

Prometheus CubeSat Constellation Ground Station

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Prometheus Constellation

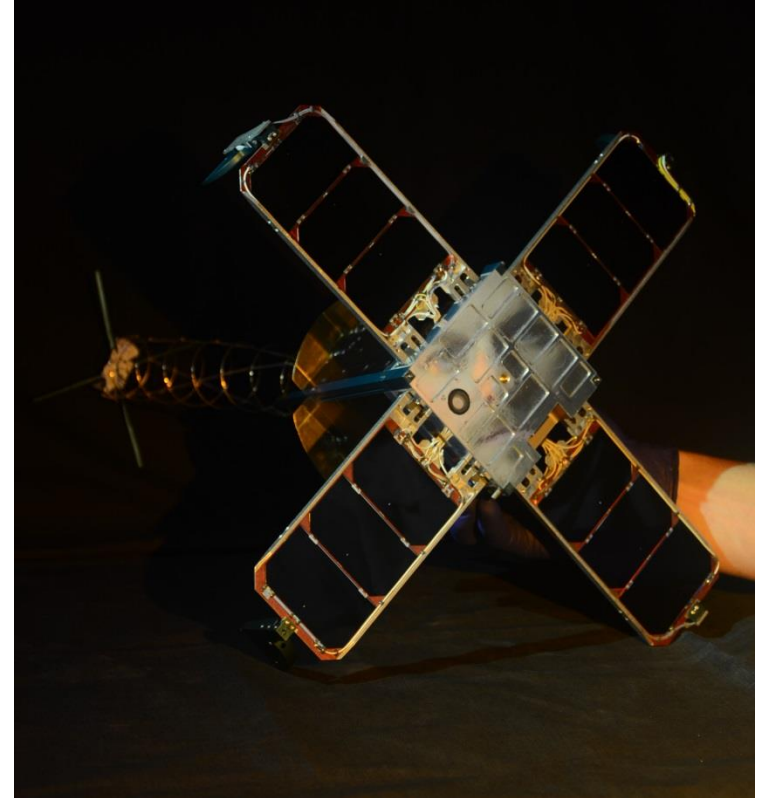
- Eight 1.5 U CubeSats
- Operationally Responsive Space (ORS) launch
November 19, 2013
- 40.5 deg 450 km orbit
- Follow on to LANL Perseus
CubeSat project launch in
2010



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CONOPS

- Data store and forward
- Satellite uplinks data from field unit
- Ground station downlinks data from satellite
- Satellite is configured not scheduled
- Onboard attitude determination and control system configured to point to targets
- After configuration the system is completely autonomous



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Ground Station Hardware

- Low cost (few \$K)
- Quick setup
- Easily transported
- Antenna located far from radio and computers
 - Protect GS encryption keys
 - Lightning protection
- Three ground stations deployed in New Mexico one in Florida

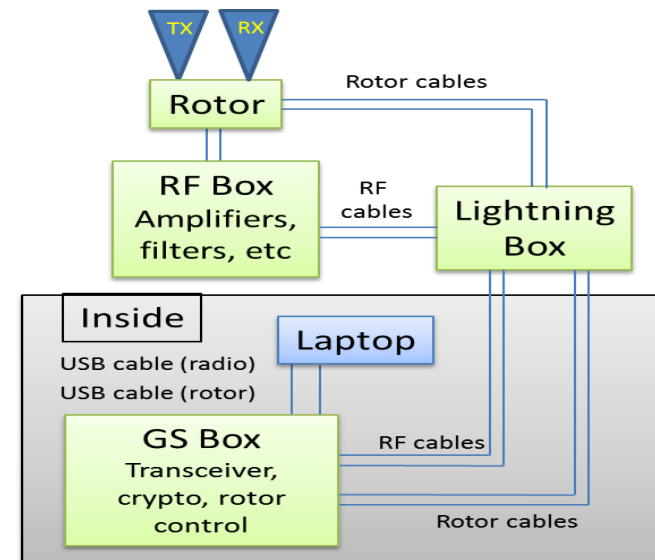


**High band outdoor
antenna hardware**

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Ground Station Hardware

- Controlled with a single laptop using two USB connections to indoor GS box
- Co-design principles throughout
 - Same software defined radio hardware used in ground station, satellite, and field units
 - Software reuse in all components

