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

Ground Vehicle Power & Mobility – May 2020

Bruce Brendle, Ph.D, PMP

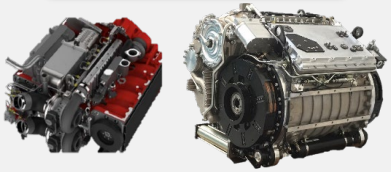
Associate Director

Ground Vehicle Power & Mobility (GVPM)

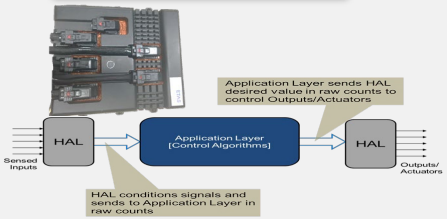
"We power and move the Nation's military ground systems"

Power & Mobility Technology

Powertrain



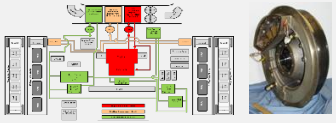
Real Time Control Systems



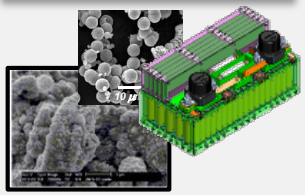
Track & Suspension

Vehicle Electrification

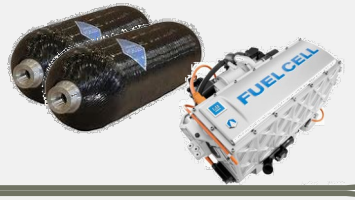
Powertrain Electrification



Energy Storage



Fuel Cell Technology



Testing & Evaluation

Propulsion System Laboratory

Ground Systems Power & Energy Laboratory

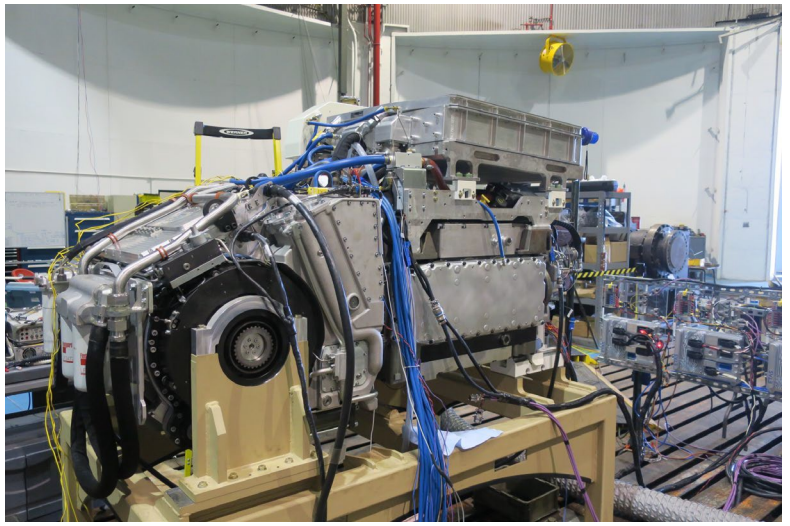
CAPABILITIES TO LEVERAGE

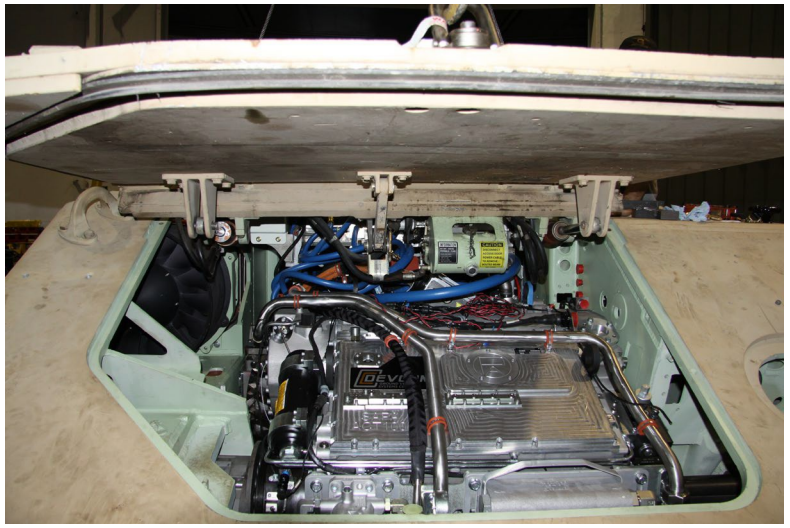
Advanced Powertrain Demonstrator (APD)

