Integration of an In-Vehicle Network Utilizing VICTORY Standards on a USMC M-ATV MRAP Vehicle

Mr. Ernest Sanchez

Ernest.Sanchez1@usmc.mil

USMC – PEO Land Systems

What is VICTORY?

- **Vehicular Integration of C4ISR/EW InTerOpeRabilitY (VICTORY)**

- VICTORY is a set of open standards developed by a government-industry partnership.

- VICTORY defines interfaces and component types to enable interoperability among automotive, C4ISR/EW, and network components within the vehicle.
  - VICTORY STANDARD SPECIFICATIONS - Version 1.6.2, March 31, 2015
  - www.victory-standards.org

- A VICTORY-compliant In-Vehicle Network (IVN) uses hardware and software component types which have been tested using the VICTORY Compliance Test Tool.

- IVN hardware typically includes:
  - A **Shared Processing Unit (SPU)** to host the shared services (Apps) and data, and enable adding future capabilities by adding software.
  - An **Ethernet Switch**, connected to the SPU and IVN hardware components (radios, jammer, sensors, etc.).
  - **Interactive Multi-Function Display Unit(s**), replacing one or more single-use displays.

Why Open Systems?

- Commercial product lifetimes are much shorter and more volatile than the weapons systems they support (i.e. years vs. decades). Acquisition managers take a **risk** to rely on unique products provided by a single supplier at high non-competitive prices and with little opportunity for technology insertion by other suppliers.

- Potential benefits of using open systems:
  - Reduced cycle time
  - Reduced life cycle costs
  - Enabling interoperability
  - Technology insertion
  - Increased competition
  - Better performance

(Defense Acquisition University: CLE013 – Modular Open Systems Architecture for DoD Acquisition)

USMC Policy and Requirements

- **Systems Engineering, Interoperability, Architectures, and Technology (SIAT) Memo,** 18 Jul 2014
- *Standardizing System Integration On Marine Corps Vehicles Utilizing VICTORY Standards*
  - **"**VICTORY is the **recommended standard** for C4ISR/EW vehicle integration within the Marine Corps and **shall be considered** for implementation by MCSC and PEO LS managed programs **as part of system upgrades, modernization, and new development.**"

- **PEO Land Systems (LS) Policy 2-14,** 22 Dec 2014
- *Implementation of VICTORY Standards*
  - PMs within PEO LS will:
    - Develop an appropriate **strategy for implementing** VICTORY considering existing architecture, planned upgrades and available resources; anticipate incremental approach for legacy vehicles.
    - Incorporate appropriate VICTORY compliant **language in the RFP for new start vehicle programs**.
    - Provide update of their VICTORY implementation plan during PMRs.
    - Appoint a POC for VICTORY implementation in your PMO.

Demonstration IVN Schedule

- PM MRAP worked with the VICTORY Standards Support Office (VSSO), Southwest Research Institute (SwRI), Agile, and SPAWAR-Atlantic to develop software and integrate hardware onto a USMC M-ATV for a VICTORY demonstration IVN system, within 12 months.

- Schedule:
  - USMC MRAP VICTORY Kick-off — 17 Sep 2014
  - Systems Functional Review (SFR) — 10 Dec 2014
  - Preliminary Design Review (PDR) — 4 Feb 2015
  - Critical Design Review (CDR) — 29 May 2015
  - Pilot Test — 14 Aug 2015

Engineering Approach

❖System Functional Review (SFR):

- Engaged USMC operating forces to prioritize In-Vehicle-Network (IVN) functions and capabilities.
- Performed Functional Decomposition focused on operational and maintenance tasks.
- A Functional Baseline was constructed, including those functions which were High and Medium priority.
- Included IVN, C4ISR, EW, and automotive systems.

❖Physical Architecture (SV-1):

- Developed physical architecture identifying necessary components, cabling and interfaces.

❖Preliminary Design Review (PDR):

- Drafted Performance Specification.
- Virtual Hardware Integration performed using CAD Solid models.
- Software design and development/reuse strategy created.
- Risks identified and assessed with mitigation plans implemented.
- Planned for incremental software testing of services and plug-ins.

❖Critical Design Review (CDR):

- Performance Specification refined to draft version 3.0.
- Final hardware design in place.
- Initial operational software developed.
- Updated risk assessment with mitigation plans implemented.

