Long Duration Flight Telemetry

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Over the horizon telemetry is necessary when flying long duration missions in remote areas beyond the reach of ground stations. This is particularly necessary for trans-Atlantic flights. To track balloons in remote areas it is also useful to have two-way command and control via a satellite-based system. A description of how to roll your own Iridium satellite tracker will be covered in detail.

Introduction

Receiving telemetry from long duration high altitude balloons poses a challenge when flying beyond the range of a local ground station. The amateur radio APRS (Automatic Packet Reporting System) national network of ground stations linked to the Internet solves this problem when flying over populated regions. However, this network will not be useful when flying in remote areas or landing in rugged terrain beyond the range of a local APRS station.

I. Iridium Satellite Modem

The Iridium satellite system consists of 66 cross-linked satellites in LEO orbit which can talk to adjacent satellites in a mesh network. It provides pole-to-pole coverage across the World with very low message latency. The lightweight SBD9602 short burst data modem provides an excellent way to send balloon telemetry via the Iridium satellite network from just about anywhere in the World.

The SBD9602 can send up to 340 bytes of data at a time and can receive 270 bytes. The uplink capability provides the ability to actually send commands to a remote balloon simply by sending an email to the modem's email address.

Photo 1. Iridium SBD9602 modem board with Sarantel helical antenna www.elktronics.com .

II. Circuit board and power supply

The circuit board for the SBD9602 is fairly straightforward but requires careful positioning for the serial interface/power connector. The other consideration is the power supply requirement to prevent voltage droop during the brief 1.5 amp current drain during the startup of the transmit sequence. I found that the combination of an OKI-78SR-5/1.5 switching regulator with a large 1.5 Farad Supercap on the output met the requirements with just a few components, offers short circuit protection and limits the large inrush current when powering up the module. I tried several antennas for the SBD9602 but finally decided on a Sarantel SL-3105SP helical antenna with built-in SMA

connector. I found it had excellent performance, provides filtering from nearby interference and works well in a dynamic environment where the antenna may not be always pointing straight up.

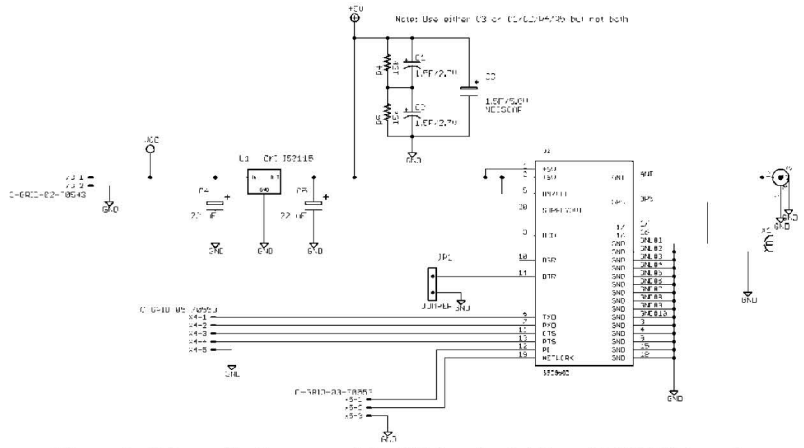

Figure 1. Schematic diagram of the Elktronics Iridium SBD9602 board.

III. Iridium modem operation

Serial data is sent to and received from the SBD9602 via simple AT+ commands at a default rate of 19,200 baud. This can be reconfigured if necessary. The technical manual describes the command structure but is not readily available online. The best online resource I found was at www.nalresearch.com and is where I ultimately signed up for the airtime service.

Most short burst data airtime providers have a setup fee, a monthly fee and some offer around 12,000 bytes of data free as part of the monthly fee. These fees are comparable to the pricing of other satellites services from Orbcomm and Globalstar (which is used by the SPOT tracker). The basic service sends data from the balloon modem to your email inbox. The latency times I observed were often under 15 seconds. Each SBD9602 module has its own serial number. Using that number you can send data to the modem via an email to the Iridium ground station's server. The latency time to receive an indication that there is an email waiting for the module is usually within 18 seconds. For a substantial fee, most airtime providers will set up a direct link to your web server.

The most economical method for displaying position data received from the balloon modem on a Google map is to parse your email's inbox with a Perl (or other) script and upload the positional information to an online map. The two free mapping services I recommend to send the converted inbox data to are www.aprs.fi or www.spacenear.us/tracker as they are already setup for high altitude ballooning.

IV. Flight Testing

The first two prototypes have been flown on five missions so far. The time interval of 5 minutes was used between transmissions. Although it is well within the capability to send data from the modem as often as one minute and even less, I opted for 5 minute intervals to keep within the 12,000 byte monthly limit and also to conserve battery life for long duration flights. I control the modem via serial commands from my primary tracker's serial port (Elktronics Multi-Mode Transmitter). In future flights I plan to update the flight telemetry every minute and once on the ground drop the update rate to every 15 minutes or send commands to the modem via email to change the update interval.

The modems have worked well during flight testing. One unique feature of the Iridium satellite network is that you receive an estimated Doppler position along with your emailed data in your inbox. If you have a GPS failure, you will still get a position estimate that is often within 2 km.

The Iridium tracker has been the primary way that we located payloads on several occasions during these flight tests. The most recent flight test was a Spaceport Indiana student flight that landed in a large cemetery near Indianapolis. When we arrived to recover the payload we found that it was no longer where it had said it had landed. After a few minutes we received a new update showing it located next to a maintenance shed a half mile north since

the grounds crew had apparently moved it. Even while sitting horizontally on the ground and next to a large metal wall, the Iridium modem was able to send a signal and steered us right to the new recovery site.

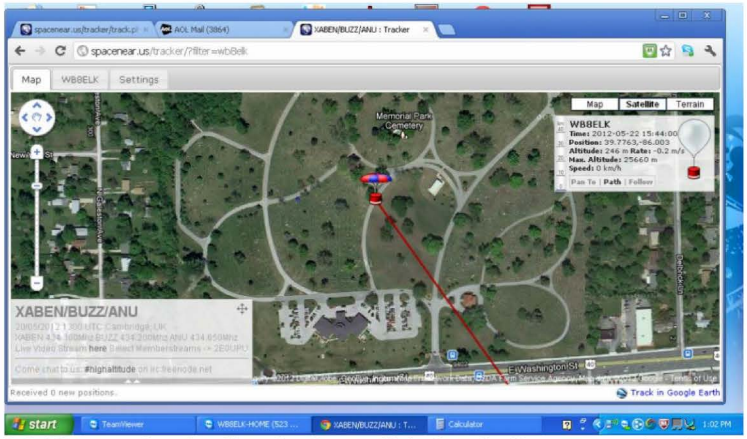

Photo 2. Iridium modem landing site data uplinked to the Spacenear.us/tracker website.

PC boards, modules and components for this board are available from www.elktronics.com . For those of you who would like to roll your own PC board, I can email you an Eagle CAD footprint for the SBD9602 modem, please email me at: wb8elk@gmail.com.