African Space Strategy

Towards economic, political and social integration

Version 4

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Executive Summary

[This will be completed at the end, once the draft strategy is in place]

1 Introduction

Africa is facing major challenges in ensuring the adequate provision of basic necessities, such as food, shelter, a clean and healthy environment and proper education for the growing population on the continent. Only through sustainable development can one hope to address these challenges. The concept of sustainability is closely linked to the carrying capacity of ecosystems, which sets the physical limits to economic development and may be defined as the maximum rate of resource consumption and waste discharge that can be sustained on a permanent basis in a defined planning region without impairing productivity and ecological integrity. Economic, political and social commitments are only effective if there is a global partnership for sustainable development and to ensure the equitable allocation of available resources.

Africa's challenges

STISA 2024

Societal Needs	Policy Framework	Required Information & Products
Food Security	CAADP Land Policy	Rainfall, Yield, production, Crops Distribution.
Water Resources	African Water Vision	Hydrography, Aquifers, Water bodies, Quality
Marine and Coastal Zones	2050 Africa's Integrated Maritime Strategy	Coastal zones degradation, Fisheries potential
Environment	NEPAD - EPF	Ecosystems, biodiversity, Vegetation, Land cover
Climate Change	Climate Development Africa	Rainfall, temperature, wind, aerosols…
Security and Emergency	Africa Regional Strategy on Disaster	Vulnerability, Risk
Health Planning	Africa Health Strategy	Disease vectors, environmental factors distribution…
Governance and Commerce	e-Government Strategy	Location- based mobile services (LBMS); spatial depicting of biotechnology and creative industries; mapping of Government ICT infrastructures, data, applications and services delivery.
Infrastructure	Programme on Infrastructure Development	Spatial information

2 How Space can address Africa's challenges

The benefits from space infrastructure are becoming more evident in the management of long-term and significant challenges faced by modern society. In the case of natural disaster management (e.g. floods), remote sensing from space can provide data for the whole cycle of information for flood prevention and mitigation, pre-flood assessment, response (during the flood), recovery (after the flood) and weather newscasts. Timely satellite imagery and communications links in hard-to-reach places can help stem catastrophic economic and human losses. The key contributions of space technology to meeting society's challenges include:

- The ability to communicate anywhere in the world;
- The ability to observe any spot on earth very accurately; and
- The ability to locate a fixed or moving object anywhere on the surface of the globe.

Space science and technology has and continues to contribute to sustainable development and offers many benefits to mankind. Depending on their mission, satellites have different orbits. Weather and communication satellites are placed in geostationary orbits (altitude of 36,000km) above the equator, from which they have a constant gaze on the same hemisphere of the Earth by completing one orbit around the Earth every 24 hours. Other satellites are placed in Low Earth Orbits (LEO), which complete on average one orbit around the earth every 100 minutes. Because the Earth rotates in the plane of the orbit, such a satellite eventually covers the whole Earth. Such orbits are used for remote sensing, and navigation and positioning applications.

In what follows we attempt to demonstrate the value that space science and technology brings to the 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. In so doing we aim to enthuse our political principles and decision makers on the value and benefits of space science and technology in addressing our manifold socio-economic challenges.

2.1 Earth Observation Applications

Earth observation/remote sensing satellites use modern instruments to gather information about the nature and condition of the land, sea, and atmosphere. Located in various orbits, these satellites use sensors that can "see" a broad area and report very fine details about the weather, the terrain, and the environment. The sensors receive electromagnetic emissions in various spectral bands, which show objects that are visible, such as clouds, hills, lakes, and many other features. These instruments can detect an objects temperature and composition, the wind's direction and speed and environmental conditions, such as erosion, fires, and pollution. Included below is a selection of specific examples of the benefits of remote sensing.

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 or other blights 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 can also help us manage scarce resources by showing us the best places to drill for water or oil. From space, astronauts can easily see fires burning in the rain forests of South America as trees are cleared for farms and roads. Remote sensing satellites have become a formidable weapon against the destruction of the environment because they can systematically monitor large areas to assess the spread of pollution and other damages. Such monitoring capabilities are critical for the long-term sustainable use of our scarce resources.

Remote sensing technology has also helped mapmakers. 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 radars 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 whole 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 was discovered using satellites.

2.2 Navigation and Positioning Applications

Satellite navigation uses satellites as reference points to calculate positions accurate to within a few meters. With advanced techniques and augmentations, satellite navigation can make measurements down to centimeter levels. Navigation and positioning receivers have been miniaturized and are becoming economical thus making the technology accessible to everyone. For example, GNSS (Global Navigation Satellite Services) receivers are currently built into cars, boats, planes, construction equipment and even laptops to provide accurate geographic coordinates of these valuable assets.
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 do not only become safer, but also more efficient by reducing delays, diversions and cancellation of flights. These interventions also assist in CO_2 emissions reduction in the aviation sector.

In general, mariners use the Global Positioning System (GPS) for either navigation or positioning. GPS has also recently been applied to the surveillance of illegal shipping activities, such as fisheries. The latter has also been extended to monitor oil spills and the ensuing environmental damages. The use of remote sensing satellites has been used extensively to map ocean colour, temperature, currents, salinity and wind direction. Such rich information is vital for protecting and extracting economic value from our Economic Exclusion Zones and better understanding of the climate change models.

Many automotive navigation and positioning applications fit within the description of intelligent transportation systems (ITS). ITS programmes are intended to improve traveller safety; improve travel efficiency by reducing congestion; save energy through reduction of fuel requirements; and lessen the environmental impact of travel. Automobile navigation applications also help the driver to make the most efficient routing decisions – this application is also valuable for fleet vehicle management and the tracking of valuable assets, especially across national borders.

2.3 Satellite Communication Applications

Satellite communications is the key technology that could bring developing countries to participate in the build up of the global information infrastructure. Research indicates that wireless systems are the most cost effective way to develop or upgrade telecommunications networks in areas where user density is lower than 200 subscribers per square kilometer. Such wireless systems can be installed 5-10 times faster and at a 50% lower cost than landline networks.

The Internet in Africa is limited by a lower penetration rate when compared to the rest of the world, and overall available bandwidth indicates that Africa is way behind the "digital divide". This is the era of internet of things and things of the internet. According to 2011 estimates, about 13.5% of the African population has Internet access. While Africa accounts for 15.0% of the world's population, only 6.2% of the World's Internet subscribers are Africans. Africans who have access to broadband connections are estimated to be in percentage of 1% or lower. In September 2007, African broadband subscribers were 1,097,200, with a major part of these subscriptions from large companies or institutions. Satellite communications can fill the gap and increase broadband access, particularly in land locked countries and rural areas where cable penetration is non-existent.

Integrating information and communication technologies (ICTs) into governance processes can greatly enhance the delivery of public services to all citizens. ICT integration will not only improve the performance of governance systems, it will also transform relationships amongst 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 internet. Satellite connectivity involving post offices may be used for access to such services for those who have no access to internet.

Technologies for education and training, in particular distant 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 (IT) 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 begin with 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 put in motion we easily see the direction of clouds and storms. An untold number of lives are saved every year by this simple ability to track the paths of hurricanes and other deadly storms. By providing farmers valuable climatic data and agricultural planners with information, this technology has improved food production and crop management. Weather satellites are integrated in the Global Telecommunications System, as an essential element of global, regional and national coverage.

