FUNcube GUI Specification

Summary

This document serves as the specification document to define the requirements for the Ground Segment GUI for use by schools, radio amateurs and other third parties.

It may also be used by the "command" stations but they will use a separate interface for generating and the transmitting instructions and the Fitter messages to the satellite.

This document should be considered work in progress, and changes are likely as the refinement of educational objectives is made after further input from educational agencies and individuals

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List of TBD's and TBC's

TBC/TBD	*Location*	*Subject*	*Due date*	*Action by*

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1. Introduction

1.1 Constraints

The FUNcube GUI shall be designed to operate on any Windows based laptop or desktop which exceeds the following minimum spec:
XP and above and screen sizes of 1024 x 768, !GB RAM (TBC)
(Ideally Linux or Mac versions could be made available at a low priority)

Generally, unless otherwise commanded, FUNcube will operate in “educational mode” when it is in sunlight and “amateur mode” when it is in eclipse. The telemetry described below is transmitted in high power only when FUNcube is operating in educational mode.

The telemetry is also broadcast at a lower power when the sat is in "amateur (transponder) mode". The GUI is not required to support transponder operations, other than to provide orbital/pass predictions

1.2 Purpose

The GUI is intended to provide an exciting output display of all the FUNcube telemetry, Material Science Experiment data and the nine Fitter message blocks.

It will need to be suitable for students of both primary and secondary school age – therefore the development of two slightly different versions may be considered perhaps with the ability to switch from one mode to the other.

The GUI will need to be capable of storing information about the “station” or school receiving (eg Name, callsign if one available, Long, Lat, Height, etc) and registering this data with a central data repository. The system should allocate a unique user name to each instance of register client software, and also require the provision of an email address.

The previous amateur satellite AO51 has some ground software which should be reviewed for comparison at http://www.amsat.org/amsat-new/echo/tlm_decode.php

The project includes the provision of software suitable for running a data repository, accessible via the internet. This software should be written in a CGI scripting language to be agreed (eg php) and for a platform to be agreed, either MS ISS or Apache (or possible either). It is important that when the GUI software (client) is communicating with the data repository that only port 80 is used (frequently other ports are blocked by school firewalls). The Data Repository should also handle software registration, software updates, etc

The data repository should also keep a list of all Fitter Messages that have been requested, and all those that have been successfully downloaded, and by what instance of the GUI software.

1.3 Outputs

- Orbital tracking (incl pass predictions) info and map to the screen with capability to output pass predictions to a printer
- Downlinked telemetry data and message information to the screen
- Downlinked telemetry data and message information with a time stamp (in UTC) to be stored on the local hard disk
- The same information printed out (TBC)

- The same information, together with user identification and location info, to be available to be uploaded over the internet to a central repository

Note there should be options to display the tlm in its 'raw' state, and also after tlm equations have been applied.

The GUI should provide the base band audio signals to the computer audio output.

2. General Display requirements

2.1 Contents

The GUI shall display all the available telemetry data and show the orbital track, footprint and pass predictions for the satellite.

Ideally a 'mimic' showing the positions of the tlm sensors (MSE, Temp, etc) should be provided

In addition the map should show the day/night terminator at ground level and also identify when the satellite is in sunlight or eclipse. Also time to next pass, max elevation, Az at AOS and Az at LOS. (see existing tracking programmes – work with G4DPZ Dave Johnson who is the AMSAT-UK expert on this! Possibly point to N2YO.com)

The GUI should show whether the received signal is locked, ie the clock is synced to the incoming clock stream.

For those using a free tuning (SSB) receiver, some form of tuning indicator should be available, eg tune high, tune lower. A waterfall type of display could be considered, eg spectran?

