FCS Supportability — Where We Are Going and How We Are Getting There

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The Future Combat Systems (FCS)-equipped Future Force Unit of Action (UA) will transform our Army's ability to conduct warfare. For supportability, the transformation brings a full-spectrum force with a much smaller logistics footprint than that required to support the Heavy Modular Brigade Combat Team (MBCT). This aspect helps achieve strategic responsiveness and allows tactical maneuver to be uninhibited by logistics constraints and linear links to echelons above the UA for up to 3 days of battle. This article focuses on how Program Manager (PM) UA is influencing the FCS program design for supportability to provide 21st-century Soldiers the best possible combat-ready systems while also reducing logistics footprint and life-cycle costs (LCCs).

A 4th Infantry Division artilleryman guides a Multiple Launch Rocket System vehicle onto a rail car in preparation for deployment April 21, 2005. (U.S. Army photo.)

When the Army developed and approved the FCS requirements — based on how the UA is expected to operate on future battlefields — more than 100 critical requirements were established that focus on supportability. The Army set aggressive thresholds that will enable reduced logistics footprint and LCCs inside FCS-equipped UAs. These requirements include extremely high operational availability, reliability at levels 2-8 times greater than Current Force systems, maintainability at levels 2-4 times greater than Current Force systems, fuel efficiency, water generation, "pit-stop" engineering, automated resupply, diagnostics, prognostics, 80-percent maintenance performed by the crew, minimal tools, very low repair times, onboard sensors, limits on scheduled services, interactive technical manuals and, most importantly, network-centric logistics enablers.

How Requirements Are Being Met

More than 200 logistics engineers and logisticians from the PM and Lead Systems Integrator (LSI) work side-by-side with design engineers to incorporate supportability requirements into emerging design concepts. Initially, this work focused on numerous "trade studies" to determine the best practical way to meet requirements, particularly when requirements are competing for limited weight and space on FCS platforms. These trade studies also provided a systematic way to challenge requirements that were deemed unachievable because of technical, cost or weight constraints associated with the program.

As a result, all supportability requirements have now been translated into the system-of-systems (SoS)-level specifications that will become part of the government's contract with the LSI. More than 3,500 of the 10,000-plus individual SoS specifications are supportability-related. The focus will soon turn to translating and decomposing these SoS specifications out to the numerous suppliers for their platform-level specifications — an enormous systems' engineering challenge.

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Supportability Network

As mentioned earlier, the network developed under FCS offers great warfighting advantages, while also greatly improving supportability. Situational awareness (SA), particularly when applied to supply levels, combat damage, casualties and maintenance status, is critical to supporting maneuver units. The network will provide this information in near real-time, automating much of what is "hand-jammed" in today's force.

The PM/LSI has funded two major logistics systems as part of the network — the Platform-Soldier Mission Readiness System (PSMRS) and the Logistics Decision Support System (LDSS). The objective is sustainment integrated with maneuver planning and UA operations, with near-perfect SA of what's needed by the unit, when they need it and how to get the necessary services to them on a noncontiguous battlefield. PSMRS/LDSS integrated into the network enables this critical program aspect.

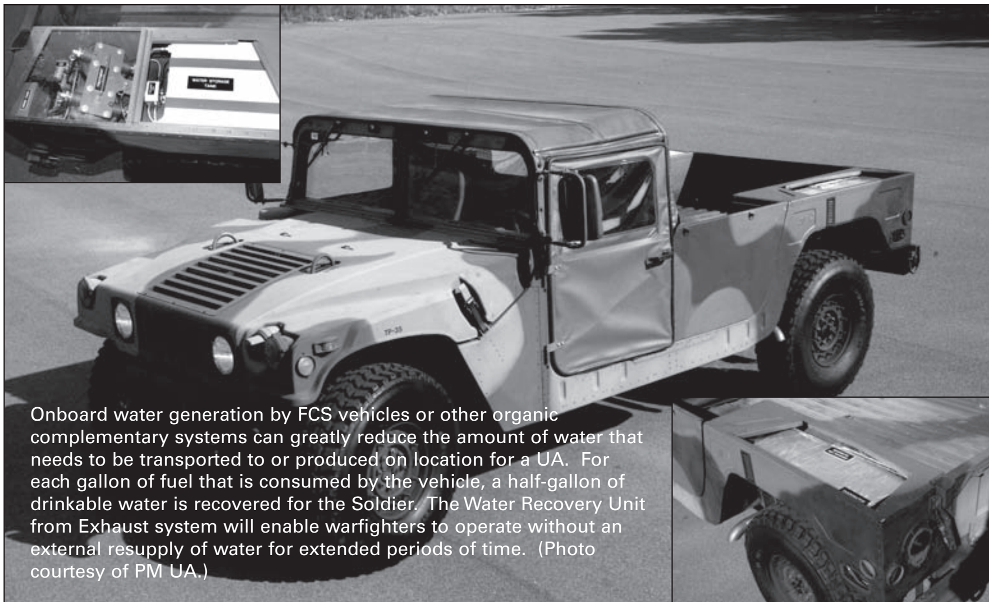
Reliability Influences Design

Reliability was deemed both a critical requirement and a technical challenge early in the program's development. The PM/LSI — understanding the criticality of high reliability to maintaining the goal of reducing logistics footprint and LCCs — entered into intense negotiations with suppliers, eventually developing a "Reliability Improvement Program" (RIP). RIP incentivizes industry to incorporate state-of-the-art best design practices, which enables industry to exceed the reliability levels necessary to meet area of operation (AO) requirements.