2.4 Space Science and Astronomy

The exploration of the universe from our solar system to the most remote parts represents one of the greatest intellectual quests of humankind. The last few decades have shaped our views of the universe, the implications of which are still to be fully realised both from a scientific and a practical point of view. Space exploration achievements of the last five decades have captured the world's attention, interest and imagination. People have shared the excitement of discovering and exploring the new worlds of our solar system. The perspectives gained from space science also help us to understand the challenges facing Earth.

Geomagnetic surveys are important tools in the commercial exploration of natural resources, such as the search for oil and gas. However, space weather related perturbations create signals in survey data that can be mistaken for signatures of sub-surface resources. Such disturbances can induce direct currents in long power lines, resulting in power outages, or surface charge effects on satellites, resulting in satellite failures. Space weather monitoring would therefore provide an effective tool for mitigation against these various effects.

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 the molecules has led to knowledge about what happens when aerosols are introduced into Earth's atmosphere. Observing and analyzing the dust storms on Mars have provided scientists with models of what happens to a planet's climate if massive amounts of dust were blown into the atmosphere, as would happen on Earth from a volcano or from a large impact of an extraterrestrial object.

Astronomy is a science that reaches from planets to stars to galaxies 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 into advances science that, until recently, has been the preserve of the industrialised world. Increasing public interest in astronomy and improving scientific education helps develop a more skilled workforce and which skills, both conceptual and practical, are easily transferred to applied fields such as meteorology, computer science and information technologies.

List of promising space applications

- Distance learning and telemedicine - broadcasting to remote areas and across national borders, medical remote surveillance.
- E-Commerce - enabling changing work patterns due to mobile workforce/home working and economic consequences, HDTV teleconferencing.
- Entertainment - digital radio, TV, data and multimedia broadcasting to fixed assets, high bandwidth to the home/convergence of different media.
- Location-based consumer services - driver assistance and navigation aids, insurance based on real-time usage data, vehicle fleet management, high-value asset tracking and road repair management.
- Traffic management - location and positioning of aircraft and ships, optimisation of airport traffic management, optimisation – road pricing – driver behaviour logging.
- Precision farming and natural resources management - precision agriculture for maximal efficiency in equipment and application of fertiliser, deforestation and forestry management.
- Urban planning - plans, maps and numerical terrain models, precise positioning of engineering structures and buildings, automatic control of job site vehicles, management and optimisation of job site vehicle routes.
- Disaster, prevention and management - telecom capability in the absence of ground infrastructure, remote assessment of damage and pollution for insurance claims.
- Meteorology and climate change - meteorological and sea condition forecasting

3 Situational Analysis

3.1 SWOT Analysis

Strengths

- Growing political goodwill that provides significant growth potential through the development of high-tech sectors, including the space sector.
- Increasing support of African governments for the establishment of national and regional space programmes.
- Growing intra-continental partnerships, such as the African Resources Management Constellation (ARMC), that fosters space science collaboration.
- Abundant natural resources that can fuel economic growth and address social challenges if harnessed in a sustainable manner.
- Large rural communities that are sparsely populated and whose needs can be supported and provided for by a suite of space products and services.
- Africa's strategic location with a unique landmass and latitude coverage that is suitable for astronomical and space physics facilities.
- Close proximity to the southern ocean islands, Antarctica and the South Atlantic Magnetic Anomaly that is suitable for space physics studies.
- A young population that provides a pipeline for postgraduate students that could easily serve the requirements of an indigenous space sector.
- Increasing public awareness and knowledge of the societal benefits of space science and technology.
- Existing nodes of space expertise and in-situ capabilities that could be used as a basis to grow the space sector.
- A number of satellite assembly, integration and testing facilities together with a growing expertise in space engineering.
- The experience gained through the manufacture and/or operation of satellites that are owned by a number of African countries.

Weaknesses

- Not all African countries are at the same technical readiness level and hence the disparity in space expertise and capabilities on the continent.
- The African user needs are not well quantified, which is exacerbated by the relatively poor management of our natural resources.
- There is no governance structure in place on the continent that could effectively coordinate and manage continental level space activities.
- There is a lack of a critical mass of core skills that is compounded by the limited number of space initiatives thus leading to a poor retention of skills.
- Duplication of efforts and suboptimal coordination leads to a lack of and uneven distribution of instrumentation, infrastructure, expertise and funding.
- The limited financial capital coupled with the relatively weak industrial sector, poses a challenge to the long-term sustainability of space initiatives.
- Not all African countries share the political will for continental level space initiatives, amidst pressing national socio-economic priorities.
- The lack of data management and sharing policies reduce continental efforts to disjointed national efforts.
- Language barriers, immigration issues, and cross border taxes and tariffs poses a significant challenge for coordination.
- Poor internet connectivity and unreliable electrical power limits the ability to host appropriate space infrastructure.
- The safety and security concerns relating to both equipment and personnel reduces the location and scope of ground based space related infrastructure.

- Access to libraries, journals, and scientific and technical databases is limited thus constraining the ability to develop appropriate human capital.
- The regulatory environments in each country are different, leading to a lack of a coordinated approach to international treaties and conventions.

Opportunities

- Africa has a spatial market that is characterised by a population of approximately 900 million people spread over 30.3 million km^2.
- Africa's endowment with natural resources provides a significant socio-economic growth potential.
- Global change and the associated adaptation and mitigation measures that are needed, require the extensive use of space products and services.
- Attraction of skilled Africans abroad presents a unique opportunity for leveraging on the skills and expertise of the African Diaspora.
- The increasing international partnerships provide opportunities for the co-development of space platforms, products and services.
- Existing space initiatives in many African countries provide a foundation on which future space initiatives could be expand or built upon.
- A collaborative plan on the allocation and use of frequencies will provide opportunities for the hosting and operations of key equipment and facilities.
- Sharing of capacity among various African countries will assist in minimising duplication and strengthening coordination.
- Learning from indigenous satellite programmes and RASCOM could assist in strengthening the future satellite expertise and capacity on the continent.

Threats

- The over reliance on support outside of the continent could erode the African space aspirations through an infiltration of external interests.
- Political instability and the weak financial base could detract attention away from future investments in the space sector.
- The brain drain could effectively erode the current space expertise that exists on the continent.
- There are many international contenders for frequencies allocated to Africa that could effectively limit the future usage of such resources.
- Rapid technological advancements could reduce the effectiveness and competitiveness of the space technology base in Africa.
- Existing space services and products become obsolete due to the rate of environmental degradation related to anthropogenic and/or global change.
- National space interests are prioritised, which leads to limited collaboration and coordination, and a duplication of efforts.
- Future treaties and policies on space debris, GEO slots, fiber optic networks rollouts, etc, could constrain the African space agenda.

3.2 Developing the Strengths and Addressing the Weaknesses

- Ensure a robust public awareness campaign that targets and solicits the support of all sectors of society, including politicians and decision makers, about the manifold benefits of space science and technology and its potential to fuel economic growth and address social challenges, especially the needs of large rural communities.
- Promote programmes and projects that fosters 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 within the changing socio-economic landscape.
- Institute an appropriate governance structure that is contextualised on an African space agenda and adequately resourced, both financially and human capacity wise, to ensure effective implementation of the African space programme, from a 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 rollout 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 that will be needed for data management and sharing.

