Pyxis Receiver and CICERO Space System Progress

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We’ve been busy, Over 14 Launches to date,
9 more nearing completion
The Highlights

- Focus on S/N, Latency, Quality and Quantity of soundings
- Designed for *Operational* Requirements
  - High Reliable, Radiation Tolerant components and designs
  - L1/L2/L5 RF ASIC and Galileo Enabled processing
  - Real Time Data- Latency measured in seconds
  - Quantity 24 s/c & GPS + Galileo, Persistence of system
- Spacecraft Status
- Instrument Status
Spacecraft Attributes

- ~40kg Small Satellite (about 55cm x 50cm x 35cm)
- Attitude Determination Star Camera, Gyro, Magnetometer
- 3-Axis Stabilized via 3 Wheels and 3 Magnetic Torque Rods
- 5 Liter ADN “Green” Propellant, 3 Thrusters ~300m/sec
- Deployed Solar Array – 70W OAP
- Li-Ion Batteries (28V, 12AHr)
- Primary Downlink via GEO, 475/464 kbps (Inmarsat SB-SAT)
- Secondary maintenance link with USN/Prioranet
- Integrated Avionics (similar to AMS, XSS-11, STP-SIV 1&2)
- GPS RO & CTIP Payloads
- 5+ Year On-Orbit Lifetime (expected > 10 years)
Spacecraft Status

- Updates from October 2010 design review
  - Changed from GPS-AD to Star Camera
    - Attitude Knowledge improvement from 0.2 deg. to 0.005 deg.
    - Have first prototype camera (at Space Symposium)
    - Flight version in development, lower power than GPS-AD
  - Received first EM Li-Ion Battery
  - Received first flight fuel tank & thrusters
  - Finished development of the Mirideon/440 card
    - 10 cards built, some out on demo, others used for GPS & SB-Sat
    - Testing so far in the 200MFLOPS, more ‘tuning’ needed
      - BSP improvements, memory access improvements & options
  - Change from the SpaceX F1e
    - Was 2 launches of 12 each, now reconfiguring
Spacecraft Status cont’d

- **Flight Software**
  - Purchased Octant Technologies
    - flight S/W & Guidance and Control experts,
    - auto-code tools & visual navigation experts (star tracking algorithms, proximity operations)
    - Primary engineers that designed S/W for many of our past missions
  - Tested some of the CICERO design and mission particulars with the Advanced Plug and Play demo for USAF (final delivery May 2011)
Spacecraft Status cont’d

- Real Time Data  SB-SAT (DARPA/Inmarsat contract)
  - First 5 Inmarsat modem boards out of manufacturing next month (May 2011)
    - one 440 uP, two DSP’s, memory etc.
    - First testing with Inmarsat network later this summer
  - Protocol Stack (~3G phone style) porting to 440 uP
  - Modulation/Demod Software Defined Radio port to DSP
  - RF Front end prototyping in work, COMDEV UK
  - First High Gain antenna “Type 6” ~15 dBiC 475kbps this summer
  - All on track for Type Approval & Flight Delivery next year
Space System Overview

- Inmarsat 14 BGAN Constellation At GEO
- Nominal Science and TTC Link
- CICERO Constellation At 750km Circular
- Backup Science and TTC Link
- S-Band Primary USN PrioraNet
- Inmarsat - Secondary USA
- Inmarsat - Primary London
- S-Band Maintenance Backup SSC - Kiruna Sweden
- Data Center Boulder - GO
- Constellation Control LASP
- VPN via Internet
- Constellation Control Mirror @ UND
- Data Center Mirror @ UND
Avionics

Typical “heritage” Avionics from BRE

BRE Radiation Hard PowerPC 440 CPU

Interface & Power Electronics with LEO and GEO Heritage

CICERO Avionics Prototype
- Prop panel integrated at prop vendor (Moog)
- Interfaces to S/C via single power/data interface
- Delivered to S/C I&T as one tested unit
Pyxis - GNSS Radio Occultation Receiver

- Evolution from IGOR/IGOR+
- Developed by Broad Reach
- 4 Antennas, GPS & Galileo
- Radio Occultation Data
  - ~2 dB more sensitive front end than COSMIC
  - Updated L1/L2 RF front end for PAZ
  - 3 freq ASIC next for Pyxis-RO
- RF ASIC development in fast track now
- New code developed over the past year
- Setting up P/L interface user requirements
  - Still working on publishing science interface w.r.t 3rd party Open Loop routines
GPS Flight Products
High Reliability, High Performance

Pyxis
new

IGOR
Retired soon

2 and 3 Frequency GPS Receivers And Sounding Instruments.

Navigator
new

Single Frequency GPS Receivers
3U format for LEO and GEO applications
GEO version pictured. ~7 meter accuracy at GEO
RO Antennas

- Improved antenna design from COSMIC
  - Higher Gain ~ >2dB better over volume of interest
  - “Banana” Pattern to maximize gain, minimize thermal noise
  - Passively phase steered to accommodate S/C geometry
  - Ground Plane & Thermally coupled to structure

COSMIC Antenna & Pattern

CICERO Antenna & Pattern
Congratulations on the 5 years

Proud to have been a part of it all

Thank You NSPO,
Thank You UCAR,
Thank You JPL