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Positioning, Navigation and Timing (PNT): The Foundation of Command and Control

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Introduction

Positioning/Navigation (Pos/Nav) and Timing information is very critical to most military operations; paramount to Command and Control.

■ **This Paper addresses**

- **Evolving Role of PNT on the Battlefield**
- **Army PNT User Requirements and Lessons Learned**
- **Current PNT Shortfalls**
- **Ongoing US Army Technology Program – Advanced Pos/Nav and Tracking the Future Force.**





Expanding Role of Pos/Nav and Timing on a Digitized Battlefield

- Traditional Role of position information is for own platform pilotage and low rate, non-automated Situation Awareness via Voice Comms
- Evolving Role of position information is as a shared resource. Automated high frequency position reporting provides a common blue force deployment picture, adds context to modern digital battlefield systems to enhance
 - Maneuver and Maneuver Control
 - Logistics
 - Intel Data Fusion
 - Air Defense
 - Fire Support
 - Munitions Emplacement
- The accuracy and availability of position and motion information directly affects the future Army's C2 and Operational effectiveness.



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Field Manual
No. 100-14

FM 100-14

Headquarters
Department of the Army
Washington, DC, 23 April 1998

Risk Management

Contents

Situational Awareness

“ability to have accurate and real-time information on friendly, enemy, neutral, and noncombatant locations; a common, relevant picture of the battlefield scaled to specific level of interest and special need.

Assessment of the Risk Management Process 3-9

Appendix Examples of Risk Management Application Appendix-1

Glossary Glossary-0

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Joint Pub 1-02 : Defn. Command and Control

Joint Publication 1-02

Command and Control

“The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.”

Conclusion: The better the situational awareness information, the better the decisions that the commander will make, and hence, the better execution of that mission.



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Lessons Learned And User Requirements for PNT

Inside The Army, June 30, 2003, Pg. 1

“....an after-action report first reported last week by Inside the Army stated that a majority of soldiers brought their own commercial GPS receivers...”

■ **TRADOC PAM 525-66 Force Operating Capabilities, Jan 2003**

- **FOC-03-01: Command and Control: (6)**
- **FOC-05-01: Mounted/Dismounted Maneuver:**
- **FOC-05-03: Operations in Urban and Complex Terrain:**
- **FOC-06-01: NLOS Lethality: (13) (e)**

■ **Operational Requirements Documents:**

- **Operational Requirements Documents for the Future Combat Systems (FCS)**
- **Land Warrior Capability Development Document (CDD) for Ground Soldier System, Block III**

Essentially these can be summed up as

“Requirement: An Affordable Precise PNT Capability for All Environments/Conditions”



The Washington Post

“'Friendly Fire' Deaths Traced to Dead Battery, Taliban Targeted, but U.S. Forces Killed”

The deadliest "friendly fire" incident of the war in Afghanistan was triggered in December by the simple act of a U.S. Special Forces air controller changing the battery on a Global Positioning System device he was using to target a Taliban outpost north of Kandahar, a senior defense official said yesterday. Three Special Forces soldiers were killed and 20 were injured when a 2,000-pound, satellite-guided bomb landed, not on the Taliban outpost, but on a battalion command post occupied by American forces and a group of Afghan allies, including Hamid Karzai, now the interim prime minister....”

*By Vernon Loeb
Washington Post Staff Writer
Sunday, March 24, 2002; Page A21*

Inaccurate information may impose devastating consequences.





GPS is great... but it has some limitations

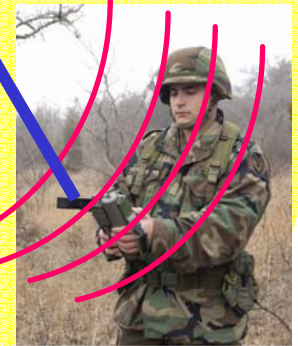
Blockage =
No Service



Multipath =
Position Error



Interference =
No Service





The Volpe National Transportation Systems Center, US DOT

“.... Once hailed as the only navigation system necessary for aviation and other modes of civil transportation, the role of GPS has been reevaluated in the last few years. GPS is accepted as an increasingly important component in the nation's transportation infrastructure, but it is no longer seen as a single-source solution”

Volpe Journal 2003: Transportation and Security

DOT understands the importance of GPS as part of the national infrastructure and recognizes the need for backups. Similarly so should the Department of Defense.





