to the surveillance of illegal shipping activities, and the monitoring of oil spills and the ensuing environmental damage. Used together with remote sensing imagery, accurate maps of the ocean colour, temperature, currents, salinity and wind direction have been produced. Such rich information is vital for protecting and extracting economic value from Africa's economic exclusion zones and providing a better understanding of climate change models.

Many automotive navigation and positioning applications fit in the category of intelligent transportation systems. Such systems are intended to improve traveller safety, improve travel efficiency by reducing congestion, save energy through the reduction of fuel requirements, and lessen the environmental impact of travel. Automobile navigation applications also help drivers make the most efficient routing decisions. This technology is also useful for fleet vehicle management and the tracking of valuable assets, especially across national borders.



2.3 Satellite Communication Applications

In 2011, only about 13.5% of the African population had Internet access, even though Africa holds 15% of the world's population. Africa made only 1% of the global subscribers with broadband connections. Satellite communication becomes vital to close up this gap particularly in landlocked countries and rural areas where terrestrial cable network is difficult.

Telecommunication satellites offer telecommunication services at national, regional and international levels. Satellite communications in Africa cover a wide range of applications, from traditional telecommunication services to the use of satellite communications to address social issues on the continent. These services include the provision of telephony and data transmission for remote areas using small dishes and advanced very small aperture terminal (VSAT) techniques, thus providing for specific services to a target group. Satellite television services are widely used for point-to-point television transmissions, as well as for direct-to-home television reception and community television.

The Internet has a lower penetration rate in Africa than anywhere else in the world, and overall available bandwidth coverage indicates that Africa is significantly behind in bridging the "digital divide". According to 2011 estimates, only about 13.5% of the African population has Internet access. Consequently, while Africa holds 15.0% of the world's population, Africa only accounts for 6.2% of the world's Internet subscribers. Moreover, the proportion of Africans who have access to broadband connections are estimated to be 1% or lower of the global broadband subscribers. Satellite communication can help fill this gap and increase broadband access, particularly in landlocked countries and rural areas where cable penetration is non-existent or hard to reach.

Integrating information and communication technologies (ICTs) into governance processes can greatly enhance the delivery of public services to all African citizens. ICT integration will not only improve the performance of governance systems, it will also transform relationships among stakeholders, thereby influencing policymaking processes and regulatory frameworks. In the developing world, however, the potential of ICTs for effective governance remains largely unexplored and unexploited. Such services can be delivered through connectivity via satellite links in areas with minimal access to the Internet. Satellite connectivity through post offices could provide Internet access to communities that currently have no access.

Technologies for education and training, in particular distance education and multimedia, may be instrumental in meeting the needs of countries that have to train and integrate a large number of workers in widely dispersed and under-equipped areas. This allows for a constant renewal of skills without being limited by information technology infrastructure. The use of VSAT terminals coupled with communication satellites makes education more accessible, especially in rural areas.

Many countries have to cope with large-scale disease outbreaks, and telemedicine may help to meet these challenges by improving the organisation and management of health care. Databases may be linked through networks to monitor the development of diseases, provide access to medical expertise through tele-consultation, and support remote medical assistance. In this regard, satellite communications can contribute to preparing and implementing health policies. Telemedicine is a cost-effective solution for providing affordable health care in rural areas.

National weather forecasts are based on a current satellite view of Earth. At a glance one can tell which parts of the country are clear or cloudy. When satellite maps are studied, it is easy to see the directional movement of clouds and storms. An untold number of lives are saved every year by tracking the paths of hurricanes and other deadly storms in this way. By providing farmers valuable climatic data and agricultural planners with information, this technology has improved food production and crop management. Weather satellites are integrated into the Global Telecommunications System, as an essential element of global, regional and national meteorological coverage.

2.4 Space science and astronomy

The runaway greenhouse effect on Venus, caused by an excess of carbon dioxide in its atmosphere, has led to an understanding of the dangers of carbon dioxide build-up on Earth and the resulting global climate change. In addition, finding aerosols in the atmosphere of Venus and observing how they interact with molecules has led to knowledge about what happens when aerosols are introduced into the Earth's atmosphere. By observing and analysing the dust storms on Mars, scientists have been able to develop models of what happens to a planet's climate if massive amounts of dust are blown into the atmosphere, as would happen on Earth from a volcano or from the impact of a large extra-terrestrial object.

