



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

Vehicle Electrification Forum – Vehicle Centric Microgrid Development

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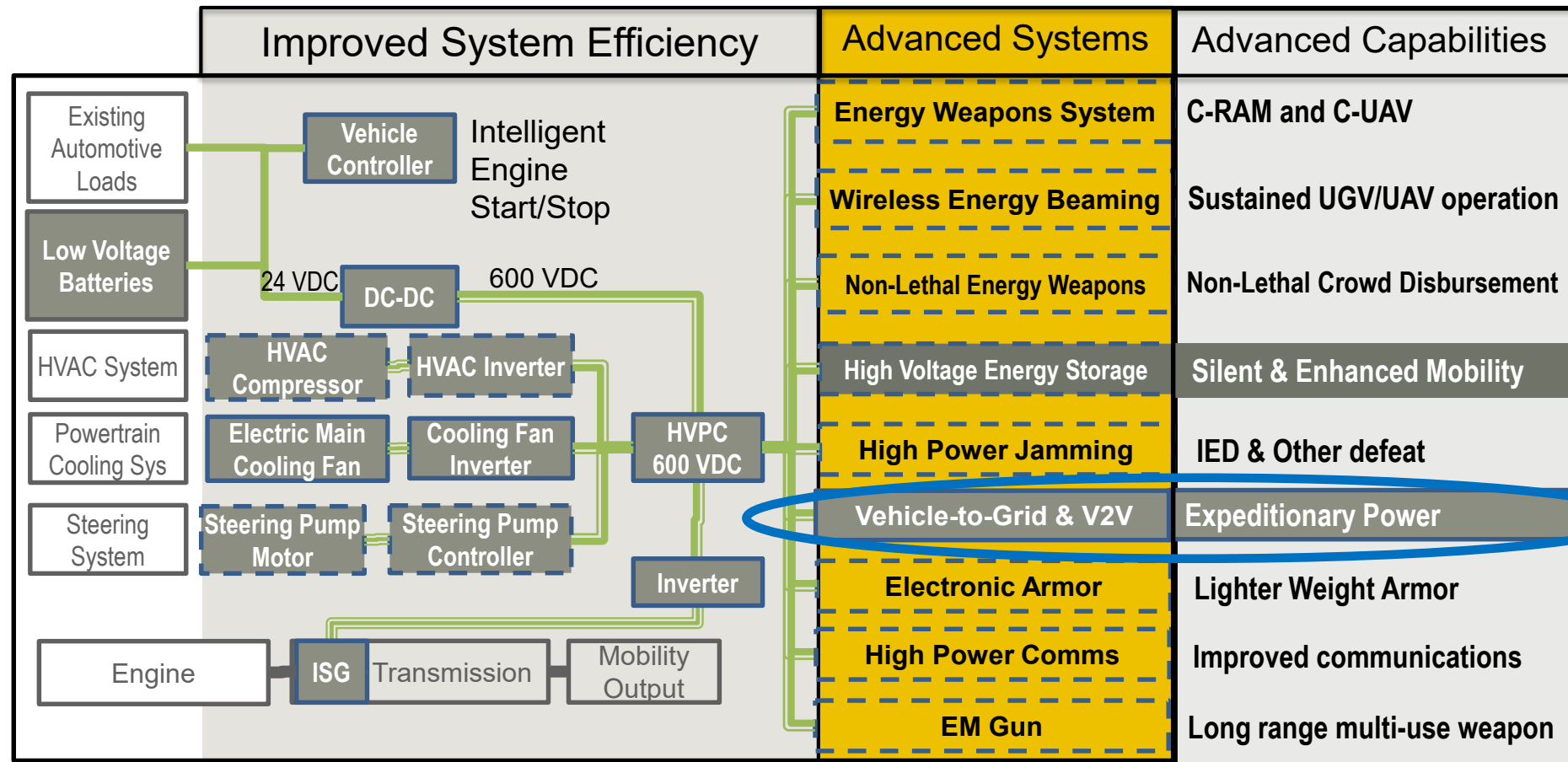
# AGENDA



- Electrification Motivations
- Discuss why Vehicle to Grid and V2G
- Multi-domain Operations
- Current On-Board Vehicle Power Generation Options
- 2016 Tactical Vehicle To Grid And Vehicle To Vehicle Demonstration
- FMTV Vehicle Centric Micro Grid Architecture
- DC Ring Bus Controller Development
- Universal Power Gateway Development
- Industry Collaboration Opportunities



# ELECTRIFICATION MOTIVATION



## Legend:

Existing Architecture

28VDC  
600VDC

Mechanical  
200 - 600VAC

Planned/Future Development

AC and VAC = Alternating Current  
C-RAM = Counter Rocket, Artillery and Mortar  
C-UAV = Counter Unmanned Aerial Vehicle  
DC = Direct Current  
DC-DC = HV/LV DC Power Conversion

