U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND C5ISR CENTER

C5ISR/EW Modular Open Suite of Standards (CMOSS) Overview

Jason Dirner

MOSA Chief Engineer

MOSA Management Office, DEVCOM C5ISR Center ESI

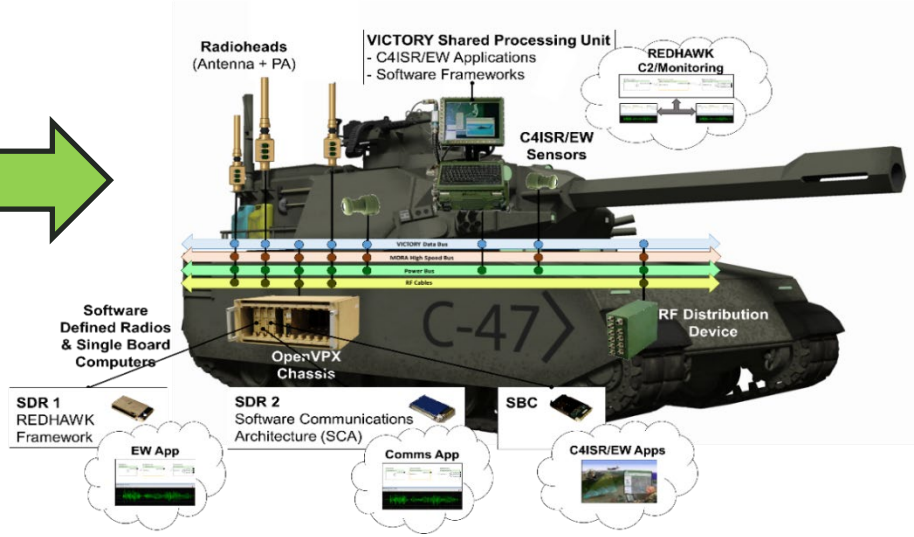
18 MAR 2022

CMOSS OVERVIEW

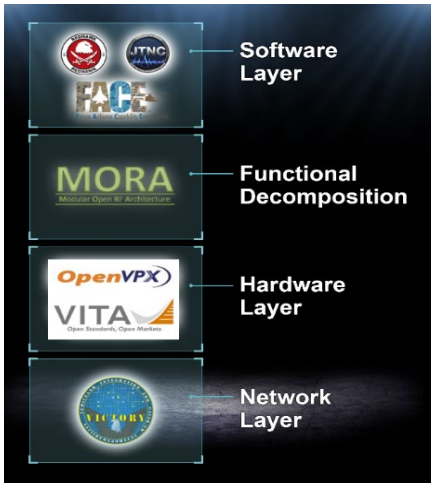
Why Converge?

CMOSS

CMOSS Architecture



C5ISR/EW Modular Open Suite of Standards (CMOSS)



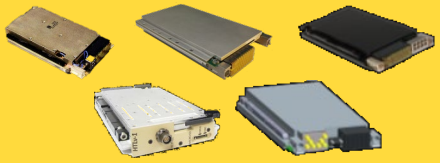
- CMOSS is a suite of standards to support the reduction of the size, weight and power of C5ISR and EW systems while increasing the flexibility and adaptability of these systems
  - Universal A-Kit – Project Managers field capabilities as cards into a common chassis
  - Pooled radio resources such as antennas and amplifiers for Communications, Electronic Warfare (EW), and Signals Intelligence (SIGINT) systems
  - Shared processing resources such as computers and displays
  - Shared data services such as Position, Navigation, and Time (PNT)
  - Foundation for enhanced interoperability and simultaneity between C5ISR systems
  - Reduced life cycle cost through increased competition, smaller logistics tails with common sparing, and upgrading to the latest hardware as parts are replaced
  - Rapid insertion of new technology/capability

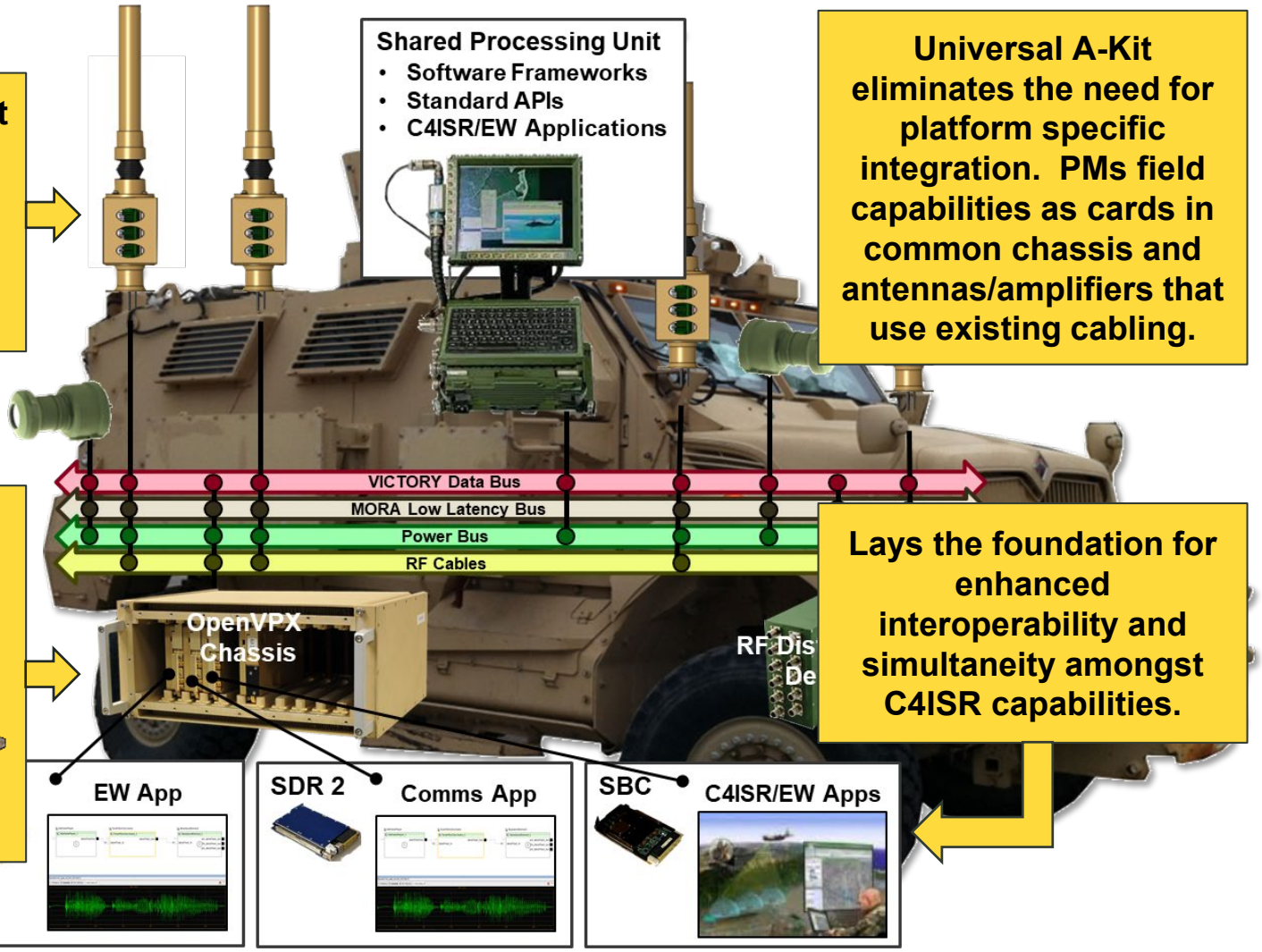
Army, Air Force, and Navy collaborate under the SOSA Consortium to develop a holistic open architecture that leverages existing standards, maximizes economies of scale, and provides the flexibility to rapidly insert the latest capabilities to achieve Future Force Modernization.

CMOSS ARCHITECTURE

Reduces the size, weight and power footprint of C4ISR systems by sharing hardware such as antennas and amplifiers.

Enables rapid technology insertion using best of breed capabilities to address emerging requirements.





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.

Lays the foundation for enhanced interoperability and simultaneity amongst C4ISR capabilities.

Reduces logistics tails by enabling common sparing. Eliminates the need for "End of Life" buys for a 30+ years sustainment by enabling hardware modernization every 5-10 years.

CMOSS DEVELOPMENT HISTORY

C5ISR Center Kickoff of HW/SW Convergence OCT 13

MORA V1.1 SEP 14

CMOSS Lab Demo APR 15

Army, Air Force, and Navy Kickoff SOSA Consortium NOV 15

MORA V2.0 JAN 16

CMOSS Lab Demo APR 17

CMOSS Vehicle Demo OCT 17

First POR Uses CMOSS SEP 18

CMOSS Profiles in SOSA Snapshot 1 FEB 18

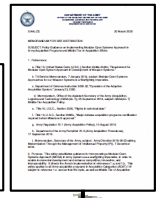
MORA V2.2 SEP 18

Tri-Service Memo JAN 19

PM EW&C CMOSS Memo JUN 19

MORA in VICTORY V1.8 APR 19

ASA(ALT) MOSA Memo MAR 20



CMFF A-CDD Approved JAN 21

VICTORY V1.9 / MORA V2.4 APR 21

SOSA V1.0 SEP 21

MORA V2.1 JUN 17

CMOSS Profiles in OpenVPX JUL 17

MORA Input to ANSI/VITA 49.2 JUL 17

MORA in SOSA Snapshot 2 JAN 19

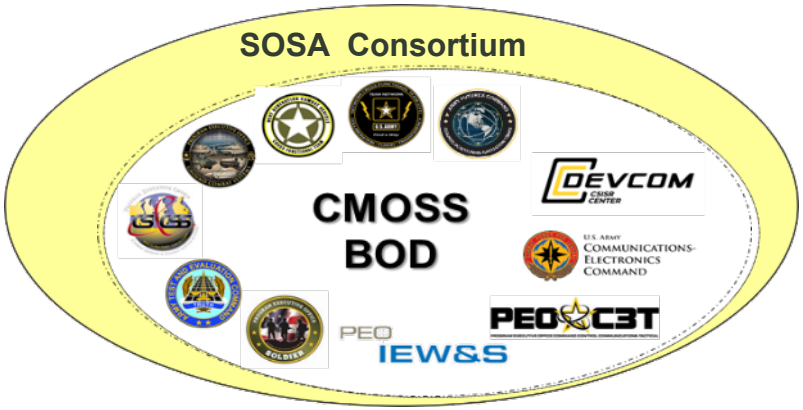
MORA V2.3 AUG 19

SOSA Snapshot 3 JUL 20

CMOSS/SOSA in NDAA FY21 HASC JUL 20

C5ISR CENTER CMOSS STRATEGY

ORGANIZE



SYNCHRONIZE

- C5ISR Center S&T and CMOSS prototyping efforts
- PEO IEW&S
- PEO C3T
- PEO GCS
- PEO Aviation
- N-CFT and APNT/Space CFT
- AFLCMC Open Architecture Management Office
- NAVAIR PMA-209
- Industry Partners
- International Partners

