Communications Satellite Program Office (PMW-146)

Mobile User Objective System (MUOS)

Communications-on-the-Move (COTM)

28 April 2009

Statement A: Approved for public release; distribution is unlimited (1 April 2010).

PMW-146-D-10-0041

Outline

- **UHF SATCOM Status**
  - UFO, FLTSAT, LEASAT, Skynet
- **MUOS Program Overview**
  - Architecture
  - MUOS Team
  - Status
- **Communications on the Move (COTM)**
  - Warfighter Needs
  - Circuit-based to Net-based transition
  - Wideband Code Division Multiple Access W-CDMA) Capability
- **Achieving Capability**
  - End-to-End Issues
  - Future Terminals

Narrowband SATCOM Overview

Mission

- Command and control interoperability between the Combatant Commanders and their components
- Connectivity for command and control of tactical forces
- Connectivity for deployed Special Operating Forces
- Connectivity supporting rapid deployments of land, air, and naval forces worldwide
- Connectivity for tactical communications in all operating environments

Nets
Command and Control
Fire Support
Combat Operations
Search and Rescue
Tactical Data Links
Broadcast
Cruise Missile/UAV
Control/Data Links
Logistics

Tactical Net supporting Joint and Allied forces

Users
Navy
Marines
Army
Air Force
Allies
COCOMS
JTF
Gov't Agencies

Over 50 percent of SATCOM users are deployed via UHF

Terminals
AN/PSC-5 SPITFIRE
CSEL
URC-133 Federated
ARC-210
WSC-3
Digital Modular Radio/Joint Tactical Radio System (JTRS) (future)

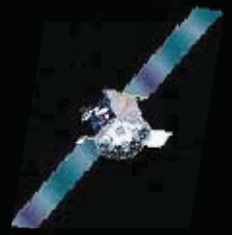
More than 50 different types and over 18,000 terminals in-service today!

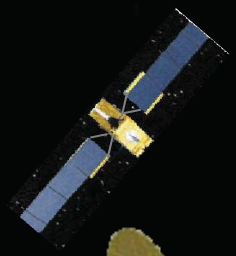
"Additionally, command and control "on the move" was hampered by the finite number of UHF Tactical Satellite channels available. The demand for UHF TACSAT exceeded the finite capacity and forced continuous prioritization of those available channels as the operations unfolded."

LTG ABIZAID Senate Confirmation hearing for Central Command (24 June 2003)

PEO Space Systems Portfolio

- **LEASAT**
  - LEASAT 5
    - 6 UHF communications channels
- **UFO**
  - F2
    - UHF Payload, 39 channels
  - F4, F5, & F6
    - EHF Payload, 8 EC services
    - Spot beam antenna, 14 SBA services
  - F7
    - Enhanced EHF Payload
    - 8 EC/SBA services or 32 SBA/EC service
  - F8 & F10
    - Global Broadcast Service Payload
    - 4 x 24 Mbps transponders
    - 3 steerable transmit antennas
    - 2 receive antennas (1 steerable)
  - F11
    - Digital Payload
    - UHF Services
    - EHF Services
- **SKYNET**
  - Skynet 5c
    - 3 UHF communications channels
- **MUOS**
  - Future MILSATCOM narrowband system
  - Replaces the current UFO constellation

