TSAT Globalstar ELaNa-5 Extremely Low-Earth Orbit (ELEO) Satellite

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See Reference section for additional publications.
TSAT Review Objectives

• Test Globalstar network for Small Sats
• Education
• Explore Extremely Low Earth Orbit (ELEO) Ionosphere 325 km to 110 km
• Plasma Density ELEO data

Talk Outline

Hank Voss on TSAT Preliminary Results
Jeff Dailey on Globalstar Communication Network Details
TSAT details in Small Sat AIAA paper proceedings SSC14-WK-6, Also NSL at Booth 117 - Hardware

TSAT is a 2U Cubesat launched April 18 on Space X to 325 km orbit
Globalstar with EyeStar Radio Simulations
(“Bent Pipe” distributed data downlink)

- $2B satellite constellation at 1414km (terrestrial use)
- Commercial Research Grade link and FCC license, Not ITAR
- Low latency near real time global data and command
- 1.61625 GHz Simplex TSAT transmitter/patch (170 deg.FOV)
- 1.6 GHz & 2.4 GHz band Duplex CDMA transmit/receive patch
- No need for conventional client Ground Station cost & time
Beacon Cycle: 32 beacons (Five second interval), 15 minute off dwell
Figure 7: Comparison of Globalstar projected coverage and normalized TSAT results.
Globalstar Link Features

- Cubesat-to-Globalstar link demonstrated by TSAT, 2014
- Downlink cubesat data anywhere at any time
- TSAT first data IP 11s after turn-on over South Pacific
- Command Cubesat anywhere at anytime
- Frequency selection to avoid Radio Astronomy EMI
- Unified Cubesat Constellation Database
- NSL Single Point of Contact for Globalstar (NSL is Value Added Reseller, VAR, for Spaceflight and High Altitude Balloons, cost $1000 Eng.Unit to $10,000 Flight)
- All satellite success using just beacon for GPS and basic health and targeted sensor data. Use S-band for Gbyte data.
ELEO Exploration

LEO Orbit Region
(Many Missions)

ELEO Horizontal Orbits
(Uncharted)

Altitude (km)

South Pole
(-90°)

Equator
(0°)

North Pole
(+90°)

Latitude

Space Weather
Ionosphere
Scintillations
Orbit Decay
Chemistry
Dynamics & Waves
Traveling Ionosphere Disturbances
VLF Coupling Region
Precipitating Electrons/Ions
Low Radiation Belt Contamination
Ionization EM Absorption
South Atlantic Anomaly Ionization
Electric/Magnetic Field Transients
Plasma Physics
Sun-Earth Connection
Atmospheric Model Checking
Intelligence Gathering
Many Others!

International Space Station

Mesosphere
Stratosphere
Troposphere

Weather Balloons
Meteorites
Commercial Jets
Figure 19: Mission medians of electron density for various orbit altitudes (20km bins). The

TSAT Reentry and Predictions

TLE Prediction

TSAT Packets
140km 0041 UT
Temp. -10 C

Last Packets
110km 0339 UT
Temp 45 C
20deg./min.

TSAT Breakup
75km 0401 UT
- Satellite Solar Illumination,
- Internal and External Temperatures,
- 3-axis Magnetometer
TSAT Data Packet Rate

Data Cost: $3000 for 40 Days

Cumulative Packet Count

Power save mode enabled

1235 pkts/day (22K)

Subscription plan changed

165 pkts/day (3K)

261 pkts/day (5K)

Increased solar exposure


Time (days)

No Dead Zones
No Lost Data
EyeStar Simplex Transmitter Product
8x2x0.6 cm, 200mW ERP, 38 Byte/s
SAT Duplex Transceiver

- Up to 7000 baud data rate
- Data and Command Control
- TCP-IP software
- Handshaking protocol
- Active patch antenna (6 cm)
- ARM Processor
- 1 Watt ERP
- 3.3 & 5 V, 5W input power
SAT-NSL-Globalstar-NSL-Client Data Flow
Satellite-Globalstar-Server Data Network

GlobalStar Satellite Constellation and Global Gateway Network

Near Space Launch (NSL) Primary Interface
FCC, Legal, POC, Rates, VAR, Tech Support

Time Ordered Common Data Base

Distributors

NSL Redundant Server & Cloud

NASA Centers
Constellation Servers

AFRL Servers

University Servers

International Servers

Industry Servers

Other SATs

TSAT
GEARRS
SHARC
UNP SATs
Other SATs
2U TSAT- ElaNa-5, 2014
Globalstar, Plasma, Reentry

3U AF GEARR SAT, 2014
Globalstar, Plasma, Other

3-6 U Aerodynamic THIN SATs,
Globalstar, Plasma, Particles, Waves, 2 booms, Other

6U AF ELEO SAT, UNP-8
Globalstar, Plasma, Particles, Waves, 4 booms, Other
NSL Space Flight Upgrades of Globalstar Modems

- FCC Cubesat-to-Satellite commercial license
- Firmware modem changes for spaceflight
- Processor board and software for data interface
- TCP-IP processor software to modem
- Thermal, vacuum, and EMI modem shield
- Radio astronomy frequency avoidance
- GSE bypass of Globalstar network for testing
- Burn-in and Testing, Conformal Coating
- Globalstar VAR POC for modifications
- Certified for Spaceflight
Student Published Papers on TSAT:


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Questions

• NSL Booth: #117 with Hardware, ICDs, CAD
• See TSAT Paper SSC14-WK-6 Proceedings
• Contact: Hank Voss or Jeff Dailey
  – NSL: Nearspace Launch Inc.
    www.nearspacelaunch.com