PROJECT MANAGER
FORCE PROJECTION

# Open Architecture for Unmanned Ground Systems: NDIA GRCCE - 08 April 2015

Mark Mazzara
PM Force Projection
Robotics Interoperability Lead

# Why Interoperability ?

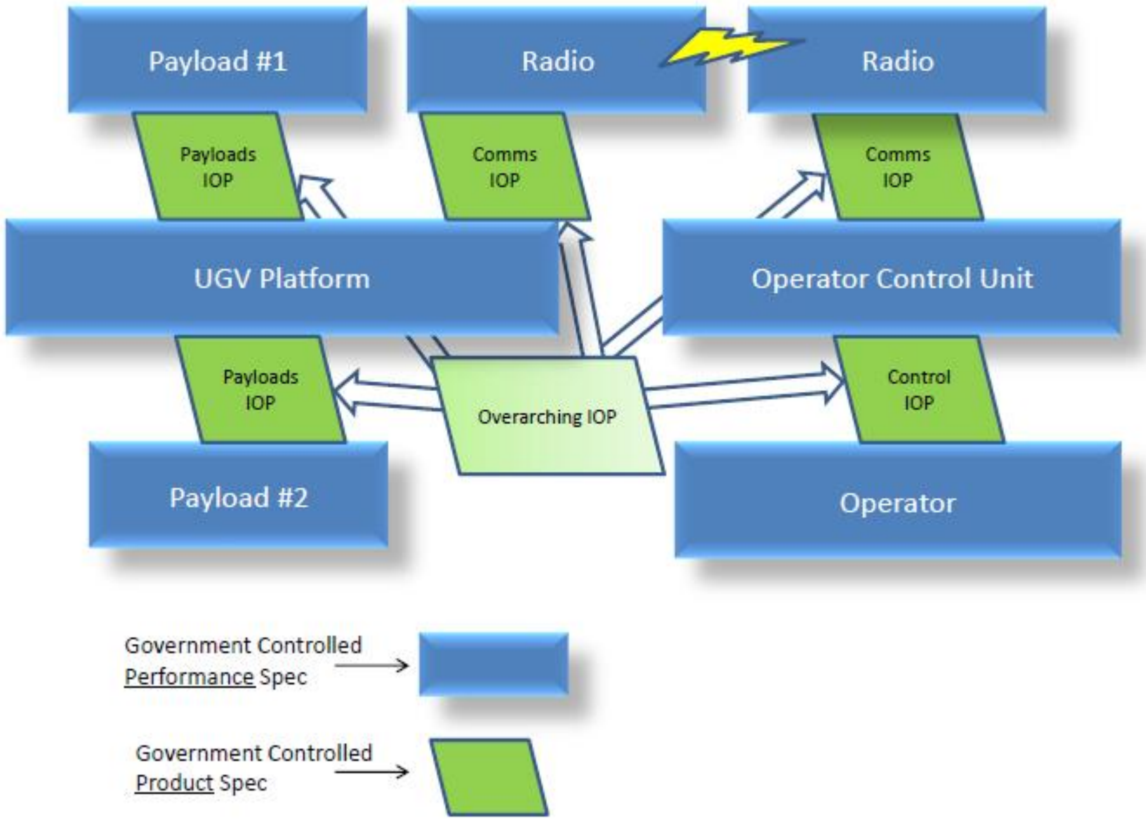
## Better Buying Power 3.0

**Achieve Affordable Programs**
Continue to set and enforce affordability caps
**Achieve Dominant Capabilities While Controlling Lifecycle Costs**
Strengthen and expand "should cost" based cost management
*Build stronger partnerships between the acquisition, requirements, and intelligence communities*
Anticipate and plan for responsive and emerging threats
*Institutionalize stronger DoD level Long Range R&D Planning*
**Incentivize Productivity in Industry and Government**
Align profitability more tightly with Department goals
Employ appropriate contract types, but increase the use of incentive type contracts
Expand the superior supplier incentive program across DoD
Increase effective use of Performance-Based Logistics
*Remove barriers to commercial technology utilization*
*Improve the return on investment in DoD laboratories*
*Increase the productivity of IRAD and CR&D*
**Incentivize Innovation in Industry and Government**
*Increase the use of prototyping and experimentation*
*Emphasize technology insertion and refresh in program planning*
*Use Modular Open Systems Architecture to stimulate innovation*
*Increase the return on Small Business Innovation Research (SBIR)*
*Provide draft technical requirements to industry early and involve industry in funded concept definition to support requirements definition*
Provide clear "best value" definitions so industry can propose and DoD can choose wisely