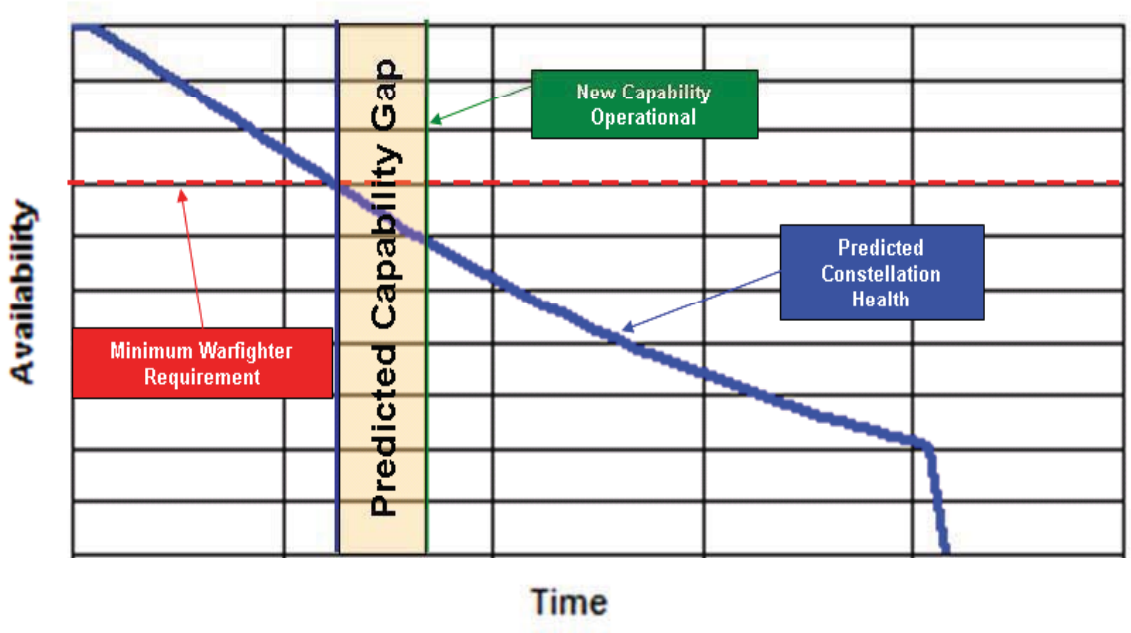




Narrowband SATCOM Constellations

- **Today's Narrowband SATCOM constellation is aging**
  - UHF Follow-On (UFO), Fleet Satellite (FLTSAT), Leased Satellite (LEASAT), and Skynet

Example Constellation Life Expectancy



Tomorrow's Narrowband SATCOM constellation will be the Mobile User Objective System (MUOS)

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MUOS Requirements

UFO

Current UFO "Man Pack"

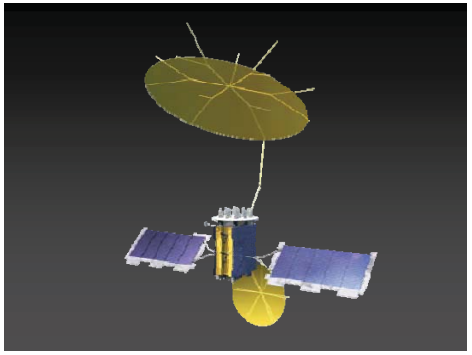
- **~ 20 lbs**
- **2.4 kbps**
- **Stop and Talk**
- **Set up/Tear Down 10 mins**
- **Military custom waveform**

Increased Performance

- ***~10X Capacity of UFO System***
- ***Higher data rates***
- ***Increase Link Availability***
- ***GIG Connectivity***

Increased Mobility

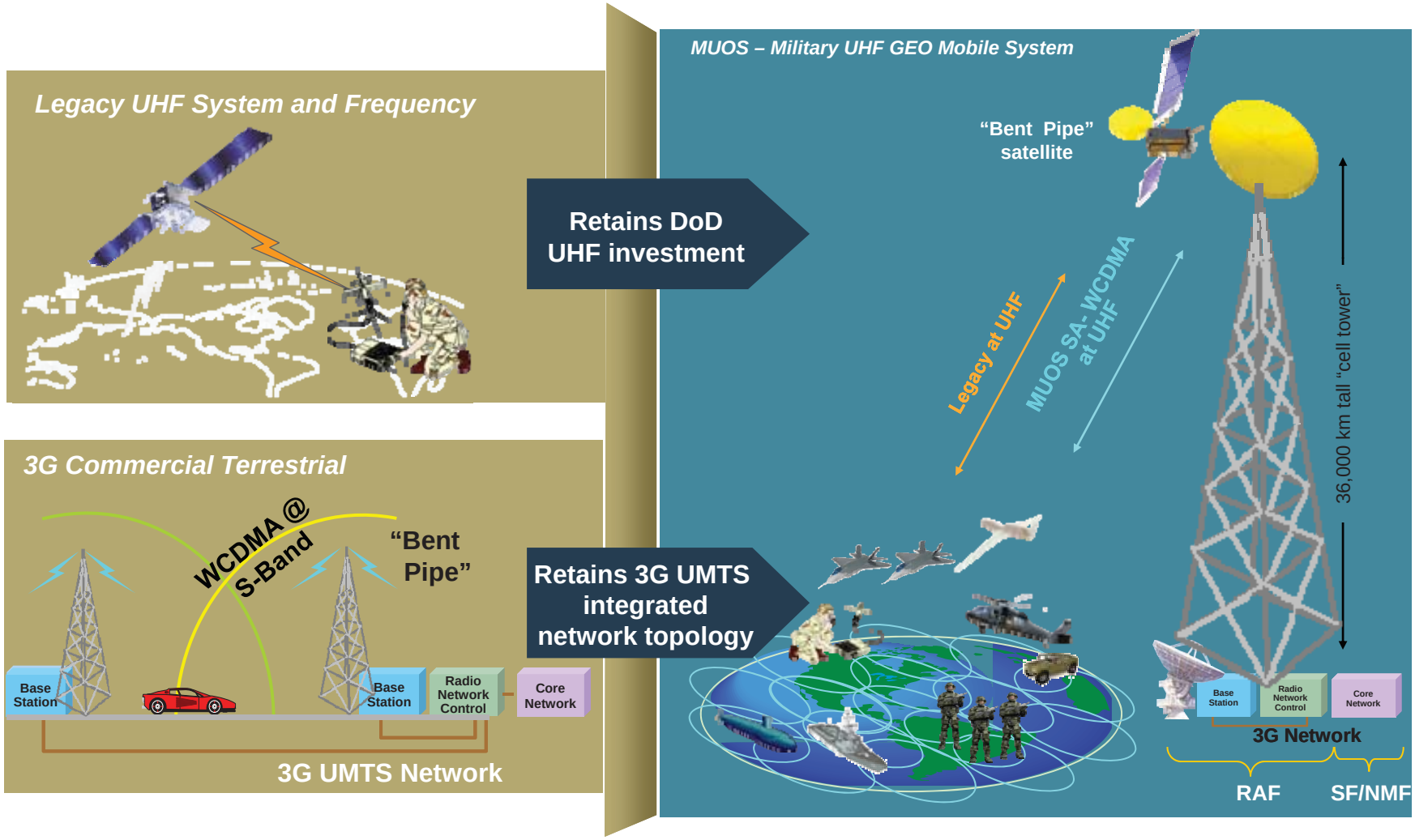
- ***"Hand Held Terminals"***
- ***"On the Move" capability***
- ***All Environments***



