

Nanosat Constellation for water monitoring system

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Exploring the Beauty of deep space

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Background

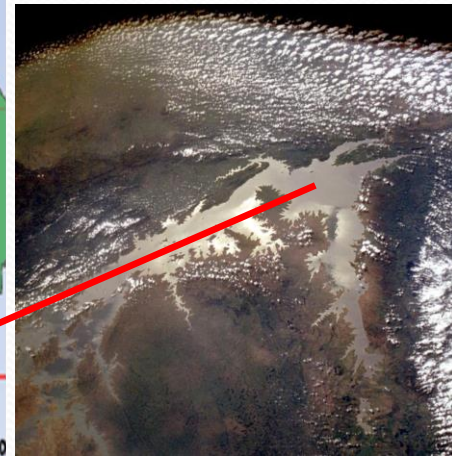
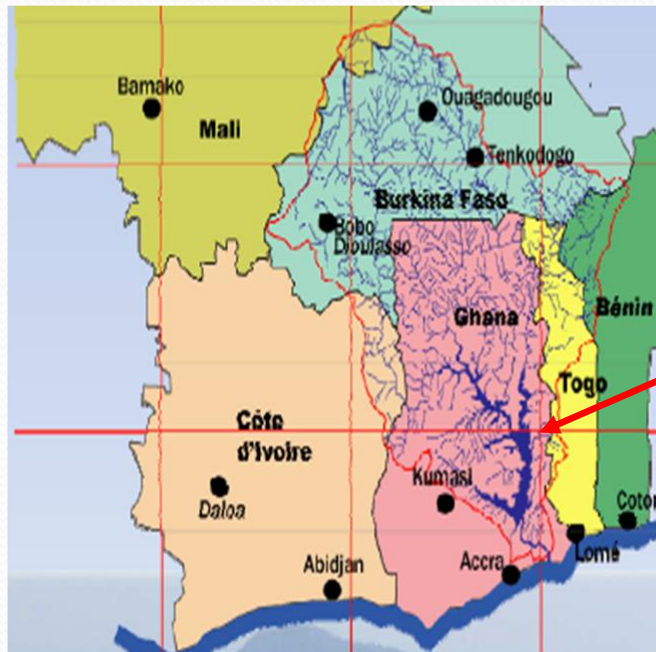
- ✕ Many people around the world living in communities near water bodies which serve as a source of generating income, nourishment and livelihood.
- ✕ Yet these communities are prone to dangers such as flooding and drought, a few of such communities include those along the Volta basin which extends from Ghana to Burkina Faso, Togo, Ivory Coast, Mali and Benin as shown in figures 1 and 2 .

River Volta Tributaries Distribution Among Countries.

Figure 1. The Countries with Tributaries of River Volta.

Country	% of Basin Area	% of Country
Benin	3.41	12.1
Burkina Faso	42.9	62.4
Cote d'Ivoire	2.48	3.1
Ghana	41.6	70.1
Mali	3.12	1.0
Togo	6.41	45.0

Figure 2. Area within Red boundary shows the Tributaries Distributions.



- ✗ Recently in Ghana the Volta Lake flooded and destroyed some communities along its bank as shown in figure 3 , the same lake suffered from a drought in 1970.
- ✗ Unfortunately the communities around the Waija Lake near greater Accra are at the mercy to the same sort of danger like the people of Volta Lake communities are facing.

Figure 3. Volta and Waija Lake flooded and destroyed communities.

