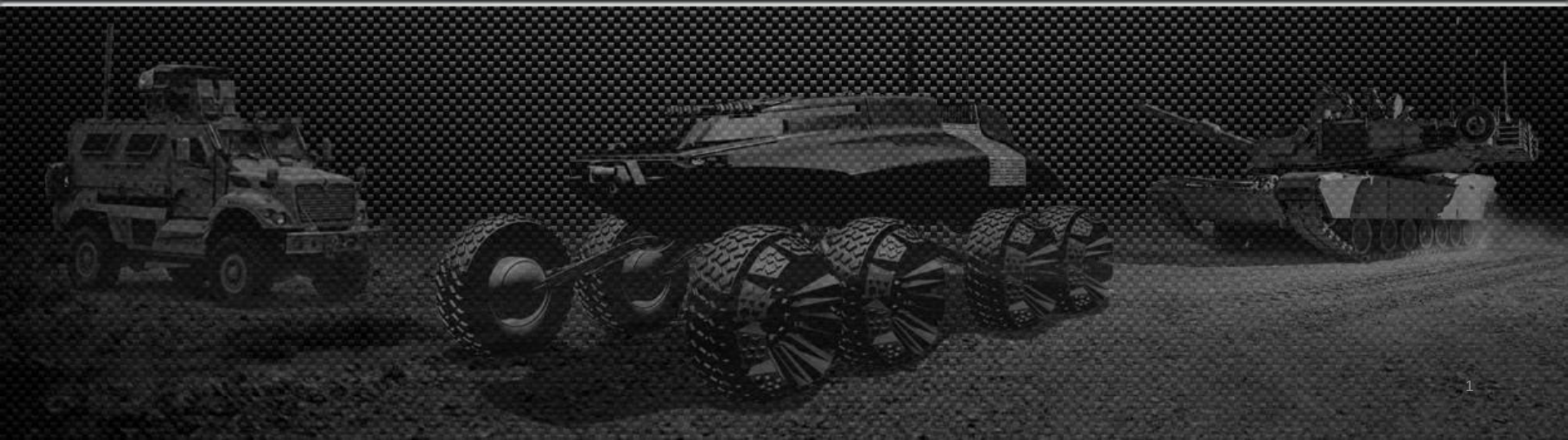
U.S. ARMY TANK AUTOMOTIVE, RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Autonomy-Enabled Platforms

4 December, 2014

Mr. Jim Parker
Associate Director, Robotics



What Do Ground Vehicles of the Future Look Like and How Do We Get There?

Ground Vehicle 30 Year Strategy

GVR leads the following Capability Demonstrations (CDs) related to the Autonomy-enabled Vehicle LOE

CD 5 - **Develop unmanned vehicles capable of maneuvering with mounted and dismounted units**
End State: Demonstrate the ability of unmanned vehicles to safely maneuver with, and increase the effectiveness of, mounted and dismounted units without increasing the number of soldiers assigned or increasing soldier burden.

CD 6 - **Achieve ground system integrated 360°situational awareness capability at extended distances from the platform, in order to enhance Soldier safety and ease the Soldier's burden**
End State: Demonstrate increased situational awareness and greater stand-off distances for both manned and unmanned vehicles in both day and night conditions

CD 7 - **Develop robotic technologies and capabilities that expand the operational capabilities of a Brigade Combat Team (air/ground teaming)**
End State: Demonstrate an integrated set of automated vehicle capabilities using combined air and ground vehicles that improve the effectiveness of a Brigade Combat Team

CD 12 - **Develop robotic technologies and capabilities that enable unit resupply and sustainment operations using optionally-manned and unmanned vehicles**
End State: Demonstrate the use of OMV/UGV to improve the effectiveness of unit resupply and sustainment operations, including automated convoy and vehicle loading/unloading operations.

Ground Vehicle Continuum

Manned ⟷ Unmanned

360° Vision	Driver Warning	Driver Assist/ Active Safety	Optionally-Driven	Optionally-Manned	Unmanned