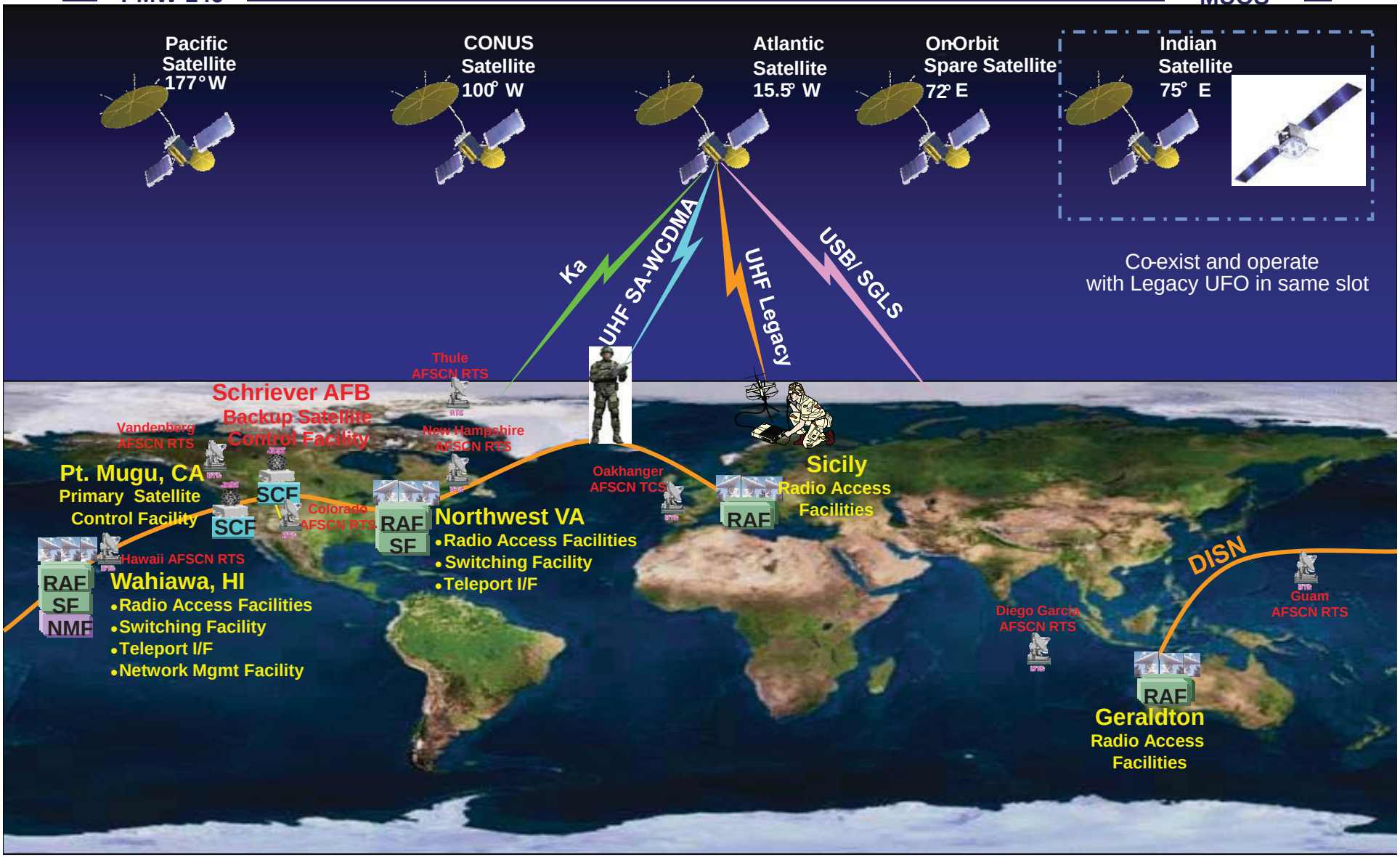
MUOS Hand Held terminal

- **2-3 lbs**
- **9.6 kbps+**
- **Leverage commercial waveform and applications like IP**

What is MUOS?

