AGILE DEVELOPMENT AND NEW APPROACHES:

The Army's Next Generation Combat Vehicles

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THE SITREP:
AGILE DEVELOPMENT AND NEW APPROACHES: THE ARMY'S NEXT GENERATION COMBAT VEHICLES

The Next Generation Combat Vehicle (NGCV) program is the Army's latest attempt to develop a family of networked, manned and unmanned vehicles with advanced sensor technology to increase battlefield awareness and engage targets beyond line of sight. New operational concepts such as autonomy and manned-unmanned teaming will require the Army to field distinctly new technologies and approaches in combat vehicle design.

Emphasis on network connectivity, new materials, vehicle autonomy, force protection and cyber/electronic capability necessitates integrating the latest networking, software, and communications technology in NGCV. The program anticipates new use transformational technologies such as artificial intelligence, the success of which rests on a computer hardware backbone with sophisticated architecture.

The NGCV variants are being developed by Army Futures Command, a new four-star command that became operational in July 2018 and now counts about 24,000 personnel. Futures Command focuses on six modernization priorities that run the gamut of the Army's warfighting domain: next-generation combat vehicle, mobile & expeditionary Army network, future vertical lift platforms, long-range precision fires, air and missile defense capabilities, and soldier lethality.

The key organizations within Futures Command with direct responsibility for NGCV include the Next Generation Combat Vehicle Cross Functional Team (CFT), and the Army Ground Vehicle Systems Center (GVSC). Both organizations are located at the Detroit Arsenal in Warren, MI, a suburb of Detroit. The arsenal has been the center of U.S. tank production since 1940, having built everything from the Lee, Sherman, and Pershing tanks of World War II to the present-day M1 Abrams battle tank used in Afghanistan and Iraq.

The Next-Generation Combat Vehicle is not a single combat vehicle, but rather a suite of five new platforms that address different needs for differ types of ground combat units. They are:

- Optionally Manned Fighting Vehicle (OMFV), a replacement for the M2 Bradley Infantry Fighting Vehicle;
- Armored Multi-Purpose Vehicle (AMPV), to replace the M113 armored personnel carrier;
- Mobile Protected Firepower (MPF), which is a light tank for Infantry Brigade Combat Teams and will replace the 1960's-era M551 light Sheridan tank;
- Robotic Combat Vehicles (RCVs), which will operate autonomously in manned-unmanned arrangements and come in light, medium, and heavy variants; and
- Decisive Lethality Platform (DLP): the M1 Abrams tank replacement

        – Barry Rosenberg
        Contributing Editor, Breaking Defense

EMPHASIS ON AN OPEN-ARCHITECTURE, PLUG-AND-PLAY CAPABILITY

With these platforms, the Army is hoping to avoid the mistakes of two earlier cancelled programs: the Future Combat System Program (FCS), which Secretary of Defense Robert Gates shut down in 2009; and the Ground Combat Vehicle (GCV) Program, which Secretary of Defense Chuck Hagel ceased in 2014. Numerous factors doomed those programs, including reliance on immature technologies that didn't perform as expected and too many performance requirements that regularly changed, leading to major cost overruns.

The NGCV platforms will also be dependent on new technologies and innovations with high expectations for performance in areas like materials, propulsion, robotics, artificial intelligence, and sensors. That puts NGCV at risk of the same factors that led to the downfall of FCS and GCV.

The team of Raytheon and Rheinmetall Defence are proposing the Lynx Infantry Fighting Vehicles as the basis for the Army's Optionally Manned Fighting Vehicle. *(Photo Credit: Raytheon)*

The Army will attempt to mitigate these concerns with an open-architecture, plug-and-play capability that it says are the enabling elements that will keep the NGCV platforms relevant fighting machines over the next decade or two.

"At GVSC we are prioritizing the use of modular open systems approaches (MOSA)," wrote program experts from both the GVSC and CFT in response to questions from Breaking Defense. "This will provide highly cohesive, loosely coupled software capabilities that can be reused across programs, providing benefits in cost, schedule, competition, and

innovation. It's vital to have an open architecture that focuses on open standards, interoperability, portability, and modularity."

They added, "Standards and working groups exist to document and help guide the use of open standards and architectures in specific domains. Prime examples include the Autonomous Ground Vehicle Reference Architecture for ground vehicle robotics, the Ground Combat System Common Infrastructure Architecture for ground combat systems, and the Vehicular Integration for C4ISR/EW Interoperability standard for C4ISR/EW.

