US ARMY CERDEC Dismounted Solder Navigation – Update

2012 Precision Indoor Personnel Location and Tracking Annual International Technology Workshop

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Critical Gaps – Technologies & Objectives

**Critical Gaps**

*Providing Position, Velocity & Time*
- Too Heavy
- Too Large
- Too Costly
- Too Much Power
- Not Robust (Urban/Indoor)

**Technical Objective**

Find Solutions Suitable for Soldier Navigation in GPS Challenged Environments.

**FY11**
- MEMS INERTIAL SENSOR TECH
  - Sensor Improvements, Error Compensation

**FY12**
- RF RANGING
  - Passive Ranging, Signals of Opportunity, UWB
- VISION BASED TECH
  - SLAM, Optical Flow, Feature Extraction
- TIME & FREQUENCY
  - Chip Scale Atomic Clock, Common Time Module

**FY13**
- IMPROVED GPS RECEIVER
  - Multipath Mitigation, Net Assisted GPS, Software Receiver, M-Code Enhancements
- INTEGRATED NAVIGATION
  - Ultra Tight, Decentralized Nav
Highly likely that we find that “one size doesn’t fit all”

* Parts of other Warrior Systems (no added costs, size or weight and minimal added power)
**Purpose:**
Develop and demonstrate software that identifies available spectrum dynamically (RF-aware) for tactical communications and for position location in GPS-degraded environments

**Products:**
- Software module that enables spectrum policy management for Dynamic Spectrum Access (DSA) enabled radios (e.g. PRC-148/152)
- Architecture to integrate and enhance DARPA Disruption Tolerant Networking (DTN) for future use in Army tactical networks such as WIN-T
- Software for position locating based on Net Assisted GPS and signal timing techniques

**Payoff:**
- Reliable message delivery in disruptive communications environment
- Provide position locating in GPS degraded environments

**Technologies:**
- RF Ranging
- NetAssisted GPS

**Platforms:**
- JTRS Radios
- Android Smartphone
- WIN-T
Radio Frequency (RF) Ranging

**Purpose of the Project:**
Increase ranging capability that serves as an aiding source for dismounted Soldiers to navigate in the GPS impaired environment

**Product:**
Software module that enables Radio platforms to perform RF ranging

**Payoff for the Army:**
- Capability to aid tracking Soldiers and platforms for Future Force operations and training
- Operational benefits for the Future Force, contributes to: enhanced communication, increased maneuver, situational awareness, reduction of friendly fires, and increased lethality.

**Technologies:**
- RF Active Ranging: Capturing the communication channel to send ranging messages.
- RF Passive Ranging: Extracting time from the header of existing communication packet exchanges.
- Hybrid Ranging: Combining Active and Passive Ranging

**Platforms:**
- JTRS Radios
- Android Smartphone

**Performers:** ITT and ENSCO
Purpose:
Deliver a soldier navigation solution that uses team-wide information and collaborative distributed computing to provide a position accuracy of 1m in GPS denied environments.

Objectives and Benefits:
• High accuracy and robust navigation for dismounted warfighters
• Team-wide solution leveraging collaborative, distributed computing
• Scales with resources available, including opportunistic use of soldier-based computing and communications resources

Performers: TRX, Mercury
• **Program Objective:** Utilize existing networks to distribute existing data to improve situational awareness
  
  – Shared information: GPS, DGPS, augmentation, ranging, timing, LADAR, MMW radar, cameras, maps, and imagery
  
  – Demonstrate network agnostic capabilities and optimization for bandwidth

**Performer:** IS4S
**Purpose of the Projects:**
Explore Potential Improvements to Navigation Sensors with the Goal of Improving the Overall Navigation System Performance.

**Approach:**
An enhanced integrated navigation system that incorporates inputs from vision sensors (COTS cameras) and leverages improved performance from MEMs gyroscopes utilizing the benefits of the commutating approach.

**Payoff for the Army:**
Provides Position Location Information (PLI) to support situational awareness in GPS degraded environments at a low cost and low SWAP

**Technologies:**
- MEMs Gyroscop
- Vision Aid, SLAM

**Platforms:**
- Net Warrior Smartphone (Camera)
MEMS Inertial Measurement Units (IMUs)

- Micro Electro Mechanical Systems (MEMS) technology enables small, low power sensors that are compatible with large-scale fabrication processes.

- By cofabricating or tightly integrating MEMS rotation, acceleration, and timing devices, compact Inertial Measurement Units can be realized with significant SWAP+C reductions versus conventional IMUs.

- Continued improvements in the accuracy of MEMS sensors and IMUs will unlock a new suite of self-contained navigation technology that will decrease reliance on GPS.
Intelligent Human Motion Sensor

**Purpose of the Project:**
- Improve Soldier Navigation System Performance to Support Battlefield Situational Awareness in GPS degraded environments.
- Enhance the Performance of Soldier Borne Dead Reckoning Navigation Devices with Improved Soldier Motion Profile Estimations
- Motion Profiles to Include: forward/backward walking, side stepping, slow/fast running, upstairs/downstairs walking, crawling, etc.

**Product:**
- Software module to enhance the performance of pedometer

**Payoff for the Army:**
- Navigation Improvements for Dismounted Soldiers in Urban and Indoor Environments
- Operational Benefits Include: enhanced situational awareness, improved coordination for troop maneuvering, and the reduction of casualties due to friendly fire.

