



# Mid Range Munition – Delivering the Lethality to Finish Decisively

Robert Muth

**A** key Army Future Combat Systems (FCS) component is to execute the “Quality of Firsts” – See First, Understand First, Act First and Finish Decisively. One area where the synergy of sensors and lethality offers decisive advantages is beyond-line-of-sight (BLOS) engagements. The BLOS capability provided by FCS gives the maneuver commander unprecedented access to targeting sensors, enabling him to effectively engage and defeat stationary and moving targets at extended ranges. The FCS Mounted Combat System’s (MCS’s) ability to rapidly deliver BLOS fires is vital to the FCS-equipped Unit of Action’s (UA’s) survivability, lethality and overall effectiveness.

General Dynamics Land Systems is developing the MCS and Abrams MBT upgrades to ensure maximum synergy of designs is achieved and risk is mitigated through fire control and gun modifications. Here, Soldiers from A Co., Task Force 1st Battalion, 35th Armor Regiment, 1st Armored Division, patrol a street in Baghdad, Iraq. (U.S. Army photo.)

The Mid Range Munition (MRM) is the gun-fired, precision BLOS munition that enables the MCS to deliver the lethality necessary to finish decisively. With FCS spin-out (SO) capabilities, MRM can be fielded to a modified M1A2 System Enhancement Package Abrams tank that will constitute the Modular Heavy Brigade Combat Teams (HBCTs). These HBCTs will fight side-by-side with the UAs well into the future. The Project Manager for Maneuver Ammunition Systems (PM MAS) at Picatinny Arsenal and its Armament Research Development Engineering Center (ARDEC) partner are prepared to execute an evolutionary incremental acquisition strategy to develop and field MRM's revolutionary BLOS capability.

### Standoff Capability for Organic Forces

An FCS Operational Requirements Document key performance parameter is networked lethality. Networked lethality distributes line-of-sight (LOS), BLOS, and non-line-of-sight lethality across the UA.

BLOS is an extension of traditional LOS in that the MCS vehicle commander firing the munition has "eyes on target" and is responsible for identifying the target. BLOS is enabled in the FCS by integrating communications and controls that allow firing platforms to control targeting and designating sensors — such as unmanned aerial vehicles — that will be resident in UA echelons down to company level. By separating the physical location of the sensor from the shooter, BLOS enables missions to be executed across terrain compartments and at extended ranges.

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Exploiting terrain and range provides the tactical standoff capability to act first. MRM provides the MCS with an organic BLOS capability, without the need to queue fires. MCS can fire MRM while stationary or on the move, providing precision defeat of single-point, high-payoff targets, including stationary or moving main battle tanks (MBTs), light armor, self-propelled howitzers and air defense artillery assets.

While an overwhelming majority of MRM-executed missions will be BLOS, MRM can also be used in LOS and extended-range engagements. A significant body of operational studies has repeatedly verified the utility of MRM in BLOS engagements and FCS requires this capability. Because of this, MRM is positioned to complement the MCS gun's propulsion and pointing accuracy to meet the platform's lethality requirements, at nominal ranges, providing many stowed kills per vehicle. The platform/munition

system approach to lethality allows the MRM to realize a lower unit production cost (UPC) and provide the finishing lethality that synchronizes the ability of other smart munitions to effectively shape the battlefield at even longer ranges.

### MRM 101

The MRM mission starts with a target being identified and a decision to engage. Targeting data — such as the target's location, type and speed — is transmitted to the MCS through the network. A firing solution is calculated and the gun is automatically aimed. Using the two-way data link, target and other necessary data is transferred to the MRM cartridge and receipt is confirmed back to the MCS crew.

Upon trigger pull, the round exits the muzzle and deploys fins to start flying a ballistic trajectory. At a point after apogee, the projectile begins the acquisition phase, searching for either an infrared or millimeter wave signature and/or a semiactive laser (SAL) designation return from the target. After the target is acquired, the projectile

MRM development and fielding will provide the UA and FCS-equipped HBCTs with the ability to perform BLOS and NLOS fire missions from multiple platforms. Here, SPC John L. Jackson, Alpha Battery, 3rd Battalion, 83rd Field Artillery Regiment, 1st Cavalry Division, loads the primer into his M109A6 howitzer during combat operations near Fallujah, Iraq, in November 2004. (U.S. Army photo by SFC Johancharles Van Boers.)

**Future MCS- and FCS-equipped Abrams MBTs will fire MRMs. Hardware and software modifications to the Abrams MBTs will include breech changes, ammunition stowage enhancements, fire control updates and data links. Here, 3rd Brigade Combat Team Soldiers assigned to the 1st Infantry Division return from a combat mission near Baqubah, Iraq. (U.S. Army photo by SSG Klaus Baesu.)**



tracks the target, guiding toward it as necessary. The projectile then strikes and defeats the target.

The MRM employs three modes of operation as follows:

- **Autonomous Mode.** The MRM searches for and engages targets using data downloaded to the projectile prior to firing to aid in target acquisition.
- **Designate Mode.** The munition searches for a SAL designator return from the target and engages it. The munition switches to the autonomous mode in the terminal phase. This allows for sensor-fused aim point refinement to maximize lethality. If the laser spot is lost or not present, the projectile will automatically revert to autonomous.
- **Designate-only Mode.** This is similar to designate except if the laser spot is lost or not present, the munition does not revert to the autonomous mode. This allows for added control where potential fratricide or collateral damage could be a concern in various operational or urban environments.