"This is also a critical component to the Army's modernization strategy. We've realized that the Army will never be able to keep up with technological advances if it does not make the ability to adopt new technologies central to all our combat platforms."

The GVSC/CFT teams point to two advances they say are built around this principle. Their autonomy and robotics efforts are based upon the Robot Operating System, a flexible software framework that can add or remove behaviors from a library of robotic behaviors based upon warfighter needs, the operational environment, and vehicle type.

Another is the Modular Active Protection System (MAPS), a vehicle survivability capability built on an open architecture that can integrate components into an active protection solution for vehicles, extending from sensors to defeat mechanisms.

The Army also says it is embracing what is known as "agile development" to reduce costs, improve outcome, lower acquisition risk, and field systems more quickly. The methodology, also known as DevOps, is widely used for software development and embraces an iterative process: develop in increments, get user feedback, make improvements, field the next increment, and repeat.

This process "reduces costs, avoids obsolescence, lower acquisition risk, and increases speed of delivery, and represents advances in materiel acquisition we're excited to be see at Army Futures Command," said the DVSC/CFT teams. "These are advances that the Army has been seeking for a long time. Identifying the places where modernization is needed the most, accepting reasonable risk of failure early, and striving to keep our collaborative industry partners abreast of the Army's needs maintains the momentum that rapid but responsible modernization requires."

This agile approach will be the key to successfully developing the NGCV's enabling technologies:

MANEUVER ROBOTICS AND AUTONOMOUS SYSTEMS:
To enable future maneuver formations to operate manned and unmanned platform in concert, extending reach, and lowering casualty risk.

DIRECTED ENERGY AND ENERGETICS:
Designed to give soldiers both lethal and non-lethal options for offensive and defensive operations, while also playing a role in vehicle protective systems.

POWER GENERATION AND MANAGEMENT:
The goal is to provide energy to all NGCV platforms through alternative energy means, which increases operational range and reduces reliance on consuming fuel and associated supply chain impacts.

ADVANCED ARMOR MATERIEL SOLUTIONS:
Designed to augment and improve upon passive armor.

VEHICLE PROTECTION SUITES:
To improve both passive armor and active protection systems so vehicles are more survivable, weigh less, have improved mobility, and reduce the supply chain tail.

When asked how the Army plans to address the challenge of development and deployment of so many next-generation technologies at the same time, GVSC/CFT team responded: "The technologies themselves are just tools. The success in their deployment will be the result of input from soldiers, how we can effectively provide proven capabilities in the real-world environment in which they'll use them.

Brig. Gen. Ross Coffman, Next Generation Combat Vehicle Cross Functional Team director, with the robotic surrogate and demonstrator. *(Photo Credit: U.S. Army)*

"This is an effort we've been progressing in parallel with technology development, most notable in robotics. As autonomous and driver-assist technologies are coming closer to the force, we've put early robotic systems in the hands of soldiers—sometimes in a virtual environment, sometimes in a field training environment—to learn how soldiers will employ these capabilities best. This parallel effort of soldier-guided feedback helps us to set our priorities best while familiarizing the force with these new capabilities."

The GVSC/CFT teams also emphasized the requirement for ruggedized hardware architecture that can accommodate and sustain news technologies within the confines of smaller, lighter vehicles operating in combat conditions.

"This is one of the biggest values that the Ground Vehicle Systems Center brings to the Army. Our engineers and scientists keep apace of the state of technology in civilian communities, identify what technologies may be of most use to soldiers, and work with our industry partners to bring these technologies to the force. Sometimes the technologies work well enough off the shelf, but oftentimes we have a broader range of use cases for the technologies that require further, military specific development.

"For example, current unmanned logistics efforts leverage commercially developed autonomy sensors to keep costs down. Combat vehicle robotic efforts will start with commercial sensors for initial experimentation but are envisioned to transition to military adapted versions to improve performance, minimize signature, and ensure operation across the full range of military operating environments."

The Mission Enabling Technologies Demonstrator manned vehicle can control two unmanned platforms. *(Photo Credit: U.S. Army)*

THE OMFV, RCV AND MANNED-UNMANNED TEAMING

General Dynamics Land Systems' Griffin III demonstrator will be based on a British Ajax armored fighting vehicle. *(Photo Credit: GDLS)*

The first NGCV platform out of the chute, and the Army's top priority for ground vehicles, is the replacement for the 1980's-era Bradley, which the Army says no longer has overmatch against near-peer vehicles from adversaries in terms of firepower and protective capabilities. The Optionally Manned Fighting Vehicle will be designed to restore overmatch by improving size, weight, architecture, power, and cooling, forming the acronym commonly known as SWAP-C.

