Control Station Human Machine Interface (CaSHMI)

An Implemented Use Case of Unmanned Systems (UxV) Command and Control (C2) via a Standards-based Enterprise Architecture

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Outline

- "Quick" History of UxV C2 Applications
- MOCU and the UCS-MDE Standard
- CaSHMI: An Use Case for the Enterprise
- Field Experimentation
- Future Work

In the not too distant past…

- Several competing industry/government approaches to Unmanned Vehicle (UxV) Command & Control (C2) UIs
  - Tight coupling between Vehicle Control and UIs
    - Monolithic software
      - Expensive to maintain
      - Difficult to extend
      - Lack of modularity or insufficient scope of modularity
  - Loose coupling to open standards
    - UI design
      - Lack of Human Factors Engineering (HFE) influence
      - Inconsistent or nonexistent use of Common Symbology
    - Data models
      - Mixed use between vendors
      - Mixed use between robot operating domains (e.g. air, surface, subsurface, ground, etc)
    - Communications
      - C2 of platforms using open standards often an afterthought
      - Industry often has purview over proprietary "on the wire" C2 protocols

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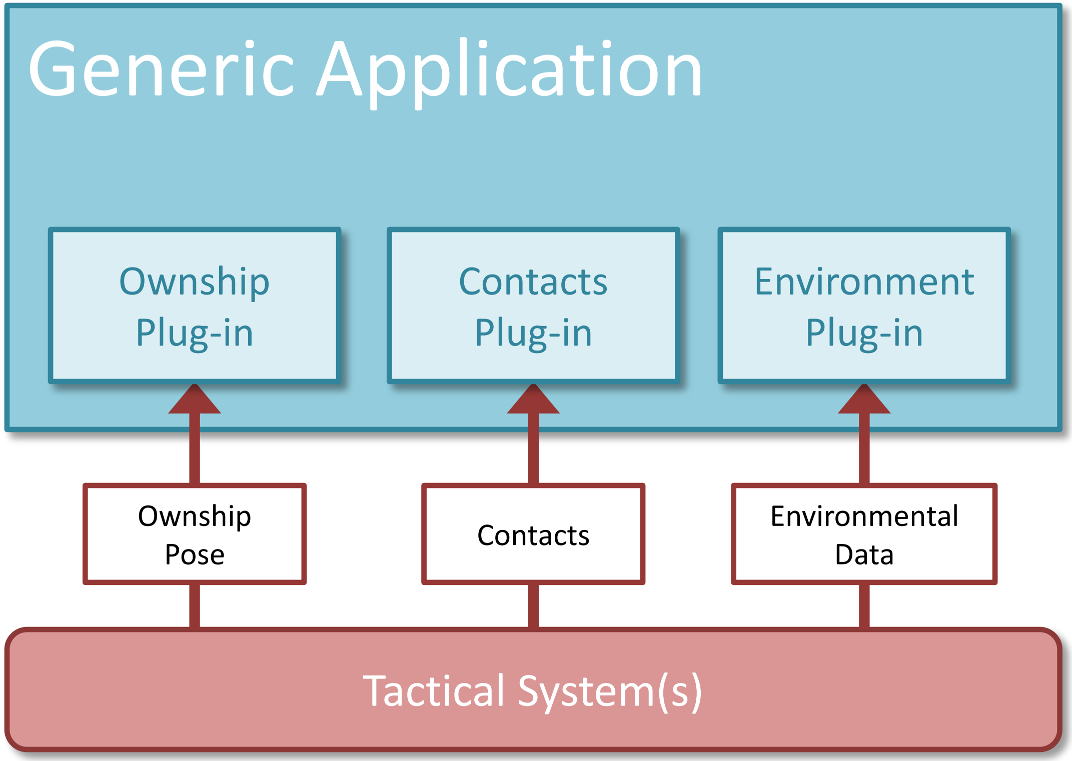
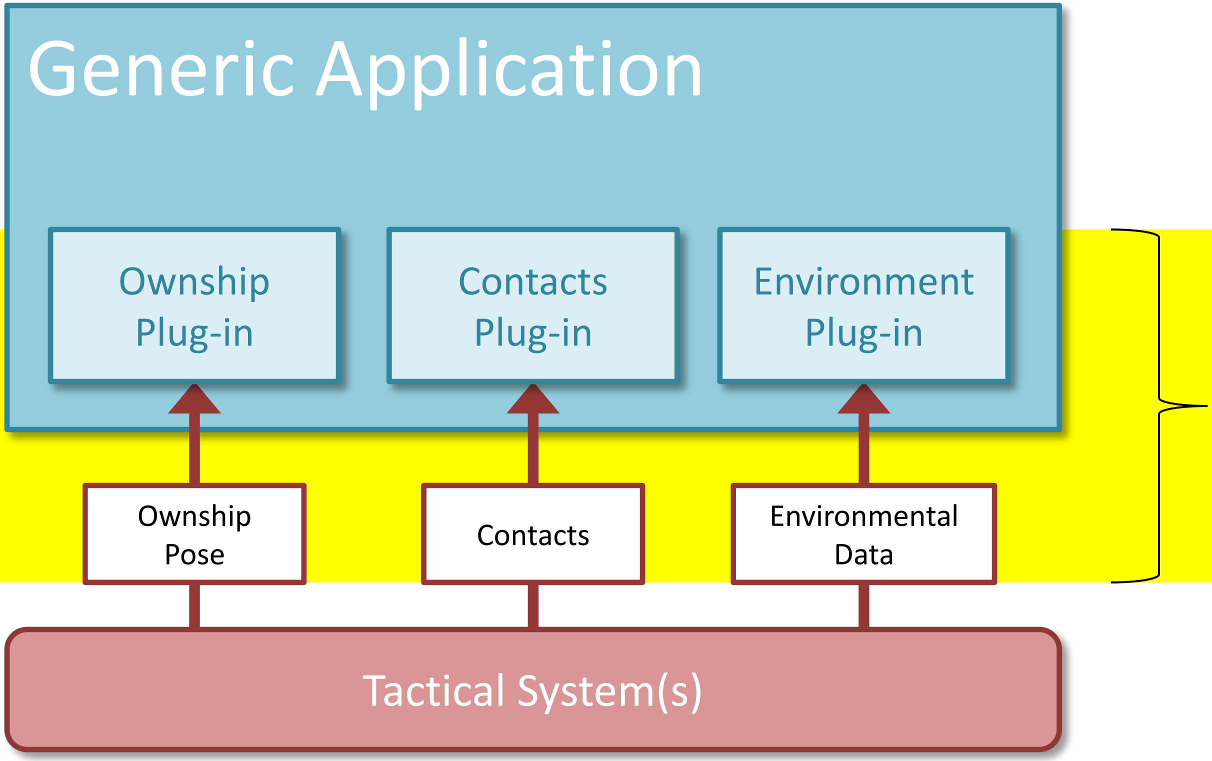
How do you extend today’s C2 applications?

