TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

Ground Station Selection

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Changes Since PDR

- **At PDR - Primary and Backup antennas were at APL; 2-meter antenna for uplink, 60-ft antenna for downlink**
- **Non-Advocate Review (NAR) raised concern that the two antenna uplink/downlink concept would be awkward, and subsequent study did reveal problems**
- **Current concept:**
  - **single uplink/downlink antenna will be used per contact**
  - **Primary support is not *required* to be at APL**
  - **If primary support is at APL, backup support will be off-site**

Ground Station Support

- **Four types of support required:**
  - **Primary**
  - **Backup**
  - **Contingency**
  - **Early Launch Support (ELS)**
- **All stations (except ELS) are required to support commanding**
  - **S-band frequency: 2039.645833 MHz (+/- 1 ppm)**
  - **16 kHz subcarrier (+/- 50 ppm)**
  - **2 kbits/sec data rate (+/- 50 ppm)**
  - **Residual carrier PM, BPSK modulated on subcarrier, NRZ-L**

Ground Station Support

- **Primary**
  - **One to two passes/day nominal throughout life of mission, providing 20 minutes of contact time per day**
  - **Must be capable of supporting all downlink modulation modes:**
    - » **Mode 1a (4 Megabits/sec, RS, Randomized DQPSK, min. G/T=16.3 dB/k)**
    - » **Mode 1b (2 Megabits/sec, RS, Randomized DQPSK, min. G/T=12.9 dB/k)**
    - » **Mode 2 (9 Kilobits/sec, RS & Convolutional Rate 1/2, k=7, Residual Carrier PM modulated directly on carrier in biphase-L format, min. G/T=12.9 dB/k)**
  - **May be on or off APL campus**

Ground Station Support

- **Backup**
  - **Must be available/scheduled for at least one contact/week**
  - **Must be capable of supporting downlink modulation modes 1b and 2 (as described for Primary Ground Station)**
  - **Mode 1a support not required of the Backup station**
    - » **driven by LEO-T marginal operation at 4 Mb/sec**

Ground Station Support

- **Contingency**
  - **Must be available and easily scheduled on short notice from TIMED Mission Operations**
  - **Must be capable of supporting downlink modulation mode 2 (as described for Primary Ground Station)**

Ground Station Support

- **Early Launch Support**
  - **Desired for coverage shortly after orbit injection**
  - **Station location should be a minimum of 75 degrees latitude (North or South)**
    - » **Current timeline shows orbit injection in Pacific, southbound over Antarctica; ground stations in that area are being evaluated**
  - **Must be capable of supporting downlink modulation mode 2 (as described for Primary Ground Station)**
  - **Commanding not required of ELS stations, but highly desirable**

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Ground Station Candidates

- **APL Satellite Control Facility**
- **NASA/Wallops (LEO-T, TOTS)**
- **Allied Signal**
- **Universal Spacenet**

Ground Station Candidates

- **APL Satellite Control Facility**
  - **5m, 10m, and 60' existing antennas were considered**
  - **Scheduling, upgrade, and interference issues were considered among the three existing assets; addition of a backup antenna was also evaluated**
  - **60' antenna is recommended as a *candidate* for Primary Ground Station; requires upgrade to support TIMED**
  - **Backup and contingency services will be sought off-site**
    - » **geographic diversity**
    - » **eliminates on-site RF interference issue**

Ground Station Candidates

- **NASA/Wallops**
  - **LEO-T (Low Earth Orbiter Terminal)**
    - » located at Poker Flat, Alaska
    - » considering for Backup, Contingency and ELS Ground Station support
    - » near-polar ground station location desirable for TIMED
  - **TOTS (Transportable Orbital Tracking System)**
    - » considering for ELS operations
    - » may be place at a variety of locations
    - » location TBD, based on orbit injection point

Ground Station Candidates

- **Allied Signal (commercial)**
  - **LEO-T-class station in Puerto Rico**
    - » **purchased by JHU for FUSE mission**
  - **Second station is proposed for Hawaii**
  - **Both Puerto Rico and Hawaii ground stations would be shared with FUSE program**

Ground Station Candidates

- **Universal Space Net (commercial)**
  - **Three Phase 1 assets (September 1998)**
    - » **North Pole, AK; Kona, HI; Horsham, PA**
  - **Two Phase 2 assets (late 1999)**
    - » **Southern Florida; Spitzbergen, Norway**
  - **Two Phase 3 assets**
    - » **Kodiak, Alaska; Seychelle Islands**
  - **Two Network Management Centers**
    - » **Newport Beach, CA; Horsham, PA**

Ground Station Selection Process

- **Ground station selection to be based on:**
  - **Ground Station Requirements Document**
  - **Off-Site Ground Station Services Statement of Work**
    - » **Off-Site Ground Station Services Scoring Plan**
  - **Agency/vendor visits**
- **Off-site ground stations scored for each type of ground station service (Primary, Backup, Contingency, ELS)**

Ground Station Selections

- **APL SCF is selected as Primary Ground Station Service Provider**
- **Benefits:**
  - **Track record of SCF**
  - **Co-location of SCF, Mission Operations Center, and Spacacraft during Integration & Test**
    - » **more opportunities for interface and compatibility testing**
    - » **operations and maintenance personnel are on-site**
  - **"Ownership" minimizes the potential for scheduling conflicts**

Ground Station Selections

- **Universal SpaceNet is selected as the Backup and Contingency Ground Station Service Provider**
  - **Universal SpaceNet is considered capable, but marginal in the role of *sole* Primary Ground Station Service Provider for the TIMED Mission**
- **Benefits:**
  - **Geographic diversity of planned assets**
  - **Redundant Network Management Centers**
  - **Candidate for ELS**

Ground Station Selections

- **ELS ground stations still being evaluated**
  - **Universal SpaceNet Spitzbergen, Norway**
  - **TOTS (southern hemisphere)**
  - **Hartebeesthoek , Africa, (and others...)**