**Eliminate Unproductive Processes and Bureaucracy**
*Emphasize Acquisition Executive, Program Executive Officer and Program Manager responsibility, authority, and accountability*
*Reduce cycle times while ensuring sound investments*
Streamline documentation requirements and staff reviews
**Promote Effective Competition**
*Create and maintain competitive environments*
Improve technology search and outreach in global markets
**Improve Tradecraft in Acquisition of Services**
*Increase small business participation, including more effective use of market research*
Strengthen contract management outside the normal acquisition chain
*Improve requirements definition*
Improve the effectiveness and productivity of contracted engineering and technical services
**Improve the Professionalism of the Total Acquisition Workforce**
Establish higher standards for key leadership positions
Establish stronger professional qualification requirements for all acquisition specialties
*Strengthen organic engineering capabilities*
Ensure the DOD leadership for development programs is technically qualified to manage R&D activities
Improve our leaders' ability to understand and mitigate technical risk
*Increase DoD support for Science, Technology, Engineering and Mathematics (STEM) education*

# UGV IOPs Basic Overview

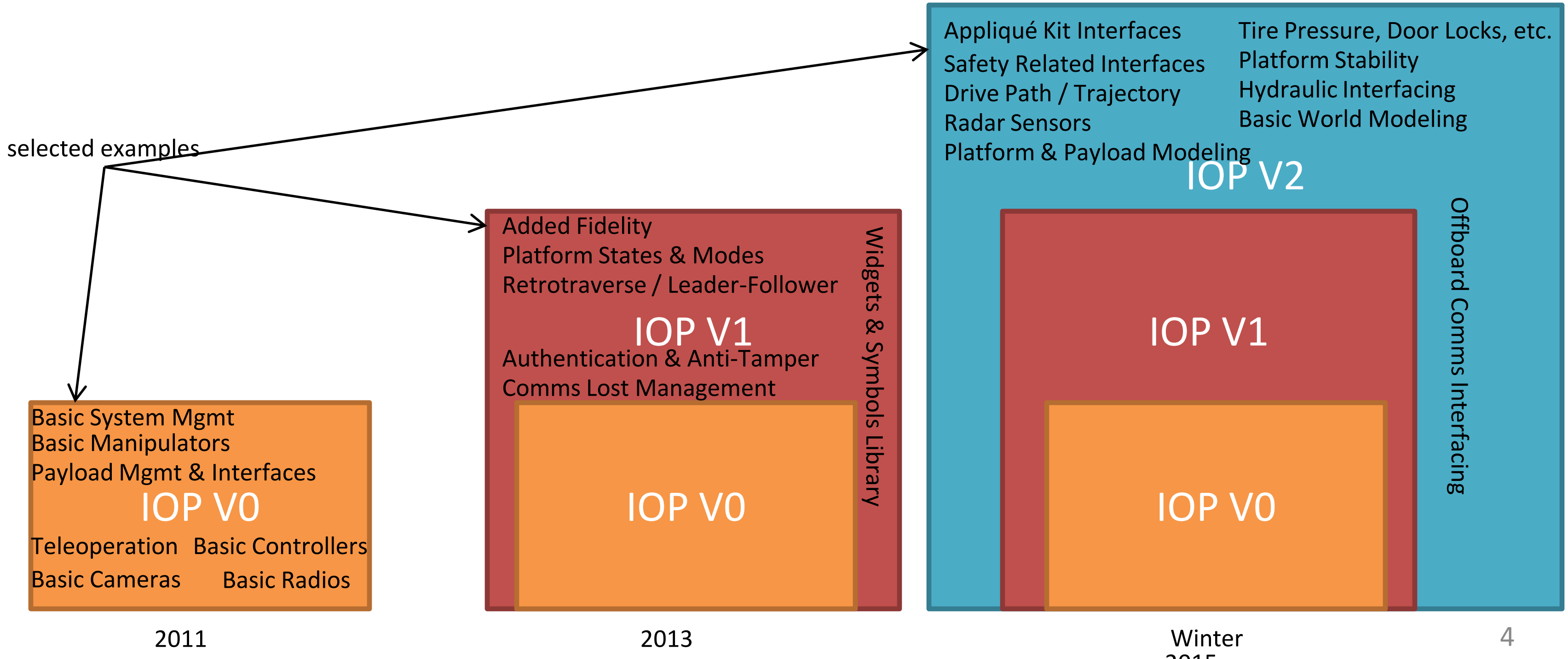
- Unmanned Ground Vehicle (UGV) Interoperability Profiles (IOPs)
- Defines software messaging & hardwar interfaces between major subsystems of unmanned ground systems