- Designed to fit in a Bradley hull space claim
- 1.5-2x power density of current Bradley.
- 20-25% fuel savings vs current Bradley.
- Comprised of:
  - Advanced Combat Engine (ACE)
    - Opposed piston 1000 hp engine
  - Advanced Combat Transmission (ACT)
    - 32 speed cross-drive transmission designed for vehicles up to 60 tons
  - Integrated Starter Generator (ISG)
    - 160 kW high voltage capable starter/generator for on-board and export power
  - Advanced Modular Batteries (AMB)
    - Li-ion batteries with an increased life cycle of 3-5x and decreased charging time from 10 hours to 1 hour
  - Advanced Thermal Management System (ATMS)
    - Electronically controlled fan to maximize fan power and advanced radiator design.

TRL 6 Testing in GVSC Propulsion Laboratory with follow-on AMEP Vehicle Demonstrations

- TRL 6 Powertrain 75 hour durability test at GVSC test cells simulating the Army's Aberdeen Proving Ground (APG) road courses
- Advanced Mobility Experimental Prototype (AMEP)
  - Bradley vehicle demonstration and performance testing





POC: Mike Claus, Michael.d.Claus.civ@mail.mil

CAPABILITIES TO LEVERAGE

Advanced Running Gear

- 50T capable running gear system
- Comprised of:
  - Advanced Lightweight Track
    - 21” Wide, 5,000 mile reliability
  - Roadwheel
    - 26” diameter, 2,500 reliability
  - External Suspension Unit
    - 21” and 18” versions, height management and adaptive damping options
  - Advanced Track Tensioner
    - Driver controlled, four modes of operation including on-road, off-road, and transport

TRL 6 Testing ongoing at Yuma Proving Grounds (YPG)

- Performance Tests Completed
  - Slope negotiation
  - Gap crossing
  - Step climbs
  - Top speed
  - Pivot steer
  - Ride quality
  - Rolling resistance
- 1,900 miles achieved to date (planned 5,000 miles)

POC: Joe Mazur, Joseph.S.Mazur4.civ@mail.mil

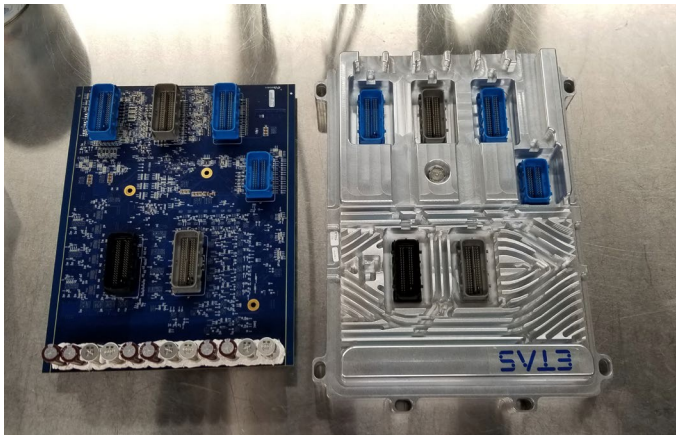
CAPABILITIES TO LEVERAGE

neXtECU controller

- State-of-the-art common powertrain controller that can be reused across the Army's vehicle fleet
- Reduces logistics footprint
  - Multiple LRUs could be supported in one neXtECU controller
- Designed for combat environment
- Capability to directly interface with and control powertrain components (Engines, Transmissions, Supervisory Functions, and Cooling Controls)
- Has a large number of various types of input and output signal capability and supports multiple communication protocols to be applicable to multiple vehicle platforms/applications
- Proto II neXtECU has already successfully run the 1790 Automotive-V Diesel Supercharged engine used in the M88A2 Hercules as well as the Advanced Combat Engine

Proto III neXtECU: initial prototypes available in 4QFY20

- NED and Crowbar Circuit
- Cybersecurity
- Backup Battery System
- Real-Time Clock
- 100 BaseT Ethernet (replaces Broad R Reach)
- 1553 Communications
- Electromechanical Sensors (4 RVDT/LVDT)



