NATIONAL ADVANCED MOBILITY CONSORTIUM

Interoperability Initiatives

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NAMC, Robotics Consultant

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Need for RAS Interoperability

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Need for RAS Interoperability

Frustration is waiting for flowers to bloom for which you haven't sown any seeds.

- Dr. Steve Maraboli
Speaker, Author, and Behavioral Scientist

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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

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Uniquely Positioned to Sow Seeds

Vehicle & Robotics Alliance (VRA)

National Advanced Mobility Consortium (NAMC)

Overarching Agreement:
10 U.S.C. 2371 Section 845
Other Transaction Agreement

DEFENSE MOBILITY ENTERPRISE

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

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

Unparalleled levels & types of collaboration accelerates the development, integration, and demonstration of prototype, ground vehicle and robotics systems, standards, and technology

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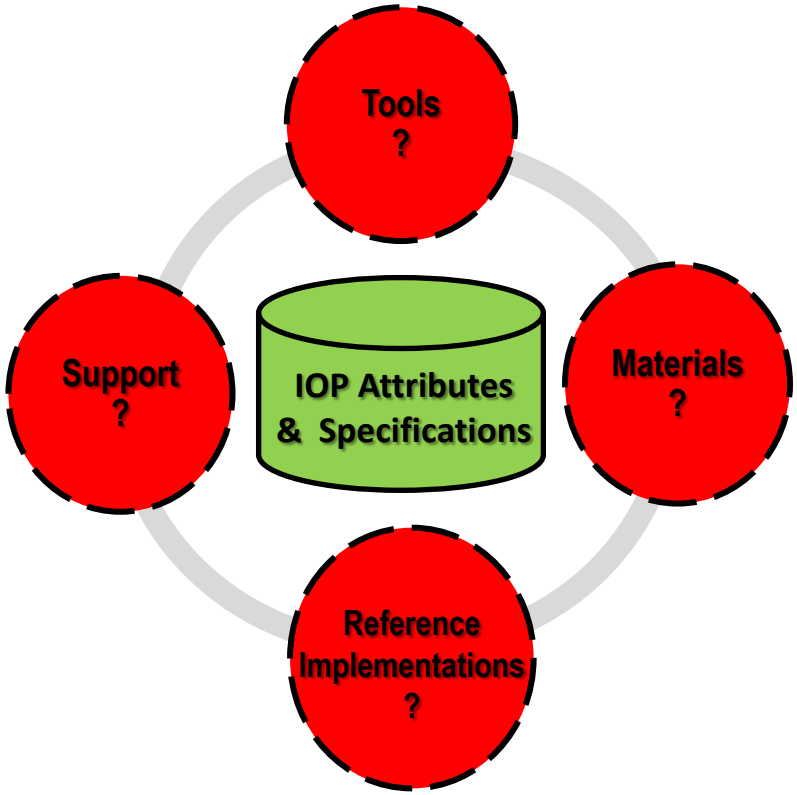
RAS Interoperability Initiatives

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

Interoperability Profiles (IOP)

Current State



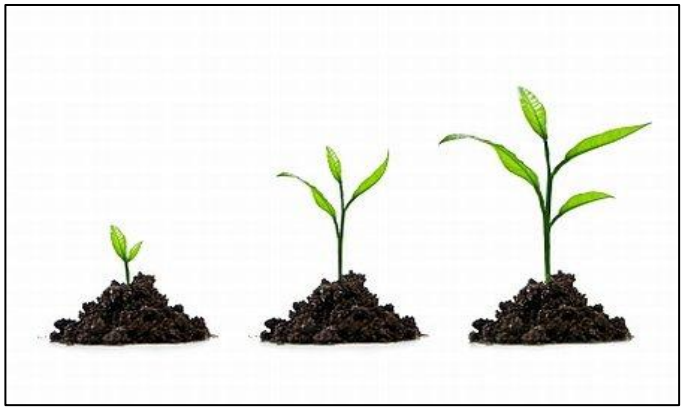
IOP V2 core documents & specifications are sufficiently advanced to define instantiations for a wide range of ground RAS

Lack of supporting infrastructure is:

- Hindering DoD organizations' ability to adopt on a ready or wide scale basis
- Limiting Industry buy-in and use

Interoperability Profiles (IOP)

Path Forward



Advance Its Maturation

- Commence Work on IOP Version 3
- Advanced Conformance Validation Tools
- Mutual Government / Industry Control & Transition to an Enduring Standards Body