Software messages primarily based on SAE AS-4 – Joint Architecture for Unmanned Systems (JAUS)

# UGV IOP Capability Coverage

- IOP V0 provided interfaces for capabilities already fielded – such as basic mobility, teleoperation, basic sensors (i.e. camera/video), manipulator arms, controller HMI, and radios
- IOP V1 provides interfaces for capabilities required for MTRS Inc II & CRS-I – such as more advanced mobility & basic autonomous behaviors, enhanced IA, and more advanced sensor types
- IOP V2 will provide interfaces for capabilities required for RCIS & HMDS, such as unmanned appliqué kits, more advanced system management, unique sensor/emitter types, etc.
- IOP V3 and beyond will expand to keep up with emerging requirements & technology developments



# IOP Composition

**Overarching IOP**

Specifies the base concepts, architecture, requirements, and overview for the UGV IOP; specifically the platform, payload, mobility, on-vehicle network, communication, and logical interoperability messaging requirements.

**Legend**

- Profile
- Separately Published Attachment

**Capability Plan**

Scopes and bounds the requirements basis for a given IOP Version

**SAE JAUS Profiling Rules**

Specifies the manner in which the SAE AS-4 JAUS standards have been profiled

**Custom Services, Messages & Transports**

Specifies additional SAE AS-4 JAUS messages and transport protocols required to support the scope of the UGV IOP

**Payload IOP**

Specifies the payload classification, standards, requirements, and conformance approach

**Control IOP**

Specifies the Operator Control Unit (OCU) logical architecture, standards, Human-Machine Interface (HMI) requirements, and conformance approach

**Comms IOP**

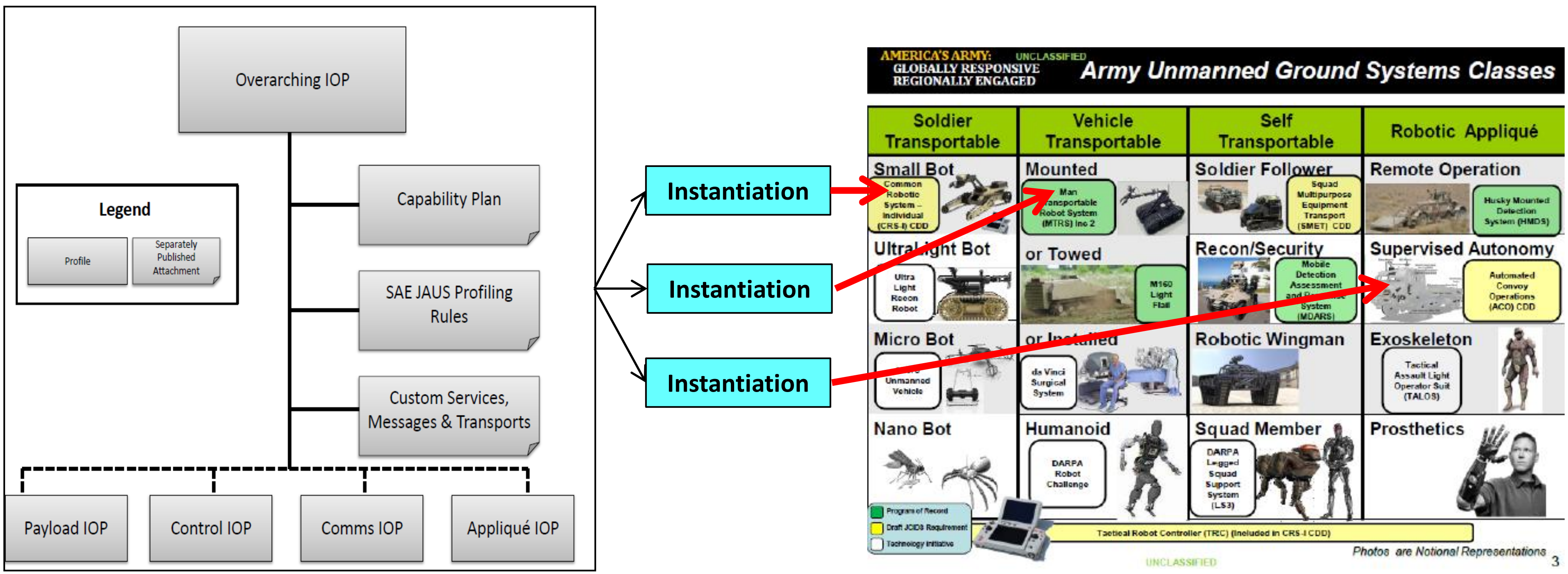
Specifies the communications standards, requirements, and conformance approach

