U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Indirect Fires Precision and Lethality Enhancements through Digitization of Artillery and Mortar Weapon Systems

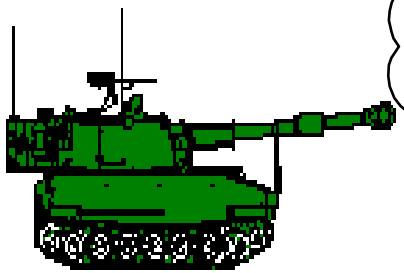
Presented by
Victor Galgano & Ralph Tillinghast
May 18, 2010

Overview and Outline

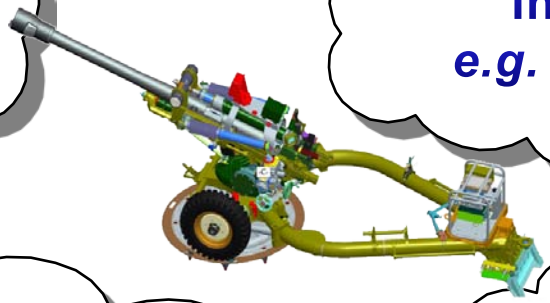
Outline

- **Fire Control Digitization** (*Presented by:* Vic Galgano)
  - Fire Control Functions
  - Indirect Fires Before Digitization
  - Digitized Systems and Their Advantages
- **Current and Future Trends** (*Presented by:* Ralph Tillinghast)
  - Smart Projectile Interface
  - The Move Toward Commonality
  - New Fire Control Technologies and Innovations

The Fire Control Functions



Navigate

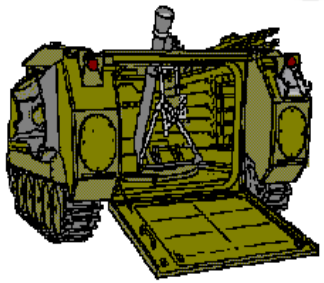


Projectile Interface *e.g.* Excalibur

Determine/Affect Weapon Pointing

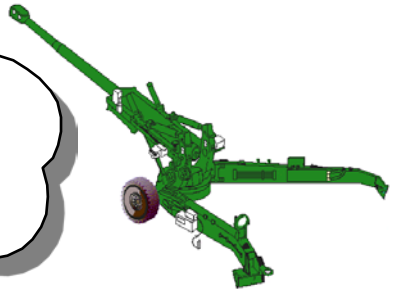
Communicate on Fire Support & Sit Aware Nets

Determine Platform Position



Sensor Interfaces Data Processing & Display

Tactical & Technical Fire Control/Data Processing



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Indirect Fires Before Digitization "Glass and Iron"

- Manual Precision Survey (Aiming Circles / Aiming Stakes / Collimators manually placed)
- Sight Units on weapons referenced to aiming circles
- Map navigation
- Voice communication of gun orders
- Instrument and weapon leveling / cross-leveling
- Plotting boards / Protractors / Slide rules at FDC
- Manual control of weapon aiming

CREW-INTENSIVE OPERATIONS

Digital technology provides significant improvements to Indirect Fire Systems

- Digital link to Fire Support Network
  - Call for fire
  - Met data
  - Logistics data
- On Board Ballistic Computation and Sensors using Ballistic Kernel
- Automated navigation and location systems
- Automated 3-axis gun orientation
- Precise weapon aiming and automatic weapon drives (Paladin)

SOFTWARE-INTENSIVE AUTOMATED OPERATIONS

M777 Towed Artillery Digitization

Pointing Devices

Software

Gunner's Display

Computer

MFCS (H) Heavy

PDA

SINCGARS Radio

Gunner's Display

Commanders Interface

Driver's Display

Pointing Devices

Software

Paladin

Gunner's Display

SINCGARS Radio

PCU-2

Computer

Position/ Pointing Devices

Software

Portable Excalibur FCS

Computer

Software

Indirect Fire Digitization Efforts for PM Customers

D120 MFCS

Gunner's Display

PDA

SINCGARS Radio

Computer

Pointing Devices

Software

LHMBC (US Army & USMC Effort)

