MSSE CAPSTONE REVIEW

Proposed Functional Architecture and Associated Benefits Analysis of a Common Ground Control Station for Unmanned Aircraft Systems

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Capstone Team

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Full report available at www.dtic.mil
Report # NPS-SE-10-002

Problem Definition

The rapid growth in UASs has resulted in a lack of commonality across the DoD which has contributed to:

- **Unique training for all systems**
- **Large manpower requirements for projected systems**
- **Unique hardware, software, and logistics support**

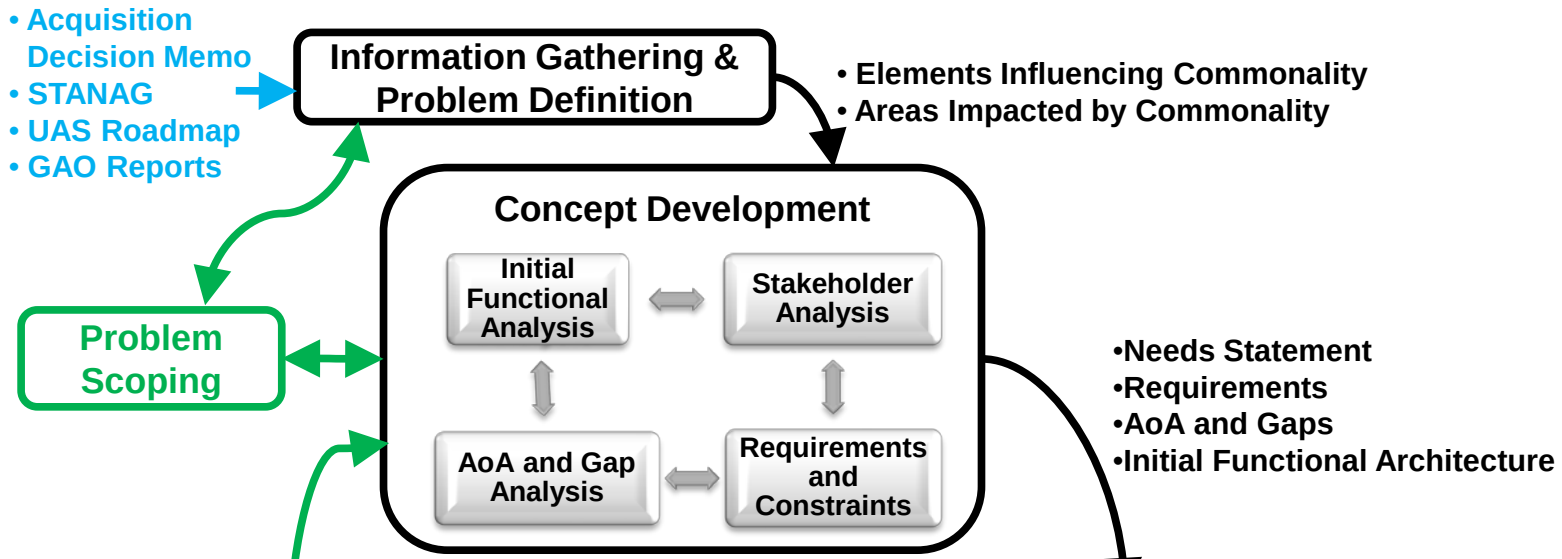
USD AT&L ADM 2009

- **ADM dated 11 February 2009**
- **Result of GCS Review of Predator, Reaper and Sky Warrior UAS**
- **Addressed to Secretary of the Army, Navy, & Air Force**
- **Goal: Reduce life cycle cost in the development, operation, and sustainment of UASs**

Hon John Young
Former USD (AT&L)

"The acquisition team has the opportunity to do something truly joint and powerful by adopting a common GCS architecture that is open and thus will allow for rapid addition of modular functionality" ***Hon John Young***

Tailored Systems Engineering Process



Black = SE Process
Green = Feedback Loops
Blue = Inputs and Outputs

Elements *Influencing* Commonality and Project Scope

- **Commonality vs. Interoperability**
- **Airframe Size and Groupings**
  - Limit scope to Groups 3 and above.
- **Air Vehicle Control versus Mission Specific Payload**
  - Explore commonality and interoperability for air vehicle control functions only.
- **Human-Machine Interface**
  - Examine common HMI for air vehicle control functions only.
- **Hardware and Software**
  - Limit to a functional level, therefore hardware and software allocation is not required.
- **Implementation through Retrofit or New Production**
  - Consider implementing the proposed functional architecture on new production assets only, retrofit will not be explored.
- **Department of Defense Multiservice Cooperation**
  - Concentrate on Department of Navy systems and requirements.
- **United States and Allied Cooperation**
  - Limit scope to U.S. only.