Traditional Example

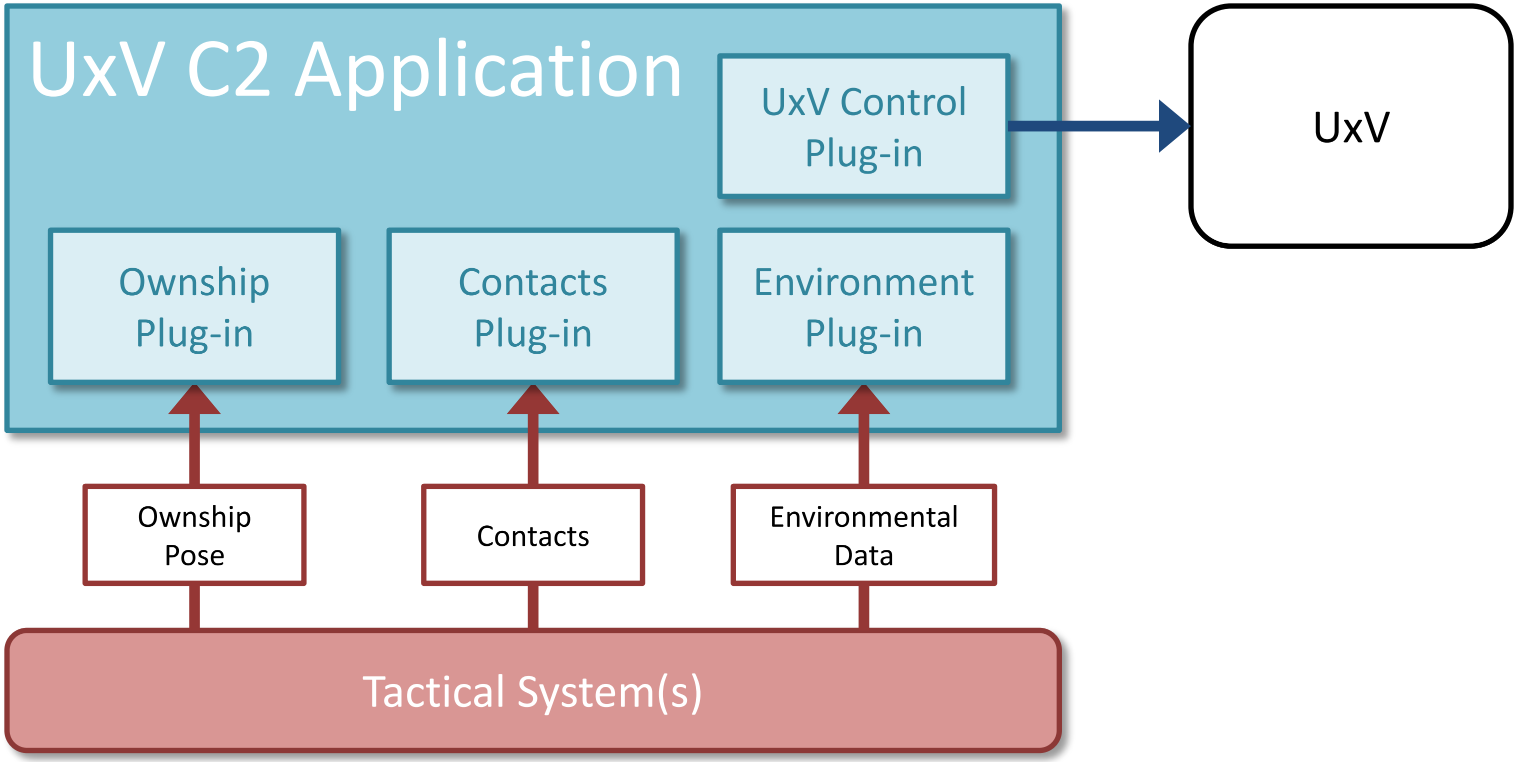


Poorly Defined Layers

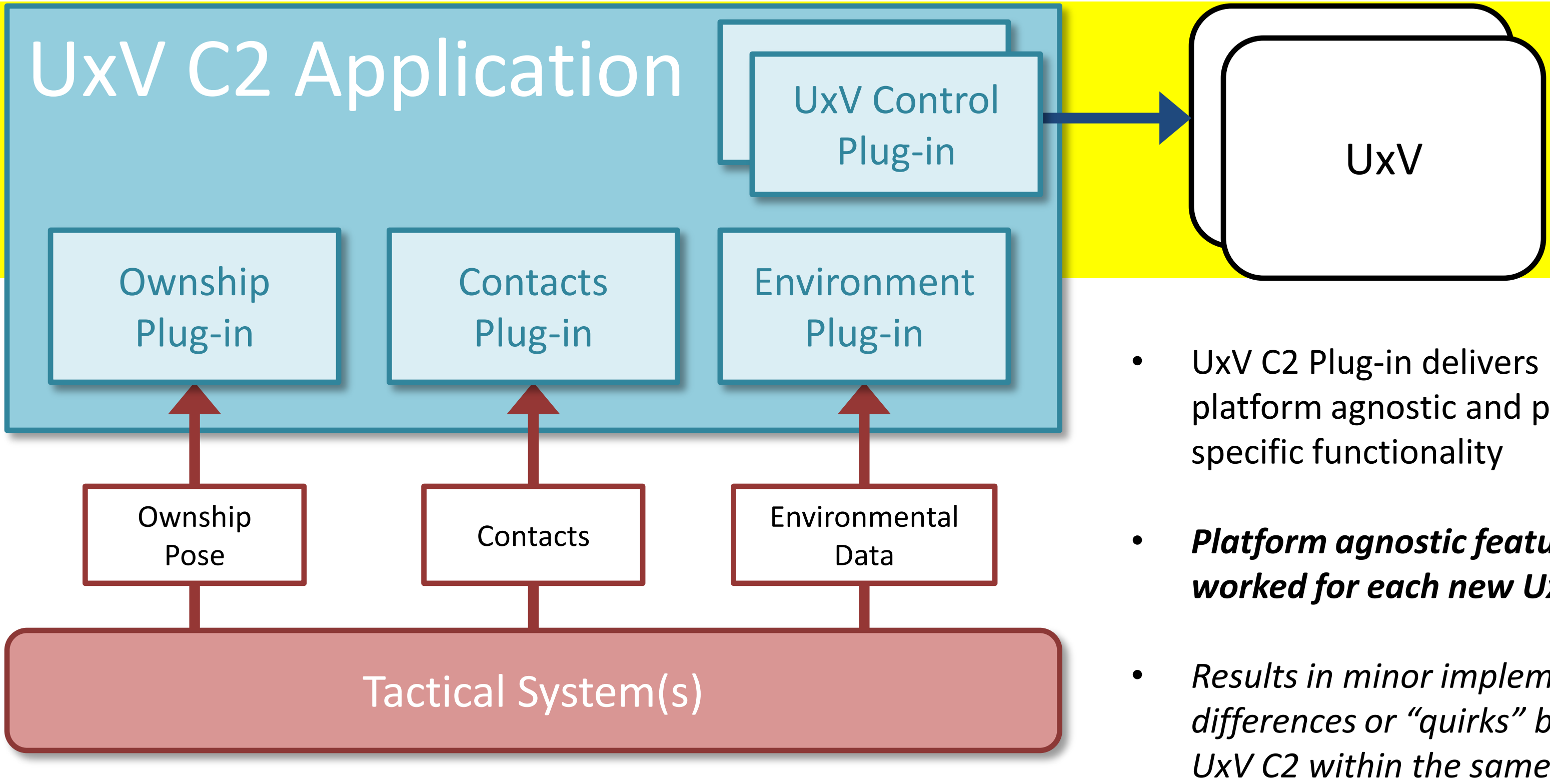


No common data abstraction leads to re-work at all levels as any piece changes.

Traditional UxV C2 Example



Prone to Re-work when Scaled



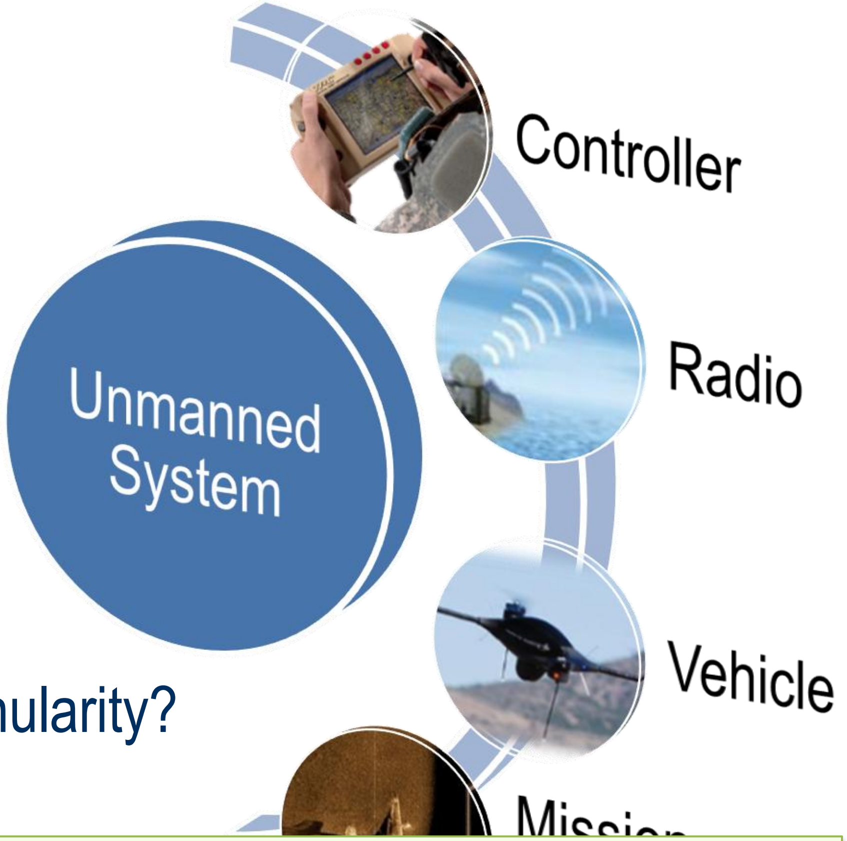
- UxV C2 Plug-in delivers both platform agnostic and platform specific functionality
- ***Platform agnostic features re-worked for each new UxV***
- *Results in minor implementation differences or "quirks" between UxV C2 within the same application*
- ***Increased complexity and cost to maintain***