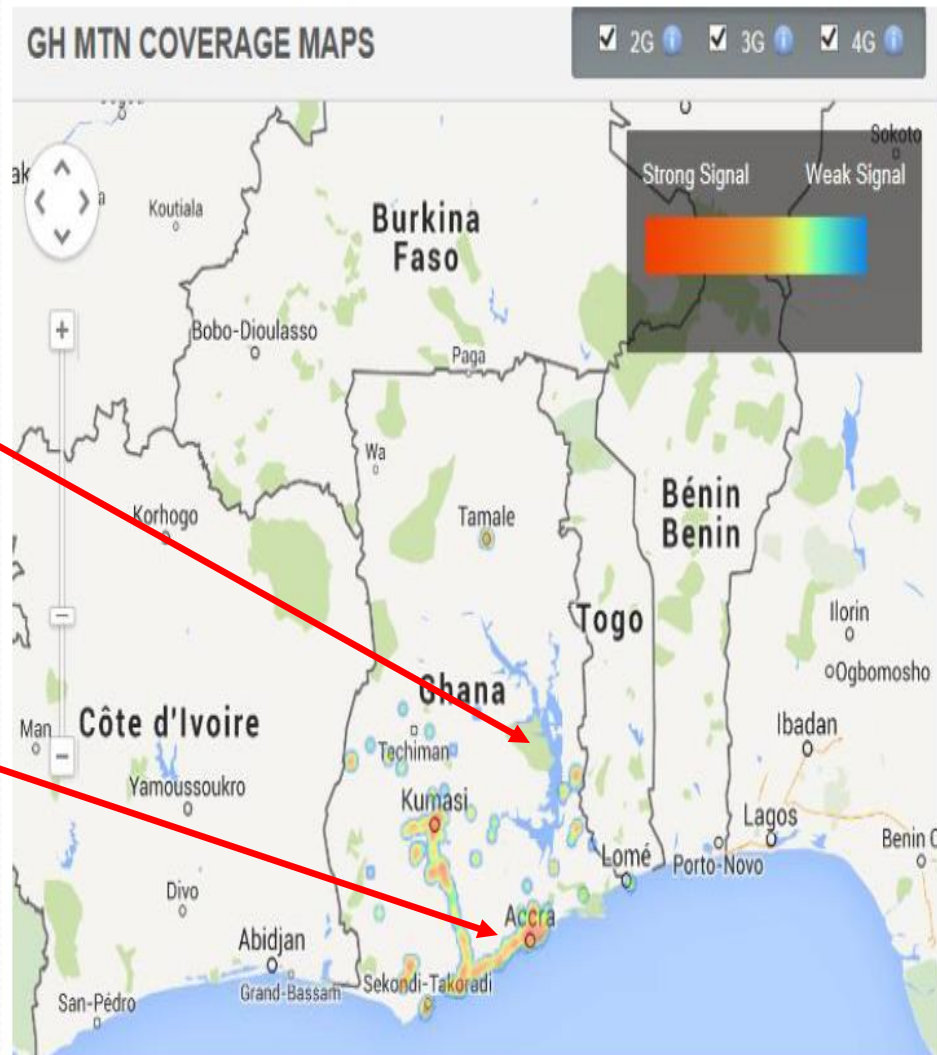




✕ On the 3rd of June 2015 a downpour flooded most of Accra and neighboring areas, these floods caused explosions at some petrol filling stations and over 200 lives were lost.

Proposed Solution To The Problem.

- ✗ Satellite System is the best method of solving our problem because unfortunately other wireless telecommunication systems such as mobile network signals are very weak and unreliable in areas such as Volta and some parts of Accra
- ✗ The Mobile network signal is weak at the Volta lake and is a flood-prone area this houses the Akosobo dam and Hydroelectric power station.
- ✗ Waija lake which is part of Accra is one of the flood-prone area this have the biggest water processing dam and station which provided portable water to the whole of Greater Accra and same part of Central Region.

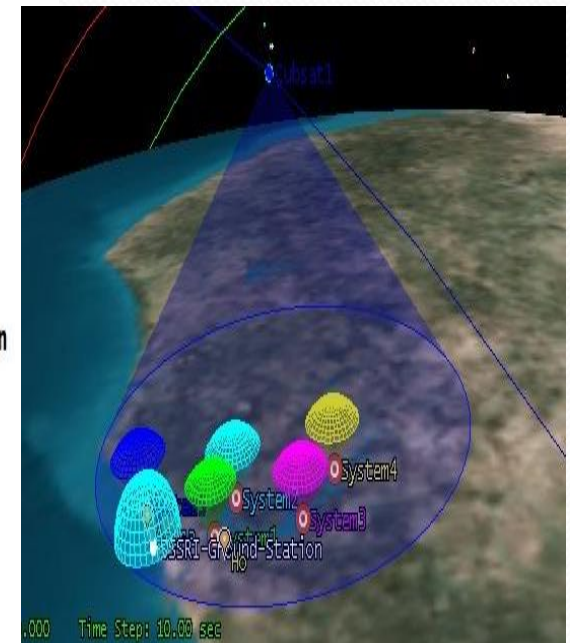
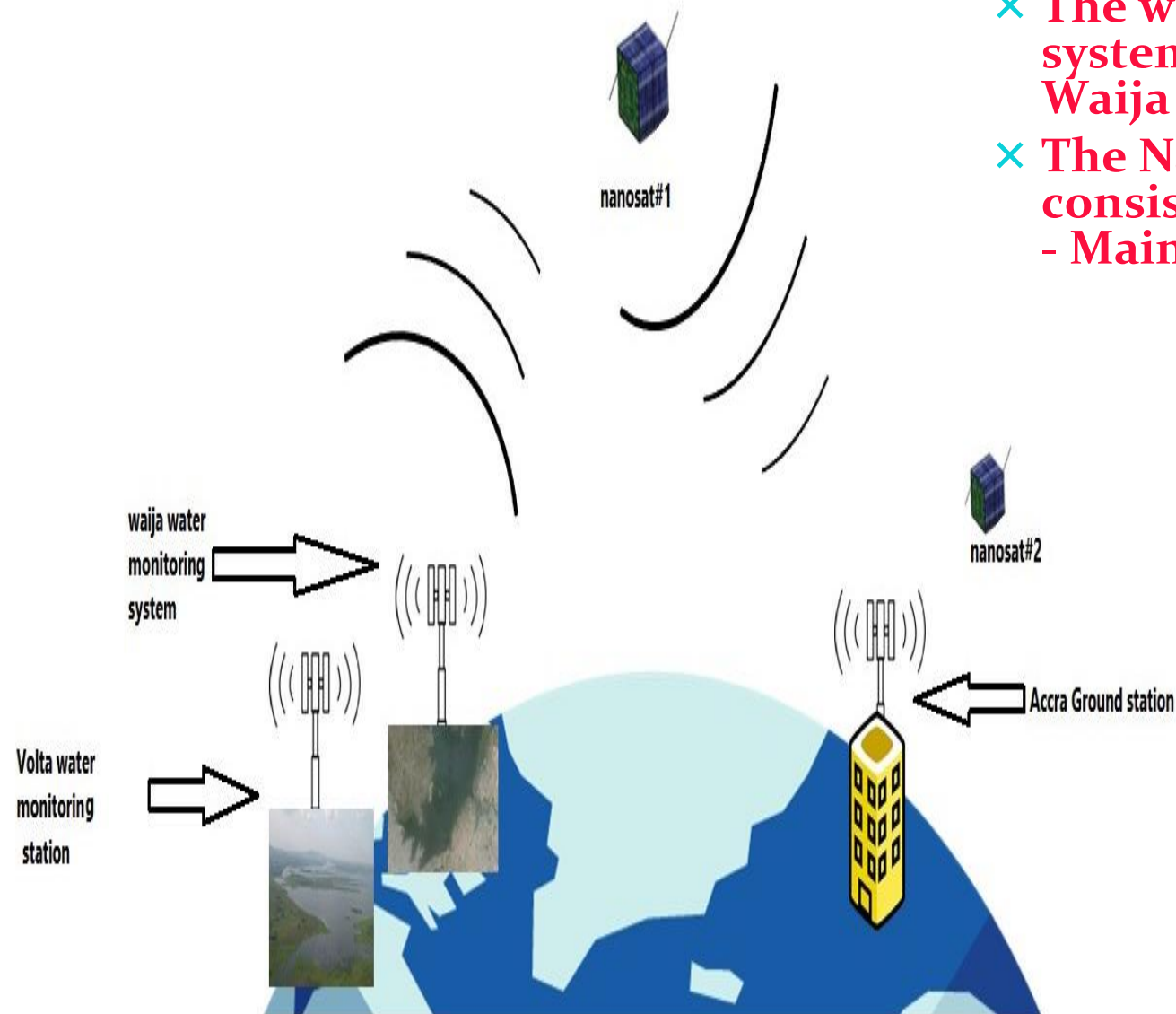