EXECUTE

MOSA Management Office

Manage
- Manage and mature standards
- Educate community
- Application to relevant S&T

SIL
- Lab and development architecture
- Transition deliverables
- Compliance/performance tools and tests

Field Experiment
- Baseline platform architecture
- Compliance/performance tests
- Tech demonstrations

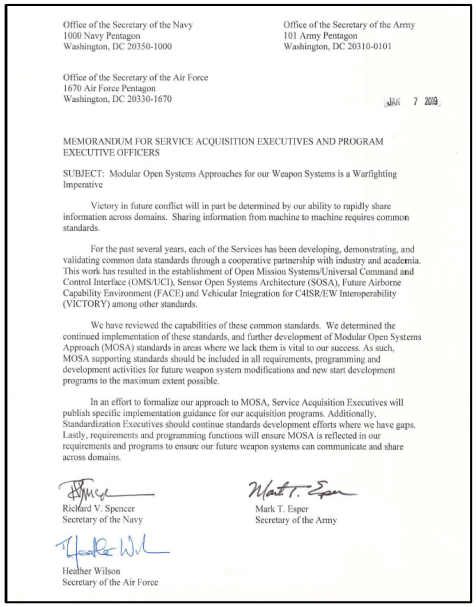
Contact usarmy.apg.devcom-c5isr.mbx.mmo@army.mil for additional info

MOSA MANAGEMENT OFFICE RESPONSIBILITIES

- Coordinate MOSA usage across C5ISR Center
  - Review S&T projects and identify cross cutting opportunities to include MOSA
  - Allocate MOSA implementation funding for labs, experimentation, and matrixed SME support
  - Provide MOSA training for directorate SME's
  - Facilitate technology transition
- Manage and mature standards
  - Develop and maintain the CMOSS and VICTORY specifications
  - Develop compliance tools and support compliance verification
  - C5ISR Center lead for standards bodies such as the SOSA™ Consortium
  - Coordinate with external MOSA activities
- Provide MOSA support to the acquisition community
  - Consolidate resource requests for MOSA support facilities and staff
  - Support inclusion of MOSA in policy and programs
- Coordinate/represent MOSA with external partners including USAF, USN, FVEY, and Industry

STATUTE AND POLICY

Tri-Service



Office of the Secretary of the Navy
1000 Navy Pentagon
Washington, DC 20350-1000

Office of the Secretary of the Army
101 Army Pentagon
Washington, DC 20310-0101

Office of the Secretary of the Air Force
1670 Air Force Pentagon
Washington, DC 20330-1670

JAN 7 2019

MEMORANDUM FOR SERVICE ACQUISITION EXECUTIVES AND PROGRAM EXECUTIVE OFFICERS

SUBJECT: Modular Open Systems Approaches for our Weapon Systems is a Warfighting Imperative

Victory in future conflict will in part be determined by our ability to rapidly share information across domains. Sharing information from machine to machine requires common standards.

For the past several years, each of the Services has been developing, demonstrating, and validating common data standards through a cooperative partnership with industry and academia. This work has resulted in the establishment of Open Mission Systems/Universal Command and Control Interface (OMS/UCI), Sensor Open Systems Architecture (SOSA), Future Airborne Capability Environment (FACE) and Vehicular Integration for C4ISR/EW Interoperability (VICTORY) among other standards.

We have reviewed the capabilities of these common standards. We determined the continued implementation of these standards, and further development of Modular Open Systems Approach (MOSA) standards in areas where we lack them is vital to our success. As such, MOSA supporting standards should be included in all requirements, programming and development activities for future weapon system modifications and new start development programs to the maximum extent possible.

In an effort to formalize our approach to MOSA, Service Acquisition Executives will publish specific implementation guidance for our acquisition programs. Additionally, Standardization Executives should continue standards development efforts where we have gaps. Lastly, requirements and programming functions will ensure MOSA is reflected in our requirements and programs to ensure our future weapon systems can communicate and share across domains.

Richard V. Spencer
Secretary of the Navy

Mark T. Esper
Secretary of the Army

Heather Wilson
Secretary of the Air Force

Modular Open Systems Approaches for our Weapon Systems is a Warfighting Imperative

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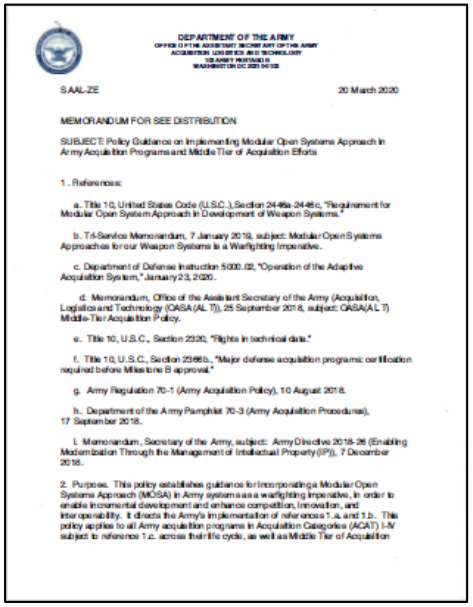
ASA(ALT)



DEPARTMENT OF THE ARMY

SAAL-ZE 20 March 2020

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Policy Guidance on Implementing Modular Open Systems Approach in Army Acquisition Programs and Middle Tier of Acquisition Efforts

1. References:

a. Title 10, United States Code (U.S.C.), Section 2446a-2446c, "Requirement for Modular Open System Approach in Development of Weapon Systems."

b. Tri-Service Memorandum, 7 January 2019, subject: Modular Open Systems Approaches for our Weapon Systems is a Warfighting Imperative.

c. Department of Defense Instruction 5000.02, "Operation of the Adaptive Acquisition System," January 23, 2020.

d. Memorandum, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology (OASA (ALT)), 25 September 2018, subject: OASA(ALT) Middle-Tier Acquisition Policy.

e. Title 10, U.S.C., Section 2320, "Rights in technical data."

f. Title 10, U.S.C., Section 2366b, "Major defense acquisition programs: certification required before Milestone B approval."

g. Army Regulation 70-1 (Army Acquisition Policy), 10 August 2018.

h. Department of the Army Pamphlet 70-3 (Army Acquisition Procedures), 17 September 2018.

i. Memorandum, Secretary of the Army, subject: Army Directive 2018-26 (Enabling Modernization Through the Management of Intellectual Property (IP)), 7 December 2018.

2. Purpose. This policy establishes guidance for incorporating a Modular Open Systems Approach (MOSA) in Army systems as a warfighting imperative, in order to enable incremental development and enhance competition, innovation, and interoperability. It directs the Army's implementation of references 1.a. and 1.b. This policy applies to all Army acquisition programs in Acquisition Categories (ACAT) I-IV subject to reference 1.c. across their life cycle, as well as Middle Tier of Acquisition

Policy Guidance on Implementing Modular Open Systems Approach in Army Acquisition Programs and Middle Tier of Acquisition Efforts

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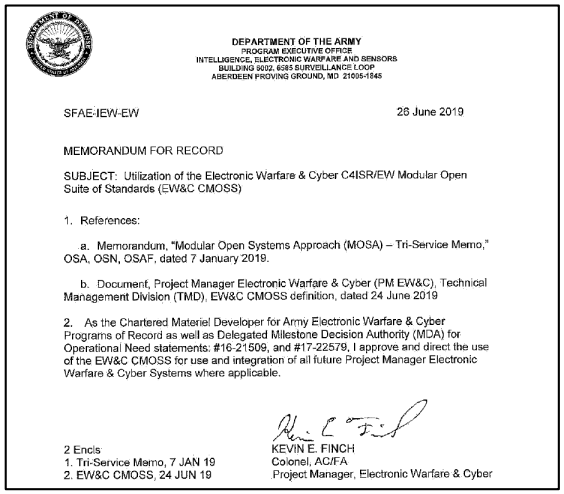
d. PMs:

(1) The PM is the designated individual with the responsibility for and authority to accomplish the objective of MOSA within assigned programs and MTA efforts.

STATUTE AND POLICY

PM EW&C



DEPARTMENT OF THE ARMY
PROGRAM EXECUTIVE OFFICE
INTELLIGENCE, ELECTRONIC WARFARE AND SENSORS
BUILDING 6002, 6585 SURVEILLANCE LOOP
ABERDEEN PROVING GROUND, MD 21005-1845

SFAE-IEW-EW 26 June 2019

MEMORANDUM FOR RECORD

SUBJECT: Utilization of the Electronic Warfare & Cyber C4ISR/EW Modular Open Suite of Standards (EW&C CMOSS)

1. References:

a. Memorandum, "Modular Open Systems Approach (MOSA) – Tri-Service Memo," OSA, OSN, OSAF, dated 7 January 2019.

b. Document, Project Manager Electronic Warfare & Cyber (PM EW&C), Technical Management Division (TMD), EW&C CMOSS definition, dated 24 June 2019

2. As the Chartered Materiel Developer for Army Electronic Warfare & Cyber Programs of Record as well as Delegated Milestone Decision Authority (MDA) for Operational Need statements: #16-21509, and #17-22579, I approve and direct the use of the EW&C CMOSS for use and integration of all future Project Manager Electronic Warfare & Cyber Systems where applicable.

