



U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND GROUND VEHICLE SYSTEMS CENTER

The Future of Army Ground Vehicles Power and Energy Systems

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Ground Systems Propulsion and Mobility

THE FUTURE OF GROUND VEHICLE POWER AND ENERGY SYSTEMS



- **Larger amounts of on-board electric power a must – O(10 KW to 1 MW)**
 - Higher power jamming, directed energy weapons, radar, counter UAS, sensing, etc.
 - Unmanned systems vs manned systems
- **Export power kits**
- **Advanced high volumetric energy density batteries with high C rate capability for directed energy weapons (DE weapons)**
- **Medium volumetric energy density batteries for hybrid propulsion applications**
- **PTO driven generators for tracked vehicles**
- **Integrated starter generators for wheeled vehicles**
- **In-hub motors for specialty wheeled vehicles**
- **Electric drive for specialty vehicles**
- **Conventional powertrain and non-conventional powertrain with on-board electric power capability**

GROUND VEHICLE SYSTEMS CENTER (GVSC) MISSION AND VISION



MISSION

Accelerate delivery and sustainment of ground system capabilities to our partners ensuring overmatch for our Warfighters

VISION

The center of excellence for DoD ground vehicle systems modernization and sustainment solutions

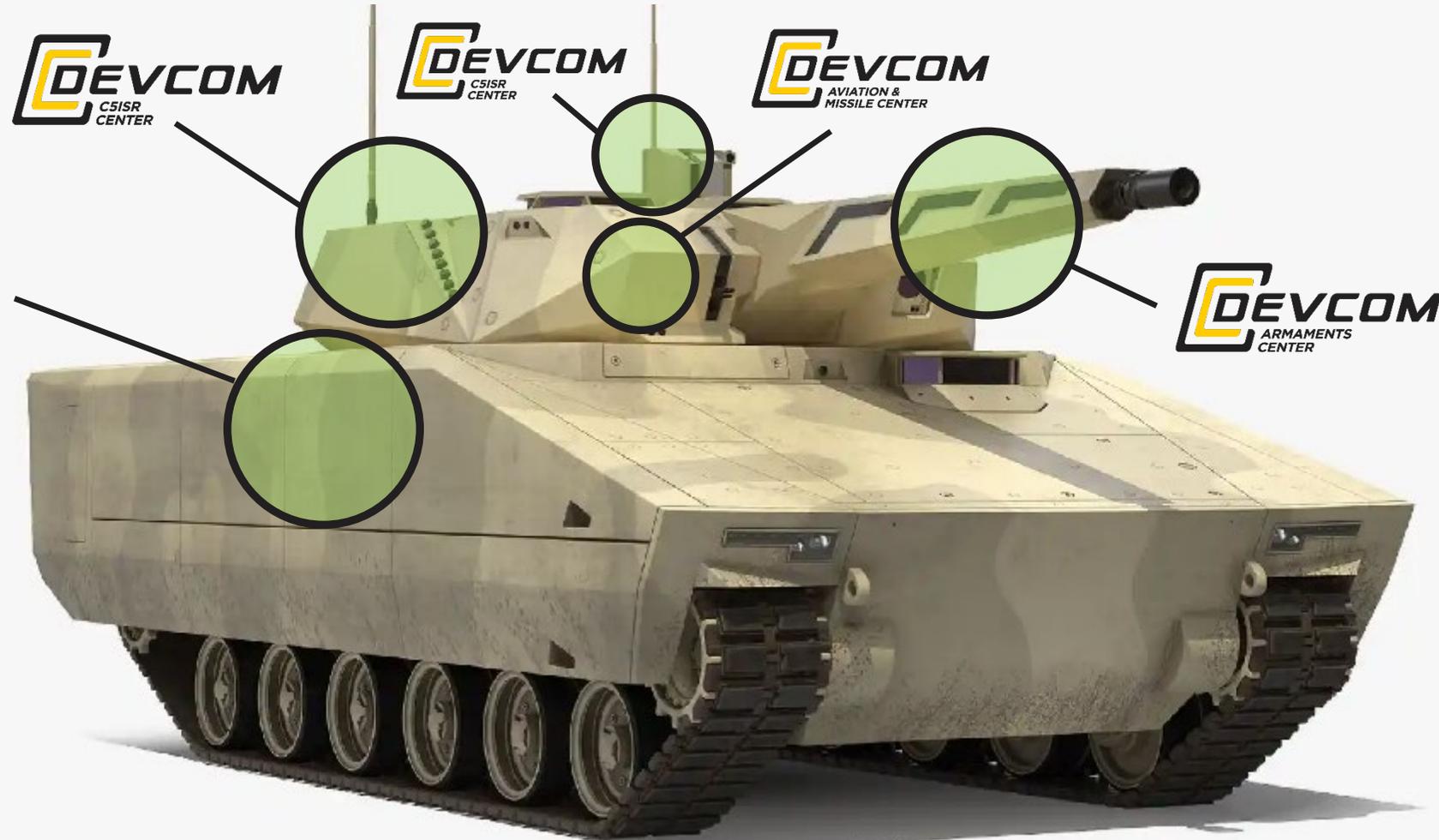


GROUND VEHICLE INTEGRATION



Core Competencies

- Survivability & Protection
- Autonomy & Robotics
- Propulsion & Mobility
- Electronics & Power Management
- Fuels & Lubricants



