

Space exploration for the African Continent: A Case for an African Space Agency

Francis Chizea, Ovie EseOghene, Akachukwu Chichebe and Reuben Umunna
(National Space Research & Development Agency Abuja, Nigeria)

Abstract: Space exploration and exploitation has become a necessary tool for growth and development of any nation. The role of space technology cannot be overemphasized in the development and industrial fortunes of most developed economies and has played a major role in the quick transformation of developed nations all over the world. As a source of national pride and human achievement, harnessing the benefits of space for Africa by Africans becomes imperative if Africa must quicken and sustain its industrialization. However, considering the resource constraints faced by many African nations and the common challenges shared by most African countries, it has become pertinent to propose the creation of a common space agency. Driven by the multiplier effects of synergy, efficiency, cost cutting, an Africa-wide space agency styled after the EuropeanSpace Agency should form a viable and practical tool for establishing Africa as a continent of space farers and space technology experts. To this end the peculiarities of such a space agency is investigated and discussed and recommendations made that can form a basis for actualizing such a venture in an optimal way.

Keywords:space exploration, development, sustainable industrialization, space agency, economy. Multiplier effect, transformation

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I. INTRODUCTION

One definition of the space industry is that which comprises goods and services produced through the process of space development [1]. With the projected incomes from space technology and exploration activities estimated to top 660Billion USD in 2030[2], it is no news that unless Africa partakes in the creation of some of this wealth, it will only be considered a consumer of space products from developed economies. This will only worsen and deepen the dependence cycle and create a huge capital flight regime. Considering the commonality of Africa's challenges, it might be safe to say that having a synergistic relationship for exploiting space might be a better paradigm than doing it individually. The gains from such a synergy are myriad and include, reduced cost, shared resources and healthy industrial competitiveness index.

If the surveys that Africa constitutes the continent with the largest young demographic and that phone usage in Africa surpassed that of most other continents [3], a clear imperative is placed on Africa to control this burgeoning market and its benefits. As at today, almost every developmental indices places Africa at the lowest end of the developmental spectrum, with this fact borne out by most available developmental indices[4]. Probably the only place where Africa surpasses other continents is in its rich availability of natural resources. In seeking the benefits that Africa stands to gain, three fundamental areas have been globally identified: innovation; culture and inspiration; and new means to address global challenges [5].

In attempting to find a workable template for such a synergy, the European Space Agency (ESA) readily comes to mind and particularly gets that attention for being quite successful at its own space exploration activities [6]. Examples of the ESA missions which have gone on to provide needed services for the benefit of mankind include the Galileo navigation satellites, Cassini space probe, Ariane V rocket launcher and probably more well-known is the activity of the ESA in the space environment joint venture (SEJV) with four other nations that make up the International space station (ISS) several experiments are being carried out to understand phenomena that affect mankind on earth and that can affect mankind who are embarking on further space expeditions into new frontiers such as colony creation on exoplanets and other satellites within our solar system.

Therefore, while the aim for pursuing space exploration remains the need to meet immediate and long term needs of the African continent, the objectives should be well spelt out to include in its core self-sufficiency and allied technologies required for space exploration, improving livelihoods of citizens across the continent through utilization of space based products and services and industrial competitiveness [7]. The challenges facing the African continent are fairly general and can be said to include poverty, insecurity, desertification, disease, illiteracy, resource mismanagement, accelerated climate change etc. these problems cut across time

zones and regional classifications[8], thereby making a combined solution to the problems are viable proposition for multiple states to tackle.