Astronomy is a science that reaches from planets to stars, and the universe as a whole, from the first light up to the present, 14 billion years later. It embraces all of physics in an endeavour to understand the origin and evolution of the universe and its constituents. Astronomy is a way of advancing science that, until recently, has been the preserve of the industrialised world. Increasing public interest in astronomy and improving scientific education help to develop a more skilled workforce. These skills, both conceptual and practical, are easily transferred to applied fields such as meteorology, computer science and information technology.

Space geodesy uses astronomical techniques to determine the International Celestial Reference Frame, which is used to define the International Terrestrial Reference Frame. This terrestrial reference frame is used to provide precise geographic coordinates that are used in many practical applications, such as ocean and ice level measurements, continental drift, and the orbits of artificial satellites. These reference frames, for example the African Reference Frame currently being developed, are also used for modern map making and location-based applications, such as the mapping of vegetation growth and the demarcation of borders. Space science and astronomy therefore provide basic knowledge that has practical use in daily location-based applications.

The Earth's magnetic field protects us from charged particles and electromagnetic radiation. However, variations in the Earth's magnetic field, due mainly to space weather-related perturbations, may have adverse effects on technical systems in space and on Earth. For example, electrical discharges inside satellites render these satellites inoperable, induced currents in long power and telecommunication lines result in power outages and communication blackouts, and disruptions in geomagnetic surveys negatively affect the commercial exploration of minerals and oil. Space weather monitoring provides an effective tool for mitigation against these disruptions to both space and ground-based operational systems.



Situational analysis

"Leverage existing space initiatives, experience, national programmes and the collective capacity of African countries to build and expand indigenous space capabilities and state-of-the-art infrastructure, and to minimise the duplication of effort."

3.1 SWOT analysis

Strengths	Weaknesses
• Political support for the growth and development of high-technology sectors, including the space sector. • Significant government support for the establishment of national and regional space programmes. • A significant number of space professionals committed to leveraging space for socio-economic development. • Intra-continental partnerships fostering space science collaboration. • Africa's strategic and geographic locations that are suitable for astronomical and space physics facilities. • Existing nodes of space expertise and in-situ capabilities. • Established satellite assembly, integration and testing facilities. • Existing knowledge base and expertise in space engineering. • Experience in the manufacture and/or operation of small satellites. • Space physics capability that leverages its proximity to the Southern Ocean islands, the South Atlantic Anomaly, and the study of the Equatorial Electrojets. • Existing and established centres focused on the exploitation of geospatial data.	• Disparities in space expertise and capabilities across the continent. • Wide range of African challenges and societal needs. • African user needs are not well quantified and documented. • No governance structure to coordinate and manage continental-level space activities. • Inadequate core skills in several areas of space science. • Limited number of space initiatives, so skills are lost. • Duplication of efforts and suboptimal coordination. • Suboptimal investments in the space sector. • Disjointed continental efforts because there are no data management or data sharing policies. • Limited access to libraries, journals, and scientific and technical databases. • Uncoordinated regulatory environments on matters such as immigration, and cross-border taxes and tariffs. • Fragmented space activities, not aligned with continental goals. • Limited funding on a continental scale that is allocated for space science and technology.
Opportunities	**Threats**
• Large rural communities whose needs can be supported by space products and services. • A young population that could be trained to serve the requirements of an indigenous space sector. • Maturing public awareness and knowledge of the societal benefits of space applications. • Servicing the sustainable development needs of a population of 900 million people spread over 30.3 million km2. • Natural resources that provide a significant socio-economic growth potential. • Contribution of space products and services to the challenges of global change. • Leveraging the skills and expertise of the African Diaspora. • International partnerships for the co-development of space platforms, products and services. • Potential to share infrastructure and other capacities among various African countries. • Learning from existing satellite programmes to strengthen continental capacity.	• Lack of a coordinated approach to international treaties and conventions. • Political will for continental-level space initiatives not universally shared, amid other pressing national socio-economic priorities. • Over-reliance on financial and technical support from outside the continent. • Political instability. • A weak financial base. • Brain drain of core skills. • Competition for radio frequencies allocated to Africa that could limit the future usage of such resources. • National space programmes not able to assimilate and adopt rapid technological advancements. • Lack of a focus on user needs and innovation in delivering relevant space services and products. • Limited collaboration and coordination owing to an exclusive focus on national priorities. • Lack of a coordinated continental approach to multilateral space agreements and guidelines.