Available Backups to GPS

■ Externally Referenced

- Positioning/Navigation Systems/Sensors which are based on sources external to the platform.
- Examples include Loran and other types of RF Ranging.
- System errors are generally consistent over time and distance traveled.
- Limitations are the availability of observations from the source.

■ Self-Contained

- Positioning/Navigation Systems/Sensors whose functions are solely based on observations experienced by the platform.
- Examples include Inertial Navigation Systems and other types of Dead Reckoning systems.
- System errors generally degrade with respect to time and/or distance traveled.



Need more than one tool in the toolbox

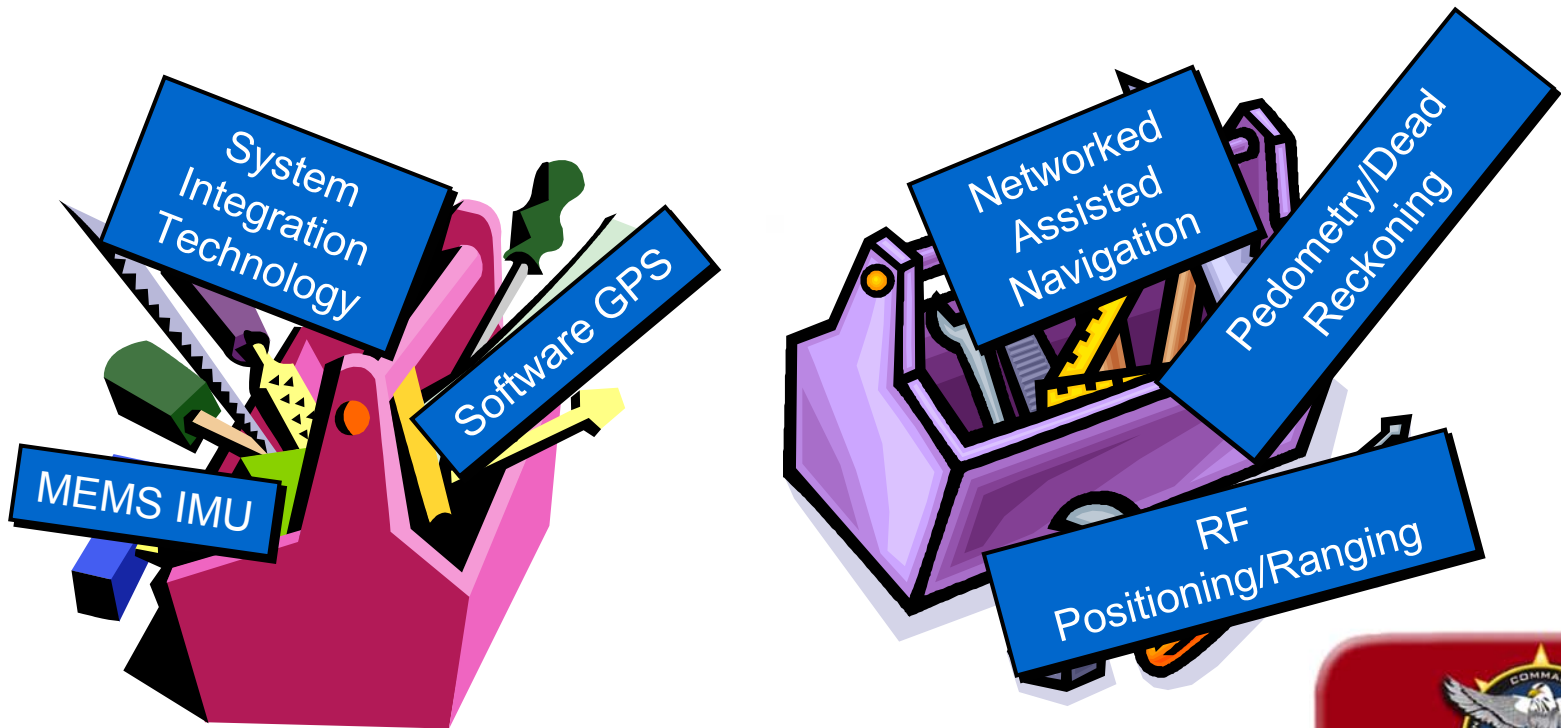
***Different Jobs Require Different Tools and
Some Jobs Require Multiple Tools***





