NATIONAL ADVANCED MOBILITY CONSORTIUM

GRCCE Open Architectures Panel

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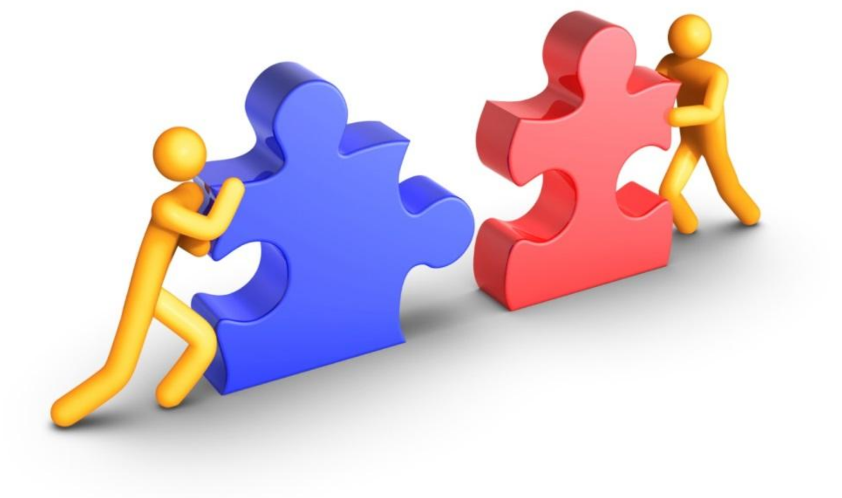
Why Open Architecture?

Enables *Interoperability* Among Applications Built by Different Parties and Procured at Different Times

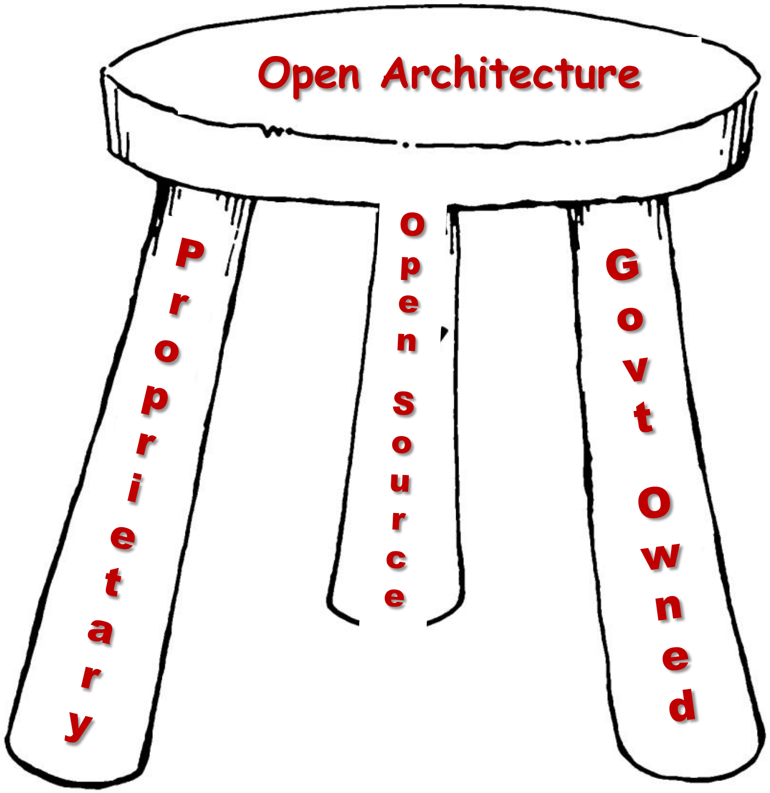
***Interoperability* is the “plug-n-play” ability for heterogeneous software components and systems to effectively operate together by: providing and accepting services to/from one another, and using the information (content, format, and semantics) so exchanged**



Increasing complexity of international conflicts and need to work with a host of agencies, branches, and political entities makes *interoperability* a fundamental requirement for future defense capability and operations
(e.g. one of eight principles the Army of 2025 will be built around)

Why Open Architecture?

- Integrate multiple components developed by different parties under different licenses
- Increase innovation, competition, time to market, and cost-effectiveness
- Enable technology to be upgraded to keep up with commercial technical advances



Army Interoperability Strategy

"To keep costs down and maximize flexibility,
the service is employing a strategy that emphasizes
open architectures; reusable, interchangeable components;
and common, publicly defined interfaces*"*

\- Hon. Heidi Shyu
Assistant Secretary of the Army
for Acquisition, Logistics and Technology

Requires Government / Industry Collaboration

Vehicle & Robotics Alliance (VRA)

Network of Participating Government Organizations: Government Labs / R&D Centers / & Program Offices

Not Subject to the FAR/DFAR

National Advanced Mobility Consortium (NAMC)

Traditional & Non-Traditional Universities, Research Organizations, Small Companies, & Large Defense Contractors

Unparalleled levels & types of collaboration helps expedite the development, integration, and demonstration of prototype, manned and unmanned systems and technology

Interoperability Profiles (IOP)

