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

Mr. Ernest Sanchez
ernest.sanchez1@usmc.mil
USMC – PEO Land Systems
21 March 2017

Why Open Systems?

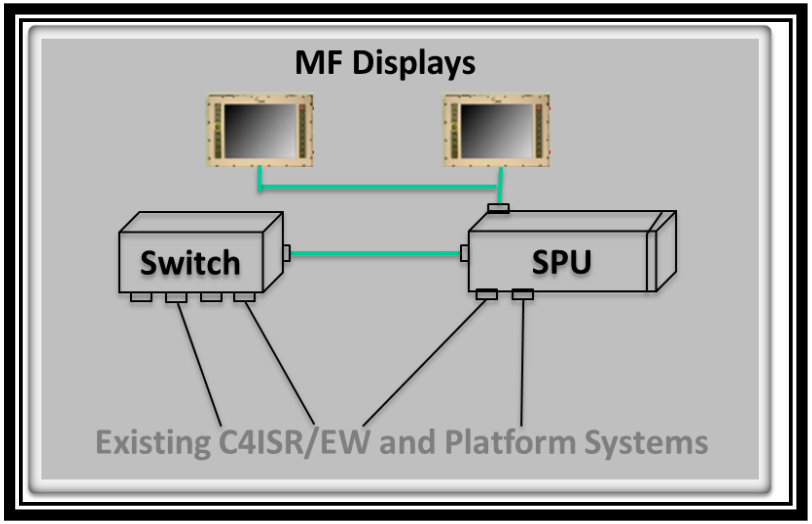
- Commercial product lifetimes are much shorter and more volatile than the weapons systems they support (i.e. years vs. decades). Acquisition managers take a **risk** to rely on unique products provided by a single supplier at high non-competitive prices and with little opportunity for technology insertion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

What is VICTORY?

- **Vehicular Integration of C4ISR/EW InTerOpeRabilitY (VICTORY)**
- VICTORY is a set of open standards developed by a government-industry partnership.
- VICTORY leverages government and commercial standards to define interfaces and component types, which enable interoperability among the automotive, C4ISR/EW, and network components.
  - 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 can be tested using the VICTORY Compliance Test Tool software suite.
- 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.



Policy and Requirements

USMC

- **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."
    - "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.

