



PROJECT MANAGER FORCE PROJECTION

Army Ground Robotics Interoperability Update

Mark Mazzara
PM Force Projection
Robotics Interoperability Lead



Agenda

- IOP Update
- IOP, VICTORY & ROS-M



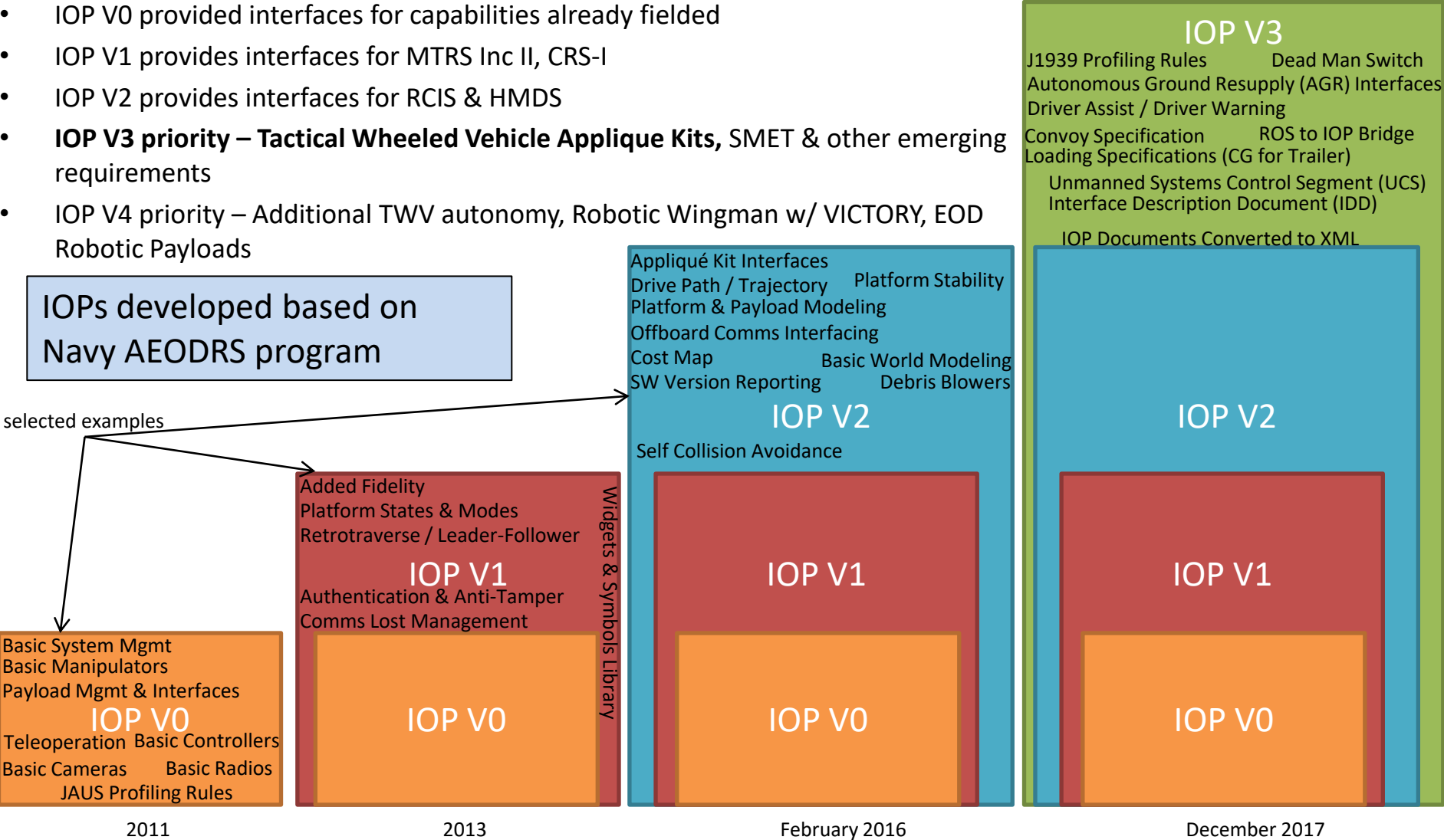
Interoperability Profiles (IOPs) Status

RAS-G IOPs enable modular open software & hardware interfaces

- IOP V0 provided interfaces for capabilities already fielded
- IOP V1 provides interfaces for MTRS Inc II, CRS-I
- IOP V2 provides interfaces for RCIS & HMDS
- **IOP V3 priority – Tactical Wheeled Vehicle Applique Kits, SMET & other emerging requirements**
- IOP V4 priority – Additional TWV autonomy, Robotic Wingman w/ VICTORY, EOD Robotic Payloads