3.3 Responding to the Opportunities and Managing the Threats

- Link the spatial market needs and the management of the natural resources in a manner that takes into account global change, and the associated responses, and ensures the sustainable long-term socio-economic development and growth of the African continent.
- Use the international partnerships and the African Diaspora to build local skills and expertise, and to support the co-development of space platforms, products and services and in so doing provide the absorptive capacity that will limit brain drain and minimise over-reliance on foreign support.
- Leverage on the existing space initiatives, space experience, national space programmes and the collective capacity of African countries to build and expand the indigenous space capabilities and state of the art infrastructure, and to minimise 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 on the allocation and use of frequencies so as to protect and maximise the usage of those frequencies allocated for Africa and in so doing maximise the opportunities for hosting and operating key space equipment and facilities.

3.4 Building on Africa's Space Heritage

[Need to reflect on the following

- Draw on existing space programmes
- Learn from RASCOM and ARMC
- Development of new and expanded capabilities]

4 Strategic Context

The primary rationale for formalising a continental-level space programme is to leverage the benefits that space science and technology can deliver to a host of socio-economic applications. This rationale remains central and for which the strategic context is highlighted below.

4.1 Vision

An integrated, prosperous and secure African continent that takes full advantage of the benefits space has to offer by integrating space products and services in decision making processes through innovative partnerships that link governments, industry and research institutions.

4.2 Goals

1. To use space science and technology to derive optimal socio-economic benefits that improves the quality of life and creates wealth for Africans and in addition contributes to the international body of knowledge and the knowledge economy.
2. To develop and maintain indigenous infrastructure, human capital and capabilities that service an African market and that cater for the geospatial and space information needs of the African continent.

4.3 Strategic Objectives

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 technology applications on the continent in order 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 duplication of resources and efforts.
6. **Promoting international cooperation –** promoting an African-led space agenda through mutually beneficial partnerships.

4.4 Expected Outcomes

The projected outcomes over the next decade must ensure a long-term sustainable and viable continental space programme that always remains aligned with user requirements. In meeting user requirements, a concerted effort must be made to put in place adequate human and financial resources, strategic intercontinental and international partnerships, and appropriate technology platforms. Whilst these efforts are undertaken, the global relevance and positioning of the continental space programme must be kept in mind. The response within the implementation framework for this Strategy could be broken into immediate (1 year), intermediate (5 years) and long-term (10 years) outcomes that provide for rolling milestones, which are expressed below.

Projected 1-Year Outcomes

- Establishing the governance elements needed for a sustainable space programme, including regional centres of excellence;
- Approval and rollout of an intercontinental and international partnership plan;
- Approval and rollout of a human capital and infrastructure development plan; and
- Ongoing research and development, and technology programmes that will contribute to building the foundations for a continental space programme.

Projected 5-Year Outcomes

- A fully established continental space programme;
- Appropriate technology platforms in place to support the building blocks of a continental space programme;
- Advances in human capital development that supports the continental space programme;
- Strategic partnerships, both intercontinental and international, through projects that promote research and technology development; and
- Operational and ongoing developments of space application services and products for the broader public good.

Projected 10-Year Outcomes

- A continental space programme that is globally positioned and ranked in the 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;
- Resident space capacity both in terms of technology platforms and human capital;
- Spin-off enterprises emanating from space activities and programmes; and
- Strategic partnerships, both intercontinental and international, that are translated into viable space missions, applications, products and services.

4.5 Expected Impact

The impacts of a continental space programme can be measured on two fronts, namely, at a macro level and a micro level. The macro view relates to impacts made at a macro economic level, whereas the micro view relates to impacts made with respect to responding to the appropriate needs of an indigenous market.

4.5.1 The Macro Level Impact

[Need to indicate the expected macro level impacts]

4.5.2 The Micro Level impact

[Need to indicate the expected micro level impacts

6 The Implementation Framework/Key Deliverables

The strategic approach in implementing an African Space Programme is to adopt a needs pull philosophy, where relevant user requirements, that are contingent on space applications, are responded to. In the process of attempting to address user requirements, recognition must be given to the current and potential technology options available in and to the continental space landscape. These options should also provide a basis from which future technology needs should stem from through appropriate research and development initiatives. Hence, the user requirements, expressed through a set of key priority areas, provide the broad parameters within which the appropriate technology platforms, both new and current, should evolve. The key deliverables, shown in Figure 1, for an African space programme, therefore, must be premised on a set of key priority areas, reflective of the needs of the African user community, and which is contingent on select thematic areas that help support the user requirements.

Key Priority Areas

Thematic Focus Areas

Figure 1: Implementation Framework/Key Deliverables

6.1 Key Priority Areas

Today, Africa faces major pressing issues: climate change impact, water scarcity, energy shortage, environmental stresses and food crisis, which affect citizens, business and the community at large. On all these challenges, the constitution of coherent seamless and up-to-date spatially enabled information is an essential precondition for setting up coordinated policy and strategy. Space technology is useful in constituting factual, precise and updated information. Such information is required for various developmental decisions, such as natural resources development, environmental protection and management, food security and vulnerability monitoring, human settlements planning and land reform, transport and communication infrastructure planning and management, peace, security and stability promotion, service delivery in commerce and government, health, education, governance and social welfare, and tourism development and management.

The strategic approach in implementing an African space programme is to adopt a needs pull philosophy where relevant user requirements, that are contingent on space applications, are responded to. In view of the manifold interests that could be vested in an African space programme, any proposed priorities must emulate the highest priorities on the continent for which effective coordination becomes the central focus. The continental level priorities can be cogently expressed, as shown in Figure 2, through the interface among the political, economic and social spheres that underlie the complex spectrum of public affairs and everyday life issues affecting the African continent.

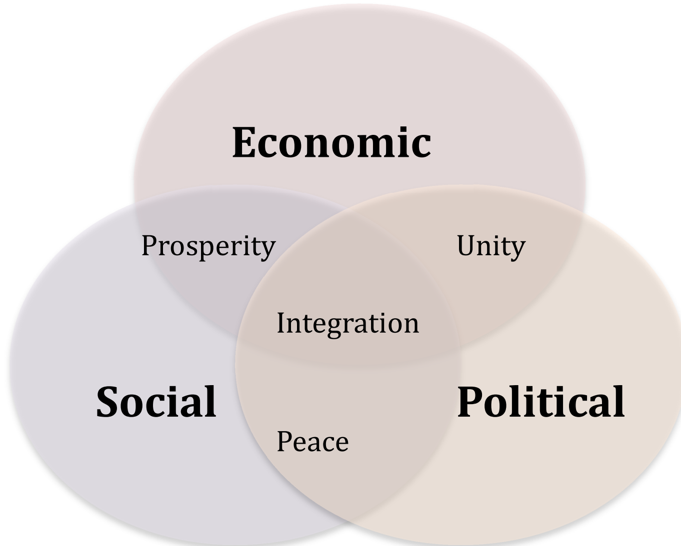

Figure 2: Key priorities for a continental level space programme

These spheres need to be seamlessly integrated to ensure optimal benefits that ultimately translate into wealth creation and improved quality of life on the continent. These benefits must be underpinned by prosperity, peach and unity, as the intersect between the identified spheres and collectively lead to economic, political and social integration. Hence, the key priorities for the African continent will be categorised according to the political, economic and social affairs, and for which the following definitions apply:

- ***Political affairs*** – at the continental level, refers to the notion of social and economic cohesion and integration, which is largely underpinned by political stability, peace and security.
- ***Economic affairs*** – at the continental level, refers to the sustainable utilisation and mobilisation of resources to support robust economic growth in a manner that ensures economic integration.
- ***Social affairs*** – at the continental level, refers to the cultural aspects and the health and wellbeing of the citizens of Africa that is gauged through an improved quality of life for all.

