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UGV Interoperability Lab October Update

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Overview

- RSJPO UGV Interoperability Profiles Overview
- UGV Interoperability Lab Overview
- Payload Testbench
- Reference Implementation (TALON)
- Reference Implementation (virtual)
- GUI-based Conformance Verification Tool
- Distributed Sensor Simulation Framework
- Other UGV Interoperability Lab and Related Efforts
- Collaboration with other Interoperability Efforts
- Questions

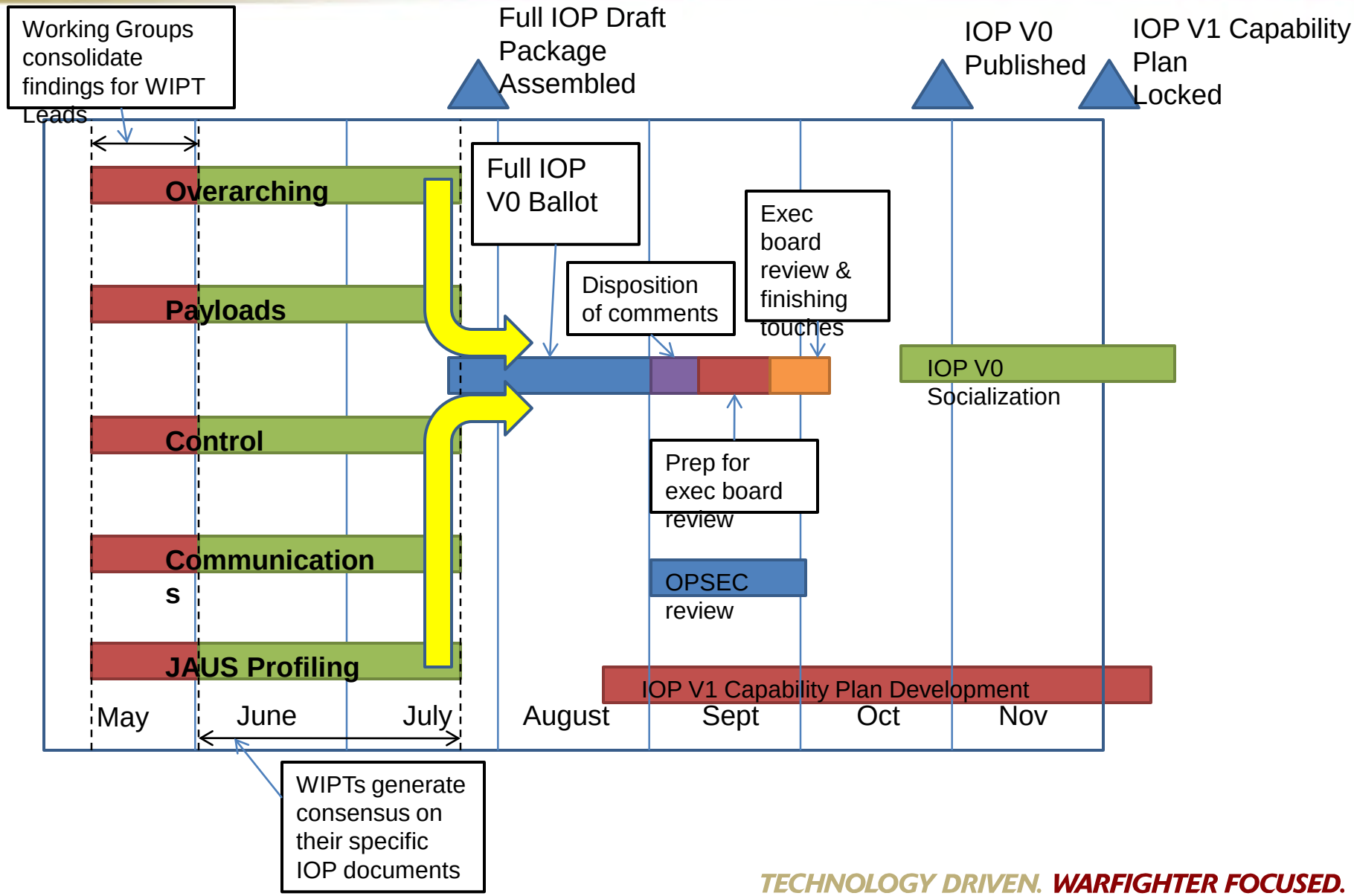
Interoperability Overview – Scope and Objectives