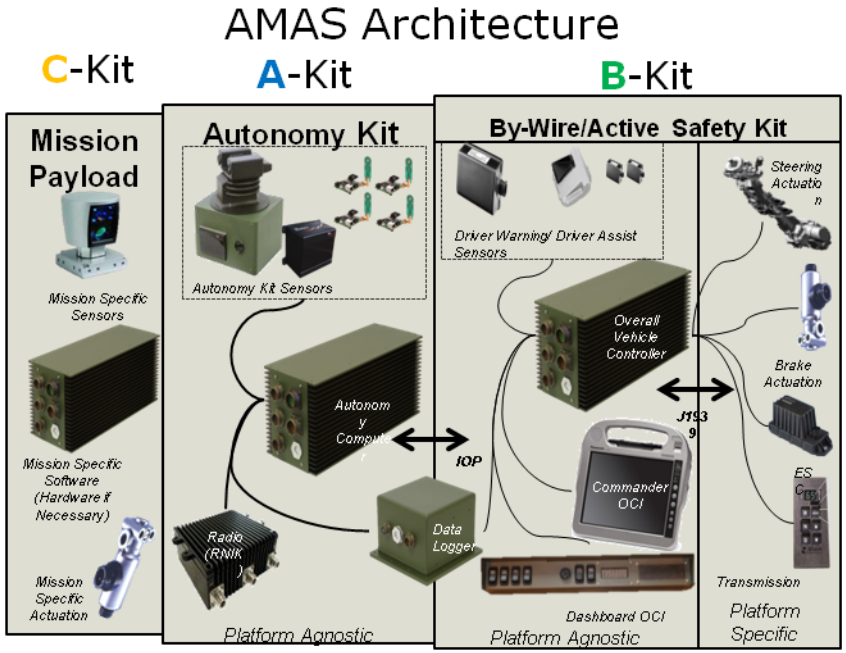
Human-Machine Interface (HMI) ⟷ Human-Robot Interface (HRI)

Enabled by:

1. Open Robotics Architecture

Autonomy **A**-Kit + Platform-by-wire **B**-Kit + Mission Module/ Payload **C**-Kit

2. Interoperability
   - Interoperability Profile (IOP) Working Group
3. Industry/Academia Participation



CD 5 Manned/Unmanned Teaming

CD 5 Dismounted Soldier Autonomy Tools (DSAT)

Purpose:

- Develop a suite of autonomy tools to enable dismounted soldiers to operate unmanned vehicles. Develop an open and extensible kernel for ground vehicle autonomy with Interoperability

Product(s):

- Operational and Performance Capabilities Summary
  - Fused Perception and World Model systems for advanced obstacle detection and avoidance
  - Optionally-manned Vehicles
    - Polaris MRZR
    - Jeep Rubicon
    - HMMWV
  - Multiple Modes of Operation
  - Advanced Communication
    - UWB low bandwidth C2
    - Rajant Radio higher bandwidth C2
  - Payload Integration
    - RSTA Sensors (CRADA)
    - “NATO Pallet” Payloads

Payoff:

- S&T Toolset for incremental development
- Feeder program for Autonomous Ground Resupply and Manned/Unmanned Teaming

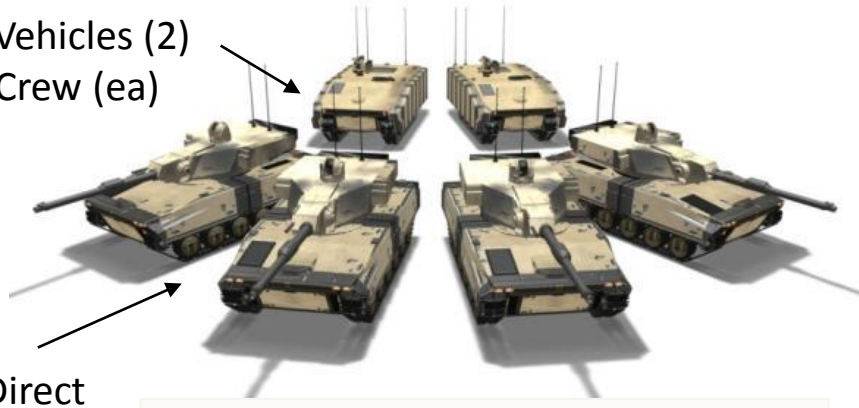
Mounted Maneuver Support

Traditional Abrams Platoon

- #Vehicles: 4
- #Crew: 16
- Overall Weight: ~280 tons

Concept Main Battle System (MBS) Platoon

Supervision Vehicles (2)
- 4 Person Crew (ea)