Architecture Focus Areas

Areas *Impacted* by Commonality and Project Scope

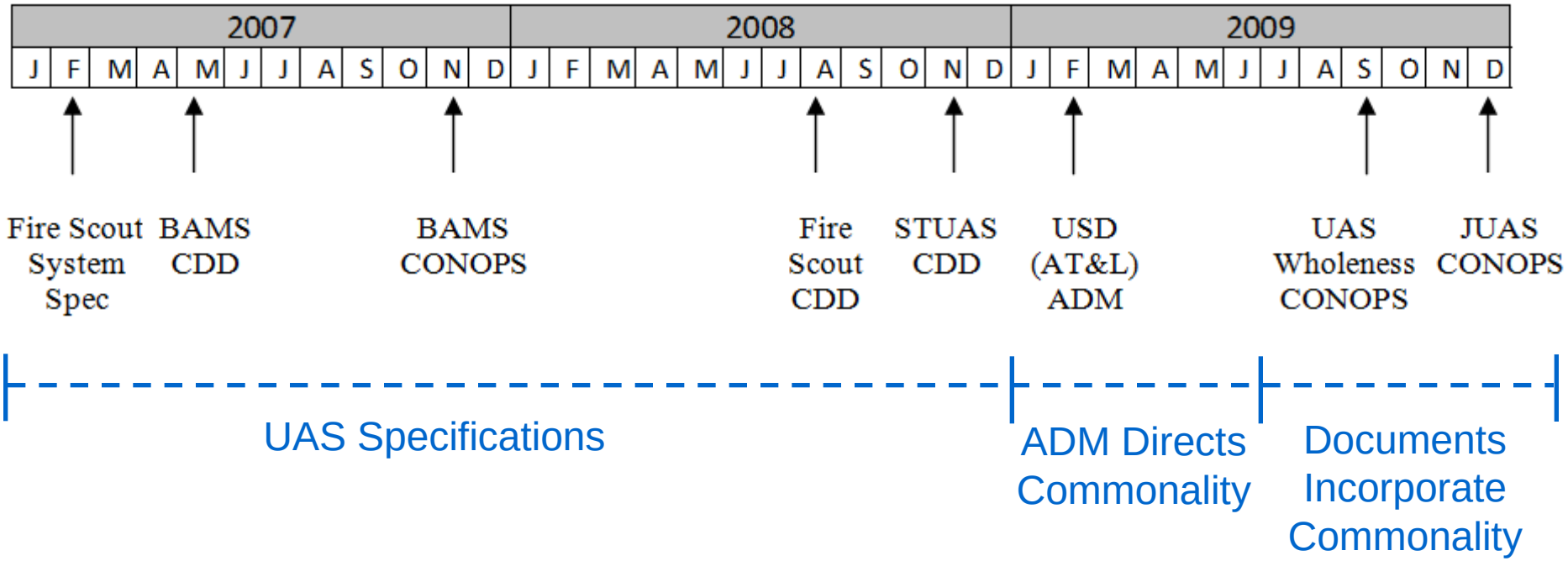
- **Training**
  - Training is the primary focus for the benefits of the proposed common architecture.
- **Basing**
  - Potential benefits examined only when related to training as described in above section.
- **Manpower Requirements**
  - Potential benefits examined only when related to training as described in above section.
- **Personnel Assignments**
  - Potential benefits examined only when related to training as described in above section.
- **Reliability and Maintainability (R&M)**
  - Not examined further as part of this effort.
- **Other Logistical Areas**
  - Not examined further as part of this effort.
- **O&S and Development Cost**
  - Potential benefits examined only when related to training as described in above section.
- **Mission Capability**
  - Not examined further as part of this effort.

Benefits Analysis Focus Areas

Navy Program of Record Comparisons

- **Researched requirements documents for the following programs of record in DON:**
  - **BAMS, Fire Scout, STUAS**
- **Review of KPPs & lower-level req’ts:**
  - **Net Ready is only common KPP between these programs**
  - **Few KPPs related to GCS, majority are for air vehicle**
  - **No requirements for:**
    - » **Interoperability with heterogeneous UASs**
    - » **GCS commonality with heterogeneous UASs**
    - » **Training commonality with other UASs**

Timeline of Requirements Development for DoN UASs



Any commonality being sought is between manned and unmanned system counterparts:

- ***BAMS & P-8A***
- ***Fire Scout & MH-60R/S***

Chairman JCS UAS Training Standards

CJCSI 3255.01 Joint Unmanned Aircraft Systems Training Standards				
UAS Group	BUQ I	BUQ II	BUQ III	BUQ IV
1	x			
2	x	x		
3	x	x		
4	x	x	x	
5	x	x	x	x

Focus Area: Group 3 and above (BAMS, Fire Scout, STUAS)

- Mandated Minimum BUQ levels and JMQs required for each UAS Group
- Dated September 2009

