



# Medium Data Rate (MDR) Satellite Communications (SATCOM) on the Move (SOTM) for Battalion (BN)-Level Warfighters

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Army-Contract MOIE



# Problem

- **Current Army digitization architecture lacks a Beyond Line-of-Sight (BLOS) Communications on-the-Move (COTM) Medium Data Rate (MDR) capability at Battalion (BN) Tactical Operations Centers (TOCs) that offers both low management and reliable communications.**
- **The mission is to provide communication links with BLOS, COTM, MDR, Low Management, fast setup, reliable communications among TOCs to support collaborative planning, and Situation Awareness (SA) and Command and Control (C2) message exchange.**
- **The objective force requires highly mobile communications in support of the Unit of Action (UA) elements. The forces in support of the UA are anticipated to be widely dispersed within their assigned cell and beyond the anticipated range of their Line-of-Sight (LOS) terrestrial radios.**
- **Currently there is no BLOS capable solution that can service the critical operational tasks on-the-move:**
  - **Dissemination of the common tactical picture (synchronization of Joint Common Database [JCDB], dissemination of SA, etc.)**
  - **Exchange of C2**
  - **Collaborative planning**

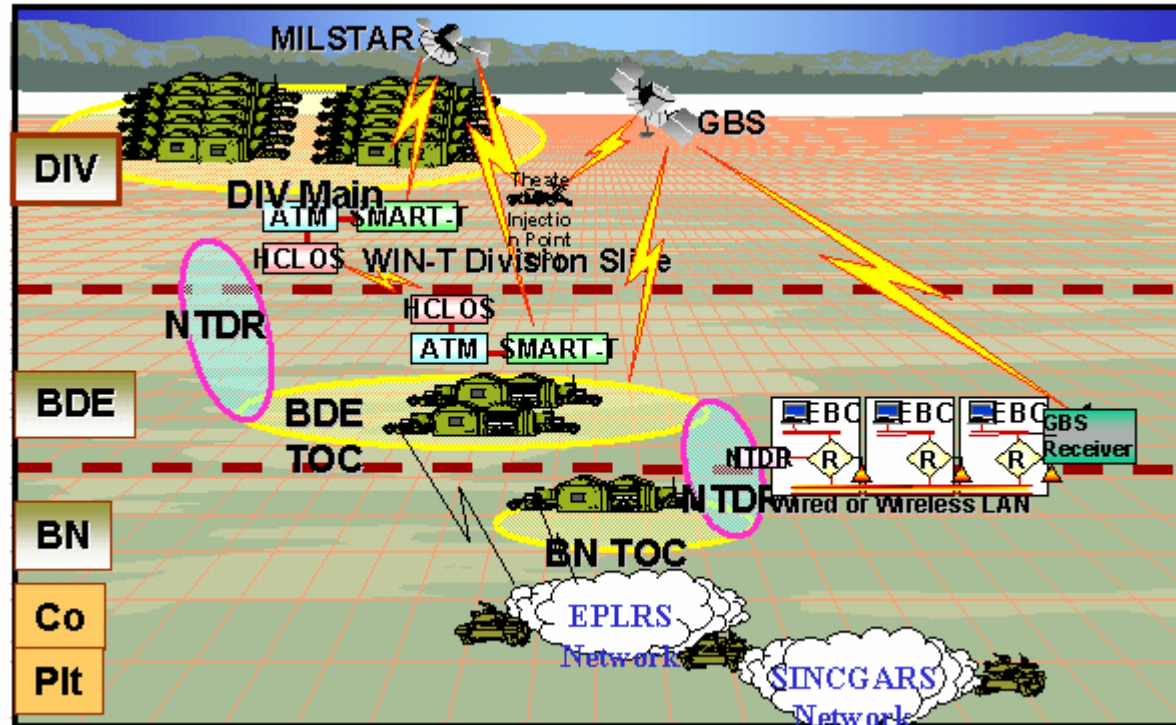
# Background Current Situation

## ■ How is the task performed today?

- Near Term Digital Radio (NTDR) is used today to link BN and Brigade (BDE) TOCs
- SMART-T (Milstar) supports BDE and above range extension of the MSE

## ■ What are the limitations of current methods or tools?

- Range: need NTDR relays for range extension
  - Range is a function of the number of hops and the co-site interference
  - As the number of hops increases, performance degrades and delay increases
- Management: need to engineer, man, and secure relays
- Spectrum authorization is an issue for NTDR
  - Recently added a non spread-spectrum mode