Mission Objectives

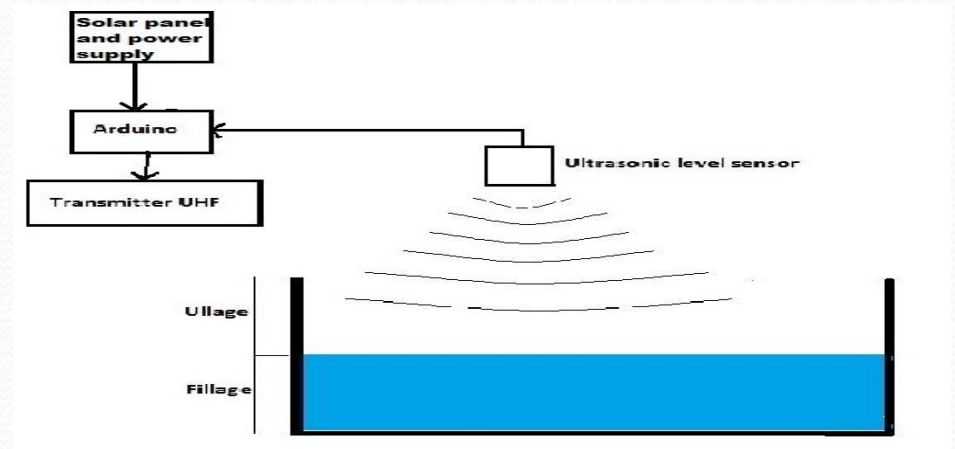
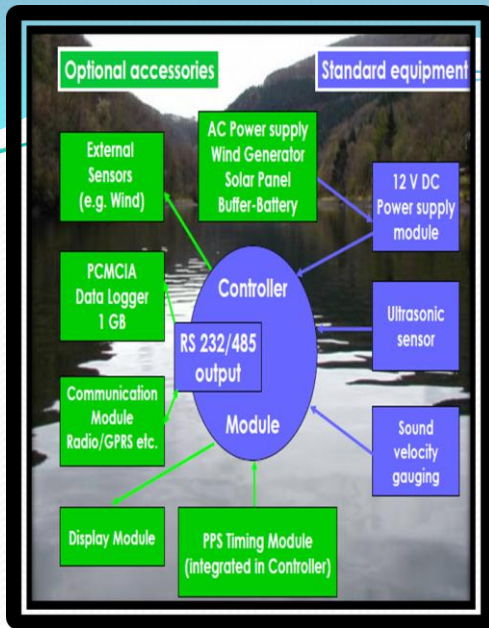
- ✗ To develop a **system to monitor water level** of Volta Lake and communicate with satellite constellation we need to follow the steps below.
- ✗ Construction of a **water monitoring systems** based on **solar power**, a microcontroller interfaced with an ultrasonic sensor to measure at any giving time the water level using UHF satellite transmitter.
- ✗ Construction of a **ground station** located in Accra Ghana, consisting of a VHF receiver, a computer and a mobile Phone.
- ✗ Construction of **three low earth orbit satellites** less than 5 kg each, since each would only carry on board computers , Transceivers, Telemetry systems that will enable communication with the water level system and ground station
- ✗ These will help the Environmental protection agency(EPA), National deserter mobilization organization(NADMO) and the Volta basin authority (VBA)conduct studies and analysis on the causes of flooding , drought and deserter.