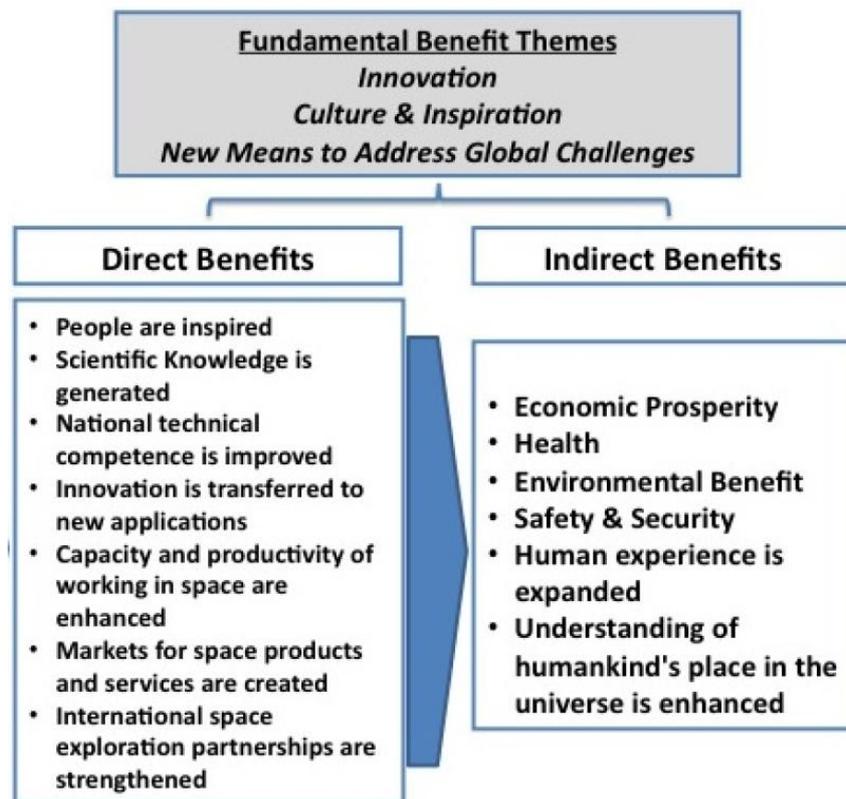


Figure 1: Benefits of Space Exploration (courtesy [5])

In summary, Fig.1 gives a concisecategorization of the benefits Africa stands to gain from a robust and collective embrace and application of space exploration and its technologies.

The highlighted items in Fig. 1 show an almost all encompassing reach of the benefits of space to nations that adopt this technology.

1.1. Location and coordinates

Africa is nestled between the Atlantic and the IndianOceans (see Fig. 2). Its relative position from the most northerly point, Ras ben Sakka in Tunisia, at 37°21' N, to the more southerly point, Cape Agulhas in South Africa, 34°51'15" S, is a distance approximately of 8,000 km (5,000 mi); from Cap-Vert, 17°31'13"W, the westernmost point, to Ras Hafun in Somalia, 51°27'52" E, the most easterly projection, is a distance (also approximately) of 7,400 km (4,600 mi)[9].Africa also contains six different time zones from the most westerly point in cape Verde(UTC/GMT-1) to the most easterly point in Reunion, Mauritius and The Seychelles (UTC/GMT+4)[10]

