Vetronics Reference Architecture

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31 May 2001
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<th><strong>Report Date</strong></th>
<th><strong>Report Type</strong></th>
<th><strong>Dates Covered (from... to)</strong></th>
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<td>NDIA (National Defense Industrial Association) 211 Wilson Blvd, STE. 400 Arlington, VA 22201-3061</td>
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Agenda

• Architecture Concepts/Overview
• VRA Objectives
• VRA Components
• Systems Reference Architecture
• Hardware Reference Architecture
• Software Reference Architecture
Architecture Concepts/Overview

- **Reference Architecture (RA)**
  - Abstract view/organization of primary elements within the domain.
  - Serves as specific System Architecture development framework.
- **Technical Architecture (TA)**
  - Standards (hw, sw, mechanical, etc.) utilized as building blocks to construct systems.
- **Intelligent Domain Model**
  - Captures system intelligence such that computational processes can be allocated to system processing components (e.g. human, robotic, man in the loop)
- **Systems Architecture (Cross product of RA, TA, and Intelligent Domain Model)**
  - Defines interconnected systems components organized to represent the final manner in which the system will be constructed to include hw and sw.

**Need to focus on refining RA, TA, and Intelligent Domain Model to derive a common Vetronics architecture.**
VRA Objectives

• The main objective of the VRA is to define a generic system architecture that can serve as a template for the development of new or upgraded Vetronics & Robotic systems

  ▸ Reduce ground combat vehicle acquisition and support costs through:
    • *Improved Commonality*
    • *Increased Hardware Component Reuse*
    • *Increased Software Component Reuse*
  ▸ Utilizes Industry Supported Open Standards
  ▸ Provides:
    • *Fault Tolerance*
    • *Redundancy*
    • *Degraded Operation Modes*
  ▸ Facilitates Upgradability through:
    • *Standard Interfaces*
    • *Technology Insertion*

*The RA maximizes the use of industry supported open standards and promotes software reuse*
The Vetronics Reference Architecture is characterized by three components:

- Systems Reference Architecture (SRA)
- Hardware Reference Architecture (HRA)
- Software Reference Architecture (SRA)

*The Reference Architecture (RA) components are partitioned by engineering discipline*
The Army ground vehicle manned/robotic system will be divided into five primary elements:

- CORE VETRONICS
  - Controls & Displays
  - Computer Resources
  - Power MGT & Generation
  - Data Cont. & Distribution

- HIGH-END REAL-TIME
- INFORMATION SYSTEMS
- HIGH POWER LOAD MANAGEMENT
- AUTOMOTIVE & UTILITY SYSTEMS

The Primary Elements provide the bins for leveraged industry & government technologies.
The System Reference Architecture defines the abstract organization of the primary elements within the system.
• High Speed Data Bus
• For vehicle applications requiring a high-speed (~1 Gbps) data transfer capability between Core Vetronics and other vehicle systems:
  ▸ Example Standards –
    - ANSI X3.230, Fibre Channel, Physical and Signaling Interface
    - ANSI X3.272, Fibre Channel, Arbitrated Loop
    - IETF Standard 6, User Datagram Protocol

Test, Debug, and Maintenance Bus
• For digital data communications to processing elements within a vehicle for the purpose of test, debug, and maintenance:
  ▸ Example Standards –
    - IETF Standard 5, Internet Protocol
    - IETF Standard 7, Transmission Control Protocol

Complete listing of the standards is in the VRA document
The Hardware Reference Architecture consists of the following of user configurable elements:

The HRA hardware is an open, expandable architecture that is scalable to meet application requirements and target unit cost.
• The HRA open architecture utilizes and supports the use of industry open standards thus providing a means to promote:
  ‣ **Commonality, Reusability and Upgradeability**

Depending on the crew size, complexity and fault-tolerance requirements of the vehicle one or more physical nodes may be required.
Hardware Reference Architecture Standards

• CVPU Chassis consists of a backplane that mechanically accept circuit cards.
  ‣ *Utilize conduction cooling as a preferred means of removing heat*
  ‣ Example Standards – ANSI/VITA 1 (VME64)
    IEEE Std 1101.2 (Conduction-Cooled Eurocards)

• SRU modules accommodate mezzanine plug-on card sites for application tailoring and I/O expansion and custom interfaces
  ‣ *Utilize PMC as a preferred interface*
  ‣ Example Standards – PICMG Version 2.1 Compact PCI (Peripheral Component Interconnect) Specification
    IEEE P1386.1 (PCI Mezzanine Cards)

• Power Supply Module (PSM) - will provide all the necessary power for components in the CVPU.
  ‣ *Utilize military standards for vehicle power requirements*
  ‣ Example Standards - *MIL-STD-1275* 
    *MIL-STD-464*

*Complete listing of the standards is in the VRA document*
Software Reference Architecture
Rationale

• Identification, selection, and application of relevant standards/middleware.
• Ensuring mixed software languages, middleware, and development environments work together.
• Selection/integration of relevant next generation technologies while avoiding technology obsolescence.
• Maximization of COTS technologies/products (promote multiple vendor sources/competition to ensure availability of market alternatives).
• Maintaining real time performance while providing protection/isolation to the application software.
• Reduce the amount of time required to develop Vetronics systems
• Keep us on schedule and budget
• Produce re-useable Vetronics hardware and software components
• Increase the level of commonality between vehicles
• Promote the adoption of open systems architecture concepts
• Improve compliance with JTA-Army standards
Software Reference Architecture
Goals

• Non proprietary and Open System
• Provide flexibility where possible
• Layered and focused on interfaces
  ‣ Provide traceability from APIs to defined system requirements.
  ‣ Design APIs for reuse and interoperability (define physical/logical interfaces).
    • Define APIs/middleware to isolate dependencies, ease porting,
    • Define APIs/middleware to be adaptable in order to map to a variety of implementations.
  ‣ Define APIs/middleware such that they can be replaced by emerging standards as they mature and are accepted by industry and DoD.
  ‣ Design APIs for testability (carry through conformance/validation requirements).
• Not locked into specific paradigms (e.g. patterns, languages, methodologies).
• Include industry, academia, and standards bodies to the degree possible when defining new APIs and/or middleware.
Software Reference Architecture

Populated from JTA-Army and Iterative TA and Domain Intelligence Modeling.
An API/Standards-based architecture concentrates on interface definition by identifying applicable APIs and standards for physical and logical interfaces.

- Utilizes SAE GOA model as a clear concise framework to partition capability.
- Concentrates on interfaces to achieve interoperability, not products.

Benefits:

- Promotes reuse at multiple layers.
- Minimizes application impact from insertion of new technologies.
- Facilitates interoperability through the identification of unambiguous interface definitions.
- Enables plug and play capability not only at the resource access services layer (hw/drivers), but at the system services and application layers as well.

Where Utilized:

- Commercial/industrial base to facilitate product line engineering.
- WSTAWG/JTA-Army
Summary

• VRA defines a generic system architecture that can serve as a template for the development of new or upgraded Vetronics & Robotic systems
• VRA consists of a system, hardware and software reference architecture
• The VRA
  ‣ Reduces ground combat vehicle acquisition and support costs
  ‣ Utilizes Industry Supported Open Standards
  ‣ Facilitates Upgradability
• The VRA is being used on the Crew-Automation and Integration Testbed/Robotic Follower Advanced Technology Technology Demonstrator

Contact Rakesh Patel, (810) 574-5188 US Army TACOM for copy of VRA