Army

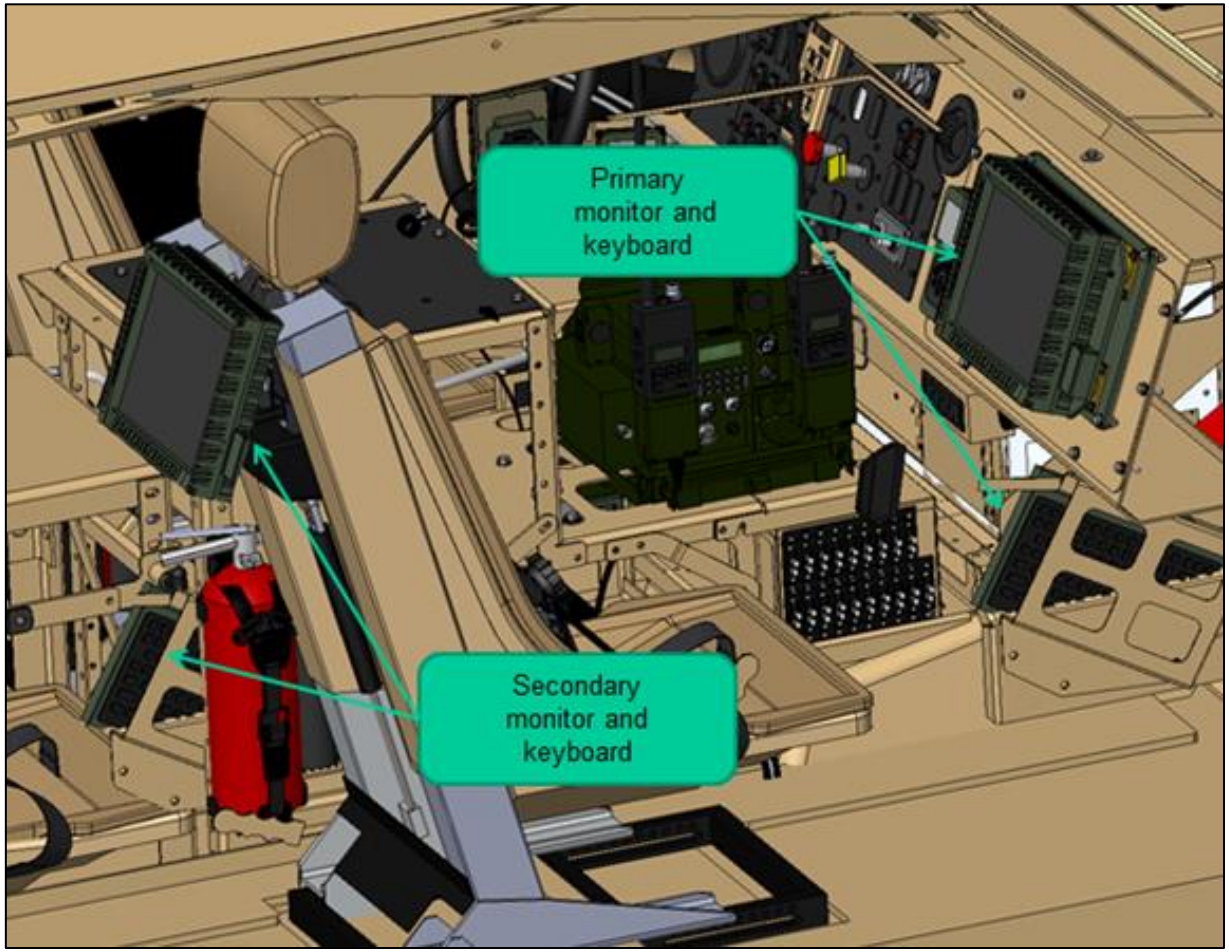
- **Management Directive**, signed 30 January 2012, forming a partnership of **PEO GCS, CSS&CS, C3T, IEW&S and CG RDECOM** to direct VICTORY effort including implementation within assigned systems
  - *Prioritize standard development*
  - *Synchronize equipment implementation*
- **PEO GCS** ADM to implement VICTORY as part of **Abrams, Bradley and Stryker** ECPs
- Briefed to and **supported by Army Acquisition Executive** on 16 August 2012
- **VSSO Compliance Verification Strategy approved** by VICTORY ESG on 19 March 2013
- Four ESG PEO issued policies for implementation and developed VICTORY implementation plans
- **ASA(ALT) and four ESG PEOs are synchronizing implementation plans across PEOs**

USMC M-ATV Systems

- **The In-vehicle network (IVN) was demonstrated to be compatible with the existing C4ISR/EW and automotive systems in the currently fielded M-ATV configuration**

1. **Voice radio #1**
2. **Voice radio #2**
3. **Voice radios #3 & #4**
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