BUQ = Basic UAS Qualification
KSA = Knowledge, Skills and Abilities

Proposed Requirements for a Common GCS

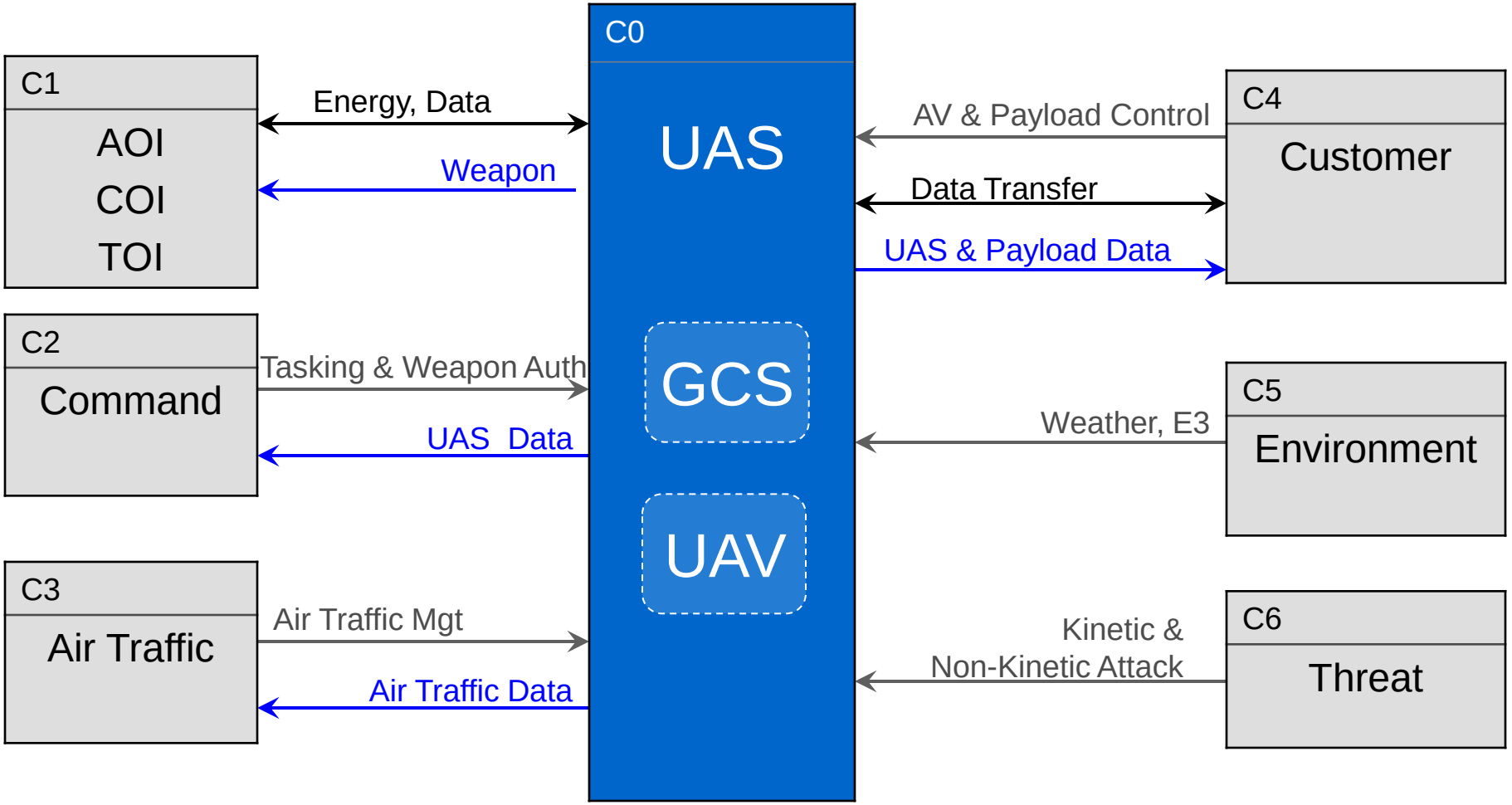
The Ground Control Station shall:

1. **Enable Air Vehicle Operator (AVO) training commonality across multiple UAS platforms.**
2. **Utilize a common HMI for AVO functions.**
3. **Utilize directed vice controlled air vehicle operation.**
4. **Utilize separate HMI for payload and air vehicle control.**
5. **Utilize a common mission planning system.**
6. **Enable interoperability between multiple UASs.**
7. **Enable common communications and data link management between multiple UASs.**
8. **Utilize a common data format to enable communication between multiple manned and unmanned systems.**
9. **Utilize modular and scalable systems software and architecture.**
10. **Enable a common approach to simplify support and maintenance across multiple UAS platforms.**
11. **Enable a common approach to reduce the manpower requirements across multiple UAS platforms.**
12. **Enable a common approach to minimize UAS basing.**