Software

MFCS Stryker

Gunner's Display

PDA

SINCGARS Radio

Commanders Interface

Driver's Display

Pointing Devices

Software

M119 Howitzer

Gunner's Display

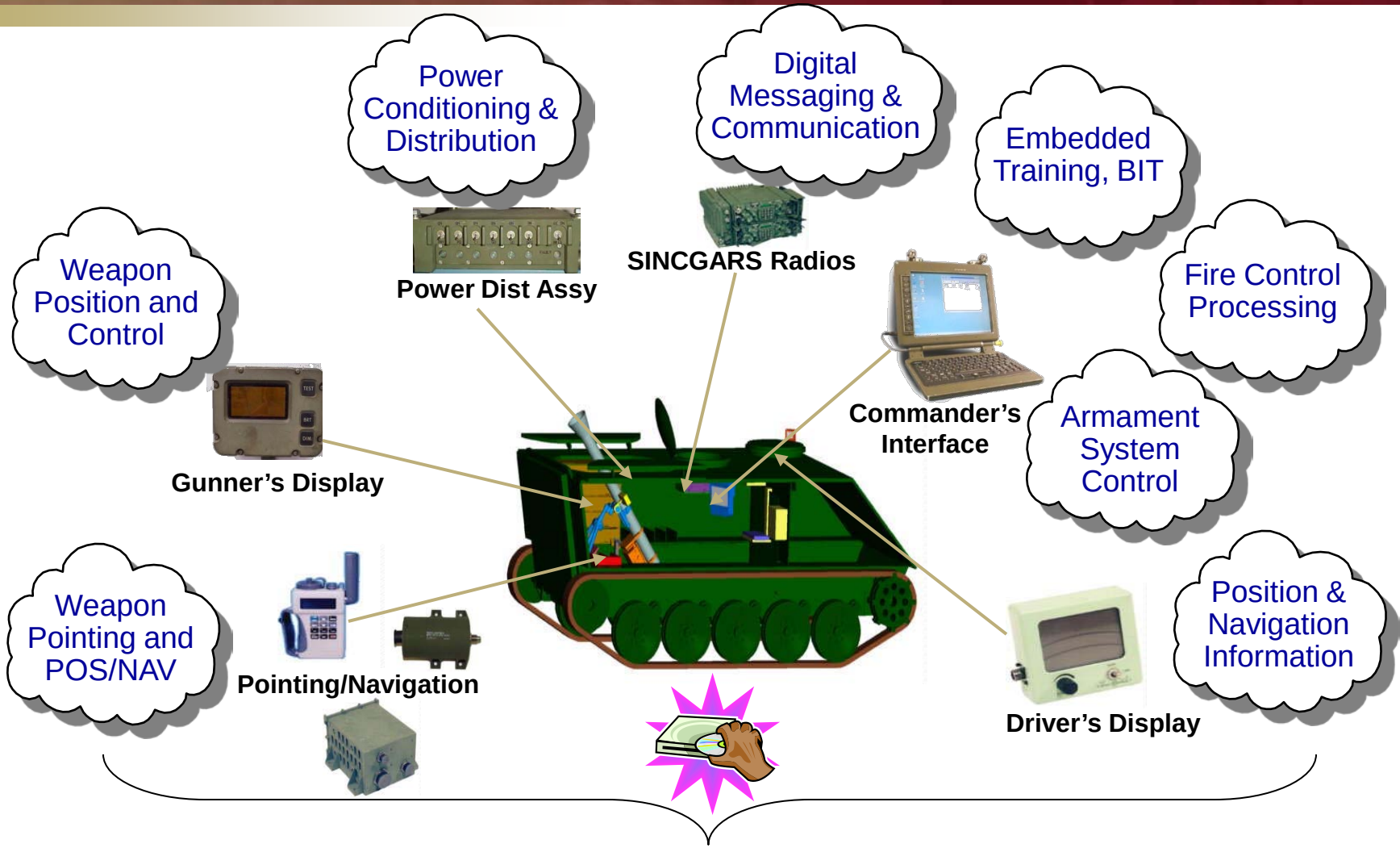
Pointing Devices

SINCGARS Radio

Computer

Software

M95 Mortar Fire Control System

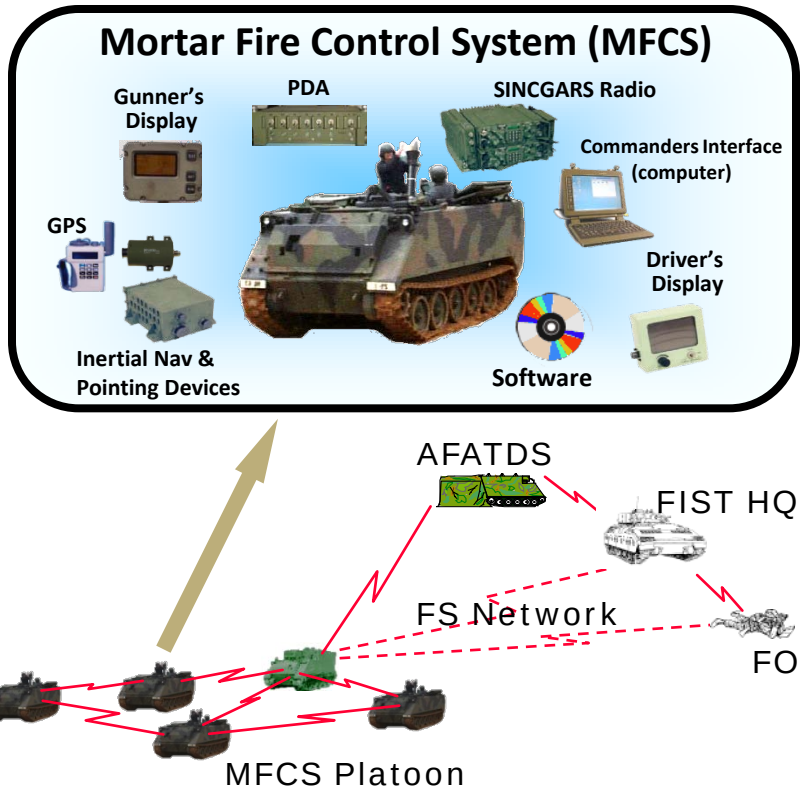


Digitizing the M1064 through integration of Hardware and Software Components

ARDEC Digitizes Mortar Warfare for PM Mortars

ARDEC Approach

- **In-house software development & system integration**
- **IPT employed**
- **EVM employed**
- **Level 5 CMMI Processes**



Full Digital Connectivity