2 Encls
1. Tri-Service Memo, 7 JAN 19
2. EW&C CMOSS, 24 JUN 19

KEVIN E. FINCH
Colonel, AC/FA
Project Manager, Electronic Warfare & Cyber

Utilization of Electronic Warfare & Cyber C4ISR/EW Modular Open Suite of Standards (EW&C CMOSS)

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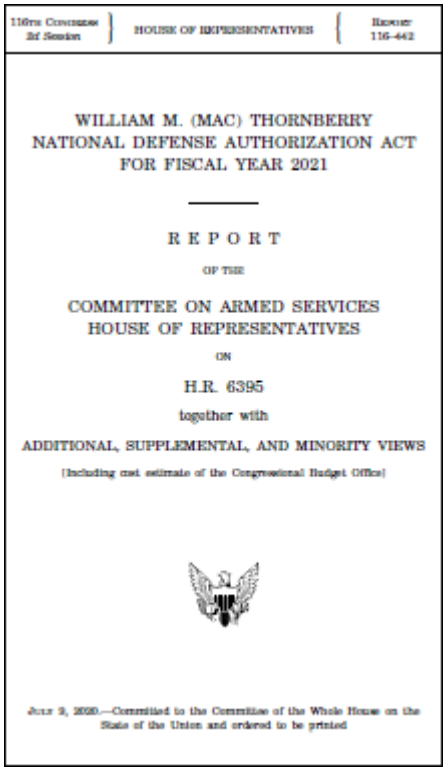
STATUTE AND POLICY

William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021
Report of the Committee on Armed Services
House of Representatives

NDAA FY21 HASC



116TH CONGRESS 2d Session | HOUSE OF REPRESENTATIVES | REPORT 116-442

WILLIAM M. (MAC) THORNBERRY
NATIONAL DEFENSE AUTHORIZATION ACT
FOR FISCAL YEAR 2021

REPORT

OF THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ON

H.R. 6395

together with

ADDITIONAL, SUPPLEMENTAL, AND MINORITY VIEWS

[Including cost estimate of the Congressional Budget Office]

JULY 9, 2020.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Sensor Open Systems Architecture and C4ISR Modular Open Suite of Standards Military Standards Initiative

The committee is encouraged by the military services supporting Modular Open Systems Architectures (MOSA) on all future programs and platform modernization efforts. For example, the Army's C4ISR Modular Open Suite of Standards (CMOSS), and the Air Force's Sensor Open Systems Architecture (SOSA) standards are significant advances.

The committee appreciates the efforts to increase capabilities, speed development, speed technology refresh, lower costs for the Government, and increase competition in the industry. The committee is aware of marked progress made by the Army's PEO (Program Executive Office) C3T (Command, Control, and Communications-Tactical), PEO IEW&S (Intelligence, Electronic Warfare and Sensors), and Network-CFT (Cross-Functional Team). The committee commends such forward thinking and movement to unify around these standards.

Furthermore, the committee recommends that CMOSS and SOSA military electronics standards be more tightly connected to use the same hardware pinout standards and, more importantly, the same software data transport protocols, such as the Modular Open RF Architecture (MORA), to further solidify a common Department of Defense-wide technical approach to create an open systems architecture standard by which small businesses and large primes can compete. To achieve a more effective economy of scale, the CMOSS and SOSA standards must both be a unified hardware and software ecosystem. The committee believes CMOSS is more established at this time and should lead.

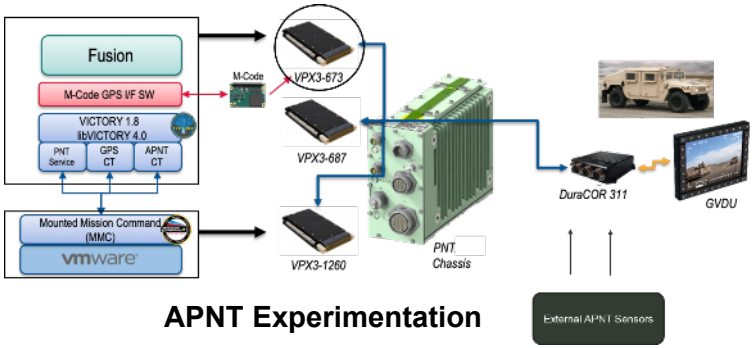
Finally, the committee believes the military services should begin to combine missions to enable CMOSS and SOSA for multi-mission tactical communications, EW (electronic warfare), SIGINT (signals intelligence), and battlefield computing in one system. Such an effort will reduce the SWaP (size, weight, and power) on various platforms for the military electronics, and unify the industry around common military hardware, as well as software, standards.

The committee looks forward to further efforts by the Department of Defense to standardize procurement of modular cards and software according to the CMOSS and/or SOSA standards, for all future modernization and new weapons systems. These efforts will increase competition rather than have the classical single vendors drive their proprietary solutions which will cost the Government much higher modernization costs and decrease innovation.

CMOSS EFFORTS

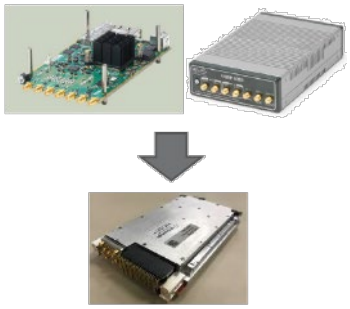
EW Pod

Crypto Card



APNT Experimentation

CEMA System

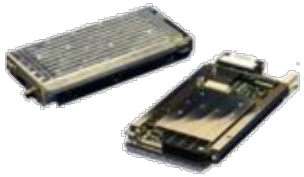


SDR Card

Radio Card

CEMA Card

Integrated Chassis



Radio & COMSEC Cards

SIGINT, EW, and Cyber System

Digital Radiohead

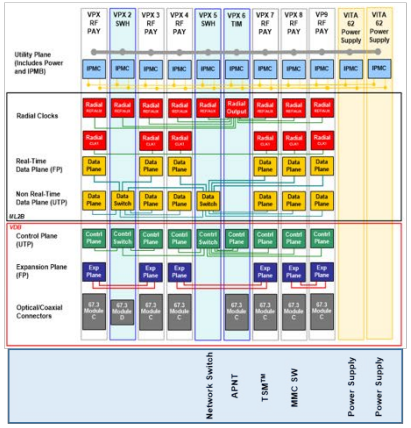
CMOSS MOUNTED FORM FACTOR (CMFF)

CMFF will:

- Integrate MC, PNT, COMMS and EW within a common CMOSS architecture on tactical vehicles

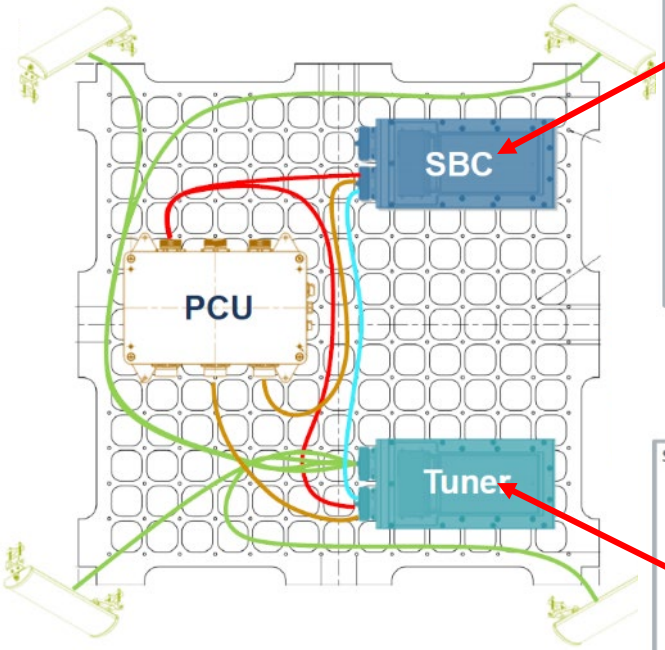
Operational Benefits:

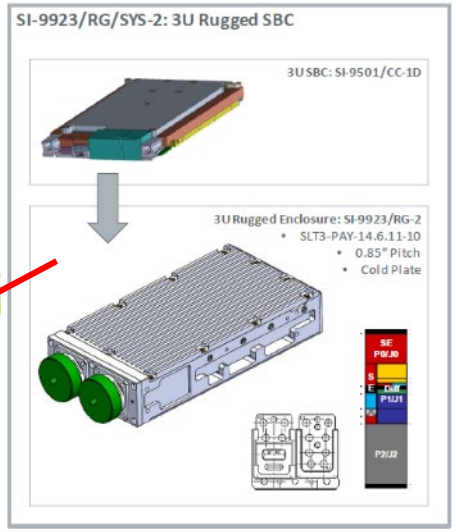
- Provides extensive flexibility to configure platform based on mission requirements
- Enables rapid insertion of new technology to meet emerging threat
- Reduces size, weight, power, and cooling (SWaP-C) of mission equipment

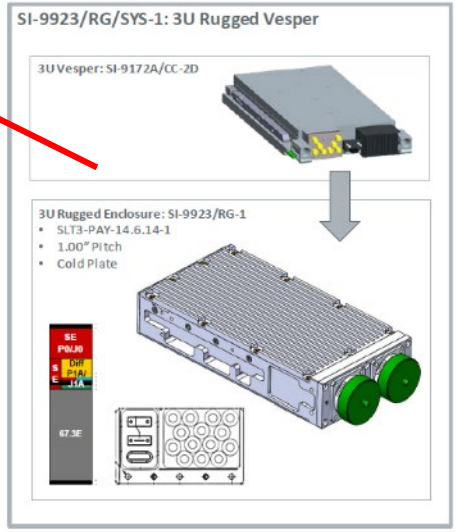
INITIAL CAPABILITIES	CMFF ALPHA PROTOTYPE (LAB SPRINT)	EXPERIMENTATION (FIELD SPRINTS)
 APNT  C2/SA  Comms	 APNT  C2/SA  Comms   CMOSS Chassis	Radiohead  CMOSS Chassis

Demonstrated successful standards implementation in a multi-card chassis integrated on a Stryker