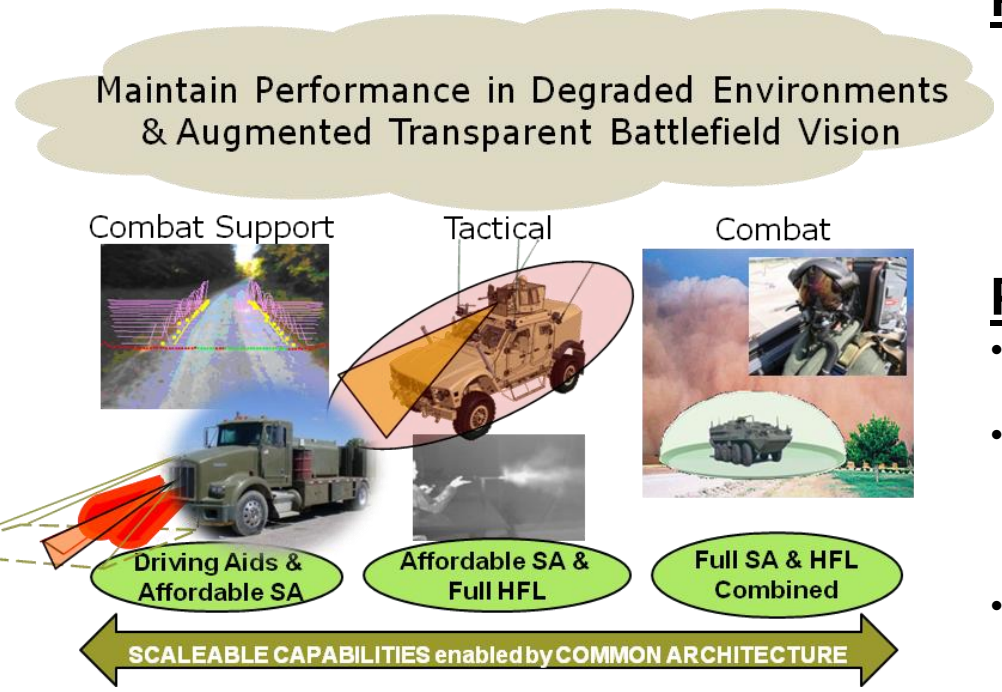
Unmanned Direct Fire Vehicles (4)

- #Vehicles: 6
- #Crew: 8
- Overall Weight Goal: ~100-200 tons

Overall weight savings and crew reduction goal through assignment of traditional functions to unmanned platforms

CD 6 Ground System Situational Awareness

CD 6 Degraded Visual Environment (DVE)



Purpose:

Increase capabilities of vehicle sensors to improve SA and to maintain performance in degraded visual environments. Utilize scalable SA sensing and immersive intelligence to improve occupant and vehicle survivability and provide augmented transparent battlefield vision.

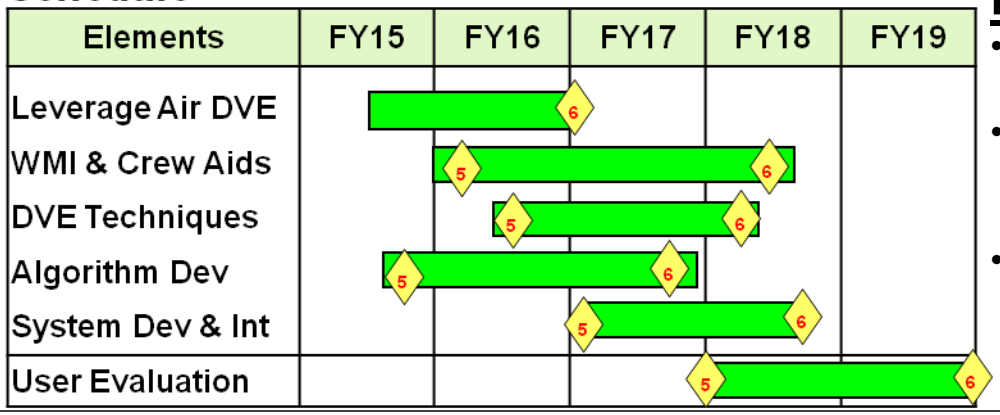
Products:

- Low cost SA sensors that remain operational in degraded visual environments (e.g. smoke, dust, fog)
- Advanced digital video architecture and sensor processing with in-vehicle displays and aviation-inspired HMD to bring timely and useful information to vehicle crew/squad
- Advanced vehicle crew stations and scalable degraded visual environment sensors (SA, HFL, and IED detection) with scalable Warfighter-Machine Interface (WMI), augmented reality and crew aids

Payoff:

- Operation in degraded visual environments to maintain OPTEMPO and decrease occupant injury
- Leveraging aviation capabilities to provide a complete sensor to Soldier system that is scalable to the mission & vehicle family
- Increased situational awareness and Hostile Fire Localization (HFL) to enable indirect vision driving maneuverability; driving aids to reduce accidents; and IED detection to improve survivability

