TacSat-4: Military Utility in a Small Communication Satellite
IAA-B9-1003

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The overall classification of this brief is UNCLASSIFIED
TacSat-4 Mission Overview

- TacSat-4 mission’s is to advance technologies & augment SATCOM
- New technologies used:
  - Thermal systems, bus standards, highly automated ground C2, VMOC mission planning, antenna, new battery, new launch vehicle configuration
- Capability can augments national SATCOM with up to 5 Legacy UHF channels…
  - Near global access (but not continuous) including Arctic circle
- Year-1: Military Utility Assessment & Experimentation

Low-HEO Orbit
2+ Hour Dwell
12,000x750km x 63.6°

TacSat-4 Ground Terminal
(for Networked COMMS)

Blossom Point Ground Station in Maryland

VMOC: SIPRNet Website for User Tasking

Comms on the Move
Legacy 5 MHz (5 MHz) Wideband (5 MHz)

Friendly Force Tracking

Data Exfiltration

2000-4000 NMI Diameter FOV
TacSat-4 Mission
Operational & S&T Objectives

Operational Objectives

- Augment UHF SATCOM, including COTM, Data-X, & FFT
- Focus on underserved Users, who are priority or equipment limited, and underserved areas
  - Augment GEO coverage to include the northern latitudes
- Provide JMU and system info for follow-on acquisition options

UHF SATCOM Mission was Selected by General and Admiral Vote

- 1 vote from Army, Navy, Air Force, Marines, and STRATCOM
- Mission designed Jointly for 9 months in prep. for selection

S&T Objectives & ORS Enablers

- New, long-dwell orbit for small satellite class
- New launch and range capability to reach this long dwell orbit
  - Minotaur-IV+ and Kodiak
- Achieve useful payload performance in small-sat class
- Demo highly automated C2
- Increase automation of mission planning including increased user access to tasking
  - Enable dynamic tasking without increased work load
- Advance spacecraft bus standards
- Multiple technologies to enable this capability in a small sat
  - 12 foot antenna, thermal pipes, Lithium Ion battery, etc…
- Advance radiation models
TacSat-4 – Spacecraft Components

 TacSat-4: Providing Communications and Enabling ORS

Spacecraft Bus Prototype for ORS Standards

TacSat-4 “COMMx” Payload
10 Channels of UHF
Launch Vehicle and Kodiak Launch Site

Launched: 27 Sept 2011

Minotaur IV+ Rocket

Kodiak Launch Complex
Ground Systems: C2 & Mission Planning

Blossom Point Tracking Facility

- 1st US Ground Station for Space Systems, 1956
- 45 miles South of Washington, DC
- Flexible for S&T/R&D
- Robust for Operations

Automated Command & Control after Checkout

Highly Automated Mission Planning and Scheduling Tool

Tacsat-4 Equipment for User IP Networking
Users Equipment

Airborne ARC-210 & ARC-231

AV-2040
AV-2091
AV-2090

PRC-117 f/g
PSC-5
PRC-152
PRC-148 MBITR

And other SATCOM radios, as tested.
User Experimentation (1 of 2) for Official Utility Evaluations

**Summary**

- **SPAWAR System Center**
  - JITC Compliance Testing (Complete)
    - MIL-STD-188-181 verification – BERT & C/No

- **Army SMDC Battle Lab & Future Warfare Center**
  - Focus on Communications-On-The-Move (COTM) and VMOC Mission Planning Systems
  - Modeling and simulation for constellations
  - Testing & report completed

- **ORS FFT Testing**
  - Completed evaluation of spacecraft FFT capabilities

- **Navy’s Trident Warrior 2012**
  - Navy Ship, Sub, and Marines participating

- **International Participation by UK & Canada**
  - via TTRDP Project & Trident Warrior 2012

**COMMS-on-the-Move testing in mountainous areas (Pikes Peak)**
User Experimentation (2 of 2) for Internal Community Evaluations

- US Coast Guard
  - Ship and, to a lesser extent, helicopter use especially at high latitudes
  - Voice (including out-to-area) & low-rate data

- US Training Use by Multiple Services

1/6/12 USCG Cutter Healy breaks ice around the Russian-flagged tanker Renda 250 miles south of Nome.
Trident Warrior 2012

Marines at MCTSSA & Hawaii

USS ESSEX (LHD-2)

USS OLYMPIA (SSN 717)
End Users Results: Summary Performance

- Supports SATCOM for All SATCOM Radios and SATCOM Antennas Tested
  - SPAWAR Testing Confirmed TacSat-4 is JITC Compliant, per MIL-STD-188-181, for Standard SATCOM Equipment & Options
  - Satellite transponder is tunable over UHF band

- Downlink – Data comparable to current SATCOM capability, Voice stronger by x2+
  - However is not reliable with NON-SATCOM antennas like whip & baton antennas

- Uplink – x4+ stronger than today’s systems, can receive low power radio transmissions
  - Can extend battery life
TacSat-4 Orbit and Global Coverage

Maximum Hours per Day for a Given Location

A Given Location Typically Sees 3 Passes per Day Averaging 2 hours each Pass

Approximate footprint for US centered pass (“hand drawn” to show scale)

TacSat-4 ~12,000km Apogee & 63.4° inc.

GEOs ~36,000km @ Equator
Example: USCG Use in Alaska Area

- **Area:** Alaskan coastal water, Aleutians, Bearing Straits, Artic Ocean
- **Voice & Data**
- **Includes networked COMMS from out-of-area locations like Alameda**

Satellite’s view during 1 of 3 passes that cover this area.
Scientific Radiation & Solar Cell Data

- **Protons are Order of Magnitude Higher than Predicted, although maybe a long transient cycle (TBD)**
  - TacSat-4 measurements confirmed proton flux is direction dependent
  - Protons mainly affect solar cells.
  - TacSat-4 is providing unique solar cell information.

- **Electrons Order of Magnitude Lower than Predicted**
  - Positively affects electronics total dose (reduces expected total dose)

Monitoring the environment with Air Force’s CEASE and Solar Cell Experiments

TacSat-4 is providing new data to AP/AE8 & AP/AE9 radiation models used nationally.
Future – 2013 & Onward

- **Satellite Status**
  - Estimated 2 years of life remaining
  - <= 5 legacy channels, 3MHz or 5MHz collect channels, X-band downlink
  - Frequency related: ITU filing is complete for TacSat-4 & constellation of 6 satellites for 40 years

- **Funding Status**
  - Navy S&T is funding Command and Control in FY13 to make available for User experimentation and potential User transition planning for FY14 and FY15
    - Available for Users to add funding for experimentation and use

- **Related Study for Future Systems**
  - Polar UHF Military Augmentation System (PUMAS) study looked at future utility of “TacSat-4 Like” systems
  - Final brief given to ORS & Navy for future acquisition decisions
Thanks for Your Attention!