Jump-Start Its Utilization

- Develop, Publish, & Support Standardized Baseline Instantiations (SBIs)
- Implement a Web-Based Portal & Baseline Support Services

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Interoperability Profiles (IOP)

Status / Progress

- **Completed Development of Initial SBIs**
  - **Man Transportable (MT/1)**
    Surrogate for CRS(I) / AEORDRS Inc 1 platform & payloads
  - **Vehicle Transportable (VT/1)**
    Surrogate for MTRS Inc 2 / AEODRS Inc 2 platform & payloads
- **Setting Up Web Portal & Baseline Support (Q2 FY16)**
  - **Common Site for Government & Industry** ***(Password Controlled)***
  - **Materials & Services**
    - IOP Documentation and Materials & Standardized Baseline Instantiations
    - FAQs, Interim Q&A Support, & Web training sessions
- **Government-Owned Validation & Compliance Tools**

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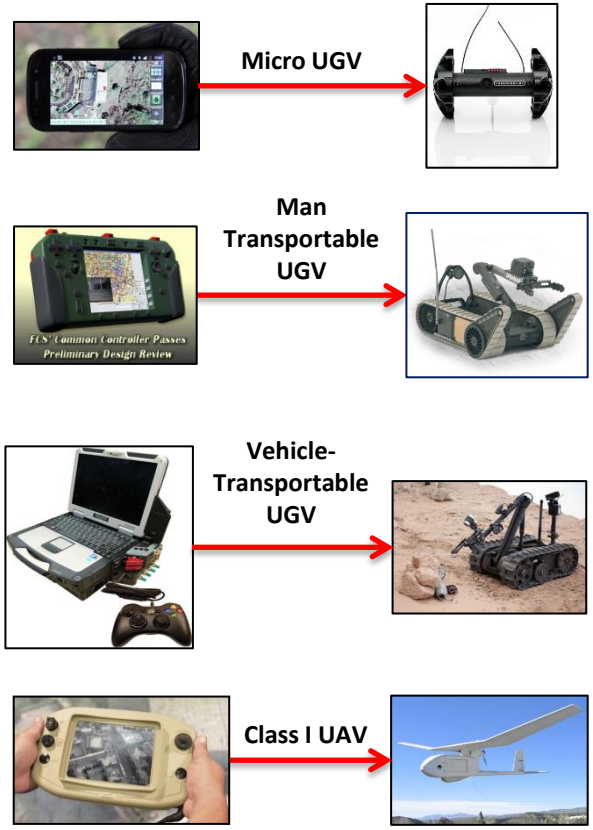
Common Tactical Controller

The Problem



Different 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 Limitations**
  (inability to interchange data for collaborative operations / dynamically distribute control of platforms & payloads)

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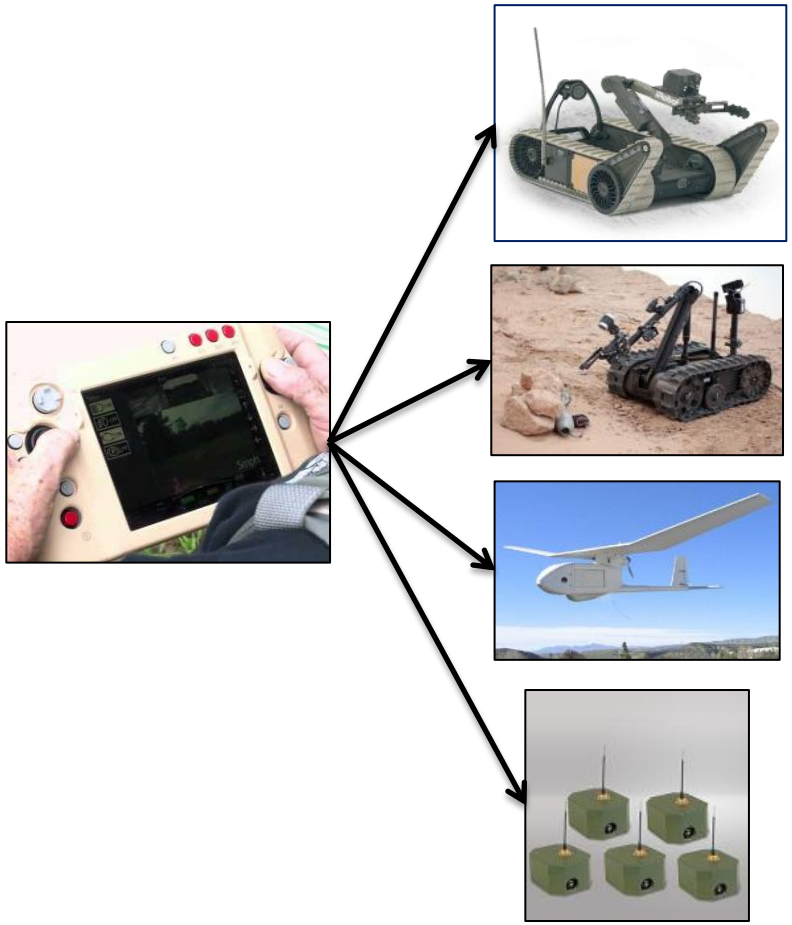
Common Tactical Controller