3. Data Display details

Consideration should be given to putting some or all of the following displays in separate windows, so that a screen can be 'decluttered'

3.1 The MSE Experiment

The MSE experiment comprises of four thermistors – two attached to silver material and two to black material – The temperatures of these thermistors are recorded every minute and stored for 104 minutes so that the difference in rate of change of temperature when the satellite enters eclipse can be shown (Leslie's cube experiment). This data needs to be displayed with suitable graphs(TBC) and print outs need to be possible. It should be possible to export this data (eg CSV file) for importing into programmes such as Xcell, for later examination/study.

There should be some form of indication as to what proportion of the WOD data has been received (Note, a complete download of the WOD data will take approx 5 mins)

There should also be a display of the WOD data for the solar cell voltages and temps, battery current and direction and battery voltage.

3.2 Real Time Telemetry

This data is transmitted in every frame and comprises of 30+ channels. See Ref Doc [RD1] and Ref Doc [RD2].This data is primarily to enable the satellite health to be determined but also to be formatted to provide the following “educational” information in graphical formats:

TBC1
TBC2
Etc
Etc

3.3 High Resolution data

This data is the currents flowing from each solar array. It is captured at a high sampling rate and high resolution so that, together with the battery current and direction data which is sampled every 1 second, the attitude, spin and tumbling rate of the satellite can be calculated. This could most usefully be displayed with a satellite image shown in relation to the earth globe. The performance of the passive attitude control system in relation to the earth’s magnetic field will also have educational value.

3.4 Fitter Messages

The satellite will transmit nine “Fitter” greeting messages which are each 200 bytes long.

3.5 Other Display items

3.5.1 Doppler Shift Demonstration

By storing the audio frequency of the data tuning tone transmitted by the satellite every approx 8 secs and displaying a graph of frequency/time

3.5.2 Links page to:

FUNcube Central Repository
AMSAT-UK website
RCF website
etc
etc

4. Interfaces

The GUI will receive the satellite data either:

- via the FUNcube RX dongle USB device which will provide an IQ output as developed by G6LVB.
- or as audio from a conventional SSB receiver via the sound card, as developed by G6LVB

Compatibility with both methodologies is required. The exact interface should be agreed with G6LVB

The RX dongle USB device will also have the capability of having frequency correction applied via a HID interface from the software (TBD)

The GUI must be capable of operating on a computer which is not connected to the internet, and storing downloaded telemetry in a file(s) for later use.

If the host computer IS connect to the internet, then the GUI should :

- Enable the update of the two line orbital elements so that the pass predictions can be kept up to date.
- Submit school/station information to a central repository generally as described in 1.2 above
- Transfer the received telemetry to a central repository generally as described in 1.3 above.
- Submit Fitter greeting messages to a central repository for moderation and eventual uplinking by a command station.
- Download, from the central repository, all telemetry collected by other schools/stations from previous passes to compare data and to enable further investigations to be undertaken by the students(TBC)

It will not be a requirement that internet access is available during actual passes.

The GUI should also be capable of importing telemetry files which have either been previously downloaded directly from the satellite, or downloaded from the central repository, or via a dedicated web site or from a CD, and 'playing these back' to show the GUI operating in real time.

The GUI should have a simple way (eg .ini or .txt file) of implementing tlm equation changes. It is envisaged that each copy of the GUI software will be distributed with a 'start up' file, but tweaks may be required to be made after distribution.

5. Implementation

It is envisaged that the GUI will interface as below.

above:
- All presentation logic, resources (images etc.)
- Configuration storage (.ini files etc.)
- Interfaces to other systems (eg: audio system, FUNcube website)
- Waterfall generation (if we want it)
- Record / replay of audio
- Record / replay of decoded telemetry

below:
- Raw audio decoder (audio buffers in, telemetry frames out: as defined in this document).
-- fixed sample format: 48k/16-bit - Howard?
-- lock indicator (clock detected - faster than whole frames?)
- Level mapper (hides/protects EPS conversion logic) - separate from decoder.
-- possible to reprogram coefficients securely?
-- stateless, unordered, time-free lookup facility

6. Reference Documents

[RD1] – FUNcube Data Download Document
[RD2] – Clyde Space EPS User Manual ver “X”