The priorities that encompass these key priority areas are as follows:

Disasters: Reducing loss of life and property from natural and human-induced disasters. Disaster losses can be reduced through observations relating to hazards such as: wild land fires; volcanic eruptions; earthquakes; tsunamis; subsidence; landslides; avalanches; ice; floods; extreme weather; and pollution events. There is a need for timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.

Health: Understanding environmental factors affecting human health and well-being. Health issues with Earth observation needs include: airborne, marine, and water pollution; stratospheric ozone depletion; persistent organic pollutants; nutrition; and monitoring weather-related disease vectors. There is a need to improve the flow of appropriate environmental data and health statistics to the health community, promoting a focus on prevention and contributing to the continued improvements in human health worldwide.

Energy**:** Improving management of energy resources. The outcomes in the energy area will support: environmentally responsible and equitable energy management; better matching of supply and demand of energy; reduction of risks to energy infrastructure; more accurate inventories of greenhouse gases and pollutants; and a better understanding of renewable energy potential.

Climate**:** Understanding, assessing, predicting, mitigating, and adapting to climate variability and change. The climate has impacts in each of the other priority areas. Coping with climate change and variability demands good scientific understanding based on sufficient and reliable observations. There is a need to enhance the capacity to model, mitigate, and adapt to climate change and variability. Better understanding of the climate and its impacts on the Earth system, including its human and economic aspects, will contribute to improved climate prediction and facilitate sustainable development while avoiding dangerous perturbation to the climate system.

Water**:** Improving water resource management through better understanding of the water cycle. Water-related issues will include: precipitation; soil moisture; streamflow; lake and reservoir levels; snow cover; glaciers and ice; evaporation and transpiration; groundwater; and water quality and water use. There is a need to improve integrated water resource management by bringing together observations, prediction, and decision support systems and by creating better linkages to climate and other data. In situ networks and the automation of data collection will be consolidated, and the capacity to collect and use hydrological observations will be built where it is lacking.

Weather**:** Improving weather information, forecasting and warning. The weather observations are based on the requirements for timely short- and medium-term forecasts. There is a need to help fill critical gaps in the observation of—for example—wind and humidity profiles, precipitation, and data collection over ocean areas; extend the use of dynamic sampling methods globally; improve the initialization of forecasts; and increase the capacity in developing countries to deliver essential observations and use forecast products. Every country will have severe weather event information needed to mitigate loss of life and reduce property damage.

Ecosystems**:** Improving the management and protection of terrestrial, coastal and marine resources. Observations are needed on the area, condition, and natural resource stock levels in ecosystems such as forests, rangelands, and oceans. There is a need to ensure that methodologies and observations are available on a global and regional basis to detect and predict changes in ecosystem condition and to define resource potentials and limits. Ecosystem observations will be better harmonized and shared, spatial and topical gaps will be filled, and in situ data will be better integrated with space-based observations. Continuity of observations for monitoring wild fisheries, the carbon and nitrogen cycles, canopy properties, ocean color, and temperature will also be prioritised.

Agriculture**:** Supporting sustainable agriculture and combating desertification. Issues to be addressed will include: crop production; livestock, aquaculture and fishery statistics; food security and drought projections; nutrient balances; farming systems; land use and land cover change; and changes in the extent and severity of land degradation and desertification. There is a need to address the continuity of critical data, such as high-resolution observation data from satellites. A regional mapping and information service, integrating spatially explicit socio-economic data with agricultural, forest, and aquaculture data will be necessary, with applications in poverty and food monitoring, planning, and sustainable development.

Biodiversity**:** Understanding, monitoring and conserving biodiversity. Issues in this area include the condition and extent of ecosystems, distribution and status of species, and genetic diversity in key populations. There is a need to unify many disparate biodiversity- observing systems and create a platform to integrate biodiversity data with other types of information.

Additional Priorities

- Peace, Security and Stability
- Human migration and settlements
- Education
- Communications
- Trade and Industry
- Transport
- Infrastructure
- Human resources

6.2 Space Discipline

In the process of attempting to address user requirements, recognition must be given to the current technology options and programmes available on the continent. These options provide a basis from which future technology needs and programmes should stem from. Hence, the key priority areas provide the broad parameters within which the appropriate technology platforms and programmes, both new and current, should evolve. Hence, to deliver on the key priority areas, four thematic areas, identified as important for a viable space programme, need to be pursued. These thematic areas include:

1. **Earth observation** – the development of integrated Earth observation services and products that respond to user needs and addresses Africa's socio-economic opportunities and challenges;
2. **Navigation and Positioning** – the development of a sustainable space based augmentation system in Africa that enhances navigation and positioning applications and improves safety-of-life applications;
3. **Satellite Communications** – the development of technologies and applications to improve information communications technologies for commercial purposes and for the broader public good, especially in rural areas;
4. **Space Science and Astronomy** – the development of mission driven initiatives that assist in understanding our solar-terrestrial environment and the universe and to leverage the related human capital and technological spinoffs.

6.2.1 Earth Observation

Earth observation will form the primary focus of an African space programme, as it has the most potential to address the socio-economic challenges of the continent. The benefits relating to Earth observation services and products have already been highlighted in preceding sections. In order to address the associated opportunities and challenges there is a need to strengthen the full value chain of activities that support Earth observation. The Earth observation value chain consists of three segments, namely:

1. Infrastructure – this consists of data that is obtained through a variety of platforms that include space, air, ocean, balloon and ground based datasets; data centres that serves as a distributed repositories for data archiving; and portals that allow users to log in and extract data and information.
2. Human capacity – this consist of the requisite expertise and skills that ensures a convenient platform for further human capital development and engagement in research and development that focuses on developing the Earth observation

value chain.

3. Products and services – this comprise of the essential core goods that respond to the user needs, both for commercial exploitation and the broader public good, and which are primarily tailored to address the socio-economic challenges on the continent.

The three segments provides for the consolidated acquisition of space and in-situ data for regional and national needs. The platform will also support intra-continental and international initiatives, such as the African Resource and Environmental Management Constellation (ARMC), GMES and Africa, the Committee on Earth Observing Satellites (CEOS) and the Group on Earth Observation System of Systems (GEOSS).

Specific interventions relating to Earth observation must include:

- Develop the critical mass of skills and expertise in Earth observation applications and usage.
- Develop and improve Earth observation institutions in Africa.
- Foster knowledge sharing among African experts, users and stakeholders.
- Develop space based and in-situ infrastructure that helps in achieving the user needs and societal benefits.
- Develop Earth observation services and products using web-based and appropriate technologies in order to meet user needs.
- Foster stakeholder engagement to ensure the generation of the relevant services and products that maximises the benefits of Earth observation applications.
- Raising awareness among the public, users, policy and decision makers.

6.2.2 Navigation and Positioning

Satellite navigation systems are space-based radio positioning systems that include one or more satellite constellations, augmented as appropriate to support the intended operations, and that provides 24-hour three dimensional position, velocity and time information to suitably equipped users anywhere on, or near, the surface of the Earth. Satellite navigation systems are not yet completely suitable for applications requiring high levels of accuracy and reliability. Under certain conditions their use is limited and there are concerns that the integrity of the signal may not be sufficient for applications where this is vital, for example in air traffic control.