Example Summary

- Existing UxV C2 approaches are problematic:
  - Lack sufficient data abstraction to promote maintainability and usability
    - Often fail to apply a cohesive open standards approach
  - Are prone to systemic re-work when scaled
    - Often leading to disparity between seemingly “common” C2 tasks

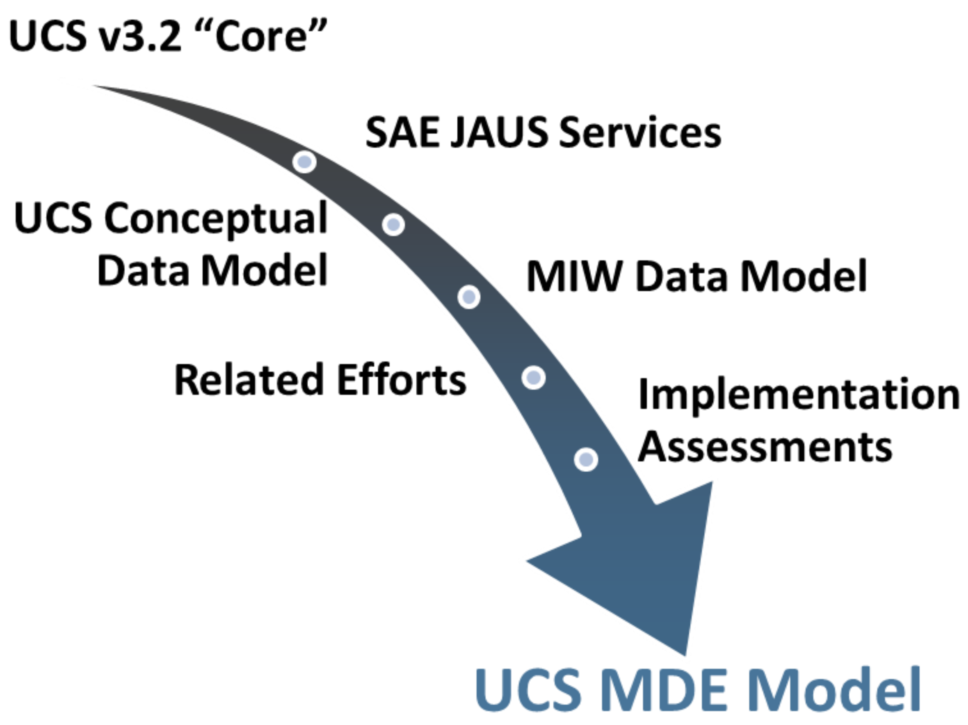
Unmanned Systems & Open Architecture

- Open Architecture Benefits
  - Reduce life-cycle costs
    - Training
    - Logistics
  - Adapt to evolving future requirements
  - Mitigate vendor lock
  - Create competition
    - Lower cost
    - Improved technology
  - Component reuse between programs
- How to define configuration item granularity?
  - Review the benefits above!



CaSHMI becomes an use case of MOSA for UxVs

UCS Multi-Domain Extension (MDE)

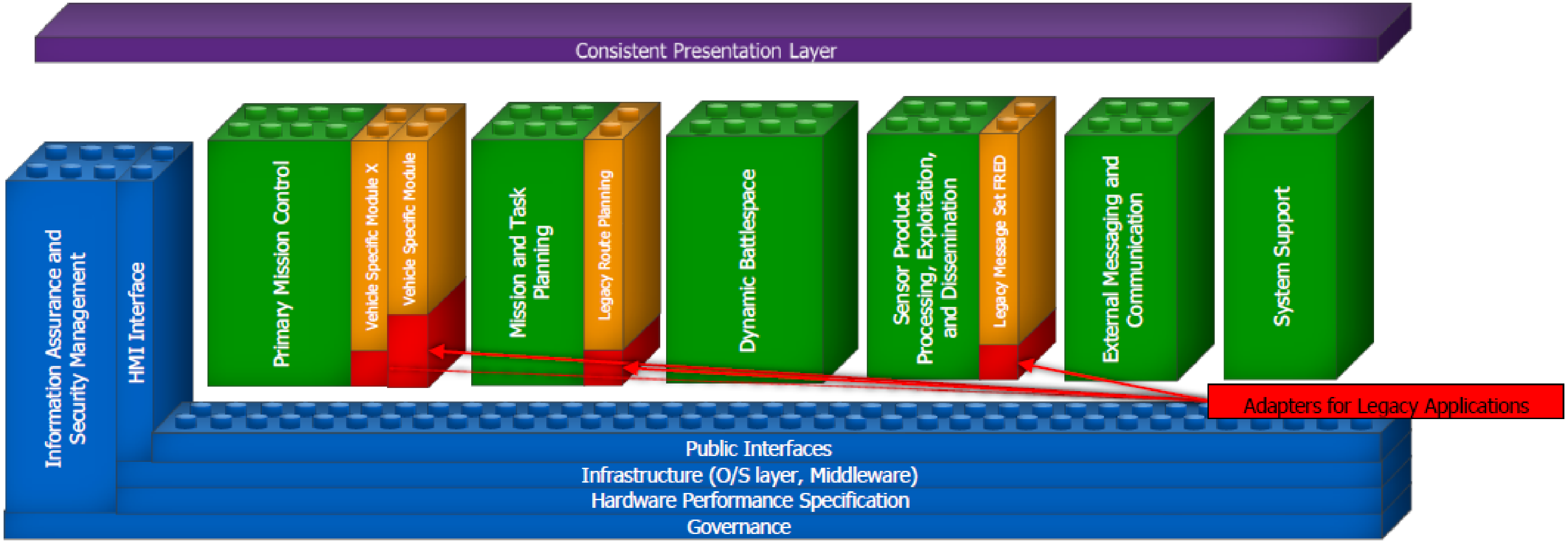


- Leveraged "core" parts of UCS Architecture Version 3.2
  - Structure, process, etc. (Tech Governance)
  - Conceptual Data Model foundational data types
  - Logical Data Model Refinements and Basis Elements
- Imported relevant SAE JAUS Services
- Included modified parts of UCS CDM through UMS RA WG effort
- Leveraged existing data models
- Included input from related efforts
- Incorporated feedback from various implementation assessments

Collaborative Effort to define UCS Multi-Domain Extension

NAVAIR's CCS gets it right...