Schedule



CD 12 Autonomous Ground Resupply

Autonomous Mobility Appliqué System (AMAS) JCTD

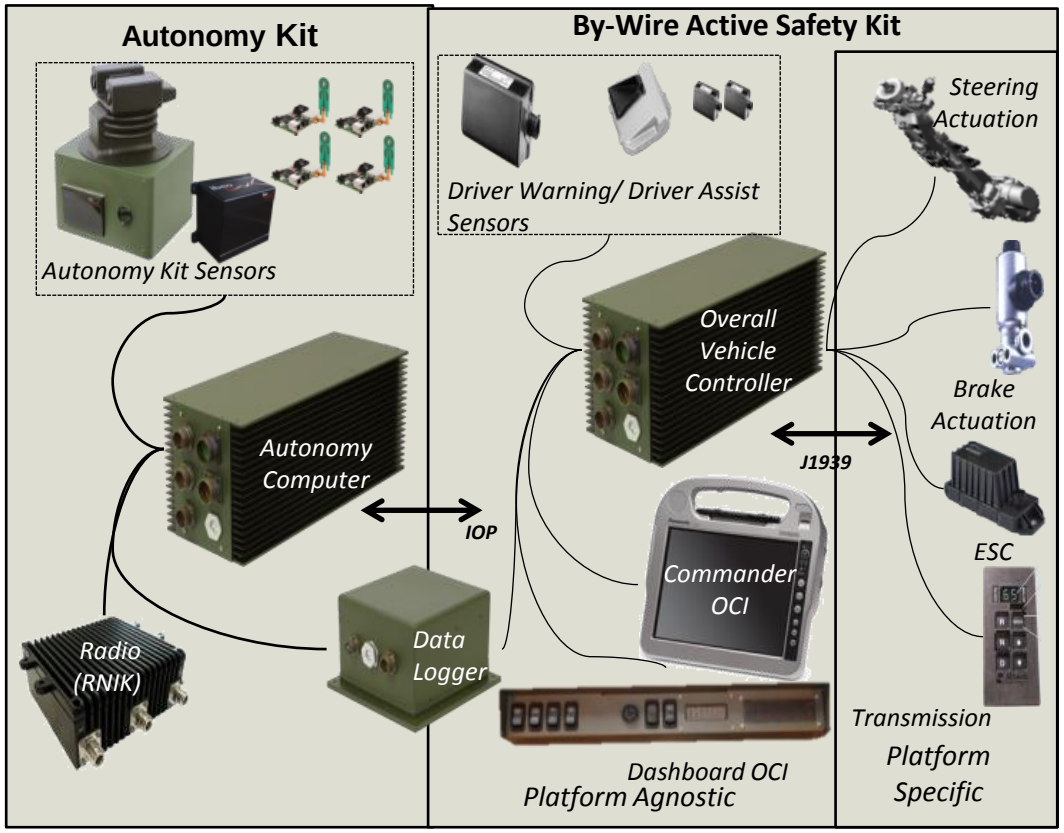
Purpose:

Provide tactical vehicles with an optionally manned capability to increase safety:

1. A vehicle-specific By-Wire/Active Safety kit to control the physical actuation of a vehicle.
2. A common, appliqué Autonomy kit that contains the primary intelligence and autonomous decision making. The Autonomy kit will function and inter-operate regardless of vehicle type.

Demonstrated Capabilities:

- Driver Safety
- Tele-Op Navigation
- Waypoint Navigation
- Off Road Navigation
- On Road Navigation
- Robust Drive By-Wire

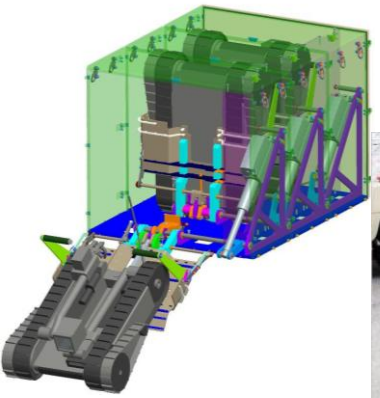


CD 7 Extending the Reach of the Warfighter

CD 7 Extending the Reach of the Warfighter

Multi-UGV Extended Range

- Operational experiment to examine the feasibility of long distance operation of multiple unmanned vehicles deployed from an unmanned marsupial vehicle.
- Expand technical development in:
  - Soldier-robot interfaces
  - Multi-platform, long distance C2
  - Power, energy, and mobility requirements for long duration missions