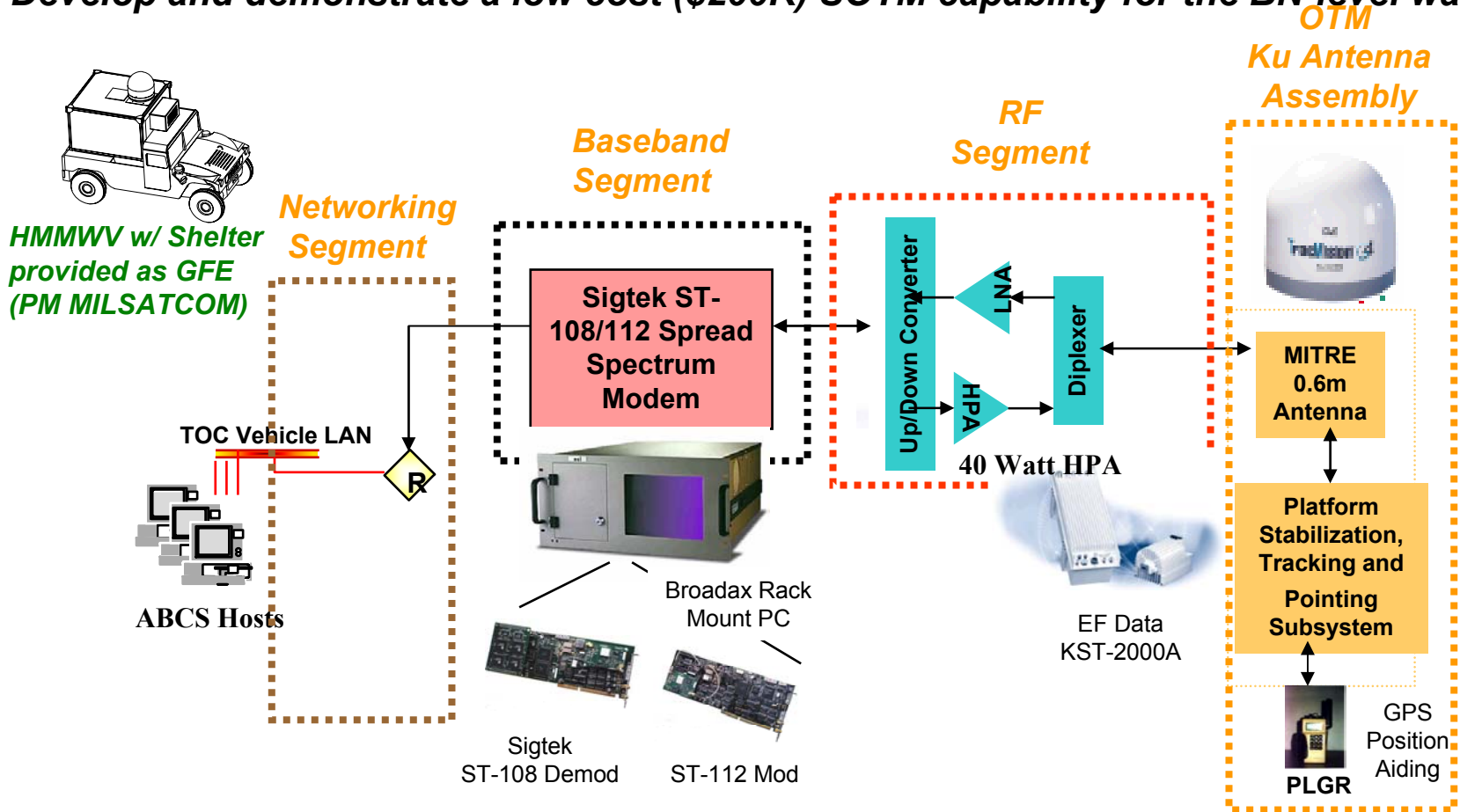


Today's Tactical Deployment

Army doctrine is moving toward lighter, more mobile/agile and more geographically spread forces. With the increased coverage area and agility demands, the current BN echelon terrestrial network must be augmented by SOTM.

# Objective

Develop and demonstrate a low cost (\$200K) SOTM capability for the BN-level warfighter

