U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND

C4ISR/EW Modular Open Suite of Standards (CMOSS) Overview

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PROBLEM STATEMENT – WHY CONVERGE?

Current generation of C4ISR/EW systems exceed the size, weight, and/or power available on current and planned future platforms

At the core, C4ISR/EW systems use many of the same building blocks, but they are not shared or distributed between systems (e.g., amplifiers, filters, processors)

Each additional capability or function comes as its own "system" resulting in:

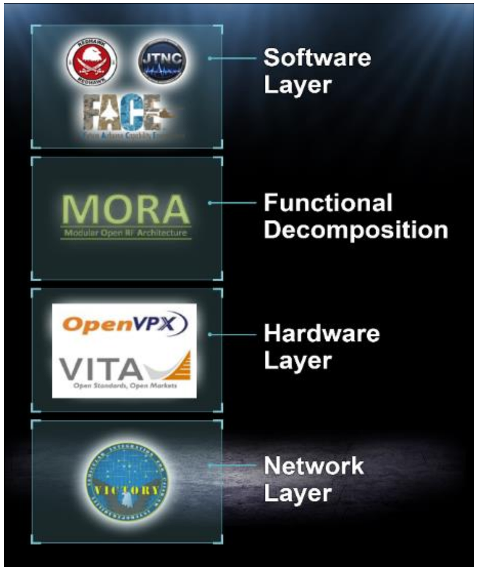
- Integration challenges
  - Competition for limited platform resources
  - Redundant sub-system components
  - Complex, costly and weighty cabling
  - Excessive heat generation
  - Less space on the platform for soldiers
- RF compatibility concerns
- High cost of maintaining and upgrading

Years of quick reaction solutions have resulted in unsustainable SWaP-C and operator overload

Platforms – not just soldiers – are overburdened

CMOSS OBJECTIVES

- CMOSS aims to:
  - Provide pools of sensors and processors available to multiple applications
  - Facilitate rapid insertion of new hardware and software into systems
  - Facilitate shared hardware to reduce SWaP requirements
- CMOSS consists of a **suite of layered standards** that are individually useful and can be combined to form a holistic converged architecture



Software Layer:
- Enables portability of software applications across hardware platforms
- Software framework selected based on mission area

Functional Decomposition:
- Allows for sharing of RF resources such as antennas and amplifiers
- Defines interfaces between RF functions and components
- Enables best of breed along with rapid component upgrades

Hardware Layer:
- Enables capabilities to be fielded as cards in a common chassis
- Common form factor including physical, electrical, and environmental specifications

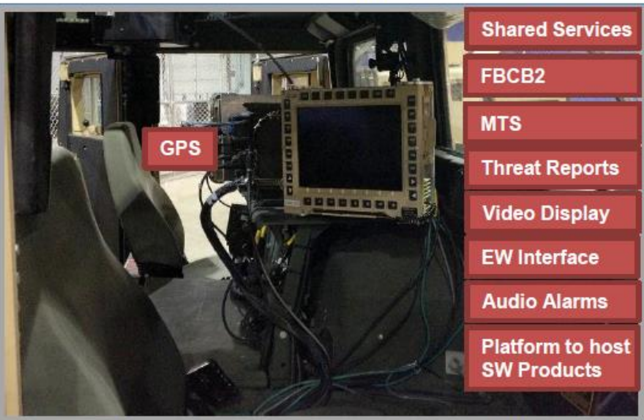
Network Layer:
- Provides connectivity within the platform and defines interfaces between capabilities
- Enables legacy systems to share services within the converged architecture

VEHICULAR INTEGRATION FOR C4ISR/EW INTEROPERABILITY (VICTORY)

Traditional Approach

"Bolt On" Mission Equipment Integration

VICTORY Approach



VICTORY Data Bus enables interoperability across C4ISR/EW and platform systems

Adds a network data bus to vehicles

- Specifies "on-the-wire" network-based interfaces for discovery, management, health publishing, and data exchange
- Provides shared hardware and user interface hardware
- Provides shared services including time synchronization, position, orientation, and direction of travel
- Supports IA requirements and "defense in depth" security designs