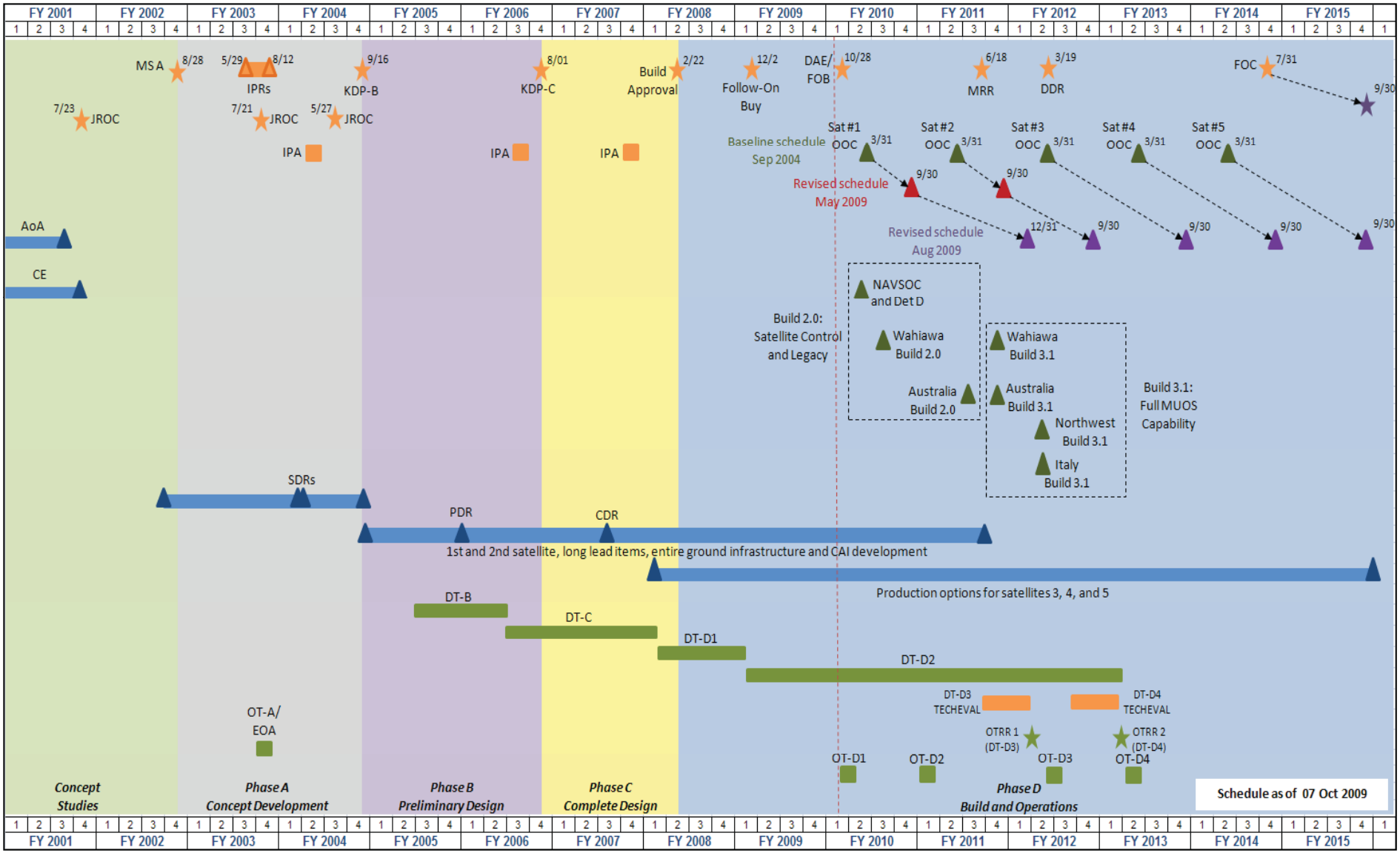

Legacy UHF System and Frequency
3G Commercial Terrestrial
WCDMA @ S-Band
"Bent Pipe"
Base Station
Base Station
Radio Network Control
Core Network
3G UMTS Network
Retains DoD UHF investment
Retains 3G UMTS integrated network topology
MUOS – Military UHF GEO Mobile System
"Bent Pipe" satellite
Legacy at UHF
MUOS SA- WCDMA at UHF
36,000 km tall "cell tower"
Base Station
Radio Network Control
Core Network
3G Network
RAF
SF/NMF

MUOS Architecture



Program Schedule

PMW-146 MUOS



The MUOS Team and Locations

Spacecraft Status

- **Satellite #1**
  - 100% flight hardware delivered, preparing to start satellite assemble integration & test (AI&T)
  - Satellite #1 schedule Sep 2011
- **Satellite #2**
  - 98% flight hardware delivered, remaining units delivered Nov/Dec
  - System Module to be shipped to Sunnyvale

