Commonality of Towed Artillery Digital Fire Control Systems (DFCS)

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Commonality of components across towed artillery platforms has been practiced at the basic weapon level for some time. Examples are common hydraulic fluids and other lubricants, as well as high-usage rate cannon components and optical fire control components. Commonality of DFCS across towed artillery platforms is a new initiative by the Joint Program Manager Lightweight 155mm (JPM LW155) Howitzer between the M777A2 and the M119A2 towed howitzers. The 155mm M777A2 was the first towed howitzer to have a DFCS. A program to integrate a DFCS capability onto the 105mm M119A2 towed howitzer was approved by Program Executive Officer Ground Combat Systems and the Field Artillery School Center of Excellence Commanding General on Jan. 24, 2008. Direction was provided to maximize commonality across the Infantry Brigade Combat Team (IBCT) to the maximum extent possible, thus minimizing the IBCT's logistic footprint.

The 155mm M777A2 was the first towed howitzer to have a DFCS. Here, 108th Field Artillery Regiment (FAR), 56th Brigade, 28th Infantry Division, Pennsylvania Army National Guard (ARNG) Soldiers fire the M777A2. (U.S. Army photo courtesy of Fort Sill, OK, library.)

This mission was assigned to the JPM LW155, who is also the life-cycle manager of the 155mm M777A2 towed howitzer. Additionally, the JPM is responsible for the Army's 155mm M198 towed howitzer (no plans for digitization), the M111 Improved Position and Azimuth Determining System, the Gun Laying and Positioning System, and the Towed Artillery Digitization program. Recently, the JPM has been assigned to manage the "non-standard" D-30 howitzer mission by the Vice Chief of Staff of the Army.

The digitized M119A2 program and the commonality effort between it and the M777A2 are being executed in an evolutionary approach. The goal is to be common where possible and as quickly as possible, without adding high technical or other programmatic risk to either of the two target platforms. The decision document to proceed with digitizing the M119A2 required the program to maximize use of hardware already within the IBCT, where possible. To accomplish this, the dismounted 120mm mortar line-replaceable unit (LRU) DFCS hardware was used as a baseline, with the goal of achieving commonality with the other artillery platforms at a later date. The digitized howitzer will be Type Classified Standard as a M119A3, consisting of all digitization hardware and Block 1.1 software that provides the capabilities of basic navigation, aiming, pointing, and Joint Variable Message Format communications with the Fire Direction Center. A comprehensive plan has been put in place to achieve the commonality goals between the future M119A3 and the M777A2 within 3 years.

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Why Pursue Commonality?

In addition to the DFCS allowing the M119A3 to become more survivable on the battlefield by emplacing and displacing faster and providing more responsive fires, ensuring LRU and software commonality will have a significant payback. Commonality will result in shorter development times for new LRUs. With a common architecture between platforms, one platform's development can leverage off another platform's development, similar to what is done in software development. This will result in lower costs as well, since separate development efforts and teams would not be needed. This quicker development time is also important because of obsolescence issues with electronic components. Baseline designs are difficult, if not impossible, to reproduce and support within a few years of first hitting the field. When artillery platforms have common LRUs, there is a huge payback from having a common logistics base; sustainment costs are reduced due to fewer configurations

The DFCS capability is being integrated onto the 105mm M119A2 towed howitzer. Here, 1st Battalion, 258th FAR, New York ARNG Soldiers lift the back of an M119A2 howitzer to spin the cannon into firing position, March 8, 2010. (U.S. Army photo by SPC Ian Boudreau, 27th IBCT Public Affairs.)

Blasting a 155mm howitzer round during a gun-calibration exercise at Destiny Range, Mosul, Iraq, Soldiers make the earth tremble as they fire more than 30 rounds from an M109A6 Paladin, April 23, 2010. Possible commonality of DFCS with the Paladin self-propelled howitzer is being investigated. (U.S. Army photo by SPC Gregory Gieske, 2nd BCT, 3rd Infantry Division Public Affairs.)

having to be maintained. Commonality also provides for training similarities across platforms.

Challenges

Each platform has unique performance and environmental requirements, such as shock loading and weight. Each platform has unique interface requirements and a different schedule for development, refresh, obsolescence, production, and fielding. The M777A2 DFCS is nearing the obsolescence and refresh timeframe, whereas, the M119A3 is in development. Lining up software development with hardware development is also challenging. Software development teams will need hardware early in their process. Also, mandated hardware changes, such as updated radio systems, may be service-unique. Each of these is a challenge to achieving commonality.