It is also envisioned to operate in conjunction with the RCVs, as was demonstrated at Camp Grayling, MI, in August. There the GVSC and CFT organizations fielded a prototype manned fighting vehicle called the Mission Enabling Technologies Demonstrator (MET-D) and a pair of Robotic Combat Vehicle Phase 1 surrogates.

The MET-D demonstrator was built on a Bradley base, and outfitted with new sensors, data display, graphical user interface, drive-by-wire capability, unmanned aerial vehicle-provided video, and advanced communications, according to an article provided by GVSC Public Affairs. The RCV surrogates were constructed from an M113 armored personnel carrier.

Contractors that developed the MET-D demonstrator include the following companies, according to Army Futures Command public affairs. SAIC, Roush, Thales, Booz Allen Hamilton, and DCS provided engineering expertise, with Roush also offering prototype build experience. Leonardo DRS and Ricardo provided field service representatives. Cedar Creek Defense offered communications network expertise. Safety drivers and safety support came from Mantech and the Army Test and Evaluation Command, respectively. Army Combat Capabilities Development Command was responsible for C5ISR and armaments.

CFT director Brig. Gen. Ross Coffman explained the value of manned-unmanned operations in the article.

"The battlefield is filled with really awful places where humans do tasks today they shouldn't have to. Our American sons and daughters go out there and willingly put themselves in those positions to accomplish a mission. But today, with the way our technology has advanced, our robotic vehicles can move forward of a manned force to see what's out there, detect chemicals, put direct fire on the enemy, determine whether or not there's an obstacle, and then team with humans to determine the best course of action."

Since the demonstration, two MET-Ds and four RCV surrogates were shipped to the Army Test and Evaluation

Command, Aberdeen, MD, for additional testing. Then they'll move to Fort Carson, CO, for hands-on use by soldiers.

It's in robotic vehicles that the Army expects to deploy artificial intelligence for maneuver operations. The GVSC/CFT teams explained how.

"The foundation of AI development is data. Current commercial AI methods utilized by the automotive industry rely on large amounts of camera recordings in high-visibility on-road conditions with street signs and lane markings, fed into an AI system that drives the vehicle using algorithms and data optimized for on-road mobility that does not address off-road military environments.

"Upcoming Army efforts, such as the Autonomous Mobility thru Intelligence Collaboration project aim to grow the data set for developing AI capabilities further, while helping to address the need for a data architecture and pipeline for military research organizations to collect, manicure, store, and share date, providing greater AI advances as development continues."

The OMFV acquisition plan originally called for five years of technology development beginning in 2019, a Milestone B decision in 2024, Milestone C decision and production in 2028, and unit equipping in 2032. In mid-2018, then Army secretary and now Secretary of Defense Mark Esper accelerated the program. The plan now is to award three-year Engineering and Manufacturing Development contracts to two vendors in 2020, make a Milestone C decision in 2023, and deploy to the first units in 2026.

Expected competitors for the OMFV work include: General Dynamics Land Systems and its Griffin III technology demonstrator, which is built on a British Ajax scout vehicle chassis; and a team of Raytheon and Rheinmetall Defence, which is proposing the Lynx Infantry Fighting Vehicle. BAE Systems was also expected to compete with its CV90 Infantry Fighting Vehicle, but took itself out of the competition in mid-2019.

RUGGEDIZED SYSTEMS TO PLAY KEY ROLES IN FUTURE VEHICLES

Craig Powell, CD is Vice President of Business Development at Systel, Inc., responsible for the defense and security market. Craig has over 25 years' experience in the defense industry, 10 of which spent serving in the Canadian Army as an Armour Officer. His defense industry experience has been primarily focused on fostering programs within the CBRNE and EO/IR sensor sectors, Full Motion Video (FMV) network technologies, and high density rugged computing technologies and their use in ground and airborne platforms.

1 If we extrapolate promising innovations in materials, propulsion, robotics, artificial intelligence and sensors 10 years down the road, a next-generation combat vehicle will have unprecedented range, stealth, versatility and autonomy. What does that require in terms of plug-and-play architecture for the vehicle?

While there will certainly be significant technological innovations and improvements over the next 10 years, the basic laws of physics will remain unchanged. As such, efficient and effective thermal management of vehicle electronics will continue to be a critical challenge.