**Appliqué IOP**

Specifies the appliqué systems classification, standards, requirements, and conformance approach

# IOP Applied to Specific Programs

- IOP Provides Gov't PMs (and others) with a master library of standardized interfaces, tools, and supporting documentation for use in defining an "**instantiation**" for a given UGV, class of UGVs, or program.



# UGV IOP Current Status

- IOP Standard
  - UGV IOP V2.0 draft released to industry for review 20 February 2015
    - Received valuable feedback & all “YES” votes – but overall level of response was low
    - Currently incorporating feedback into IOP documents & preparing for official IOP V2.0 release (April 2015)
  - Initiating IOP V3.0 Capability Plan (March-June 2015)
- Utilization & Adoption
  - Over a dozen companies have applied IOP in systems
  - Draft IOP Instantiations exist for several current & emerging DoD PORs
  - Several NATO member nations embracing

# UGV IOP V3 Priorities

- Define optimal level of interoperability & modularity for ground vehicle applique autonomy strategy
  – Enable evolutionary upgrade of autonomy kit to support continued advancement
  – Enable industry to innovate
  – Focus on Heavy Tactical Vehicles
- Resolve concerns over safety criticality
  – JAUS/Ethernet vs. J1939/CAN vs. Other vs. Combo

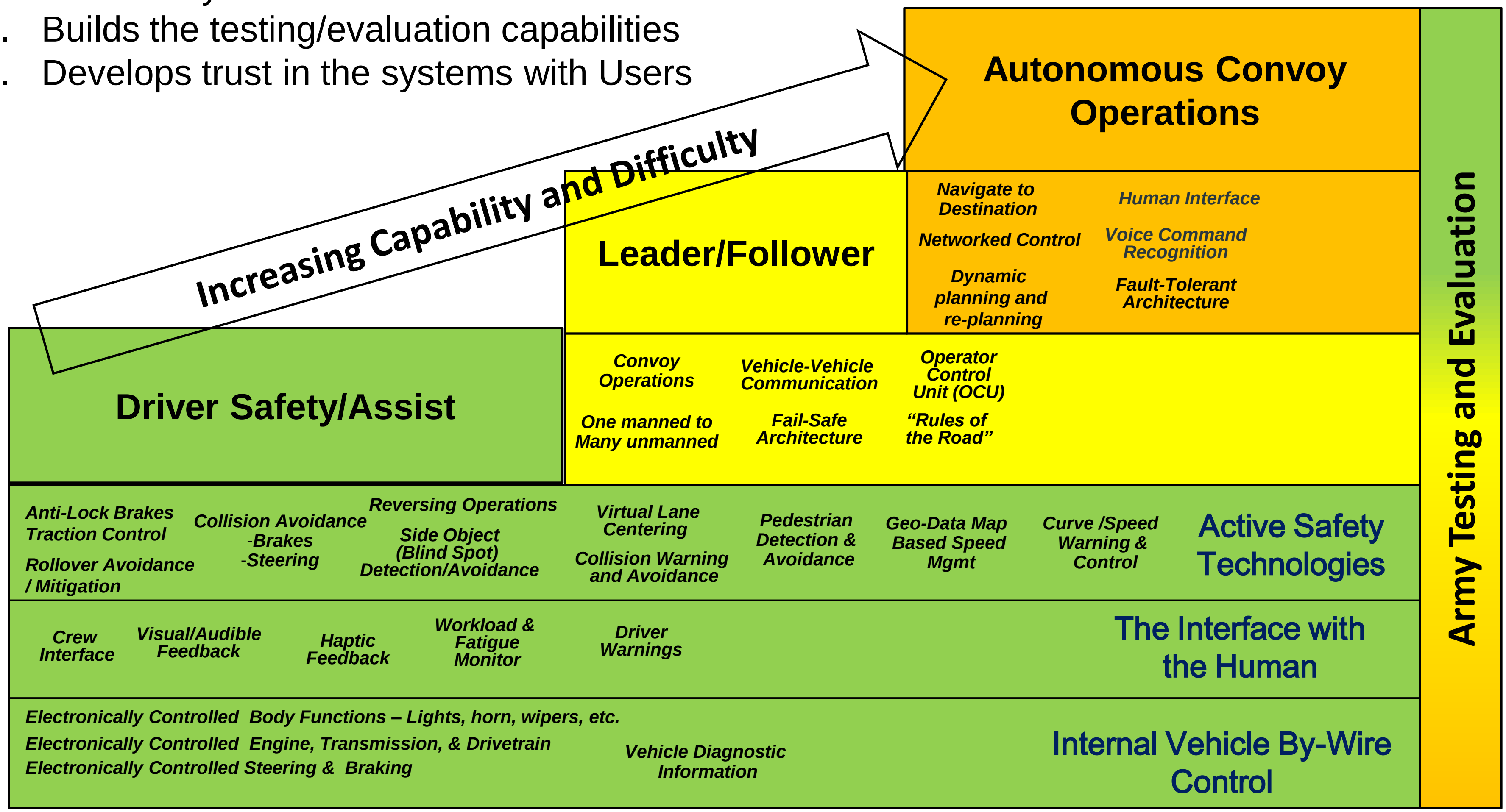
# UGV Interoperability Planning

| | |
|---|---|
| Near Term (0-5 yrs) | Standardized interfaces must be enforced between UGV platforms, payloads, controllers, and wireless communication devices. This will enable interoperability and modularity within systems and will lay the foundation for an affordable and sustainable lifecycle management model. |
| Mid Term (5-10 yrs) | UGVs must begin interfacing with authorized external systems and domains, such as other unmanned systems, manned ground vehicles, remote video terminals, and mobile/hand-held devices. This will enable a variety of new capabilities for Warfighters in different domains, as well as for UGVs themselves. This activity will be coordinated through the Army Common Operating Environment and other joint activities. Additionally, joint and multinational interoperability with key allies must be established through the use of shared interface requirements. |
| Far Term (10-20 yrs) | The ability to interface with UGVs will be widely achievable by authorized external systems. Higher level interoperable message types will facilitate increases in system autonomy and distributed computing will be enabled via interoperable offloading of computing-intensive functions to appropriate systems. UGVs will be capable of sharing a variety of collected and processed information to a variety of consumers, which will enable enhanced situational awareness and decision making capability in both manned and unmanned consumers. |