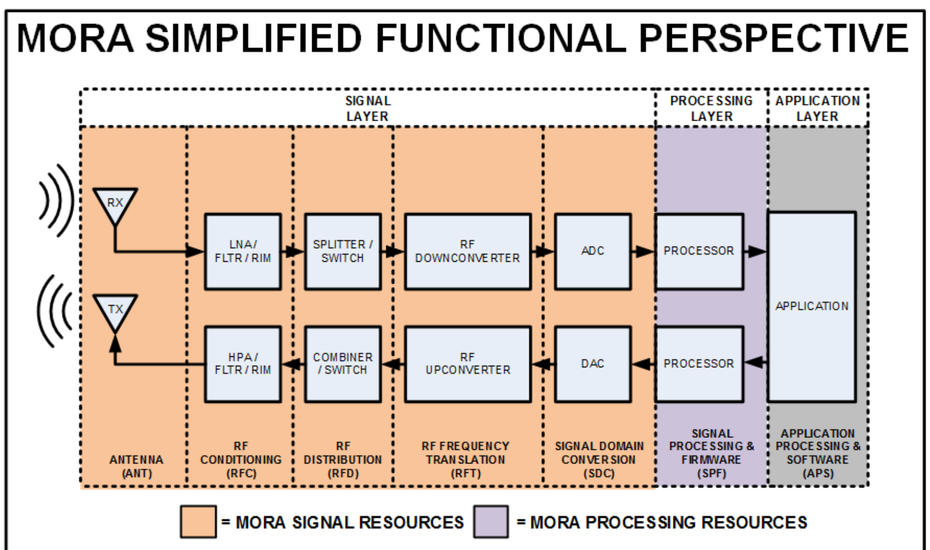
VICTORY leverages the following commercial technologies:

- SOAP-based web services and Simple Network Management Protocol (SNMP) for management
- Syslog over UDP and SNMP for health publishing
- VICTORY Data Messages (VDMs) for data distribution
  - XML application layer payload encapsulated in a VDM-specific binary header
  - Multicast UDP provides a simple publish/subscribe paradigm
- Zero Configuration Networking (Zeroconf) for node and service discovery

VICTORY enables interoperability across C4ISR, EW, and platform systems on Army ground vehicles. Technical approach is applicable to air, sea, and subsurface platforms.

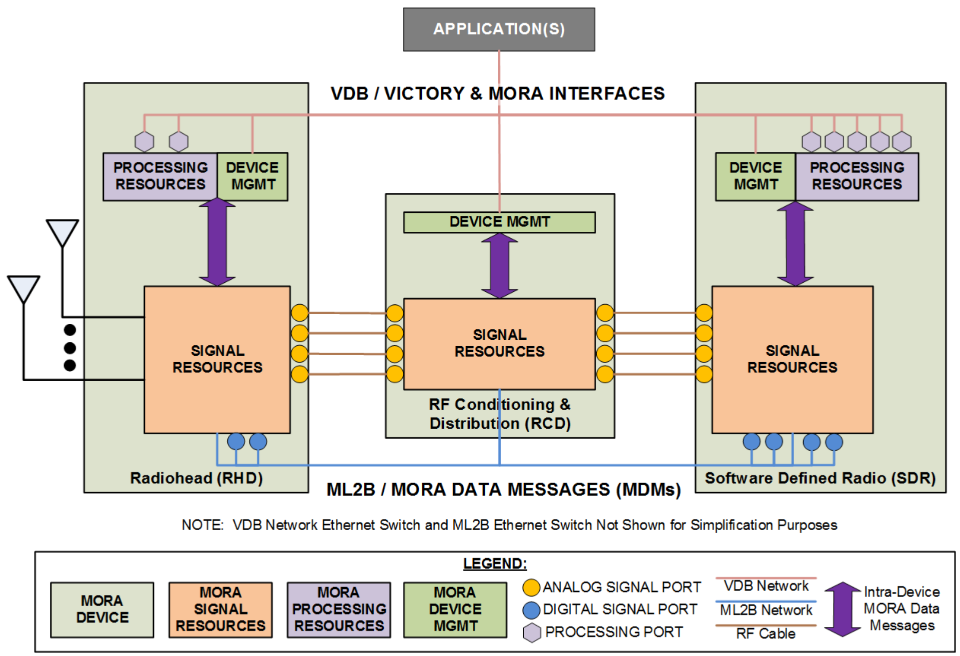
MODULAR OPEN RF ARCHITECTURE (MORA) OVERVIEW