The most significant item in new vehicle design is accommodating for the heat demands of powerful electronics, specifically providing for environmentally controlled space claims, which need to be designed into the vehicle. Requirements for edge-deployed AI capability complete with sensor fusion, software analytics, and big data throughput in a rapid decision-cycle necessitate high performance and consequently high wattage CPU and GPU processing power integrated into a ruggedized hardware system.

Systel utilizes advanced thermal management techniques to cool fully sealed, fully rugged computers with high wattage electronics at extreme operating temperature ranges. A great example of this is our Raven-Strike computer which is a fully sealed, fully rugged, single line replaceable unit (LRU) system designed for centralized ingest and data fusion of all vehicle sensors. It is successfully hosting the Hostile Fire Detection and Localization system being tested in the OMFV and RCV surrogate vehicles.

In order to get to a plug-and-play vehicle architecture, the electronics hardware must become a fundamental pillar of the vehicle's design. This involves electronic equipment chambers built into the vehicle's hull with a standard power source, appropriate input/output (I/O) connectivity, and necessary environmental conditions for the AI-enabling compute solutions to successfully run at 100% capacity.

2 How might a rapid, iterative process to development lead to reduced costs, prevent obsolescence, lower acquisition risk, and increase speed of delivery for NGCV?

There's an old adage that says, "you can have good, fast, and cheap but you can only pick two." Rapid processes and lower costs typically move in opposite directions of performance and price when applied simultaneously. To combat this, Systel's design philosophy is founded on a common standards approach that can be seen in our rugged COTS hardware solutions. Adoption of common and sanctioned standards allows for faster time-to-market of bleeding-edge technology while mitigating program risk, and thus, reducing costs.

Choosing Austin, TX, for Army Futures Command clearly indicated the path forward for the Army's top priorities, including NGCV, and for government to partner with industry at the initial program development stages. Leveraging commercial technologies based on a combination of an open systems architecture approach and the adoption of proven and common standards is key.

Amazon Web Services (AWS) and their blazingly efficient networks and processing could serve as an example

RUGGEDIZED SYSTEMS TO PLAY KEY ROLES IN FUTURE VEHICLES

of a computer architecture utilizing an established standard (typically a mix of Intel CPUs and Nvidia GPUs). AWS hardware is based on a hyper-convergence of capabilities in a single space and is networked using high-speed and large-bandwidth Ethernet or other high bus speed architectures. This hardware is verifiable and is based on an architecture that is common, cost effective, and selected based on proven reliability and performance.

Systel's single LRU systems, based on established standards in the C4ISR space allow for robust obsolescene management and a rich upgrade path for new technologies to be easily accomodated over the lifespan of a vehicle.

3 **Is the state of ruggedized hardware architecture able to accommodate and sustain these capabilities within the confines of a smaller, lighter vehicle in harsh combat conditions? Is this technology available and/or achievable in a near term sense?**

Forward deployed systems must be fully rugged for harsh environment use. This state of ruggedized hardware architecture does currently exist. Systel's current hardware solutions are engineered to withstand the austere combat conditions seen in combat vehicles and smaller, lighter vehicles. Ruggedization is one of three major considerations, along with capability and SWaP-C.

In order to meet the processing demands of sophisticated electronic suites, the vehicle must be capable of supporting high-power, fully sealed rugged computers. A modern vehicle's capability (mission effectiveness) is driven by the quality and accuracy of the sensor's output. These sensors necessarily generate an enormous amount of raw data for the analytical software to provide precise responses. In order to output the most accurate response, the data must be consumed and processed rapidly before any decisions are made, especially on autonomous vehicles. The higher the quantity of sensors and the more powerful the sensor, the greater computing power required. This can lead to rapidly diminishing returns as vehicles become larger to accommodate, potentially rendering a vehicle like the RCV-Light not so small or light.

The push-pull is that new requirements demand increasingly higher-performance and higher wattage electronics in small footprints with size, weight, power, cooling, and cost (SWaP-2C) considerations at the forefront. The result is that companies like Systel are asked to take data center server rack performance and implement it into fully sealed, small-form-factor embedded systems for vehicle integration.

Systel utilizes advanced thermal management techniques to cool fully sealed, fully rugged computers with high wattage electronics at extreme operating temperature ranges. Additional vital environmental and rugged build considerations include shock and vibration, electromagnetic interference and power filtering, and dust and water ingress. A robust engineering and production loop of analysis, validation, and testing must be ingrained to ensure prototype and production systems are designed and manufactured with paramount importance placed on harsh environment survival.

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