- Define interoperability standards for integration across UGVs leveraging other standards work to the greatest extent possible
  - Open Architecture and Interfaces
  - Common Control Standards
  - Communications Data Links
  - Modular Payload Interfaces
  - Conformance and Validation Criteria
- Interoperability Profile Version 0 (IOP V0) will define baseline capabilities
  - Fundamental system capabilities and functionality of fielded systems
  - Standard message sets for common control across platforms lag OEM unique software coding
- Successive IOPs (V1, V2, etc.) expand capabilities based on Combat Developer guidance

Interoperability Overview – Structure

Working IPT (WIPT)	Working Groups		
Overarching	• Sys Eng & Architecture • Test & Validation		
Communications	• Radio Link • Physical/Power Interface • Logical Interface	• RFI Mitigation • Security	• Radio Status Messages (Communications Services)
JAUS Profiling	• Platform Manager • Capability Plan Compliance • ID Assignment & Discovery • Autonomy/Behaviors • Access Control	• Digital Video Stream • Sensors Message Implementation	
Payloads	• Existing Standards • Logical Interface / Metadata • Physical Interface • Configuration / Taxonomy		
Control	• OCU • Human / Machine Interface	• Existing Standards	

Interoperability Overview – Schedule



UGV Interoperability Lab Overview - Objectives

- Develop IOP Conformance Verification Testing Capabilities
- Create test and verification tools that systems can be plugged into and tested for compliance against IOP attributes
- Develop reference libraries and tools to make implementation and integration using IOPs easier
- Feedback loop with the Interoperability Profiles and WIPTs
  - Test out concepts and technologies under consideration within the WIPTs for IOP inclusion and provide performance feedback to proposed concepts
  - Run experiments against current baselines on different technologies and approaches that can be used to input new content for the IOPs
- Provide virtual simulation capabilities to support conformance testing

UGV Interoperability Lab General Timeline / Key Dates

- Until Now – develop initial reference implementations, tools, simulations, etc.
- 12-16 Sep 2011 – First integration session (DCS and TARDEC) – integrated virtual and TALON reference implementation, got simulation software into lab
- September – December – continue refining and expanding reference implementation, testing tools, and hardware setups
- December – Final integration session and product deliverable
  - Documented and packaged TARDEC reference implementation (full IOP support)
  - Improvements to testing tool (all tests added, message sequence tests fully integrated, state checking and instrumentation based tests added)
  - Simulated reference implementation added services
  - Completed testbench (programmable power supply received and integrated into test bench, wiring cables and harnesses cleaned up)
- December and on – start building V1 capabilities

UGV Interoperability Lab Elements

- Payload Testbench
- Reference Implementations
- Conformance Verification Tool
- Virtual/Simulated Assets
- Communications Modeling
- Simulated Payload Infrastructure
- Other Projects

Payload Testbench

- A bench top setup with at least four payload “stations” for connecting payloads to:
  - Each station provides each type of IOP data/electrical receptacle (MIL-DTL-38999L series II 10-35 and 12-35 insert arrangement connectors)
  - Each station provides both IOP physical mounting options (optical bench and Picatinny rail)
- All stations connect into Gigabit Ethernet switch
  - Allows payloads to talk to each other
  - Allows testing of multiple components at once (i.e. take all IOP compliant payloads from robot and represent that robot using the bench)
- Conformance Verification tool also plugged into switch – allows for testing of payloads
- Wireless radio links and simulated assets can also be plugged into testbench network
- Programmable power supply* will allow for providing 12V and 24V power levels (IOP power interface A and B)
- Plans to add per-payload power monitoring and control, Labview interface for programmable supply
- * Programmable power supply still on order – stand in being used

Reference Implementations

- Two separate IOP reference implementations (mainly from the JAUS Profiling rules and Custom Services, Messages, and Transports documents) are being created
  - One by TARDEC
  - One by DCS
- TARDEC reference implementation focusing on hardware assets – first use case is a stock TALON IV being “upgraded”
- DCS reference implementation focusing on simulated assets in a virtual world
- Separate reference implementations allows for independent verification of IOP documents and testing to see if two separate implementations work together based on the IOP
- Basic testing of both reference implementations performed during October integration period
  - Was able get the simulation OCU controlling TALON and simple TALON reference implementation OCU controlling simulated asset fairly quickly
  - Main issues were implementation specific and not related to interpretation of IOP documents