- MORA integrates VICTORY and VITA Radio Transport (VITA 49.2) to standardize access and control of the RF chain
- Decomposes the RF chain into the following signal resources:
  - Antennas (antenna elements / arrays)
  - RF Conditioning (e.g., LNAs, filters and HPAs)
  - RF Distribution (e.g., RF switches)
  - RF Frequency Translation (e.g., tuners and up converters)
  - Signal Domain Conversion (e.g., ADCs and DACs)



MODULAR OPEN RF ARCHITECTURE (MORA) RESOURCE MANAGEMENT

- Resource management occurs over different physical links than control and data due to performance and security considerations
- Discovery and allocation occur in non real-time (milliseconds or seconds) over the VICTORY Data Bus (VDB)
  - Leverages SOAP-based web services with MORA defined WSDLs and schemas
  - Inherits the IA controls and attribute-based access control (ABAC) framework provided by VICTORY
  - Priority-based resource reservation restricts control to a single entity at a given time
  - Data can be subscribed to by multiple entities
  - Interfaces enable but do not prescribe implementation of the resource manager itself



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MODULAR OPEN RF ARCHITECTURE (MORA) CONTROL AND DATA

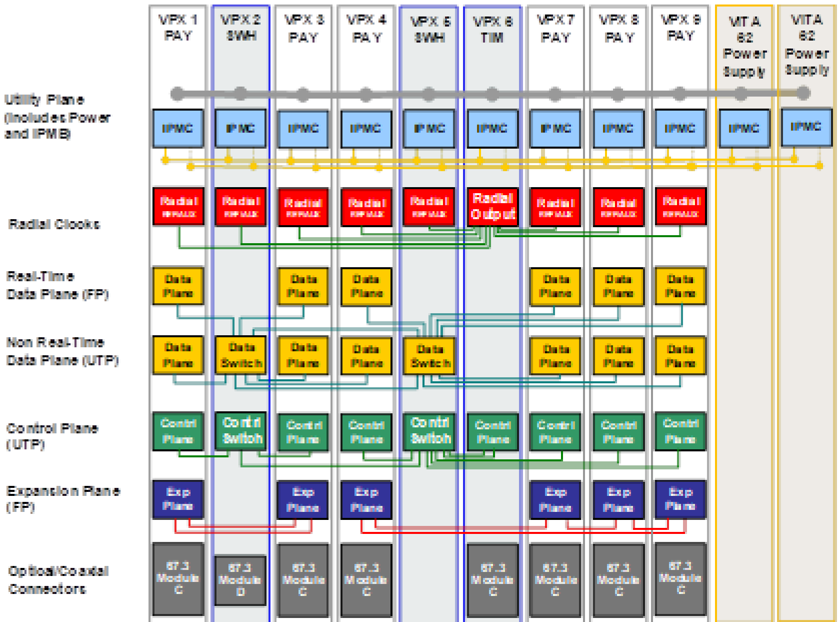
- RF control and data distribution occur in real-time (microseconds) over the MORA Low Latency Bus (ML2B)
- MORA Data Message (MDM) binary header encapsulates VITA 49.2
  - Enables ACK-based reliable delivery over UDP without degrading performance
  - Data and context messages use multicast for one-to-many distribution
  - Different Ethernet and IP service classes defined for control and data packets
- MORA necks down VITA 49.2 to ensure interoperability
  - Limits packet types that are supported
  - Identifies required fields
  - Limits field options such as timestamp and data format
  - Defines the Discrete I/O field to replace discrete signals