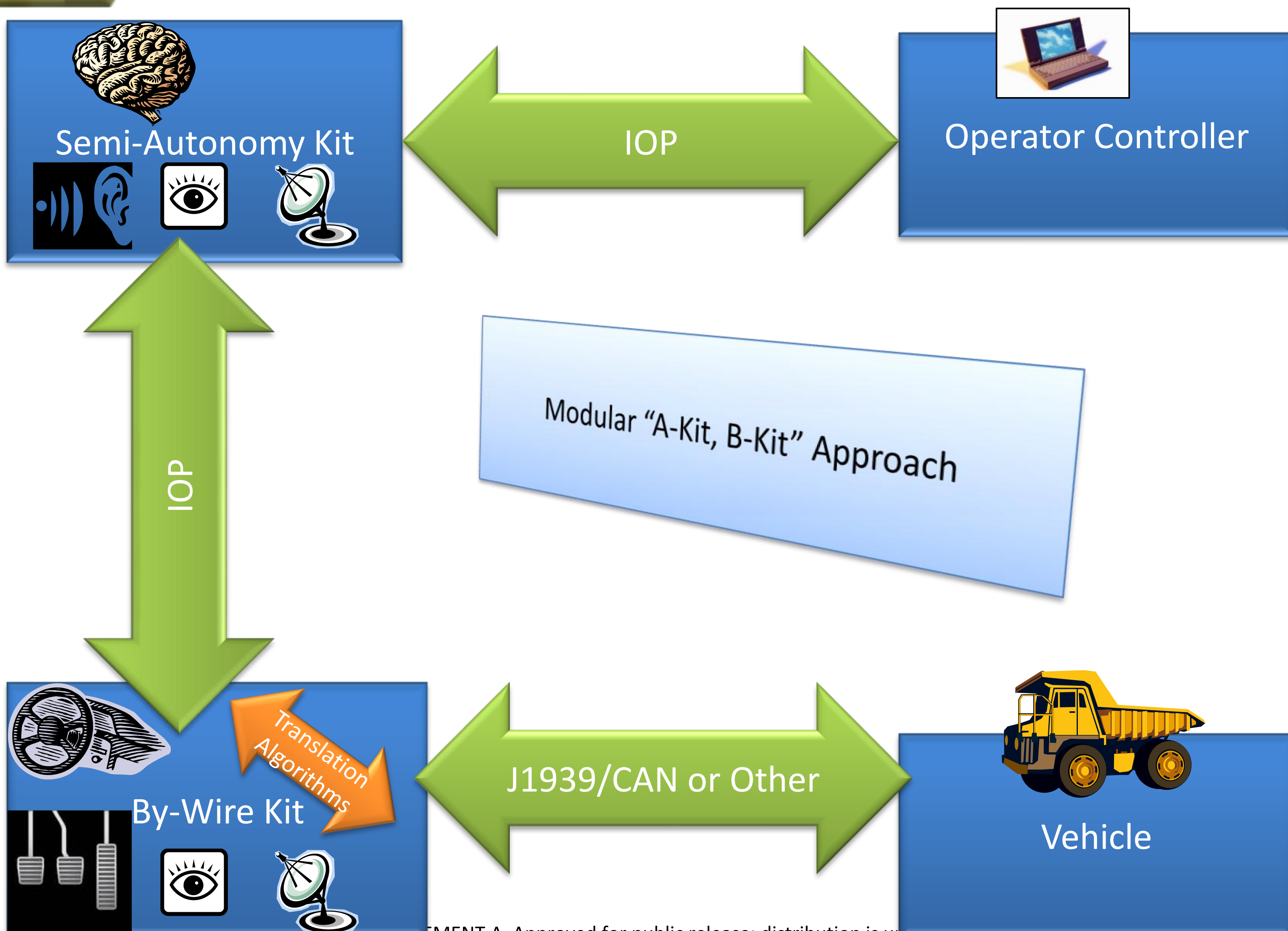
# Tactical Wheeled Vehicles: Autonomy Building Blocks

**Driver Safety/Assist – Sets the conditions for autonomy**

1. Enables by-wire internal vehicle control
2. Builds the testing/evaluation capabilities
3. Develops trust in the systems with Users



# General Unmanned Appliqué System Approach to Open Architecture



# TARDEC UGV Interoperability Lab

- TARDEC UGV Interoperability Lab consists of tools for testing for compliance to the UGV IOP
  - Provides the ability to validate conformance to IOP attributes
  - Supports IOP development process
- Tools:
  - Conformance Verification Tool (CVT)
  - Payloads & communications testing equipment
  - IOP compliant reference implementations
- How industry can leverage:
  - Test your system for IOP compliance in the TARDEC UGV Interoperability Lab
  - Utilize the CVT for your product development

POCs: Paul Bounker, paul.j.bounker.civ@mail.mil
Matt Skalny, matthew.w.skalny.civ@mail.mil
*Use of lab or CVT requires Test Services Agreement (TSA), DoD contract, or NAMC membership

# UGV IOP Challenges

- Communication of what IOP is/does
- Coordination, Propagation, & Adoption within the Government
  - Cross-functionally (requirements, RDT&E, acquisition, etc.)
  - Across the services
- Supported, Standardized Instantiations for R&D Purposes
- Tools and processes
  - specifying, documenting, and validating instantiations
  - verifying compliance
- Industry Education, Buy-In, & Utilization
- Potential Commercial Market Interest
- Longer term transition to an enduring standards organization

# How Can the Services Promote IOP Success?

- Combat Developers & Battle Labs:
  - Require standard interfaces in CDDs/CPDs
  - Encourage industry adoption of IOPs
  - Help synch IOP adoption w/ other domains through requirements
    - i.e. AMDS, NGCS, UAS, M/HH, manned/unmanned, radios, joint/multi-national
- S&T Organizations
  - Encourage IOP compliance in S&T programs
  - Increase body of knowledge in gov't labs
- PM FP & Other PM Offices
  - Require IOP in RFPs; Develop IOP Instantiations
- Resource Providers
  - Recognize the value of 1) IOP development/evolution (across programs), and 2) IOP application (within programs)
  - Recognize IOP as an investment for BBP 3.0
    - BBP >> Promote Effective Competition >> Enforce Open Systems Architecture