The CONSISTENT UI (PRESENTATION LAYER) –
Built through Human Computer Interface (HCI) Style Guide and common task execution, maximizes benefits in training, allows for synergy in usability initiatives, reduces development costs


Consistent Presentation Layer
Information Assurance and Security Management
HMI Interface
Primary Mission Control
Vehicle Specific Module X
Vehicle Specific Module
Mission and Task Planning
Legacy Route Planning
Dynamic Battlespace
Sensor Product Processing, Exploitation, and Dissemination
Legacy Message Set FRED
External Messaging and Communication
System Support
Adapters for Legacy Applications
Public Interfaces
Infrastructure (O/S layer, Middleware)
Hardware Performance Specification
Governance

The FRAMEWORK –
Maximize Commercial Off The Shelf (COTS) and H/W independence, minimize size, leverage JMPS model for Bus./Tech. Rules. Must include Information Assurance Boundary

The UNIQUE Applications/Services –
Program of Record (POR) requirements not currently common, POR responsible for development, CCS responsible for specifications to work in FRAMEWORK and support consistent presentation layer

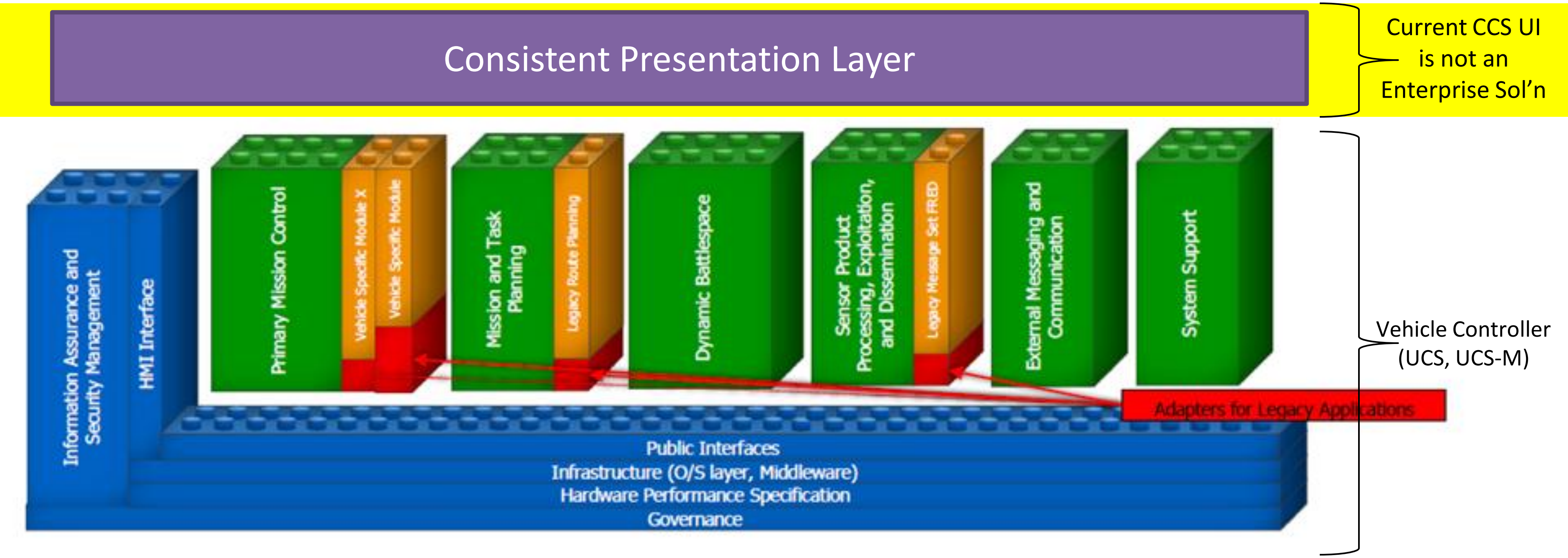
The COMMON Applications/Services –
Services or Applications that are shared/reused by Unmanned vehicles (UxV's), CCS responsible for specifications to work in FRAMEWORK and support consistent presentation layer

NAVAIR’s CCS gets it right…

…and we think CaSHMI does too.

(Human-Machine Interface focused)

CCS needs an Enterprise UI



Consistent Presentation Layer

Current CCS UI is not an Enterprise Sol'n

Information Assurance and Security Management

HMI Interface

Primary Mission Control

Vehicle Specific Module X

Vehicle Specific Module

Mission and Task Planning

Legacy Route Planning

Dynamic Battlespace

Sensor Product Processing, Exploitation, and Dissemination

Legacy Message Set FRED

External Messaging and Communication

System Support

Adapters for Legacy Applications

Public Interfaces

Infrastructure (O/S layer, Middleware)

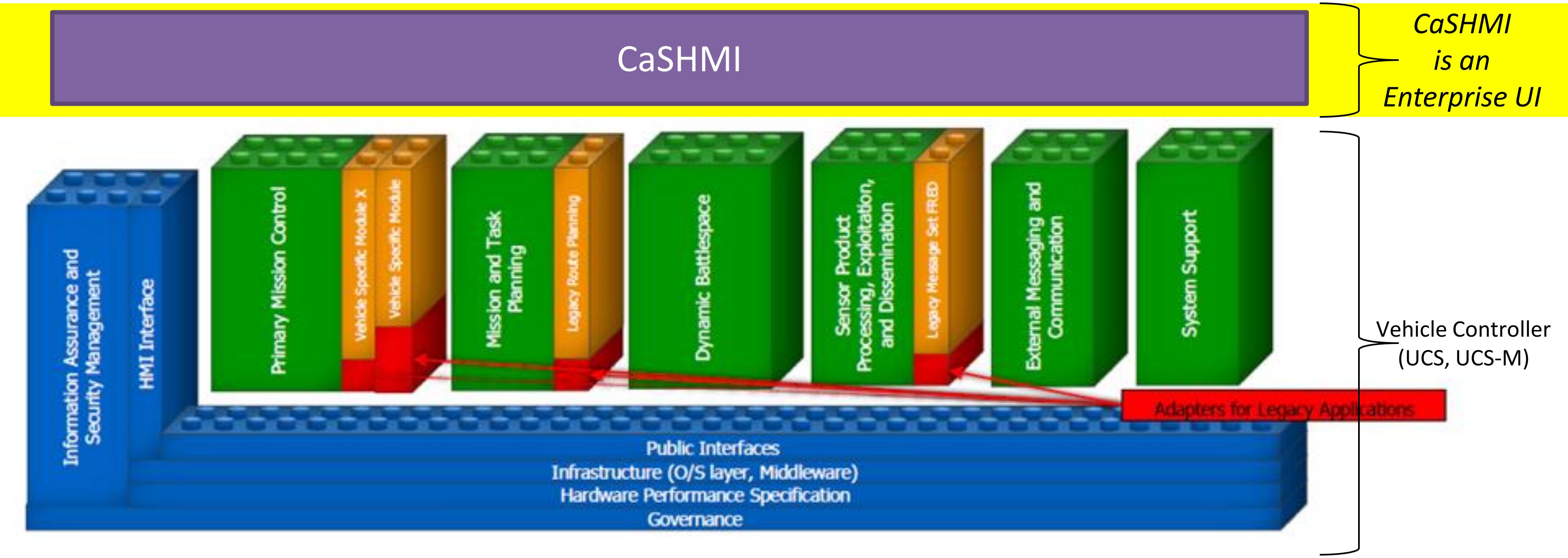
Hardware Performance Specification

Governance

Vehicle Controller (UCS, UCS-M)

CaSHMI is an HFE design – an Enterprise UI – for UxV Supervisory Control.

