NavFire Product Family – Cost-effective Precision Guided Navigation Packages for Artillery, Mortar, and UAS

Walter Trach, Jr.

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NavFire Guidance System Outline

- Precision-Guided Artillery
- NavFire GPS
- NavFire Guidance System (NFGS) Design
  - Features
  - Subassemblies
- Core Functionality
- Integration
- Summary

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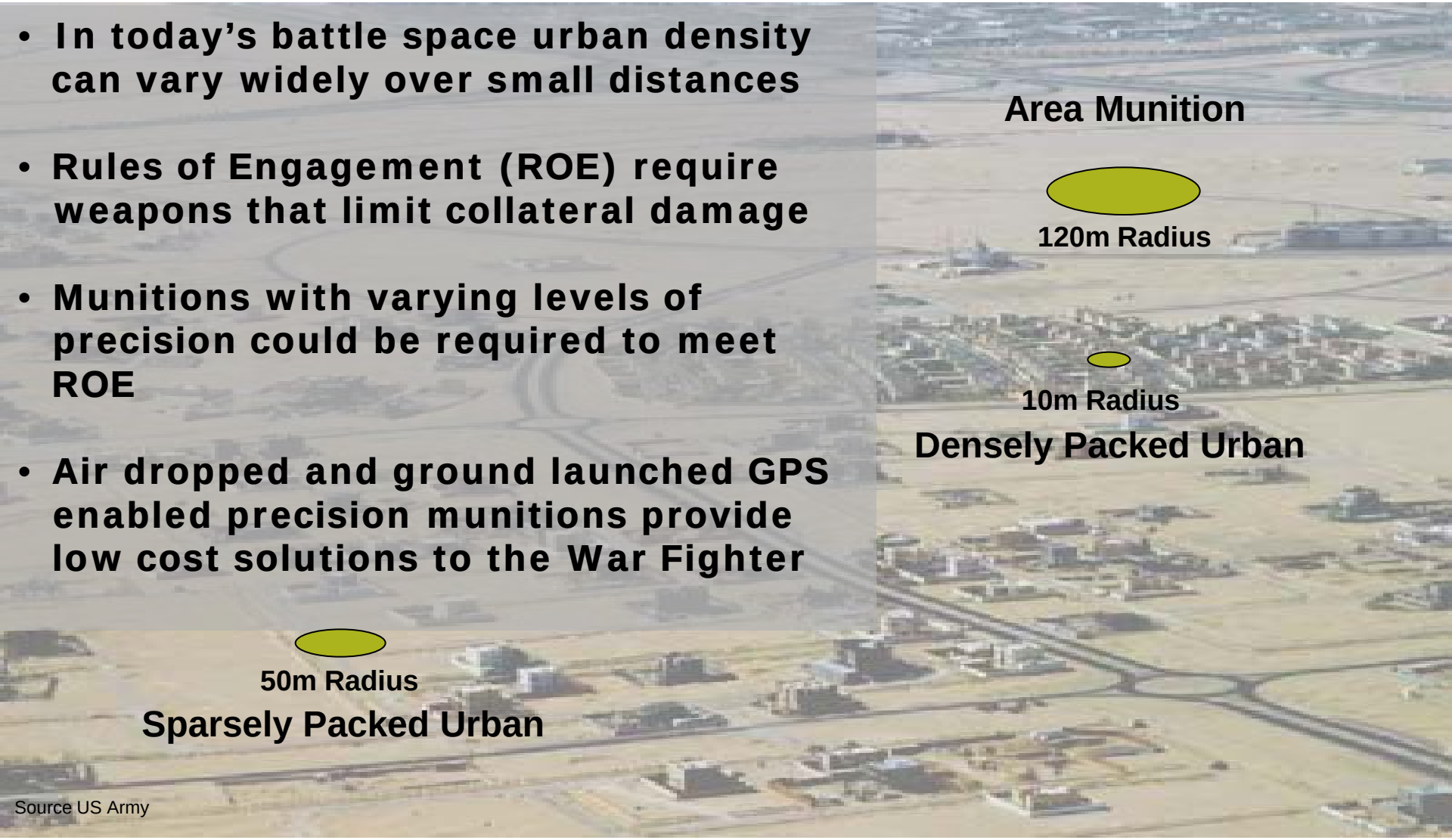
Precision Strike Capability

- In today's battle space urban density can vary widely over small distances
- Rules of Engagement (ROE) require weapons that limit collateral damage
- Munitions with varying levels of precision could be required to meet ROE
- Air dropped and ground launched GPS enabled precision munitions provide low cost solutions to the War Fighter