**All: Promote Industry Adoption**

# Backup

- Backup

# Unmanned Ground/Air Capabilities – Food for Thought

- Technically straightforward:
  - sUAS as a comms relay for UGV
  - UGV video available on RVTs
  - UGV controller display of sUAS video
  - Chat/text comms btwn UGV controller & UAS controller
- Technically more complex
  - Partial/full control of ground systems from air domain & vice versa
  - UGV access to geospatial/recon/intel databases
  - Coordinated behaviors btwn UAS & UGV assets (ex.: target designation)

# UGV IOP Challenges

- Communication of what IOP is/does
- Collaboration: difficult to keep up with so many different organizations
  - Different industries (robotics, automotive, S/W, networks)
  - Different domains (ground, air, manned systems, network/COE)
  - Joint Services
  - Multi-National
- Technical solutions often compete w/ economic forces
  - Is robotics industry converging w/ automotive industry?
  - What about mobile computing industry?
- DoD Color of Money
  - Small amounts of RDTE can go long way

# Better Buying Power 3.0

**Achieve Affordable Programs**

Continue to set and enforce affordability caps

**Achieve Dominant Capabilities While Controlling Lifecycle Costs**

Strengthen and expand "should cost" based cost management

*Build stronger partnerships between the acquisition, requirements, and intelligence communities*

Anticipate and plan for responsive and emerging threats

*Institutionalize stronger DoD level Long Range R&D Planning*

**Incentivize Productivity in Industry and Government**

Align profitability more tightly with Department goals

Employ appropriate contract types, but increase the use of incentive type contracts

Expand the superior supplier incentive program across DoD

Increase effective use of Performance-Based Logistics

*Remove barriers to commercial technology utilization*

*Improve the return on investment in DoD laboratories*

*Increase the productivity of IRAD and CR&D*

**Incentivize Innovation in Industry and Government**

*Increase the use of prototyping and experimentation*

*Emphasize technology insertion and refresh in program planning*

*Use Modular Open Systems Architecture to stimulate innovation*

*Increase the return on Small Business Innovation Research (SBIR)*

*Provide draft technical requirements to industry early and involve industry in funded concept definition to support requirements definition*

Provide clear "best value" definitions so industry can propose and DoD can choose wisely

**Eliminate Unproductive Processes and Bureaucracy**

*Emphasize Acquisition Executive, Program Executive Officer and Program Manager responsibility, authority, and accountability*

*Reduce cycle times while ensuring sound investments*

Streamline documentation requirements and staff reviews

**Promote Effective Competition**

*Create and maintain competitive environments*

Improve technology search and outreach in global markets

**Improve Tradecraft in Acquisition of Services**

*Increase small business participation, including more effective use of market research*

Strengthen contract management outside the normal acquisition chain

*Improve requirements definition*

Improve the effectiveness and productivity of contracted engineering and technical services

**Improve the Professionalism of the Total Acquisition Workforce**

Establish higher standards for key leadership positions

Establish stronger professional qualification requirements for all acquisition specialties