Proto II

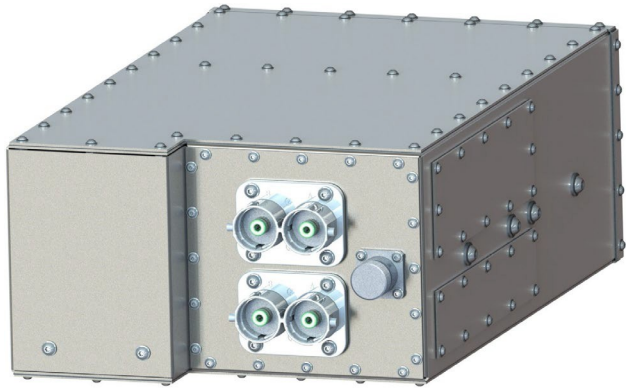
Proto III

POC: Joe Stempnik,
Joseph.M.Stempnik.civ@mail.mil

CAPABILITIES TO LEVERAGE

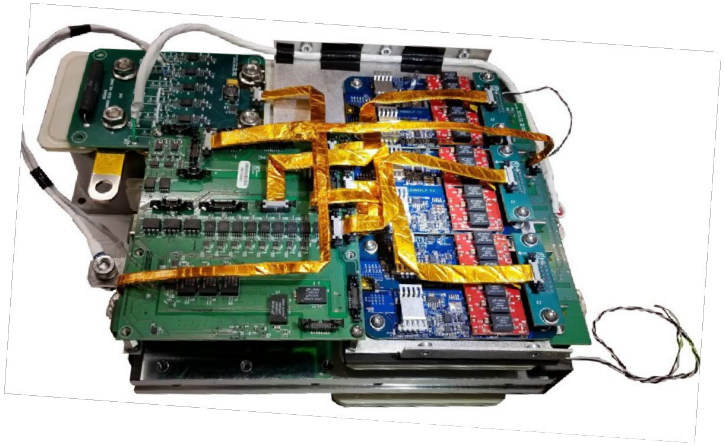
ZEUS: 200KW SILICON CARBIDE INVERTER

- 105C engine coolant capable operation
- 14kW/L power density - Size 411x249x140mm (L x W x H)
- Bi-Directional for multi-pole PMAC motoring/ regeneration
- Pre-charge with dual high voltage interlocks
- MISRA-C / FRAMA-C compliant codeset
- Full datasheet available



STATUS / PLANS

- Patent-pending technology
- Core technology being successfully implemented into Army RDTE programs
- Fully matured TDP and evaluation units slated for October 2020



HOW TO LEVERAGE

- Technical Data Package licensing options available through CCDC GVSC's Business office Oct 2020, POC: Erin K Dunn, Erin.K.Dunn10.civ@mail.mil

POC: Alexander Soles, Alexander.M.soles.civ@mail.mil

FY20 OPPORTUNITIES

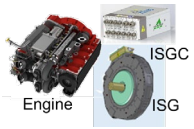
Platform Electrification and Mobility (PEM)

This project develops and demonstrates a modular, scalable electrification architecture for manned and unmanned Next Generation Combat Vehicle platforms.

Primary Investment Areas

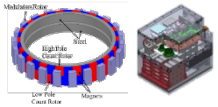
- Development of series hybrid electric powertrain and demonstrators for RCV-L, RCV-M, and OMFV platforms as well as components scaled to OMT requirements.
- Optimized scale-able high voltage architecture to permit future all electric power pack options.
- Power dense onboard ISG power generation and energy storage to enable DEW, electrified armors, etc.
- Segmented Composite Rubber track coupled to an Advanced suspension for weight reduction and improved off road performance.
- Li-ion based Modular HV Battery System.
- JP8 Fuel Cell for light vehicle propulsion and continuous silent watch/extended silent mobility on larger platforms
- Electrified sprocket drive.

