NATIONAL SPACE RESEARCH AND DEVELOPMENT AGENCY,ABUJA NIGERIA.

TITLE: **EBELESAT 1**

PRIMARY POC: **KIO MICHAEL.T.E.**

ORGANIZATION: **NATIONAL SPACE RESEARCH AND DEVELOPMENT AGENCY, NIGERIA.**

NEED

"Determining the Magnetic, Electrical and Space Weather Effects in the Equatorial Plane"

MISSION OBJECTIVES.

- To study magnetic field intensity and other space weather effects in the equatorial plane.
- To educate Nigerian students and engineers in space technologies and space system engineering thereby increasing the general interest in space projects.
- To enable Nigerian students and engineers undertake research in space experiments in their immediate neighborhood and to design and build Nano satellites to address such concern and interest.
- To enable Nigerian students and engineers design and implement Nano satellite Ground stations and launch systems of a Nano satellite with the purpose to provide "hands-on" education and gain experience with Nano-satellite technology.
- To Enable Nigerian students, research institutions, universities and scientists, Network in the development of Nano satellites and understand the principles and benefits of Nano-satellite constellation System.

CONCEPT OF OPERATION

Ground Segment: **EBELESAT 1** will operate on the ground facility positioned in Abuja. This satellite will employ a full duplex dual-band communication system using designed radio systems. Uplink takes place in the UHF band with a 4 kbps GMSK receiver connected to a circularly polarized quad-canted monopole antenna system. The primary downlink is in the space-research science S Band, using a variable data rate transmitter capable of rates between 8 and 1024 kbps, with BPSK or QPSK modulation, as set by the Main OBC. The project team of **EBELESAT-1** will operate an amateur-band ground station. A 4 kbps UHF transmitter will also be present for back-up purposes.

Satellite operation/control and the acquisition of telemetry data such as experimental data will be conducted by the Center for satellite Development Technology NASRDA. The ground station of NASRDA will be supporting telecommunications with the satellite using S-band frequencies.

Space Segment : **EBELESAT 1** is a cube measuring 20 x 20 x 20cm with a mass of 10-kg. Since the satellite carries many instruments and experiments, an aluminum 6061- T6 tray-based design was chosen to simplify assembly and integration. A large majority of EBELESAT **1's** internal components are directly mounted to the tray, as are most of the body panels that enclose them. Externally, four aluminum rails act as contact surfaces with the deployer. The thermal design of **EBELESAT 1** follows a passive thermal control strategy. Computer modeling and simulation will lead to prudent material selection and placement of components as well as selection of external surface treatment. The thermal control strategy will be designed to be effective over a wide range of orbits. **EBELESAT 1** will rely on forty solar cells spread over its surfaces to generate power. In eclipse, power is drawn from a rechargeable 10 A-h lithium-ion battery. Direct energy transfer will be used to enable the 4 to 15 W of generated electrical energy for use by the various subsystems. We are envisaging an EOL of 3months but the satellite can stay up to four years. Power will be disseminated via an unregulated power bus, which nominally will operate at 8 V.

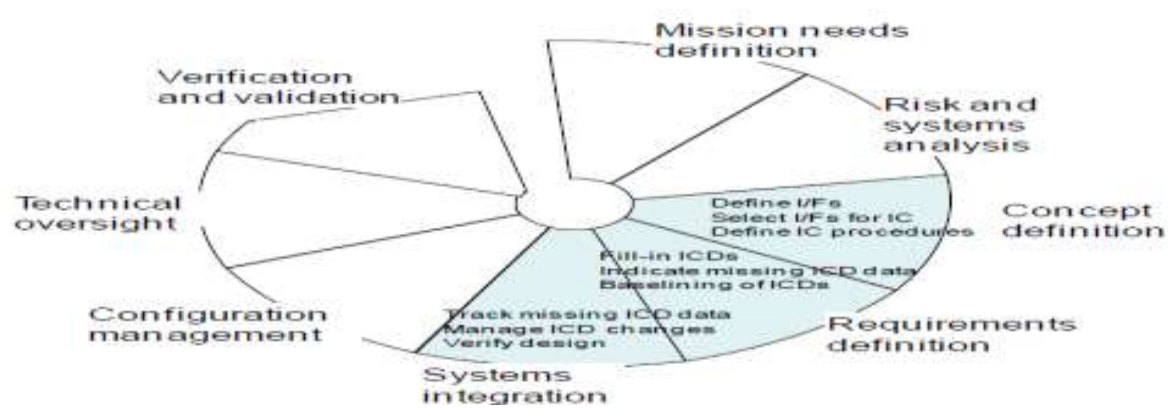
In Nano-satellites, the EPS design is a very important factor because of the limited available surface area. Several methods such as EPS analysis this will be employed to confirm the feasibility of the satellite system. An EPS and interface simulator will be developed to examine many electrical power control parameters. There will be future analysis of power generation considering sunlight angle, sequential power analysis like power consumption, power generation, battery discharge etc.