More than $400 million in research and development funding has been set aside for this effort. In parallel, the U.S. Army Training and Doctrine Command adjusted the reliability requirements to be consistent with the higher priority AO requirement, which resulted in "order of magnitude" improvements when compared against currently fielded Army systems.

Maintainability Reduces Logistics Footprint

FCS will be one of the first Army

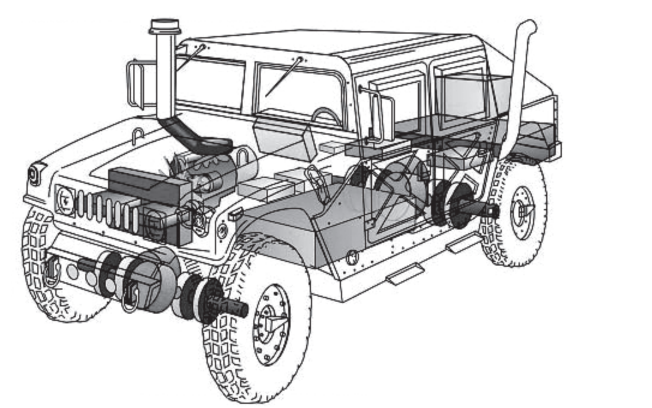


Onboard water generation by FCS vehicles or other organic complementary systems can greatly reduce the amount of water that needs to be transported to or produced on location for a UA. For each gallon of fuel that is consumed by the vehicle, a half-gallon of drinkable water is recovered for the Soldier. The Water Recovery Unit from Exhaust system will enable warfighters to operate without an external resupply of water for extended periods of time. (Photo courtesy of PM UA.)

programs designed from the ground up for two maintenance levels. FCS will take this initiative even further by directing that 80 percent of all field-level repairs be performed by the crew. This approach, coupled with commonality and other enablers, is a remarkable improvement when compared against current combat systems. Today's systems have numerous echelons of mechanics and supply stocks — logistics footprint — available to keep the systems operationally ready for combat.

Under the FCS program, it will primarily be the crew's responsibility to care for their platform, with a minimal number of dedicated mechanics in the UA to make repairs that exceed the crew's capabilities, including combat damage. It is a huge challenge providing the crew the technical ability and training necessary to make these repairs. FCS logisticians and engineers are designing features to ease this burden and to ensure that crews will be able to maintain their platforms. These actions include:

- *Minimizing maintenance workload.* Current air and ground combat systems require anywhere from 30 minutes to well over an hour of maintenance for every hour of operation. Most FCS platforms are limited to no more than 1 hour of maintenance for every 20 hours of operation. This "maintenance ratio" is a key requirement that supports crew maintenance and dramatically reduced maintenance infrastructures. Also, specific maintenance tasks can take no longer than 30 minutes for the crew to repair. Integrated logistics support (ILS) managers will work closely with design engineers to maximize accessibility for maintenance, including locations of fasteners and connectors to assist in achieving these goals.
- *Ease of maintenance.* For those repair actions that must still be done, FCS is pursuing a suite of initiatives to reduce maintenance task efforts and complexity for the crews and remaining maintainers. FCS is aggressively working to simplify maintenance actions via a concept known as pit-stop repair, which leverages ideas from a NASCAR-derived think tank headed by Dennis Carlson of Carlson Engineering, Livonia, MI. Carlson demonstrated this concept by dramatically redesigning the command shelter used by the Army's high-altitude air defense system. He reconfigured the interior by restacking the electronics into trays allowing easy identification and tool-less removal/replacement of failed components. Carlson is working with design engineers/logisticians on the PM/LSI team and with the primary platform contractors to ensure FCS platforms will be easy to maintain with minimal crew impact.
- *Embedded diagnostics/prognostics and automated supply transactions.* Embedded software and sensors will predict failures and initiate supply requests with limited to no crew involvement, optimizing crew time and the platform's operational availability. Crew chiefs will be informed of failed/failing parts and will be linked to repair procedures via the onboard PSMRS. Additionally, this approach eliminates the need for ancillary diagnostics equipment within the UA, reducing yet another logistics footprint aspect.
- *Line replaceable module (LRM).* The PM/LSI is redesigning how electronics are packaged on FCS platforms to ensure that high failure points will no longer be buried within large and expensive electronic line replaceable



Vehicles with hybrid-electric drive trains — like that shown in this artist's rendition of a hybrid-electric Humvee — use much less fuel than conventional vehicles and can greatly reduce the tonnage of fuel transported to the UA AO. (Image courtesy of PM UA.)

units. FCS will maximize the use of LRMs, which are durable, sealed circuit boards and power supplies that are plugged into highly reliable backplanes. Embedded diagnostics will "fault isolate" down to failed LRMs, which can then be easily removed or replaced by the crew with few or even no tools.