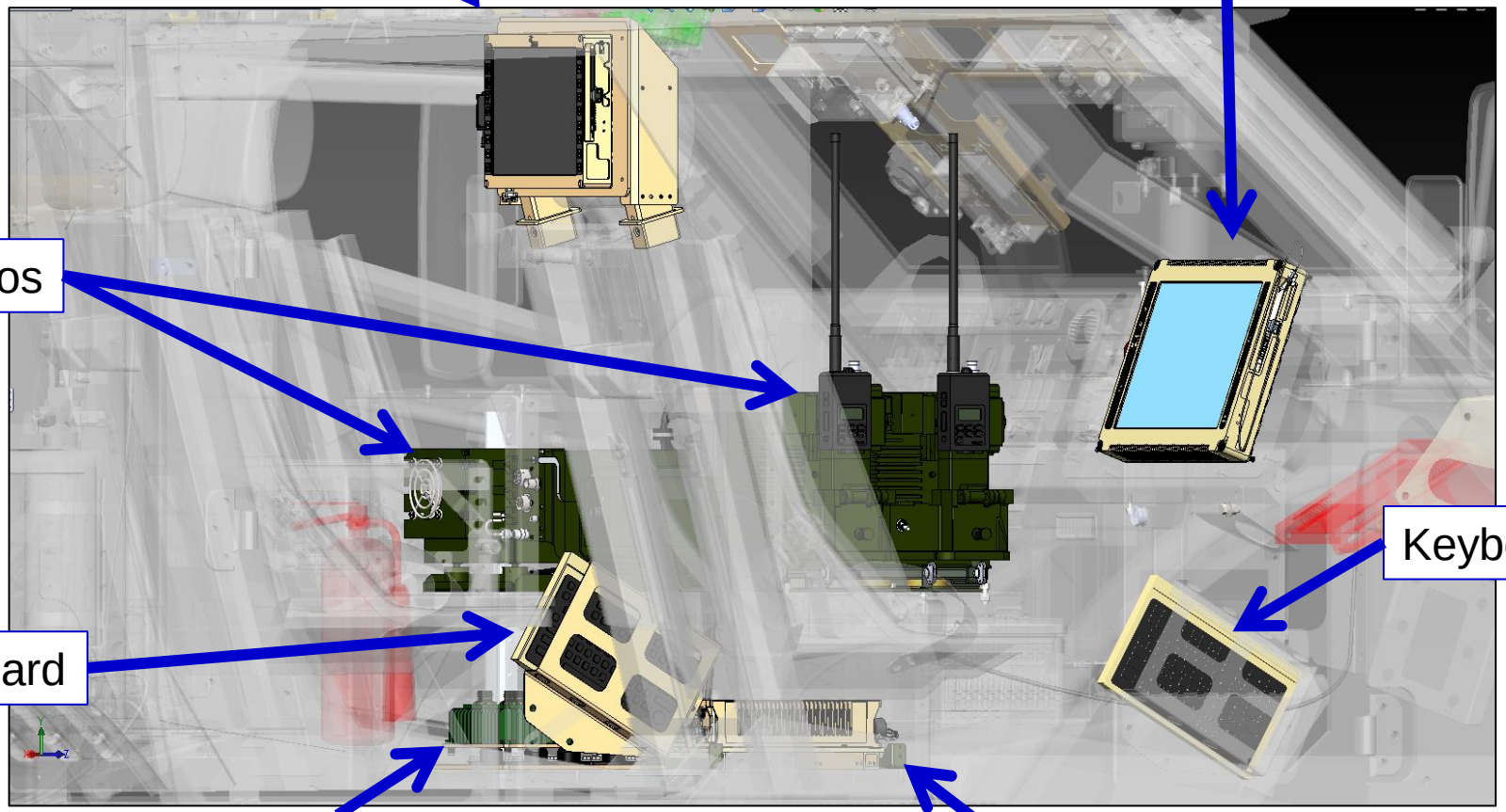


(Early design pictured)

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



(Final design pictured)

Engineering Approach

❖System Functional Review (SFR):

- Engaged USMC operating forces from multiple Military Occupational Specialty (MOS) groups to prioritize functions and capabilities for the In-Vehicle-Network (IVN).
- Performed Functional Decomposition to break down user and performance requirements to reflect the corresponding operational and maintenance tasks.
- A Functional Baseline was constructed, focused on functions which were High and Medium priority.
- Included IVN, C4ISR, Electronic Warfare (EW), and automotive (J1939 CAN-bus) systems.

❖Physical Architecture (SV-1):

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

❖Preliminary Design Review (PDR):

- Virtual Hardware Integration performed using CAD Solid models.
- Strategy created for software development and software reuse.
- Risks identified and assessed with mitigation plans implemented.
- Planned for incremental software testing of services and plug-ins.

❖Critical Design Review (CDR):

- 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 for testers and Marine users.

IVN Demonstration Schedule

PM MRAP worked with:

- **VICTORY Standards Support Office (VSSO),**
- **Southwest Research Institute (SwRI),**
- **Space and Naval Warfare Systems Command (SPAWAR) – Atlantic, and**
- **Agile Communications, Inc.**