IOPs developed based on Navy AEODRS program

selected examples



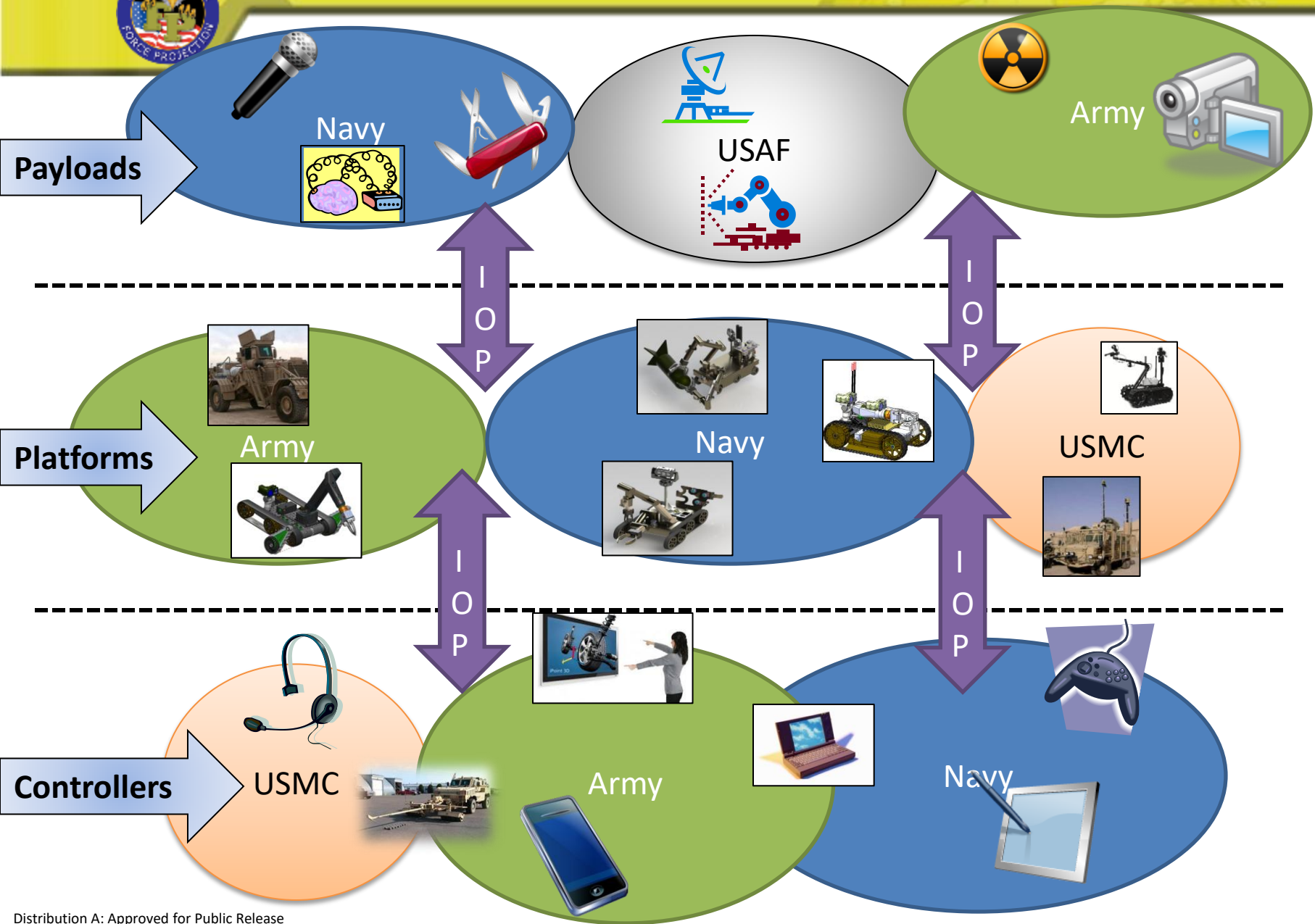


Interoperability Profiles (IOPs) Status

- RAS-Ground IOP Standard
 - IOP V2 published February 2016
 - IOP V3 under development – target publish date December 2017
- IOP Instantiations
 - Instantiations included in upcoming RFPs:
 - MTRS Inc II
 - CRS(I)
 - RCIS
 - Upcoming IOP Instantiation developments:
 - SMET
 - Leader Follower
 - CRS(H)
 - EOD Robotic Payload