Bit	CIF 0 (V49.0) *Legacy Fields, CIF enables*	CIF 1 (V49.2) *Spatial, Signal, Spectral, I/O, Ctl*	CIF 2 (V49.2) *Identifiers (tags)*	CIF 3 (V49.2) *Temporal, Environmental*	CIF 7 (V49.2) *Attributes*
31	Context Field Change Indicator	Phase	Bind	Timestamp Details	Current Value
30	Reference Point Identifier	Polarization	Cited SID	Timestamp Skew	Average Value
29	Bandwidth	3-D Pointing Vector	Sibling(s) SID	*Reserved*	Median Value
28	IF Reference Frequency	3-D Pointing Vector Structure	Parent(s) SID	*Reserved*	Standard Deviation
27	RF Reference Frequency	Spatial Scan Type	Child(ren) SID	Rise Time	Max Value
26	RF Reference Frequency Offset	Spatial Reference Type	Cited Message ID	Fall Time	Min Value
25	IF Band Offset	Beamwidth	Controllee ID	Offset Time	Precision
24	Reference Level	Range (Distance)	Controllee UUID	Pulse Width	Accuracy
23	Gain	*Reserved*	Controller ID	Period	1st Derivative (Velocity)
22	Over-range Count	*Reserved*	Controller UUID	Duration	2nd Derivative (Acceleration)
21	Sample Rate	*Reserved*	Information Source	Dwell	3rd Derivative
20	Timestamp Adjustment	Eb/No BER	Track ID	Jitter	Probability
19	Timestamp Calibration Time	Threshold	Country Code	*Reserved*	Belief
18	Temperature	Compression Point	Operator	*Reserved*	*Reserved*
17	Device Identifier	2nd and Third-Order Intercept Points	Platform Class	Age	*Reserved*
16	State/Event Indicators	SNR/Noise Figure	Platform Instance	Shelf Life	*Reserved*
15	Signal Data Packet Payload Format	Aux Frequency	Platform Display	*Reserved*	*Reserved*
14	Formatted GPS	Aux Gain	EMS Device Class	*Reserved*	*Reserved*
13	Formatted INS	Aux Bandwidth	EMS Device Type	*Reserved*	*Reserved*
12	ECEF Ephemeris	*Reserved*	EMS Device Instance	*Reserved*	*Reserved*
11	Relative Ephemeris	Array of CIFS	Modulation Class	*Reserved*	*Reserved*
10	Ephemeris Ref ID	Spectrum	Modulation Type	*Reserved*	*Reserved*
9	GPS ASCII	Sector Scan/Step	Function ID	*Reserved*	*Reserved*
8	Context Association Lists	*Reserved*	Mode ID	*Reserved*	*Reserved*
7	Field Attributes Enable	Index List	Event ID	Air Temperature	*Reserved*
6	*Reserved for CIF expansion*	Discrete I/O (32-bit)	Function Priority ID	Sea/Ground Temperature	*Reserved*
5	*Reserved for CIF expansion*	Discrete I/O (64-bit)	Communication Priority ID	Humidity	*Reserved*
4	*Reserved for CIF expansion*	Health Status	RF Footprint	Barometric Pressure	*Reserved*
3	CIF 3 Enable	V49 Spec Compliance	RF Footprint Range	Sea and Swell State	*Reserved*

Required VITA 49.2 Context/Command Indicator Fields (CIF)

DOD OPENVPX PROFILES

Example Backplane



Supports DoD-specific concerns including:

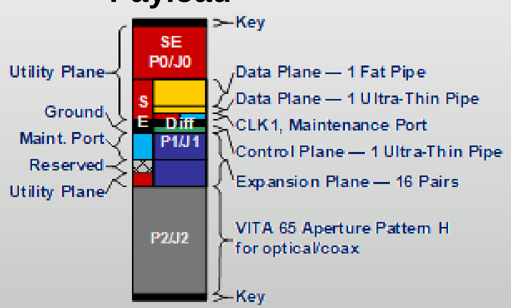
- Connectivity for the VICTORY Data Bus (Control Plane) and MORA Low Latency Bus (Real-Time Data Plane)
- Radial clock distribution for phase coherent operation
- Blind-mate optical and coaxial connectors for two-level maintenance

Maximizes interoperability by:

- Specifying a single slot profile for each type of card (e.g., Payload, Radial Clock, etc.)
- Limiting protocols to a single technology family
  - Ethernet for Control and Data Planes
  - PCIe for Expansion Plane
- Limiting the use of user-defined pins

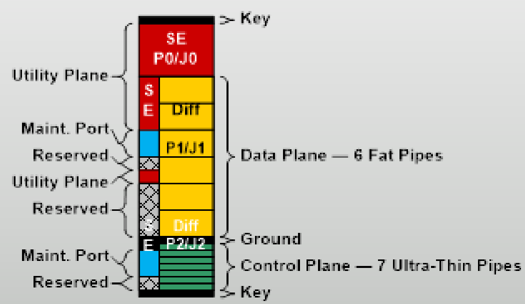
Slot Profiles

Payload



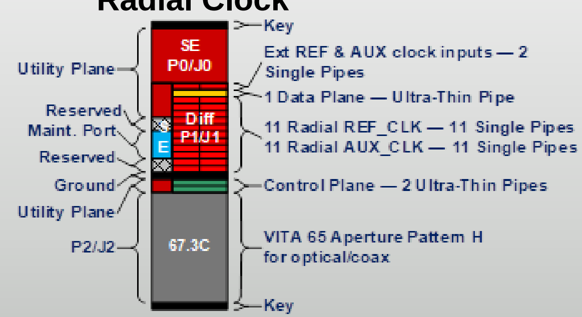
RF and Computing
SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-n