3.2 Developing the strengths and addressing the weaknesses

• Establish a continental space programme that is able to promote programmes and projects that foster intra-continental partnerships by strengthening the existing nodes of space and in-situ capabilities; harmonising and standardising the suite of critical facilities and infrastructure; adopting appropriate data management and sharing policies to promote data access; and sharing the space experience to bolster the capacity of member states that wish to pursue national space programmes.
• Leverage Africa's strategic location to attract mega-science projects in astronomy and space physics studies that will enhance the scientific profile of the continent and support the building of critical scientific infrastructure, which will also be used to develop the cohort of skills and expertise required to service the various scientific disciplines.
• Establish human capacity development programmes that attract the young student population into a postgraduate pipeline that primarily serves the requirements of an indigenous space sector and the broader requirements for high-end skills in the changing socio-economic landscape.
• Develop an appropriate governance structure in the context of an African space agenda that is adequately resourced, both financially and in terms of human capacity, to ensure the effective implementation of the African space programme, from continental to sub-regional levels.
• Ensure a regulatory environment that is conducive to the promotion of the African space agenda, but yet is cognisant of the international obligations and responsibilities for ensuring the long-term sustainable use of outer space resources.
• Use the extensive roll-out of optical fibre networks across Africa to secure broadband capacity that will be needed to operate scientific equipment and infrastructure and to ensure seamless connection for data management and sharing of geospatial information.

3.3 Responding to the opportunities and managing the threats

• Establish communities of practice for the sharing of experience and best practices, as well as the definition of user needs.
• Develop a robust public awareness campaign that targets and solicits the support of all sectors of society for the manifold benefits of space science and technology and its potential to foster economic growth and address societal challenges, especially the needs of large rural communities.
• Link spatial market needs and the management of natural resources in a manner that takes into account global change and responses to climate change, and ensures the sustainable long-term socio-economic development and growth of the African continent.
• Use international partnerships and the African Diaspora to build local skills and expertise, and to support the co-development of space platforms, products and services, providing employment opportunities that will minimise the loss of skills and over-reliance on foreign support.
• Leverage existing space initiatives, experience, national programmes and the collective capacity of African countries to build and expand indigenous space capabilities and state-of-the-art infrastructure, and to minimise the duplication of effort.
• Pursue a common regulatory framework on the continent that will counter any limitations imposed on the African space agenda and ensure the long-term sustainable use of outer space resources.
• Adopt a collaborative plan for the allocation and use of wavelength frequencies so as to protect and maximise the use of the frequencies allocated for Africa, which will also maximise the opportunities for hosting and operating key space equipment and facilities.





Strategic Focus

4.1 Vision

An African space programme that is user-focused, competitive, efficient and innovative.

4.2 Goals

1. Space-derived products and services used for decision-making and addressing economic, political, social and environmental challenges.
2. An indigenous space capability, in both the private and the public sectors, for a coordinated, effective and innovative African-led space programme.

4.3 Strategic actions

Strategic actions are intended to give direct effect to the strategic objectives and underlying principles identified in the African Space Policy. The strategic objectives are listed here for ease of reference.

1. Addressing user needs – harnessing the potential of space science and technology to address Africa's socio-economic opportunities and challenges.
2. Accessing space services – strengthening space mission technology on the continent to ensure optimal access to space-derived data, information services and products.
3. Developing the regional and international market – developing a sustainable and vibrant indigenous space industry that promotes and responds to the needs of the African continent.
4. Adopting good governance and management – adopting good corporate governance and best practices for the coordinated management of continental space activities.
5. Coordinating the African space arena – maximising the benefit of current and planned space activities, and avoiding or minimising the duplication of resources and efforts.
6. Promoting international cooperation – promoting an African-led space agenda through mutually beneficial partnerships.

4.3.1 Leveraging space-derived benefits

The primary marker of success in an African space programme would be how effectively it responds to user needs, its positive impact on the quality of life of people on the continent, and the improvement of Africa's global economic standing. The initiatives must resonate with and respond to Africa's needs in a relevant way that ensures a reasonable financial and/or social return. The initiatives must also be globally competitive in order to be positioned in the global space market, as there is a significant need in many developing countries outside of Africa for such initiatives.

Space-derived-benefits must transcend all spheres of government, from continental level right down to municipal level. In addition, benefits for women and the youth must be factored into the outcomes of these initiatives.

Indicators

- Number of communities of practice.
- Returns on investment.