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).

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Common Tactical Controller

Proposed Strategy

Pursue an Open Architecture approach based on the UCS standard in order to meet the CRS(I) common controller requirement and serve as the basis for future common tactical controller development

- **Enables Government-Owned & Proprietary Components to be Easily Integrated**
  - ✓ **Leverages MOCU 4 Government-owned software**
  - ✓ **Stimulates Innovation & Competition**
- **Enables Control of Additional Platforms & Payloads to be Incrementally Added *with Minimal Disruption to the PoRs***
- **Reduces Software Development & Support Costs**

UCS (UAS Control Segment)

Interoperable Software Architecture for Common Controllers

- **Background**
  - Initially Developed for Group 2–5 UAS
  - Significant DoD Investment & Traction
  - State of the Art: Data-Centric, Service-Oriented, and Model-Driven
- **Recent Developments**
  - Being Extended to the Ground & Maritime Domains
  - Responsibility for Maintaining & Supporting the UCS Information Architecture has Transitioned to SAE (same group as JAUS)
  - Agreement to align UCS with FACE
  - SPAWAR developing a UCS compatible version of its MOCU control software (Version 4)
  - Software development tools coming to market

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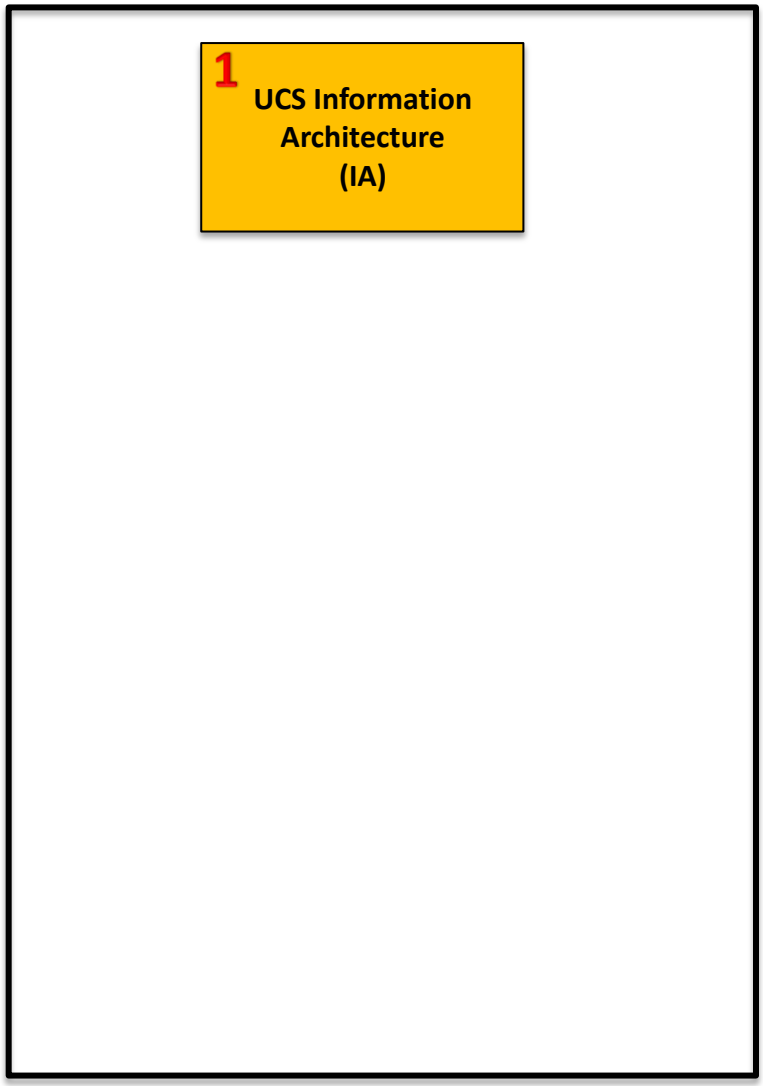
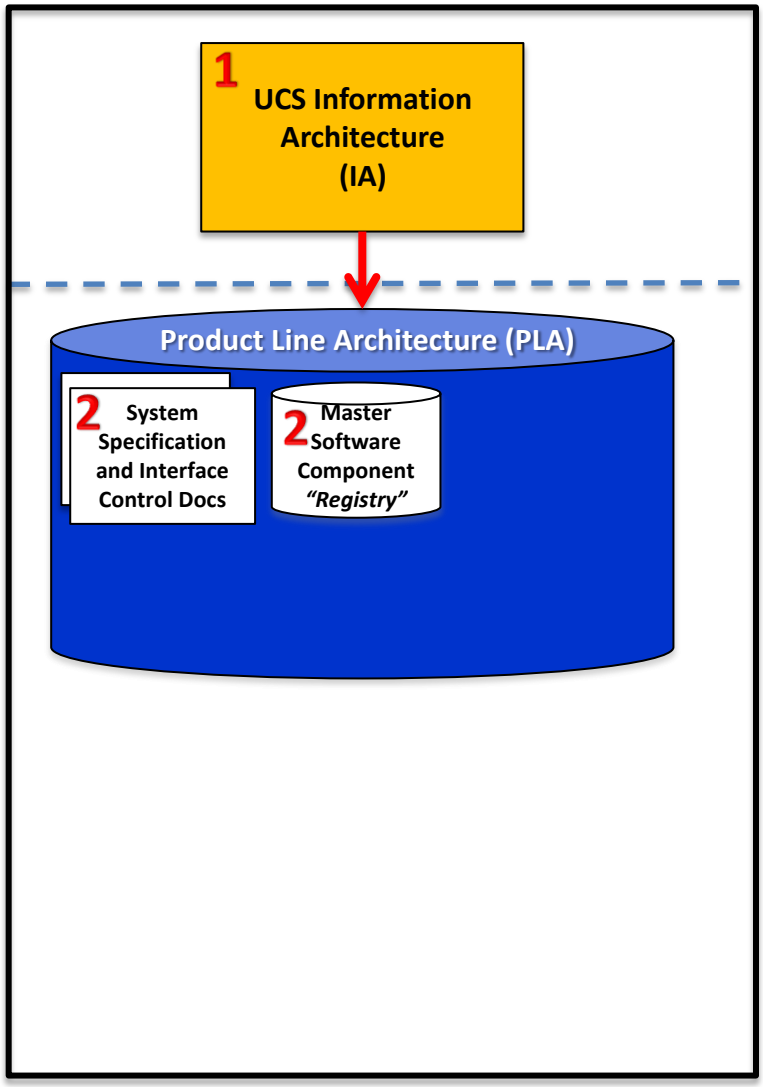
CRS(I) Common Controller
Notional Implementation using UCS



1. **SAE** (with Industry/Government input/guidance) develops & maintains the high-level, IA that defines all of the generic, abstract service descriptions and data and message interoperability specifications for controlling air, ground, and maritime RAS

CRS(I) Common Controller
Notional Implementation using UCS



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2. **Government & Industry SMEs** via the DME, using the UCS IA, define a PLA for the CRS(I) controller containing the particular attributes, characteristics, supported services, platforms and payloads to be controlled, cyber/information assurance requirements, and interface specifications. The PLA is made available to a (trusted) Community of Interest (COI) and a master software registry is established.