Operational Concept

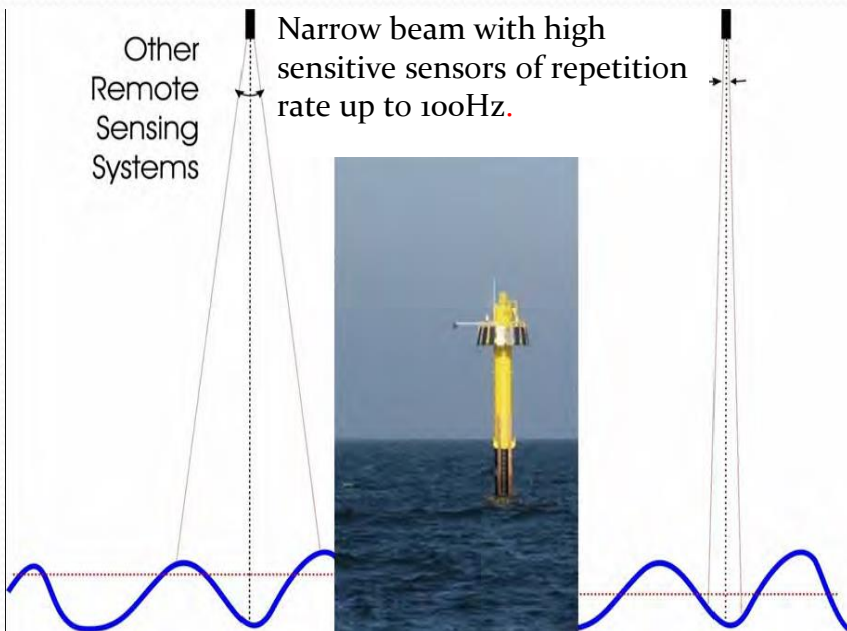
- ✕ The water level monitoring systems at Volta Lake and Waija Lake - solar powered
- ✕ The Nanosat constellation consisting of 3 x 3U Nanosats - Main G/S: Accra Ghana.



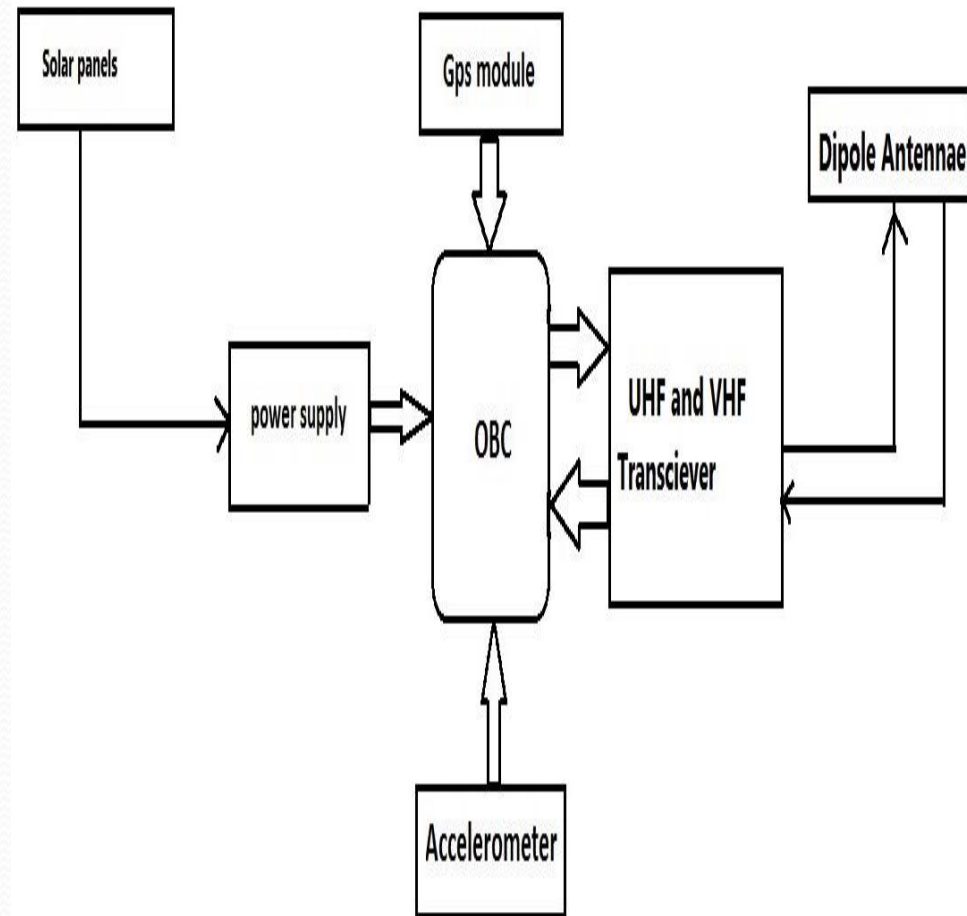
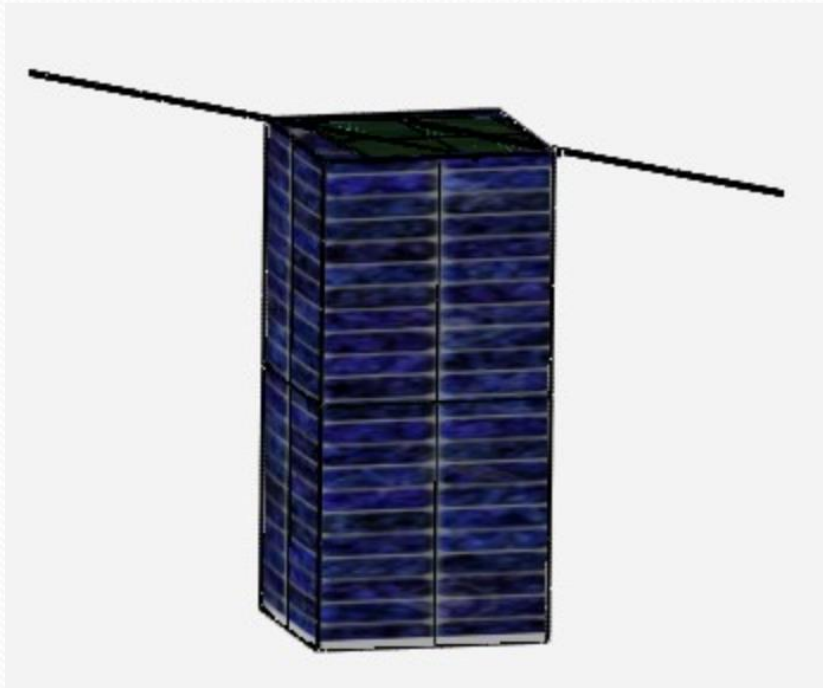
Ground segment