Need more than one tool in the toolbox

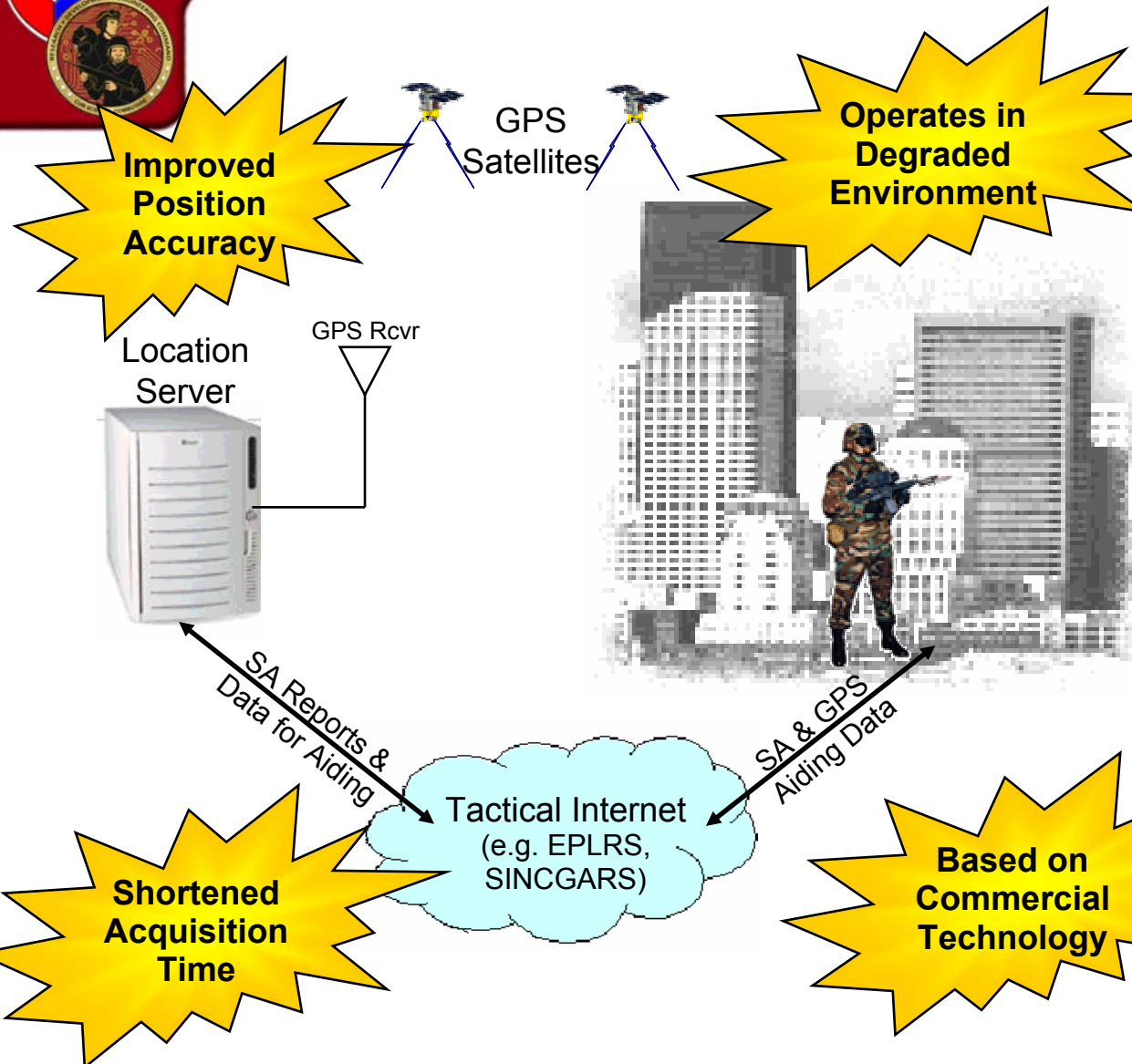
Different Jobs Require Different Tools and Some Jobs Require Multiple Tools