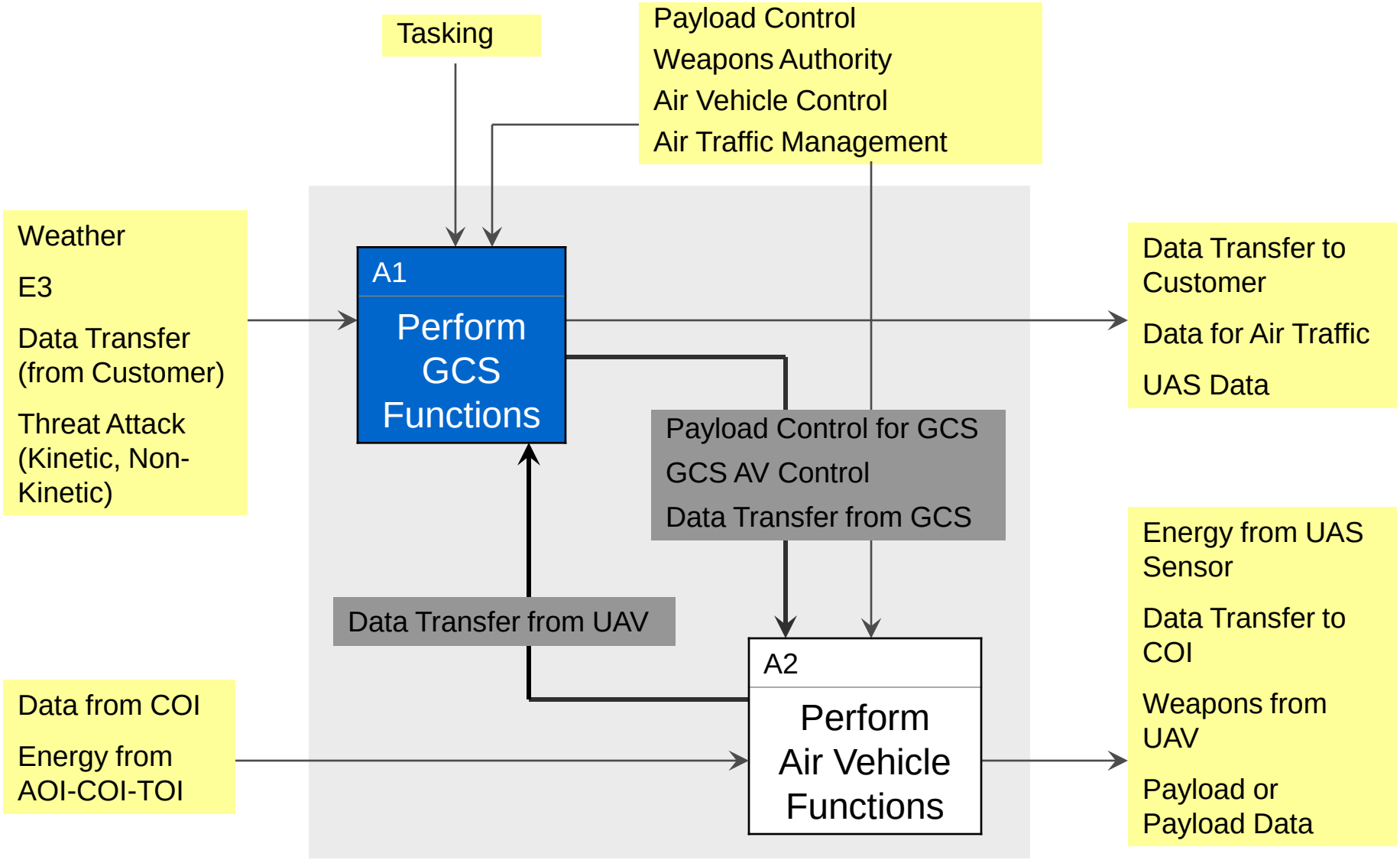
Design of the Proposed Common GCS Architecture

- **Focused on a common HMI for the air vehicle control functions of Groups 3-5 UASs**
- **Based on:**
  - **The preceding 12 requirements**
  - **Documents from BAMS, Fire Scout and STUAS**
  - **NATO and US standards**
  - **Unmanned Systems Integrated Roadmap**
- **Functional architecture created with CORE (commercial model-based systems engineering tool) and communicated via hierarchical charts, flow diagrams and IDEF0 language**

