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Towards a Common Controller Software Architecture

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Why a common control software architecture

1. Unmanned systems mission space is becoming more advanced (air/ground/sea collaboration)

2. Unmanned systems vehicles are becoming more autonomous and have a decreasing need for unique and dedicated controllers to command them.

3. The opportunity for a reduction in cost, logistics, training, and greater situational awareness with a CCA implementation grows larger as 1 & 2 trend onward.

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Core Team

- Douglas Gregory: *Neya Systems*
- David Barnhard: *Kutta Technologies*
- Kurt Bruck: *QinetiQ North America*
- Bill Huff: *JHNA*

Team members representing the NAMC -
not their individual companies.

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Problems with existing common software

- **Common to a subset of departmental needs**
  - Each government organization has unique objectives for a CCA.
  - Strategy between departments vary: long-term versus short-term
  - Air domain focused departments generally leave out ground domain:
    - (E-Stop, multi-path radios, IOP/JAUS, teleop control).
  - Ground domain focused departments generally leave out the air domain
    - (Stanag 4586, complete mission planning features, general lightweight expectation).
- **Maintenance required**
  - Common control software requires a high level of maintenance in order to not become obsolete in one or more domains.
- **SDK maturity**
  - A solid SDK is critical to take advantage of innovation from industry

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Scope & Application

Hardware scope – hardware independence

- Objective – All hardware
  - 8 bit microcontrollers to up 32 core server systems
- Threshold – Tactical hardware
  - ~smartphone to ~x86 quad-core

Heterogeneous Robotics and Autonomous Systems (RAS)

- Tactical air platforms (Group 1 UAS)
- Ground vehicles/systems

Representative Operational Environments

- Tactical dismounted operations (e.g. CLARK)
- Support and logistics operations (e.g. runway clearing)

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The Approach

1. Top-Down
   - **Evaluate High level architectures provide a solid basis to inform enterprise level decision**
     - UAS Control Segment (UCS)
     - Future Airborne Capability Environment (FACE)
     - STANAG 4586 (Unmanned Aerial System messaging)
     - Joint Architecture for Unmanned Systems (JAUS – ground and maritime robotics)
   - **Determine ideal, concept architecture: "blue-sky"**
2. Bottom-up
   - **Investigate Specific programs and prototypes provides a rapid path to "real" development**
     - Navy: SPAWAR's Multi-robot Operator Control Unit (MOCU)
     - Army: Tactical Open Government Architecture (TOGA), WMI, Nett Warrior
     - Marines: Tactical Robot Controller
3. Develop solutions for how the two meet

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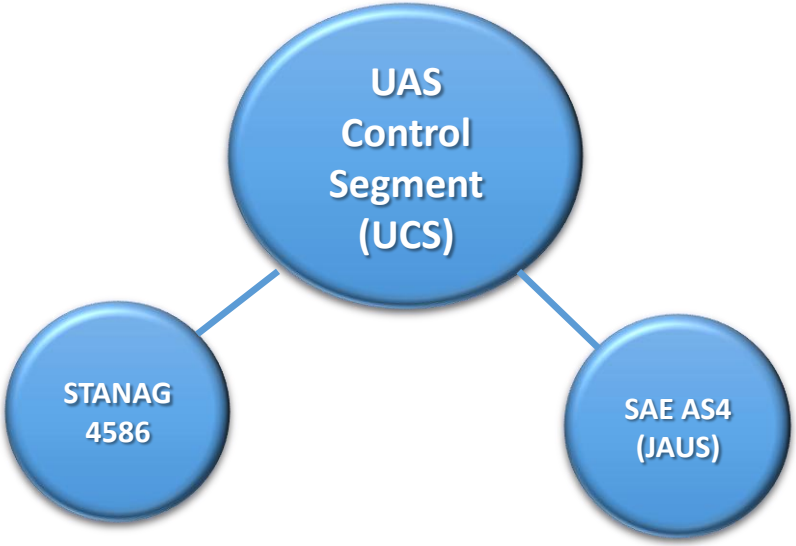
Top-down (ideal concept architecture)



- **AS4-JAUS is ubiquitous amongst UGV's**
  - Strengthened by IOP standards
  - Gradual adoption by UUV's
- **STANAG 4586 is ubiquitous amongst the UAV community**
  - Soon to be a required messaging standard
- **UCS is a well-established, Mature, well-funded**
  - UCS is migrating under the AS4 umbrella
  - UCS extensions can be created to allow for interoperability between STANAG 4586 and AS4-JAUS

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Bottom-Up Potential Candidate being explored: MOCU

Development of a Common Controller Architecture could be expedited using a product like MOCU

- **Strengths:** Mature, government owned product that has been used across many different robotic systems.
  - MOCU is being utilized in many different programs, including the Army's TOGA program.
- **Weakness:** The way MOCU is implemented works well for the Navy, but is not modular enough to suit the needs of industry and the larger robotics enterprise
- **Conclusion:** MOCU would require industry and government support to enhance its architecture to more directly align with the UCS architecture and business model
- **Impact:** MOCU, in its present form, is not a ready made solution for the CCA, but is very close
- **Risk Mitigation:** Revise MOCU architecture to fundamentally align with UCS architecture and create transition package including data use rights, etc. for industry.