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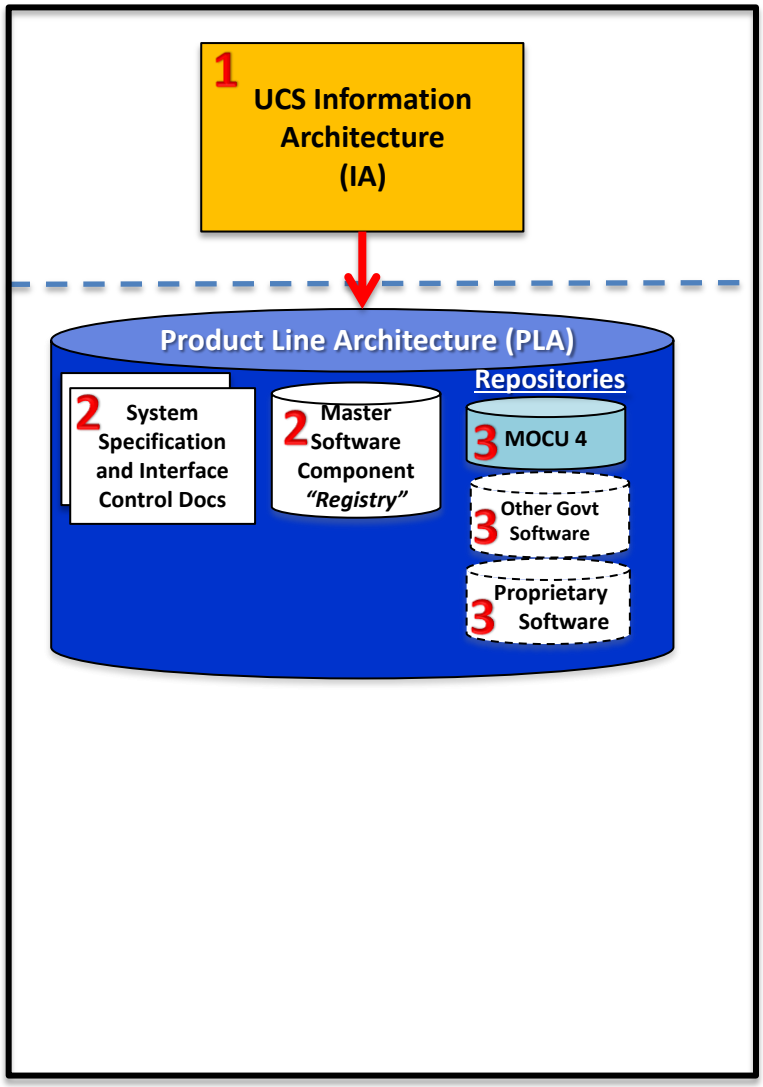

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3. **MOCU 4** software components are made available to the COI as an initial reference implementation of the PLA. The COI develops additional PLA compliant software components, makes them available in one or more repositories, and registers them in the master "registry".

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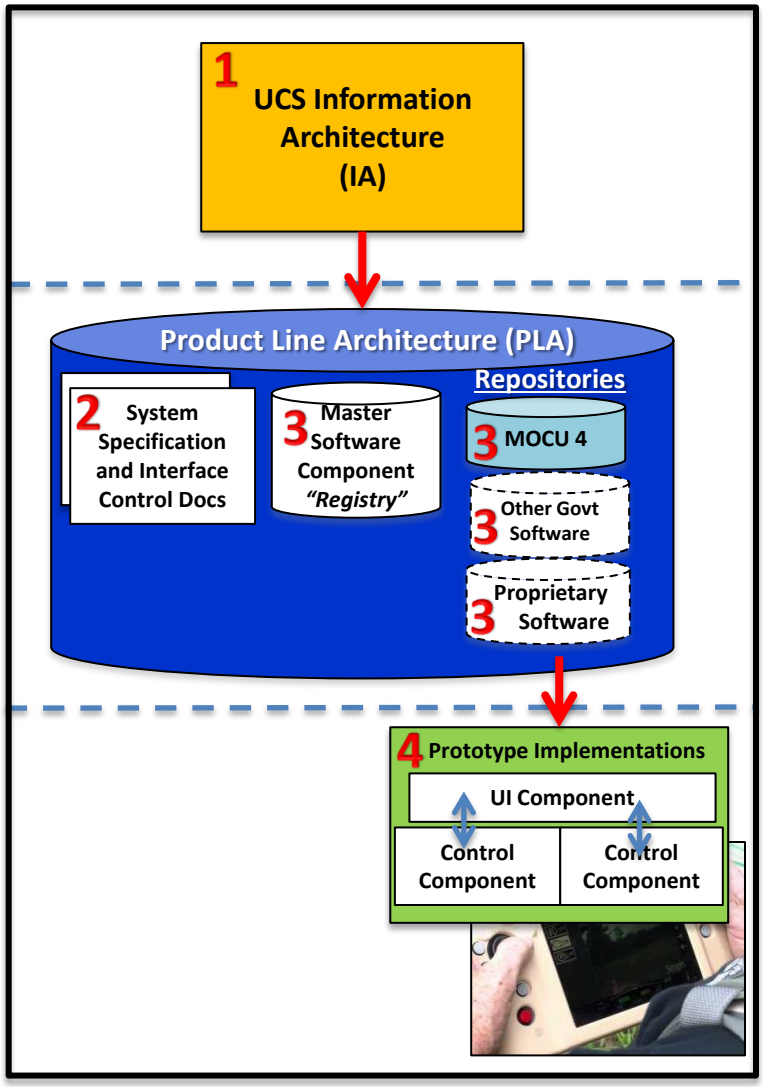