Water monitoring station #1 and #2



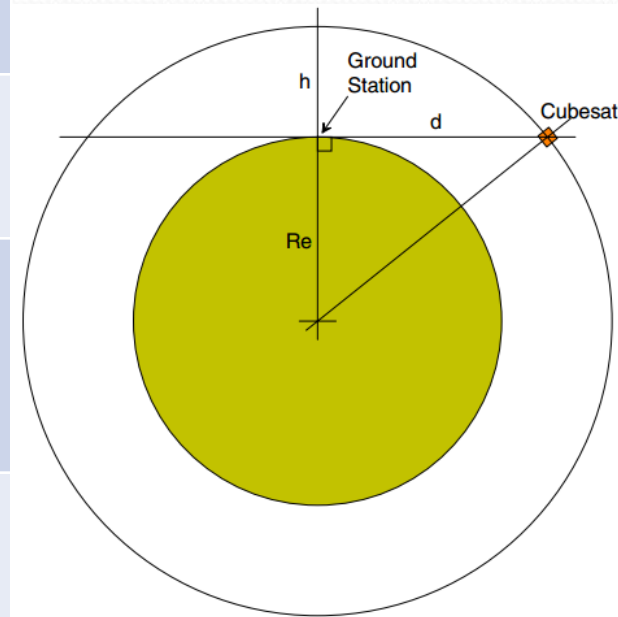
Space Segment



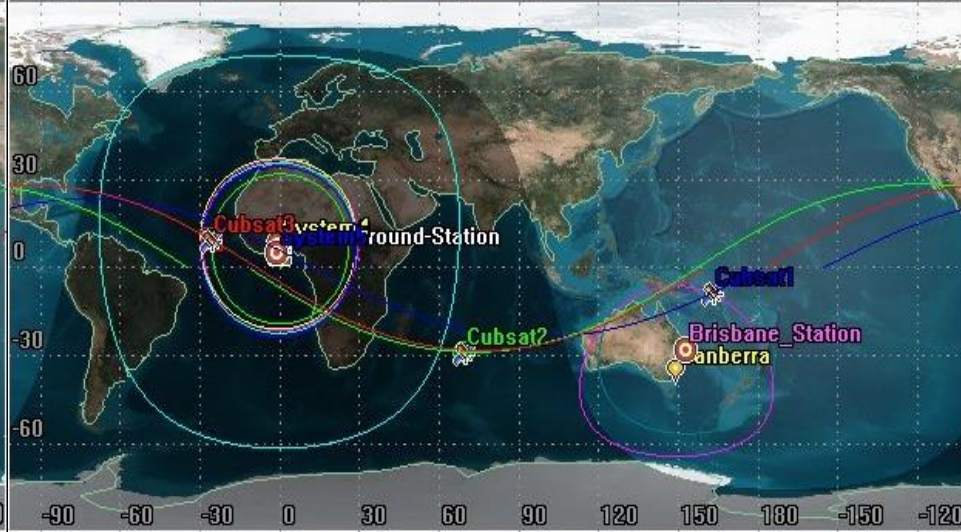
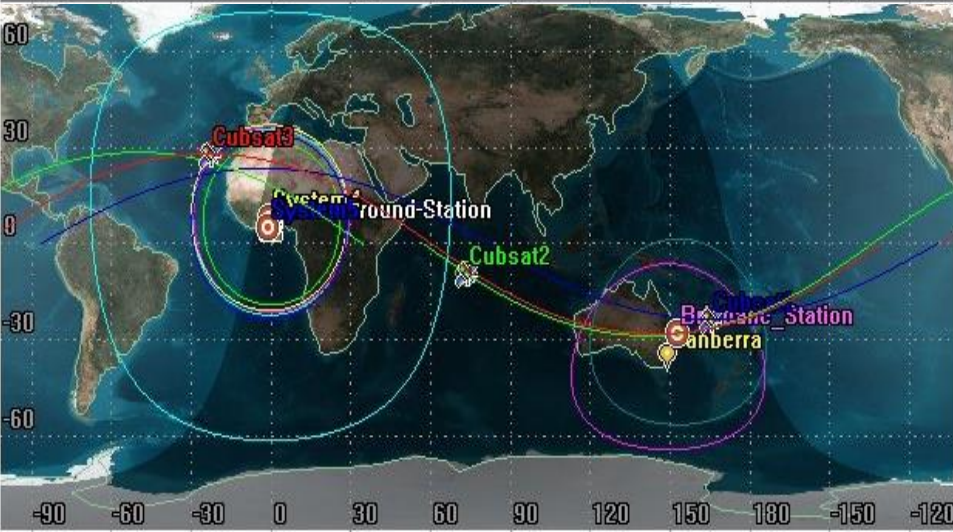
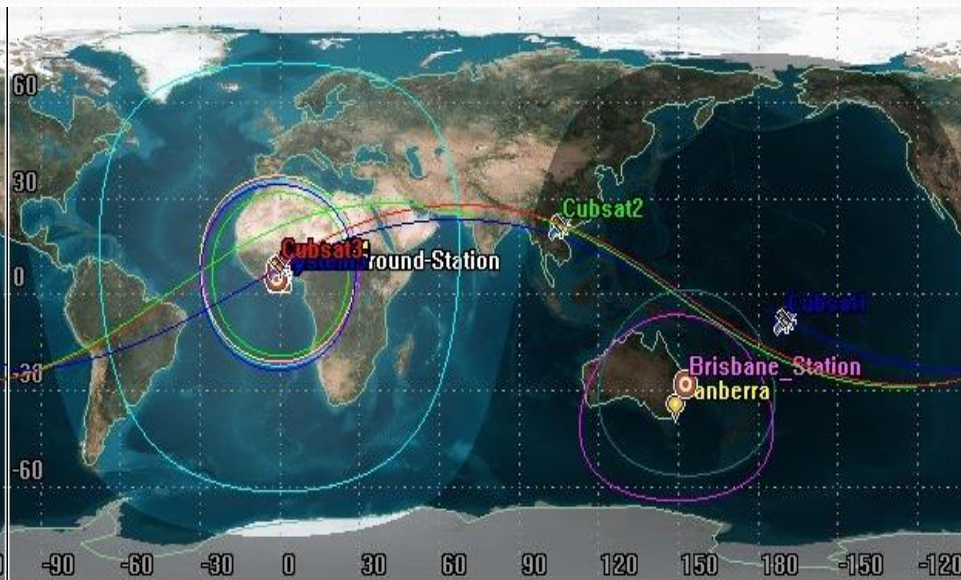
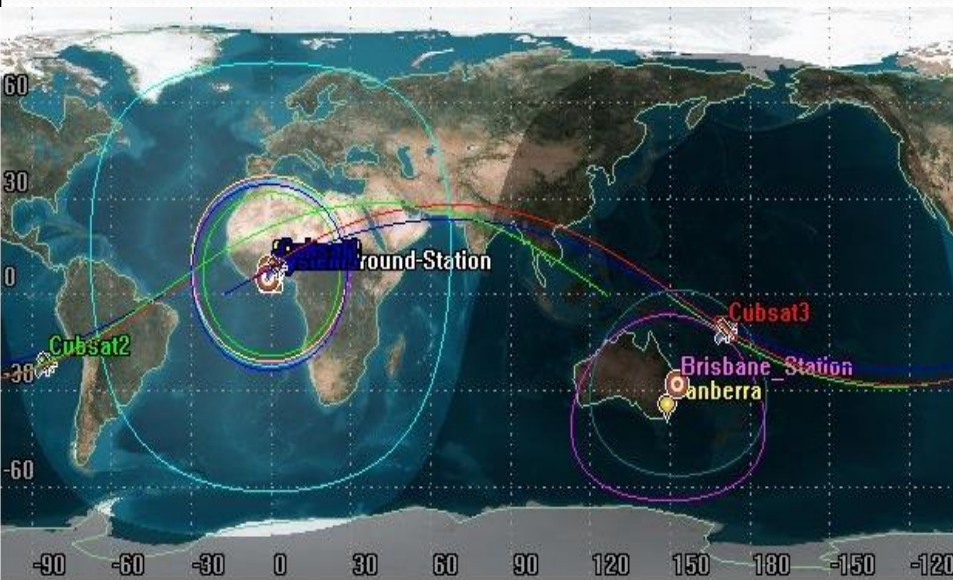
Link Budgeting