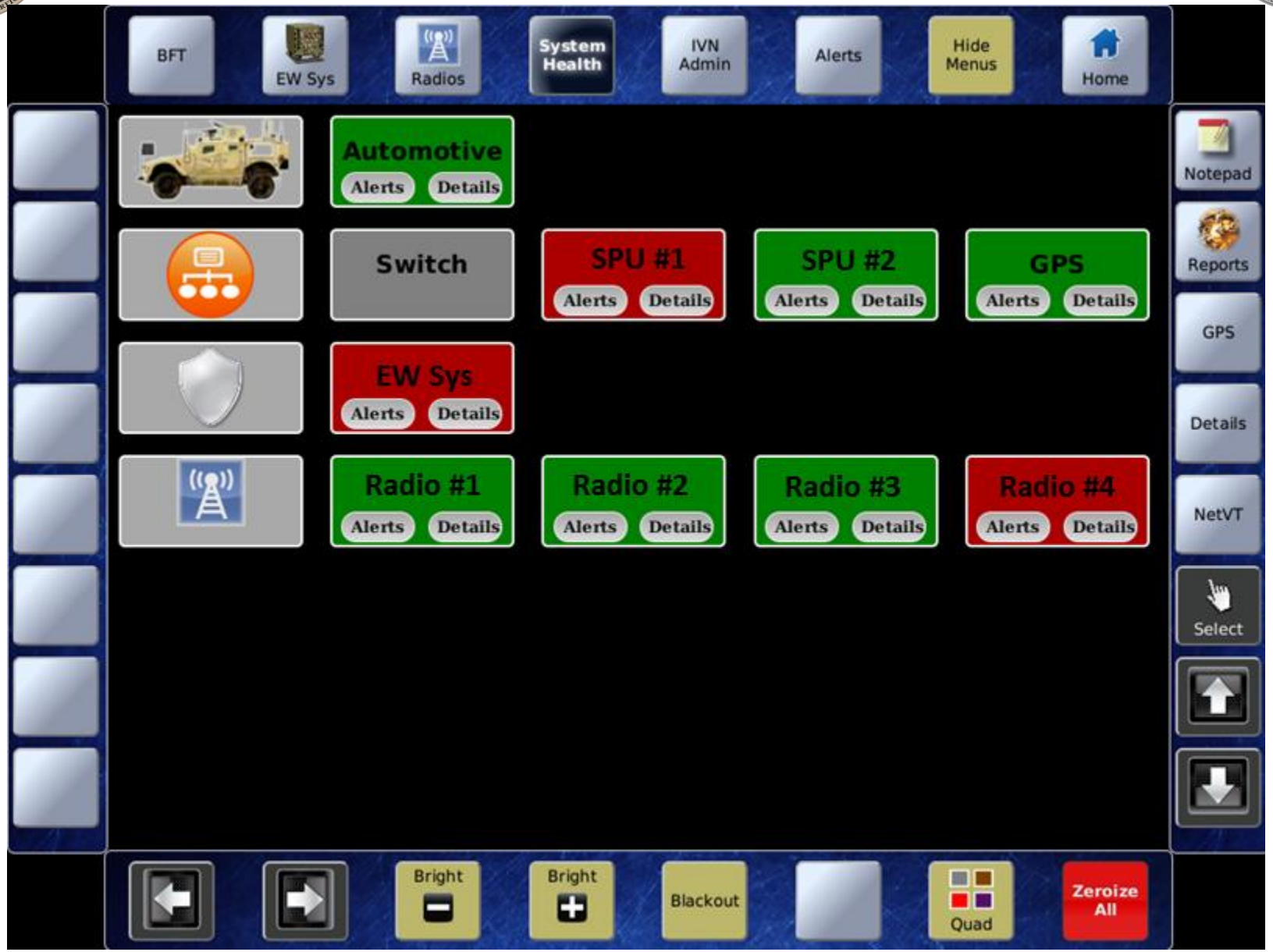
to develop a functioning in-vehicle network (IVN) prototype utilizing VICTORY standards for the M-ATV. Integration consisted of software development and hardware integration onto a USMC M-ATV with a goal to have a functioning prototype within 12 months.