Power Electronics Components Maturation

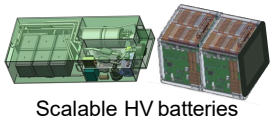


High Density Diesel Electric powerpack

SIL Integration and Maturation

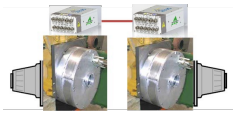


Advanced Distributed Power



Scalable HV batteries and JP8 Fuel Cell

Integration and Evaluation



Power Dense Motors Controllers

Advanced Suspension and Segmented Band Track

FY20 Contracts	Type	RFP/RPP Date
Electric Sprocket Drive	OTA (NAMC)	June 2020
Motor/Generator Inverter	Work Directive	July 2020
HV Modular Li-Ion Battery	OTA (NAMC)	June 2020
Generator	OTA (NAMC)	June 2020
External Suspension Unit (ESU)	OTA (NAMC)	June 2020
Composite Track	OTA (NAMC)	June 2020

POC: Kevin Boice, kevin.j.boice.civ@mail.mil

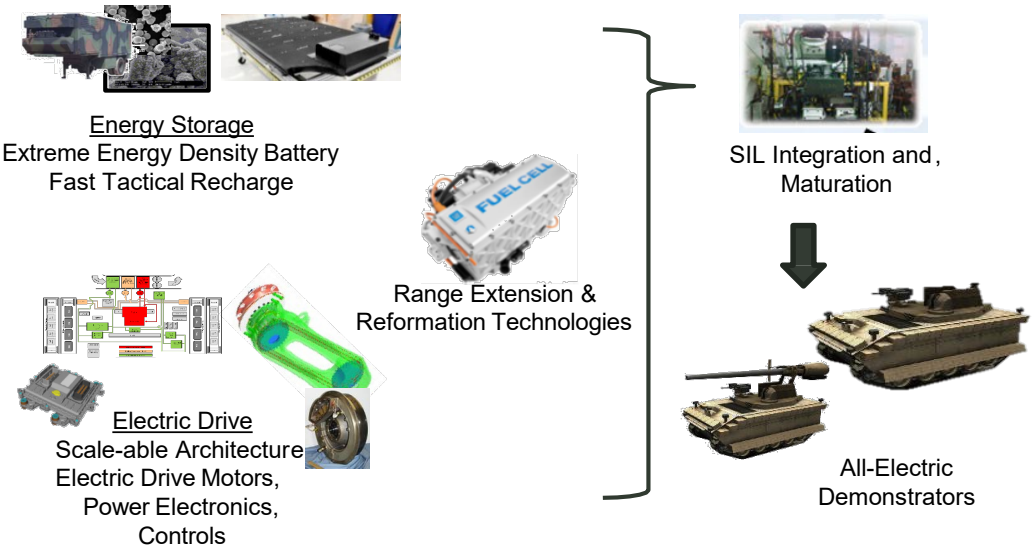
FUTURE OPPORTUNITIES

All-Electric Combat Powertrain (AECP)

This project develops, integrates, & tests essential electrification technologies necessary to convert the surrogate Next Generation Combat Vehicle (NGCV) hybrid electric platforms to All-Electric vehicles.

Primary Investment Areas

- Determination of optimal all-electric propulsion configuration for the medium and light combat vehicle applications (unique military conditions).
- Optimized scalable power architecture to permit future all-electric options for various platform applications.
- Extreme energy dense / fast recharge batteries.
- Optimized, combat weight class electric drive propulsion motors.
- Power dense range extension and advanced reformation technologies.
- Tactical electrical recharge research and development.
- Development of all-electric powertrain and demonstrators for RCV & OMFV platforms.



FY23 Contracts	Type	RFI Date	RFP Date
Advanced All-Electric Drive Components	OTA (TBD)	~Mar 2022	~Jan 2023
Extreme Energy Density Energy Storage w/ Fast Tactical Recharge	OTA (TBD)	~Mar 2022	~Jan 2023
Power Dense Range Extender	OTA (TBD)	~Mar 2023	~Jan 2024
Advanced Reformation Technologies	OTA (TBD)	~Mar 2024	~Jan 2025

POC: Elise Joseph, Elise.M.Joseph2.civ@mail.mil

TECHNOLOGY GAPS
PRODUCT, CRADA, SBIR OPPORTUNITIES

Powertrain

- Thermal Management (Heat Exchangers, Fans)
- High efficient, compact transmissions for wheeled & tracked vehicles
- Power Dense, Multi-Fueled Engines

POC: Constantine.Panagos.civ@mail.mil

Real Time Control Systems

- System/Vehicle Models
- Automated Testing and Software Documentation Tools
- Smart, Combustion Controls with Real Time Algorithm for Vehicle Applications