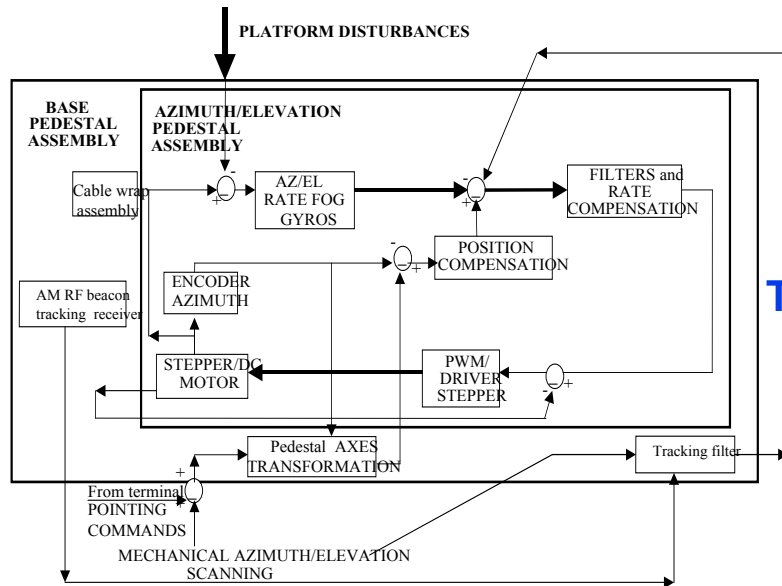


Ku-band SOTM terminal will provide Medium Data Rate (MDR) Communications to the Battalion (BN) Tactical Operations Center (TOC) for Beyond Line-Of-Sight (LOS) range extension

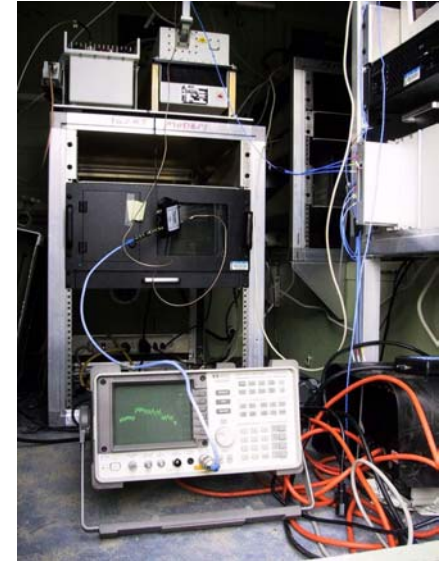
# Activities

- **Develop and demonstrate a 0.6 m transmit-capable prototype antenna and integrate the prototype antenna into the tracking pedestal**
- **Analyze waveform performance using channel simulator to tune modem hardware**
- **Develop a protocol stack, which includes a custom-designed link layer protocol (i.e., Dynamic Frame Protocol), and implement it to demonstrate shared channel access**
- **Develop a hybrid platform stabilization system that includes both open and closed loop tracking subsystems**
- **Perform system integration of the end software, computers and processors, modems, RF equipment, and antenna and tracking system onto a High Mobility Multi-purpose Wheeled Vehicle (HMMWV)**
- **Test and characterize the performance of the prototype terminal**
- **Conduct a series of demonstrations that confirm the prototype terminal's ability to exchange SA and C2 messages on-the-move (OTM) and provide full communications support support, including collaborative planning, on-the-pause (OTP)**

# Highlight



Tracking Dynamics:  
85 deg/sec  
45 deg/sec<sup>2</sup>



Elevation hardware not shown; similar to Azimuth except secant filter correct

**Challenge: Will a hybrid platform stabilization system yield a sufficiently small tracking error to support SOTM under rough terrain dynamics**

- Mechanical rigidity/inertia increase: structural stiffening.
- Increased micro-stepping torque consistent w/ 95% percentile dynamics and increased step resolution/ encoder readouts to counter stall-out
- Selective-open loop tracking: rely on high quality Fiber Optic Gyro (FOG) rate loop and inherent low drift -- solution provides inherent Blockage Mitigation
- Utilizing existing COTS sensors and mechanical gearing to minimize cost.
- Major portion of the work in development of DSP/embedded controller(s) to give terminal its unique characteristics

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# Highlight: Modem and Field Test