Source US Army

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Precision Strike Operational Benefits

- All weather 24/7 continuously "loitering" precision capability
- Responsively and precisely attack targets… can precisely "mass" fires
- Minimizes collateral damage
- Increases Number of Kills per Basic Load of Ammunition
- Big reductions in logistics burdens and costs (less quantity and transport/storage)

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NavFire Market

- Markets
  - Artillery and mortar market.
    - Artillery 155mm and 105mm
    - Mortars 120mm, 81mm, and 60mm
  - Government desires common GPS design
  - Hard to change GPS vendors mid-program
    - Prime contractor SW and HW are locked into that design.
    - Not a trivial or inexpensive

- Additional Market
  - Support Unmanned Aerial Systems (UASs) are future high volume market

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NavFire Guidance System (NFGS)

- NFGS Scope
  - Support artillery programs
  - Support UAS platforms
  - Integrated guidance and navigation package
    - Reduce number of parts
    - More efficient design
  - Reduce integration time
    - Modular Open System Design

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Artillery / Mortar Program Challenges

- Hostile Environment
  - High Velocities
  - Shock
    - Set-Backward
    - Set-Forward
    - Balloting
    - Canard/Fin/Wing Deployment
  - Rocket Boost
  - Spinning Round
    - Variable depending on platform, up to 350 Hz
- Space limitation
  - Due to artillery round ogive
  - Smart weapons fuze kit contains fuze and guidance system
- Shorter time to fielded system
  - Less time for design, implementation, integration, etc.
- Cost

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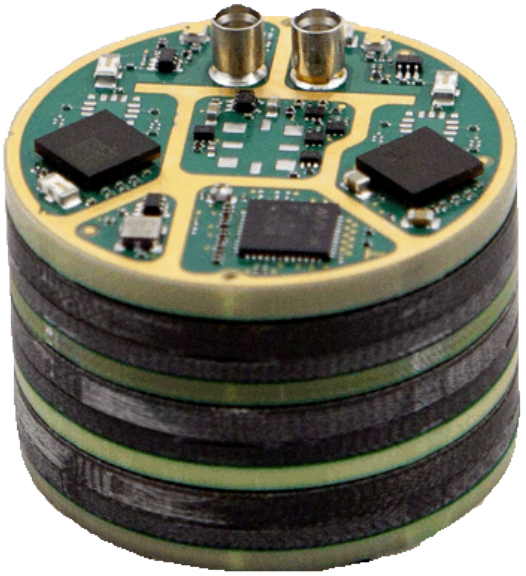
The NavFire GPS and NavFire Guidance System



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NavFire GPSR

- Integrated GPS and AJ
  - 2 RF channels
  - Scalable RF
- 2 Packages available
  - Mechanical Chassis and encapsulation
  - Embedded and encapsulation
- Gun Hard
  - Up to 25,000 G's
- Small form Factor
  - 1.64"Φ x 0.95" (42 mm x 24 mm)
  - 2.82 oz
- ≤ 2.8 Watts nominal
- Over 250 units built to date
  - LRIP scheduled July 2012
- GPS Directorate BDR – March 2012
- Qualification Testing
  - On track to complete FY2012, Quarter 3

NavFire Guidance System SAASM 3.7 Enabled

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NavFire GPS Testing

- Gun Testing - ARDEC
  - 3 test dates in 2011
    - Shock ranges from 15 kG to 17.5 kG
  - Non-Functional
    - Mechanical Tests
    - Chassis and Encapsulation Survivability
  - Functional
    - Hardware/Software Verification
    - Oscillator Shock Effects
    - Live Sky Track not possible

NavFire Guidance System (NFGS) Features

- Small Form Factor
  - 42 mm outer diameter by 37 mm height
  - 150 grams
- Low Power
  - ≤ 5 Watts, nominal operation
- Performance
  - ≤ 6.0 second Guidance Solution availability (from Power On)
  - ≤ 5.0 meters CEP (standalone GPS)
  - ≤ 2.0 m/s velocity accuracy
- Same GPS card as standalone NavFire GPSR
  - Integrated 2-channel Anti-Jam
- Gun Hard to 25,000 G
- 10 Built/Tested to date – 1st Pass

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Core Functionality

- GPS Interface
  - Handles GPS message format, protocol, and GPS key data
  - Provides Pseudorange and Delta range (PR/DR)
  - Provides Position, Velocity, Time (PVT)
- Flexible message protocol
  - User defined messages
  - NFGS and user application share memory
  - NFGS defined messages
    - All data in NFGS defined messages available to user in memory
- Supports user guidance algorithms
  - Hosted on NFGS Mission Processor
- Provides Up-finding
- User's integration focus
  - Guidance, Navigation, and Control (GNC)
  - Fuzing