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Network Assisted GPS



- **Current**
 - Commercial system
 - C/A code only
 - Cell Phone
 - Demonstrated with SINGARS
- **Ongoing Development**
 - Develop P/Y Code Algorithms (Military)
 - Interface with or embed in military radio system
- **Future**
 - Investigations into the entre' in Network Centric Warfare





“Dead Reckoning” Device Enhancements

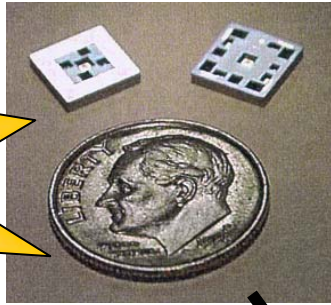
- The Land Warrior Nav subsystem uses measurements of distance traveled (DT) and heading to calculate position. DT is measured using an accelerometer triad to detect and count user steps.
- Limitations
 - Requires careful control of stride, i.e. walking upright and “rocking steady”
 - Cannot distinguish between steps that result in horizontal movement and vertical movement
- Enhancements
 - Improved Human Motion Modeling to account for running, crawling, pacing, crab-walking, etc.
 - Additional sensors and/or improved sensor processing for the detection of vertical motion to compensate for stair climbing



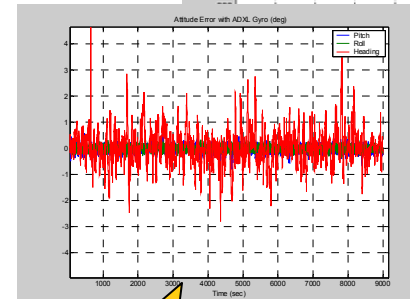
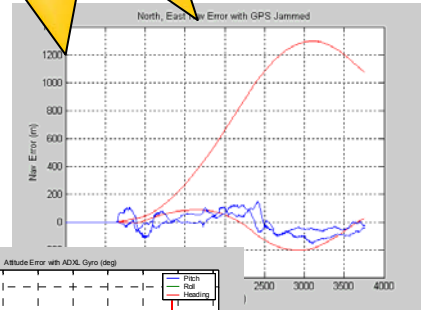
Integration of MEMS Inertials with GPS