Mate

Multi-Beam Antenna Install

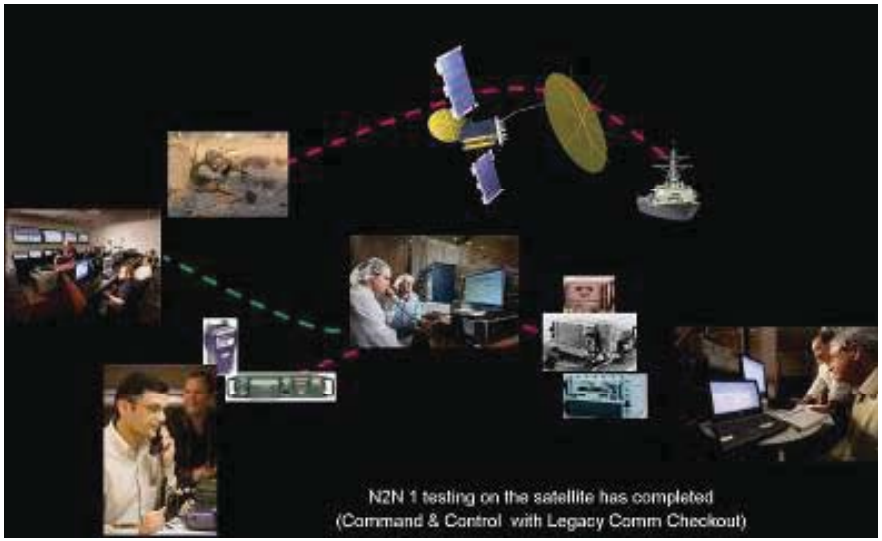
Legacy Antenna Install

Ground Status

- **Ground System**
  - Build 1: Satellite command and control completed
  - Build 2: WCDMA code and unit test completed, made first end-to-end call; Factory Acceptance Testing complete
  - Build 3: First 4 of 9 Integration Points coded/integrated, incorporating Secure Communications ECP

- **Software Build Descriptions**
  - **Build 1:** Satellite control, Legacy point-to-point and netted communications, minor network management functionality (ET failover and hardware fault connection/reporting)
  - **Build 2:** Completed Satellite control, Legacy point-to-point and netted comms
  - **Build 3.1**: Full MUOS point-to-point and group communications with cover, spectrum adaptation, geolocation, comm planning, key management, full network and operations management, congestion management, and access to DSN/SIPRNET

B153 MNSC - successful N2N1a Test



Ground Sites

Ground Site in Wahiawa

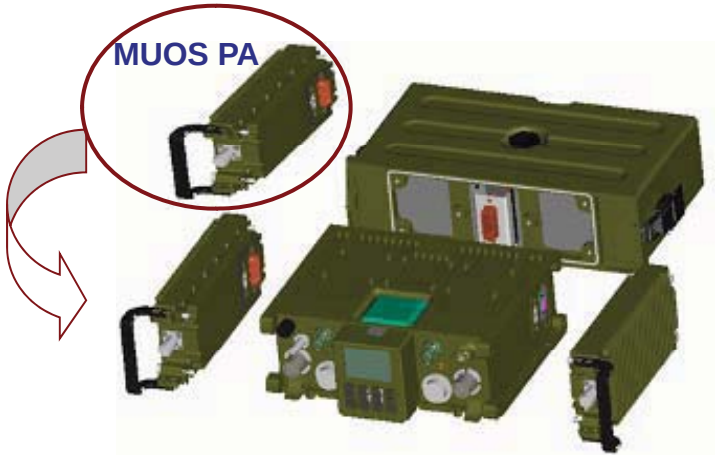
Site Prep in Australia

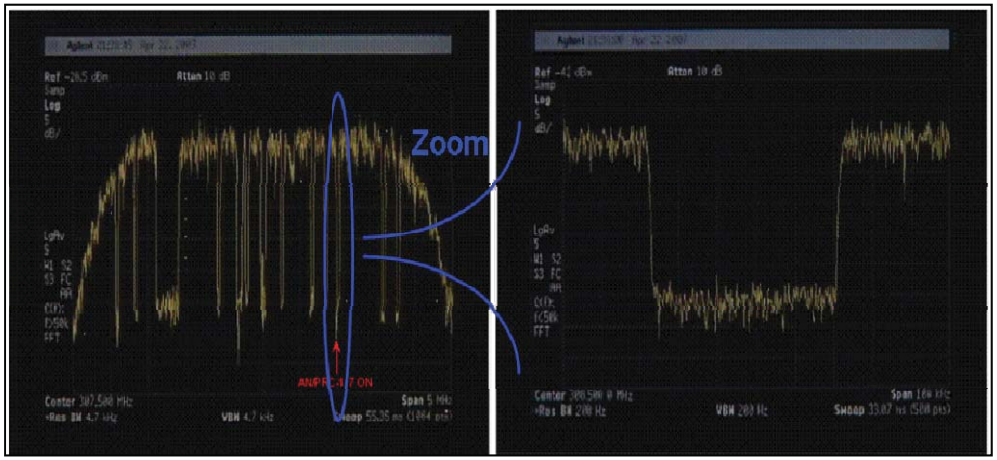
Site Prep in Northwest

Site Prep in Italy

Waveform Status

- **Waveform**
  - Waveform initial integration with ground complete, v1.2 delivered to Information Repository May 2009
  - WF v2.3 FQT scheduled for Oct 2010
- **MUOS-JTRS Coordination**
  - Coordinating with JTRS, full MUOS waveform on contract, target platform HMS man-pack
- **Spectrum Certification Status**
  - Obtained Stage 3 certification for MUOS SA-WCDMA in Sep 2007
  - Stage 4 Frequency Allocation request in review by NTIA