CMOSS AT HIGH ALTITUDE





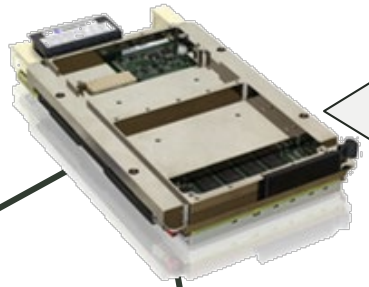


TSOA-ID DEMONSTRATION (2020)

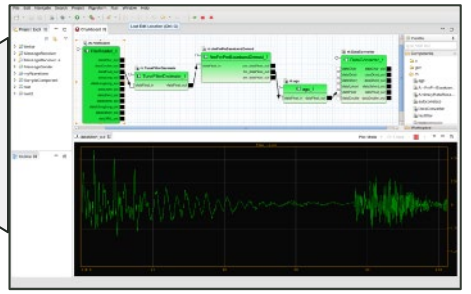
Transceiver Plug-In Card

Transceiver Plug-In Card

Single Board Computer



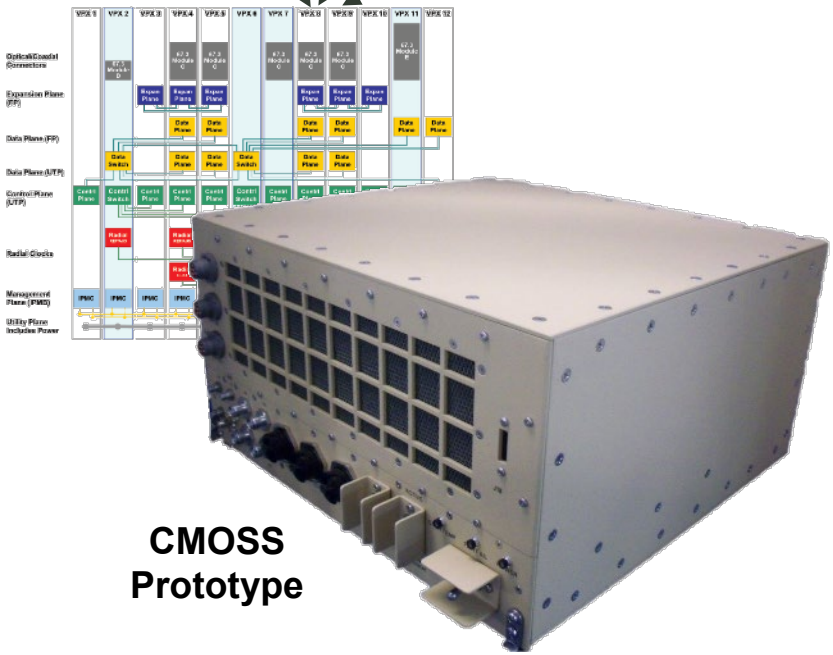
SDR Framework



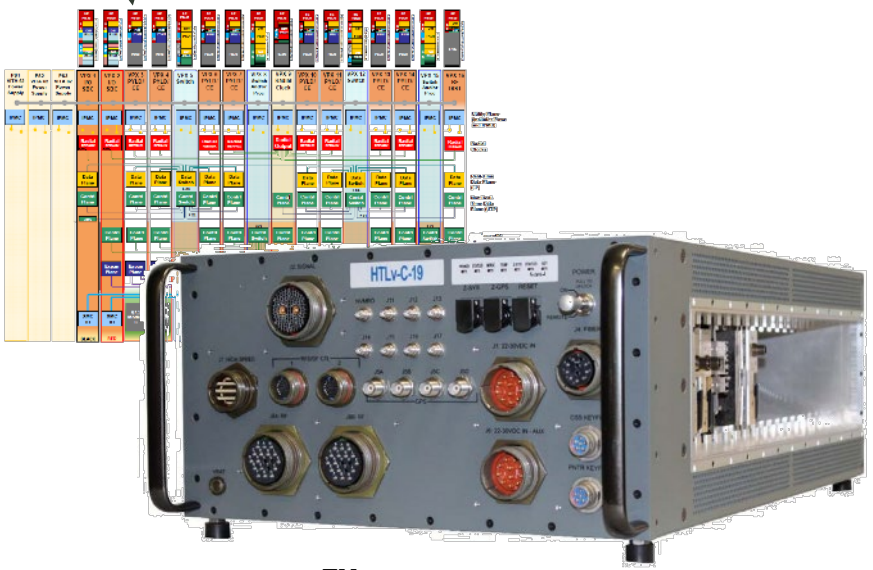
Rapid tech refresh enabled by standard payload profile

Capability reuse across programs and services enabled by common standards

Independent HW and SW upgrades enabled by RF front end abstraction

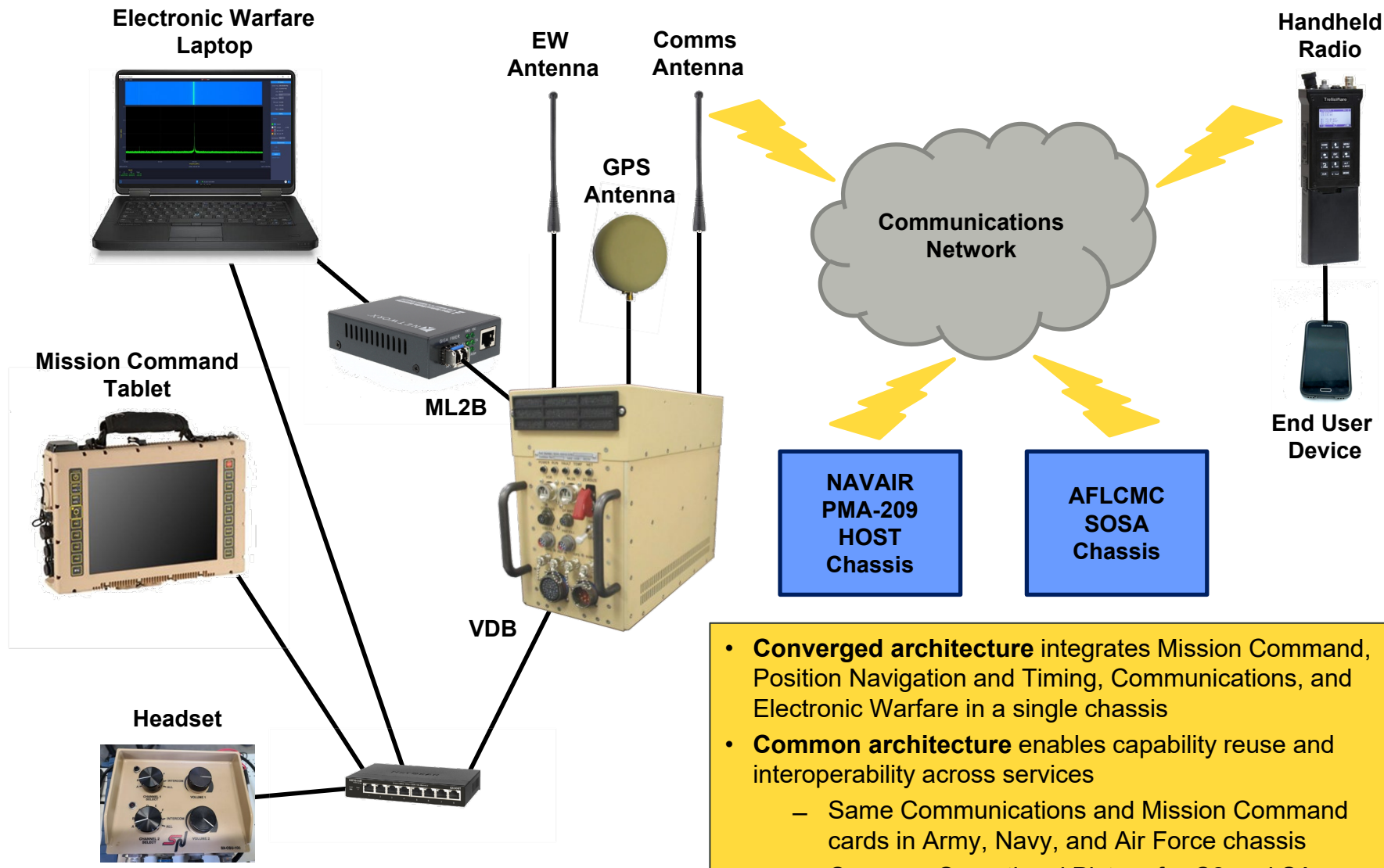


CMOSS Prototype



SOSA™ Prototype

TSOA-ID DEMONSTRATION (2022)

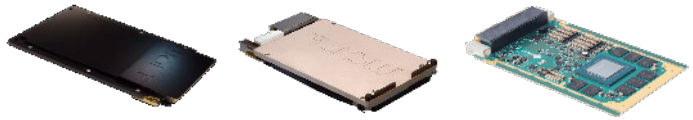


- **Converged architecture** integrates Mission Command, Position Navigation and Timing, Communications, and Electronic Warfare in a single chassis
- **Common architecture** enables capability reuse and interoperability across services
  - Same Communications and Mission Command cards in Army, Navy, and Air Force chassis
  - Common Operational Picture for C2 and SA
  - SOSA System Management

CMOSS CARDS

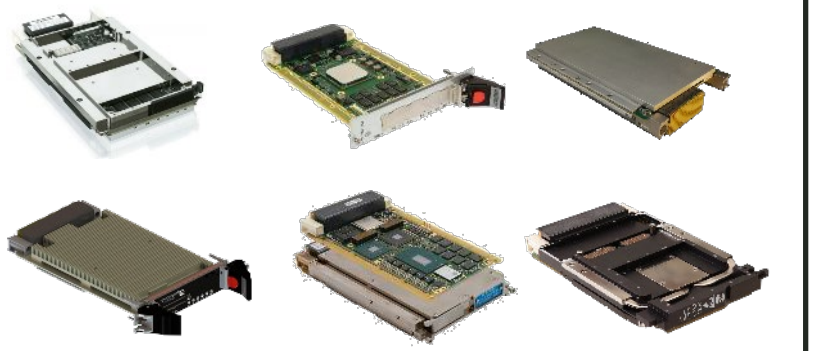
Radio Cards

Graphics Processing Units



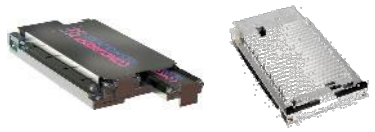
Switches

Singe Board Computers



PNT Cards

Storage Cards

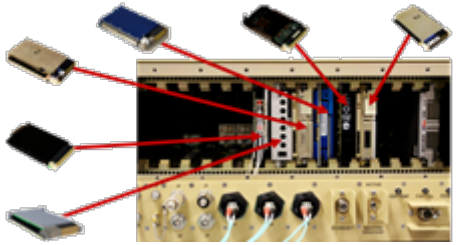


Power Supply Modules

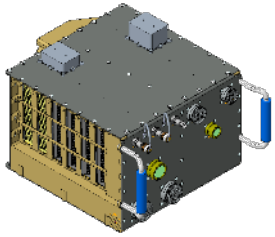
Note: List is not exhaustive or an endorsement. New capabilities are constantly being developed.