IOP V3 Priorities

- Define optimal level of interoperability & modularity for SMET & ground vehicle applique autonomy strategy
 - Enable evolutionary upgrade of autonomy kit to support continued advancement
 - Do not compromise industry's ability to innovate
 - Focus on SMET & Heavy Tactical Vehicles
 - Resolve concerns over safety criticality (JAUS/Ethernet vs. J1939/CAN vs. others)

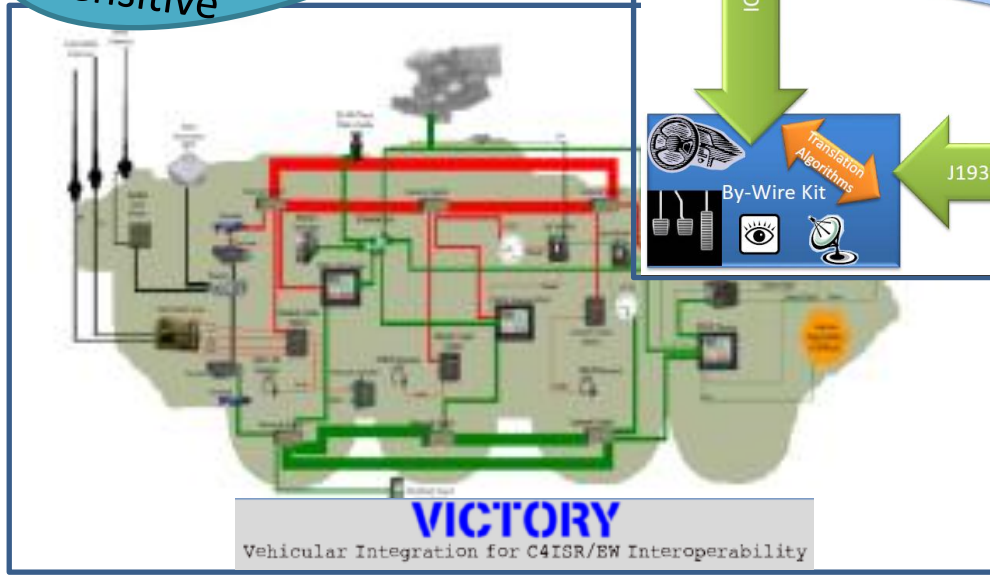
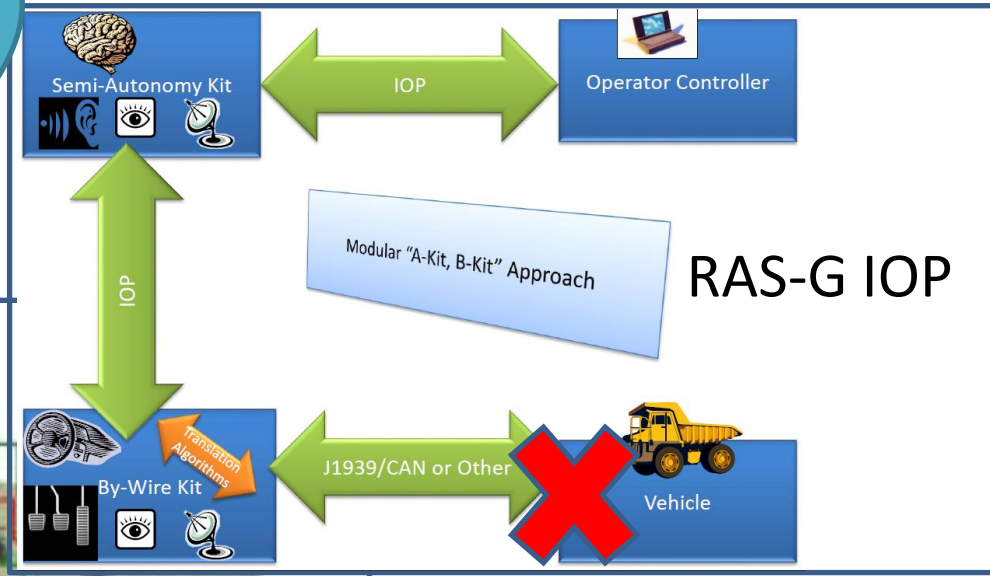