Significant Performance Improvements

- **Improved Responsiveness (1.5 vs. 8 min)**
- **Increased Survivability (No need to dismount)**
- **Increased Accuracy (75 M CEP)**

ARDEC applies digital technology providing significant improvements to mortars

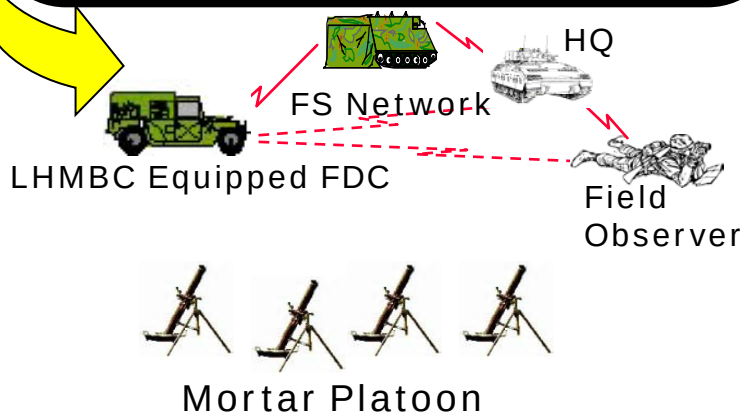
Lightweight Handheld Mortar Ballistic Computer M32 LHMBC

Performance vs M23

- **Computational Accuracy 10M** (vs 25)
- **Uses Ballistic Kernel**
- **<2 lbs** (vs 8)
- **Response time 4 min** (vs 8)
- **6 simultaneous missions** (vs 3)
- **Accommodates all fielded ammo**
- **Digital connectivity**
- **MET Data**
- **Integrated GPS**