Leveraging from
Missile/Munitions
Optimizing for
Soldier/Vehicles



GPS
Calibrates
Inertial Errors



Light
weight

Continuous
Operation

No Electronic
Signature

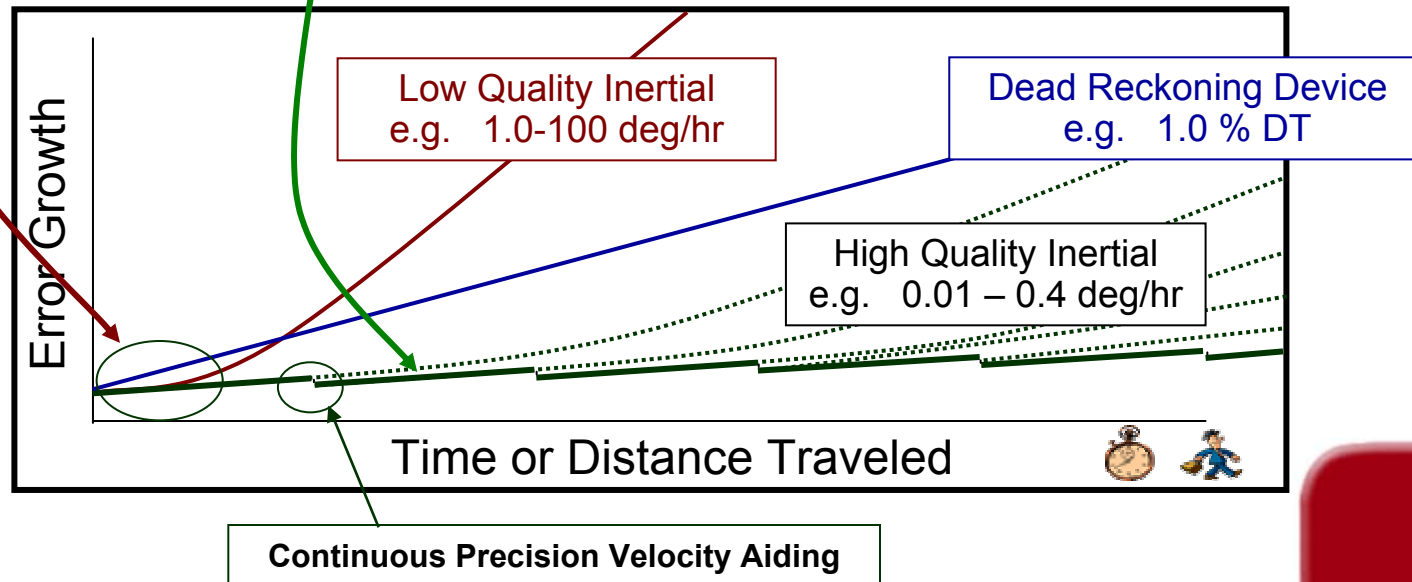


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Self Contained Navigation System Performance

- Self Contained navigation systems have errors that drift with time and/or distance traveled.
- Lower quality systems are adequate for short duration missions (missiles/munitions).
- Higher quality systems are required for longer missions (soldiers, vehicles, aircraft) and require integration with precision velocity aiding.