4.3.2 Strengthening research, development and innovation

The development of indigenous capacity and capabilities will enable research, development and innovation in the African space sector. Given that space science and technology is still a fledgling sector on the continent, research, development and innovation should play a key part in industrial development. Hence, knowledge production (research and development) and the exploitation of this knowledge (innovation) will be central in ensuring a financial and/or social return. Knowledge production and transfer should, therefore, be a strategic focus for the diffusion of innovation.

Research, development and innovation initiatives should provide opportunities for the scientific and engineering space workforce to internalise the current intellectual capital and excel in the development of next-generation technology platforms, products and services.

Indicators

- Number of services and products using African capacities.
- Number of publications.
- Number of patents.
- Number of industrial designs.
- Number of space-related research Centres.

4.3.3 Developing and using human capital

Human capital development is the bedrock of a viable and sustainable African space programme. The requisite skills and expertise will be harnessed through robust training and human capital development programmes. Africa should develop its human capital for space science, draw on the intellectual capital of its strategic partners, and make effective use of the African Diaspora. Optimal use should be made of the Pan African University Space Science Institute.

Investment in human capital development should ensure that higher education and training institutions, including the special purpose Pan African University Space Science Institute, are capacitated to produce the next cohort of scientists and engineers.

Indicators

- Number of graduates in space-related fields.
- Number of space-related experts employed in space-related professions.

4.3.4 Institutionalising a corporate governance structure

The contextualisation of a centralised governance framework must be embedded in current attempts to formalise African space initiatives. The current African Space Policy provides for principles to be adopted in a programme for African space initiatives, whereas this strategy articulates the space ambitions of the African continent. These instruments must be used as a frame of reference for all indigenous and developmental assistance programmes to ascertain their relevance and fitness for purpose in relation to the needs of the African continent. If this is not done, the result will be a proliferation of initiatives that will ultimately contradict the developmental focus and initiatives of the African continent.

A corporate governance structure, including rules and procedures should be adopted for the management of Africa's space programme and activities.

Indicators

- A formal corporate governance structure established.
- Achievement of strategic goals.

4.3.5 Adhering to regulatory requirements

To ensure Africa's commitment and response in preserving and maintaining the long-term sustainability of the outer space environment, African representatives should actively participate in and commit to relevant multilateral forums, especially where such participation is critical for securing outer space resources for Africa's use. A regulatory framework should be institutionalised to ensure that the outer space resources are used in a sustainable manner.

A regulatory framework should be institutionalised to support Africa's space activities so that the continent can compete effectively in the global space market, in line with international treaties, conventions and principles. It is also important to ensure effective African participation in international multilateral forums to secure Africa's access to space, including the assignment and use of orbital slots and the frequency spectrum, for both space infrastructure and ground-based infrastructure.





Indicators
- A regulatory framework that is supportive of space activities.
- Number of contributions made in multilateral forums crucial for the peaceful uses of outer space.
- Coordination of mechanisms instituted by AU member states.
- Number of orbital slots obtained for Africa.

4.3.6 Building critical infrastructure

Leveraging existing facilities and developing strong regional and continental coordination in respect of new facilities is crucial for success. Despite the strong public-sector-driven approach in Africa, public-private partnerships will be needed to promote the development of the continent's space infrastructure, particularly through the integration of space technology into other sectors of the economy.

An integrated network linking regional and continental institutions should be established to build appropriate infrastructure. It is also necessary to develop an integrated network and complementary data processing facilities dedicated to the provision of data to users for applications at continental, regional and local levels. African governments should be encouraged to create an enabling environment for the development of an indigenous space-related industry. The African Resource Management Constellation initiative should be leveraged, and the participation of other African countries encouraged.

Indicators
- Number of early warning systems on the continent.
- Number of space missions.
- Number of space receiving/transmitting/processing facilities.
- Number of networks created and percentage of coverage.

4.3.7 Fostering regional coordination and collaboration

Strong regional coordination is vital for the success of space activities on the continent, given resource constraints and the need to minimise duplication and maximise complementarity. Regional collaboration should be underpinned by the sharing of experiences and knowledge, both tangible and intangible, in order to strengthen the space base on the continent. Such collaboration will be in the form of bilateral and polylateral engagements.

Joint technology development, knowledge sharing, technology transfer and the management of intellectual property should be promoted and strengthened.

Indicators
- Number of collaborative intra-continental programmes.