Attitude determination and control of the satellite
Centers on a conceptually simple system.(Make it simple). Determination, with an accuracy of about ±1.5º, will be achieved using a set of six sun sensors, supplemented by a, three-axis, magnetometer, which is deployed approximately 20 cm from the satellite. Orbit-normal alignment, of the satellite's minor axis, will be achieved through simultaneous application of wheel bias and rate-damping control.

EBELESAT-1 will be equipped with two 32-bit based computers. The Main On-board Computer (OBC) will have 6 MB of low-power SRAM, normally configured as a 2 MB region with triple-mode error detection and control (EDAC) for single-event upsets that occur in LEO. 16MB of serial flash memory will be used to store application software and experiment data. Using the on-board peripherals and an off-chip quad-UART, the Main OBC interfaces with all the subsystems on EBELESAT-1.

LAUNCH: **EBELESAT I** nanosatellite will be launched into a 635km sun synchronous orbit with a 9:30 am descending node. The XPOD deployment system (single or triple) developed and found off the shelf can accommodate nanosatellites with a 10 x 10 cm cross section and 1 kg mass, but the new XPOD (GNB, DUO) is designed to accommodate satellites with the cross-section of 20 x 20 cm , for weighting up to 7.5 kg and 14 kg respectively. These 'XPOD' deployment systems have significant space heritage and have been successfully used to deploying several spacecraft. Therefore this system will be suitable for EBELESAT 1. The satellite will be mounted on an interface that will be attached to this deployment system. The launcher to be used is TBD. Since the satellite will be launched in constellation probably two at time proximity of the two satellites will be inevitable therefore uplink margins in EBELESAT1 UHF design will have to be sufficient to overcome the added noise input.

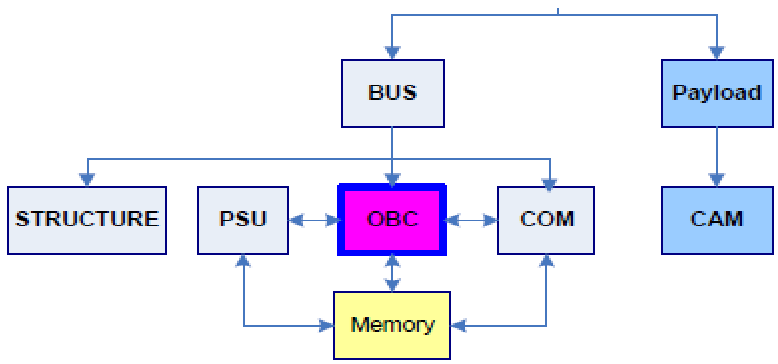
PRIMARY INTERFACES: Using the on-board peripherals and an off-chip quad-UART, the Main OBC interfaces with all the subsystems on EBELESAT-1. We will also consider how NASA considers IC to be applied throughout a satellite development cycle. The figure shows system engineering phases that can be defined within a satellite project. Within these phases several tasks are assigned to the interface controller and the level of involvement of the development team and external parties are defined. Although the NASA guidelines are a good starting point they have been adapted to a more reasonable implication for university satellite projects. As can be concluded from the shaded phases, IC efforts are not expected throughout all systems engineering phases. The different IC phases and tasks are summarized below.



PAYLOAD INTERFACE: The payload consist Magnetic and electrical sensor that protrudes outside the satellite but connected to its own board that transmits the signals to the ground station, with the payload board connected to the Bus, and interfaced with the OBC.

MECHANICAL INTERFACE: Since the satellite carries many instruments and experiments, an aluminum 6061- T6 tray-based design was chosen to simplify assembly and integration. A large majority of EBELESAT 1's internal components are directly mounted to the tray, as are most of the body panels that enclose them. Externally, four aluminum rails act as contact surfaces with the deployer.

ELECTICAL INTERFACE: The bus will provide the voltage for the functioning of the payload,OBC and altitude determination and control system, it will also be connected to the batteries during discharge period we are also proposing a kind of power distribution unit that will be embedded in the EPS Board, possible harness of the EPS and other subsystems using UART will be described in details during the main design. The interface of the satellite and launcher has already been explained earlier but of importance is that the satellite will be bolted and placed strongly on an XPOD which will have a release mechanism and be attached to the fairing of the launcher.