CMOSS CHASSIS AND RADIOHEADS

Chassis





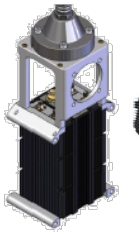



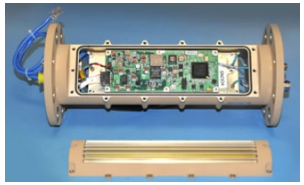
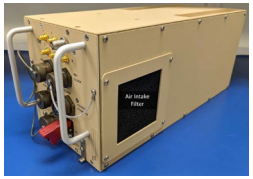






Radioheads

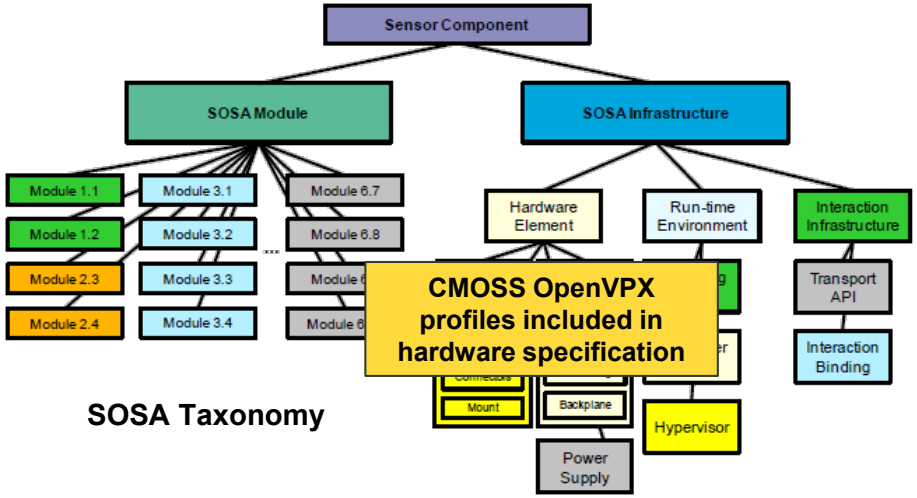


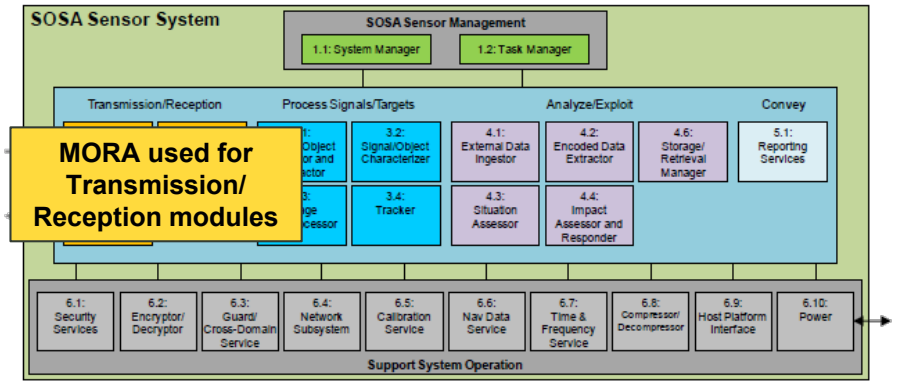

Note: List is not exhaustive or an endorsement. New capabilities are constantly being developed.

SENSOR OPEN SYSTEMS ARCHITECTURE (SOSA™) CONSORTIUM

- Initiated by AFLCMC at Wright-Patterson Air Force Base, OH
  - Working group under the FACE Consortium formed in November 2015
  - Independent Open Group consortium stood up in November 2017
  - Air Force, Army, Navy, and industry participation with 132 member organizations
- SOSA™ Consortium enables Government and Industry to collaboratively developed open standards for use across the C5ISR community
  - Accelerate the development of affordable, agile, and composable sensor systems
  - Enable common components for Radar, SIGINT, EW, Communications, and EO/IR sensors
  - SOSA™ Technical Standard defines architecture modules with well defined open interfaces
  - SOSA™ Business Guide, Contracting Guide, and Conformance Plan facilitate future acquisitions



SOSA Taxonomy



SvcV-1 Top-Level SOSA Services Context Description

CMOSS is aligned with the SOSA™ Technical Standard

SOSA CONSORTIUM

SOSA™ Sponsors

- Air Force Life Cycle Management Center
- Boeing
- Collins Aerospace
- Joint Tactical Networking Center
- Lockheed Martin
- NAVAIR
- U.S. Army DEVCOM C5ISR Center
- U.S. Army PEO Aviation
- U.S. Army Project Manager Electronic Warfare and Cyber
- U.S. Space Force Space and Missile Systems Center

SOSA™ Principals

- BAE Systems, Inc.
- Booz Allen Hamilton
- Cubic Corporation
- Curtiss-Wright Defense Solutions
- Elbit Systems of America
- FLIR Systems, Inc.
- GE Aviation Systems
- General Dynamic
- Huber+Suhner Astrolab
- Intel Corporation
- L3Harris
- Mercury Systems
- Northrop Grumman
- Raytheon
- Sierra Nevada Corporation
- SRC Inc.
- VadaTech Inc

SOSA™ Associates

- Abaco Systems
- Acromag, Inc.
- Aegis Power Systems
- Aitech
- AirBorn, Inc.
- Ampro ADLINK Tech.
- Anduril Industries, Inc.
- Annapolis Micro Systems
- AREA-I, INC
- Ascendant Engineering Solutions, LLC
- Atrenne
- Ball Aerospace
- Behlman Electronics, Inc.
- Booz Allen Hamilton
- CACI International, Inc.
- Chameleon Consulting Group
- Cobham Advanced Electronic Solutions Inc.
- CodeMettle, LLC
- Comtel Electronics, Inc.
- Concurrent Technologies
- CoreAVI
- COTSWORKS, LLC
- CRFS, Inc.
- Critical Frequency Design
- Crossfield Technology
- Cynosure, Inc.
- Dawn VME Products
- Delta Information Systems
- DornerWorks
- DRS Signal Solutions
- DRTI
- EIZO Rugged Solutions
- Elma Electronic Inc.
- ENSCO Avionics Inc.
- EPI
- Epiq Solutions
- FEI-Elcom Tech, Inc.
- FiberQA
- Freedom Power Systems
- General Micro Systems
- Georgia Tech Research Institute
- GORE
- Herley Industries, Inc.
- Herrick Technology Laboratories, Inc.
- IDEAS Engineering and Technology, LLC
- iRF Solutions
- ITZ, LLC
- Jacobs
- Jovian Software Consulting LLC
- Kontron America
- LCR Embedded Systems
- Lead Dog Technologies
- Leidos
- LGS Innovations
- Meritec
- Micro Focus (US), Inc.
- Micropac
- Midwest Microwave Solutions Inc
- Milpower Source
- Motorola Solutions
- New Wave Design and Verification, LLC
- NVIDIA Corporation
- North Atlantic Industries
- Orion Technologies, LLC
- Orolia Defense & Security
- PacStar
- Parry Labs, LLC
- Pentek, Inc.
- Perspecta Labs Inc.
- Pixus Technologies USA
- QRC Technologies, LLC
- RADA Technologies, LLC
- Radiall USA, Inc.
- Rantec Power Systems
- Real-Time Innovations
- REDCOM Laboratories
- Red Rock Technologies
- Riverside Research
- RTD Embedded Tech.
- Saab, Inc.
- Samtec
- ScioTeq LLC
- Sciens Innovations
- Sealevel Systems, Inc.
- Selex Galileo Inc.
- Shared Spectrum
- Skayl LLC
- Smiths Interconnect Americas Inc.
- Southwest Research Institute
- Spectranetix, Inc.
- Spirent Federal Systems
- SR Technologies, Inc.
- StreamDSP LLC
- Systel, Inc.
- SV Microwave
- TE Connectivity
- Technology Service Corp.
- Tektronix, Inc.
- Telephonics
- Tomahawk Robotics
- Tucson Embedded Systems
- University of Dayton Research Institute
- Viasat, Inc.
- VITA
- Wolf Advanced Technology Inc.

SOSA™ Consortium - Brings together DoD, industry, and academia under a *rigorous consensus based approach* for standards development. SOSA leverages CMOSS development. The consortium has 132 members. US Army CMOSS developers serve in many key roles within the consortium.