At frequency of 430MHz for UHF and 140MHz for VHF, transmitting power at 1.8w, Distance of 2294 km, 30° elevation

	VHF Uplink	UHF Downlink
Frequency[Ghz]	0.14	0.43
Transmitter power[w]	1.8	1
Transmitter Antennae Gain[dB]	20	0
Receiver antennae Gain[dB]	0	20
Space losses [dB]	-140.87	-150.37



Space Segment



Risks

There exist possible risks such as

- 1) Component failure after launch.
- 2) In-lab equipment failure.
- 3) Communication system failure.
- 4) Missed deadlines.
- 5) Loss of expertise

Uniqueness

- ✗ Similar to the Utilizing Nano Satellites for Water Monitoring for Nile River, yet unique in the sense that It is the first time a satellite mission is designed in Ghana that would encourage more African nations to make a step forward in considering miniature satellite technology as a platform to solve their issues locally already our system would serve about 5 or more countries within the sub region.
- ✗ Narrow ultrasound beam, high sensitive sensors for distance measurement also at steep, small and fast waves with high resolution and accuracy.
- ✗ Free of calibration due to synchronization of sensors and high repetition rate up to 100Hz for measuring of wave contours up to breaking wave.

Implementation Schedule

- ✕ The construction of the NanoSat will be largely done by internship students under supervision in the laboratory of the Space Science Systems and Research Institute.
- ✕ Current team size = 6

Final prototype design	2017
Flight model	2018-9
Monitoring station Construction	2015
Launching of Nanosat	Depends on launching operators

Collaborations

The SSSRI will collaborate with University of New South Wales Canberra as our local collaborator ,Ghana space science and technology ,the Multinational Authority which comprises of Benin-Burkina Faso-Côte d'Ivoire- Ghana-Mali-Togo and Miyazaki laboratory in Japan as our foreign partner in achieving our said targets.