CCS needs an Enterprise UI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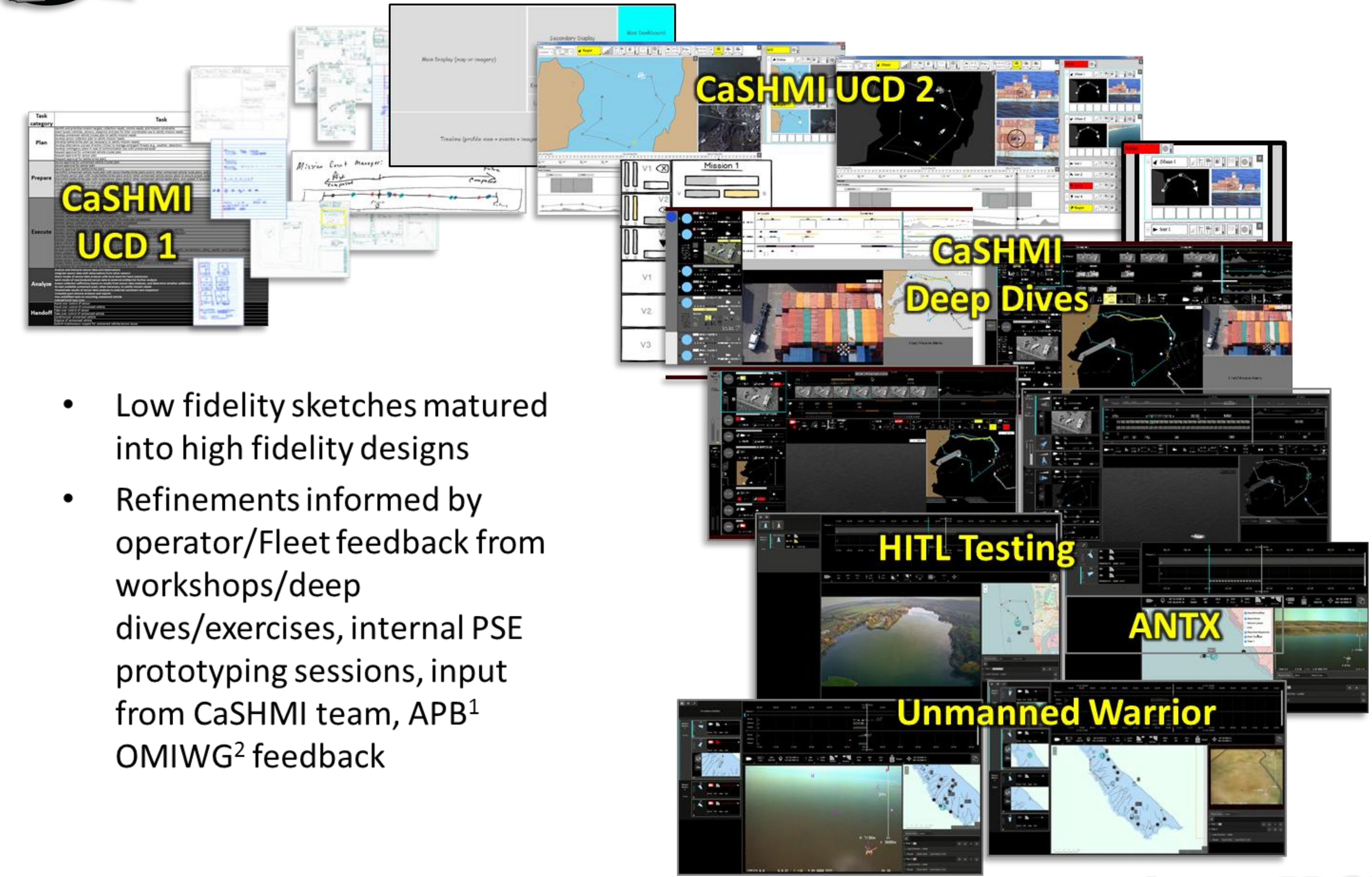
CaSHMI

CaSHMI is an Enterprise UI

Vehicle Controller (UCS, UCS-M)

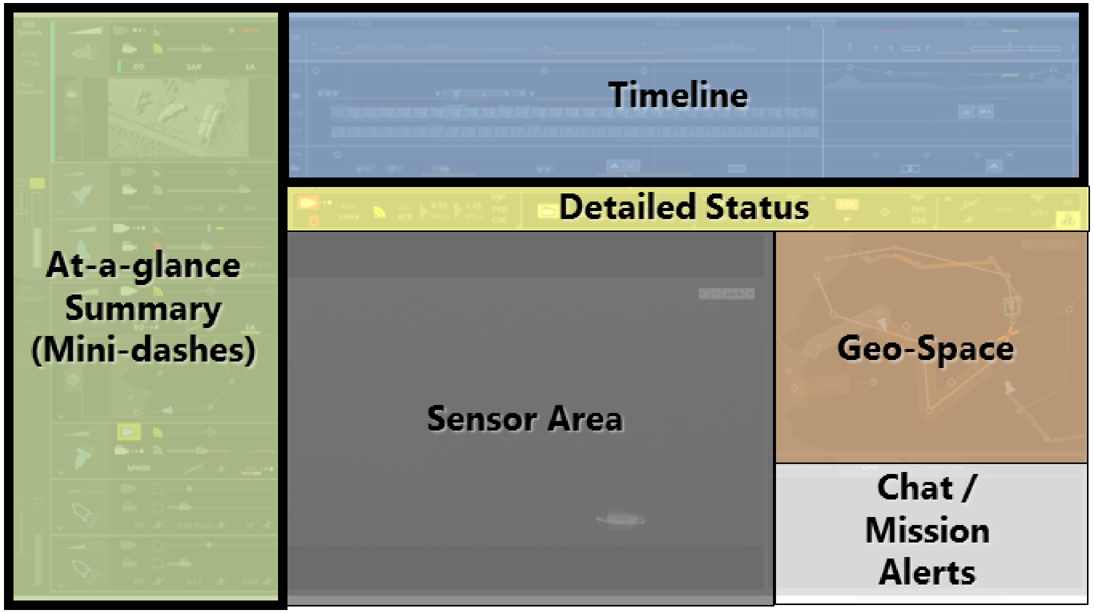
CaSHMI Design Process



- Low fidelity sketches matured into high fidelity designs
- Refinements informed by operator/Fleet feedback from workshops/deep dives/exercises, internal PSE prototyping sessions, input from CaSHMI team, APB[1] OMIWG[2] feedback

CaSHMI User Interface

Build 1 (Oct, 2015)

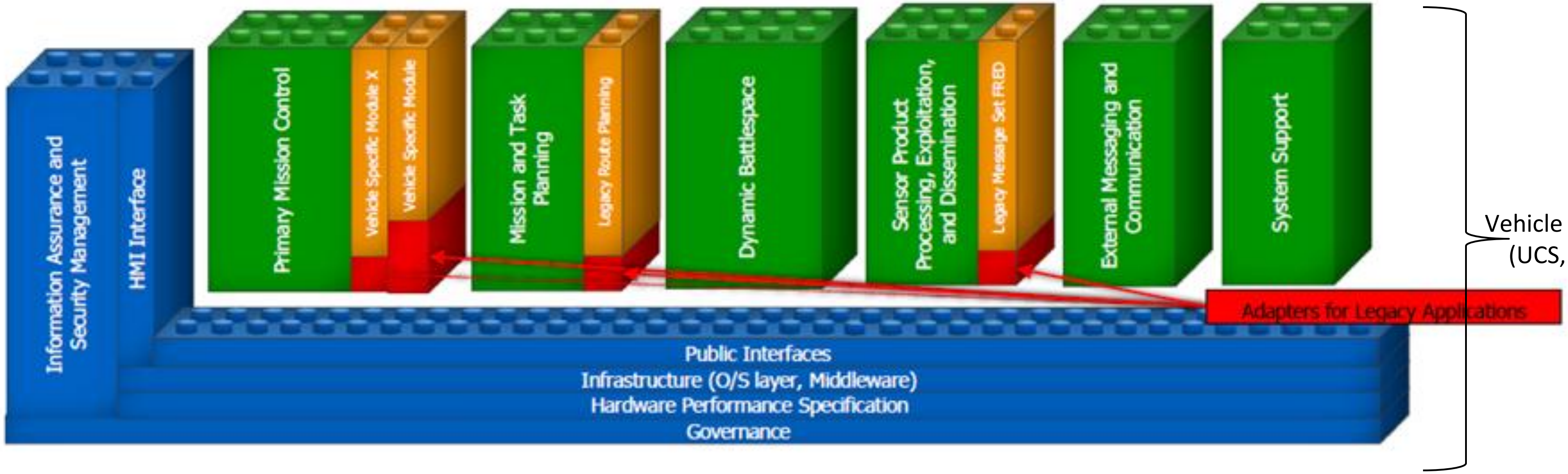


- Supervisory elements more prominent
- More intuitive progression from summary to details
- Larger, standard-ratio Sensor Area
- Design fits all containers into a single screen
  - CaSHMI's 16:9 fits beneath SWFTS common header in 16:10 BYG-1
- Alternatives for expanding onto multiple screens