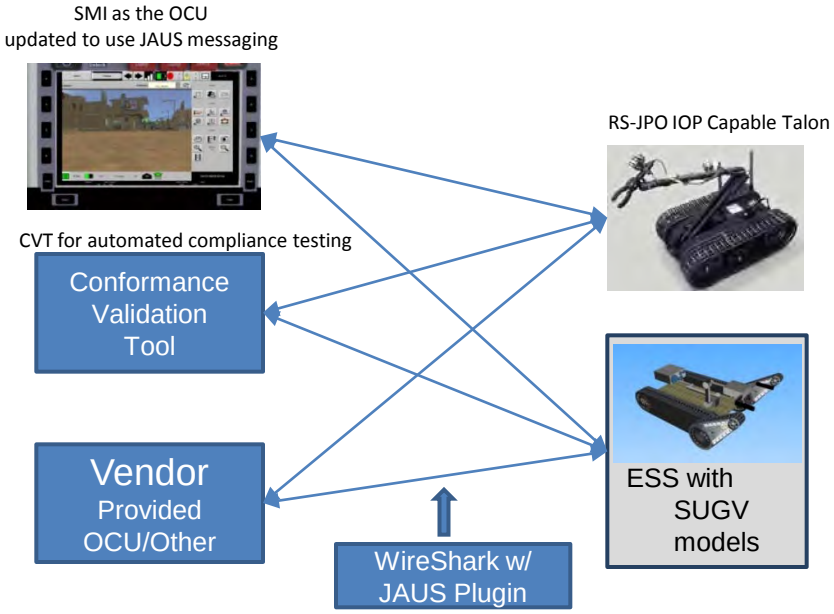
Reference Implementation (TALON)

- TALON reference implementation being created by TARDEC
- Represents an “upgrade” use case scenario
  - Use stock TALON equipment (cameras, arms, mobility, etc.) – not replacing their physical and electrical connections with IOP compliant ones
  - Adapt the TALON to use IOP specified interfaces and protocols for command and control and reporting for payloads and platform driving
  - TALON code runs on an embedded computer that attaches to low level TALON driving interface (through the fiber cable serial lines in this case)
- The following IOP requirements are implemented (some still being refined and tested)
  - Use JUDP transport
  - Provide Teleop capability
  - Provide Platform Management Capabilities
  - Provide one IOP compliant connector for tethering/testing purposes
  - Provide capability to control manipulator arm with gripper and PTZ mount with camera
  - More detail in technical report being prepared

Reference Implementation (Virtual)

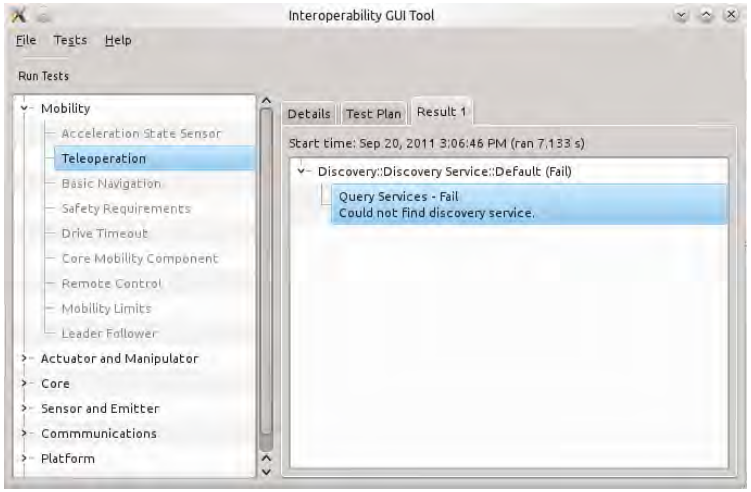
- Virtual environment (Embedded Simulation System) reference implementation being created by DCS
- Controller (OCU)
  - SMI from TARDEC ATOs
- Simulation
  - Embedded Simulation System (ESS) from TARDEC ATOs with UGV visualization models from Joint Center for Robotics Virtual SIL
- Allows testing with assets that might not normally be available or might be difficult to do in space constrained environment
  - Leader follower (convoy)
  - Expensive / limited availability payloads
- Allows for flexibility in testing

Example showing how simulation can be used as part of the conformance verification process in place of *or* in conjunction with physical assets