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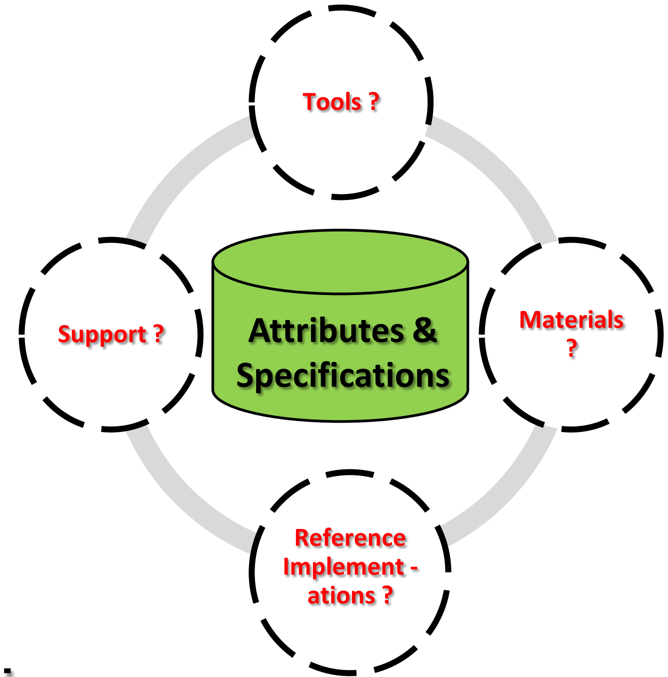
The Problem

How to Accelerate Adoption of the IOP Standard

- Core IOP V2 documents and specifications are sufficiently advanced to define instantiations for a wide range of UGVs & ground RAS
- Lack of supporting infrastructure is serving to:
  - Hinder DoD organizations' ability to adopt IOP on a ready or wide scale basis
  - Limit Industry buy-in and use for RDT&E purposes



Recommendation

Further mature IOP, accelerate its near term utilization, and progress towards its eventual transition to an enduring standards body

Near Term

- **Develop, Publish, & Support Standardized Baseline Instantiations for Certain UGV Classes**
- **Implement a Web-Based IOP Portal & Baseline Support Services**
- **Commence work on IOP V3**

Longer Term

- **Develop Advanced Conformance Validation Tools**
- **Mutual Government / Industry Control & Eventual Transition to an Enduring Standards Body**

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Military Robotics Operating System (ROS-M)

The Problem

How to Establish A Common / Shared / Open Environment for Ground RAS Autonomy Software

- Duplicative / different / incompatible variations of the same defense robotics autonomy software
- No means of addressing unique technical / programmatic / security-related needs of military robotics
- No current means of publicizing / sharing common software components unique to DoD needs

Proposed Strategy & Approach

Develop a Military Variant of the Open Source Robotic Operating System and Overarching Architecture

- Approach modeled after one taken to produce a variant of ROS for industrial robotics (ROS-I)
- Develop a "Concept Definition" Document Synched to the Army RAS Strategy Document
- Further Investigate Certain Aspects & Develop a Proposed Implementation Plan
  - **Technical** - interoperable open architecture, security-enhanced, core software components, and other software components & development tools unique to military needs
  - **Management Infrastructure** - Registry and repository management, verification and validation tools, and other supporting tools and processes
  - **Business Model** - Licensing and data rights, user access/restrictions, and other elements related to propagating adoption and use

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Common Controller Architecture

The Problem

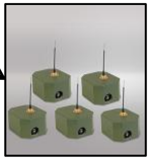
Unique operator control stations for each RAS platform

- Greater Acquisition & Life-Cycle Costs
  (incompatible display units, batteries, & radios)
- Physical & Cognitive Burden on the Warfighter
  (1:1 ratio of controllers to RAS; different user interfaces)
- Operational Inflexibility
  (inability to interchange data for collaborative operations / dynamically distribute control of platforms & payloads)

The Requirement

CRS(I) KPP 4: Unmanned System Control

- ***The CRS(I) OCU must have ability to achieve & maintain active and/or passive control of any current Army and Marine Corps PoR battalion & below level Unmanned (Air or Ground) System and/or their respective payloads in less than 3 minutes (T), 1 minute (O).***



Proposed Strategy

Prototype an Interoperable Open Architecture based on SAE UCS in order to meet the CRS(I) requirement and serve as a basis for future common tactical controller development

- Enables Government-owned and proprietary components to be readily integrated
- Leverages Government-Owned Interoperable Software (e.g. MOCU 4, WMI)
- Enables Control of Additional Platforms & Payloads to be incrementally added *with minimal disruption to the platform PoRs*
- Reduces Software Development & Maintenance Costs