HMI is not a monolith…

CaSHMI

CaSHMI is an Enterprise UI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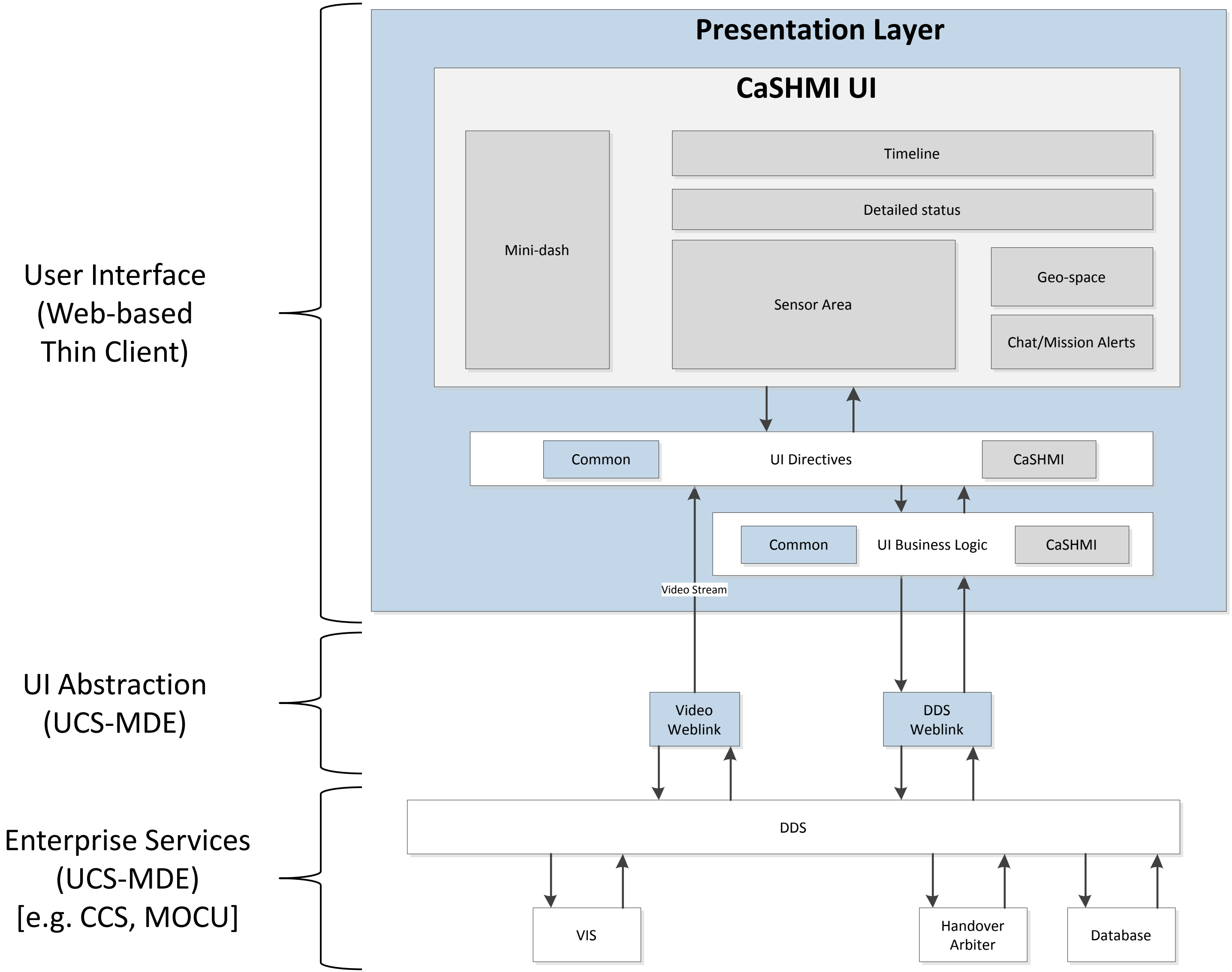
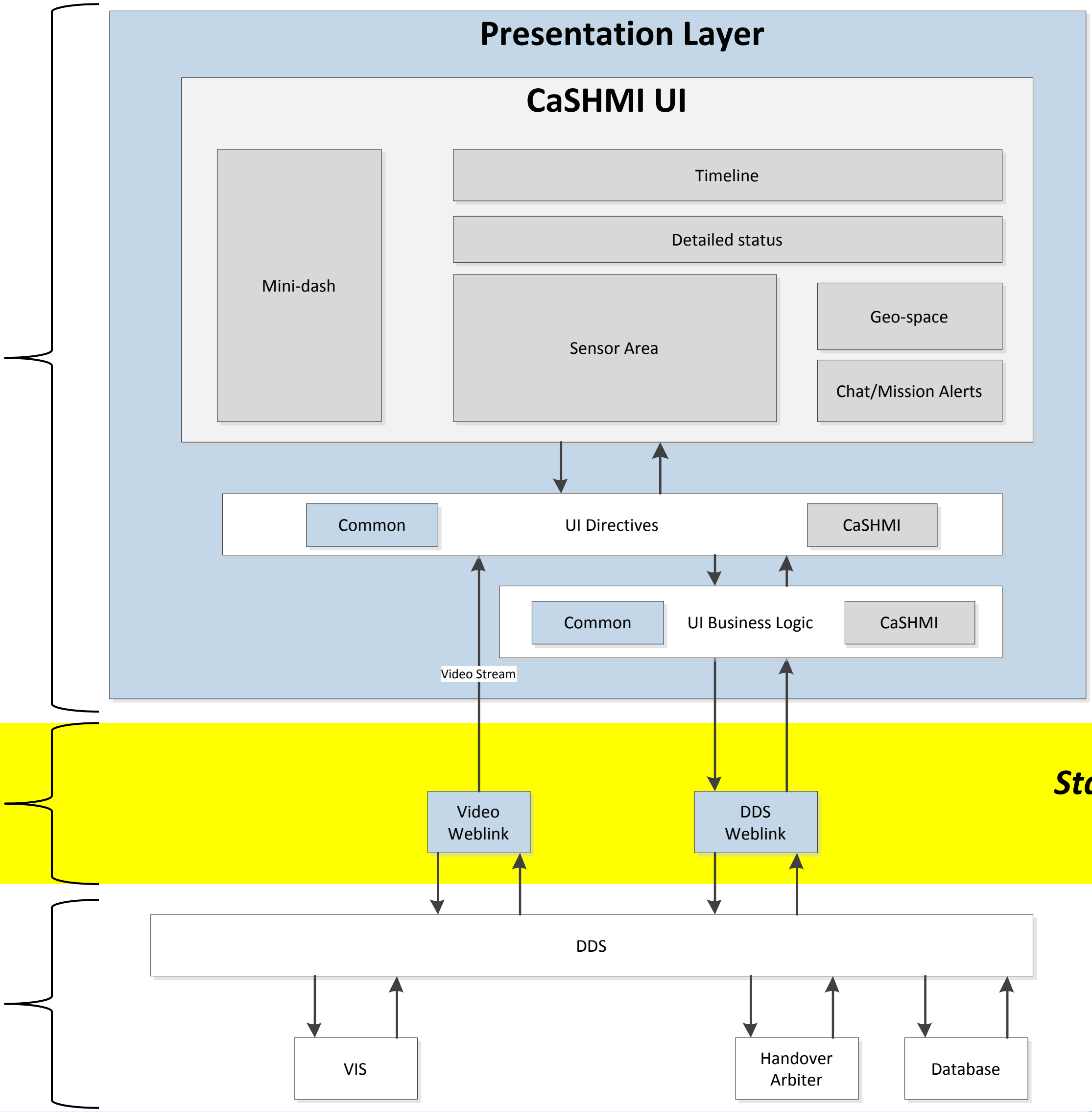
Vehicle Controller (UCS, UCS-M)

CaSHMI Layered Approach



CaSHMI Layered Approach



User Interface (Web-based Thin Client)

UI Abstraction (UCS-MDE)