HV = High Voltage  
HVAC = Heating Ventilation and Cooling  
HVPC = High Voltage Power Control  
ISG = Integrated Starter Generator  
LV = Low Voltage (24 VDC)

UAV = Unmanned Aerial Vehicle  
UGV = Unmanned Ground Vehicle  
VDC = Volts Direct Current  
V2G = Vehicle to Grid  
V2V = Vehicle to Vehicle

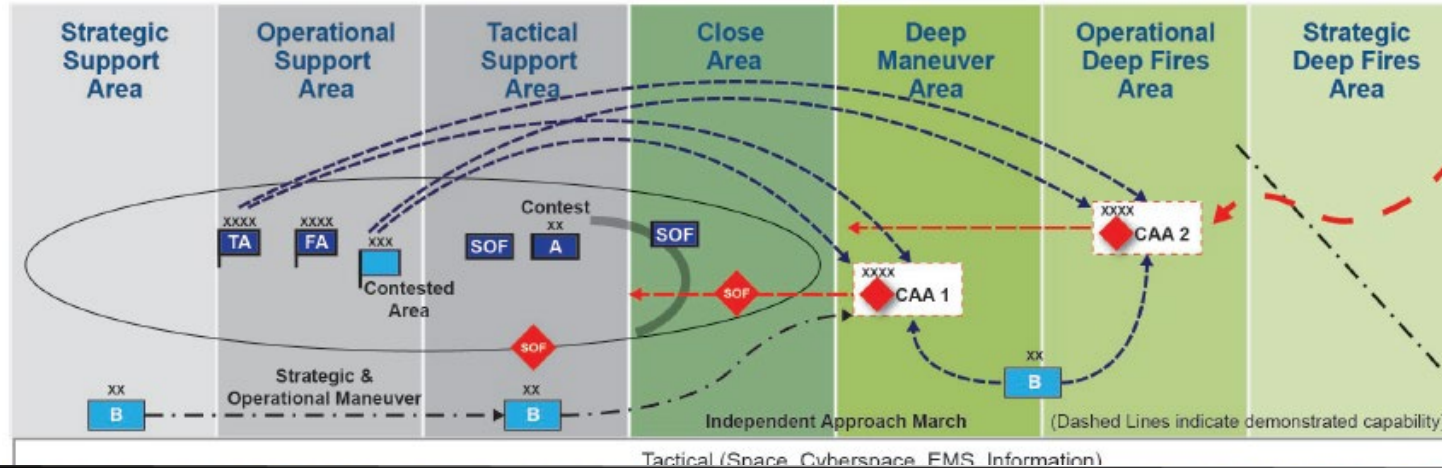


## WHY VEHICLE-TO-GRID & V2V?

- Reduces fuel consumption through micro grid sharing of power.
- Enables mobility to more places and reduces footprint by reducing number of towed generators.
- Fast forming micro grid enables rapid deployment.
- Open source cyber secure Tactical Micro grid Standard & Controls enable interoperability between future suppliers.
- Supports Humanitarian Missions.
- Supports Multi Domain Operations.



# MULTI-DOMAIN OPERATIONS



From The U.S. Army in Multi-Domain Operations 2028 TRADOC Pamphlet 525-3-1:

- “(b) Footprint. An increase in forward presence forces requires a commensurate increase in the forward footprint (facilities)” pg.D-5
- “The appropriate balance of capabilities across the Total Force provides cohesive, fully capable forward presence forces and **expeditionary forces** able to deploy within strategically relevant time periods.” pg. 17
- “Precision logistics is enabled by: ... significant demand reduction across the Total Force to lessen delivery requirements by as much as 50% and extend operational time and reach of formations.” pg. B-1

## Tenets of Multi-Domain Operations

### Calibrated Force Posture

- Forward presence forces\*
- **Expeditionary forces\*\***
- National-level capabilities
- Authorities

### Multi-Domain Formations

- Conduct independent maneuver
- Employ cross-domain fires
- Maximize human potential

### Convergence (time, space, capabilities)

- Cross-domain synergy
- **Layered options**
- Mission command / disciplined initiative

\* contact and blunt forces; \*\* blunt and surge forces

## Convergence at Echelon

XXXX  
Theater  
Army

- Provides AOR-tailored capability
- Maintains enduring initiative
- Sets the theater
- Enables expeditionary maneuver
- Responds immediately to regional emergencies
- Protects bases, key nodes, and networks

XXXX  
Field  
Army

- Executes competition against a near-peer
- Conducts all-domain operational preparation of the environment
- Provides credible deterrence
- Commands multiple corps
- Enables partners and SOF
- Employs long-range fires