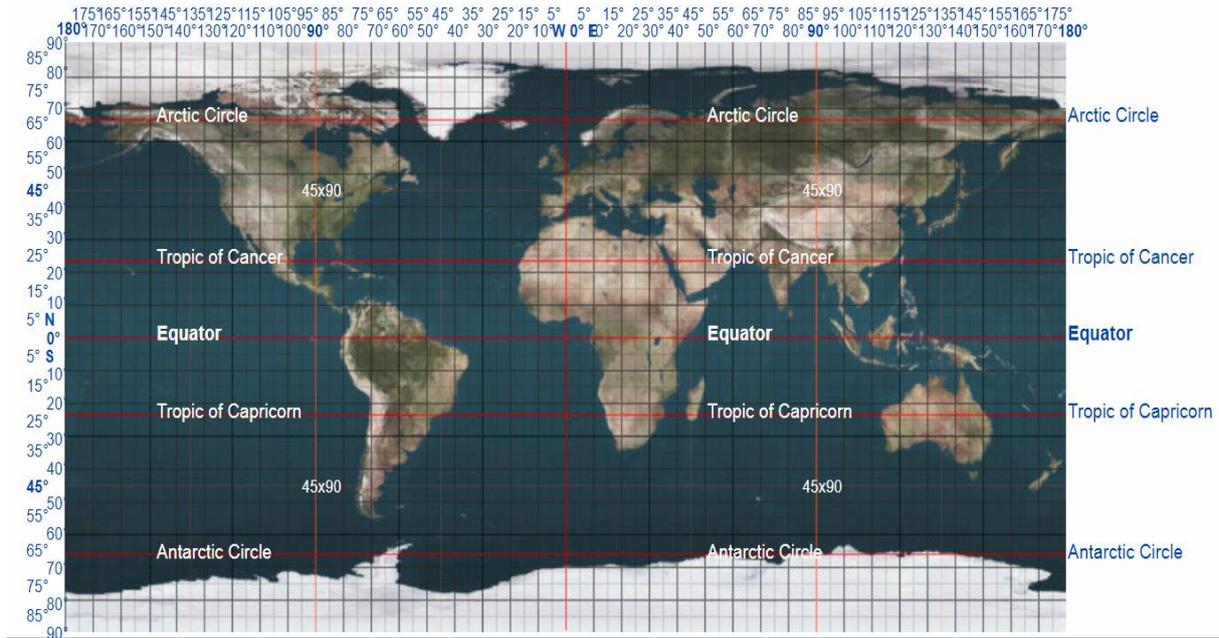


Figure 2: Circles of Latitude and meridian [source [11]]

It can also be seen that Africa has the unique advantage of having the global datum null coordinate which lies just off the Gulf of Guinea. Africa is very well positioned for continent wide satellite systems that can cater for many of its pressing needs and challenges.

The organization of the remaining paper is as follows: Section two discusses the proposed methodology for implementation of an African space agency, section three looks at the possible working structure of such a space agency by itemizing the various workgroups and a brief summary of their functions, section four addresses the affiliation and finally the paper concludes in section five.

II. SPACE INDUSTRY: AMETHODLOGY FOR AFRICA

There is no global consensus as to what entails the space industry. However, different countries and organizations have given their own unique categorization. One such categorization from the Space Foundation shows four categories: satellite services, launch industry, satellite manufacturing and ground equipment (see Fig. 3). The Groupement des Industries Françaises Aéronautiques et Spatiales (French Association of Aeronautics and Space Industry-GIFAS) divides it into three categories: space systems manufacturers (satellite industry), propulsion systems manufacturers, and equipment manufacturers [7].

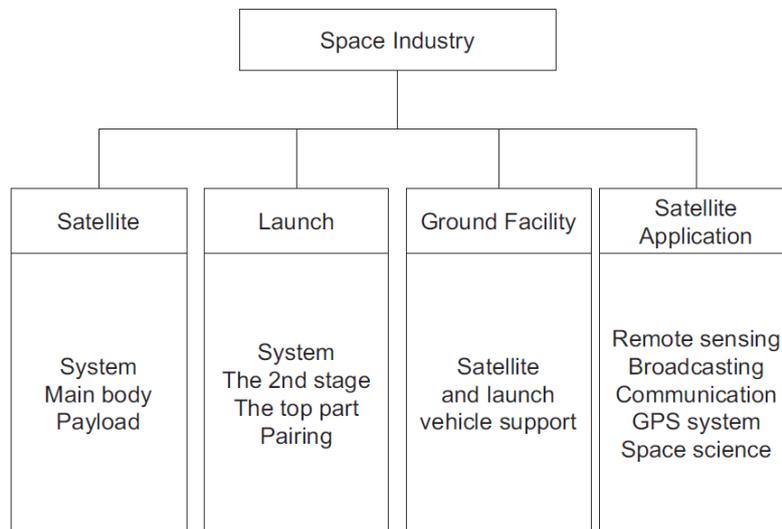


Figure 3: Aerospace Industry categories [7]

2.1 Drivers for Africa's Space Industry

Utilizing ESA template for an African Space Agency, recognition must be made of the role played by business and economic cooperation, made possible through the framework of the Economic union of the European Union (EU). This business and monetary union forms an integral component for the actualization of the goals set for ESA. The ability to allow for free trade between participating European nations in the EU is the glue that makes possible a continent wide space agency of shared responsibility and benefits[6].

