NATIONAL ADVANCED MOBILITY CONSORTIUM

Interoperability Initiatives Update

Bill Thomasmeyer

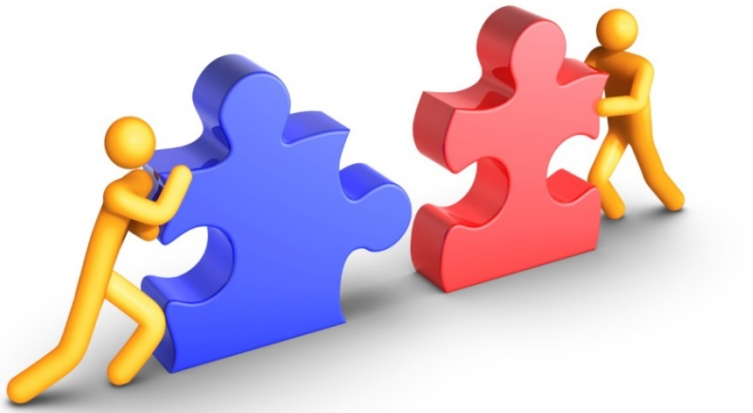
NAMC, Robotics Consultant

June 22, 2016

NATIONAL ADVANCED MOBILITY CONSORTIUM

What is Interoperability?

The ability for heterogeneous software components and systems *(different applications built at different times by different providers)* to effectively work together in a "plug-n-play" fashion



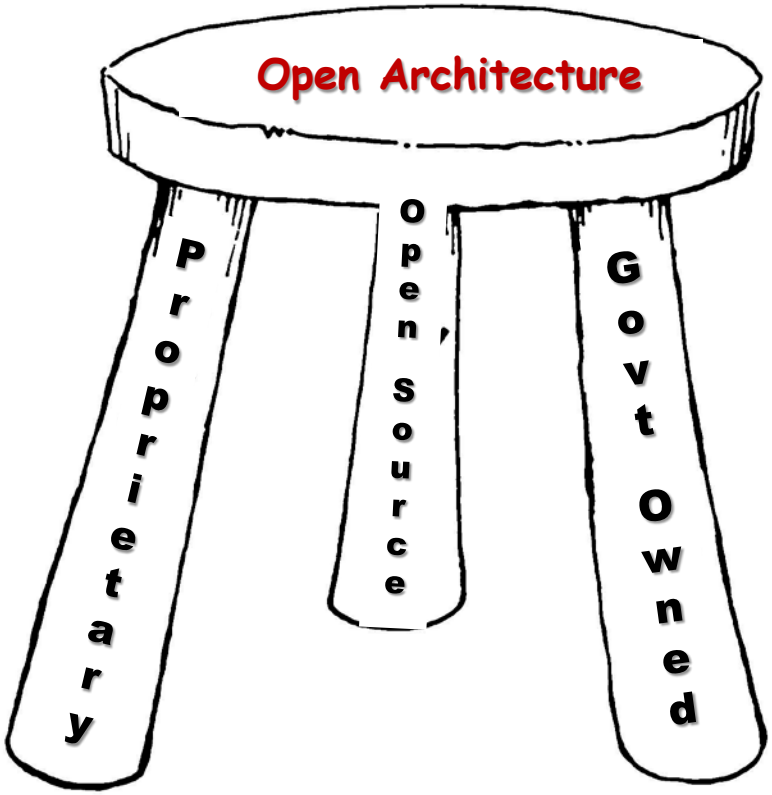
- **Provide and accept services to/from one another**
- **Understand and use the information so exchanged (content, format, semantics, and context)**

NATIONAL ADVANCED MOBILITY CONSORTIUM

How is Interoperability Achieved?

Adoption of Open Systems & Architectures

- Enable systems integrators to utilize best of breed components and applications from different providers according to different license terms
- Increase innovation, competition, and time to market; lower costs
- Enable systems to be incrementally upgraded as each component technologically advances



NATIONAL ADVANCED MOBILITY CONSORTIUM

DoD Commitment to 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

NATIONAL ADVANCED MOBILITY CONSORTIUM

Requires Government / Industry Collaboration

Vehicle & Robotics Alliance (VRA)

National Advanced Mobility Consortium (NAMC)

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

Overarching Agreement:
10 U.S.C. 2371 Section 815
Other Transaction Agreement

DEFENSE MOBILITY ENTERPRISE — DME — VRA — NAMC

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

Not Subject to the FAR/DFAR

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

NATIONAL ADVANCED MOBILITY CONSORTIUM

RAS Interoperability Initiatives

- Propagation & Utilization of Interoperability Profiles (IOP)
- Universal Tactical Controller Open Software Architecture
- Military Variant of the Robotic Operating System (ROS-M)