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Mobile UHF SATCOM Need

- Based on lessons learned and after action reviews, **the #1 documented communications shortfall for the mobile warfighter is beyond line of site communications on the move.** (AARs: OEF/OIF, CENTCOM, V Corps, 82nd,101st, 3ID, 3-7 and 1-3 Marines)

LTG Abizaid, as former Deputy Cmdr CENTCOM

- **"To increase our capability [to] command and control on the move, it is imperative that we secure additional UHF (TACSAT) bandwidth or alternate means."**

LTG Wallace, as former V Corps Cmdr

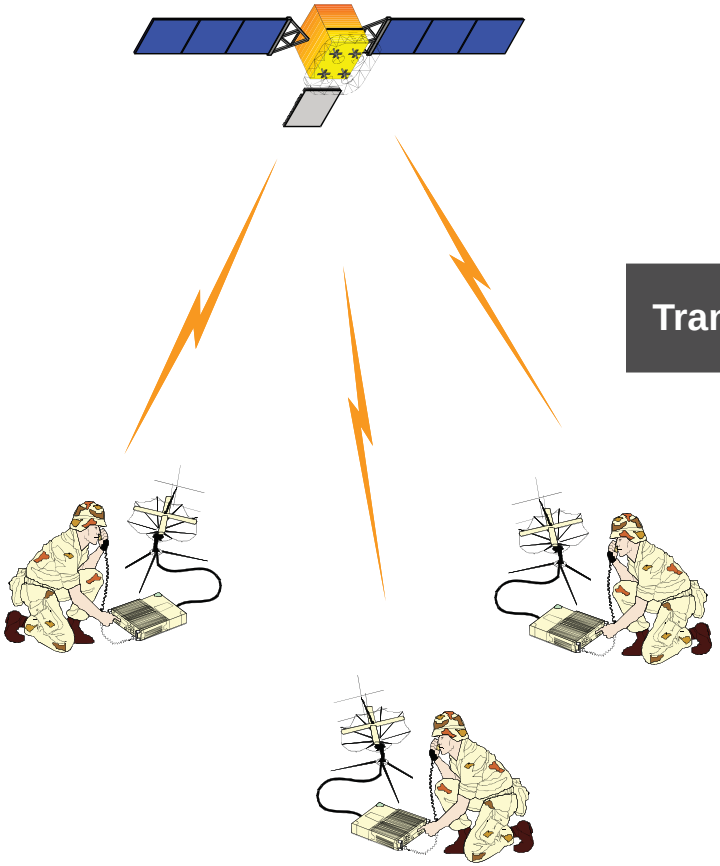
- **"…there is a big demand for the limited number of channels available… we were under resourced in SC TACSAT channels …this placed a significant strain on my ability to provide solid command and control…"**
- **"Despite our efforts to realize network enhanced warfare since Desert Storm, the trigger puller on the ground still cannot tap into the network and realize its benefits."**