UNSW Canberra – Resource Provider

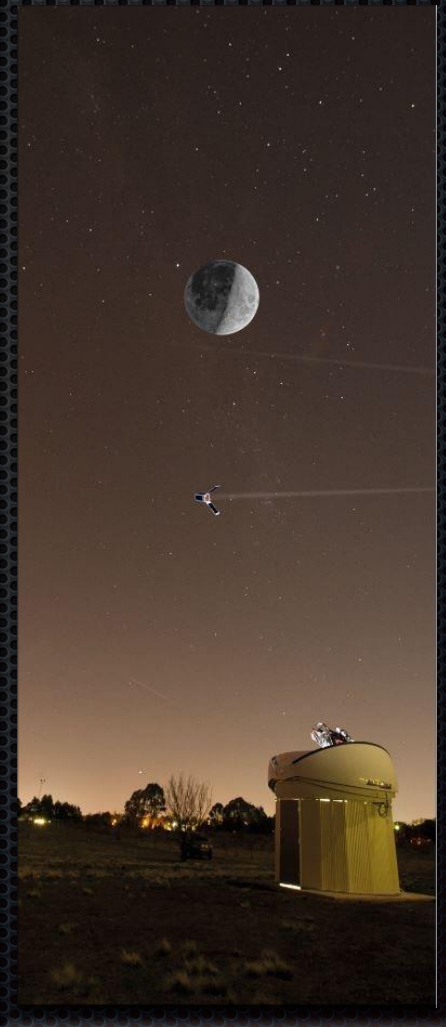
Dr Sean Tuttle

Capability Overview

Experience

Facilities

Teaching



Capability Overview

- **Aims:**

- Education
 - Masters programmes
 - Research degrees (PhD & Masters)
- Research
 - Applications of space technology to improve life on Earth
 - Improved knowledge of space environment
- To play a global role as a responsible organisation – engage with the developing world



Relevance to the Mission Idea “Nanosatellite Constellation for Flood Monitoring”

- Queensland (sub- to tropical part of Australia) suffers regular flooding on a significant scale. (2010, 2010.11, 2013)
 - The state could also benefit from such as system
 - Land management is poor, planning in the lead up to crises is inadequate, there is insufficient real- or near-real-time monitoring to enable effective evacuation, there is a total reliance on foreign satellite imagery and subsequently, insurance costs have increased dramatically
 - The state government has been severely criticised and public inquiries have been conducted. Implementation of an effective flood monitoring system would be a positive step.
 - While the latitudes of Ghana and Queensland are not the same, they are close enough to allow effective use to be made of the same nano sat constellation
 - Including more countries in the system will make it easier to fund
- UNSW Canberra is starting to develop cube sat experience simultaneous with the arrival of this mission idea
- UNSW Canberra is developing cost-effective environmental test facilities
- UNSW Australia has stated the importance of making a global impact – thus, out-reach in an undertaking like this is in line with this aim



Image: Australian Geographic

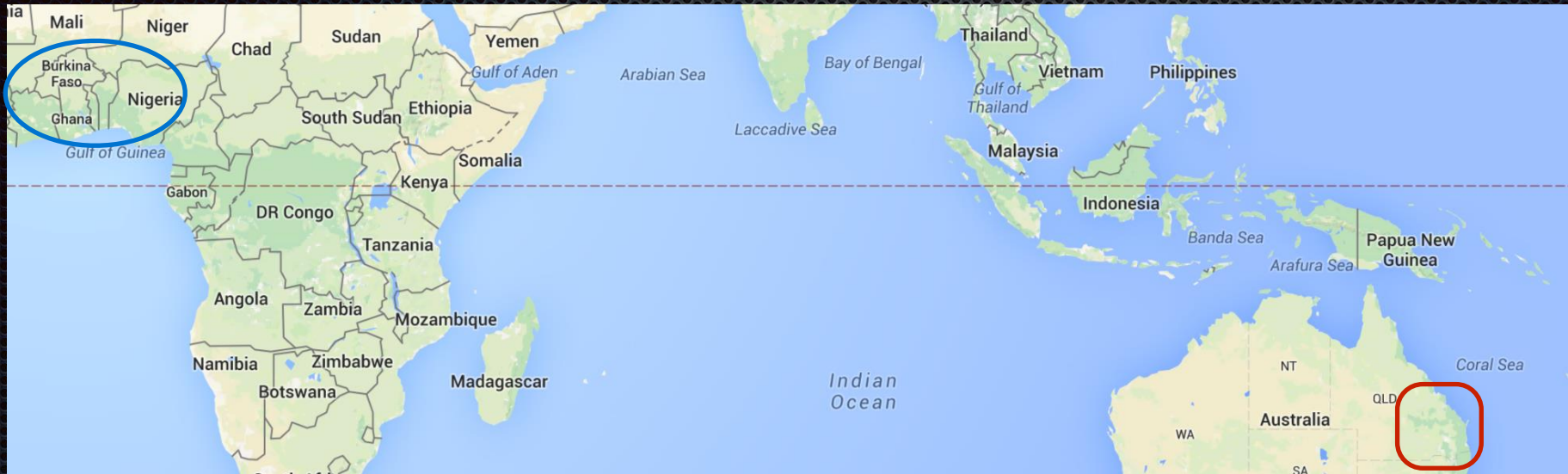


Image: Exonews



Image: news.com.au

Ghana – Australia Connection



- Although you could identify many areas in this belt with similar flooding issues, the volume of data and its management on-board the cube sats would become challenging
- Latitudes are similar enough to make a combined system sensible
- Longitudes are conveniently separated to facilitate data download

