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| BLUEsat UNSW Student Satellite Project  Document BLUE.2011.4.0 |
| Balloon Launch Mission |
| The Functional Goals for BLUEsat during flight on a stratospheric balloon in 2013. |
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# Abstract

The aim of the operation of BLUEsat during a Stratospheric Balloon flight is to prove the core functionality of the satellite under the conditions of the balloon flight itself. That is the mission of the BLUEsat balloon flight is to achieve multiple levels of telemetry and telecommand links between a Groundstation and a satellite over Amateur Radio frequencies. The proof of this platform will leave development open for the majority of the Satellite systems to be adapted for a space-borne mission in the possible future. Optional future payloads include the Namuru GPS unit and a standalone camera unit. These payloads will be finalised with the project plan to be delivered in January 2012.

# Introduction

The aim of this document is to provide a functionality ‘freeze’ for the systems that are needed to be developed for the BLUEsat balloon launch in mid-2013. Previously, the function suite and mission statement that BLUEsat and its Groundstation were tailored specifically for a Low-Earth Orbit, 1.5 year flight. The change of the nature of the flight from this long-term orbit to a short term, 40km altitude balloon flight necessitates a new mission statement specific to the nature of said balloon flight.

To that end, the following defines a new Mission Statement for the BLUEsat balloon flight and a list of Functional Specifications that the satellite and its Groundstation will fulfil during the balloon flight itself. This new mission will aim to prove the functionality of the base satellite systems under the new environmental conditions resulting from a stratospheric balloon flight.

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# Mission Statement

During flight on the proposed Stratospheric Balloon, BLUEsat will perform functions in order to proof its functionality as an extensible Amateur Radio Satellite bus. That is, on the balloon, the satellite will perform all basic communications and telemetry functions whilst demonstrating the ability to service the Amateur Radio community and to provide an extensible bus on which future payloads can be interfaced.

The satellite on the balloon will transmit telemetry and receive telecommands on specified Amateur Radio bands from a local, mobile Ground-Station system. These transmissions will provide a proof of concept of the Licklider Transmission Protocol (LTP) proposed for deep space communication. On these Amateur Radio Bands, we will also provide functionality for a ‘Bent Pipe RF’ service for reception and rebroadcast of Radio Frequency (RF) transmissions.

Furthermore, the satellite will also demonstrate its ability to allow for higher-function payloads to send telemetry and receive telecommand via a generic Payload Interface. This Payload interface will interact with the main Satellite Bus to transmit and receive data on the same Amateur Radio Bands.

# Functional Specifications

## Proof of Bus

On the environmental conditions provided by the balloon, the satellite will be able to

* Provide power to all electrical subsystems
* Successfully charge batteries from solar panels in charge/discharge cycles as the satellite moves from darkness to sunlight
* Keep an accurate log of temperature, voltage and current telemetry
* Operate and react autonomously in the event of component failure identified by the above telemetry
* Periodically transmit an Audio Frequency (AF) Morse code beacon whilst ‘idle’ or not otherwise transmitting.
* Receive Telecommand through the specified Amateur Radio Band via Dual Tone Multi-Frequency (DTMF) modulation.
* Transmit critical telemetry and receive telecommmand through the specified Amateur Radio downlink Band through Audio Frequency Shift Keying (AFSK) Modulation.
* Transmit non-critical high bandwidth data through the specified Amateur Radio Band via Gaussian Minimum Shift Keying (GMSK) Modulation

## Proof of Groundstation

Once the satellite has been launched on the stratospheric balloon, the Groundstation system will be able to

* Autonomously recognise the AF Beacon transmitted by the satellite
* Transmit telecommands to the satellite through the specified Amateur Radio Band via DTMF modulation.
* Transmit telecommand to and receive telemetry from the satellite through the specified Amateur Radio Band through AFSK Modulation
* Receive telemetry from the satellite through the specified Amateur Radio Band via GMSK Modulation.

## Bent Pipe RF

The Satellite will demonstrate the ability to receive and rebroadcast transmissions on Amateur Radio Bands. That is the satellite and its ground station will

* Send and Receive RF Transmissions
* Function as an Analogue repeater for the rebroadcast of RF transmissions received on-board the satellite.

## Licklider Transmission Protocol (LTP)

Whilst on the balloon, the satellite will proof the Licklider Transmission Protocol. The intention is BLUEsat is to test this protocol simulating intermittent connectivity data error and data loss as large strings of digital data are transmitted via RF frequencies between the satellite and the Groundstation.

To that end, the satellite must be able to

* Transmit and receive digital data using the Licklider Transmission Protocol to and from the Groundstation using the specified Amateur Radio Bands over both AFSK and GMSK modulations.

Furthermore, the Groundstation must be able to

* Transmit and receive digital data using the Licklider Transmission Protocl to and from the Satellite using the specified Amateur Radio Bands over both AFSK and GMSK modulations.

## Payload Extensibility

During flight on the balloon, the satellite is also intended to demonstrate that an extensible payload interface can exist within both the environmental conditions put forward by the balloon and with the communicative constraints put forward by the nature of Amateur Radio transmissions between the Groundstation and the Satellite.

To that end, the satellite will be able to

* Provide an extensible, open-source, easily portable Payload Interface in the form of a Beagle Bone development board.
* Co-ordinate critical systems to allow for the Payload Interface to survive during launch and flight
* Co-ordinate critical systems to allow for the Payload Interface to communicate with the Groundstation.

## Optional Payloads

The following outlines payloads that are yet to be decided upon. At the moment they are being kept open as possibilities for the satellite. However, pending a risk investigation, they may not be able to be developed in time for the March 2013 Balloon Launch. A final decision will be made on these payloads with the delivery of the final project plan by January 2012.

### Namuru GPS

The satellite will aim to be able to support the Namuru GPS unit that will be undergoing experiments form space. That is, the satellite must

* Provide a power and data interface for the Namuru Unit
* Provide a mechanical interface for the Namuru Unit
* Allow for a GPS antenna to be mounted onto the satellite
* Provide telecommand and telemetry capabilities for the Namuru Unit via the specified amateur radio bands.

### Standalone Camera

The satellite may also have a standalone camera unit. This camera will operate separately from the satellite and have internal memory, such that it requires no data or power bus. The camera will also not require telemetry or telecommand. Hence, the satellite must

* Provide a mechanical interface for a standalone camera unit and independent battery source.

# Conclusion

The mission statement and functional specifications put forward in this document define the technical focus for BLUEsat over the next 12 months as the project readies for launch on a stratospheric balloon. The main aim of the balloon launch is to prove the satellite systems’ ability to be integrated and to survive a set of harsh environmental conditions. On the balloon, the satellite and it’s Groundstation will function to enable Amateur Radio communications in a smaller context than that defined by a Low Earth orbit.

The functions defined in this document will go toward defining the delivery criteria for the satellite to the launch provider.