**Technologies:**
- Signal processing on sensor data

**Platforms:**
- Nett Warrior Android Smartphone
- Regular Pedometer

**Performer:** Scientific Systems
Program Objective: Develop vision based navigation technology, exploiting the emerging small, lightweight, lowcost cameras. Evaluating Stereo and Mono camera capabilities. Investigating SLAM, Optical Flow, Feature Extraction, and database correlation concepts.

Performer: Draper Laboratories, OKSI, IAI
Warfighter Integrated Navigation System (WINS)

- Goal: To Integrate a Dismounted Soldier Navigation System for Battlefield Situational Awareness
  - Performance (position accuracy and reliability)
  - Robust (operates in absence of GPS such as indoors/urban)
  - SWAP-C Compliant (can be worn by Dismounted Soldiers)

**WINS V1.0**
- SAASM GPS Rcvr
- Pedometer
- Android* Integration
- Android* Processing

**WINS V2.0**
- RF Ranging
- Vision Sensor
- Net Assisted

**WINS V3.0**
- CSAC Integration
- Motion Classification
- Productization/Soldier Integration
- Natick (Integration Partner)
- PM SWAR/PD PNT (Transition)

**Demonstratable Products Each Year**
Multi-Global Navigation Satellite System (GNSS) Receivers

**Purpose:**
- To investigate a more robust satellite based navigation solution for use by the US Army.
  - Relies on many different RF signals making it more difficult to deny or spoof.
- Investigate feasibility of developing SWAP-C compliant multi-GNSS receivers and antennas.

**Results:**
- Receiver capable of operating with several different GNSS signals from space. Configurable and dynamic to take advantage of good signals and optimize a navigation solution.
- Tools to analyze performance and model and simulate the effects of GNSS receivers in place of GPS receivers in navigation equipment/systems. Utilize CIGNM and new Spirent GNSS Simulator.

**Payoff for the Army:**
- Better understanding of value (strengths and weaknesses) of a multi-GNSS solution.
- Simulation tool to investigate impacts on various navigation systems.
- Potentially more robust space based navigation solution than a pure GPS based navigation solution.
Positioning and Navigation for the Future Warrior

GPS with CSAC/AJ
- IMU
- Velocity Sensor(s)
- Altimeter
- Magnetic Compass
- * Comm/Network
- * Video Camera
- * Databases
- * Other

Navigation Processing
- Modular/
- Tailorable/
- Reconfigurable
- Constrained Optimization
- Moding
- Filtering
- Video/Map Registration

Display

Highly likely that we find that “one size doesn’t fit all”
* Parts of other Warrior Systems (no added costs, size or weight and minimal added power)
Future Dismount Comm/Nav

- Pos / Nav Sensors
- Radio / Communications
- Processor
- SW Applications (C2, Mission specific sw e.g. Speech/Text Language Translator)
- Mission Specific Inputs
- Flexible Display
- Human Interfaces (Voice, headphone, Video/Camera, “Key Pad / Mouse”)

- Enables you to plug and play, swap in/out devices or software, and tailor to the mission
- No longer have to buy a single system for a single function (radio, GPS, PFED, FBCB2, etc…)

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
BACK UPS
Project Objective:

Provide affordable, reliable and accurate position location information for dismounted Soldiers and platforms to support battlefield situational awareness and operations in urban and other complex environments.

Approach:
- Investigate improvements in navigation sensors
  - MicroElectroMechanical (MEM) gyroscopes
- Develop innovative navigation systems
  - Vision Based Navigation (Cameras as sensors)
- Leverage existing equipment as nav sensors
  - RF based ranging with Rifleman Radios
  - Network Assisted Navigation

Benefits/Metrics:

Warfighter Payoff:
- Enhanced Situation Awareness
- Enable Soldier-based Cooperative Engagements
- Improved Dismounted Soldier Navigation

Program Provides:
- Determine dismounted Soldiers’ own position and track other unit members to 1m for operations in urban and other complex environments where GPS signal reception may be degraded or unavailable.
FY13 New Starts

**Signals Of Opportunity (SOOP)**
Leveraging the Robust Surface Navigation (RSN) DARPA effort to explore alternative RF based navigation sources for the user
FY 13 Start TEC-Demo in FY14/FY15

**Simultaneous Location And Mapping (SLAM)**
Secondary benefit from vision based navigation that requires additional processing and data storage as well as algorithm development to handle new angles of approach. (provides Soldier generated map reference as a nav aid)
FY13 Start TEC-Demo FY14/FY15

**Mini LIDAR** - (Light Detection And Ranging, aka LADAR (LAser Detection And Ranging)) - optical remote sensing technology. Solid State Scientific Corporation (SSSC) is currently developing an imaging LADAR receiver using a novel epitaxial layer transfer (ELT) integration technique developed by AFRL/SNHC.
FY 13 Start TEC-Demo in FY15
FY13 New Starts (cont’d)

**GNSS SV Monitor**
Develop a CERDEC Global Navigation Satellite System (GNSS) satellite monitoring station. The monitoring station will track the health of each GNSS satellite and provide an analysis of satellite availability for use by US Forces based on performance.
FY13 Start

**Nuclear Magnetic Resonance Gyro (NMRG)**
Investigate the NMRG and determine performance characteristics for integration into US Army platforms.
FY13 Start

**CSAC Based Time Synchronization for Comms**
Incorporation of the CSAC into command post communications systems to maintain communications synch in the absence of GPS (no GPS time). This reduces dependence upon GPS for Command Post functions. (team with S&TCD)

**Mission Data Distribution Effort**
Support development of Mission Data Distribution with the PLI necessary to geographically separate command post functions (team with Sys Eng & Software Architecture branch)