POC: Kevin.T.Sharples.civ@mail.mil

Track & Suspension

- Segmentation of composite track systems at weights above 45T
- Combat vehicle suspension units.
- Electric height management capability
- Running gear conversion systems (Convert from tracked and wheeled systems)

POC: Jason.T.Alef.civ@mail.mil

Powertrain Electrification

- High Temperature, Power Dense Motors and Generators
- High Temperature, Power Dense Inverters
- Embedded Motor Controls Software

POC: Dean.Z.McGrew.civ@mail.mil

Energy Storage

- Scalable HV Battery Architecture
- High Energy Density Cell/Batteries (>400Wh/kg)
- Battery Safety
- Thermal Management technologies

POC: Laurence.M.Toomey2.civ@mail.mil

Fuel Cell Technology

- Metal Supported Solid Oxide Fuel Cells
- Multi-fuel reformation Technology
- High Temperature Proton Exchange Membrane (PEM) fuel cells

POC: Kevin.S.Centeck.civ@mail.mil

Ground Vehicle Power & Mobility
Propulsion Systems Laboratory (PSL)

Capabilities:

- 6 Engine/Transmission Test Cells
- 3 Full Vehicle Test Cells Cells

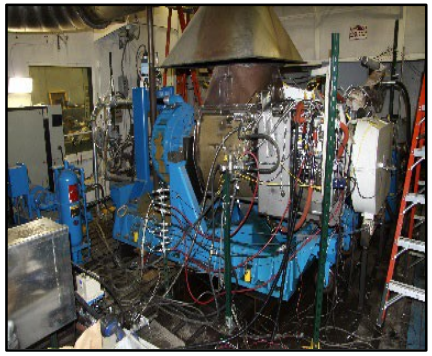
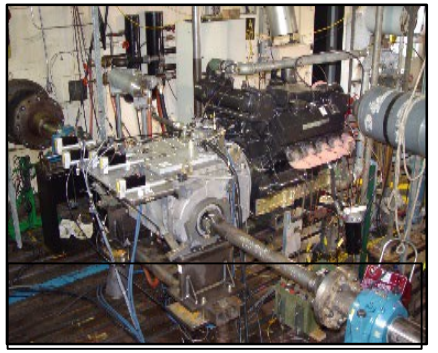
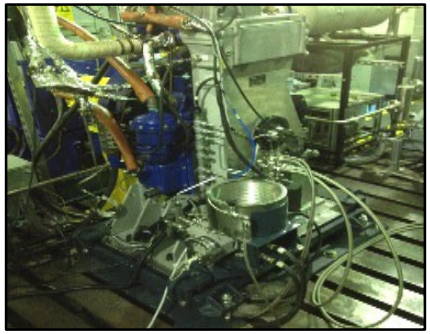
- Ground Systems Propulsion Systems Lab
  - Engine performance, endurance, qualification and acceptance
  - Transmission performance and efficiency
  - Vehicle full load cooling, tractive effort to speed, fuel economy and air conditioning
  - Drive axle endurance
  - Testing from 50 up to 3000 HP using Eddy current, water brake and AC dynamometers
  - Total dynamometer sprocket output load absorbing capacity enables testing of any known military ground vehicle in any transmission gear range

- Standardized or customized ISO 17025 accredited test procedures

LABORATORY ACCREDITATION BUREAU
ACCREDITED ISO/IEC 17025
Certificate L2330 Testing

Temperature
Ambient to 160 ˚F
Wind Speed
0 to 60 mph
Solar Loading
1,200 W/m²




POC: John Hubble, John.E.Hubble.civ@mail.mil

Ground Vehicle Power & Mobility
Ground Systems Power & Energy Laboratory (GSPEL)

Capabilities:

- 32,000 ft² of laboratory space
- 7 Labs Focused on Technology Development and Maturation:
  - Energy Storage
  - Fuel Cells
  - Heat Exchangers
  - Air Filters
  - Electrical Components
  - Real Time Controls
  - HVAC
- Power & Energy Vehicle Environmental Lab (PEVEL)
  - Wheeled Vehicles (up to 10X10 Drive)
  - Tracked Vehicles (up to Bradley)
  - Controlled Environmental Conditions

POC: Igor Baseski, Igor.Baseski.civ@mail.mil

ONE-ON-ONES

Sign-up for one-on-one meetings with
Ground Vehicle Power & Mobility
by filling out the request form on the MDEX main page and submitting.