East African Communications Organisation

Communications for all in East Africa

EACO CUBESAT PROJECT

CONCEPT PAPER

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Acronyms

EACO	East African Communications Organisation
EAC	East African Community
STI	Science, Technology and Innovation
ITU	International Telecommunications Union
SDG	Sustainable Development Goal
UN	United Nations
UNOOSA	The United Nations Office for Outer Space Affairs

EACO East African Communications Organisation

Communications for all in East Africa

1. Introduction

The East African Communications organization (EACO) is a regional organization that brings together the National ICT regulators, operators in the telecommunications, broadcasting and postal sectors as well as ICT institutions in the East African Community (EAC) member states of Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda.

The broad objective of EACO is to strengthen and promote cooperation among the Member States through the development and provision of telecom, postal and broadcasting services in East Africa. In order to achieve this objective EACO coordinates various regional program and projects aimed at the development of the communications sector in the region. The projects and programmes enhance regional integration through collaboration by the key stakeholders in the region and mobilizing resources for those programmes.

EACO developed a five-year strategic plan from 2018-2023, intended to ensure that EACO embarks on activities that are in line with its objective. Implementation of the EACO CubeSat Project is one of the key deliverables of the strategic plan.

The EACO CubeSat project is aimed at laying strategy for innovation and investment in the Space sector by the EAC members. CubeSats are low cost satellite commonly used for applications such as education programmes, climate monitoring disaster management, tracking and logistics, among others.

This concept paper presents a proposal for the regional CubeSat project, it describes the project, sets out the rationale, lists the stakeholders and provides the design and cost estimate of the project. It also provides a sustainability plan as well as Monitoring and Evaluation techniques.

2. Project Description

2.1 Objectives of the Project

The main goal for this EACO CubeSat project is to plant a seed for innovation and investment in the Space sector in the EAC region. The project will demystify satellites by demonstrating how some of the needs can be met using lean satellite[1] technologies (CubeSat). For so long, satellite technologies have been explored by a few countries, due to the high investment required for

[1] Prof Mengu Cho defines a lean satellite as a satellite that utilizes non-traditional, risk-taking development and management approaches – with the aim to provide value of some kind to the customer at low-cost and without taking much time to realize the satellite mission.

establishing a satellite network. For example, a traditional Broadcasting or communication satellite costs approximately US $500 million[2].

With the evolution of lean satellite technologies, it is now possible to design, assemble, test and launch a satellite with a budget of approximately US $350,000.

The specific objectives of the CubeSat project are;

a) To build technical capacity on lean satellite and space technologies in the region

b) To raise awareness among decision-makers, on lean satellite and space applications

c) To facilitate innovation and research to enable the region to develop satellite technologies

d) To spur the use of space technologies in the region by leveraging spatial data utilization in different sectors such as agriculture, environment, disaster management, and others.

e) To encourage local and international investment in space technologies benefiting from economies of scale and local professionals.

2.2 Outputs of the Project

The following outputs are expected from the EACO CubeSat project:

a) Launch and operate one regional CubeSat;

b) 30 local professionals trained (at least 5 per Each EACO member country);

c) Convene a regional workshop to raise awareness in space technologies focusing;

d) Convene one policy round table conference for CEOs/DG of Regulatory Authorities, EAC secretariat, EAC Ministers who have Space sector in their portfolio; and

e) Availability of spatial data for regional stakeholders such as academic institutions, relevant government agencies.

2.3 Scope of the Project

EACO CubeSat project will focus on the following:

a) Defining the mission,
b) Designing and assembling,
c) Testing and launching,

[2] Bernard Fox et. al, Guidelines and Metrics for Assessing Space System Cost Estimates, 2008 https://www.rand.org/content/dam/rand/pubs/technical_reports/2008/RAND_TR418.pdf

d) Operating and,
e) Data utilisation of the CubeSat.

In order to stay within a reasonable timeframe and budget, the project will not include the acquisition of a ground station for control and telecommand. It is recommended to access the payload data via an existing ground stations from the partners in the region or beyond.

3. Project Rationale

3.1 Regional Social-Economic Analysis

The EAC is composed of six member countries whose population is estimated at 150 million, of which 78% live in rural areas depending mostly on Agriculture for their livelihood. The land area is estimated to 1.82 million square kilometres with a combined Gross Domestic Product of US$ 146 billion ***(EAC Statistics, 2016).***

3.2 Problem to be Addressed

The social-economic and geographical situation of the region described above raise an inevitable need for satellite technologies in order to reach all corners of that immense territory and to provide innovative ways for addressing key challenges of important sectors such as Agriculture, Health, Environment & Natural Resources, et cetera.