IOP, VICTORY & ROS-M

- Hypothesis: VICTORY + IOP + ROS-M = Robotic Wingman Interoperability

Software
Autonomy Re-Use
Critical Algorithms
ROS-M
Cyber-Hardened
ITAR-Sensitive





Robotic Wingman Interoperability

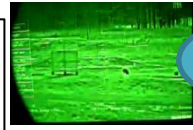
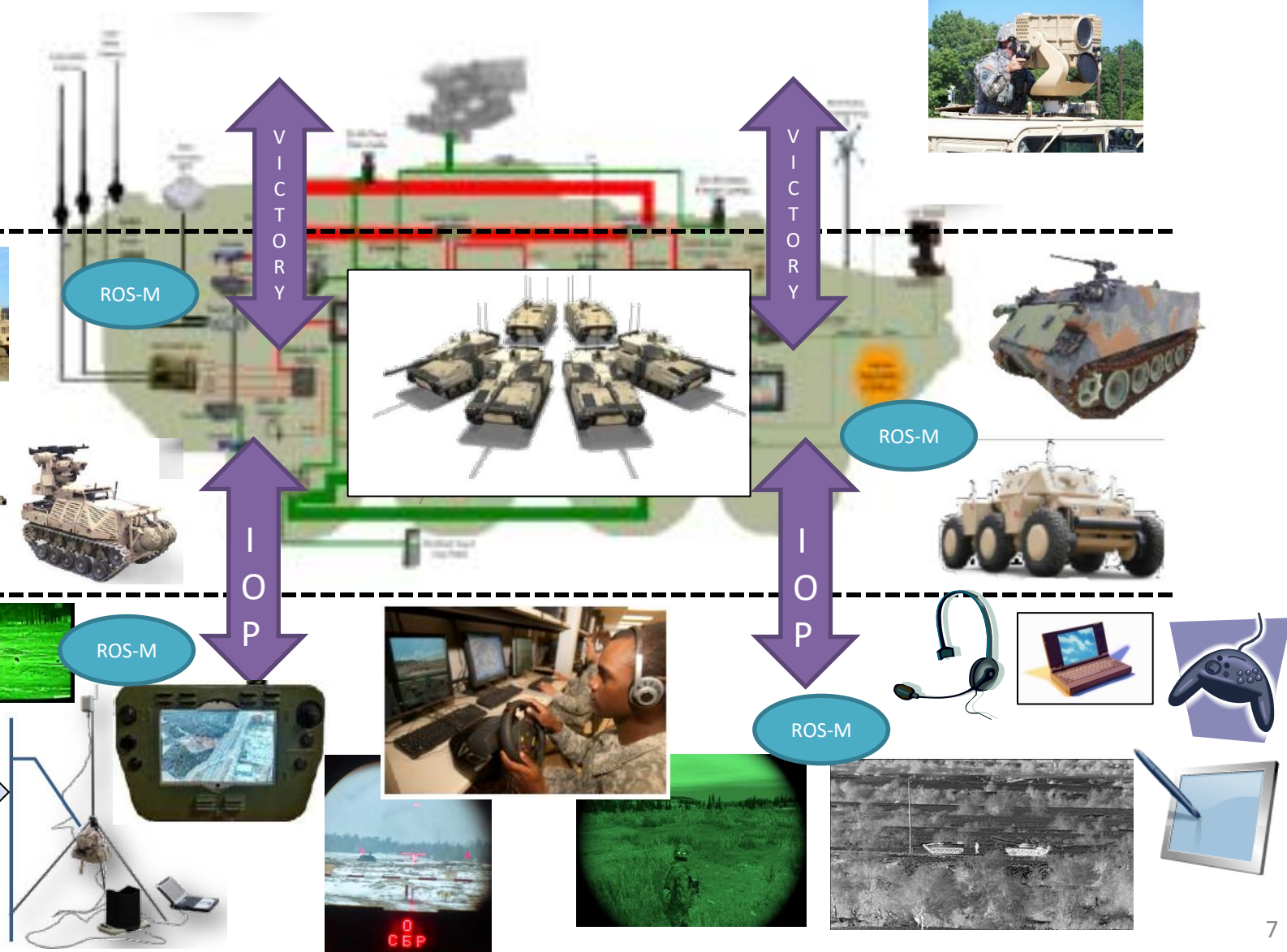
C4ISR/EW Systems