Ethernet Switch



SLT3-SWH-6F1U7U-14.4.14-n
SLT3-SWH-4F1U7U1J-14.8.7-n

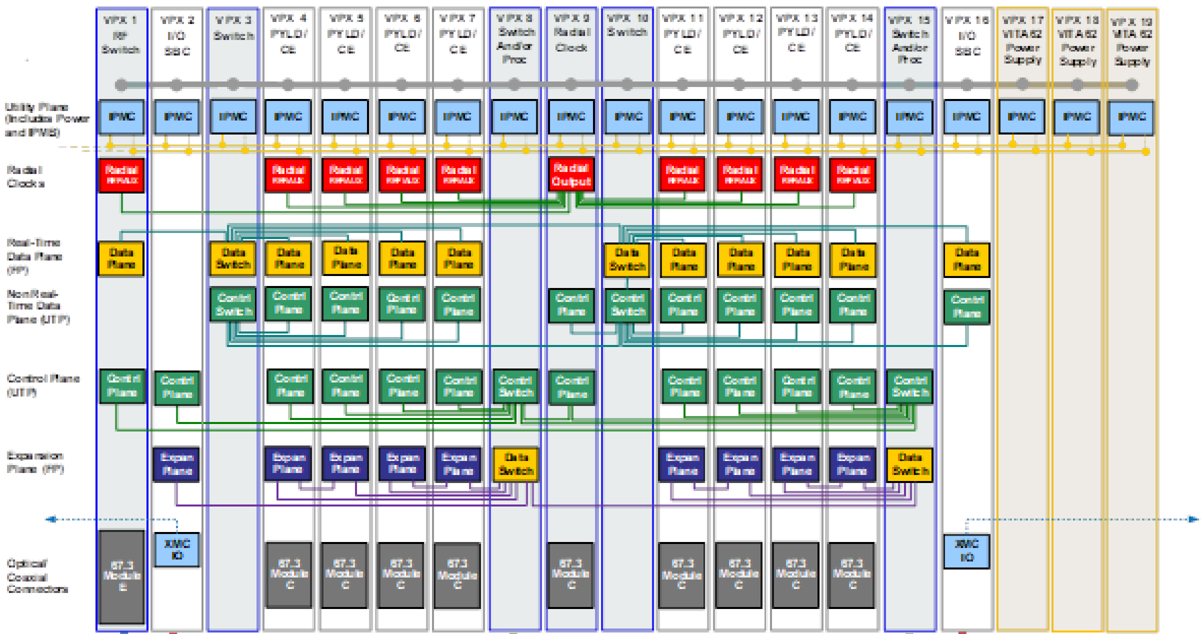
Radial Clock



Position, Navigation, and Timing
SLT3x-TIM-2S1U22S1U2U1H-14.9.2-n

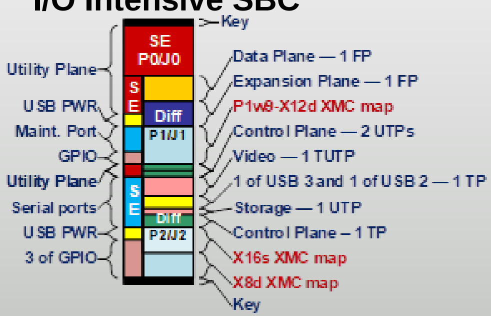
DOD OPENVPX PROFILES

Example Backplane



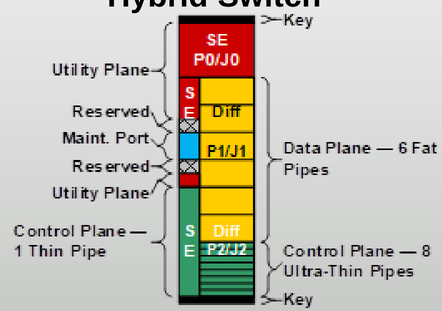
Slot Profiles

I/O Intensive SBC



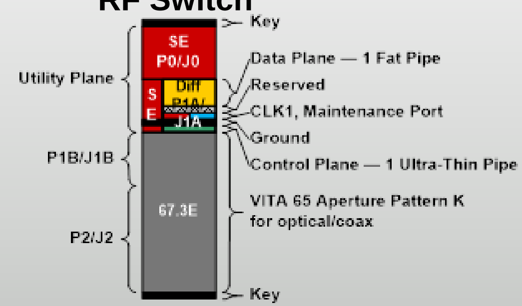
Platform I/O
SLT3-PAY-1F1F2U1TU1T1U1T-14.2.16

Hybrid Switch



Ethernet and PCIe
SLT3-SWH-6F8U-14.4.15

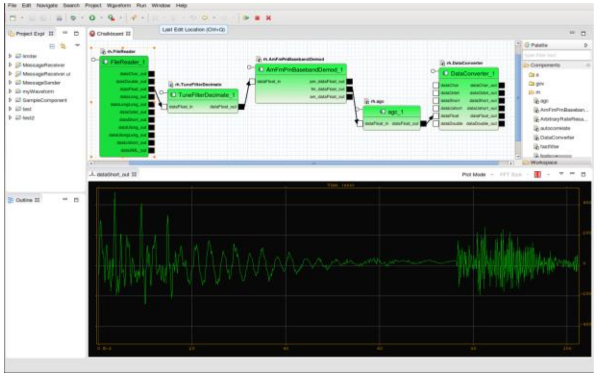
RF Switch



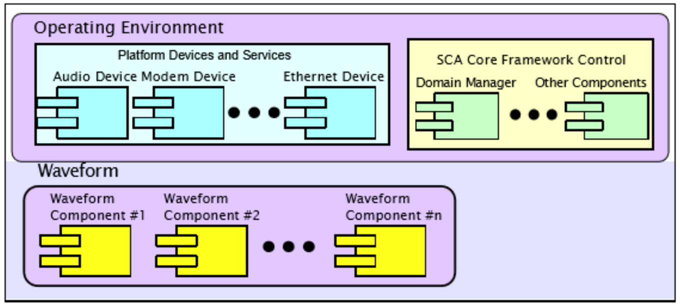
Analog RF Distribution
SLT3-SWH-1F1S1S1U1U1K-14.8.8-n

SOFTWARE FRAMEWORKS

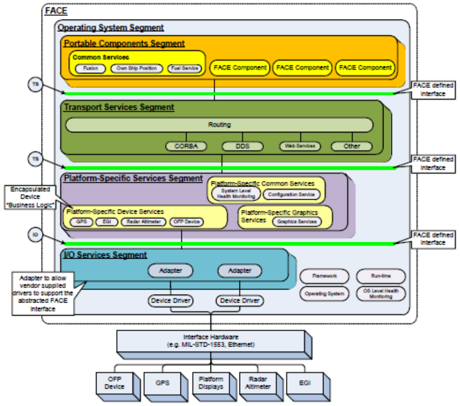
- Enable portability of software applications across hardware platforms
- Appropriate software framework is dependent on mission area
  - REDHAWK: Free and Open Source Software (FOSS) Software Defined Radio (SDR) framework
  - Software Communications Architecture (SCA): Developed by JTNC for Comms applications
  - Future Airborne Capability Environment (FACE): Developed by NAVAIR PMA-209 for avionics applications
- Software frameworks can be integrated with network layer to maximize reuse and leverage existing capabilities
  - MORA REDHAWK Device
  - VICTORY Platform-Specific Services Segment (PSSS) within FACE



REDHAWK IDE (from REDHAWK website)