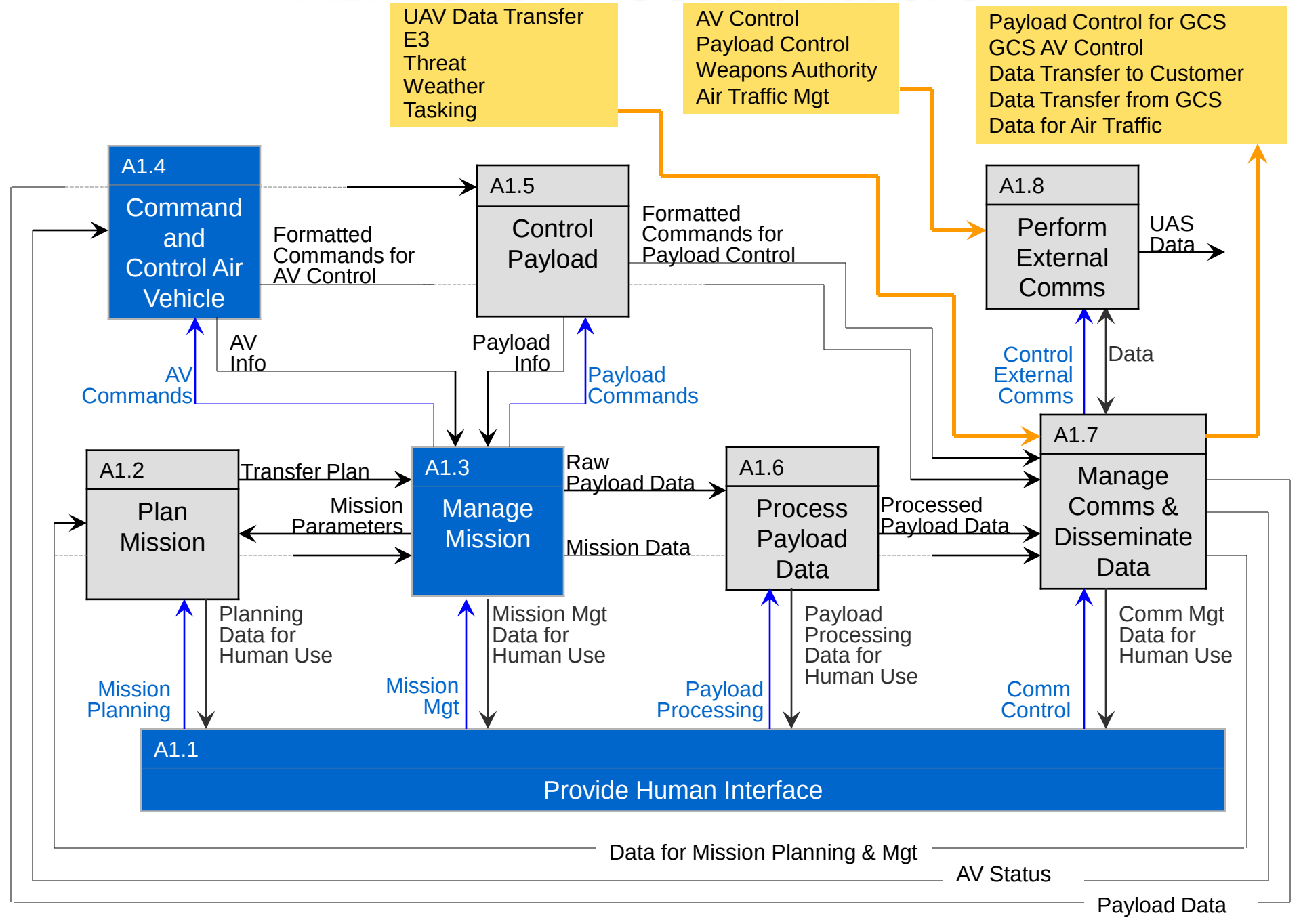
A-1: External Systems Diagram



A0: UAS Functions Diagram

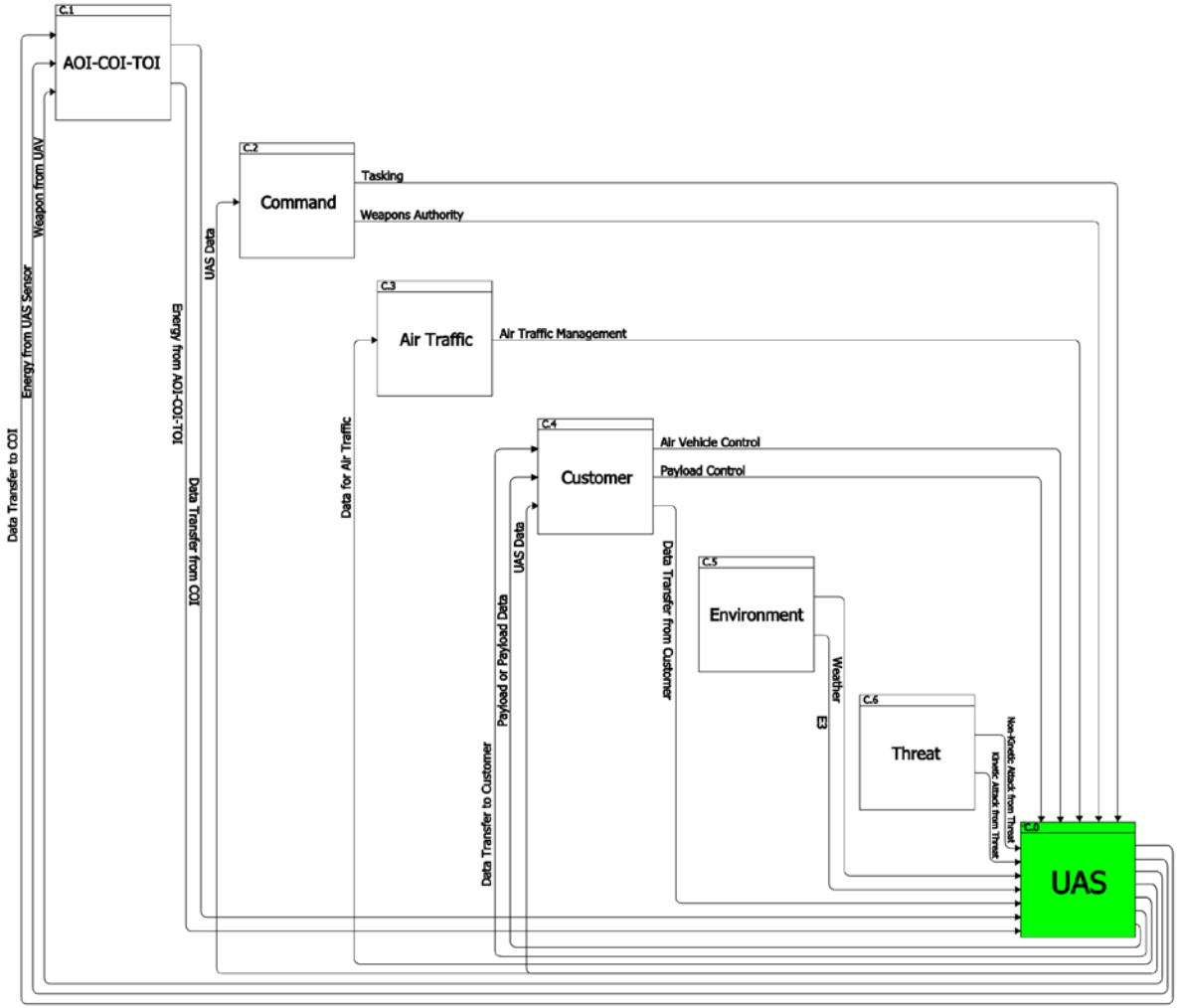


A1: Perform GCS Functions



Complete IDEF0 Diagrams