Enabling Competencies

- Systems Engineering
- Product Assurance & Test
- Software & Cyber Engineering
- Modeling, Simulation & Prototyping

INTRODUCTION TO GROUND SYSTEMS



- Diverse portfolio of product
 - Armored trucks – light, medium, heavy
 - Construction equipment – wheeled and tracked
 - Combat vehicles – tracked and wheeled
 - Material handling equipment
 - Power generation systems
 - Robotic systems – wheeled and tracked
 - Other support functions
- Environmental considerations
 - Desert and arctic extremes
 - Particle laden (dusty)
 - Soft soil – muddy, rutty, snowy, sandy
- Energy source – jet fuel (heavy fuel)



MOBILITY EXPECTATIONS



- Wheeled Vehicles

- Speed on grade
- Gradeability
- Top speed
- Towing
- Acceleration
- Range
- Others



- Tracked combat vehicles

- **Steering**
- **Off-road/High tractive effort**
- Top speed
- **Towing**
- Acceleration
- Range
- Others

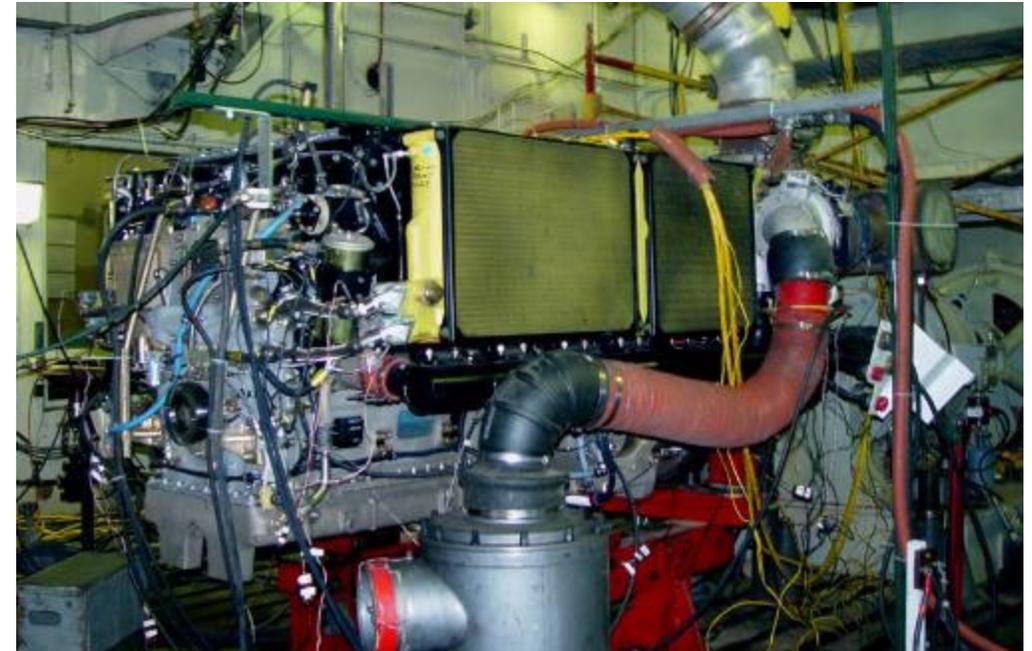
- Other considerations

- On-board electrical power demands
- Idle fuel consumption
- Mission duration
- Silent watch or mobility
- Export power options

ON BOARD ELECTRICAL POWER AND ENERGY OVERVIEW



- Must keep in mind mobility and operational requirements
- Automotive \neq heavy-duty on or off-road applications
- Army ground systems pursuit based on operational benefits
 - Approach based on application and mission space
- Reasons to pursue
 - Offensive and defensive measures
 - Extended silent watch / 'silent mobility'
 - Reduce fuel consumption
 - Augmented transient mobility
 - Reduction in stationary generator use
- Potential options
 - Accessories (fans, pumps, etc)
 - Expeditionary power kits / Export Power
 - Hybridization options – wheels vs tracks, manned vs unmanned
- Challenges
 - Volume, weight, thermal management, and cost



STAMP (Secure Tactical Advanced Mobile Power) Vehicle Centric Microgrid – Ft. Irwin:



Six Generators replaced by one Vehicle Integrated Power Kit (VIPK) FMTV @ Fort Irwin – National Training Center