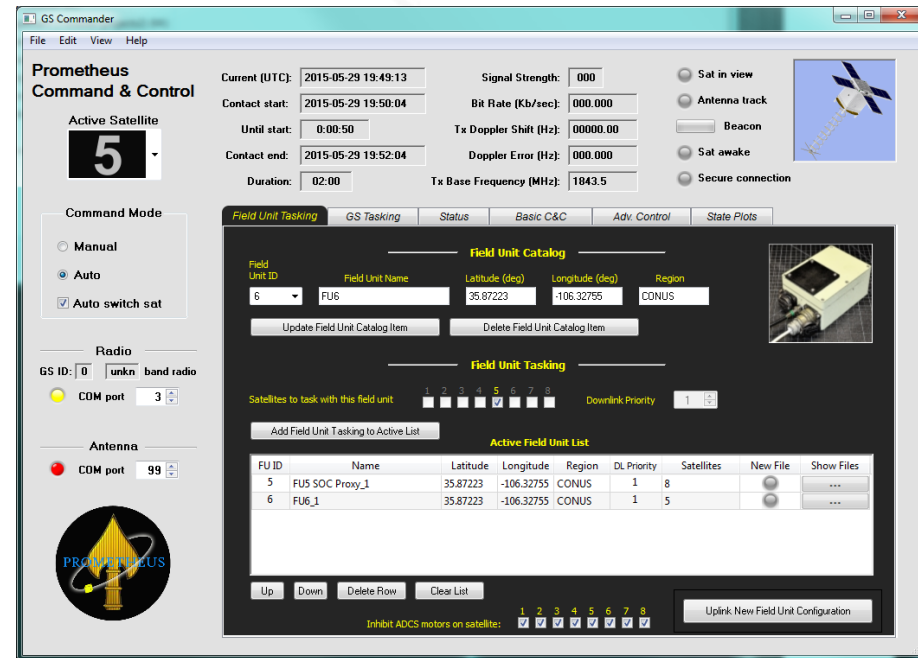


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Ground Station Software

- Custom LANL co-designed software
 - Embedded radio sw
 - GUI user interface
- Easy to use
- Single piece of software for all operations
- Automated
 - TLE retrieval
 - Doppler correction



Ground station software
main user interface

Ground Station Software

- Automated
 - Orbit propagation
 - Constellation maintenance
 - Configuration file creation and uplink
 - Antenna rotor control
 - SOH downlink
 - Alarm distribution
- User SOH and status display
- Scripting

Prometheus

- (ALARM SV5 GS4 Power Config) SV5 GS4 Power configuration: 0x02 does not match expected: 0x02 2015-03-09 20:48:21 UTC (5546.366910) 2:48 PM
- (Pass INFO SV5 GS4: (19,3,6,0,0)) Contact summary SV5 - GS4 Pings recvd: 19 Cmd replies: 3 SV Frames up: 6 SV Frames down: 0 FU Frames down: 0 2015-03-09 2:49 PM
- (ALARM SV3 GS4 Battery Low) Battery voltage limit violation. SV3 GS4 Battery voltage: 3.253V < 3.260V 2015-04-06 12:02:38 UTC (5574.001829) 6:02 AM

Auto Mode Control

Auto Mode Actions

- Wakeup
- Connect
- Feed Watchdog
- Pause Beacon
- Set Time
- User Command
- Uplink Satellite Files
- Downlink Satellite Files
- Downlink Field Unit Files

Auto Mode Configure

Contact Summary | User Command | Field Unit Downlink | **File Downlink** | File Uplink | Priority

Auto File Downlink

Daily SOH Daily Log

Satellite: 5 Subsystem: Attitude Control Filename:

Previous partial download (existing file id)

Auto File Downlink List

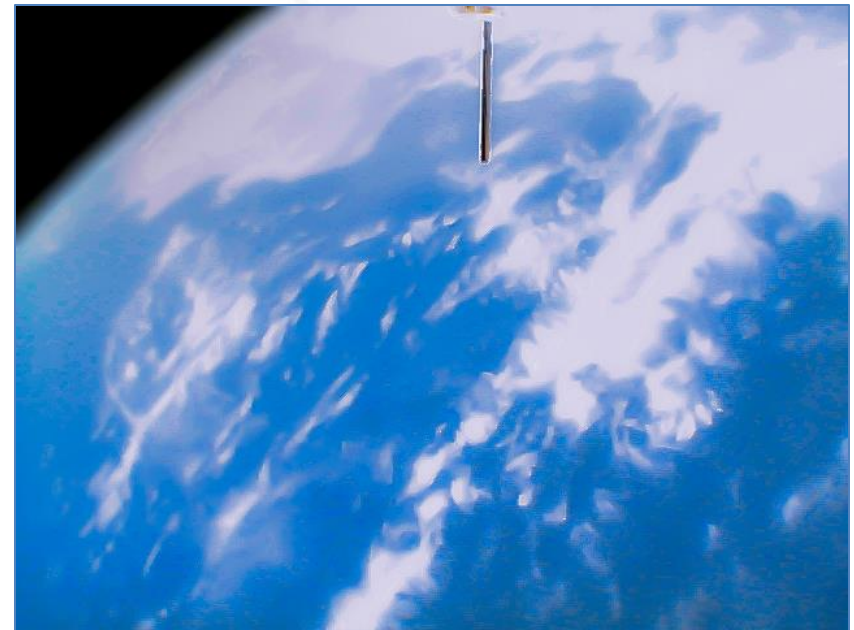
Satellite	Subsystem	File ID	Filename	Recvd
6	cdh	0x0082	SoH2\SOH_15880001.SAT	0 / 0
6	cdh	0x0081	SoH2\SOH_15880002.SAT	0 / 0
1	adcs	0x0458	adcs_log_53041	0 / 0
1	adcs	0x0459	adcs_log_53042	0 / 0

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Ground Station Performance

- 18 Months of operation
 - Successful contact on 7,200 passes
 - 16,300 successful command replies
 - 20 MB data uplinked
 - 16 MB downlinked
- Next Generation
 - Prometheus block 2 in work
 - Easier GS user interface and operations
 - Robustness
 - Expand to other missions



Prometheus photos of Oman
and Arabian Sea
(low band antenna element
top center)

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Acknowledgements

- Ground station team at Los Alamos National Laboratory
 - Nick Dallmann
 - Jerry DeLapp
 - Stephen Judd
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 - Robert Wheat

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