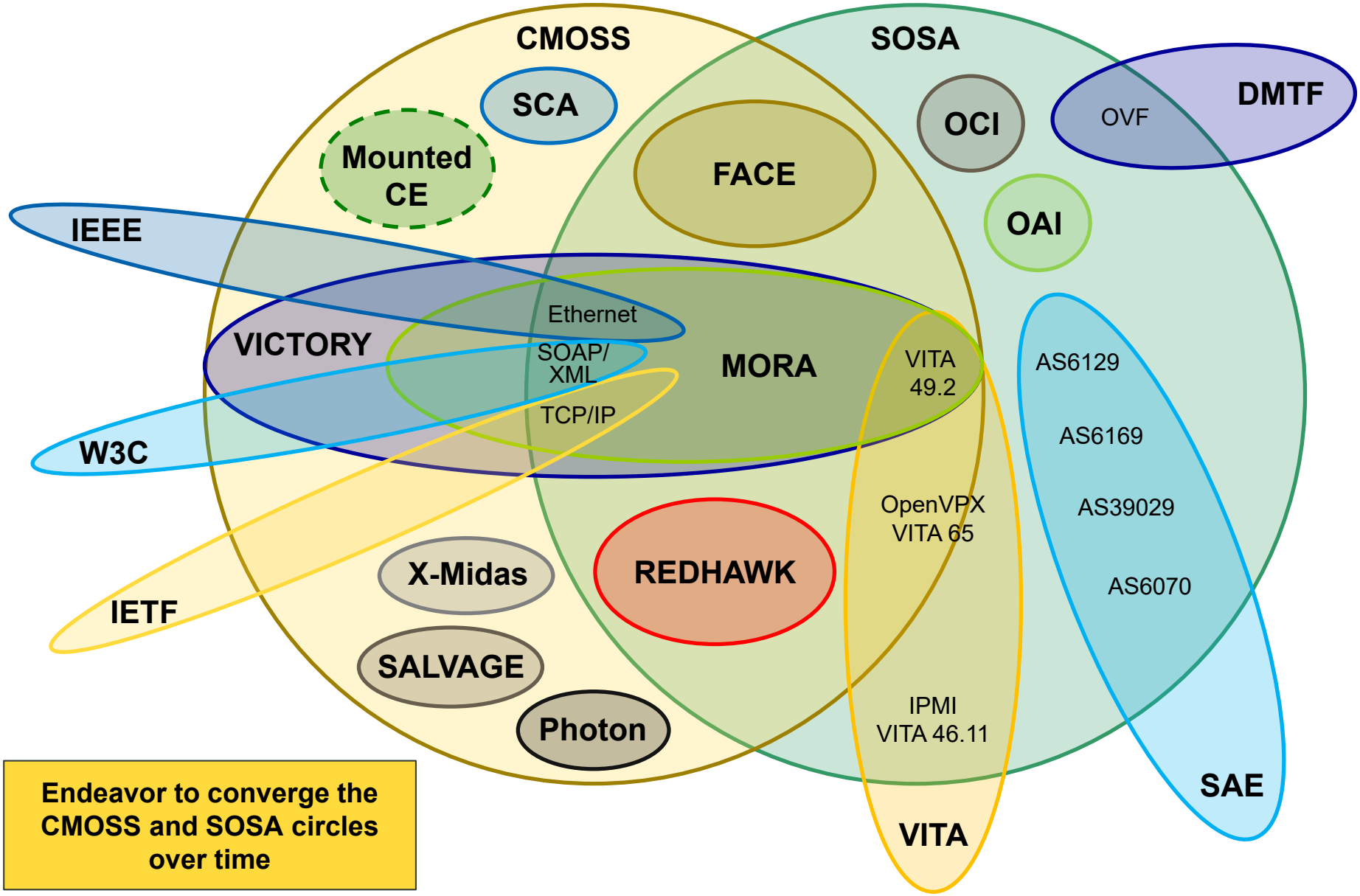
CMOSS - Standards developed and maintained by the US Army to support Army procurements which *respond to program office* schedules and needs. CMOSS defines an instantiation of the SOSA reference architecture which *provides the necessary specificity* to achieve the Army's reuse and portability goals. We strive to maintain alignment between CMOSS and the SOSA™ Technical Standard.

VICTORY TRANSITION TO SOSA CONSORTIUM

- Army is in the process of transitioning sustainment of the VICTORY Standard Specifications to the SOSA Consortium
  - Leverage existing Industry-Government consensus-based standards body
  - Facilitate alignment between CMOSS and SOSA
  - Maximize efficiency of individuals developing and using the specifications
- VICTORY Standard Specifications V1.9 (which includes MORA V2.4) will be transitioned and distributed in its entirety by the SOSA Consortium
  - Future updates will be made within the SOSA Consortium
  - Initial transfer does not imply applicability to SOSA components (i.e., start as separate standards managed by the same consortium)
  - Integration with the SOSA Technical Standard will be accomplished via change proposals per the current process
- Army will retain ownership of the VICTORY Compliance Test Suite (CTS) although it is expected that it will be leveraged as part of the SOSA Conformance Program
  - Currently available for download from the VICTORY project on DI2E (investigating alternatives due to DI2E sunset)

Army remains committed to the use and sustainment of VICTORY

SPECIFICATIONS AND STANDARDS BODIES



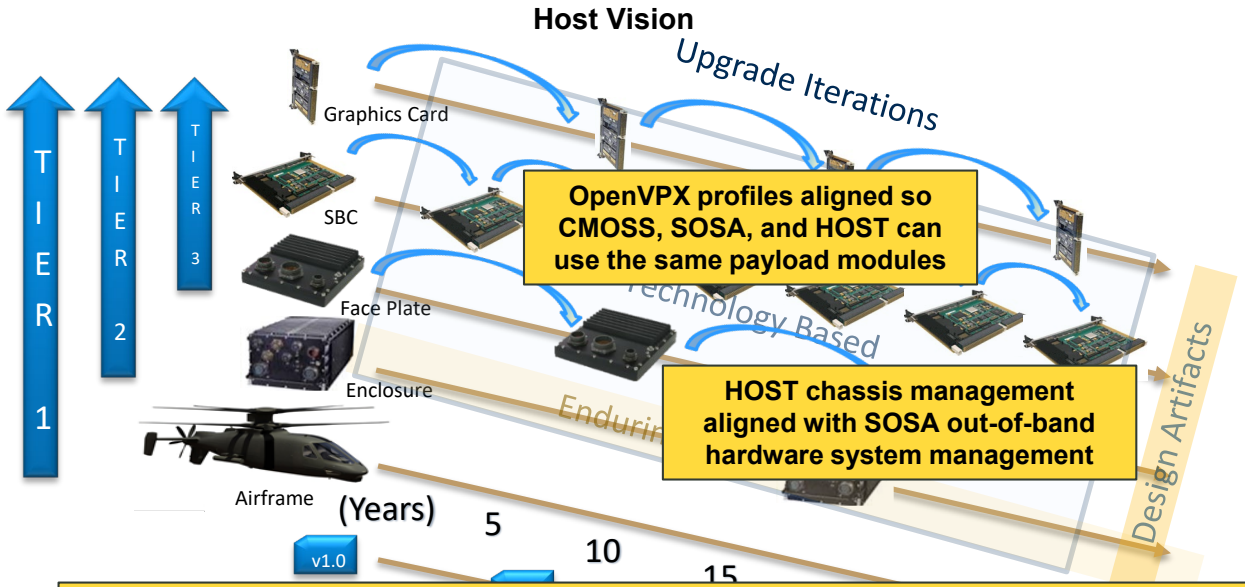
Endeavor to converge the CMOSS and SOSA circles over time

SPECIFICATIONS AND STANDARDS BODIES

- CMOSS – C5ISR/EW Module Open Suite of Standards
- DMTF – Distributed Management Task Force
- FACE – Future Airborne Capability Environment
- IEEE – Institute of Electrical and Electronics Engineers
- IETF – Internet Engineering Task Force
- IP – Internet Protocol
- IPMI – Intelligent Platform Management Interface
- MORA – Modular Open RF Architecture
- Mounted CE – Mounted Computing Environment / Common Operating Environment
- OAI – OpenAPI Initiative
- OCI – Open Container Initiative
- OVF – Open Virtualization Format
- SAE – Society of Automotive Engineers
- SCA – Software Communications Architecture
- SOAP – Simple Object Access Protocol
- SOSA – Sensor Open Systems Architecture
- TCP – Transmission Control Protocol
- VICTORY – Vehicular Integration for C4ISR/EW Interoperability
- VITA – VMEbus International Trade Association
- W3C – World Wide Web Consortium
- XML – Extensible Markup Language

HARDWARE OPEN SYSTEMS TECHNOLOGIES (HOST)

- Initiated by US Navy's Naval Air Systems Command (NAVAIR) at Patuxent River, MD in 2014
- Specification methodology for state-of-the-art embedded systems development and acquisition
  - Compilation of established industry standards such as OpenVPX and IPMI
  - Flexibility to add new Tier 2 standards for other technologies
  - Initial focus on airborne mission processing
- Focused on establishing interoperability and interchangeability at the module level



- Tier 1: Universal requirements that apply to all HOST components
- Tier 2: Technology specific requirements (e.g., OpenVPX)
- Tier 3: Module level requirements used to create component registry

HOST chassis management augments CMOSS network layer interoperability to provide enhanced system management

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 CMOSS efforts are on-going providing EW, SIGINT, Comms, and Cyber capabilities
- CMOSS is being aligned with the SOSA™ Consortium with Army, Air Force, and Navy participation
- The CMOSS specifications can be obtained from:
  - VICTORY (https://www.di2e.net/, VICTORY project)
  - MORA (https://www.di2e.net/, MORA project)
  - 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)
  - Open Innovation Lab (https://apntoil.army.mil/)