Platforms



Controllers

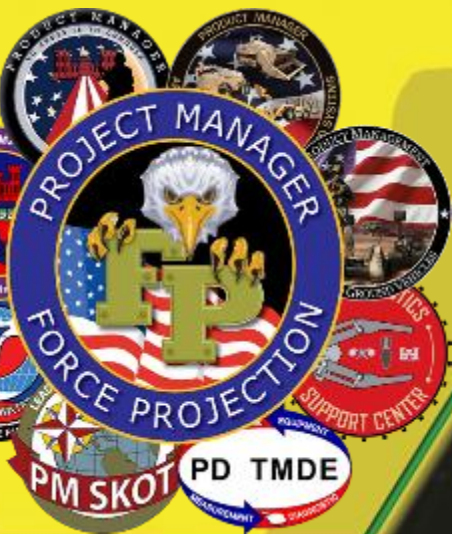


ROS-M



ROS-M





PROJECT MANAGER FORCE PROJECTION

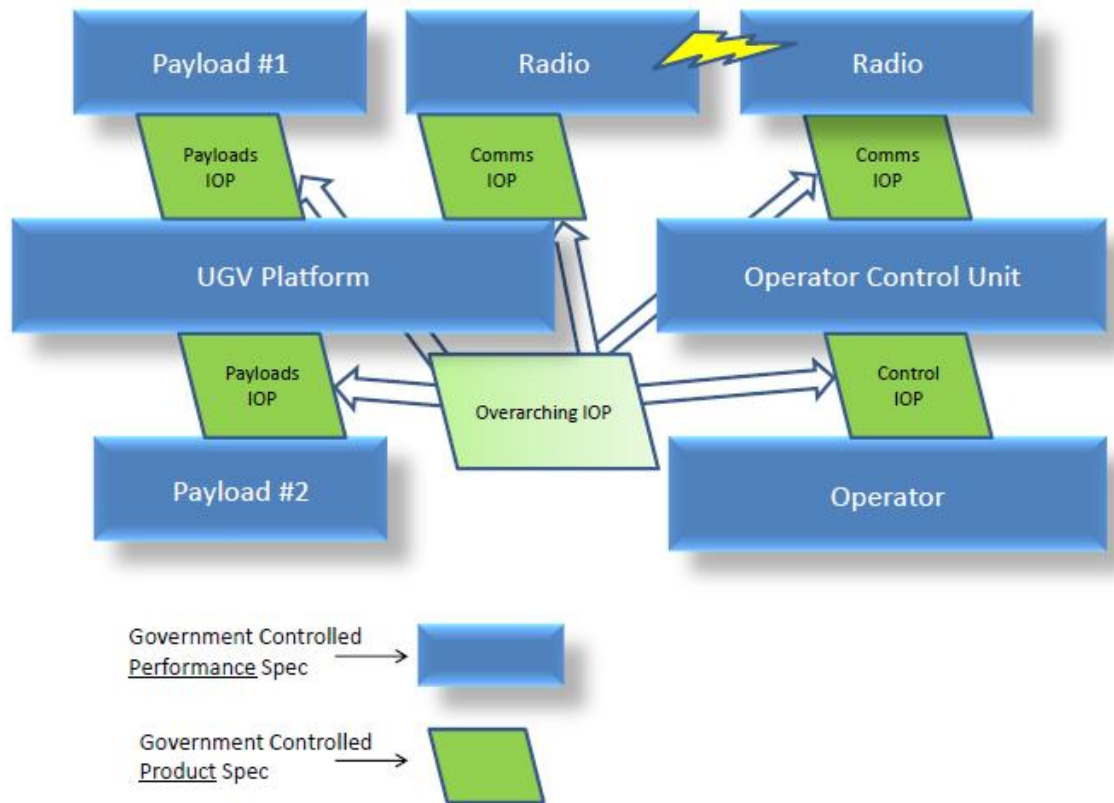
Back Up

Mark Mazzara
PM Force Projection
Robotics Interoperability Lead



RAS-G IOPs Basic Overview

- Robotics & Autonomous Systems, Ground (RAS-G) Interoperability Profiles (IOPs)
- Defines software messaging & hardware interfaces between major subsystems of unmanned ground systems