FMTV Shelter
30 kW



CP 1 – DRASH
30 kW



CP 1 – AC power
10 kW



CP 2 – DRASH
30 kW



CP 2 – AC power
10 kW



Sat Comms
10 kW

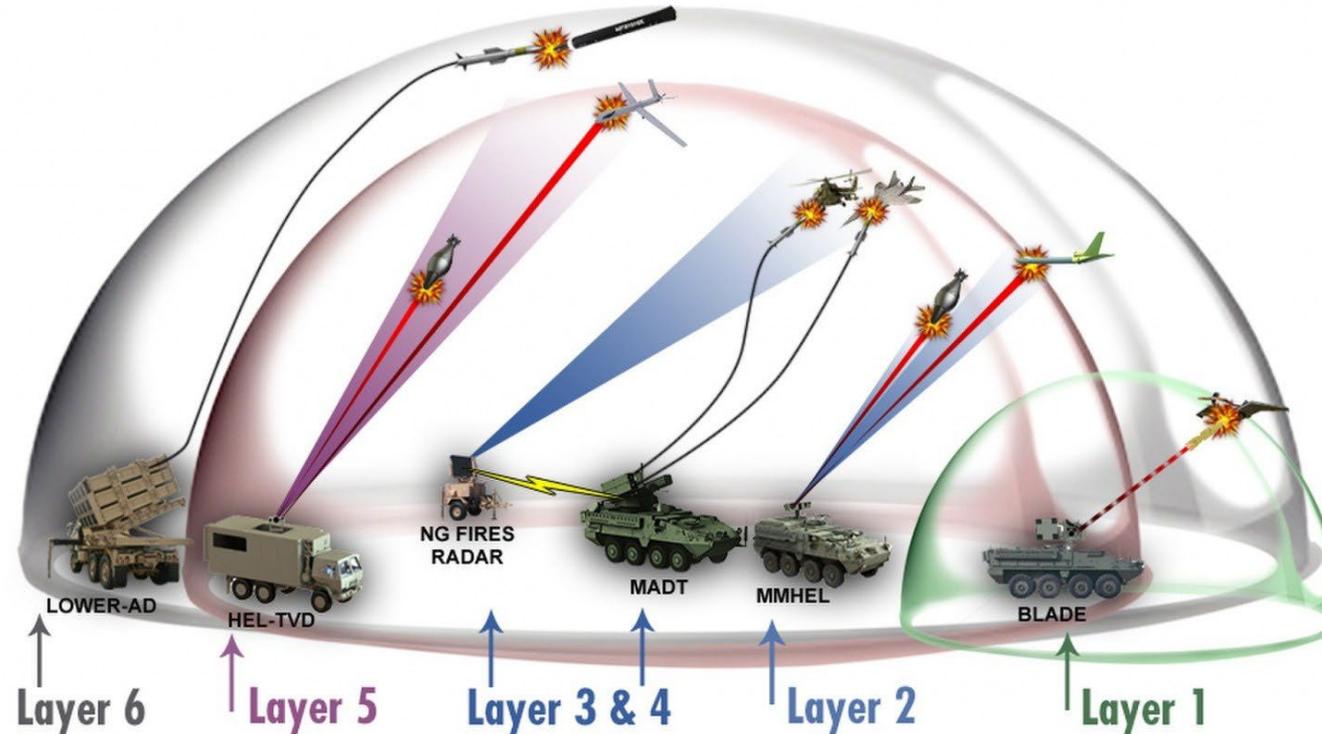
Two FMTVs provided power ~ three days w/o resupply. Only one vehicle ran (at a time) to provide power –FMTV's ran based on fuel level



Results:

- Powered 3 Command Posts ~ 2 wks
- 2x Operational duration improvement ~50% reduction in fuel use
- Average power provided ~12kW.
- Soldiers maintained the system (also restored operation 2x in ~ 9 minutes)
- Eliminated Jerry Can filling every 5 hrs
- Improved shelters air quality
- 10 minutes transition time moving from one post to another post
- Soldiers can set up in 10-15 minutes
- Requires 6 less generators
- Each vehicle capable of 120 kW – high power not needed – vehicles idled

LAYERED PROTECTION – NOTIONAL



Weapon Power, kW
Peak Power Needed, kW

300 kW
>700kW

30-50
150-200

Layered Protection Systems need electrical power.
Some need a LOT of electrical Power!

ILLUSTRATIVE DEFENSIVE WEAPON SYSTEMS



LOCUST LASER WEAPON SYSTEM (LWS) – BLUEHALO



IFPC (Indirect Fire Protection Capability System) Microwave



- High discharge rate batteries?
- Thermal management?
- Power generation?



Notional IFPC (Indirect Fire Protection Capability System) High Energy Laser (HEL) by Dynetics

HYBRIDIZATION



- **Parallel vs series options**
- **Mobility requirements – tracked vehicles more severe than wheeled vehicles**
 - Full load cooling – high tractive effort at desert like operating conditions
 - Steering maneuvers – high g turns
 - ‘frozen mud’ challenge
 - gradeability
- **Weapon system needs – directed energy, advanced sensing, etc.**
- **Limited grille size for cooling – ballistic protection**
- **Limited under vehicle air flow for wheeled vehicles (armor kits)**
- **Limited available volume for packaging – battery pack size, rotating machines/inverters, cooling system, plus other systems such as an engine, transmission, inlet/exhaust ducting, air filtration, etc.**
- **Unmanned systems offer larger and more flexible packaging volumes – may favor series versus parallel architecture**
- **Most applications are unique and will require a specific solution**

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