- *Limit on tools.* FCS platform crew maintenance actions will be accomplished with no more than 10 common tools, which will be carried onboard each platform. The entire suite of UA tools will be limited to a common list of 20 tools for all FCS field-level maintenance actions.
- *Commonality.* FCS has a design requirement to implement commonality across FCS platforms. The goal is to have 90-percent commonality of spare parts across systems, and the baseline is 70 percent. All components replaced in the field will be required to use metric fasteners. Commonality, along with common fasteners, will allow a much greater probability of having the necessary spare within the UA when needed. This will dramatically lower the platform-level downtime we see in today's combat units as they await parts.

Reducing Supply and Demand Requirements

The PM/LSI has numerous initiatives to first reduce demand for supplies within the UA, then to appropriately plan to efficiently provide the supplies at the right place and right time. The FCS program has set aggressive goals for fuel efficiency, as well as building platforms much lighter than today's combat systems, which will result in much less Class IIIB fuel required to cover comparable distances. Hybrid-electric drives are considered state-of-the-art in efficient drivetrains and are being incorporated into manned ground systems and other platforms.

Water generation is another innovative technique to reduce the second greatest tonnage (behind fuel) class of supply distributed on the battlefield. While onboard water generation was not technically achievable within weight/space constraints on the FCS manned ground systems, the PM/LSI is investigating the possibility of placing water generation on other UA organic complementary systems, minimizing the need to transport water to the UA from other areas within a theater.

To better address Class V ammunition storage and transport concerns, precision munitions are being developed/used on FCS platforms to reduce the rounds required. Automated resupply for large caliber ammunition on specific platforms is also being pursued to minimize the stress and workload on Soldiers, allowing them to focus on their combat missions.

To address future Class V ammunition storage and transport concerns, precision munitions will be developed for all FCS platforms. Precision munitions, ultimately, will reduce the number of rounds required for specific platforms. Here, SFC John Konken (left) and SPC Darryl Leija load sabot tank rounds into an M1A2 Abrams Main Battle Tank at Camp Taji, Iraq. (U.S. Army photo.)

Finally, PM/LSI is implementing a Performance-Based Logistics (PBL) concept to manage and provide Class IX repair parts. PBL is a strategy exercised by DOD Weapon System Managers, PMs, industry partners and system integrators to increase key warfighter performance metrics, while reducing total ownership costs and logistics footprints. Implementing PBL support strategies aids in reducing the logistics footprint through distribution-based logistics, total asset visibility and a seamless logistics system integration across all platforms.

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FCS PBL support strategies are being designed to provide a single point of accountability for sustainment stocks. This enables optimal consolidation of shipments and resupply loads, decreasing the number of travel assets required for UA support, while enabling Soldiers to track the status of requested parts. Another key PBL advantage is that the suppliers will be incentivized to increase system and component reliabilities, as opposed to generating profits through the sale of expensive repair parts.

Measuring Progress

To ensure that the FCS program achieves its supportability goals, the PM/LSI has instituted periodic supportability assessments in sync with design reviews that will include technical performance measures (TPMs) and measures of effectiveness (MOEs) designed to provide quantitative estimates of progress. The TPMs are UA self-sustainment index and system operational availability. The MOEs are UA footprint index, UA sustainment efficiency index, UA maintenance efficiency index and SoS operational availability. The UA footprint index MOE quantifies the footprint of a UA and compares it to the footprint of a like-sized MBCT. As such, the MOE will clearly indicate whether the UA has achieved a significant reduction in footprint as measured in total metric tons.

The TARDEC Mobility Group is beginning an exciting new project to acquire a Dynamic Test Rig, which is also known as a Dynamic System Integration Laboratory. The new asset is a mobile platform for qualifying advanced hybrid-electric power components and subsystems to Technical Readiness Level 6. The platform will actually be a modified 20-ton hybrid-electric powered tracked combat vehicle demonstrator. (U.S. Army photo courtesy of TARDEC.)

The PM/LSI has an aggressive and disciplined effort in place to influence FCS design and supportability. At this point in the program's Systems Development and Demonstration phase, this effort has made a tremendous impact in setting the azimuth for FCS, delivering maximum combat power and a minimal logistics footprint and LCC to 21st-century Soldiers. While PM UA has numerous challenges ahead of it, the end result will be a modernized fleet of combat systems with high operational availabilities and reduced logistics footprints and LCCs. This effort will provide future Soldiers the best possible capabilities to meet tomorrow's threats without leaving them with unnecessary logistics burdens.

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