Replaces Obsolete M23 Computer

Centralized Fire Direction



Improvements In:

- **Responsiveness** ↑
- **Survivability** ↑
- **Accuracy** ↑
- **Portability** ↑
- **Ease of Use** ↑

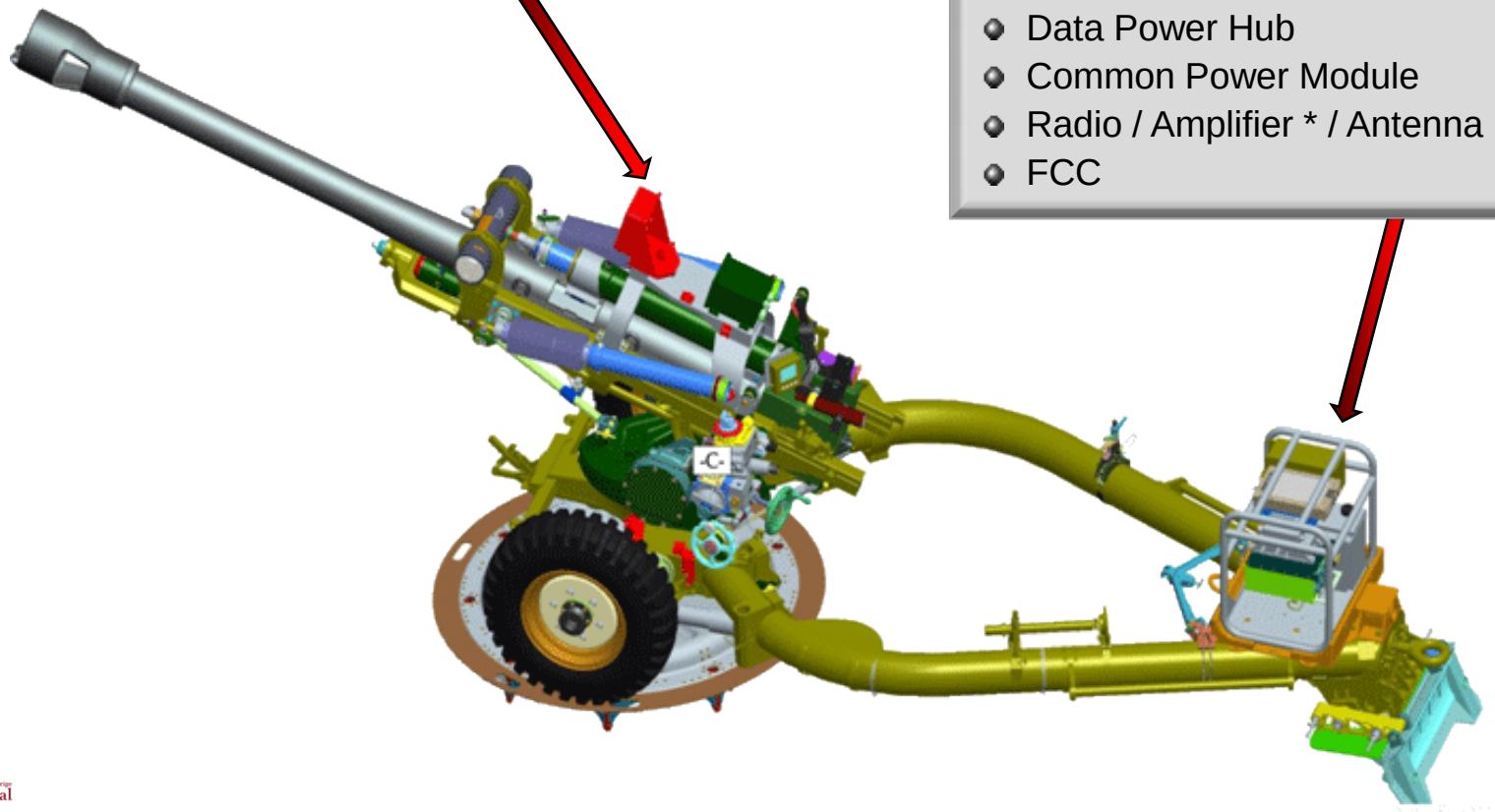
Enables "Shoot & Scoot" Tactics

Winner of "DoD Top 5 Program" and "Army's 10 Greatest Invention Award"