A-1: JUCCS External Node Context Diagram



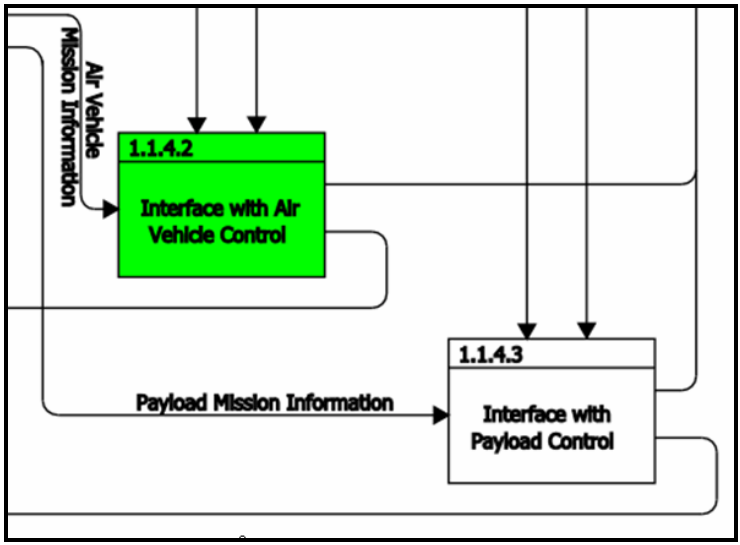
Architecture Traceability back to the Requirements

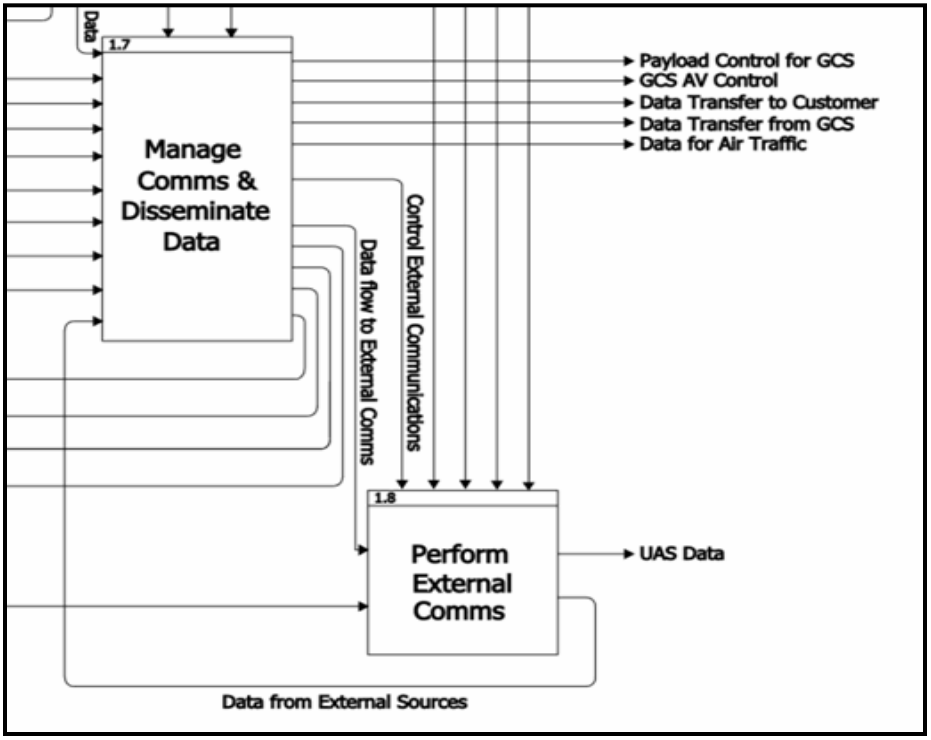
Requirement 2: Common GCS HMI for AVO Functions