❖Pilot Test

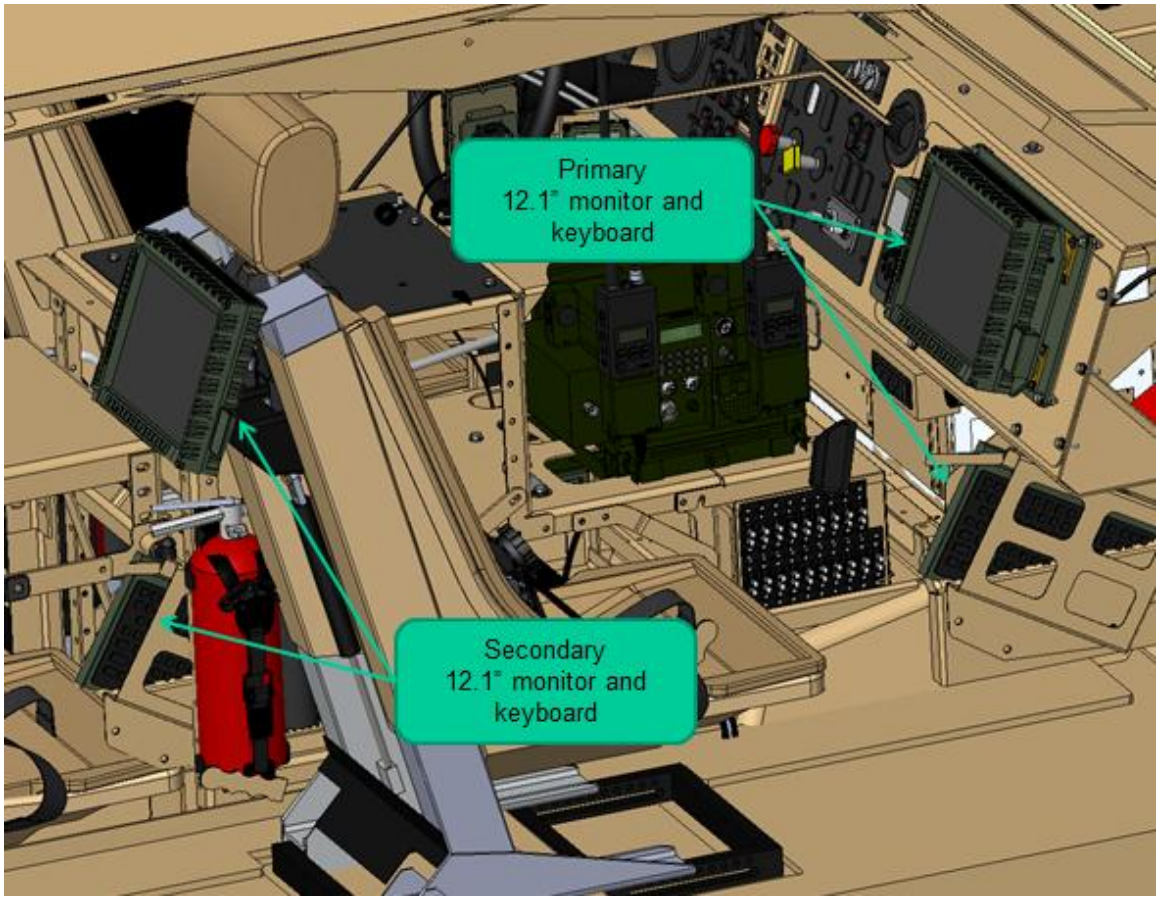
- Operated the demonstration IVN system installed on a USMC M-ATV.

M-ATV Systems

- To support the currently fielded M-ATV configuration, existing C4ISR/EW and Automotive systems were demonstrated to be interoperable with the VICTORY IVN.

1. Voice radio
2. Voice radio
3. Voice radios
4. GPS Receiver
5. Counter Radio-Controlled Improvised Explosive Device (RCIED) Electronic Warfare (CREW) system
6. Blue Force Tracker (virtualized)
7. SAE-J1939 vehicle CAN Bus