MOCU 4

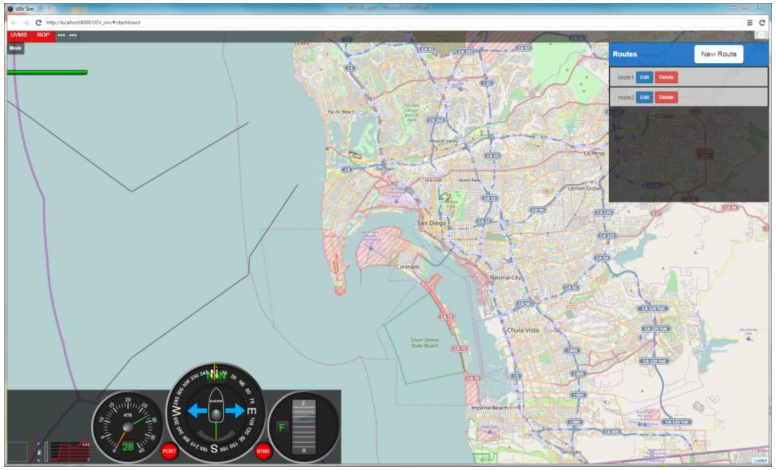


Image courtesy of AeroVironment, Inc.

- MOCU4 was developed to enable a single control station to operate multiple RAS platforms and payloads
- MOCU4 was designed so that open and commonly available tools and middleware can be used to develop and maintain graphical user interfaces as well as platform and payload control interfaces “native” to various manned and unmanned systems
- MOCU4 modular software components provide / accept services and exchange information using UCS defined services over a DDS communications bus and can thereby be readily integrated with other software components (government-owned, proprietary, or open source) compatible with the applicable UCS architecture.
- This creates a lightweight system for updating and maintaining user interfaces while also allowing custom user modules to be plugged in and adapted to existing systems with ease.

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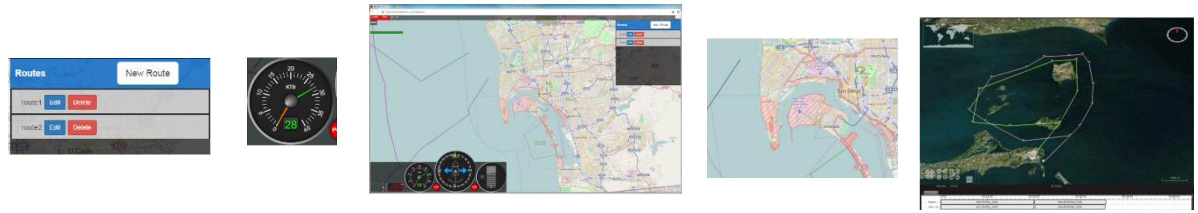
MOCU 4

UI Modules

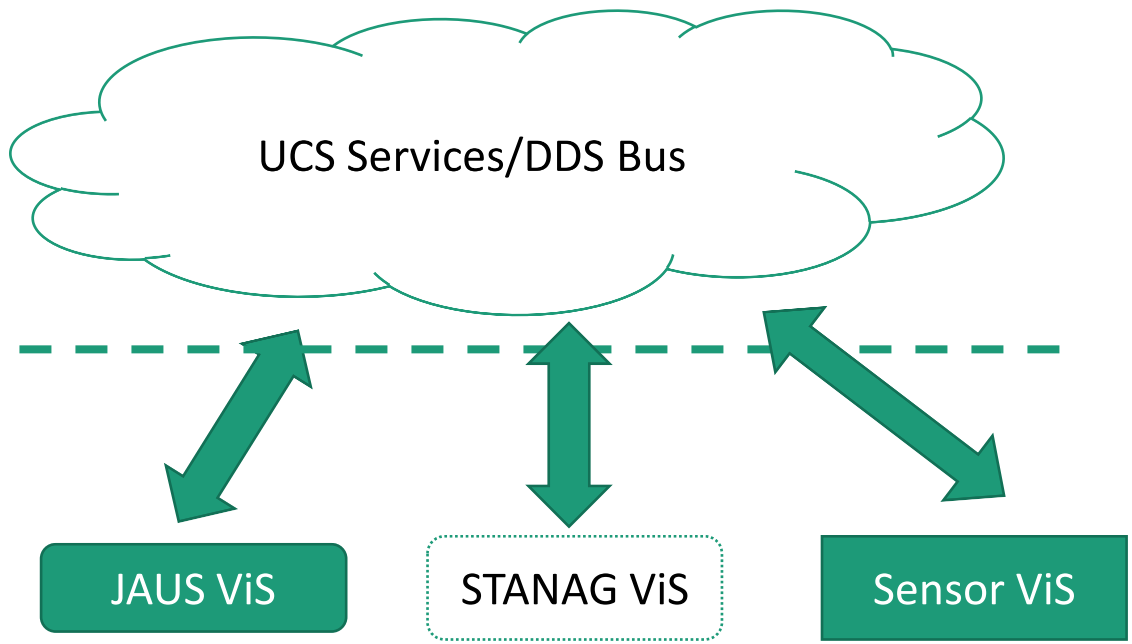
Lightweight user interfaces written with JavaScript that leverages large set of existing tools and packages used in everyday web development.



UI / Video Data Translation Modules

Translate data using JSON objects from and into the DDS bus; also supports streaming protocols such as rtsp

JSON to DDS



Platform & Payload Interface Modules

Translate UCS service requests / DDS messages into equivalent services and messages native to the platform and payload being controlled