Digitized M119 Sled Configuration - Transport

On Carriage:
- Inertial Navigation Unit
- Muzzle Velocity Sensor
- Gunner Display

Sled:
- iPIK
- Battery
- Data Power Hub
- Common Power Module
- Radio / Amplifier * / Antenna
- FCC



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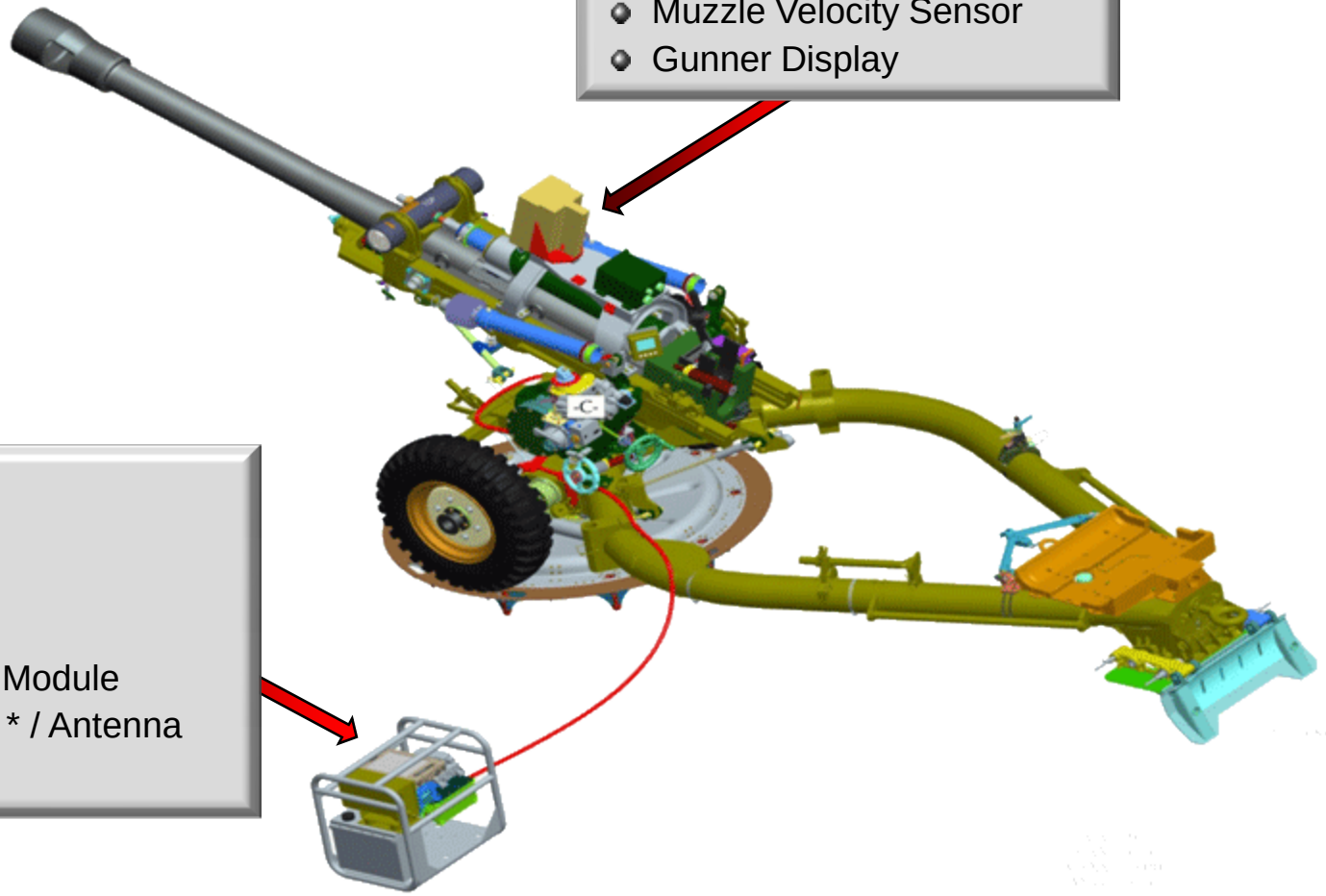
Digitized M119 Sled Configuration - Firing