## ■ Field Test

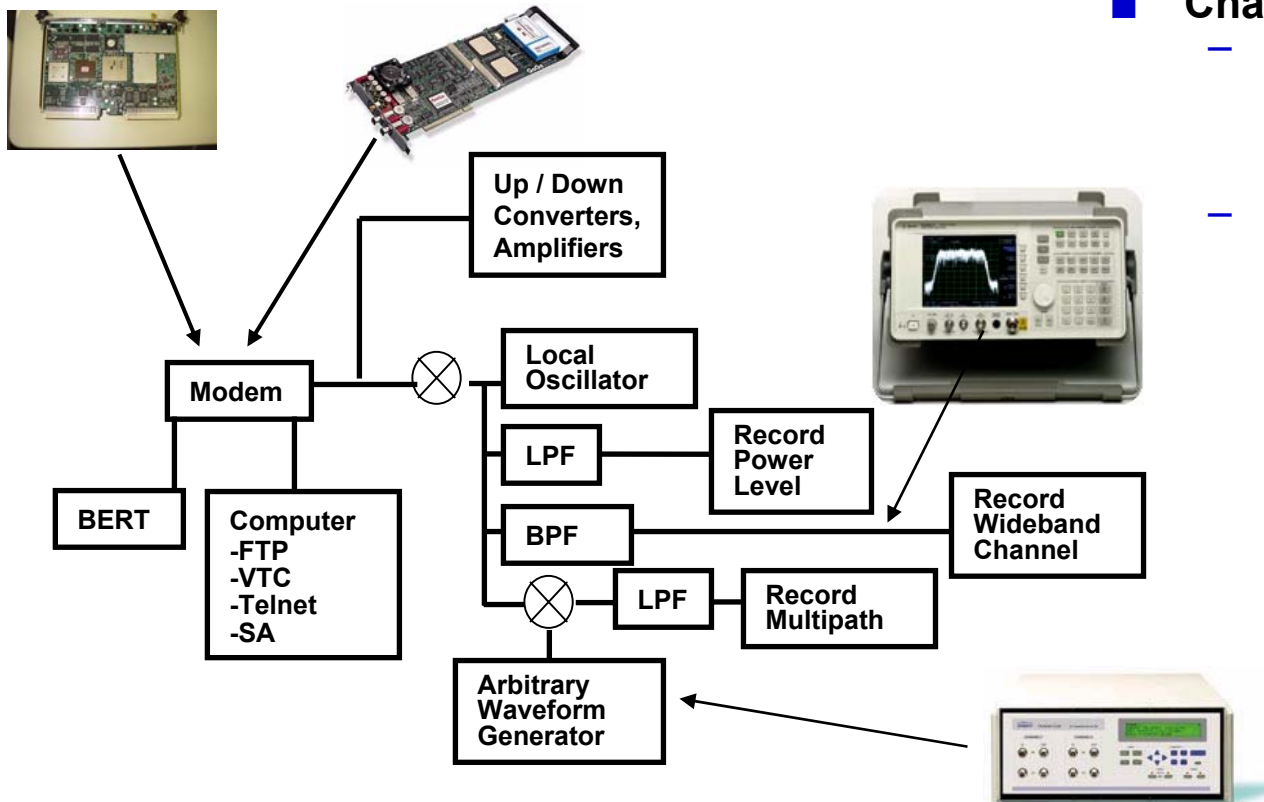
- Lab testing using Channel Simulator with Multipath, Shadowing and Doppler
- Field tests integrated with testbed equipment
- Channel characterization of power and multipath effects in SOTM environment using data capture

## ■ Modem Performance

- Bit Error Rate Test
- Acquisition Testing
- Application performance
  - Real Time
  - File Transfer
  - Army Application Specific

## ■ Channel Characterization

- CW measurements
  - Signal Level Variation
  - Doppler Characterization
- Multipath Characterization
  - Pulse Generation Technique
  - Sliding Correlator Technique



# Highlight/Demonstration

- **Test and characterize the performance of the prototype terminal under off-road operations**
  - **Terrain can range from relatively benign improved road at moderate speed to rugged off-road conditions**
  - **Course B in the Churchville Test Area at Aberdeen Proving Grounds**
  - **Westford, MA**
    - **Former sand and gravel pit**
    - **Near MITRE-Bedford**
    - **Selected for accessibility and variable terrain characteristics**
- **Conduct a series of operational-like demonstrations that confirm OTM communications and the effectiveness of link layer protocol**

QuickTime™ and a  
Photo - JPEG decompressor  
are needed to see this picture.

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# Impacts

- Enable improved understanding of SOTM technology to assist the Army in future SATCOM terminal developments in support of the Army's Objective Force
- DARPA interest in transfer of MITRE's technology to Future Combat System-Communications (FCS-C) program (requested collaboration with Lincoln Laboratory thru CECOM S&TCD, Fort Monmouth)
- Assist PM MILSATCOM with their Ka-band terminal specification in specifying the mobile performance parameters
- Develop requirements for WIN-T procurement which will address the FCS Objective Force requirement for BLOS mobile communications
  - WIN-T is the Army's Objective Force (e.g., Unit of Action/ Unit of Employment (UA/UE) through Theater) common user communications/networking system
  - UA elements have a critical need for SOTM capability
- Lead technology transfer to DOD and industry in the area of mobile SATCOM
  - Relevant publications/presentations made at MILCOM 2001 and planned publications for MILCOM 2002 (3 MILCOM papers submitted as draft)

# Future Plans

- Complete the ongoing design and development of the SOTM prototype terminal subsystems and integrate terminal subsystems onto the HMMWV with S-250 shelter
- Test and characterize the performance of the prototype terminal under various terrain conditions
- Conduct a series of demonstrations that confirm OTM communications using real C2 apps.
  - Exchange SA and C2 messages
  - Demonstrate collaborative planning
  - Video dissemination OTM
- Provide full communications support OTP
- Develop requirements for next generation Army Ka-band SOTM terminal
- Assess adaptation of selected technologies developed under this MOIE effort for programs such as Blue Force Tracking and FCS-Communications
- Provide SOTM prototype design and terminal performance characterization information to Government sponsors, academia, and industry through the MITRE Technology Transfer Office