Progress is under way to overcome the current weaknesses of these systems. The major technological challenges are to improve the reliability, accuracy and integrity of positioning systems. In this regard, the development of new differential GNSS systems, such as augmentation systems and overlay services, significantly increase the quality and robustness of the signal. Satellite augmentation involves using external information, often integrated into the calculation process, to improve the accuracy, availability, or reliability of the satellite navigation signal.

Specific interventions relating to navigation and positioning must include:

- Develop the critical mass of skills and expertise in navigation and positioning applications and usage.
- Ensuring seamless integration into existing global navigation satellite services;
- Build on existing infrastructure such as ASECNA, EGNOS, TRIGNET and AFREF;
- Promote an African array study for seismic applications using seismic reference receivers;
- Developing an indigenous continental level navigation augmentation system; and
- Developing navigation and position application products and services to support user requirements.

6.2.3 Satellite Communications

There is a rising demand for mobile satellite services on the continent, often characterised by a lack of an adequate terrestrial telephone line infrastructure. Mobile satellite service systems offer three types of services, namely:

1. Worldwide personal communications services to users via single or dual mode cellular/satellite phones;
2. Mobile data terminals used to transmit "store and forward" messages; and
3. Fixed applications in developing countries and emerging markets such as "village phones".

Satellite systems have important features that fibre optics lack, namely, (i) mobility – mobile users cannot be connected to the fibre network directly, (ii) flexibility – once terrestrial infrastructure is built, it is extremely expensive to restructure it, (iii) rural and remote connections – it is still not cost effective to deploy high-capacity fibre networks in areas with low-density traffic and difficult topography, and (iv) broadcast capability – where point-to-multi-point connections are able to reach millions simultaneously in a cost-effective way.

Satellite communications is thus a key technology that could enable Africa to participate in the build-up of the global information infrastructure. Satellite communication systems, featured by large "footprints", ranging in size from a country to a continent, avoid the need for terrestrial infrastructure and shorten the time for establishing basic and advanced communications, especially in rural areas. These services also provide numerous opportunities for commercial applications such as fleet and cargo tracking and monitoring; low cost message to rescue workers, especially during post disaster recovery; and transmitting data from remotely monitored automated devices.

Specific interventions relating to satellite communications must include:

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

6.2.4 Space Science and Astronomy

The exploration of the universe from our solar system to the most remote parts represents one of the greatest intellectual adventures of humankind. The past four decades have witnessed a dramatic change in our views about the universe and its constituent parts. This is an ongoing revolution whose implications are still to be fully understood not only in the scientific context, but also from a practical view. Scientific illiteracy is one of the world's greatest problems and an increasingly divisive factor between developed and developing countries. Increase in the quality of life and economic growth now depend to a large extent on scientific and technical awareness and on the ability to incorporate new knowledge and devices into the economies of societies and the lives of individuals. The technology of space science and astronomy is crucial in this respect.

Basic scientific exploration has invariably been a catalyst for the development of a variety of new technologies. Space technology is no exception, driven as it is by the exacting requirements of space science and astronomical experiments requiring very accurate pointing mechanisms, better attitude control systems and a variety of highly sensitive sensors. It is widely recognized that today's science is tomorrow's technology and that any nation that wants to advance technologically cannot afford to ignore investments in space science and astronomy. In addition, the power of space science in the educational system to motivate the learning of such skills cannot be overestimated. It captures public interest and provides a vision like little else in modern science and technology.

Specific interventions relating to space science and astronomy must include:

- 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 capacity and 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 programmes.
- To ensure value addition to Africa's economy through the spinoff development of human capital and technologies in space science and astronomy.

7 Implementation Guidelines/Critical Success Factors

The key deliverables are necessary for informing a viable and sustainable space programme, but are not in themselves sufficient. They will rely on a number of critical success factors that are needed in order to realise the key deliverables in an effective and efficient manner. The critical success factors, as shown in Figure 3, will include functional programmes, which are indicative of the operational requirements of an African space programme; support platforms, which assist in consolidating and strengthening the African space programme; space awareness, which is intended to ensure that there is broad public buy-in and appreciation of an African space programme; and the economic model, which is needed to ensure that the African space programme is appropriately resourced.

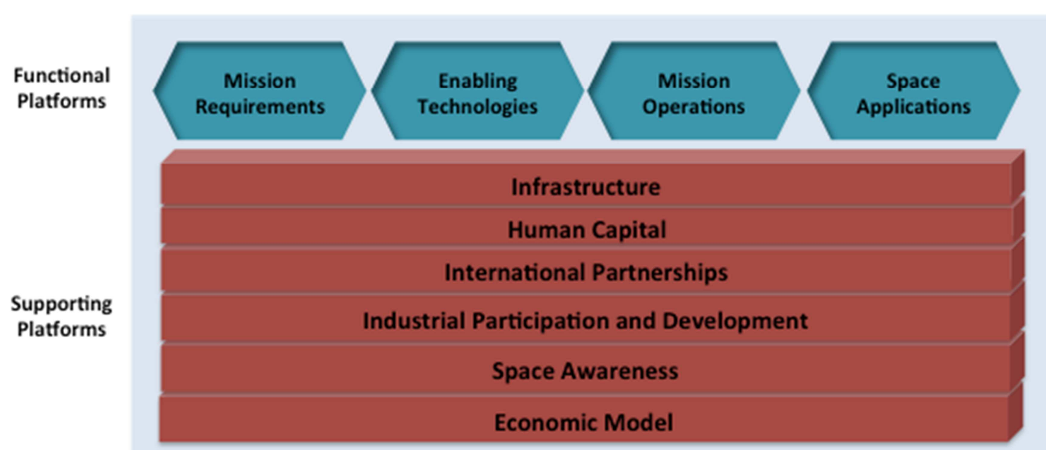

Figure 3: Key deliverables and critical success factors.

7.1 Functional Platforms

Functional programmes represent the means to achieving the key deliverable and are primarily embedded in the underlying technology platforms. It represents the key elements for a space mission concept, which comprise of 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, which seeks to organise the scientific and engineering capacities into four large clusters, where each cluster carries out specific functions, which are summarised as follows:

1. Through **mission requirements**, provision is made for identifying the appropriate technology platforms that support the key deliverables. The related activities include the development of space missions through the definition, critical design, manufacturing, integration, testing and delivery phases leading to the launch and early operations of space systems.
2. Through **enabling technologies** provision is made for leadership, coordination and support to applied research in order to increase the knowledge base, devise new applications through space missions, and allow for the transfer of intellectual property and proven technologies to local industry, academia, and government organisations.
3. Through **space mission operations**, support is given to space missions through ground support, personnel training, mission analysis and planning, in-orbit ground control operations, systems monitoring, maintenance and logistics support, as well as data handling and delivery.
4. Through **space mission applications**, value is delivered to stakeholders by employing best practices in developing new and advanced applications to support stakeholder user requirements through the provision of relevant services and products.