4.3.8 Promoting strategic partnerships

Strategic partnerships will be pursued to address inherent gaps in skills and capabilities. Where possible such gaps should be addressed through continental partnerships, public-private partnerships and partnering across different economic sectors. International partnerships should be encouraged to address any remaining gaps and pursue new learning opportunities through active participation in global space initiatives.

All partnerships should be underpinned by complementary contributions and mutual benefits.

Indicators
- Number of public-private partnerships.
- Number of intra-Africa institutional partnerships.
- Number of international partnerships.

4.3.9 Funding and sustainability

It is crucial that adequate funding is committed to ensure the optimal development and long-term sustainability of space initiatives on the continent. It is critical that such funding be sourced from within the continent to allow for an African-led space programme under a consolidated space agenda. Space technology is costly and it is, therefore, essential to exploit existing space resources on the continent and to build on and optimise such resources. Monitoring and evaluation will be vital to ensure relevance and the long-term sustainability of space activities in Africa.

Funding should be secured from African governments, the private sector and philanthropists. A financial mechanism/instrument should be developed to generate the funds needed for the African space programme.

Indicators
- Level of long-term funding secured from the continent.
- Financial mechanism for the raising of funds developed.

Implementation Guidelines

5.1 Thematic focus areas

In developing programmes and missions, user needs should be the guiding compass

The thematic focus areas, namely Earth observation, navigation and positioning, satellite communications, and space science and astronomy, provide the broad framework within which the appropriate technology platforms and programmes, both new and current, should evolve to address user needs. The use of space applications to facilitate responses to Africa's most pressing socio-economic challenges is shown in Table 2, which identifies the primary user requirements mapped against the thematic focus areas. The various deliverables for each of the thematic focus areas are set out in the table below.

5.1.1 Earth observation

Specific interventions relating to Earth observation should include the following:

- Developing adequate skills and expertise in Earth observation applications and usage.
- Developing and improving Earth observation institutions in Africa.
- Fostering knowledge sharing among African experts, users and stakeholders.
- Developing space-based and in-situ infrastructure to help in responding to user needs and ensuring societal benefits.
- Developing Earth observation services and products using web-based and other appropriate technologies in order to meet user needs.
- Fostering stakeholder engagement to ensure the generation of the relevant services and products that maximise the benefits of Earth observation applications.
- Raising awareness among the public, users, and policy and decision makers.

5.1.2 Navigation and positioning

Specific interventions relating to navigation and positioning should include the following:

- Developing adequate skills and expertise in navigation and positioning applications and usage.
- Ensuring seamless integration into existing global navigation satellite services.
- Building on existing infrastructure such as the Agency for Aerial Navigation Safety in Africa and Madagascar, TRIGNET (a network of continuously operating global navigation satellite system base stations) and the African Geodetic Reference Frame.
- Promoting an African array study for seismic applications using seismic reference receivers.
- Developing an indigenous continental-level navigation augmentation system.
- Developing navigation and positioning application products and value added services to support user requirements.

5.1.3 Satellite communications

Specific interventions relating to satellite communications should include the following:

- Developing technologies for communication applications in rural and remote areas.
- Developing technologies for e-applications.
- Providing flexible extensions for the terrestrial network expansion and backup.
- Developing platforms to support disaster management.



5.1.4 Space science and astronomy

Specific interventions relating to space science and astronomy should include the following:

- Developing robust and coordinated programmes in the various disciplines of space science and astronomy, such as space physics, space geodesy, aeronomy, and optical, gamma and radio astronomy.
- Instituting capability-building programmes to ensure sustainable space science and astronomy initiatives.
- Developing and maintaining the appropriate infrastructure and facilities for a vibrant space science and astronomy programme.
- Ensuring value addition to Africa's economy through the spin-off development of human capital and technologies in space science and astronomy.

5.2 Functional programmes

Functional programmes are the means for achieving the key deliverables and are primarily embedded in the underlying technology platforms. They cover the key elements for a space mission (the collection of satellites, orbits, launch vehicles, operations networks, and all other elements that make a space mission possible). Functional programmes support each of the thematic areas. Scientific and engineering capacities are organised into four clusters, each of which carries out specific functions, as summarised below.

5.2.1 Space missions

The space missions include the following:

- Develop low Earth-orbiting satellites with multispectral and hyperspectral optical payloads and navigation augmentation payload systems.
- Develop low Earth-orbiting SAR satellites to complement optical satellite missions.
- Develop a geostationary orbiting communications satellite with multiple communication transponders and a navigation augmentation payload system.
- Develop independent space launch capabilities.
- Develop space science missions.