On Carriage:
- Inertial Navigation Unit
- Muzzle Velocity Sensor
- Gunner Display



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Smart Projectile Interface for Precision Munitions

- Fire Control Interface with EPIAFS / PIK
- Munitions / Weapon Systems
  - Excalibur
    - Paladin (Portable Excalibur Fire Control System (PEFCS) was Interim Solution)
    - LW 155
    - M198 (Australian PEFCS)
  - PGK (Precision Guidance Kit)
    - Paladin
    - LW 155
  - Advanced Precision Mortar Munition Initiative (APMI)
    - MFCS-M M113
    - MFCS-M STRYKER
    - MFCS-D

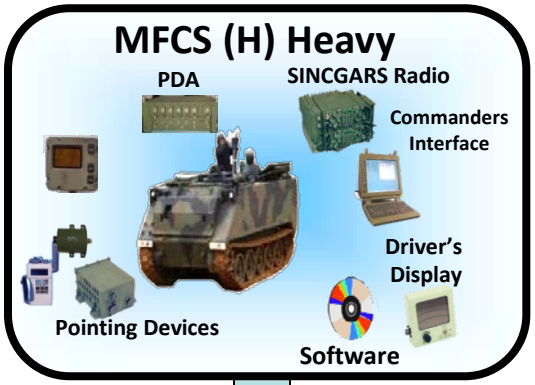
Memcam2.avi

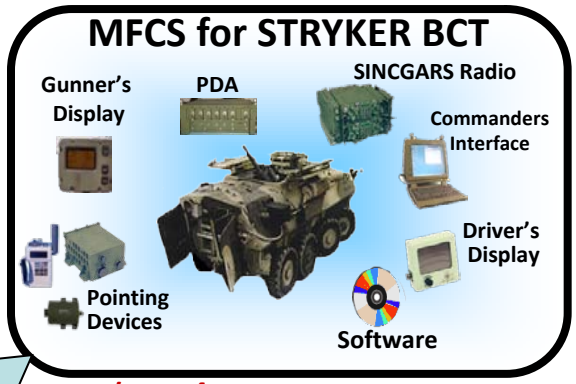
The Move Toward Commonality

- Numerous potential applications across US and NATO FC systems
- Technical Feasibility
  - Fire control functions largely independent of weapon requirements - their implementation varies
  - “Weapon-Specific” technical requirements are essentially the same and mainly affect HW integration
  - “Weapon-Independent” requirements such as network interfaces/protocols and situational awareness affect all platforms and influence software upgrades
- Opportunity for
  - Enhanced development and interoperability among Nations
  - Potential Future Joint System Development
  - Significant Schedule and Life Cycle Cost Savings

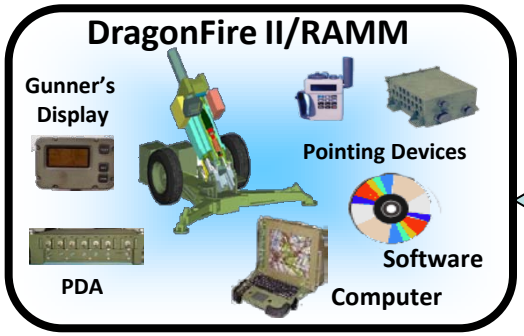
Example of the Effectiveness of Commonality