TARDEC IOP Activities

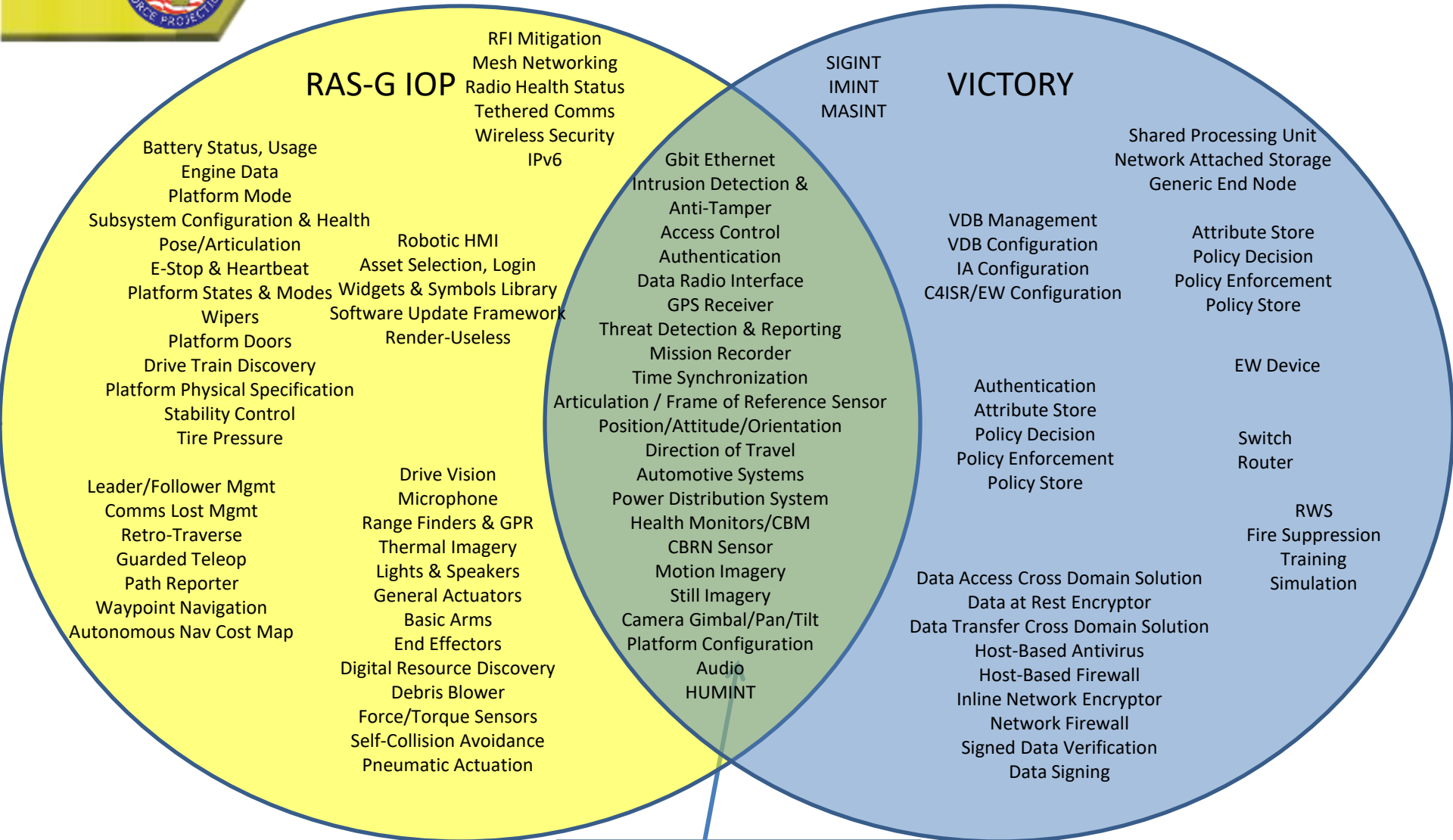
- TARDEC RAS-G IOP Lab
 - Conformance Verification Tool (CVT) v2.4.2-1.beta released Nov 2016
 - CVT March 2017 update will no longer be “beta”
- Joint Communications Architecture for Unmanned Systems (JCAUS) testing in IOP lab – January 2017
- Common CBRN Sensor Interface (CCSI)
 - Obtaining tools in house & determining how to test
- AEODRS
 - Formally assessing how well AEODRS complies w/ IOP
 - Conducting comparison between IOP tools & AEODRS tools
- IOP/JAUS Library & IOP to X Bridge



Key Requirements Drivers – RAS-G IOP versus VICTORY

Consideration	RAS-G IOP	VICTORY
Controllers/HMI	Wirelessly removed from vehicle; Shared across vehicles	Within vehicle
Safety critical mobility control	Computer (Real Time Teleop or Autonomous Mobility)	Operator (in vehicle)
Wireless	At least 1 wireless link within “single system”	No wireless link within “single system”
Interoperability, MOSA, SWaP	Facilitate interop; reduce platform SWaP; share resources; prevent “bolt-on” approach; open architecture for future upgrades	
Payloads / C4ISR/EW Devices	Shared across vehicles	

Key differences



RFI Mitigation
Mesh Networking
Radio Health Status
Tethered Comms
Wireless Security
IPv6