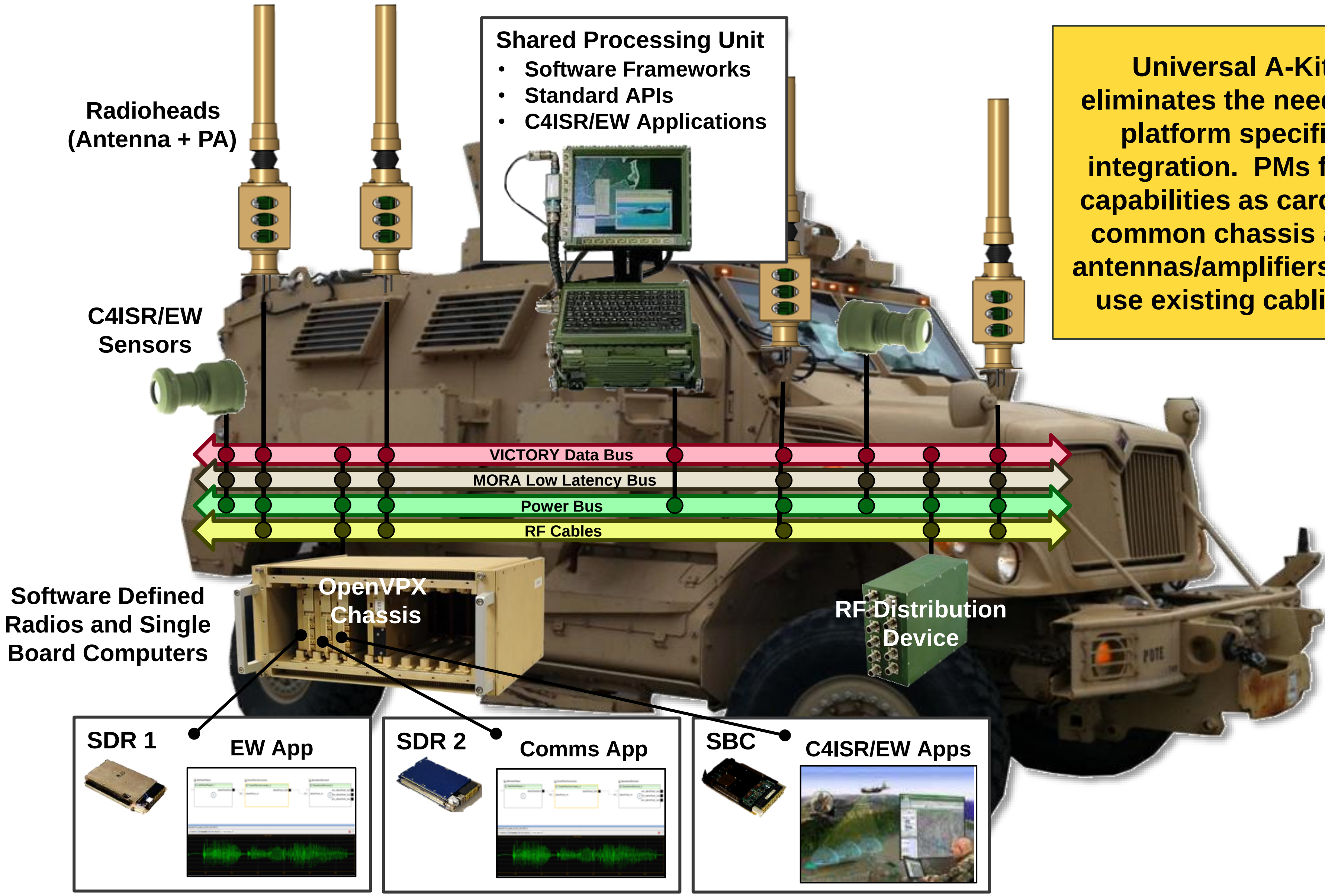


Composition of a SCA System (from SCA Specification V4.1)



Architecture Segments Example (from FACE Technical Standard 2.1)

CMOSS ARCHITECTURE



Universal A-Kit eliminates the need for platform specific integration. PMs field capabilities as cards in common chassis and antennas/amplifiers that use existing cabling.

SUMMARY

- Built upon open standards, CMOSS enables the soldier for the next fight while providing significant cost savings during the procurement and sustainment phases of the life-cycle
- Multiple cards and capabilities are available or under development providing EW, SIGINT, Comms, and Cyber capabilities
- CMOSS is being included in and managed under the SOSA initiative with Army, Air Force, and Navy participation
- The CMOSS specifications can be obtained from:
  - VICTORY (https://portal.victory-standards.org)
  - MORA (https://portal.victory-standards.org/MORA)
  - OpenVPX (http://www.vita.com)
  - REDHAWK (https://redhawksdr.github.io/Documentation)
  - SCA (http://www.public.navy.mil/jtnc)
  - FACE (http://www.opengroup.org/face)
  - SOSA (http://www.opengroup.org/sosa)