7.1.1 Mission Requirements

At the heart of the space architecture is the mission. Simply stated, the mission is why we're going to space. All space missions begin with a need, such as the need to monitor water resources or to monitor pollution in the upper atmosphere. Understanding this need is central to understanding the entire space mission architecture. For any mission the need informs the mission statements that include three elements:

1. The mission objective – *why do the mission*;
2. The mission users or customers – *who will benefit*;
3. The mission operations concept – *how the mission elements work together.*

The specific needs identified under each key priority area can be mapped onto the thematic areas. Focusing on the Earth observation requirements there are a range of spatial resolutions that are required to cover the array of user needs. We note that at the lower spatial resolution end (> 10m) datasets are readily available, but as we progress to higher spatial resolutions the availability diminishes – with limited access to sub 1m resolution data.

The focus of the Earth observation satellite missions should therefore revolve around medium to high-resolution satellites. Apart from the satellite missions with optical payloads, there is a definite need for Synthetic Aperture Radar (SAR) data. This is essential for continuous data coverage, especially where cloud cover would limit optical satellite missions. In addition, SAR data is important for military applications where terrain profiling and mapping is critical for the deployment of ground troops, especially in hostile and remote territories.

The focus in the area of navigation and positioning will concentrate on augmentation systems to improve the accuracy and integrity of satellite signals on the continent. The augmentation systems will form secondary payload options on future satellite missions and where necessary these will be complemented by indigenous ground based augmentation systems.

In the area of satellite communications a two-pronged approach will be followed:

1. Development and operations of communication transponders as secondary payload options on future LEO satellites with the prime focus being for disaster management communications, uploading of ground sensor signals and low data rate applications.
2. Development and operations of a dedicated GEO communications satellite for commercial end-to-end services and for extending communications access to rural communities.

The mission requirements can therefore be summarised as follows:

- Low Earth orbiting satellites with multispectral and hyper spectral optical payloads and navigation augmentation payload systems.
- Low Earth orbiting SAR radar satellites to complement the optical satellite missions.
- A geostationary orbiting communications satellite with multiple communication transponders and a navigation augmentation payload system.
- Ground based augmentation systems that complement the space based GNSS systems.

7.1.2 Enabling Technologies

Following identification of the primary mission requirements we now move to the satellite systems technology and engineering requirements. This consists of two broad categories shown in Figure 9 below, namely:

1. Payloads – consist of single or multiple sensors that receive and/or transmit electromagnetic signals.
2. Subsystems – provides all housekeeping functions needed to operate the payload/s and get the data to users.

Payloads – in line with the high-level mission requirements identified above, a series of payloads will be required and these consist of the following platforms:

- Optronic sensors – passive optical sensors that collect reflected signals from objects under observation and converts these to pixel information;
- Synthetic aperture radars – a form of radar in which multiple radar images are processed to yield higher-resolution images than would be possible by conventional means;
- Navigation augmentation systems – produce time coded signals that are used to accurately measure distance and position; and
- Communications transponders – active sensors that either transmit or receive radio waves to or from the ground, respectively.

Subsystems – in order to optimally support the payload operations, a number of housekeeping functions are required and these comprise of:

- Spacecraft control – a satellite has to have the right attitude, or orientation, to point payloads at targets on Earth and to be able to control its position and velocity so that it can get to where it needs to go.

- Communication and data handling – consists of computers, internal data communications networks, and radios needed to process mission data, as well as send and receive information from operators on the ground.
- Electrical power – converts energy from some source into usable electrical power to run the other subsystems and the payload.
- Structural subsystems – holds together all the other subsystems and payload and withstands launch and mission stresses.
- Propulsion subsystems – provides torque and thrust needed by the spacecraft control subsystem.

In order to ensure that the payload and subsystem requirements are met for future satellite missions there is a need for technology development. However, in order to identify the approaches to be adopted in developing the various technology platforms, it is appropriate to gauge the sense of technology readiness in each of these. The readiness of the African space industry to participate in several possible future space missions will critically rely on a systems engineering approach, where a consortium of African countries undertakes research and development, and subsequent operational activities.

The general guidelines 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;
- For the communications satellite
  [Need to discuss the approach here
    - Full procurement through international tenders;
    - Procurement through international tenders with African participation on the technology and engineering front
    - Partnerships with other technologically advanced partners]
- All satellite subsystems will rely on a fully indigenous capability.

7.1.3 Mission Operations

Mission operations include all “cradle to grave” activities needed to take a mission from a blank sheet of paper to on-orbit reality, to the time when the satellite is terminated. The mission operations systems include the ground and space based infrastructure needed to coordinate all elements of the space mission concept. It is the glue that holds the mission together and includes manufacturing and testing facilities to build the satellite, launching facilities, communications networks and operation centres to coordinate activities once a satellite is in orbit.

In order to unpack the requirements for mission operations, we will focus at some of the critical operations systems that function during the three basic phases of a satellite’s life and these include:

- Satellite manufacturing – the systems that support design, assembly, integration and testing.
- Orbital slots -
- Launch – the systems that bring the satellite and launch vehicle together and get them safely off the pad.
- Operations – including communication, command, and control systems.

Satellite Manufacturing

To ensure the highest quality, most satellite components are assembled and integrated in dedicated clean rooms to limit the exposure of sensitive components, such as sensor lenses, to particulates that could damage them or reduce their performance in space. The discipline required by working in a clean room creates a carefully controlled work environment that helps to prevent carelessness and mistakes.

Ground support equipment (GSE) helps during subsystem and system assembly, integration and testing (AIT). After the satellite is assembled and integrated, testing can begin. Prior to this, individual components and subsystems need to undergo their own testing. Functional testing determines how well the subsystems work as required under a range of operational scenarios. Environmental testing, on the other hand, ensures that the satellite can survive heat, cold, vacuum, radiation, vibration and g-force loading it will experience throughout the mission.

Orbital slots

Countries in Africa are lifeline users of spectrum and satellite resources, perhaps more than developing countries in other continents. Most of their international traffic is channeled through satellites to the rest of the world. Thus, developments in satellite policy and governance are of priority concern to the continent.

To allow radio interference-free operation, the Geostationary Satellite Orbit Spectrum becomes an international limited natural resource, requiring for its orderly use, the application of Radio Regulations as formulated by World Radio Conferences (WRCs) of the ITU. Such a procedure entails the frequency coordination among administrations of satellite networks that might cause unacceptable mutual radio interference due to their close spacing to one another in the Geostationary Satellite Orbit. The congestion of the Geostationary Satellite Orbit Spectrum as reflected by the above large number of filings for the limited resource is causing considerable complication to the coordination procedure.

In reforming ITU, principles of "first come first served" on these scarce and finite resources should be reviewed. Those who are poor today and without technological power will not be so forever. Hence, principles of equity and conservation should prevail to ensure access by humankind in present and future generations. In seeking solutions to the satellite backlog issues and increasing cost recovery in processing fees, care should be taken to ensure that new barriers for excluding the developing world are not created. An affirmative asymmetric approach with defined transition periods should be considered, so that the statement of transforming the digital divide into digital opportunity does not become just another slogan. African countries will stand a better chance of securing orbital slots and spectrum resource if they file as a block.

After securing the Orbital Slot and Associated Frequencies, then concerned countries start the 4-5 year process of specifying, ordering, launching & insuring the satellite, which once launched, will operate for up to 15 years and the license can no longer be modified.