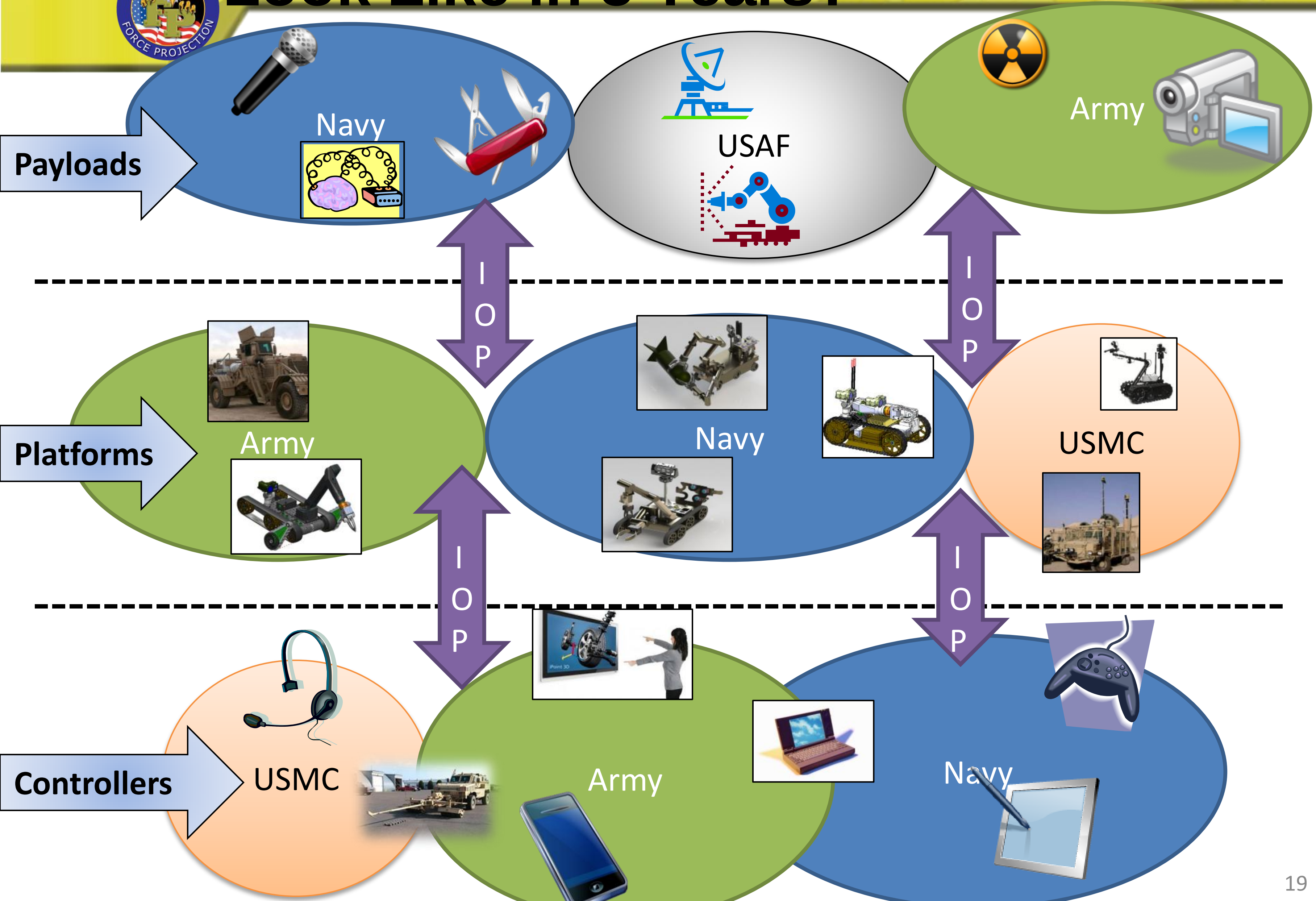
*Strengthen organic engineering capabilities*

Ensure the DOD leadership for development programs is technically qualified to manage R&D activities

Improve our leaders' ability to understand and mitigate technical risk

*Increase DoD support for Science, Technology, Engineering and Mathematics (STEM) education*

# Modularity: What Does Success Look Like in 5 Years?



# Army Unmanned Ground Systems Design Philosophy

- While the exact composition of the PEO's future RAS portfolio of systems remains volatile, there are several intended design philosophies that stakeholders can plan to – regardless of exact requirements.

1. Modular Open Systems Approach thru IOP
2. Common Mobility Platforms & Varying Mission Payloads
3. Design for Growth & Technology Evolution
4. Limit Unnecessary Redundancy
5. Materiel Development Preference (GOTS>COTS>NDI>Developmental Item)
6. Utilize Modular "Kits" Where Appropriate
7. Provide Intelligent Behavior to Existing Systems
8. Take Advantage of Intelligent Systems (i.e., CBM+)
9. Warfighter Centric Design

# Challenges Facing the Robotics Portfolio

- Lack of single requirements advocate
  - No Army TRADOC Capability Manager (TCM)
  - Disparate requirements from MCOE, MSCOE, SCOE, MCCDC representing Engineer, Chemical, Infantry, EOD, SOF, Transportation schools
- Lack of centralized budget planning (PPBE)
  - Programs in multiple Army G-8 portfolios (Soldier, Mobility, Protection)
  - Lack of early funding to dedicate manpower to getting new PoRs off ground
- High level interest regardless of program magnitudes
  - Joint issues between Army, USMC & Navy
  - Significant external program dependencies
  - Desire to retain technological edge amid quickly evolving technology
- Complex mix of 80% Non-Standard Equipment (NSE) transitioning to mostly PoR