Satellite & GSM Coverage

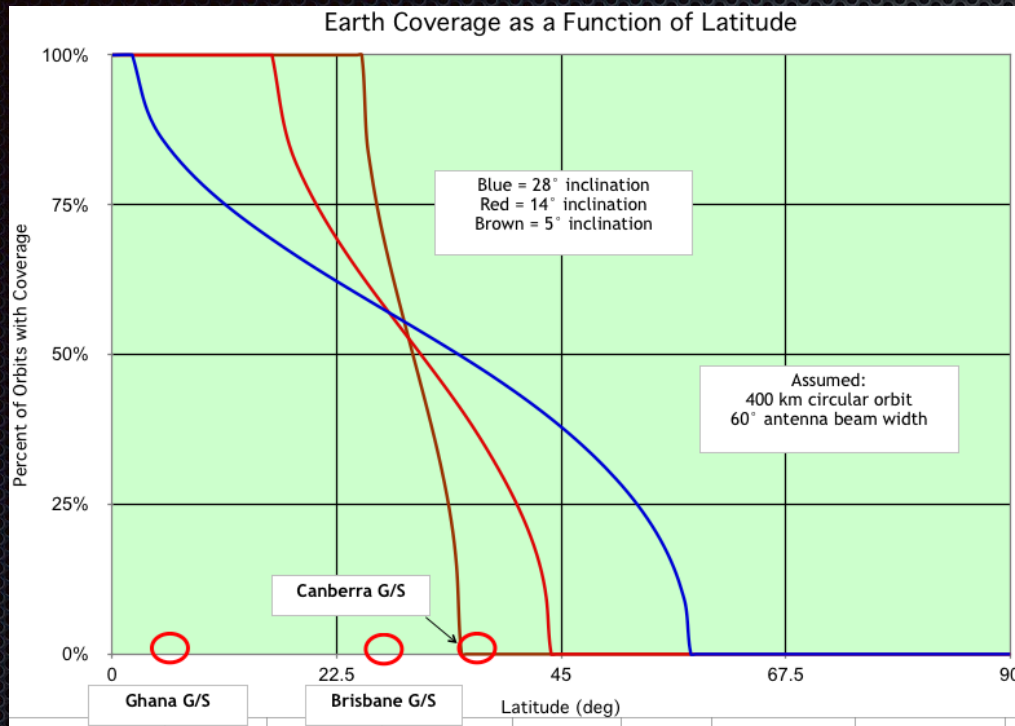
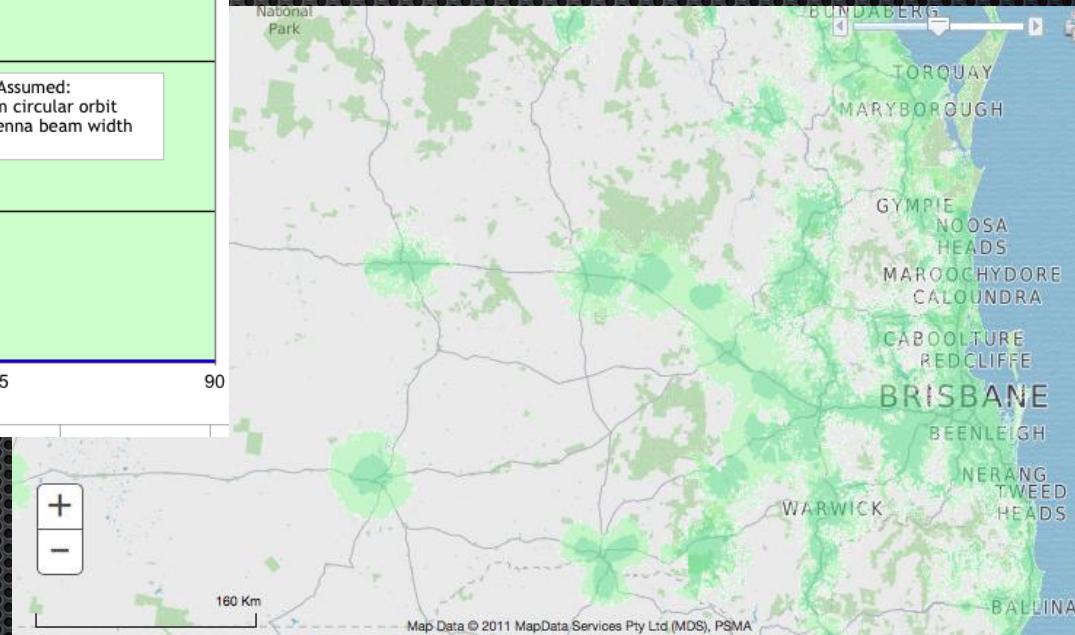


Image produced using "Livecalc" from SMAD,
Wert et al, 2011



GSM coverage in south east Queensland (Telstra)

Further motivations & Way Ahead

- Although in theory you could implement such a system with an entirely ground-based solution using the GSM (mobile phone) network, this has the following disadvantages:
 - Coverage is poor to non-existent in those areas of Ghana most prone to flooding
 - Coverage is patchy outside urban areas in QLD
 - The ground-based infrastructure is vulnerable during extreme weather events such as flooding and the associated storms and should not be relied upon for a disaster management system
- In conclusion, this is another reason why UNSW Canberra is interested in supporting the aims of this mission
- Next Steps:
 - Build ground sensor prototype & prove to demonstrate minimum cost and power
 - Communications strategy – detailed analysis (especially sat to multi-sensor)
 - Make bi-lateral approaches to respective governments WHEN a sound plan has been developed