Despite Agriculture being the region's leading economic contributor, there is inadequate geospatial data for agricultural planning. There is a need to map agricultural in the region and define areas with excess or insufficiency and strategize accordingly. Within the primary sector, natural resource and environmental management is hampered by inadequate spatial data.

Though space technologies can provide solutions to the above mentioned challenges, they are considered expensive coupled with limited technical skills to design and build satellites.

3.3 Regional Development Strategies and Policies

The Strategic Development Direction for the EAC (2016/17 – 2020/21) highlights seven (7) key priorities including the improvement of agricultural productivity.

The same development strategic articulates eleven (11) strategic objectives to be attained in five (5) years. Among those strategic objectives the following are worth highlighting:

a) accelerating and consolidating sustainable production, productivity, value addition, trade and marketing in key regional growth and productive sectors – with emphasis on rural development, agriculture, fisheries, livestock, food and nutrition security, and high value industrialization.
b) increasing investment in Science, Technology and Innovation (STI), as key drivers and enablers of sustainable regional development and socio-economic transformation, as well as creating an enabling environment for their application

c) enhancing regional mechanisms and strategies for ensuring sustainable natural resource utilization and conservation, environmental sustainability and climate change management.

At the African Union level, the Space Strategy **(*African Space Strategy, Oct 2017*)** recognizes that space-based solutions are necessary for the effective management of resources such as water, forests, marine ecosystems and the use of agriculture. Given this reality, it is inconceivable that so many of Africa's space-derived services and products are imported. In this context the African space strategy intends to advance an indigenous space sector and provides direction for a formal African space programme. The strategy is aligned to Africa's aspirations and is premised upon the following core principles:

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

At the global level, the United Nations (UN) has defined Sustainable Development Goals (SDGs) for ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity. The SDG No.9 recognizes Investment in infrastructure and innovation as drivers for economic growth and development; SDG 17 ensures that through partnerships among different entities and organs, projects such as the EACO CubeSat provide a platform for partnership among African countries for sustainable development.

3.4 Justification for the Project

Space Industry is currently valued at around US$ 360 Billion and is estimated to grow to US$ 1.1 Trillion by 2040[3]. This is a market that our region and African continent in general cannot continue to ignore.

Space technologies can significantly contribute and accelerate the achievement of the strategic goals mentioned above especially in the Agriculture sector and exploration of natural resources. CubeSat can be equipped with sensors which can be used to map strategic agricultural products as well as natural resources of the region to inform decisions for those sectors.

[3] *https://www.morganstanley.com/ideas/investing-in-space*

The CubeSat project will therefore constitute a first step and a trigger for developing Space technologies in the region by creating a pool of experts in the entire value chain of space and raising awareness among EACO members, and policy makers in the region.

4. Stakeholder Analysis

4.1 Project Organisation

The executing team for the project will be headed by a project manager supported by a task group composed of professionals pooled from the member states and research partners. This arrangement will ensure a good knowledge foundation and practical experience is established in the region on CubeSats and other space based technologies which will form a talent pool for future space projects. The role of the project team is described below:

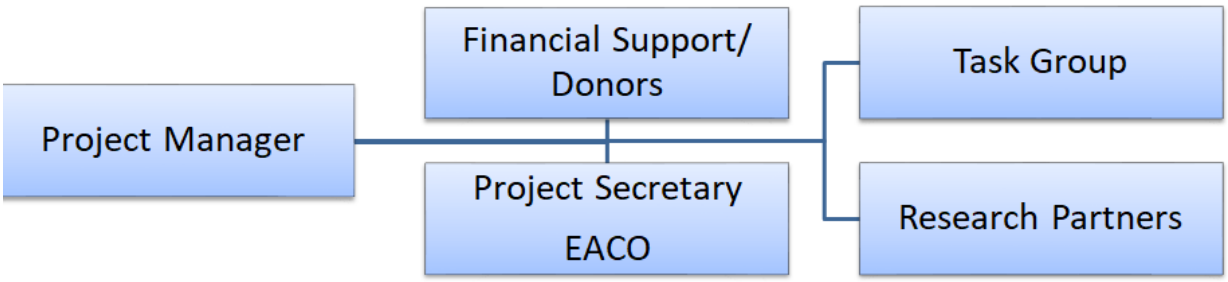

Figure 1: Project Executing Team

4.2 Project Manager

For efficient implementation of this project, EACO secretariat will employ a full time project manager with proven qualifications and good knowledge base in satellite technologies in general and in-depth experience in CubeSats. The responsibilities of the project manager will include the following:

a) To provide project leadership and coordination.
b) To manage project finances and resources.
c) To be the project focal point for communications with EACO secretariat and other partners
d) To perform project monitoring and evaluation and submit reports to EACO secretariat
e) To perform other duties as may be assigned by the secretariat.