While Africa has a political union in the form of the African union (AU), there is no currently existing continental economic union. Nonetheless, recent happenings point us to the direction of the formation of such a union. The much talked about African free trade zone agreement (AFTZA), has gained much media attention and governments in Africa are also following through with the ratification of the African continental free trade area (AfCFTA). AfCFTA was agreed to in March of 2018 after about six years from its year of inception in 2012 to the start of the negotiations in 2015. It has so far been agreed to by 44 of the 54 nations in Africa, with ten nations withdrawing their accent at this time [12]. On the 7th of July 2019, AfCFTA would come to market, implying a single market for goods and services for more than 1.2 billion people across the Africa continent.

Such an agreement if fully implemented could form the basis for a thriving economic union that should see a space industry as a necessary component of the AfCFTA. The African space industry in this case providing the needed continental services that would drive the efficient workings of communication, weather, terrestrial and maritime security and a host of other services. Countries within the AU having experience in space could create a nucleus around which an African space agency will be built to bolster the aim and objectives of AfCFTA framework. As the AfCFTA kicks off in earnest, satellite services will play a major role in bridging the entire continent and fostering the goals for which such an agreement was inked which are cooperation, development, acceleration of growth, improved integration and eventually the creation of a single customs union [13-14].

Therefore, it would seem that Africa is charting a similar trajectory to the EU in terms of greater economic advantages for its people. Africa could as well follow suit with the formation of a continent wide space agency that caters for the needs emanating from such a huge and immensely beneficial agreement. Next, this paper proposes some extra specifics to the structure of the proposed space agency by identifying a possible structural composition of the agency.

III. WORK GROUPS AND UNITS FOR AN AFRICAN SPACE AGENCY

In seeking a workable solution to such an African space agency, the idea for such a venture must be agreed to and sanctioned by all the participating countries. In the strictest definition of a Joint venture, all the countries must setup working groups to carry out proper evaluation and research on the viability of such a venture and the various aspects to be contributed to by participating countries[16]. Some of the working groups(WG) which this paper proposes are the following:

1. Launcher WG
2. Launch site WG
3. Satellite development WG
4. Equipment manufacture WG
5. Frequency coordination WG
6. Ground station WG
7. Academic and cultural affairs network WG

3.1 Launcher WG

The launcher WG will be tasked with the coordination of all activities that pertains to development of launchers and rocket engines for conveying the payload into space. Although this is strictly dual use technology, the agreements to be crafted would ensure that all legal angles are considered to avoid degeneration of the primary use of the developed technology into malignant offensive uses or the acquisition of such technology by belligerent state or individual actors.

3.2 Launch site WG

The launch site WG will be tasked with identifying viable and practical launch sites on the African continent. Already, the location of Africa ensures that a wide expanse of water can be found in both the western and eastern sea board. With counties bordering both the Atlantic and Indian Ocean being prime candidates for suitable launch sites. Already Kenya has a launch agreement with Italy where offshore launch facility was built and operated by Italians and used for launch of small payloads. Other nations in the Indian Ocean such as Madagascar, Mauritius and Seychelles can also be considered for this leveraging their proximity to the equator and favorable equatorial assist during rocket launch.

3.3 Satellite Development WG

Satellite development WG will probably be one of the more ubiquitous and widespread as any nation with proven capacity and expertise should be enlisted to contribute their quota in this regard. Various types of satellites and satellites parts can be manufactured and later assembled in a central assembly facility. Similar to what is done by Airbus on the European continent where parts are built in several countries before final assembly in France, a similar template might be adopted after studying the strengths of various countries.

3.4 Equipment manufacture WG

Equipment manufacture WG will be tasked with the development of space certified equipment to be used onboard the launchers and spacecraft's such that the need for sourcing these equipment pieces abroad is remarkably reduced. Some of the satellite equipment to be manufactured include will include those that are already within manufacturing and technology readiness on the African continent or where needs be such potential should be developed. This obviously will have the cascading effect of being a market multiplier and creator of new jobs. Equipment to be manufactured will have to meet space certification test standards and where necessary be sourced from outside the African continent.

3.5 Frequency coordination WG

Frequency coordination WG will be tasked with frequency coordination in line with ITU requirements. This group will be comprised of experts and radio frequency specialist. They will be charged with holding consultation with ITU to decide allocation of bandwidth and orbital slot considerations such that interference with other satellite operators is minimized.