5.2.2 Enabling technologies

The requirements for the future satellite missions, as per the payload and subsystem technology options, are as follows:

- Develop a fully indigenous capability for the medium to high-resolution payloads and subsystems.
- Develop the SAR payload and subsystem requirements.
- Develop a geostationary communications satellite with indigenous African participation on the technology and engineering front.

5.2.3 Space mission operations

The requirements for the space mission operations are as follows:

- Develop assembly, integration and testing facilities and design centres to support the satellite manufacturing facilities.
- Develop ground segments for telemetry, tracking and command to support the satellite operations and the retrieval of data.
- Develop space segments, such as mission control centres for the effective housekeeping and health of the satellite.
- Secure appropriate orbital slots for use by indigenous satellites.

5.2.4 Space applications

In order to ensure that the services and products developed in response to user needs are relevant, the following should be achieved:

- Develop a data-sharing policy that ensures affordable and equitable access to spatial data and information.
- Develop timely access to the right data sets in accordance with user needs.
- Develop the provision of appropriate services and products that respond to all user needs.
- Develop robust processing capabilities to ensure that timely access to the requisite services and products are available to end users.
- Ensure that all levels of governments are able to access space and ground-based data through a centralised portal.
- Provide geospatial and scientific data for education, and research and development.
- Provide geospatial data for commercial exploitation at a minimal cost.

5.3 Supporting programmes

Supporting programmes are cross-cutting elements that are critical for the realisation of the thematic focus areas and the functional platforms. The supporting programmes comprise of the following:

- Human capital – The appropriate expertise and skills necessary for an African space programme will be an area that will receive priority attention, as without this all existing and envisaged programmes and infrastructure will be of limited value.
- Space awareness – For the African space programme to appear meaningful to the broader public it is necessary to create public awareness of the benefits of space technology and its manifold applications (products and services).
- Infrastructure – Appropriate infrastructure is the cornerstone of an effective space programme, enabling technology transfer and human capacity development initiatives.
- International partnerships – Strategic, mutually beneficial partnerships with foreign partners are necessary for tangible and intangible technology transfer and a viable and sustainable space programme.
- Industrial participation and development – Development of the continental space industry to participate in the various functional platforms is a key requirement for the sustainability of a space programme.

5.3.1 Human capital development and space awareness

The following are strategic interventions for human capital development and increasing space awareness:

- Developing coordinated, sustained and targeted public awareness and outreach programmes that:
  - o Use classical and contemporary communication platforms;
  - o Demystify space science through popularising space science with high-quality outreach material for all audiences;
  - o Create opportunities to engage and attract the best minds towards careers in space science;
  - o Promote gender parity in space science.
- Supporting space science teaching and research at universities through:
  - o The Pan African University Space Science Institute, and linking existing training, research and innovation initiatives;
  - o Enabling bi-directional linkages between continental research efforts and national programmes, and between continental research efforts and global research programmes; and
  - o Establishing continental researcher and student exchange programmes;
  - o Creating an enabling research and technical environment for

graduates to be employed;
o Enabling the development of networks and the dissemination of information using modern media platforms for drawing on the expertise of African Diaspora scientists and engineers;
o Enabling easy access to open data and processing tools to facilitate capacity development in the use and dissemination of geospatial data and information; and
o Introducing space science and astrophysics at undergraduate level with a focus on technical and academic requirements on the continent.
• Supporting space science and astronomy teaching and outreach at primary and secondary school level through:
o Developing and introducing basic space science and astrophysics courses aimed at science students;
o Developing in-service training programmes in space science and technology for teachers to promote the discipline at school level;
o Developing specialised curricula, material and teaching aids to create awareness of space science and technology;
o Enabling the development of a student portal for the development of virtual space science clubs, access to information, open data, processing tools and advice;
o Drawing on the deep roots of Africa's indigenous civilisations to explore synergies with space science and astrophysics; and
o Developing space museums, planetariums and observatories.