Integrated Package and Open Systems Design = Reduced Cost

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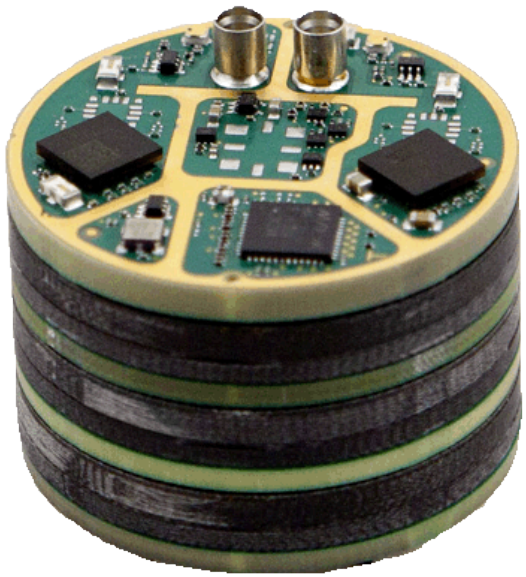
NFGS Subassembly - Mission Processor

- Driven by GPSR oscillator
  - Common time reference
- Real Time Operating System
  - Linux RTOS
  - POSIX-compliant
  - Portable to other RTOS
- Deep Integration/Ultra Tight Coupling
- Interfaces to guidance sensors
- Provides Status and Control Information



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NFGS Subassembly - Power and Signal

- User provided power
  - 4.75 VDC – 12.0 VDC
- Condition power for NFGS
- Primary power to auxiliary power switching
  - Supports Data Hold phase
- Charging circuit
  - Supports charging a super-capacitor
    - Used for Data Hold phase
- Provides all interfaces for the NFGS
  - Configurable for unique interfaces
- Common interfaces supports
  - Serial
  - GPS Key
  - 1PPS/TimeMark
  - Pulse Width Modulated (PWM)
- Artillery specific interfaces
  - FUZE
  - Enhanced Portable Inductive Fuze Setter (EPIAFS)

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EPIAFS

- Handles EPIAFS inductive interface
  - Directly accepts Power and Data Waveform
  - Power
    - Charges user supplied super-capacitor
      - Charging circuit is included in NFGS
      - Super Capacitor size for artillery applications exceeds package diameter or height requirements
    - Used to power system during initialization
  - Data
    - Parses and routes data messages

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NFGS Up-Finding

- Required for precise guidance
- Determine roll angle and roll rate
- Advanced Spinning Vehicle Navigation (ASVN)
  - Developed and patented by Rockwell Collins, awarded 2003
  - Determines when antenna system is facing the sky
  - Applicable for variable rotation rates (<10 and up to 1000 Hz)
- Magnetometer
  - Determines up based on Earth's magnetic vector
  - Hardware up-finding solution for high threat GPS jamming environment

Flexible up-finding solutions to address multiple CONOPS

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NFGS Integration

- 70% Package Volume reduction, 40% reduction in part count
  - Compared to other federated or integrated GPS/MP navigation packages
- Up to 80% reduction in user integration time
  - Combines GPSR, Mission Processor, signal and power conditioning
  - Handles GPSR and EPIAFS I/O interface
  - User defined messages
- User's host software
  - Guidance, Navigation, and Control (GNC)
  - Fuzing

Integrated Package and Open Systems Design = Reduced Cost

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NavFire Guidance System Testing

- Gun Testing - ARDEC
  - 1 test dates
    - Shock up to 17.5 kG
  - Non-functional
    - Mechanical Tests
    - Chassis and Encapsulation Survivability
- EPIAFS interface
  - Power and Data Waveform
- Super Capacitor Charging Circuit
  - Logic and Hardware
- Full GPS Initialization
  - Artillery Timeline
  - Internal and User supplied data
- Message Traffic

Summary

- NFGS developed as a complete integrated Guidance System
- NFGS designed for precision artillery and mortar market
  - Small form factor
  - Gun hardened 25KG
- Reduces user integration time
  - Users focus on GNC and fuzing
  - NFGS handles I/O to/from sensors
  - Up-finding built in

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Thank You

Questions?

- Contact Information
- Walter Trach
- System Architect – NavFire Guidance System
- Rockwell Collins
- wtrach@rockwellcollins.com
- (319) 295-7433

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