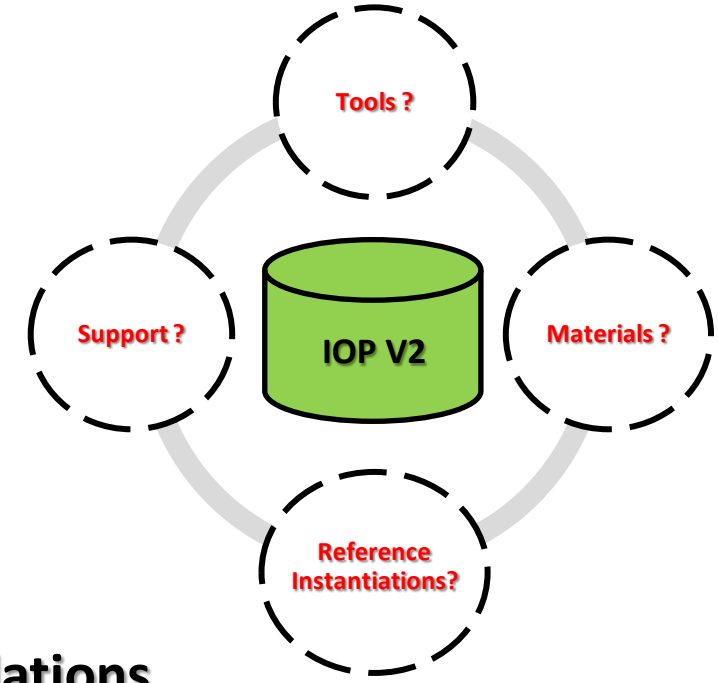
NATIONAL ADVANCED MOBILITY CONSORTIUM

Interoperability Profiles (IOP)

The Problem

How to Accelerate IOP Adoption

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



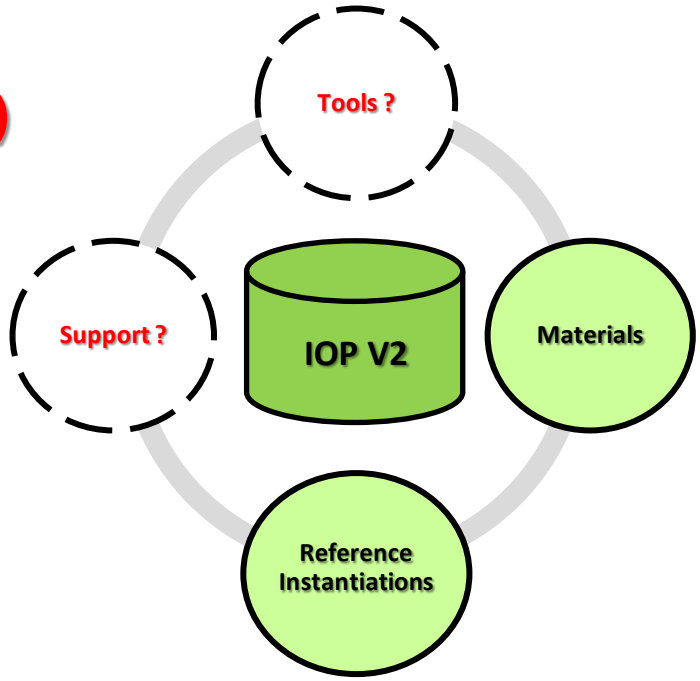
Phase I Recommendations

- Develop, Publish, & Support Standardized Baseline Instantiations for Certain UGV Classes
- Implement a Web-Based IOP Portal & Baseline Support Services
- Commence work on IOP V3
- Develop Advanced Conformance Validation Tools
- Mutual Government / Industry Control & Eventual Transition to an Enduring Standards Body

Interoperability Profiles (IOP)

Phase II Mission Accomplished

- **Standardized Baseline Instantiations (SBIs)**
  - Man Transportable (MT/1)
    Common Baseline for CRS(I) / AEODRS (Inc 1) platform & payloads
  - Vehicle Transportable (VT/1)
    Common Baseline for MTRS (Inc 2) / AEODRS (Inc 2) platform & payloads



- **NAMCgroups.org Web Portal**

  Common Site for Government & Industry (Password Controlled)
  - IOP V2 Documentation and Materials
  - MT/1 and VT/1 SBIs

NATIONAL ADVANCED MOBILITY CONSORTIUM

RAS Interoperability Initiatives

- Propagation & Utilization of Interoperability Profiles (IOP)
- Universal Tactical Controller Open Architecture
- Military Variant of the Robotic Operating System (ROS-M)

NATIONAL ADVANCED MOBILITY CONSORTIUM

Universal Tactical Controller (UTC)

The Problem

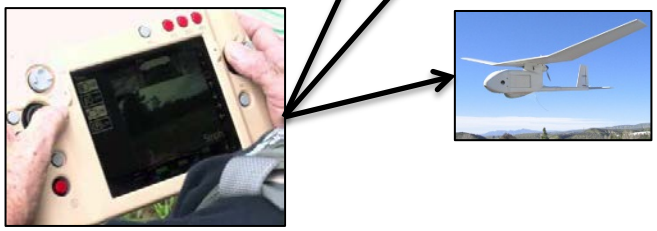
Proprietary operator control stations per RAS platform

- 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).*



Phase I Recommendation

Adopt an Open Architecture approach to meet the CRS(I) requirement and serve as the basis for future universal tactical controller development