Launch [Launch to be done in Africa]

The launch of a satellite can sometimes account for nearly 30% of a mission cost. Not only is the launch vehicle expensive, but we also pay for the complex operations systems that provide the infrastructure to get the launch vehicle and the satellite off the ground and into space. These systems include:

- The launch site and its associated range;
- The launch pad;

- Payload and vehicle processing facilities; and
- Launch operations centre.

[Need to discuss if we would want to pursue launch capabilities, as a continent]

Operations
For space missions, communication is the exchange of commands and engineering data between the spacecraft and ground controllers, as well as the processing and transmitting of payload data to users. The communication architecture is the configuration of satellites and ground stations in a space system and the network that links them together and comprise of four elements:

- Satellites – the space borne elements of the system.
- Ground stations – Earth-based antennas, transmitters, and receivers that talk to the satellites.
- Control centre – the command authority that controls the spacecraft and all other elements in the network.

To receive mission data, antennas on the ground must point at the satellite whenever it's within range. This means ground stations must know where the satellite is at all times. This is an extensive operation and requires dedicated ground support.

The testing facilities that will be required include:

- AIT and design centre
- Ground segments
- Space segment
    - Control centres
- Securing appropriate geostationary orbital slots

7.1.4 Space Applications

Space applications form the cornerstone of a space programme and will therefore form the primary performance indicator for the sector. All technology options presented thus far are a means for realising various services and products that respond to user needs. Central to addressing the user needs is the Earth observation value chain. This comprise of the requisite infrastructure and skills and expertise needed to support the development and maintenance of the products and services.

In terms of developing a suite of products and services for the broader public good, each region will champion the definition and scoping of the services and products pertinent to that region, whereas the continental space programme will respond by investing in the common base platform that is required. In the case of commercial goods, the private sector will pay for the cost of accessing the data and the full costs associate with the development of the services and products.

[What are the key elements we would want to see with respect to?

- Infrastructure
- People
- Products and services]

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

- Data policy
- Timely access to the right data sets at the procurement end;
- The provision of appropriate services and products that respond to all user needs identified under the three key priority areas;
- Robust processing capabilities to ensure that timely access to the requisite services and products is available to the end users;
- Ensure that all tiers of governments are able to access space and ground based data through a centralised portal;
- Provision of data for education, and research and development; and
- Provision of data for commercial exploitation at a minimal cost.

7.2 Supporting Platforms

Supporting platforms are critical for the realisation of the technology platforms needed for the various functional platforms and comprise of the following:

1. **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.
2. **Infrastructure** – appropriate infrastructure is the cornerstone of an effective space programme, enabling technology transfer and human capacity development initiatives.
3. **International partnerships** – strategic partnerships with foreign partners are necessary for tangible and intangible technology transfer and a viable and sustainable space programme that is underpinned by mutual benefits.
4. **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 formal space programme.
5. **Space Awareness** - for the African space programme to be meaningful to the broader public there is a need for creating public awareness relating to the benefits that space technology and its manifold application products and services can deliver.

7.2.1 Human capital development and space awareness

(Group: Nana, John, Jiwaji, Pascal)

The realization of envisage vision of the space science and astronomy strategy can be realized if there is a need for dedicated and qualified human resources to drive the process. In order to realize the above, the general population should be knowledgeable to accept and appreciate astronomy and space science as a useful tool for development.

- Mainstreaming Astronomy and Space Science Programs (ASSP) into all levels of society
- Intervention of ASSP into the school curriculum in the primary and secondary level
- Demystify misconceptions in ASSPs arising from common experiences
- Introduce programs and attract best minds from schools to ASSP
    - Encourage science and astronomy clubs
- Introduce ASSP at undergraduate degree programmes in the universities with multiple exits – technical and academic
- Policy for attracting the best minds towards ASSP at the national level

- Opportunities for postgraduate at any African country should be open to any African university
- Creating an enabling environment for graduates to be attracted for opportunity for employment
- Basic astronomy courses for introducing the non-science students at university level and for teacher trainees
- Development of curriculum and teaching aids towards ASSPs
- Public outreach programs
    - Regular bulletin, current affairs in the Media
    - Training of journalists and media men
    - Astronomy activities
    - Public lectures
    - Science centers and Planetarium
- Data pull on indigenous knowledge

Mission requirements

- Promote gender parity in ASSP
- Encourage science and astronomy clubs
- Develop of curriculum and teaching aids towards ASSPs at all levels of education
- Provide an enabling environment for:
    - attracting the best minds towards ASSP at the national level
    - teaching and learning of science in all universities in Africa
    - postgraduate training opportunities in ASSP at African universities
    - graduates to be attracted for opportunity for employment in ASS industry
    - engaging scientists and engineers in the diaspora
- Provide ASSP training for science teacher trainees
- Develop basic astronomy courses for non-science students
- Build mechanisms for facilities and funding for research
- Create public awareness through
    - Regular bulletin, current affairs in the Media
    - Training of journalists and media men
    - Astronomy activities
    - Public lectures
    - Science centers and Planetarium
    - Contribution of experiences from diaspora
- Collect data pool on indigenous knowledge

7.2.2 Infrastructure

(Group: Adil, Kofi, Paul)

Initial investment in space technology is considered "Strategic" and might prove difficult to attract private sector investment. However, through the integration of space technology into other sectors of the economy, it shall lead the sector to become a self-sustaining business model. The key success factor is the creation of a linkage between space and other sectors such as communication, agriculture, energy, transport, peace and security … etc

Leverage on existing facilities in Africa as well as Public and private sector partnership to help build infrastructure in Africa. Member states in the African Space consortium may build the infrastructure and avail for use at a negotiated fee. The public -private partnerships, partnership with some external space agency (ies) to help build infrastructure for manufacturing of space hardware and software.

Propose the following:

- Build and Strengthen Pan African Space University to enable it to support space centers across the continent
- Build centers of excellence across regions in Africa and expand and upgrade existing ones.
- Build AITs centers in the continent
- Build data banks and high performance computing centers and/or use existing ones.
- Leverage on partnerships to build space based industry for manufacturing space hardware and software and could serve as center of hands-on training
- Develop and expand existing mission control centers (e.g centers in Kenya, Algeria, Nigeria, Egypt, South Africa.. etc)
- Develop and strengthen research and development center so that they be accessible by researchers across the entire continent
- Expand existing observing infrastructure and ensure data accessibility for research (e.g GPS receivers, Magnetometers, ionosondes, etc)

7.2.3 International partnerships

(Group: Mohomed, Mahama, Ridha, Dinga)

The development of the African space strategy should take advantage from a strong and diversified cooperation and partnership network established through a clearly shared understanding of relevant international treaties and best uses and practices.

To that end, specific actions should be conducted to :
Promote a panafrican cooperation and partnership specific framework and networking process for the development of the intracontinental complementarity in the fields of :
. Human ressources development
. space Infrastructure development
. Space industry development.
. Space R&D

Establish cooperation agreements with governemental and intergovernemental and regional organizations and agencies (such as the International Telecommunications Union, and Committee of Peaceful use of Outer Space), in charge of space activities. Such agreements should focus on exchange of experiences and launching common programs with the objective of reducing the space divide and technological gaps in terms of space access and space R&D.

encourage African Academia to establish partnership arrangement with Academic networks concerned by space activities and join such networks.

Establish the appropriate framework for the development of an African space industry operating in close cooperation with the foreign space industry with the purpose of establishing a complementarity between them.

To make appropriate efforts in order to integrate the African space infrastructure and programs as a part of the global space infrastructure with a clear recognition of the African rights in this regard.