Requirement 3: Directed vice controlled air vehicle operations

Requirement 4: The AVO and payload operators shall have separate controls

(The common HMI and directed vice controlled operations are enabled by breaking out the interface function separately)





Requirement 7: Common communications and data links

Requirement 8: Common data format

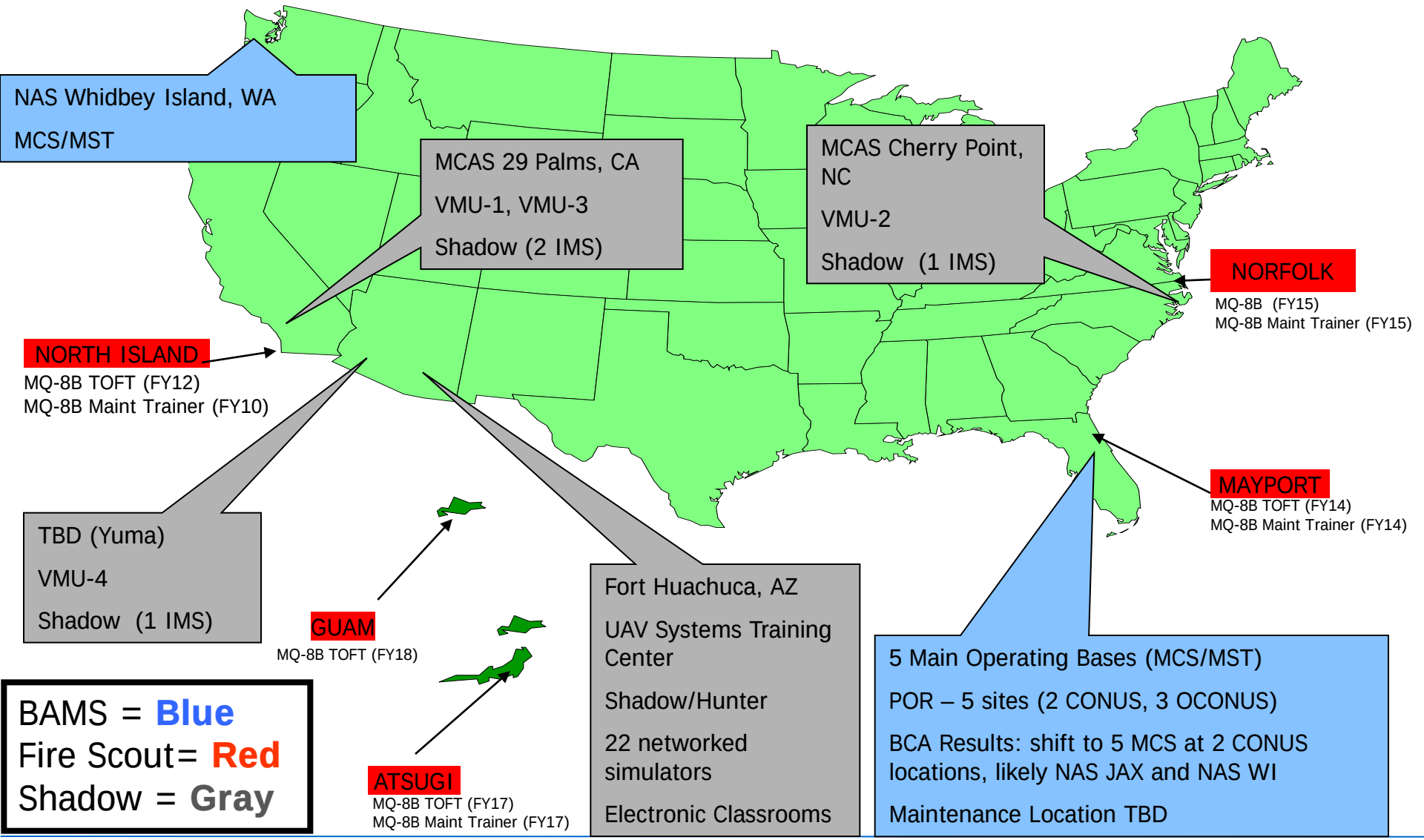
Basic UAS Qualification (BUQ) Analysis Results

	As-Is GCS Architecture		*JUCCS Proposed Common GCS Architecture*		Total KSAs per Architecture
	Common KSAs	Unique KSAs	Common KSAs	Unique KSAs	
BUQ I	36	68	97	7	104
BUQ II	13	18	31	0	31
BUQ III	5	14	19	0	19
BUQ IV	5	54	59	0	59
TOTAL	59	154	206	7	213

A Common GCS Architecture reduces the number of platform-unique KSAs to only seven. These seven KSAs all deal with functions that are unique to the specific UAS (pre-flight, post-flight, emergencies).