4.3 Project Secretary (EACO Secretariat)

The role of the project secretary will include the following:

a) To share the project concept with members and stakeholders.
b) To identify potential funding sources for the project

c) To mobilise funds for the project.
d) To recruit and supervise project manager and research partner.
e) To constitute a task force with members seconded by the partners from the region.
f) To coordinate and facilitate awareness activities on CubeSat and space-based technologies in the region.
g) To perform other administrative tasks necessary for the success of the project

4.4 Financial Support/Donors

The sources of funding for the project will include contributions from member states and Industry. Other sources of funding could include donations solicited from development partners as well as utilization fees from consumers of the services that will be delivered by the CubeSats.

4.5 Task Group

The task group will be composed of two (2) representatives from each member state for the project duration whose responsibilities will include;

a) To define the mission of the CubeSat .
b) To contribute towards the design, assembly and testing of the CubeSat
c) To work with the researcher and the project manager for registration and other required legal processes with the International Telecommunication Union (ITU) and The United Nations Office for Outer Space Affairs (UNOOSA).
d) To support EACO secretariat during awareness workshops and sensitization activities in the region.
e) To develop expertise in space technologies to enable future regional projects.
f) To perform other tasks necessary for the success of the project

4.6 Research Partner(s)

The secretariat will seek the participation of expert(s) experienced in the design, construction and launch of CubeSats whose tasks and duties will include the following:

a) To give technical assistance and leadership to the task force in the implementation of the project.
b) To lead design, simulate, test, build and launch the CubeSat.
c) To ensure the right components are sourced for the project.
d) To involve the task force at all stages of the project cycle and gain all the practical skills necessary.
e) To perform other tasks necessary for the success of the project

5. Project Management and Implementation

CubeSats are commonly put in orbit by deployers on the International Space Station, or launched as secondary payloads on a launch vehicle. Over 1000 CubeSats have been launched as of January

2020. Over 900 have been successfully deployed in orbit and only 80 have been destroyed in launch failures.

5.1 Design & Implementation of the EACO CubeSat

5.1.1 Key Notables

a) CubeSat projects are usually technology demonstrations aimed at testing in-house developed technology, needed for visual earth observation.

b) 18 months proposed development time: 1st July 2020 – 31st December 2021

c) Development of the satellite, including design, integration and testing.

d) Notification to relevant Authorities and fulfilment of license requirements

e) Partners to be requested to support ground operations

f) Matching with the ISS plan of activities (negotiated with launch partner.)

g) Therefore, two main design drivers are followed:

- Simplicity of the on-board system, guaranteeing basic functionality;
- Choice of on-board components based on "commercial off the shelf" technology

h) To perform experiments - on-board power and attitude control system

i) The CubeSat size will be defined depending on the mission

j) Optical Payload in visual band to capture images of the Earth

k) Ground Station operation to be supported by partners

l) The primary mission goal is to build capacity in space technologies.

m) The secondary objective is the acquisition, store on-board, and transmission to ground stations of images of the East Africa region, where the interest of EACO lies for the Earth Observation applications in terms of agriculture and coastal areas monitoring.

5.2 Communication Aspects

To consider the S- band for payload and V/UHF for command and control

a) Coordination required for frequency spectrum

b) Tentative Launch date: 1st February 2022.

c) Planned altitude and Orbit: 400-409 km.

d) Proposed Earth Command Station Location: EACO HQ, Kigali

5.3 Mission Operation

5.3.1 Phase 1

a) Data about the on-board system performance is gathered by transmitting the system telemetry data to the ground station,

b) Assessment of the performance of the components.

c) CubeSat transmits a Beacon signal containing telemetry data every minute.

d) The CubeSat starts its nominal mode based on a passive magnetic attitude stabilization:

e) Telemetry is stored on-board and downloaded to ground upon command to verify the health-status and performance.

5.3.2 Phase 2

The second nominal operation mode, activated by specific command from ground,

a) Regular data collection and transmission to the ground station.

b) After 2 years of nominal operations, the CubeSat is de-commissioned: discharging of batteries, reaction wheel desaturation, camera switching off.