7.2.4 Industrial participation and development

(Group: Islam, Tich, Mash, Harry)

Space industry will be an ultimate goal for Africa to begin harvesting the resources of space both for their use in space and to increase the wealth and prosperity of the African citizens. This will develop a coherent and sustainable indigenous space industry that creates a competitive and reputable global market. This will be a continental space industry that will participate in the various functional platforms for a sustainable space programme. Such space industry will be 0built on existing African heritage and resources, human capital and local private sector with strong public-private partnerships. The motivation of Africa Space industry is to provide services and products for Africa to improve the life quality and wealth with strong contribution to the global market.

The anticipated indigenous space industry include:

- Design, test and manufacture of satellite subsystems for:
  - Global position systems satellites
  - Communication satellites
  - Earth observation satellites
- Design and manufacture of ground segment (launching, control and receiving stations, AIT facilities)
- Develop software engineering for data processing and applications
- Strengthen industry - research and development partnerships (spin-offs and entrepreneurships)
- Strengthen public-private partnerships
- Promote and support SMEs

It is also important to note that any technology platform can only be embraced if there is broad scale understanding of the value and functionality of the said platforms. In addition, there is a need to ensure the long-term sustainable use of the outer space environment through appropriate legislation and knowledge sharing. Therefore, awareness and advocacy programmes will be vital to the development of a long-term sustainable African space programme.

10 Key Performance Indicators

[This section should list the KPIs relating to the success of a continental space programme]

11 Conclusion

[This will be done at the end]

3 The global space economy

Estimates of the size of the global space economy vary widely owing to the lack of internationally comparable data. However, from institutional budgets and new commercial revenues from space-derived products and services, it appears that the underlying trend in the global space economy is one of growth. Figure 1 shows the space budgets of selected Organisation for Economic Development and Cooperation (OECD) and non-OECD countries in 2005.

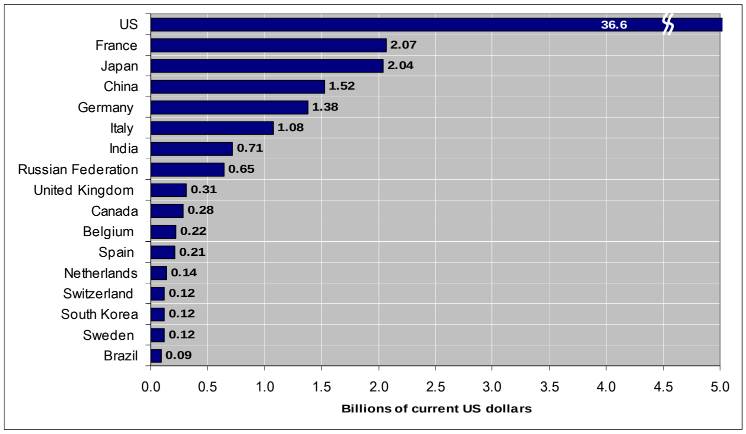

Figure 1: Space budgets of selected OECD and non-OECD countries for 2005
(Source: OECD Report, Space Economy at a Glance, 2007)

In terms of the relative spend of these budgets; there are more downstream space activities (applications) than in the traditional upstream segment (manufacturing). In 2006, manufacturing revenues (e.g. satellites, rockets) were estimated at around USD12 billion, and space-related services (e.g. direct to home satellite television, GNSS) were estimated at more than USD100 billion. In terms of servicing these different segments, in 2006 an estimated 120 000 people in OECD countries were employed in upstream sectors. Figure 2 shows the revenues generated for different technology platforms in the space sector.

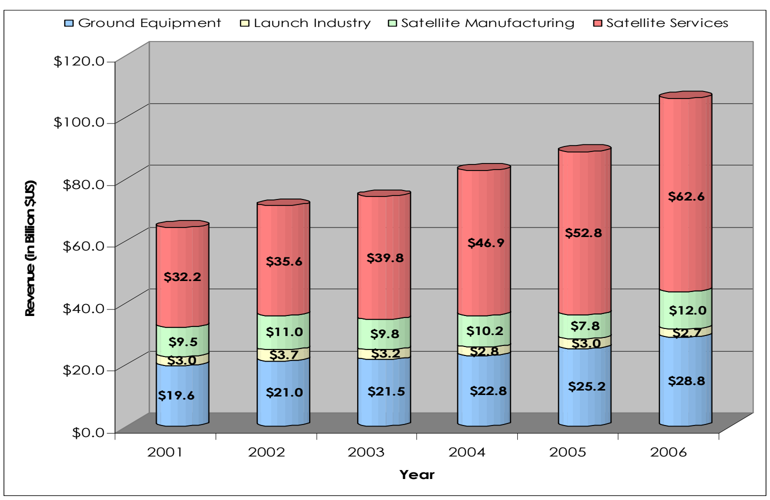

Figure 2: Worldwide revenues of space industry per sector
(Source: OECD Report, Space Economy at a Glance, 2007)

Revenues from satellite manufacturing and launch services averaged USD14.6 billion per year over the decade 2001 to 2011, with a record high of USD18.7 billion in 2011. Government customers have dominated the decade in terms of revenues generated from satellite manufacturing and launches (USD94 billion), while commercial customers generated USD52 billion, almost all of them derived from geostationary communication satellites. The historical dominance of the space industry by governments is explained by the number of satellites launched per year and their high cost driven by complex and mission specific requirements, especially for space science and military applications, mainly in the domain of communications, navigation and imagery intelligence.

Capital stocks for space assets, as well as annual levels of investment in them, are very difficult to estimate. However, focusing on satellite values, a 2005 study estimated that the 937 satellites in the Earth's orbit at the time had a replacement value of USD170 to 230 billion. During the last decade extending from 2002 to 2011, the world satellite industry launched an average of 79 satellites per year. Governments dominate the space industry with 525 of the 791 satellites launched. The remaining 266 satellites were for commercial satellites with 203 being in the geostationary (GEO) and 63 in low Earth orbit (LEO).

Commercial operators dominate in terms of mass traffic to orbit, with 865 tons launched over the decade 2001 to 2011 versus 849 tons for governments, as a result of larger communications and broadcasting satellites launched into geostationary orbit. Government traffic to orbit is dominated by military satellites accounting for 60% of the 849 tons. Because of their small masses, the 63 commercial satellites launched into LEO during the decade represented only 40 tons to orbit. The mass to orbit grew by 14% between 2010 and 2011 to reach 222 tons. The market value for satellite manufacturing and launch services grew by 26% in 2011 to a record of USD18.7 billion. As a reflection of the mass traffic to orbit, the past five years averaged USD16 billion of annual revenues, up from an average of USD13.3 billion between 2002 and 2006.

Patent data is considered an indicator of technological innovation and the economic vigour of a given sector and, between 1990 and 2000, the number of space-related patents tripled in both Europe and the United States of America, with the USA, France, Germany and Japan accounting for a major portion of these. These patents have significant commercialisation potential and result in economic spinoffs. In Norway, the "spin-off effect" of space programmes on space firms has been measured at 4.4, implying that for every 1 million of Norwegian Kroners (NOK) of governmental support, the space sector companies have on average attained a turnover of NOK 4.4 million. Although this impact measure may vary widely depending on the country and level of specialisation, it is indicative of possible increased competitiveness owing to involvement in the space sector.