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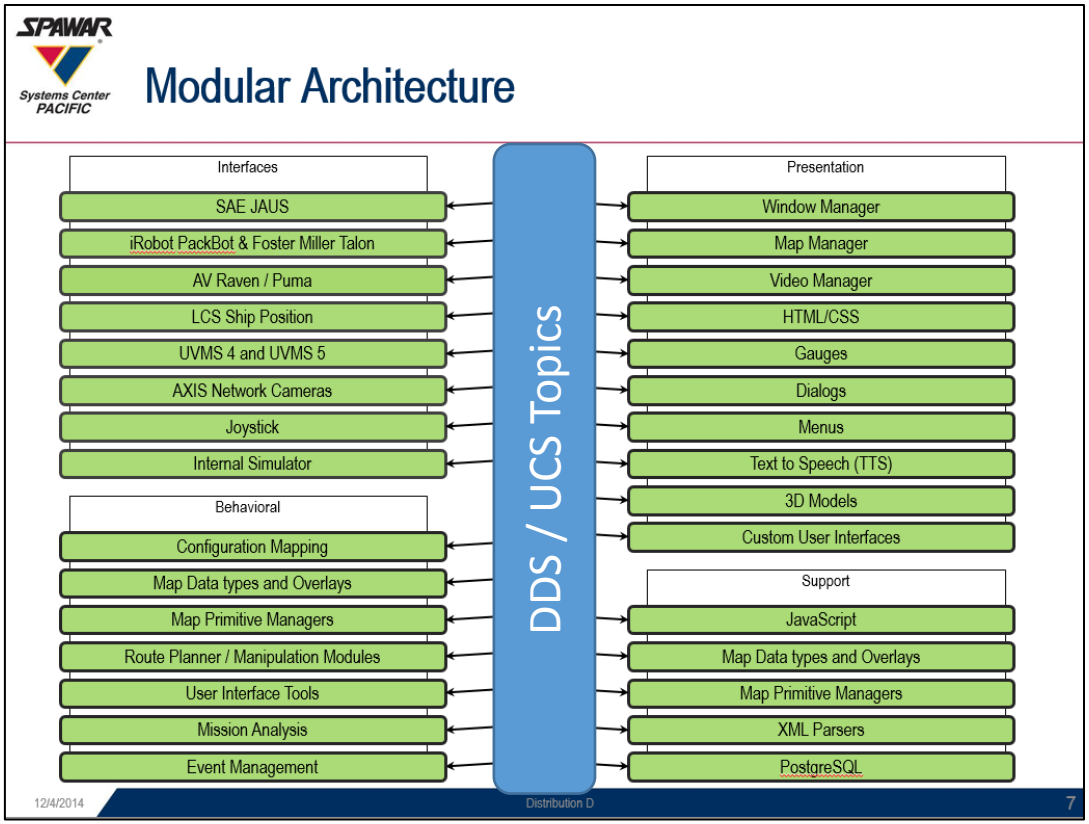
Bottom-Up Meets Top-Down Option 1



- Implement UCS service interfaces with MOCU component architecture

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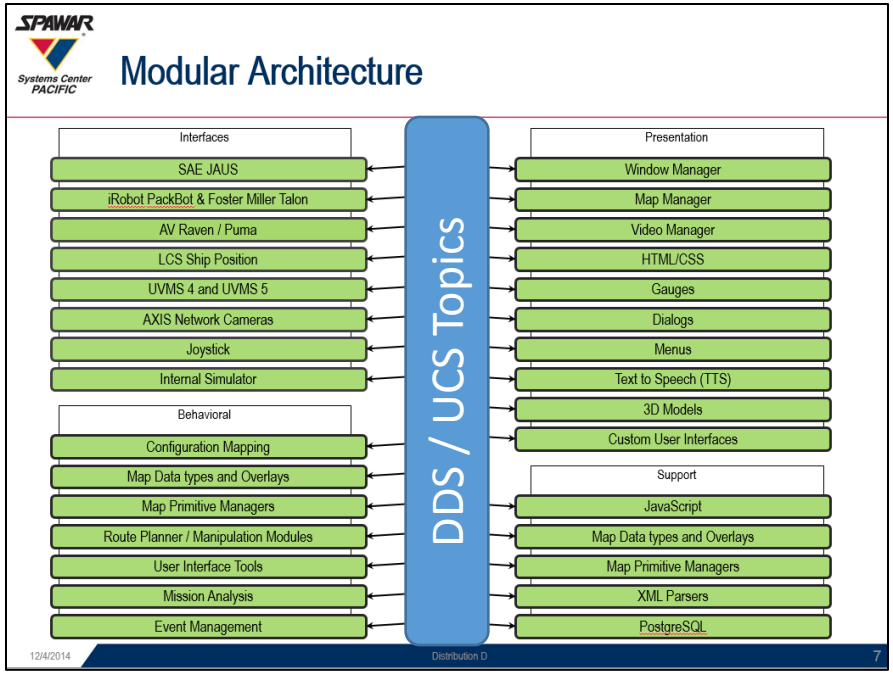
Option1 Advanced implementations



- MOCU/UCS “thin-client” resides as a component within Nettwarrior software framework
- Host MOCU/UCS on MCWL Tactical Robot Controller
- Host MOCU/UCS on TOGA controller
- Implement TARDEC’s WMI presentation layer as a UCS component within MOCU

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Next Steps

- Decide on 2-3 key architectural approaches
- Develop a prototype
- Test component elements on existing hardware