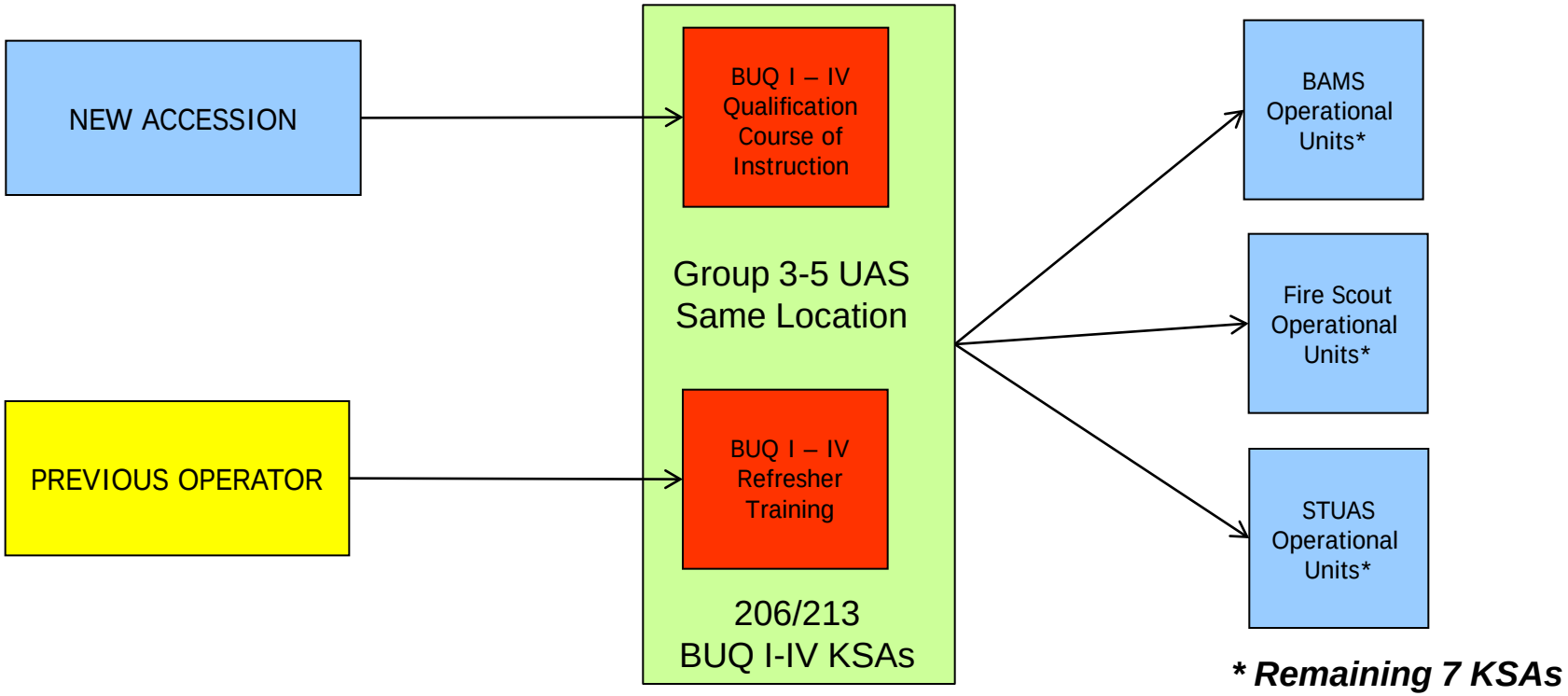
KSA = Knowledge, Skills and Abilities

Current Training Concepts Utilize Multiple Locations



BAMS = **Blue**
Fire Scout= **Red**
Shadow = **Gray**

Possible AVO Training Flow for the Proposed Common Architecture with a Common Schoolhouse



**** Remaining 7 KSAs taught at Squadron***

Highlights

- 206/213 KSAs taught across all Group 3-5 UASs
- 7 KSAs pushed to operational units for instruction
- Two Courses of Instruction
  - New Accessions
  - Previous Operators (Refresher Training)
- Common location proposed for Core Training

Recommendations

- **Modify NAVAIR acquisition process for UAS programs**
  - **Create common GCS program office that is separate from UAV program offices**
  - **Common GCS program office would:**
    - » **Coordinate with all UAS program offices**
    - » **Maintain and update the architecture and software**
    - » **Utilize a common HMI module**
    - » **Hardware agnostic (minimum req’ts and ICDs)**
    - » **Maintain single command set for interoperability between heterogeneous UAVs**
- **Mandate the requirement for a common GCS**

Questions?

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