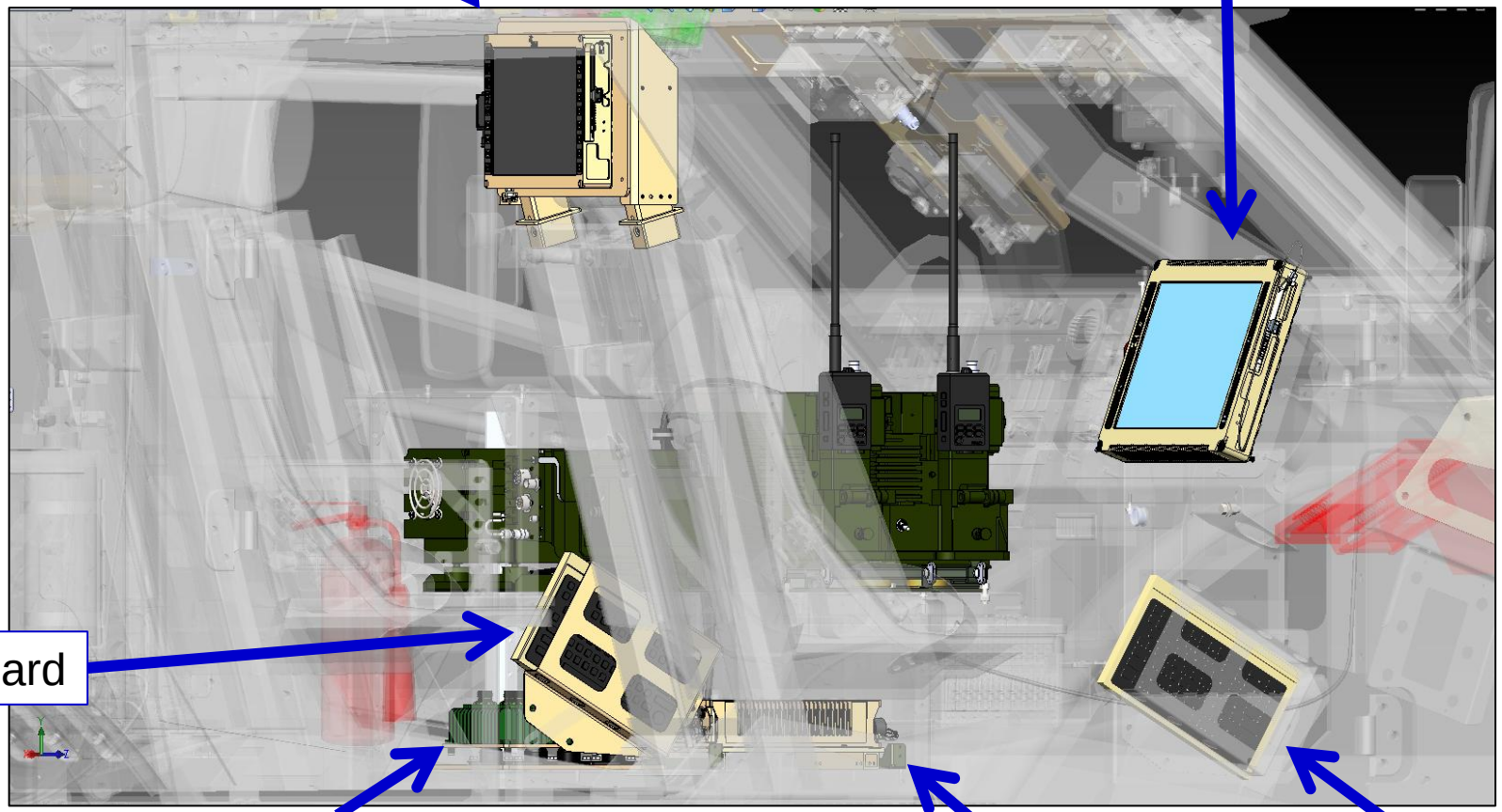
VICTORY Demo Implementation



M-ATV Demonstration System

- **Replaced BFT processor** by hosting software on the SPU
- Multiple components accessible via a **multi-function display**
- Enable centralized **remote control** of radios and CREW system

M-ATV VICTORY IVN Solid Models



Potential Benefits

Improve SWaP-C in the vehicle (clean up the cab)

- Reduce the SWaP-C burden and improve ingress and egress

❖ Enhance local situational awareness

- Integrate video, diagnostics, warnings, & other data in vehicles and can enable sharing across units

❖ Reduce users' operational burden

- Automate manual and duplicative tasks

❖ Realize cost conscious integration

- Integrate C4ISR, EW, and platform systems affordably with core IVN
- "Plug and Play" versus typical "Bolt-On" integration
- Provides an Open Architecture
- Reuse of software components across multiple platforms

❖ Reduce the Logistics footprint

- Significantly reduce costs of logistics operations by enabling condition-based maintenance (CBM), and automating configuration management and & health management tasks

❖ Reduce test and training costs

- Improves the availability of information to support test and training operations
- Reduces costs and time necessary to integrate test and training systems with vehicles

Lessons Learned

- **System requirements:**
  - Start by clarifying requirements with user community.
  - Scale IVN to reflect program priorities and requirements.
  - Maintain room for growth.

- **Integration:**
  - Perform high fidelity bench integration before starting vehicle integration.
  - Procure production grade equipment for development and testing.
  - Install components with consideration given to ease of access and maintenance.

- **Network & software expertise is critical.**

- **Information Assurance & Cybersecurity are required for fielding.**
  - NIST Risk Management Framework

- **User Comments:**
  - Menu is easy to navigate.
  - Do not introduce a single point of failure.

Conclusions

❖**For programs pursuing a new VICTORY IVN acquisition:**

- Focus on priorities of your program, and scale the system accordingly:
  - Interoperability of systems.
  - Data logger for condition based maintenance (CBM).
  - Increased situational awareness.
- Information assurance and cybersecurity are necessary for production systems.
- Consider Human Systems Integration (HSI) when placing hardware components in the vehicle and when creating GUI menus.
- Plan and resource for User Interface and Adapter development.
- Engage the OEMs for C4ISR/EW and networked systems.
- Perform frequent incremental testing.
- Perform formal configuration management of the software code.
- Consider creating redundant systems & hardware.
- Use the expertise of the VSSO.

Questions?