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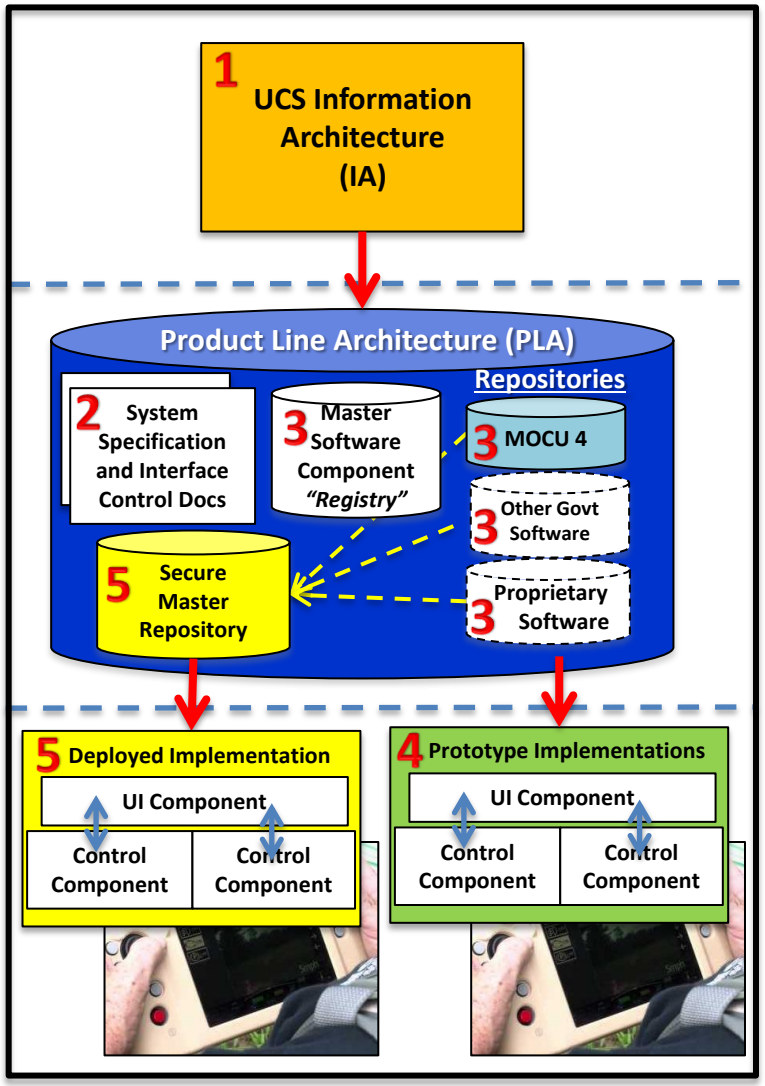

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5. **PdM UGV** selects the PoR systems integrator. Components to be used in the deployed controller are scrubbed, updated to add required cyber-security capabilities, and moved to a secure master repository. System integrator produces and tests the integrated control software using the components in the secure master repository.

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Where / When / How to Begin

CRS(I) Common Controller

Proposed Prototyping Effort

- **Proof-of-Concept (Q2 FY16)**
  - **Define a prototype UCS architecture for a common tactical controller**
    Initial RAS ground domain information architecture and common controller product line architecture
  - **Integrate and test an initial prototype common controller**
    MOCU 4 plus one or more proprietary software components running on one or more OCU(s)
  - **Conduct a demonstration of the initial prototype common controller operating multiple platforms and/or payloads**

CRS(I) Common Controller

Proposed Prototyping Effort

- **Proof-of-Concept (Q2 FY16)**
- **Propagate the Concept (Q3/Q4 FY16)**
  - **Provide the UCS prototype architecture, MOCU 4 software, software development tools, and training and support to an initial group of developers and integrators**
  - **Organize and conduct a Lean Prototyping Cycle**
    - ✓ Kick-Off Meeting & Presentations
    - ✓ Mid-Term "Plug-Fest"
    - ✓ Final Demonstration(s)

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RAS Interoperability Initiatives