E.g. Diagramatic Interphase of EBELESAT 1.

KEY PERFORMANCE PARAMETER.

- The magnetometer and sensors are protruded outside the satellite to avoid magnetic influence in the satellite
- The use of constellation makes it possible for more DATA to be taken at the same time and everyday along the equatorial plane. For a sunsynchronous orbit, the satellites will be phased by 180° in the same orbital plane to make it seem as if the satellite is always present in the equator spanning the whole plane.
- The Xplod launch mechanism is chosen to avoid failure of release of the satellite to orbit.

ORBIT CONSTELLATION DESCRIPTION

Coarse Satellite -1	Coarse Satellite –2
a = 7098.137 [kms]	a = 7098.137 [kms]
e = 0.0 [Deg]	e = 0.0 [Deg]
i = 98.28 [Deg]	i = 98.28 [Deg]
Ω = 157.5 [Deg]	Ω = 157.5 [Deg]
ω = 0.0 [Deg]	ω = 0.0 [Deg]
M = 0.0 [Deg]	M = 180.0 [Deg]

ETC.

The Orbit for each satellite is choosen in such a way that the corresponding Q-factor
is 14 1/2 (N = 29 Orbits in 2 days). Equatorial crossing distance between two successive passes is D = 2780.0 kms. The two days ground track map with a single satellite is very possible. The gap between the two neighbour equatorial crosses is 1381.89 kms.

Orbit Characteristics	
Orbits Per Cycle	59
Repeativity (Days)	4
Semi major axis (kms)	7017.484
Inclination (Deg)	97.949
Ground track separation (kms)	679.238
Local Time (UT)	9:30

All the spacecrafts are separated with a separation of 90 deg in a same orbital plane. All spacecrafts plane angle wrt sun is 22.5 Deg for the local time selected.

The Rational for this selection is that there will be Data available every day since the revisit time is four days each of the constellation will downlink everyday at 9.30am local time.

IMPLEMENTATION PLAN

If this idea scales through and refined I am sure my organization will be ready to provide part sponsorship for the successful completion of this project because it will not only be a honor to our president (**EBELE**) and been among the best in space technology but it will bring the technology closer to the country which my organization is passionately pursuing this project will be a dream come through.

BUDGET AT COMPLETION: $2MILLION.

I am hopeful and sure after the success of the first the second will commence immediately and will be sustained.

FACILITIES/INFRASTRUCTURES

AIT HALL	ONGOING
SYSTEMS ENGINEERING LAB	ONGOING
DESIGN CENTER	ONGOING
LAUNCHER	NEEDED
LAUNCH SITE	NEEDED.

PROJECT ORGANIZATION

The Project is organized into the following subsystems

PROJECT LEAD Kio Michael.T.E,. **SYSTEM ENGINEERING, ATTITUDE AND ORBIT CONTROL SUBSYSTEM , ONBOARD DATA HANDLING SUBSYSTEM , PAYLOAD SUBSYSTEM, POWER SUBSYSTEM , STRUCTURE SUBSYSTEM , THERMAL SUBSYSTEM TT&C SUBSYSTEM ,PROPULSION SUBSYSTEM, RADIO FREQUENCY SUBSYSTEM, INTERFACE DATA CONTROL SUBSYSTEM.**

PROJECT AUTHORITY

Project authorized by the Director General National Space Research and Development Agency, Director Engineering and Space Systems (24Months), PROJECT MANAGER/LEAD (20 months), PROJECT TEAM (18months).Time schedule given by the DG of NASRDA.

PROJECT RISKS

- Readiness of the AIT/DESIGN Center: The agency will wish that the satellite is assembled, integrated and tested in our facility but the Non completion of the AIT/DC Center can pose a challenge.
- Activity Duration; Due to lots of holidays in the country the time and schedule of the project can be affected.
- Cost of Project: The cost of the project by the end of the year might have gone up due to instability in exchange rates.
- External Influence; The organizers of the project might not want to fund the project again due to reasons beyond their control.
- Internal Influence: People that are not qualified might be imposed on the project due to balancing diversity.

REFERNCES

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http://cubesat.org/images/cubesat/presentations/DevelopersWorkshop2009/1_New_Tech_1/3_Voronka-Orbital_Debris.pdf.

N/B. The Name EBELE is the current President of Nigeria who came into power by the Grace of God and Destiny.