MUOS provides greater than 10X capacity increase

MUOS Capability Transition

From

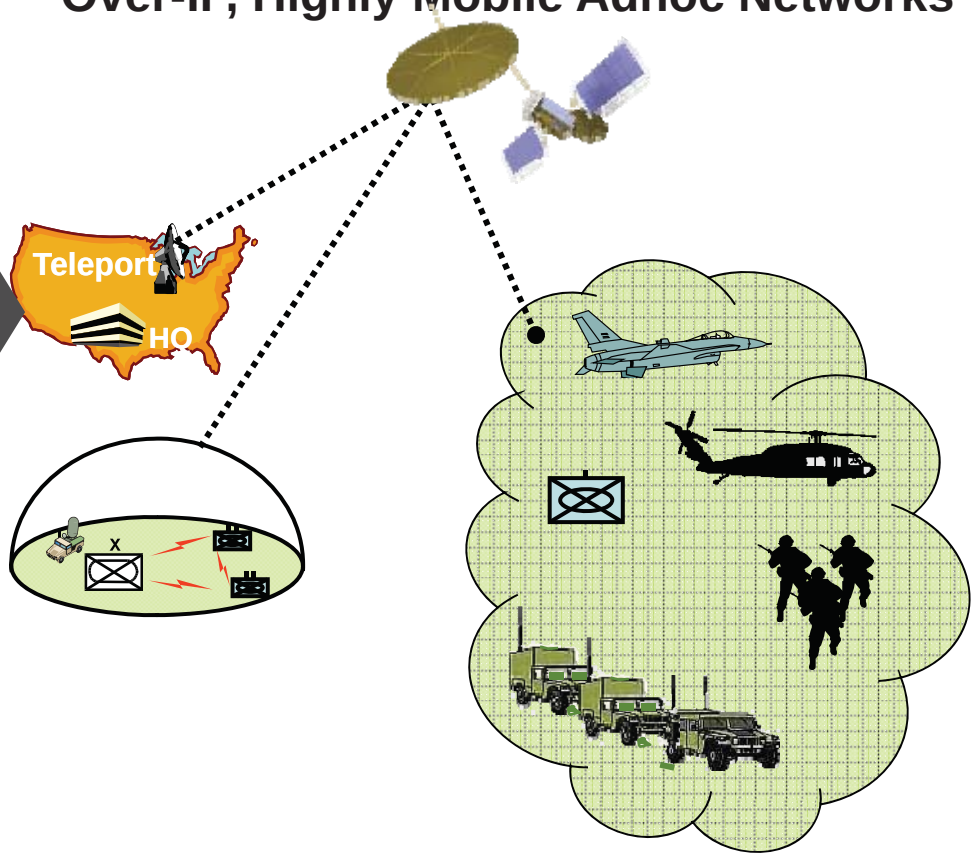
Circuit-based, Closed Networks



Transform

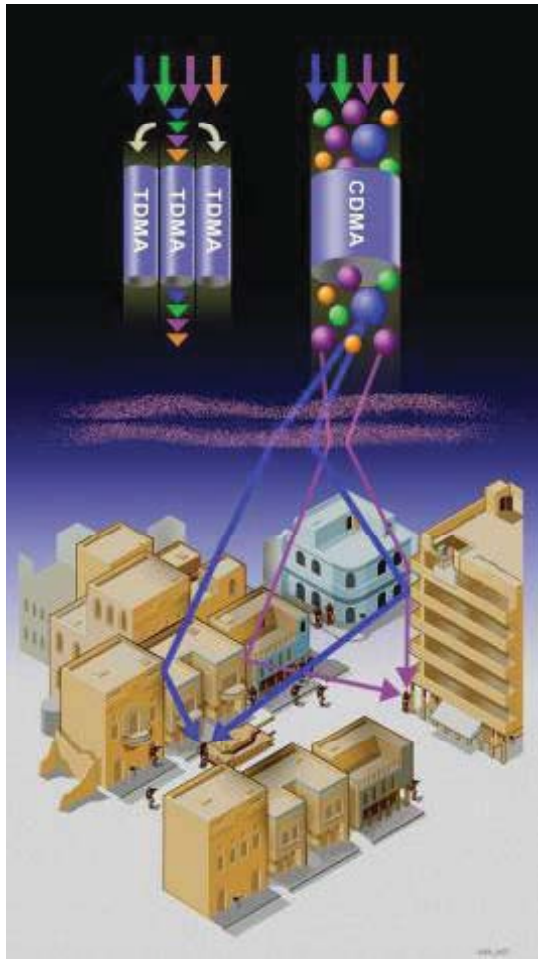
To

Net-centric, On Demand,
Over-IP, Highly Mobile Adhoc Networks



Direct Sequence Spread Spectrum WCDMA Supports Comms on the Move

- **Inherent multi-path gain enabled by recombination with rake receiver**
  - Single satellite link closure to a stressed user (full ops with 4 satellites)
  - Reduced dropouts with soft handover
- **Short frame timing enables near-objective latency**
- **Simultaneous operations with Legacy**
- **Adaptive power control allows transparent maintenance of connectivity and QoS to stressed users**
- **Inherent LPI/LPD/LPE and jamming interference tolerance**



CDMA
Multiple users, data rates & applications sharing bandwidth

TDMA
One user at a time

WCDMA overcomes ionospheric scintillation and integrates multi-path signals with WCDMA RAKE receiver (+11dB advantage)