5.3.2 Infrastructure

The following are strategic interventions for infrastructure:
• Building centres of excellence and competence in the five regions in Africa, while expanding and upgrading existing facilities.
• Building new and expanding existing national assembly, integration and testing centres on the continent to service continental and regional needs.
• Building national and regional vicarious calibration facilities to support continental and global Earth observation efforts.
• Building national and regional data banks and high performance computing centres, and/or using existing ones.
• Leveraging continental and global partnerships to build a space-based industry for manufacturing space hardware and software, which could serve as a centre for hands-on training.
• Developing and expanding existing mission control systems to service continental and regional needs.
• Developing and strengthening research and development centres so that they are accessible to researchers across the entire continent.
• Expanding existing observing infrastructure and ensuring data accessibility for research (for example, GNSS receivers, magnetometers and ionosondes).
• Developing complementarities between space-based and in-situ infrastructure.

5.3.3 International partnerships

Specific strategic interventions relating to international partnerships include the following:
• Establishing a pan-African cooperation and partnership framework to enable coordination and networking for the effective implementation of continental-level activities.
• Establishing cooperation agreements with governmental, intergovernmental and regional organisations and agencies that focus on the exchange of experience with the objective of reducing the space divide and technological gaps.
• Encouraging African academia to establish a partnership arrangement with international academic networks concerned with space activities.
• Establishing a framework for the development of an African space industry operating in close cooperation with outside space industries with the purpose of establishing synergies between them.
• Integrating African space infrastructure and programmes as a part of the global space infrastructure with a clear recognition of African rights and access.

5.3.4 Industrial participation and development

The strategic interventions for industrial participation and development include the following:
• Developing an industrial framework to unlock industrial opportunities and to enhance industrial development, strengthen manufacturing capabilities and provide support for industry and related services.
• Building an industrial base to support Africa's requirements for space technologies by ensuring maximum participation of the private sector in public sector space projects.
• Establishing a supportive continental regulatory framework to ensure compliance with the United Nations regulatory provisions and applicable international obligations when competing in international space markets.
• Maximising the benefits of innovation and technology transfer into and out of the space sector, thus promoting the broader industrial development on the African continent.
• Creating an enabling environment for small and medium enterprises by supporting their effective participation in the development of the space industry and market.

5.4 Projected outcomes

The projected outcomes over the next decade should ensure a long-term sustainable and viable continental space programme that remains aligned with user needs. To meet user needs, a concerted effort should be made to obtain adequate human and financial resources, establish strategic partnerships in Africa and beyond, and set up appropriate technology platforms. While this is being done, the global relevance and positioning of the continental space programme should be kept in mind. The response within the implementation framework for this strategy can be divided into immediate outcomes (within a year), intermediate outcomes (within five years) and long-term outcomes over (10 years) that provide for rolling milestones, which are expressed below.

Projected one-year outcomes
• Establishment of the governance elements needed for a sustainable space programme, including regional centres of excellence.
• Approval and implementation of an intercontinental and international partnership plan.
• Approval and implementation of a human capital and infrastructure development plan.
• On-going research, development and technology transfer programmes that will contribute to building the foundations for a continental space programme.

Projected five-year outcomes
• An established continental space programme.
• Appropriate technology platforms in place to support the various components of a continental space programme.
• Advances in human capital development that support the continental space programme.
• Strategic partnerships, both intercontinental and international, through projects that promote research and technology development.
• Operational and on-going developments of space application services and products for the broader public good.
• Well-defined funding mechanisms for sustainability.

Projected 10-year outcomes

- A continental space programme that is globally positioned and ranked in the world's top 10.
- Independent Earth observation high-resolution satellite data available for all of Africa from a constellation of satellites designed and manufactured in Africa.
- Appropriate services and products relating to space applications.
- Indigenous space capacity, in terms of both technology platforms and human capital.
- Spin-off enterprises emanating from space activities and programmes.
- Strategic partnerships, both within and outside Africa, that are translated into viable space missions, applications, products and services.



Conclusion

The African Space Strategy hinges on the African Space Policy, which provides the main tenets and guiding principles for the establishment of a formal African space programme. This strategy is an expression of the key intent and programmes of action that are needed to give effect to the identified goals and strategic objectives, so that maximum impact can be made in leveraging the benefits of space science and technology as a tool for informing solutions to our political, economic, social and environmental challenges. Appropriate governance structures will be mandated to ensure that this strategy is implemented to ensure the effective development and coordination of an African space programme, which will draw on the capacities of member states and regional programmes.

Furthermore, this strategy is intended to support the Science, Technology Innovation Strategy for Africa 2024 and other relevant continental Strategies, and thus contribute to the achievement of Agenda 2063.



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