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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Traditional Example

Generic Application

- Ownship Plug-in
- Contacts Plug-in
- Environment Plug-in

- Ownship Pose
- Contacts
- Environmental Data

Tactical System(s)
Poorly Defined Layers

No common data abstraction leads to re-work at all levels as any piece changes.
Traditional UxV C2 Example

UxV C2 Application

- Ownship Plug-in
- Contacts Plug-in
- Environment Plug-in
- UxV Control Plug-in

Tactical System(s)

- Ownship Pose
- Contacts
- Environmental Data

UxV
Prone to Re-work when Scaled

UxV C2 Application

- Ownership Plug-in
- Contacts Plug-in
- Environmental Plug-in

UxV Control Plug-in

Tactical System(s)

- Ownership Pose
- Contacts
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UxV

- 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)

UCS v3.2 “Core”

- SAE JAUS Services
- UCS Conceptual Data Model
- MIW Data Model
- Related Efforts
- Implementation Assessments
- UCS MDE Model

- 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.

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

Vehicle Controller (UCS, UCS-M)
CaSHMI is an HFE design – an Enterprise UI – for UxV Supervisory Control.
CCS needs an Enterprise UI

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, APB¹ OMIWG² 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

Vehicle Controller (UCS, UCS-M)
CaSHMI Layered Approach

User Interface (Web-based Thin Client)

UI Abstraction (UCS-MDE)

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

**User Interface** (Web-based Thin Client)

**UI Abstraction (UCS-MDE)**

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

**Presentation Layer**

**CaSHMI UI**
- Mini-dash
- Sensor Area
- Timeline
- Detailed status
- Geo-space
- Chat/Mission Alerts

**UI Directives**
- Common
- Video Stream

**UI Business Logic**
- DDS
- Video Weblink
- DDS Weblink
- Handover Arbiter
- Database

**Common CaSHMI**

**Standards-based UI separation from Vehicle Controller.**
Identifying Common Elements & Business Logic

Presentation Layer

CaSHMI UI – Mini-Dash

Mission Overview

Priority Summary

Control Level & Status

Progress

Vehicle

Collection

Onboard Sensors

Collection & Geo Preview

Common Directives

Angular

Battery-status

Element-swap

Dialog

Toggle-switch

UI-bootstrap

Video

LiveVideo

Common Services

Contact

Contact Manager

TimelineData

UserServices

Robot

Util

Joystick

DataLink

RouteRate

RouteElevationSeries

VehicleControl

Onboard Control

Onboard Sensors

Onboard Data Link

Video

DDS

UI Directives

Common, re-usable UI elements

Business Logic
Identifying Common Elements & Business Logic

Clear separation between common elements and business logic.
Field Experimentation
ANTX 2016

CaSHMI Focus: Enable simultaneous C2 of cross-domain UxVs...
Unmanned Warrior 2016

- **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)**

*CaSHMI Focus: Enable handover in the enterprise environment...*
Thanks!

Any questions?

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