Bandwidth-on-demand capability thriving in stressing environments

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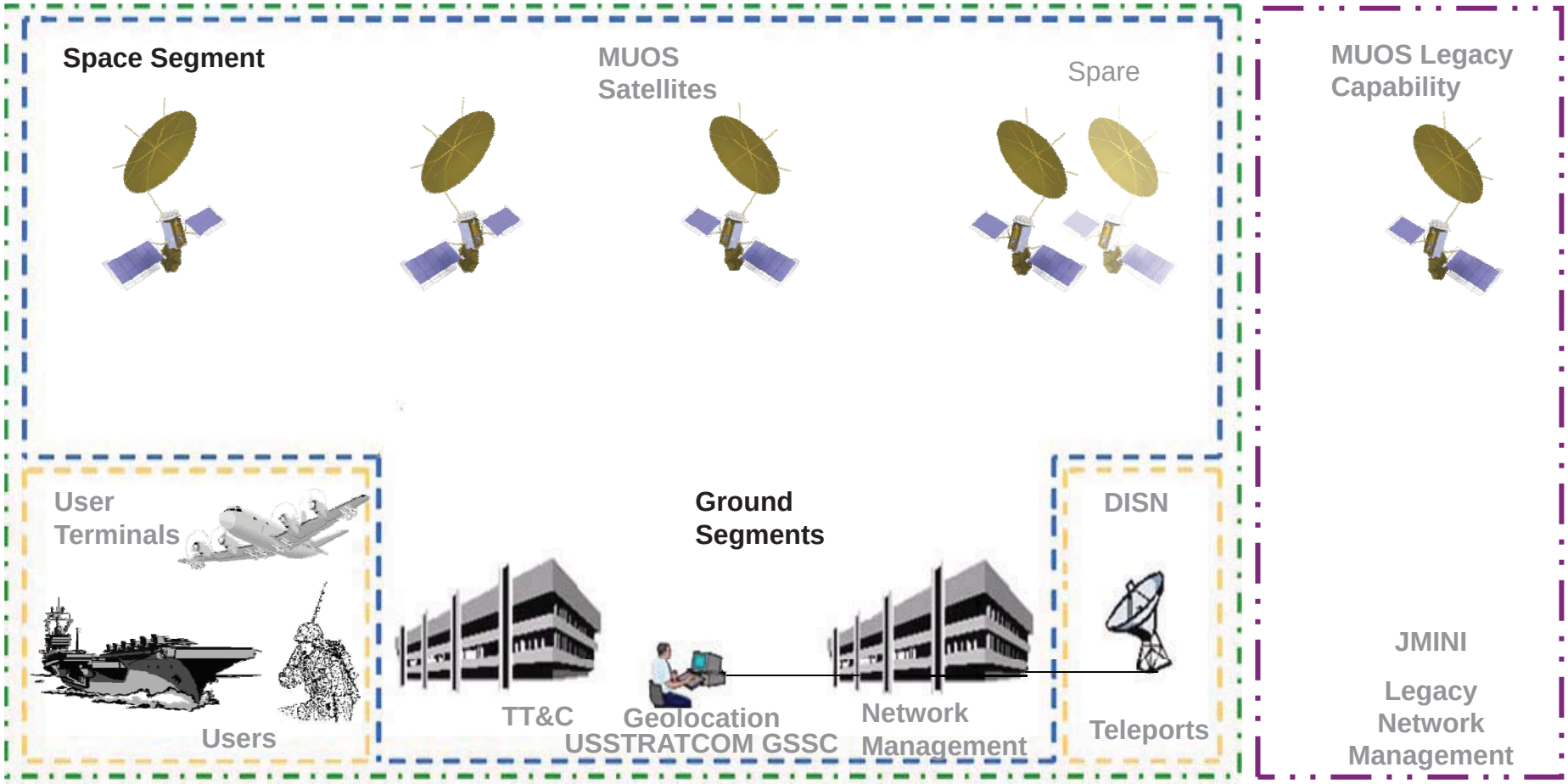
MUOS: End-to-End System



Radios for MUOS

- **Two Joint Tactical Radio System (JTRS) form factors will be MUOS Compatible**
  - Handheld, Manpack, & Small Form-fit Radio (HMS)
    - JTRS Acquisition Decision Memorandum dated Nov 28, 2007 directs funding of MUOS capable Manpack, with work begun in FY2008.
    - JTRS Manpack engineering design models anticipated by 2011, production in 2012
  - Airborne and Maritime/Fixed Station (AMF)
- **Other Aviation Terminal Efforts**
  - Joint Strike Fighter (JSF)
    - MUOS to be incorporated into Block 4 aircraft
  - Naval Air Systems Command (NAVAIR)
    - MOA with PMA-209 for ARC-210
  - Army Aviation
    - MOA with PM-AME on ARC-231
    - Awarded study contract to Raytheon to determine required changes to ARC-231

PMW-146 working with ALL terminal program offices

MUOS Waveform / Information

- **The MUOS Waveform is ITAR Sensitive and has the following requirements for distribution:**
  - Proof of U.S. Citizenship
  - Company has valid DD2345 (Militarily Critical Technical Data Agreement)
  - Signed MUOS Use and Non-Disclosure Agreement
- **Location**
  - WF v1.1 and v1.2 are located in the JTRS IR
    - JTRS sponsored registration process (http://ir-public.jpeojtrs.mil/)
  - WF v1.2 is available on CD per request to PMW-146
    - Submit request to PMW-146 and follow process provided in the response
  - Future WF Versions, MUOS Technical and Programmatic information
    - MUOS Technology Exchange Website (maintained by PMW-146)
      - Estimate Website will be available May 2009
      - Additional guidance can be found in E-Commerce announcement

Summary

- **Current UHF SATCOM systems are reaching end of life**
- **MUOS will replace UFO constellation**
  - Working to on-orbit date of Dec 2011
  - Ground & Waveform development still on schedule
    - End-to-End service with “Secure Comms”
    - MUOS Waveform being distributed to developers; waiting for final version
- **MUOS will provide a significant increase in narrowband communication capability**

MUOS is vital to future UHF SATCOM operations and will change the way services are delivered!