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

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

The Problem

- Different, incompatible variations of the same defense robotics autonomy software
- No current means of addressing unique technical / programmatic / security-related needs of military robotics
- No current means of publicizing and sharing common software components unique to DoD needs that have distribution restrictions

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

Proposed Approach & Status

- Develop a military variant of the open-source Robotic Operating System (ROS)
- Approach modeled after one taken to produce a variant of ROS for industrial robotics (ROS-I)
- Phase I effort to develop a preliminary "Concept Definition" document

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

Proposed Phase II Effort

- **Review the Findings in the Concept Definition**
- **Synch Up with the Army RAS Concept & Strategy Document**
- **Technical Aspects**
  Overarching open architecture, security-enhanced, core software components, 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

Questions / Discussion

Back Ups

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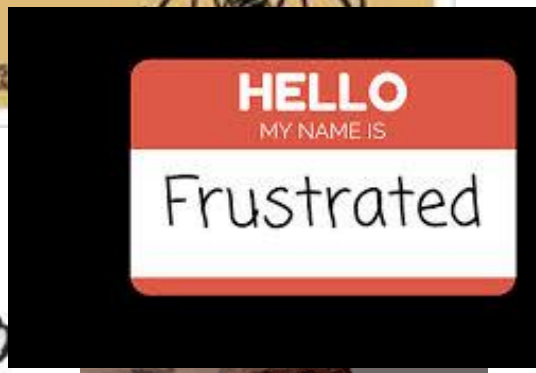
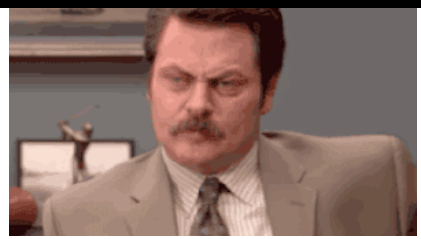
Frustration





Technology Interoperability

The capability of systems to communicate with one another and to exchange and use information including content, format, and semantics.
- NIST