$9.59M/36mo avoided



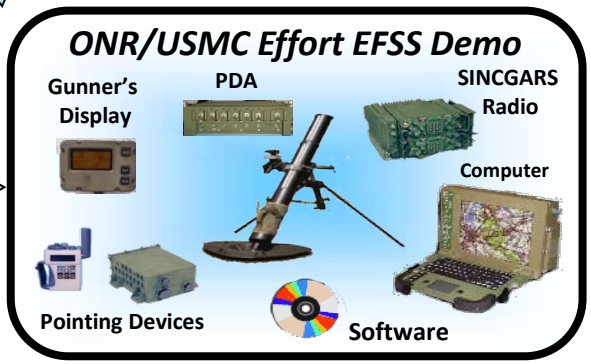


$6M/35 mo avoided



$5.5M/36 mo avoided

MFCS Software & Hardware

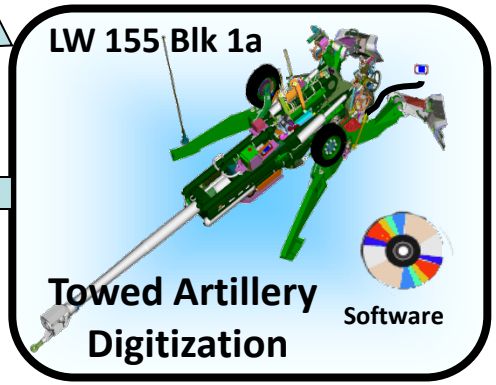


$5.67M/30 mo avoided

$2.2 M/12 mo avoided

$2.4M/18 mo avoided

$6M/31 mo avoided



$2.4M/36 mo avoided

NOTE: SOFTWARE DEVELOPMENT COSTS ONLY

Total Avoided: $55.35M

Long Term Vision

Common Requirements

- System Management
- Communication: FBCB2 & FS Nets
- Technical Fire Control
- Data Management/Processing
- Projectile Interface (e.g. XM982, MRM)
- Soldier Machine Interface/Displays
- Hardware/Peripheral Interfaces
- Sensor Interfaces
- Weapon Positioning
- Autoregistration
- Navigation
- Embedded Training
- Maintenance

Common Solution

- Maximum Use of Existing, proven HW & SW
- Facilitates Pre-planned HW & SW Upgrades
- Promotes HW & SW Commonality
- Reduces Development, Testing, Production, Training, Maintenance, O&S Costs

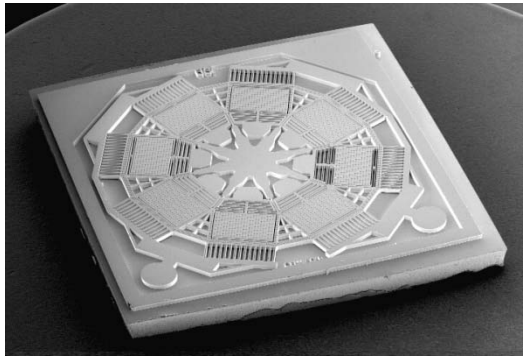
Enhanced Products & Capabilities

- Prototypes for Beta Fielding
- Responsiveness to User
- System Growth & Enhancements
- Consistent Products
- Concurrent Deployments
- Technology Capabilities
- Increased Reliability
- Common Maintenance
- Lower Life Cycle Costs
- Operating Systems & Hardware Platform Porting

Structured Approach and Integration of Complementary Hardware & Software Fire Control Elements

New Fire Control Technologies & Innovations

- MEMs Based Technologies
- Commercial Market Drivers
  - Automotive
  - Gaming (WII)
  - Smart Phone / Tablets
- SBIR Work, AVAM-JWG
- Secure Wireless



MEMs Vibratory Gyroscopes Prof. Andrei Shkel, University of California at Irvine

- What does that drive?
  - Smaller
  - Lighter
  - Cheaper
  - More Accurate
  - Less Power
  - Increase in Operation

Fire Control In-A-Box

Example of Future State:
Wireless Universal Light Fire-Control (WULF)

WULF provides weapon pointing data from the LHMBC wirelessly to gunner. The Gunners display unit indicates the required gun shift information.

- Embedded Computer
- 3-4 mil Accuracy
- Target Battery Life: 24+ hours
- Report Delta Deflection and Elevation
- Adaptable to different wireless standards
- 60, 81 and 120mm compatible

Questions

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