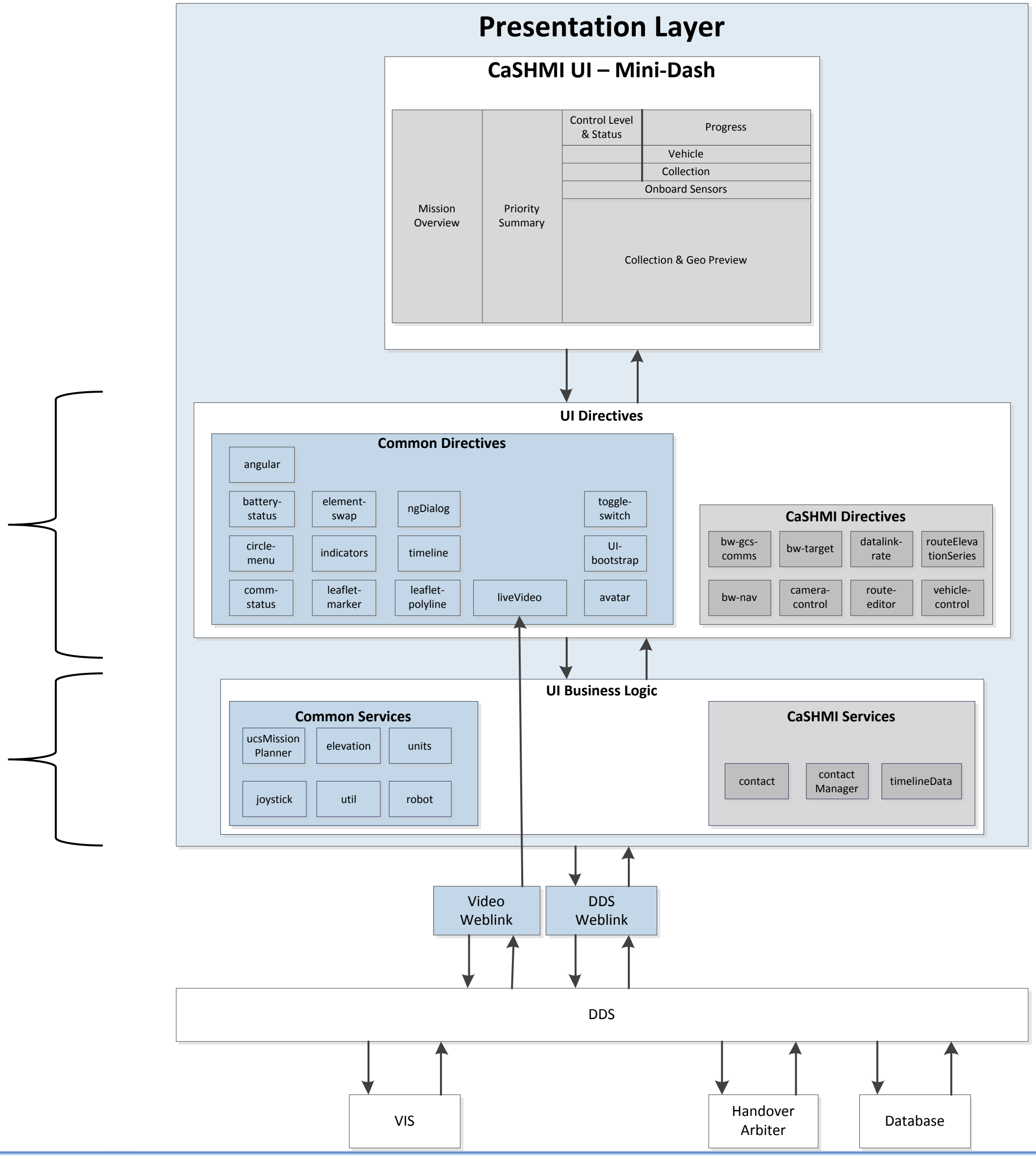
Enterprise Services (UCS-MDE) [e.g. CCS, MOCU]

Standards-based UI separation from Vehicle Controller.

Identifying Common Elements & Business Logic

Common, re-usable UI elements

Business Logic



Presentation Layer

CaSHMI UI – Mini-Dash

- Mission Overview
- Priority Summary
- Control Level & Status
- Progress
- Vehicle
- Collection
- Onboard Sensors
- Collection & Geo Preview

UI Directives

Common Directives

- angular
- battery-status
- element-swap
- ngDialog
- toggle-switch
- circle-menu
- indicators
- timeline
- UI-bootstrap
- comm-status
- leaflet-marker
- leaflet-polyline
- liveVideo
- avatar

CaSHMI Directives

- bw-gcs-comms
- bw-target
- datalink-rate
- routeElevationSeries
- bw-nav
- camera-control
- route-editor
- vehicle-control