3.6 Ground station WG

This work group will have a mandate to scout for the ideal locations for satellite ground stations on the African continent. The group will also be tasked with considering ground station relays where switching of control is embarked upon by the various countries along the flight path of the satellite. For communication satellites the ground stations will be so placed as to rest within the satellite signal footprint.

3.7 Academic and cultural affairs network WG

This work group will be perhaps form the nucleus of the all activities that underpin the proposed African space agency. A review of academic curricula across higher institutions on Africa will be made to ascertain the level of expertise and human resource available to the various areas of specialization to be had in any space agency. The pool of experts to be drawn from the academia and research institutes should be such as to compliment any lack of expertise in any of the participating nations. This WG will have to ensure that a healthy network of academic and industry experts are constantly in touch and meet on a regular basis in conferences that will be used to showcase and highlight the direction of stated objectives. Being able to properly link the scientific program and its results with a robust applications program (as was the case with the ESA [6-Krij]) is key to a successful African space agency. Some insights on the role knowledge based economic drivers such as space research and exploitation gives to any nations can be seen in the facts and figures of the Nigerian space agency with a steadily growing number of experts in various fields[15]

IV. AFFILIATIONS AND COLLABORATIONS

When the need for an Africa-wide space agency is considered, global trends must be at the forefront of the adopted strategy for implementation. What is seen in almost every case where nations have begun with state owned and controlled space agencies, they have invariably and ultimately transited to some form of collaboration with privately owned firms and businesses that are beginning to takeover certain aspects of the traditional space technology monopolies. Such partnerships are sometimes drawn up as part of public private partnership (PPP) agreements [16].

Understanding the terms and limits of the PPP is vital for any such future collaboration. PPP agreement defined by Basic Joint Venture Model document of the European union and broadband as "a long-term, contractually regulated cooperation between the public and private sector for the efficient fulfilment of public tasks in combining the necessary resources (e.g. knowhow, operational funds, capital, personnel) of the partners and distributing existing project risks appropriately according to the risk management competence of the project partners".

In addition, the Basic Joint Venture Model document describes four main characteristics of PPP:

- i. efficiency gains through appropriate sharing of risks and responsibilities; the public sector retains mainly sovereign tasks and the private bears those for implementation;
- ii. lifecycle and private investment as crucial elements of PPP's incentive structures;
- iii. long term contractual relationship; and

- iv. Innovation, in particular through output specification, service levels and payment mechanisms, as a new way of describing the services to be supplied.

For the long term future of Africa's space program, private enterprise must be encouraged and assisted where necessary to take up provision of some of the aspects of space technology. This will build stronger economies and help the long-term sustainability of Africa's space endeavor. Further, there are complicated issues that would need to be discussed towards ensuring an effective African space agency. For example, which nations get favored the most from the proposed African space collaboration? Various nations that would make-up the proposed African Space Nations have made varying investments towards building and acquiring space capacity. Hence, the question of which nations get to compose the critical mass of human and infrastructural resource being supplied to the collaboration/union must be worked out. Some countries on the African continent like Nigeria, Algeria, South Africa has over the year's garnered huge human capital in space sciences and engineering, while some nations expected to be a part of the union are yet to have any form of space policy, agency or related institutions. Again looking to the ESA model, we have seen the European Space Agency strengthen some institutions within its member nations with its procurement capital more than others. A major determinant factor is the technological advancement and capability of these nations to deliver often complex space-engineering systems on behalf of ESA. Along similar lines, the African space agency would need to find means to resolve such complications, which are far from straightforward, within its member nations.

V. CONCLUSION

Need analysis of the African continent shows there are common challenges spread across wide areas of the continent that are not localized to national borders. Some of these issues include health and disease, security, desertification, drought and water management, information technology, education, which are still begging for answers and viably sustainable solutions that are home grown and repeatable across different countries in Africa. Satellite technology offers an easy and optimal way to meet many of these challenges at reduced cost in the long run. However satellite technology is expensive and out of the reach of many African nations at this time. This paper has proposed a synergy that will leverage on Africa's location, size and human resource to create a continent-wide space agency that can serve to meet the identified needs in a process driven and well thought-out way.

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