- Leverage Significant DoD Investment in UxS Control Segment (UCS) Architecture
- Utilize Government-Owned Software (e.g. MOCU 4)
- Enables Control Software to be Incrementally Implemented (*with minimal disruption to the platform & payloads*)
- Enables Government-owned and Proprietary Components to be Readily Integrated
- Reduces Software Development & Maintenance Costs

NATIONAL ADVANCED MOBILITY CONSORTIUM

Universal Tactical Controller (UTC)

Develop & Propagate a Prototype Architecture

- ✓ Define an initial prototype UCS ground domain architecture ("UCS(G)")
- ➢ Build Initial Prototype UTCs (Jul - Aug)
  - o Produce an extended version of the MOCU 4 software ("MOCU 4x") compliant with the UCS(G) architecture
  - o Integrate and test MOCU 4x on various Government-developed OCU devices
- ➢ Conduct a series of demonstrations of the initial prototype UTCs operating multiple platforms and payloads (Aug – Dec)
- ➢ Develop a standardized baseline UCS PLA for the UTC (Sep – Dec)
- ➢ Provide the UCS prototype architecture, MOCU 4 software, software development tools, and training and support to a vetted group of developers and integrators (Q1 FY17)
  - o Develop "plug-n-play" software components, applications, and user interfaces
  - o Integrate MOCU 4x onto other OCU hardware
  - o Test prototype UTCs with various RAS platforms and payloads

NATIONAL ADVANCED MOBILITY CONSORTIUM

RAS Interoperability Initiatives

- Open Architecture for a Common Tactical Controller
- Propagation & Utilization of Interoperability Profiles
- Military Variant of the Open Source Robotic Operating System

Military Variant of the Robotic Operating System (ROS-M)

Problem Statement

- Overlapping & incompatible autonomy software code bases
- Each with its own unique internal software architectures, programming practices, and other conventions
- Developed at different times, by different vendors, for different platforms, and for different purposes
- Sponsored by different DoD organizations / paid for multiple times over
- No centralized means of documenting the existence of various code bases
- No standardized means of characterizing or encapsulating the contents of the code bases
- No ability to mix and match components from different code bases without modifying / re-writing the code

Problem Statement – Questions Begged

- How to consolidate and integrate existing code bases?
- How to "normalize" code bases (i.e. enable interoperability among all components, etc.)?
- How to "memorialize" code bases (i.e. document existence, content, availability , etc.)?
- How to enable access to the code bases?
- How to capture, recycle, and leverage improvements to the software?
- How to meet evolving needs and requirements unique to military RAS?
- How to facilitate future compatibility?

Military Variant of the Robotic Operating System (ROS-M)

Proposed Approach & Assumptions

- ROS-M Increment 1 will focus on and support efforts to research, develop, integrate, test, and demonstrate **prototype R&D** military RAS, but will be designed to be extended in the future to support fielded, program of record RAS
- ROS-M Increment 1 will focus on and support military **ground** RAS, but will be designed to be expanded in the future to allow for air and maritime domain military RAS as well.
- ROS-M will be exclusively based on and build upon **ROS 2.0** and **ROS-SE**
- ROS-M will **not require** contributors to provide **open source code**; the ecosystem will enable proprietary software to be equally and as readily integrated, utilized, and supported as open source software components
- ROS-M will **not require** compliance with **a common, universal licensing model**; the ecosystem will support various types of licenses; and enable each software application, module, application, and component to be accessed and used according to its own applicable license terms and conditions

Project Phases

- ✓ **Phase 1 – Produce a Concept Definition Document**
- ❑ **Phase 2 – Produce an Implementation Strategy & Plan**
  - √ Vet the Concept Definition document
  - √ Engage the RAS COI
  - √ Organize a core team and one or more working groups
  - – Document how ROS-M relates to the Army RAS Strategy Document
  - – Investigate existing models and standards for autonomy and control software on military RAS and determine whether/how ROS-M intersects
  - – Prioritize, investigate, and reach consensus on various issues identified in the Concept Definition document
  - – Define and document the ROS-M goals, objectives, scope, operating assumptions, constraints, deliverables, and other considerations
  - – Develop and deliver a detailed, plan, budget, and proposal for the next phase effort
- ❑ **Phase 3 – 5 Incrementally Develop, Deliver, and Demonstrate (the value of) an operational, prototype ROS-M framework (FY17 – FY19)**

NATIONAL ADVANCED MOBILITY CONSORTIUM

Military Variant of the Robotic Operating System (ROS-M)

Working Groups

- **Software Stack**
  - Demonstration Scenario
  - ROS 2 modules to be incorporated or developed
  - ROS 1 modules to be bridged
  - Tool and OS requirements
- **Software Process**
  - Repository and Access Control
  - Registry
  - Configuration Management
  - Metadata
  - Wiki/shared documentation
  - Software maturity and coding standards
- **Security**
  - The mil-standards associated with open source software
  - Ros-M consortium IA responsibilities versus acquisition body's responsibilities
  - Security best practices
- **Business Process**
  - Marketing and educational material requirements
  - DFARS and Licensing analysis
  - Community standards
  - DoD open source community best standards

Questions / Discussion