❖ **Actual 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**

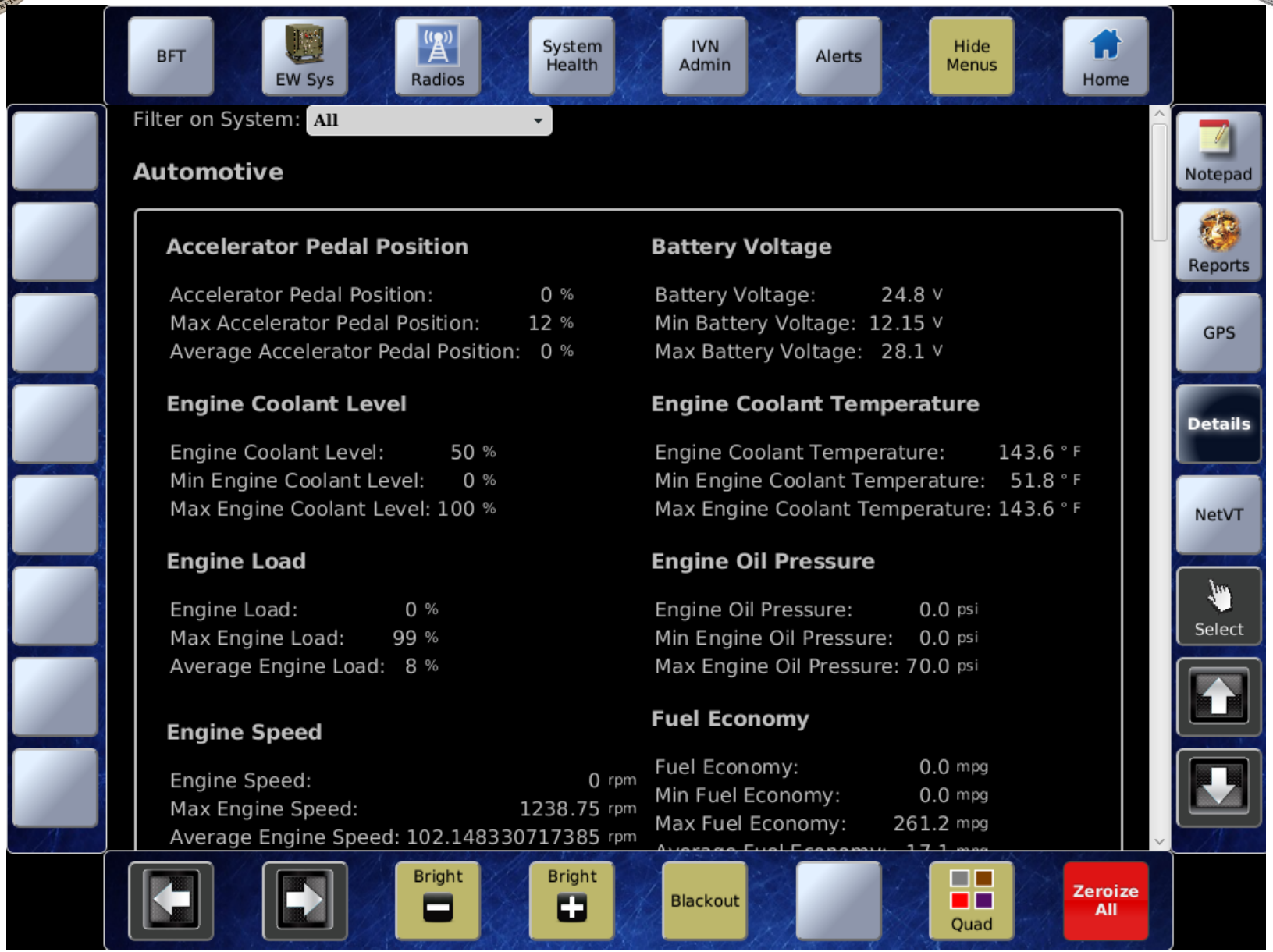
IVN Screen: Home Screen

IVN Screen: System Health



IVN Screen: Radios

IVN Screen: Details - Automotive



IVN Benefits

- **Improve Size/Weight/Power/Cost (SWaP-C) considerations**
  - Reduce the SWaP-C burden and improve ingress and egress
- **Enhance local situational awareness**
  - Can 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
  - Multiple use hardware: "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 (more/less complex) to reflect program priorities and requirements.
  - Maintain room for future 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 was easy to navigate.
  - Concern over introducing a single point of failure or additional vulnerability.

Conclusions

❖**For programs considering 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 requirements 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 original equipment manufacturers 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 working groups. (www.victory-standards.org)

Questions?