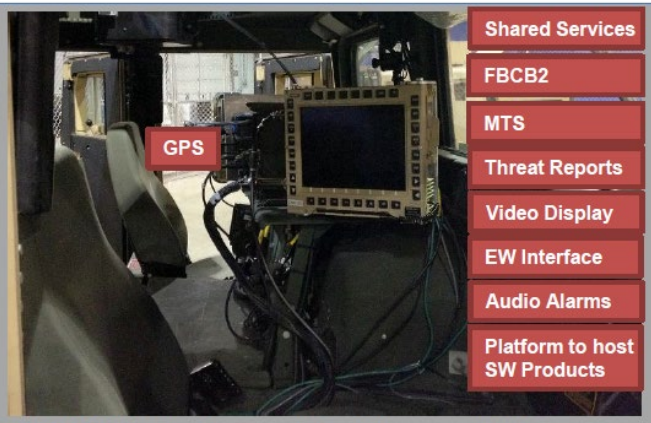
TECHNICAL OVERVIEW

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

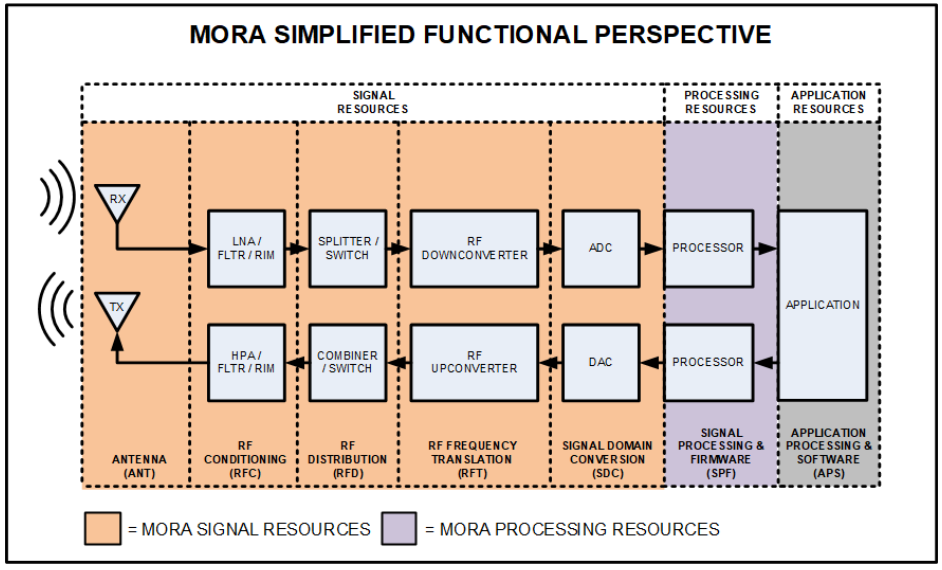
VICTORY leverages the following commercial technologies:

- 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.

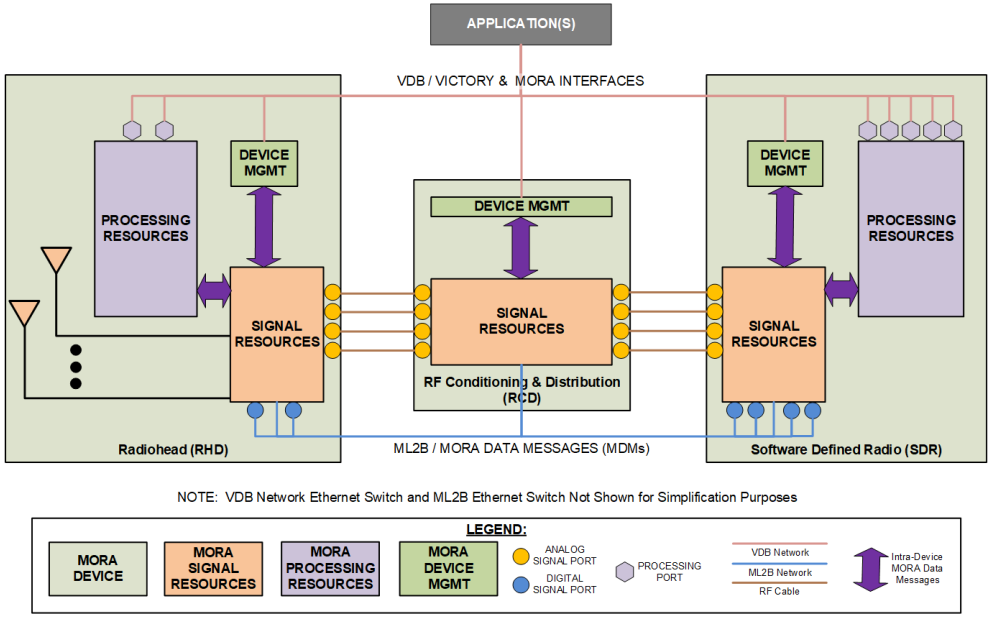
MODULAR OPEN RF ARCHITECTURE (MORA) OVERVIEW

- 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



MODULAR OPEN RF ARCHITECTURE (MORA) CONTROL AND DATA

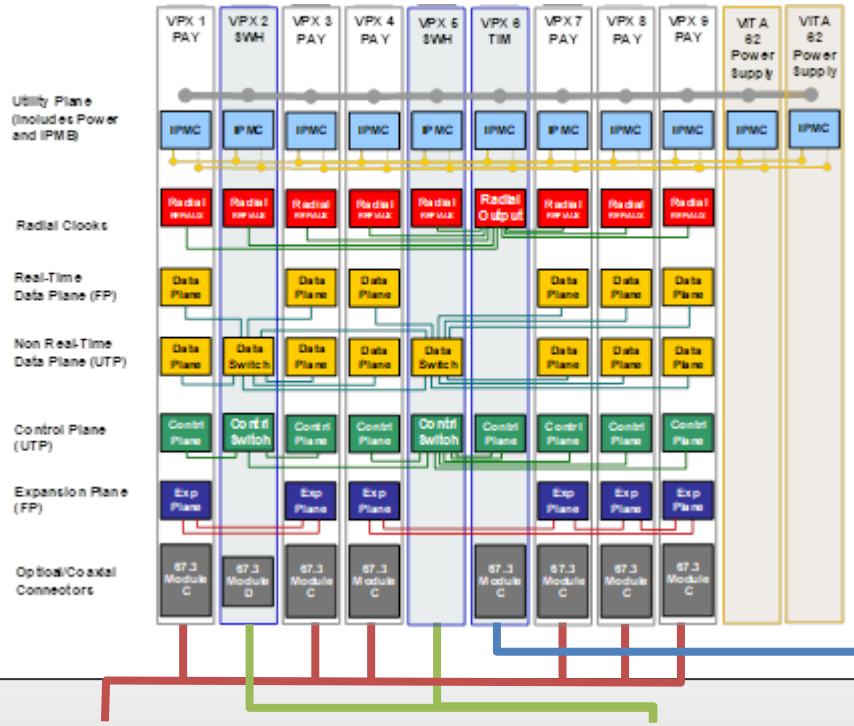
- RF control and data distribution occur in real-time (microseconds) over the MORA Low Latency Bus (ML2B)
- MORA Data Message (MDM) binary header encapsulates VITA 49.2
  - Enables ACK-based reliable delivery over UDP without degrading performance
  - Data and context messages use multicast for one-to-many 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 (VITA 49.0) *Legacy Fields, CIF enables*	CIF 1 (VITA 49.2) *Spatial, Signal, Spectral, I/O, Ctl*	CIF 2 (VITA 49.2) *Identifiers (tags)*	CIF 3 (VITA 49.2) *Temporal, Environmental*	CIF 7 (VITA 49.2) *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*
2	CIF 2 Enable	Version and Build Code	*Reserved*	Tropospheric State	*Reserved*
1	CIF 1 Enable	Buffer Status	*Reserved*	Network ID	*Reserved*
0	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*

Allowed VITA 49.2 Context/Command Indicator Fields (CIF)

DOD OPENVPX PROFILES

Example Backplane



Supports DoD-specific concerns including:

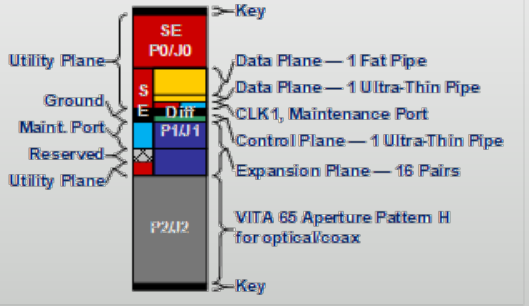
- Connectivity for the VICTORY Data Bus (Control Plane) and MORA Low Latency Bus (Real-Time Data Plane)
- Radial clock distribution for phase coherent operation
- Blind-mate optical and coaxial connectors for two-level maintenance

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

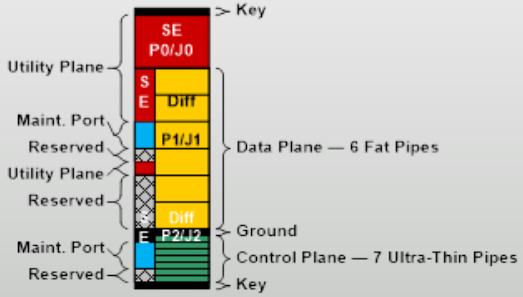
Slot Profiles

Payload



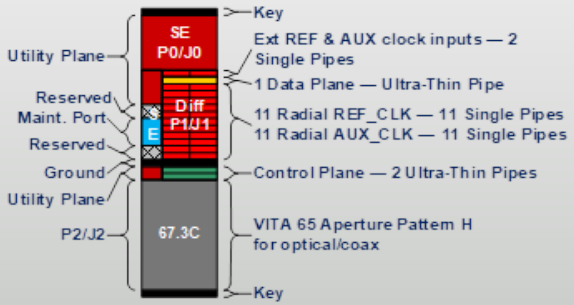
RF and Computing
SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-0/4