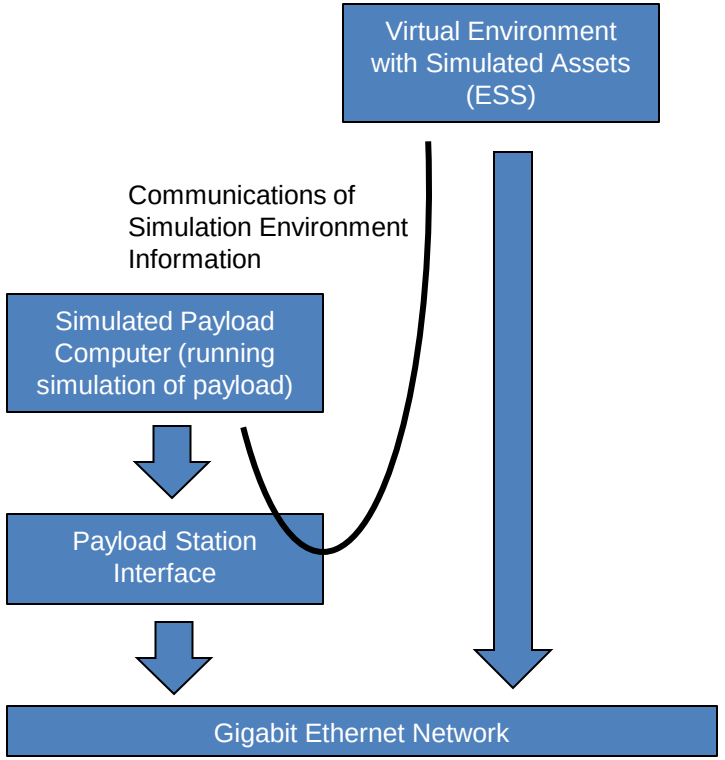
Conformance Verification Tool (CVT)

- Tool with graphical user interface that allows for IOP conformance verification, based on attributes specified or included as mandatory
  - Ensure required services exist in the right locations
  - Test messages sequences against each service and ensure proper responses (IN PROGRESS)
  - Check for proper states based on message sequences (IN PROGRESS)
  - Ensure proper response to command messages using instrumentation (DECEMBER)
- Will generate human-readable test plans and results, allow saving of loading of tests, and customization of parameters
- Test results can be provided to program of record or testing personnel (i.e. ATEC) to support next steps for system under test
- Tests added to CVT using XML definitions, message sequences generated from sequence generator tool that is being developed



Distributed Simulation Framework

- Distributed simulation framework allows sensor and payload simulations to be run independent of the main virtual environment (ESS)
- Could run a simulation on dedicated hardware and plug it into the payload testbench for testing just like would be done with the real payload
- Allows payload IOP compliance to be tested without having access to the actual hardware, while still utilizing many of the same interfaces and approaches
- Initial test case – MultiRAE Plus CBRN (Gas) sensor
- Information from simulated environment is provided using IP communications (UDP or TCP)
  - Chemical "plumes"
  - Locations of various entities
  - Others
- Goal: Allow vendors to provide simulated payloads for testing and evaluation prior to committing to testing actual payload



Other UGV Interoperability Lab Efforts and Related Efforts

- Common CBRNE Sensor Interface (CCSI) wrapper
  - CCSI specified as way for communicating with CBRNE sensors in the Payload IOP document
  - Writing wrapper for the MultiRAE Plus sensor
  - Looking into code auto-generation using the provided XML schemas
- Robodexs
  - Innovation project (TARDEC GVR)
  - Deployment system for small UGVs
  - Making into an IOP compliant payload (or at least a provisional test case for version 1 of the IOP if v0 does not support)
- Instrumentation for IOP command message testing
  - Wireless instrumentation that can be attached to moving parts of a payload or platform
  - Report back data to base station (and eventually on to the CVT) on when things move
  - Use information to assert if a system under test properly moved or reacted in response to a command
  - Warn if did not – could be interoperability or performance issue

Other UGV Interoperability Lab Efforts and Related Efforts

- SBIR Use of IOP V0
  - Considering using IOP reference TALON on a SBIR to integrate monocular camera based person following and drive-to-object features
  - IOP V0 use is objective in multiple other SBIRs
  - Testing would occur using lab assets
- Being planned for in Robotic Armed Maneuver Platform (RAMP) project
  - IOP layer will sit on top of Vehicle Management System (VMS) to allow added kits or operators to control and get information from RAMP vehicle
- AMAS
  - V1 testing capabilities will likely be applied to AMAS program

Collaboration with AEODRS

- IOP WIPT leads and AEODRS document leads have been communicating with each other for a while
- Recent developments related to IOP and AEODRS collaboration (call with SPAWAR)
  - Talked about each others' reference implementation and assessed similarities and differences
  - Plan to exchange very basic reference implementations and do cross-testing
  - Plan to collaborate on testing tools

Questions

- Questions
- For additional information or questions, please contact
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