RF Ranging/Positioning

1-meter accuracy

MOUT

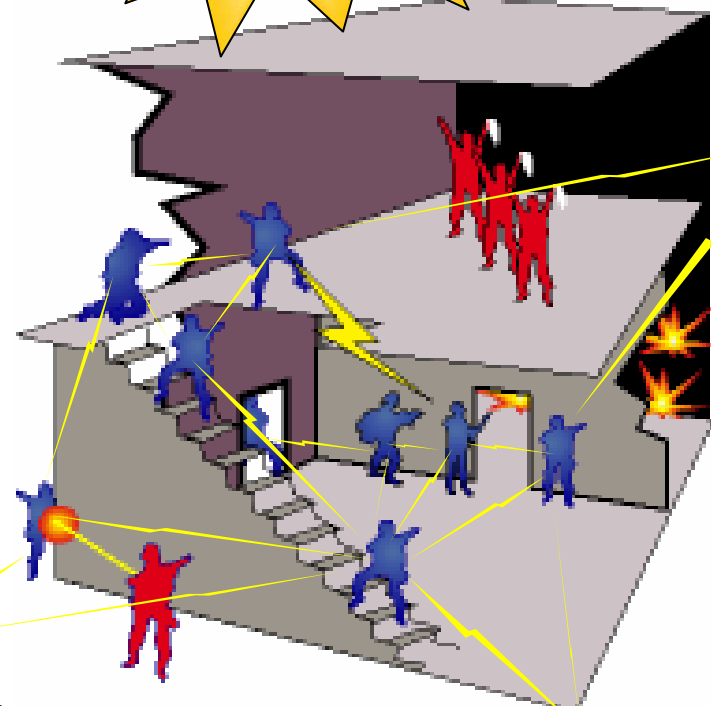
Penetrates Interior Walls

200-400m range

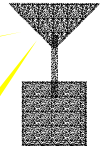
TOA Transceiver

Computer

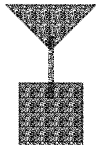
Light weight



GPS Receiver



LPI/LPD



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PNT: The Foundation of Command and Control

Summary

- Positioning, Navigation and Timing (PNT) information is enormously important to the Warfighter, the Commander, and hence to all Command and Control.
- Size, Weight, Power and Cost have been traditionally performance limiting factors in PNT equipment.
- CERDEC undergoing efforts to overcome these limiting factors by employing:
 - Advanced MEMS IMUs
 - Software GPS Receivers
 - Employ RF Ranging
 - Datalinks to Assist GPS Performance
 - Merging Communication and Navigation Functions

*Positioning, Navigation, and Timing:
The Foundation of Command and Control
You bet – and More.*



Assured Positioning/Navigation

Network Assisted Navigation

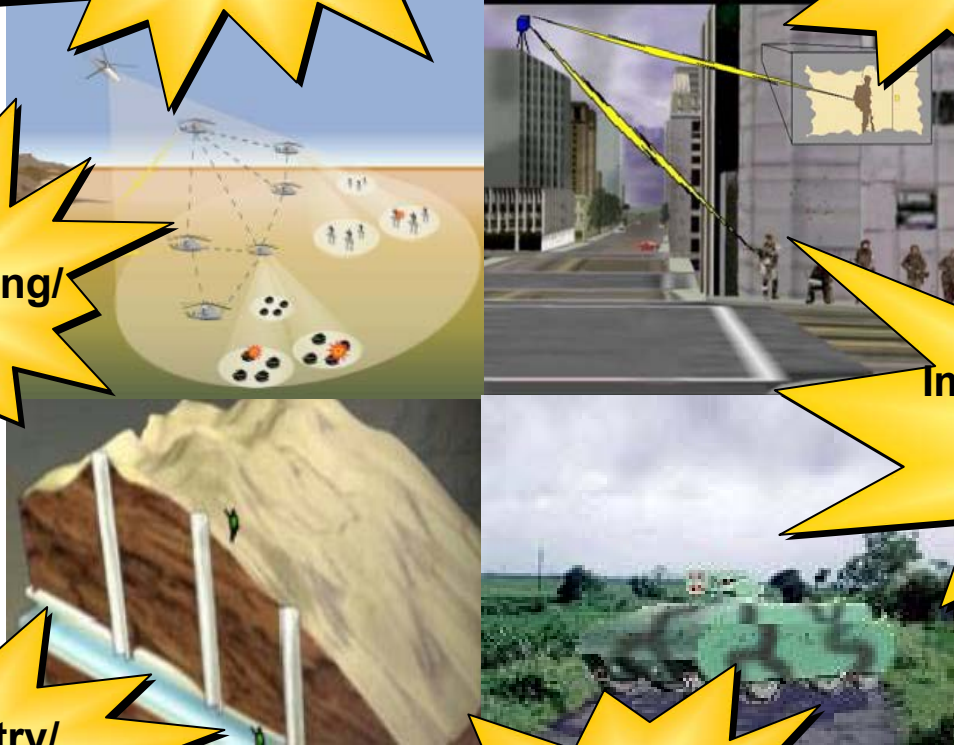
Software GPS Receivers

**RF Positioning/
Ranging**

**Improved MEMS IMUs
for Soldiers and
Ground Vehicles**

**Pedometry/
Dead Reckoning**

**System
Integration
Technology**



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