XXX  
Corps

- Tailors to multiple missions and roles (e.g., Joint Task Force)
- Coordinates deep cross-domain maneuver
- Commands multiple divisions
- Shapes Close Areas: enemy mid-range fires and IADS
- Defeats long-range fires

XX  
Division

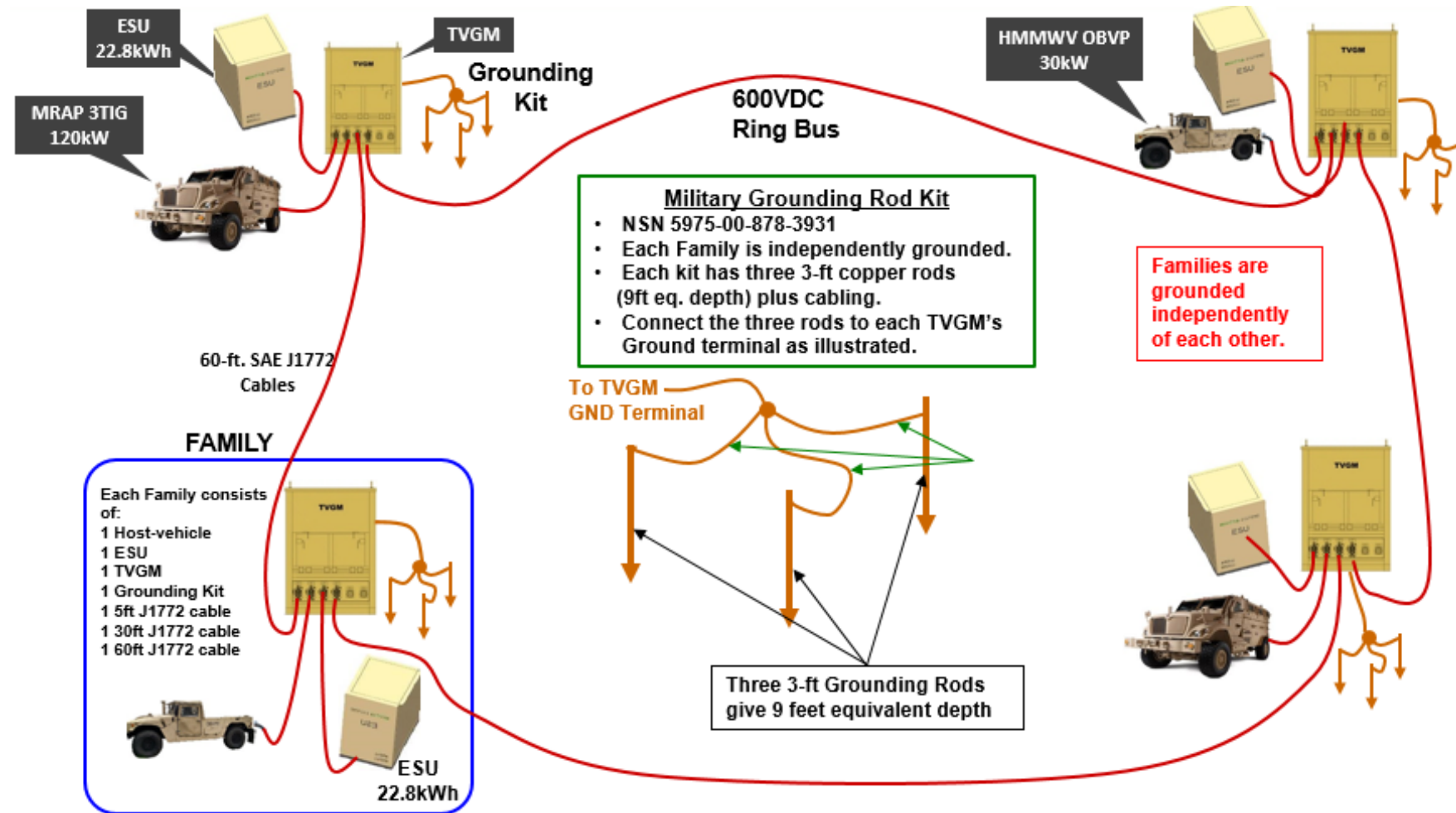
- Commands multiple BCTs and enablers
- Converges cross-domain capabilities in the Close Area
- Shapes Deep Maneuver Area
- Executes expeditionary and deep maneuver
- Dominates the close fight