UI Business Logic

Common Services

- ucsMission Planner
- elevation
- units
- joystick
- util
- robot

CaSHMI Services

- contact
- contact Manager
- timelineData

Video Weblink

DDS Weblink

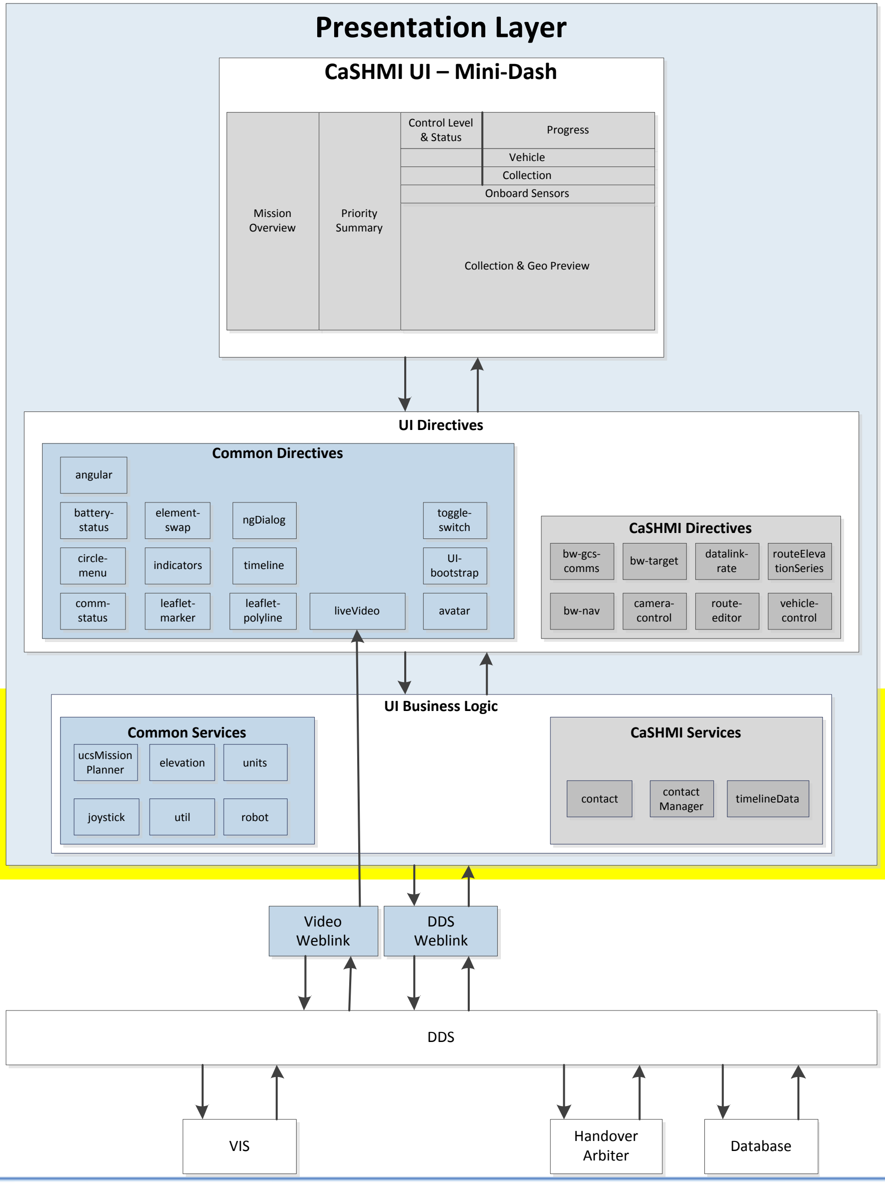
DDS

VIS

Handover Arbiter

Database

Identifying Common Elements & Business Logic



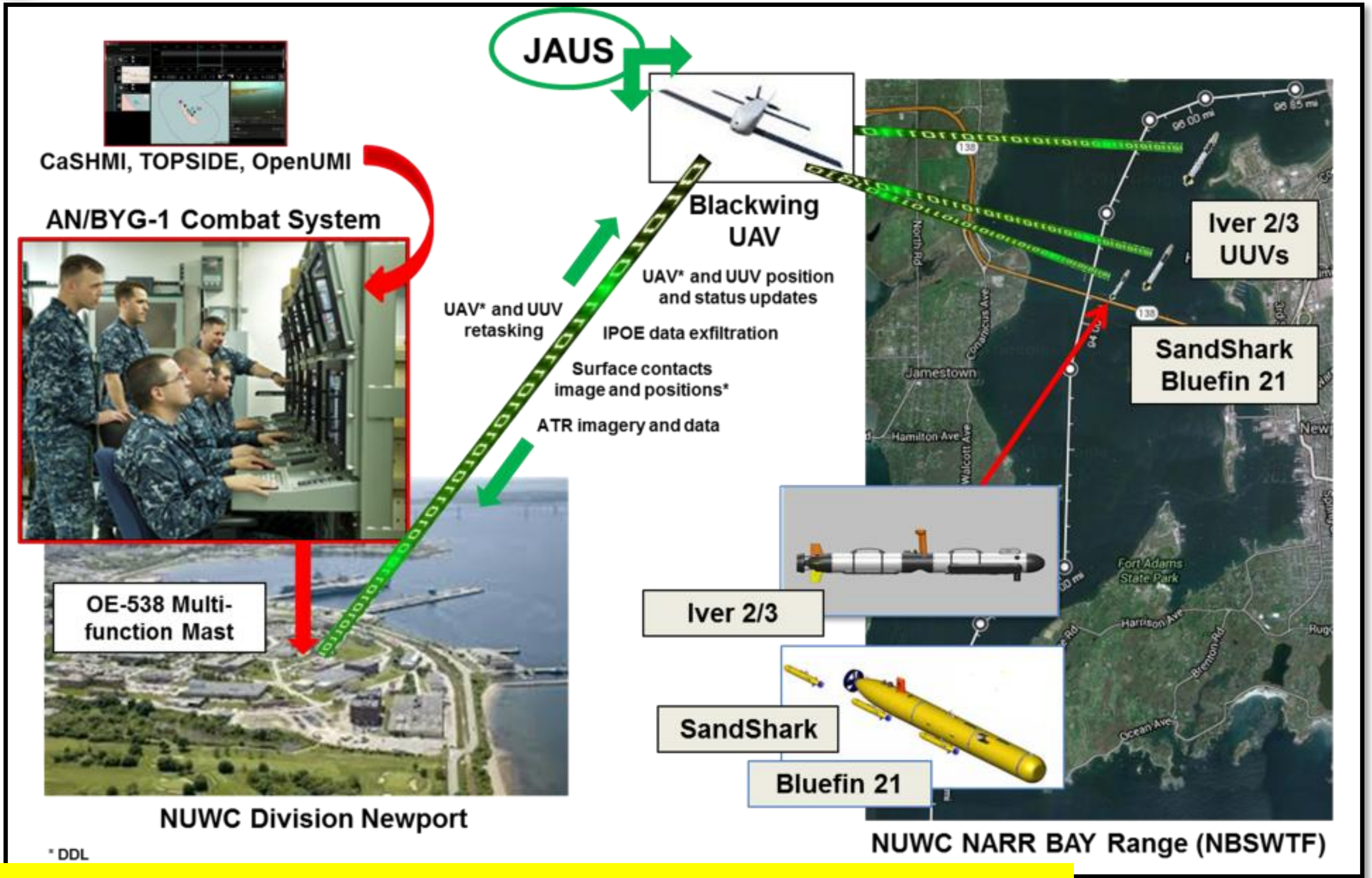
Common, re-usable UI elements

Business Logic

Clear separation between common elements and business logic.

Field Experimentation

ANTX 2016



JAUS

CaSHMI, TOPSIDE, OpenUMI

AN/BYG-1 Combat System

OE-538 Multi-function Mast

NUWC Division Newport

Blackwing UAV

UAV* and UUV position and status updates

IPOE data exfiltration

Surface contacts image and positions*

ATR imagery and data

UAV* and UUV retasking

Iver 2/3 UUVs

SandShark Bluefin 21

Iver 2/3

SandShark

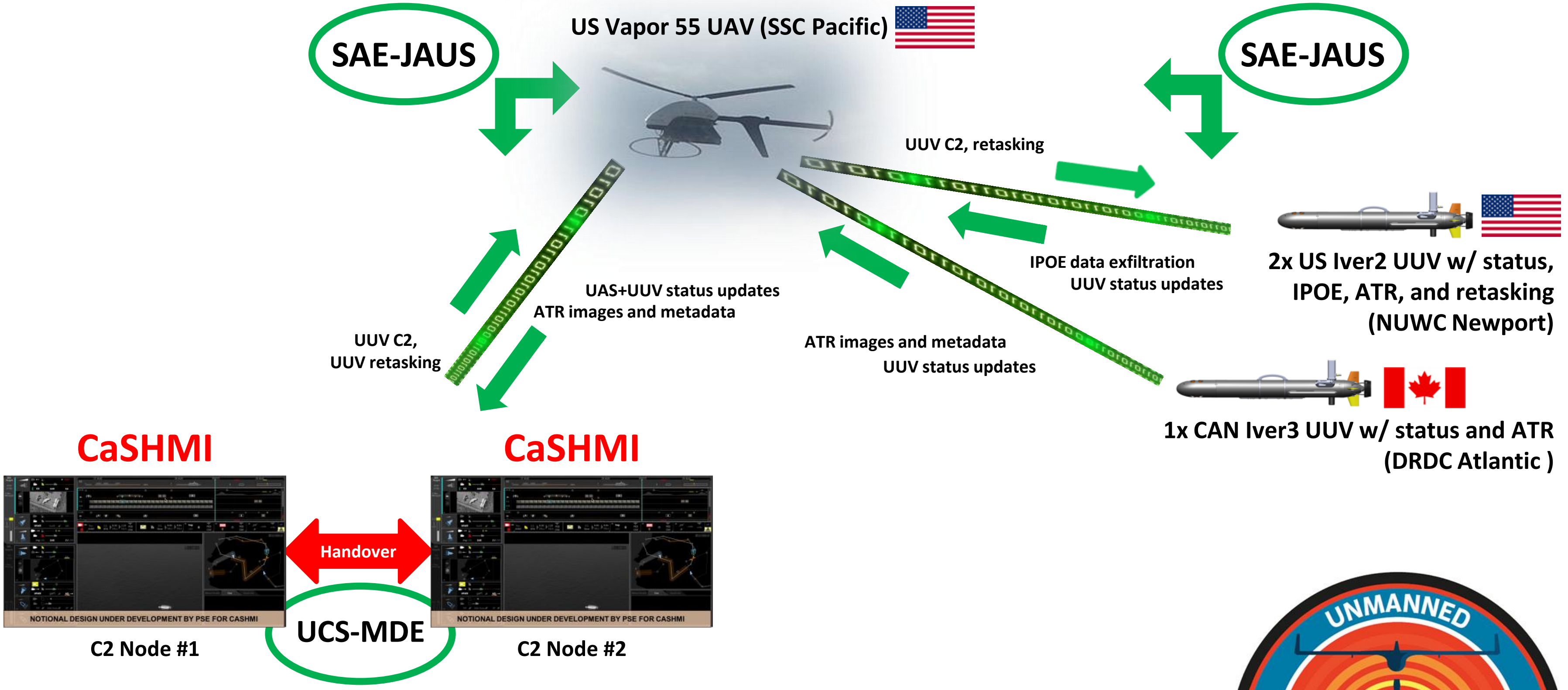
Bluefin 21

NUWC NARR BAY Range (NBSWTF)

* DDL

***CaSHMI Focus*: Enable simultaneous C2 of cross-domain UxVs…**

Unmanned Warrior 2016



SAE-JAUS

US Vapor 55 UAV (SSC Pacific)

SAE-JAUS

UUV C2, retasking

IPOE data exfiltration
UUV status updates

2x US Iver2 UUV w/ status,
IPOE, ATR, and retasking
(NUWC Newport)

UAS+UUV status updates
ATR images and metadata

UUV C2,
UUV retasking

ATR images and metadata
UUV status updates

1x CAN Iver3 UUV w/ status and ATR
(DRDC Atlantic)

CaSHMI

CaSHMI

Handover

NOTIONAL DESIGN UNDER DEVELOPMENT BY PSE FOR CASHMI

NOTIONAL DESIGN UNDER DEVELOPMENT BY PSE FOR CASHMI

UCS-MDE

C2 Node #1

C2 Node #2

- C2 node for cross-domain UxV operations
- UxV status, IPOE data display, and ATR imagery
- UUV retasking (mission toggle) through UAV relay
- Multi-station (2x) sharing of UxV display (status and data exfil) and locally shared control of UUVs (data queries, retasking of UUVs through UAV relay)

<u>CaSHMI Focus</u>: Enable handover in the enterprise environment…

Thanks!

Any questions?

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