The survival of the Inertial Navigation Unit (INU) in the M119A2 shock environment is a known issue. Shock values when firing on the M119A2 are much higher than on the M777A2, so simply taking the INU currently on the M777A2 and putting it on the M119 was a non-starter. An effort was conducted to identify potential suppliers and evaluate the ability of their devices to meet M119A3 requirements while still being backward-compatible onto the M777A2.

Another commonality challenge is the DFCS power supply, since the size and weight of each system's power supply is driven by its own system level requirements. The M777A2 has more LRUs to power, and its run-time requirements are greater. The digitized M119A2 system has lower weight requirements. A new power supply, common to both platforms, is being designed with both systems' requirements being taken into account.

Some technical risk because of differences between the dismounted 120mm mortar's environment and the M119A2's environment is also present. This will be addressed through qualification testing. If an engineering modification is needed as a result of this evaluation, an Engineering Change Proposal will have to be negotiated with the common platform or an agreement from the user obtained to relax the requirement through a cost-as-an-independent-variable exercise.

The weight requirement for the digitized M119A2 is 4,500 pounds or less. Weight plays a big factor in transportability and operability of the M119A2.

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The weight of the DFCS components and their configuration on the weapon also factor in the operability of the weapon for emplace/displace and out-of-traverse functions. Close attention has been paid to the weight and balance of the system, and an acceptable configuration has been determined and vetted with the user community.

Commonality Steps

The first step in developing common hardware is to create a generic system architecture for towed artillery DFCS that meets all the associated platforms' requirements. Hardware diagrams specific to each platform then have to be prepared. These diagrams have to synchronize software development schedules for each platform and the proposed funding for refresh and obsolescence. Road maps, then created for each LRU, will include requirements development, prototype development and testing, system level testing, and procurements.

Commonality is being executed using the U.S. Army Armament Research, Development, and Engineering Center (ARDEC) as the systems integrator. ARDEC is the current design authority for the M119A3 howitzer and will become the design authority for the DFCS hardware on the M777A2 as more components become common. ARDEC has an established artillery fire control software capability used by the M777A2 and Paladin systems. Using ARDEC allows the program to leverage digitization hardware from other existing programs. In addition to systems integration, ARDEC will write the computer code using the M777A2 code as a baseline.

Proposed Common LRUs

There are a number of planned common DFCS LRUs. The Muzzle Velocity System (MVS) will initially be a stand-alone system that will be integrated into the DFCS during a future software upgrade. The Power System and the Power Distribution System (PDS) will have a new power control and conditioning module, a power data hub, and new batteries. There will be a combined Mission Computer and Chief of Section Display; currently, these are separate LRUs on the M777A2. The digitized M119A2 will use a combined unit called the Fire Control Computer (FCC). Also, the Gunner's Display, INU, radio, and Platform Integration Kit (PIK)/integrated PIK (iPIK) will be common.

LRUs that won't be common between the digitized M119A2 and the M777A2 are the Laser Ignition System, the Electronic Thermal Warning Device, and the Hydraulic Power Assist Kit. However, the PDS and FCC will be designed to interface with these LRUs when implemented on the M777A2. The FCC used on the dismounted 120mm mortar achieves all requirements. Under the guidance to maximize commonality, the same computer will be acquired as part of the digitization package.

Current Status

The solicitation for a common MVS has been released and includes all requirements for the M777A2 and the digitized M119A2 platforms. Bid sample testing will be conducted in support of a procurement decision. A working group has been established to write the power system specification and a draft currently exists. It is planned to build and test power system prototypes to this specification. The proposed M119A3 FCC solution was demonstrated on the M777A2 in January 2010 using modified software, and user assessment will be obtained after the demonstration. The proposed gunner's display was also demonstrated on the M777A2 in January. The M119A3 program is in the middle of a source selection for the new INU to meet specified shock requirements. After a down select, a compatibility study will be initiated to determine the steps needed for the INU to be retrofitted on the M777A2.

Both platforms currently use Advanced System Improvement Program (ASIP)-compliant radios. Since ASIP may be replaced in the near future, a study will be initiated to determine potential issues with integrating a new radio solution. The M777A2 currently uses PIK and the Defense Advanced Global Positioning System Receiver (DAGR). The M119A3 will use iPIK, which combines the functionality of the PIK and DAGR into one device. A study will be conducted to determine potential issues with integrating iPIK into the M777A2.

Possible commonality with the Paladin self-propelled howitzer is also being investigated. The same types of challenges will be encountered as those between the two towed platforms. A commonality study will be conducted by the offices of the JPM LW155 and PM Heavy BCT.

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