RAS-G IOP

VICTORY

Gbit Ethernet
Intrusion Detection & Anti-Tamper
Access Control
Authentication
Data Radio Interface
GPS Receiver
Threat Detection & Reporting
Mission Recorder
Time Synchronization
Articulation / Frame of Reference Sensor
Position/Attitude/Orientation
Direction of Travel
Automotive Systems
Power Distribution System
Health Monitors/CBM
CBRN Sensor
Motion Imagery
Still Imagery
Camera Gimbal/Pan/Tilt
Platform Configuration
Audio
HUMINT

Robotic HMI
Asset Selection, Login
Widgets & Symbols Library
Software Update Framework
Render-Useless

Drive Vision
Microphone
Range Finders & GPR
Thermal Imagery
Lights & Speakers
General Actuators
Basic Arms
End Effectors
Digital Resource Discovery
Debris Blower
Force/Torque Sensors
Self-Collision Avoidance
Pneumatic Actuation

VDB Management
VDB Configuration
IA Configuration
C4ISR/EW Configuration

Authentication
Attribute Store
Policy Decision
Policy Enforcement
Policy Store

Data Access Cross Domain Solution
Data at Rest Encryptor
Data Transfer Cross Domain Solution
Host-Based Antivirus
Host-Based Firewall
Inline Network Encryptor
Network Firewall
Signed Data Verification
Data Signing

Shared Processing Unit
Network Attached Storage
Generic End Node

Attribute Store
Policy Decision
Policy Enforcement
Policy Store

EW Device

Switch
Router

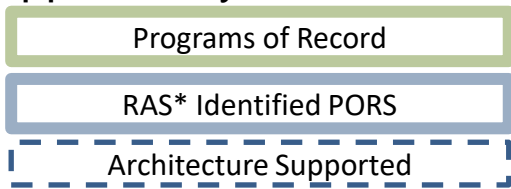
RWS
Fire Suppression
Training
Simulation



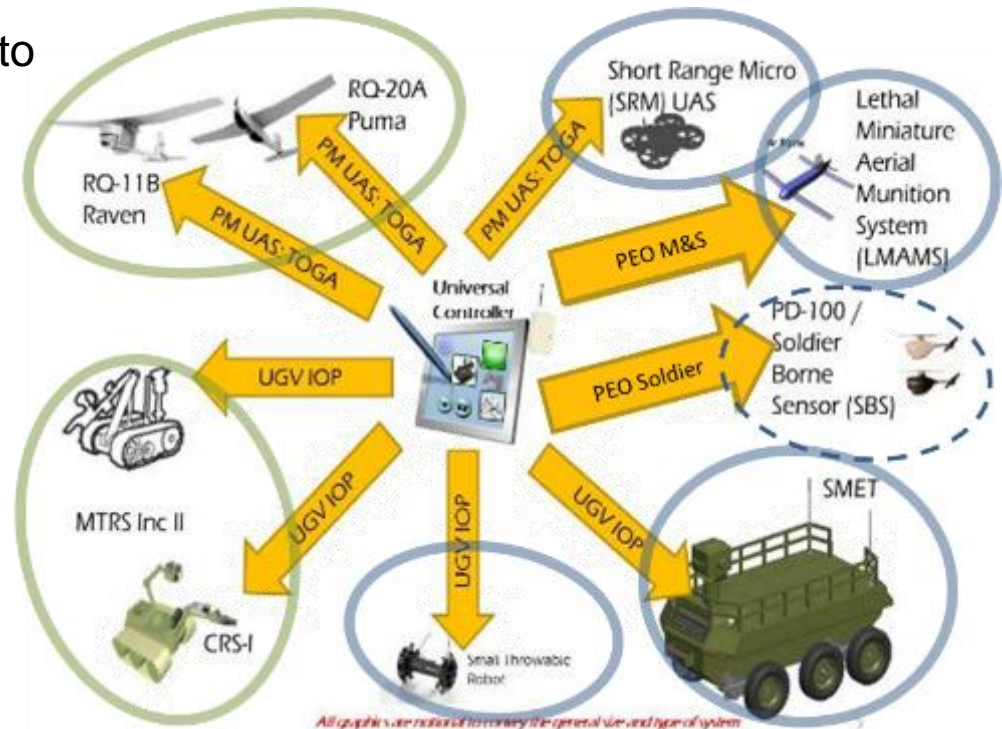
Universal Controller Strategy

Vision: Controller(s) which meets or exceeds CRS(I) threshold while leveraging Better Buying Power emphasis areas:

- Provide draft technical requirements to industry early and involve industry in funded concept definition
- Modular Open Systems Architecture
- Interoperability
- Organic engineering capabilities
- Extensibility & Commonality
- Cybersecurity
- Commercial Technology
- Supportability & Maintainability



*RAS – Robotic and Autonomous Systems



All graphics are notional to convey the general use and type of system

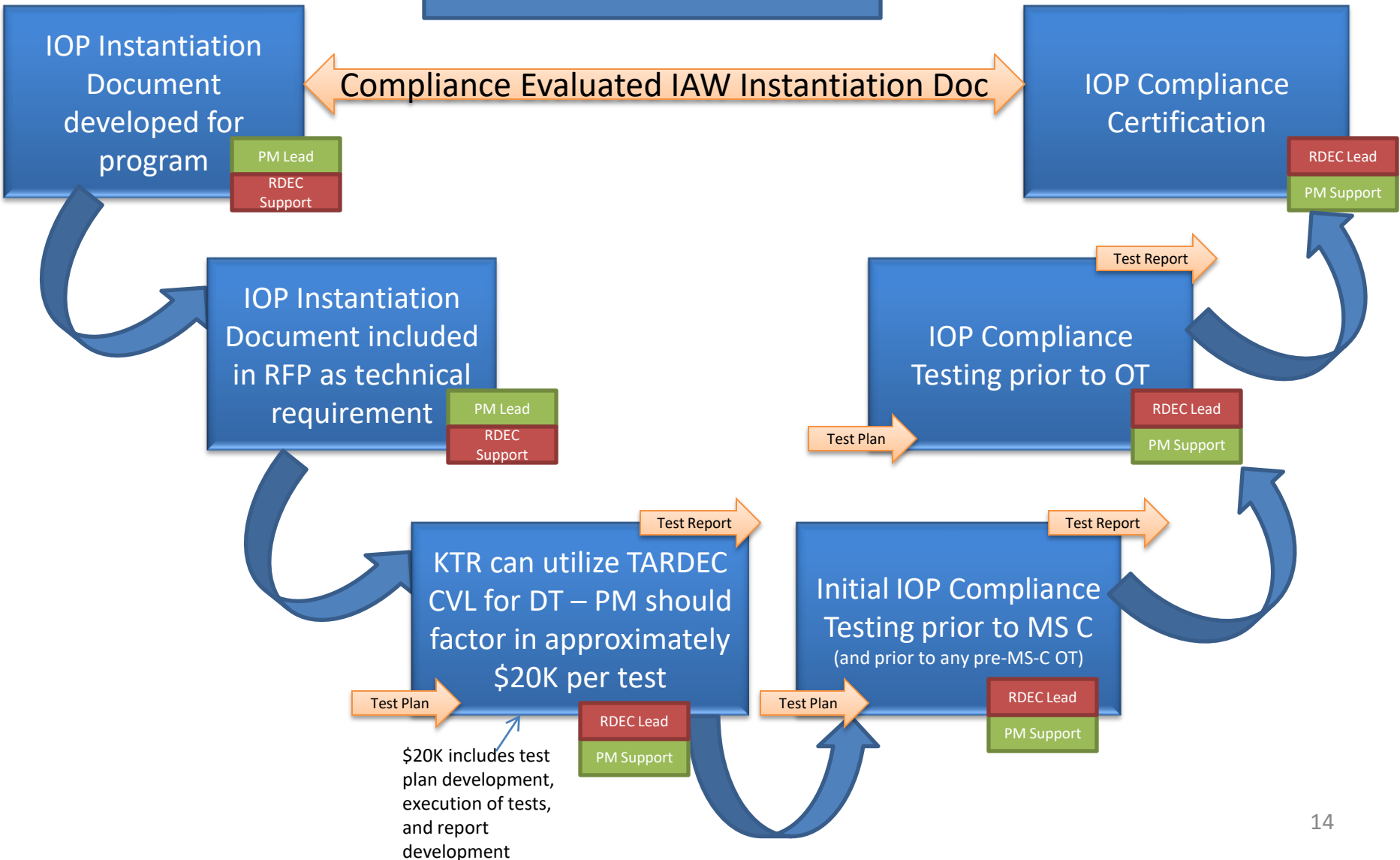
Risk Mitigation:

- **Controller and Software demonstrations (Sept 16 and Jan 17) to mature MOCU4 software to handoff/operate on multiple controllers controlling multiple platforms**
- **Robotic Enhancement Program (REP) authorized purchase of Bokam, TRC-Lite controllers and UAS controller (TOGA H-GCS)**



IOP Conformance Validation Process

Similar to VICTORY Process





RAS-G 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.