Control/Data Plane Switch



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

Radial Clock

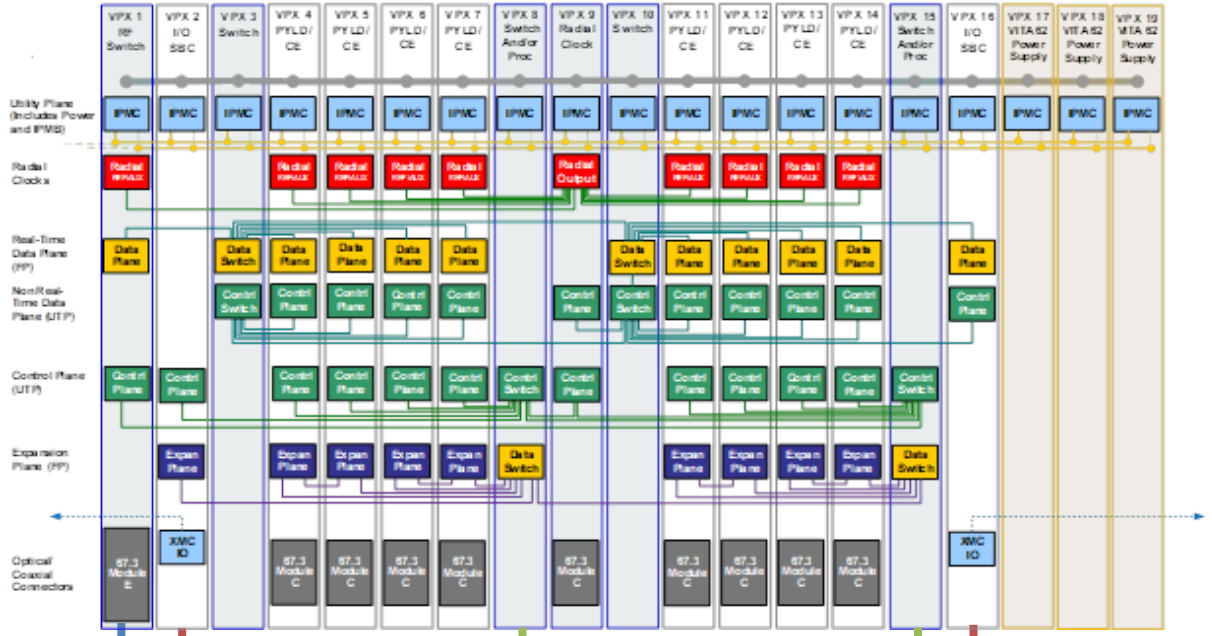


Position, Navigation, and Timing
SLT3x-TIM-2S1U22S1U2U1H-14.9.2-1

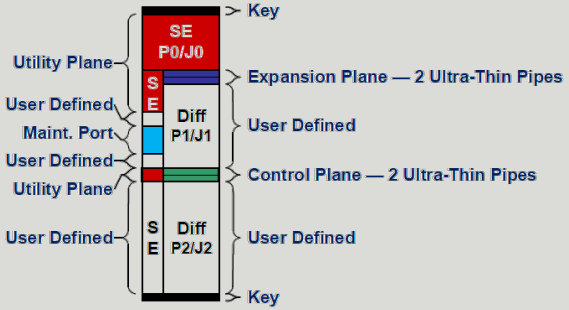
Refer to SOSA™ Technical Standard for additional details

DOD OPENVPX PROFILES

Example Backplane



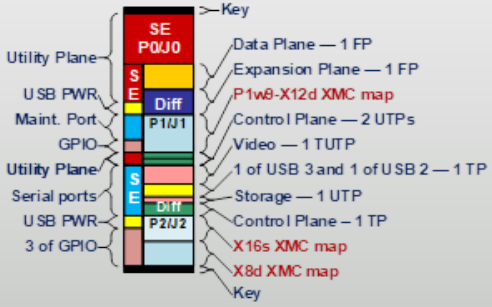
External I/O



Platform Specific I/O
SLT3-PAY-2U2U-14.2.17

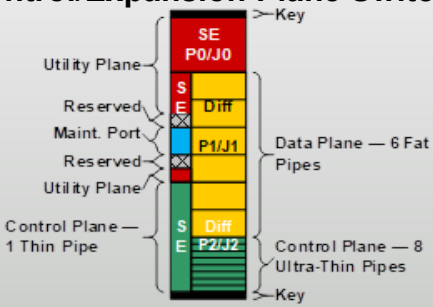
Slot Profiles

I/O Intensive SBC



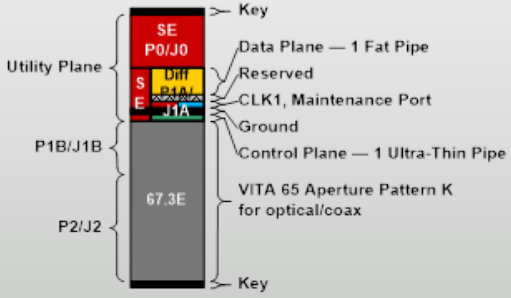
Platform I/O
SLT3-PAY-1F1F2U1TU1T1U1T-14.2.16

Control/Expansion Plane Switch



Ethernet and PCIe
SLT3-SWH-6F8U-14.4.15

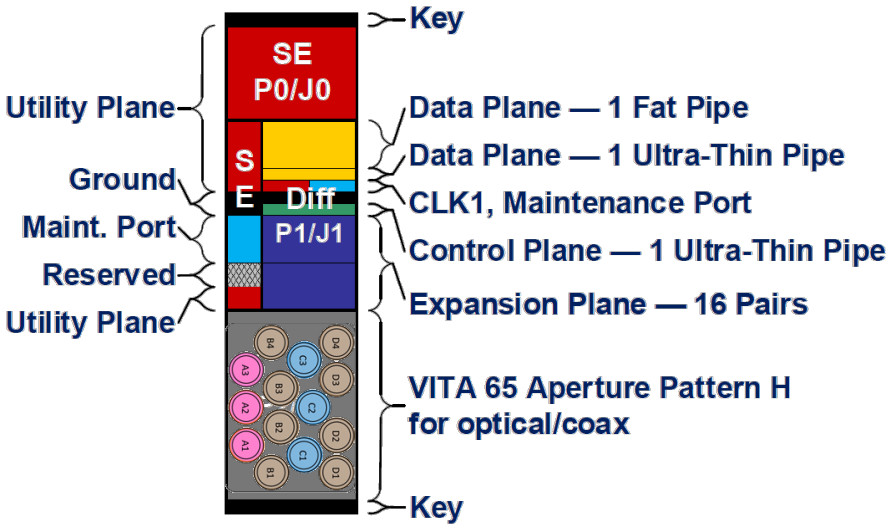
RF Switch



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

Refer to SOSA™ Technical Standard for additional details

PAYLOAD SLOT PROFILE
SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-4



- VITA 67.3 Module C provides coax and/or fiber over the backplane
  - 14 coax connections using SMPM pins
  - Coaxial pin assignment is as follows:

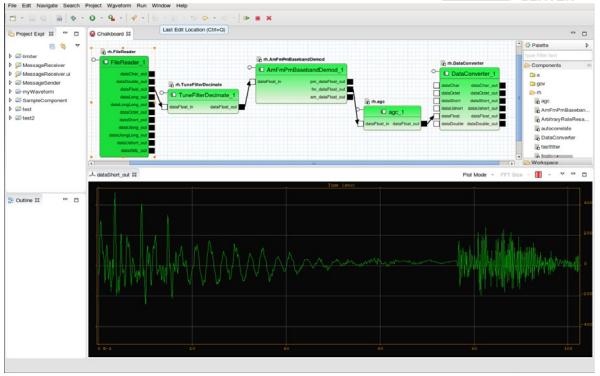
Module Type	Channel 67.3C SMPM Designation							
	1	2	3	4	5	6	7	8
1 Channel Module	B1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 Channel Module	B1	B4	N/A	N/A	N/A	N/A	N/A	N/A
3 Channel Module	B1	B4	D1	N/A	N/A	N/A	N/A	N/A
4 Channel Module	B1	B4	D1	D4	N/A	N/A	N/A	N/A
5 Channel Module	B1	B4	D1	D4	B2	N/A	N/A	N/A
6 Channel Module	B1	B4	D1	D4	B2	B3	N/A	N/A
7 Channel Module	B1	B4	D1	D4	B2	B3	D2	N/A
8 Channel Module	B1	B4	D1	D4	B2	B3	D2	D3

  - 6 user-defined pins for coherent operation across payloads (e.g., local oscillator distribution)
  - Future support for optical interfaces using high density MT ferrules

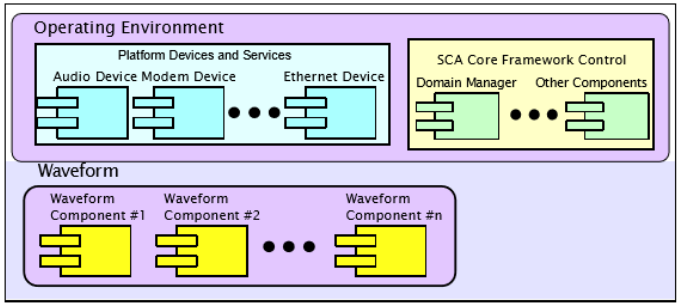
- Control Plane (1 Ultra-Thin Pipe)
  - Ethernet
  - Routed over backplane in star topology using switch card
  - Monitoring/management over the VICTORY Data Bus
- Real-Time (RT) Data Plane (1 Fat Pipe)
  - Ethernet
  - Routed over backplane in star topology using switch card
  - Real-time control over the MORA Low Latency Bus
- Non Real-Time (NRT) Data Plane (1 Ultra-Thin Pipe)
  - Ethernet
  - Routed over backplane in star topology using switch card
  - Non real-time control over the MORA Low Latency Bus
- Expansion Plane (2 Fat Pipes)
  - EP00 – EP03: PCIe
  - EP04 – EP07: PCIe / User Defined
  - Routed over backplane in ring or star topology
  - Supports tight coupling of adjacent cards
- Maintenance Port provides console for use during board maintenance
- Radial clocks terminated on plug-in module
  - 1 PPS AUX_CLK
  - 100 MHz REF_CLK
- Data Plane separated from Control Plane by an unused Ultra-Thin Pipe (GND)
- Only uses 12V, 3.3V_AUX, and VBAT to maximize portability

SOFTWARE FRAMEWORKS

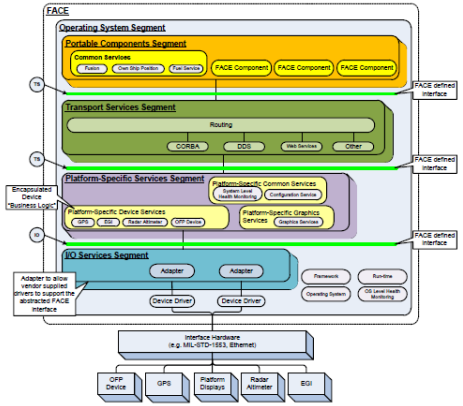
- Enable portability of software applications across hardware platforms
- Appropriate software framework is dependent on mission area
  - REDHAWK: Free and Open Source Software (FOSS) Software Defined Radio (SDR) framework
  - Software Communications Architecture (SCA): Developed by JTNC for Comms applications
  - 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)