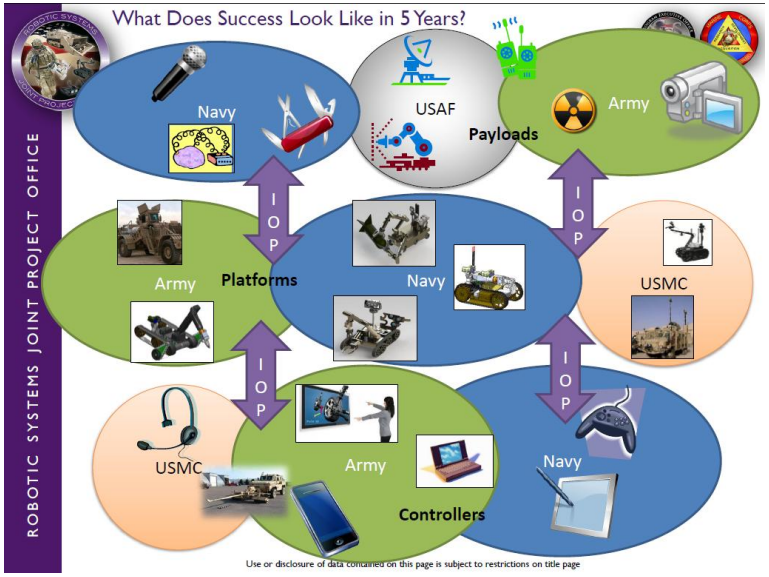
Grayling II

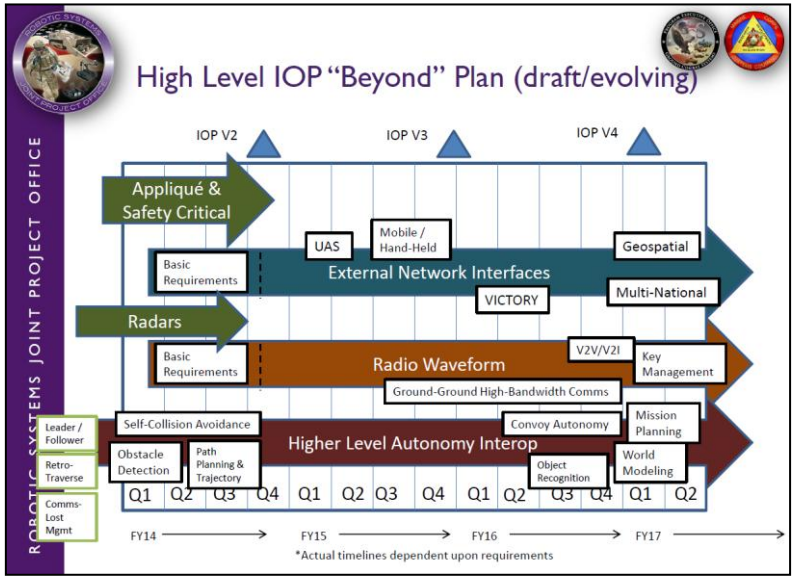
- Utilize a UAV to deploy a UGV at remote locations without a soldier on the ground
- CBRN payload integration & mission execution
- Air Assault mission scenario

Interoperability Profiles (IOP)

UGV Interoperability Profile (IOP)

- IOP V1.0 defines S/W & H/W interfaces for unmanned ground vehicles (UGVs)
- Establishes payload/controller modularity with UGVs
- Will expand to establish interoperability with key external systems
- Primarily based around SAE AS-4 – Joint Architecture for Unmanned Systems (JAUS)
- UAS STANAG 4586 not currently appropriate for UGVs
  - UGVs require greater level of real-time control – different optimization of message formats
- NATO LCG2 proposing adoption of IOPs for new NATO STANAG
  - SG-157 reviewed UxV standards in 2011 and various approaches for UGV STANAGs
  - July 2013 Ft. Benning NATO LOE using IOPs – interop between US, Germany & Turkey UGVs & controllers
  - September 2014 – EOD CoE (Slovakia) demo of int'l interop between US, Germany, Turkey, Canada
- IOP being evaluated by TTCP
- New UGV IOP Challenge in 2014 Intelligent Ground Vehicle Competition (IGVC) – June 2014 @ Oakland University in Rochester, MI
  - University teams from US, Canada, Japan, India, France, Jordan





Questions?