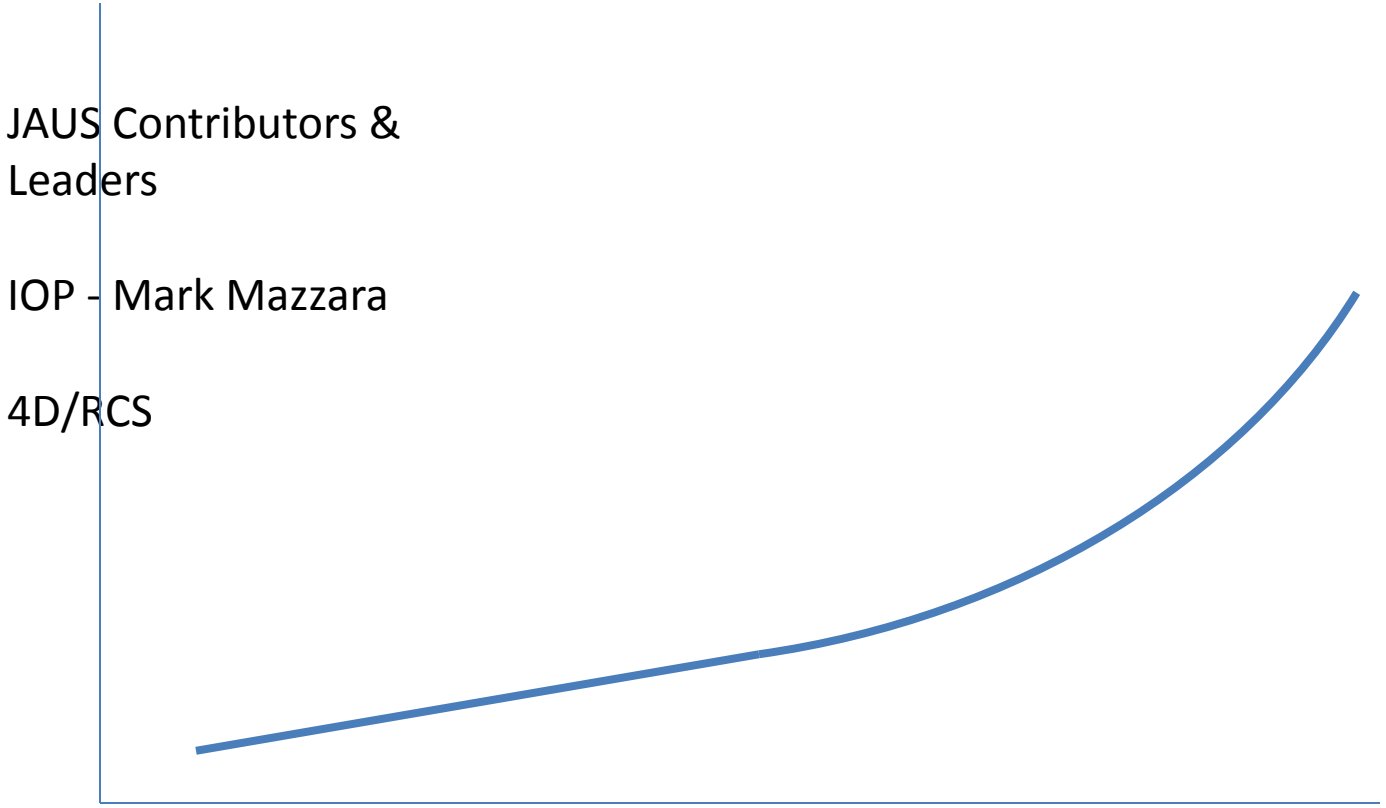
Why Interoperability

One of the eight principles that the Army of 2025 will be built around

The increasing complexity of international conflicts means the Army will be required to work with a host of agencies, branches, political entities and countries. ***To be successful in the future, Army personnel must learn how to be "plug and play,"****….*

- Army Vision V2

Interoperability Progress Timeline



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CRS(I) Common Controller
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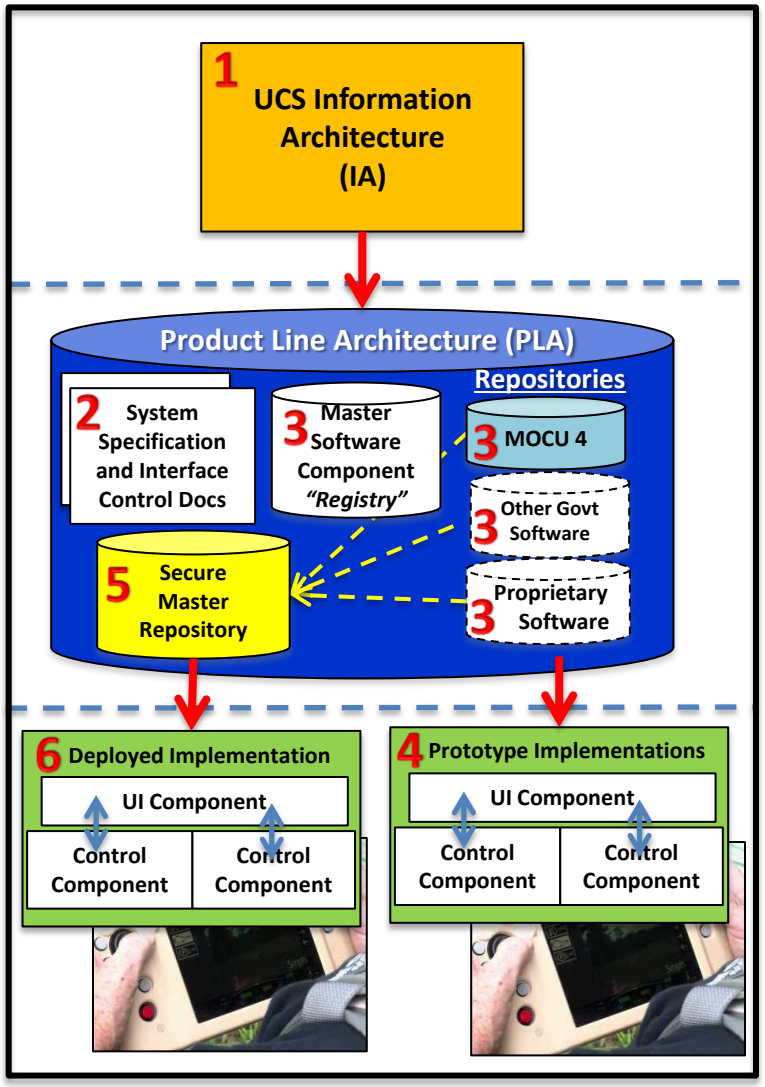

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5. **Selected components** are scrubbed, updated to add required cyber-security capabilities, and moved to a secure master repository.
6. **Awarded system integrator** produces and tests the integrated control software that runs on the controller hardware using the components in the secure master repository.