5.4 Stages of CubeSat Development

Table 1: Stages of CubeSat Development

Stage	Time (Months)	Tasks
Management	12	Planning, Capacity Building, Notification & Licensing
Design	4	Preliminary & Critical Design Review
		Acceptance Review
		Interface and Safety Review
		Compatibility Review
Procurement	3	Purchase & delivery of Off-the-Shelf components
Integration	4	Assembly of components
Testing	3	Communications test
		Telemetry, batteries and Photovoltaic tests
Launch	4	Standard CubeSat Deployer
		Transport to ISS and Launch

5.5 Estimated cost

The estimated cost is **$ 350,000.00**, a breakdown is as follows is tabulated on Table 2 below:

Table 2: Estimated Cost

Stage	Time (Months)	Tasks	Estimated cost in USD
Management	12	Planning, Capacity Building, Notification & Licensing	60,000
Design	4	Preliminary & Critical Design Review	40,000
		Acceptance Review	
		Interface and Safety Review	
		Compatibility Review	
Procurement	3	Purchase & delivery of Off-the-Shelf components	130,000
Integration	4	Assembly of components	20,000
Testing	3	Communications test	60,000
		Telemetry, batteries and Photovoltaic tests	
Launch	4	Standard CubeSat Deployer	40,000
		Transport to ISS and Launch	

6. Sustainability of the Project.

Sustainability of the project is premised on the following aspects:

a) Member states should ensure that funds are available for the project by supplementing donor contributions and any other sources of funds.
b) Commitment of member states and partners in supporting the project progress and sustainability.
c) Continuous monitoring and evaluation with regular reports and review of the project performance.
d) Capacity building, knowledge-transfer and technical training on the project will help in ensuring continuity of the project in the absence of donor technical support.

7. Monitoring and Evaluation.

The monitoring and evaluation procedures for the CubeSat project will enable the project manager to ensure the objectives of the project are met in a timely manner and within the planned budget.

The project manager will regularly monitor the progress of the project and work to meet the mission objectives and submit the reports to the EACO secretariat.

7.1 Evaluation

Evaluation will consider the following questions: -

a) Did the CubeSat project meet the overall objectives?
b) How valuable are the outcomes to the region, stakeholders, and partners?
c) Was the project cost effective? i.e. Cost-benefits analysis.

7.2 Tools for Monitoring

The tools used for monitoring may include the following:

a) Technical documents of the CubeSat components.
b) CubeSat test results
c) Project implementation plan;
d) Documented procedures, agreements and contracts.
e) Quarterly project performance review report.

7.3 Project Milestones

The EACO CubeSat project will have the following milestones: -

Table 3: Project Milestone

Milestone.	**Deliverable**	**Timeline**
Project plan.	Gantt chart with: Detailed activities, Resources, Budget, Timeline	4 Months
Design	Engineering diagram showing all the subsystems of the CubeSat	3 months
Assembling the Engineering model	Exact copy of the CubeSat for the purpose of testing before building the actual CubeSat	2 Months
Assembling the Flight model	the CubeSat to be launched	3 months
Flight model shipment for launch	the CubeSat is received by the launcher	4 months
Establishing the communication	the CubeSat receives command from the ground station and responds	1 months

with the ground station		
Establishing access points for the payload	every country has an access facility for receiving CubeSat data	2 months

8. Risks Analysis

The identified risks that might affect the EACO CubeSat Project and proposes mitigation measures to be taken are as tabulated below:

Table 4:Risk Analysis

Risk Event	Rating	Mitigation Measures
Limited involvement of all EAC member states in the Project	Major Risk	To raise awareness among decision-makers within the EAC from the start of the project
Failure to get support from the right project partners	Major Risk	• Constant follow up and engagement with identified project partners • to involve high level officials from EACO members countries in discussion with the partners
Failure to secure enough funds for the project	Major Risk	• Involvement of decision makers and top level leadership from the start for the project funding approval • Look for alternative sources of funding from donors and development partners early on • Ensure proper budgeting prior to start of the project
Inconsistent participation of technical team from all member states	Minor	Seek formal commitment from members states appointing representatives to the task group.

9. Recommendations

For the success and sustainability of the project and for future developments, the following are recommended for EACO;

a) To develop a regional space strategy;

b) To seek and foster collaborations with international organizations on space technologies such as ITU. UNOOSA, among others;

c) To encourage member states to develop their national space policies;

d) To explore more regional space projects; and

e) To submit the CubeSat concept paper to other relevant entities such as EAC and the council of EAC ministers for their consideration.