# 2016 TACTICAL VEHICLE TO GRID AND VEHICLE TO VEHICLE DEMONSTRATION

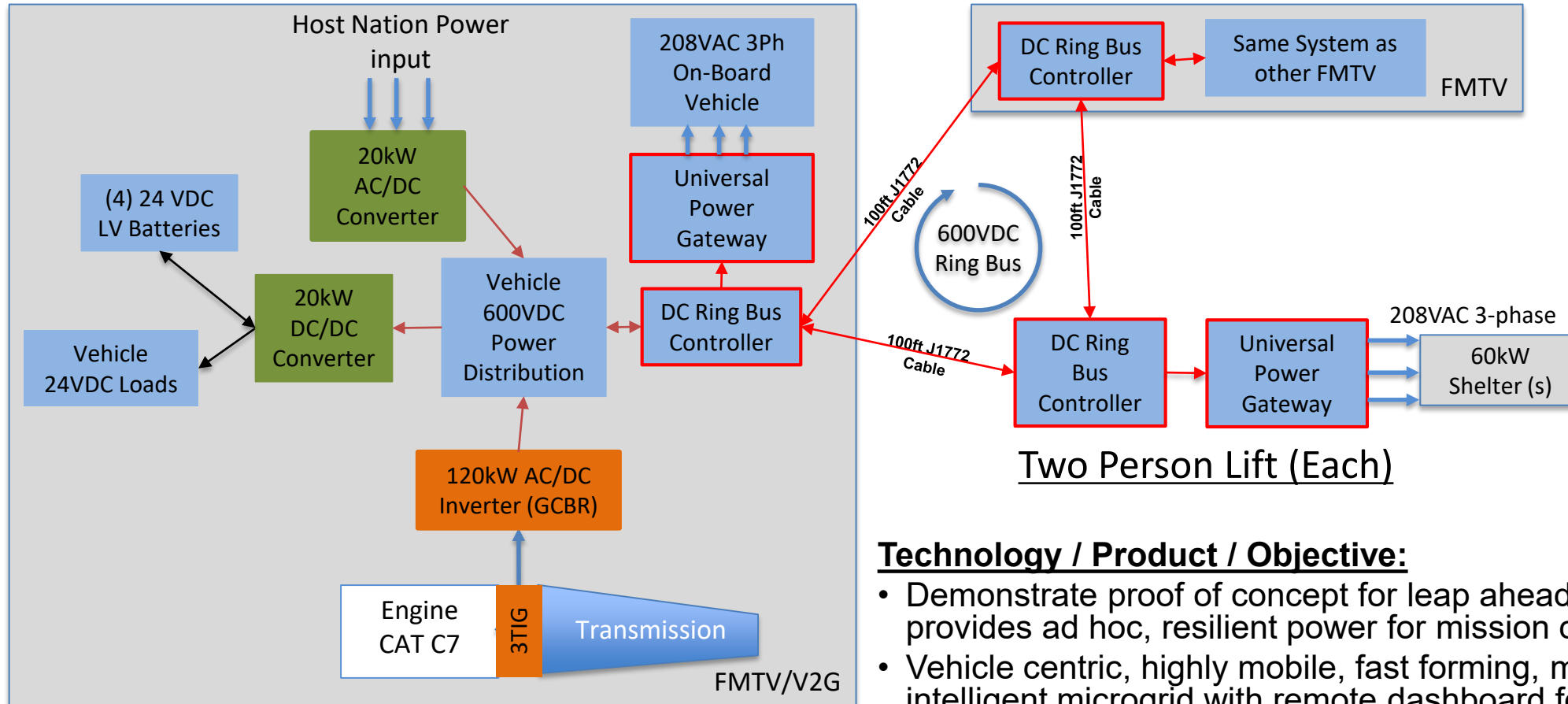




UNCLASSIFIED



# FMTV VEHICLE CENTRIC MICRO GRID ARCHITECTURE



Two Person Lift (Each)

## Technology / Product / Objective:

- Demonstrate proof of concept for leap ahead power capability which provides ad hoc, resilient power for mission critical loads
- Vehicle centric, highly mobile, fast forming, multi-source, cyber secure, intelligent microgrid with remote dashboard for situational awareness
- Vehicle on-board on-the-move capable power generation
- Modular open architecture design extends solution to other services and mission applications

Partners:

Army Labs: CCDC ARL, GVSC & C5ISR, ERDC/CERL

Others: DRS, Allison, MITRE, MIT-LL, Polaris Alpha





# DC RING BUS CONTROLLER DEVELOPMENT



- Four 200A Channels at 600V.
- Solid state breaker/relay design
- Air Cooled
- Cyber secure, fast forming micro grid
- Connections modeled on SAE J1772 specification
- 95 lbs. (less than 2 man lift) estimated weight



# UNIVERSAL POWER GATEWAY DEVELOPMENT



- 60kW 600VDC to 208VAC isolated 3 phase converter
- Silicon Carbide based design
- Air Cooled
- Two power stages - isolated DC/DC and DC/AC.
- 112 lbs. (2 man lift) estimated weight



# INDUSTRY COLLABORATION OPPORTUNITIES



- Scaled up manufacturing of parts and assembly of Micro Grid components.
- Build to print or licensing the designs.
- Source for advanced, lightweight power cables.



Thank you for your time.

Questions?