**Competing Technologies Offer Options**

MRM concept maturity has been demonstrated in two separate versions

as depicted in the figure. The kinetic energy (KE) version, being developed by Alliant Techsystems, and Raytheon's chemical energy (CE) version have both undergone a series of subsystem demonstrations to validate performance and the ability to survive high-g gun shock of the seekers, guidance and control, airframe, propulsion and lethal mechanism.

The subsystems — minus the warheads and SAL sensor — were then integrated and gun-fired at Yuma Proving

Ground (YPG), AZ, in a series of Autonomous Seeker Guide-to-Hit demonstrations for both concepts. Both concepts proved successful in meeting most test objectives, including surviving gun launch and acquiring targets. One concept scored a direct hit against a T-72 MBT at 5,200 meters.

These accomplishments were realized during the FCS 120mm LOS/BLOS System Advanced Technology Demonstration program run by ARDEC in partnership with PM MAS. Currently, integration of a full dual-mode seeker — autonomous and designated — is being conducted under the MCS Ammunition System Technologies Army Technology Objective. This concept is at Technology Readiness Level (TRL) 6 for an integrated autonomous-only MRM with TRL 6 for a dual-mode flight demonstration to be achieved by the end of FY07.

**Involving Stakeholders**

PM MAS formed an Overarching Integrated Product Team (OIPT) last year to address the overall systems-level requirements and strategy for the MRM.

## The Two MRM Concepts

<p style="text-align: center;"><b>MRM - KE</b> Alliant Techsystems</p>	<p style="text-align: center;"><b>Attributes</b></p> <ul style="list-style-type: none"> <li>• Fleeting High-Payoff Targets</li> <li>• Single Point Defeat</li> <li>• Stationary or Moving (Fleeting)</li> </ul> <p style="text-align: center;"><b>Target Types</b></p> <ul style="list-style-type: none"> <li>• Main Battle Tanks w/Explosive Reactive Armor</li> <li>• Light Armor</li> <li>• Self-Propelled Artillery</li> <li>• Air Defense Artillery</li> <li>• Bunkers (Earth and Timber)</li> </ul>	<p style="text-align: center;"><b>MRM - CE</b> Raytheon</p>
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**FCS SO technology will be spiraled into most MCS platforms to help deliver more accurate precision munitions that will provide unprecedented lethality. Here, an NLOS cannon fires a round downrange at YPG. (U.S. Army photo courtesy of YPG.)**



The OIPT included representatives from the UA Maneuver Battle Lab, U.S. Army Training and Doctrine Command (TRADOC) System Manager for the Abrams tank, PM Combat Systems, PM Mounted Combat Systems, PM UA Lethality Systems Integration and ARDEC.

The OIPT recommended that MRM be developed in two increments for fielding with both the MCS and the Abrams MBTs that will be part of FCS-capable HBCTs. The plan called for the first increment to develop an interim BLOS capability starting in FY08, with Milestone C occurring in early FY11. This increment will be fielded to Abrams MBTs in 2014.

MRM Increment 2 development will build upon the first design with Milestone B to occur in FY11 and Milestone C in FY13. Increment 2 MRMs will be used in both MCS- and FCS-equipped Abrams. Hardware modifications to the Abrams MBTs, including a data link, breech changes, ammunition stowage enhancements and fire control updates, will be incorporated one time and will be implemented in time for Increment 1. It is anticipated that only software updates to the Abrams will be required to accommodate Increment 2 MRMs.

### Strategy Offers Advantages

The incremental strategy offers numerous benefits and program management advantages as follows:

- Earlier production of an initial capability can be achieved, starting at the end of FY10, compared to an MCS-only program that would start producing MRM in mid-FY12.
- Process reduces risk of not delivering fully capable ammunition to the MCS by producing an early increment of MRM.
- Lessons learned can then be fed into the development and production of a fully capable Increment 2 MRM.
- Process initializes a production capacity, so proven production lines can be used to start Increment 2 production.
- Strategy offers payback in reducing the overall UPC.

MCS risk can also be reduced as the first version of fire control and gun modifications is produced and exercised on an Abrams MBT. Because the same prime contractor — General Dynamics Land Systems — is developing the MCS and Abrams upgrades, maximum synergy of designs can be achieved. From an operational standpoint, future tactics, techniques and

procedures (TTPs) are also enhanced in that Increment 1 will allow the FCS Experimental BCTs to vet the operational issues of using MRM. This will allow TRADOC and other users the capacity to optimize TTPs for the final FCS fielding.

### A Decisive Finisher

The final and most important benefit is that MRM increments will help bridge the lethality gap from the Current Force to FCS. Developing and fielding MRM in two increments provides the UA and FCS-equipped HBCTs the flexibility to execute BLOS missions from multiple platforms. This approach permits the FCS MCS to achieve both lethality and survivability requirements. If the network sees and understands first, MRM will help assure that the FCS force can “finish decisively.”

**ROBERT MUTH** is the Systems Integration Lead for the MRM program currently assigned to PM MAS from ARDEC. He has both a B.E. in electrical engineering and an M.E. in integrated engineering from Stevens Institute of Technology. Muth is Level III certified in systems planning, research, development and engineering and has more than 17 years of acquisition experience.