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SOSA and VITA: Working Together for Next-Gen Defense Systems

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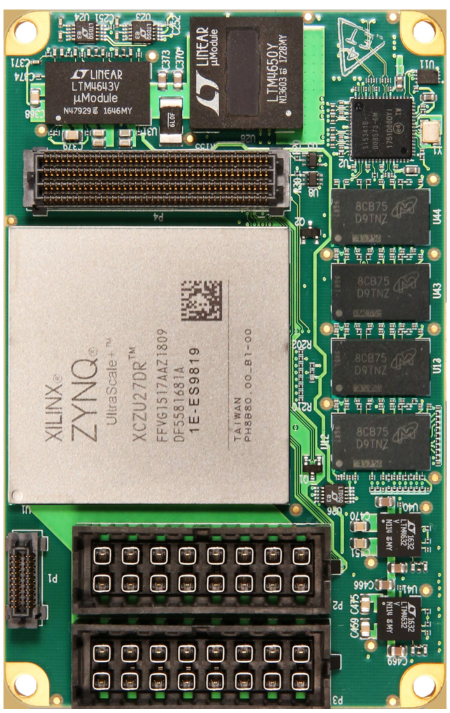


Model 6001: **8-Channel A/D & D/A Zynq UltraScale+ RFSoC Processor QuartzXM eXpress Module**

Introduction

The Sensor Open Systems Architecture™ (SOSA™) Consortium is developing common open standards for designing, building, and deploying hardware, software, and firmware components of new military electronic systems. SOSA contributing members are U.S. government organizations including the U.S. DoD, Army, Navy, and Air Force, as well as key representatives from industry and universities.

SOSA™
Sensor Open Systems Architecture

SOSA adopts the most appropriate subsets of existing open standards to form a multi-purpose backbone of building blocks for current and future embedded systems for Radar, EO/IR, SIGINT, EW, and communications.

Objectives include vendor interoperability, lower procurement costs, easier new technology upgrades, quicker reaction to new requirements, and longer life cycles.

Because the emerging SOSA hardware standard draws primarily from OpenVPX and other related VITA standards, the new technologies, topologies, and environmental requirements critical to meeting SOSA objectives must be supported by extensions to these VITA standards.

VITA
Open Standards, Open Markets

This article is an overview of the SOSA and VITA organizations and how they interact, along with the challenges, successful strategies, and illustrative examples.

VITA Background & Mission

Introduced to the market in 1981, the VMEbus architecture began gaining market presence with specification development and products from Motorola and other early vendors, who formed the VMEbus Manufacturers Group (now VITA) in 1983.

In 1985, VITA (VMEbus International Trade Association) was founded to promote VMEbus in worldwide markets, and published its first directory of 174 vendor companies and over 2,700 product families. VMEbus soon won widespread acceptance and adoption by defense, government, research, and industrial customers.

The VITA Technical Committee, formed in 1987 to develop dozens of new extensions to VMEbus, evolved in 1994 into the present day VITA Standards Organization (VSO). A year earlier, VITA became an accredited standards development organization with the American National Standards Institute (ANSI).

To overcome performance limitations of the parallel bus backplane of VMEbus, in 2003 VITA introduced the VITA 46 VPX standard to take advantage of new gigabit serial interconnect technology for 3U and 6U boards. In 2010, after widespread use, refinements, and serious interest in VPX for long-term defense programs, VITA announced the VITA 65 OpenVPX system specification, quickly ratified by ANSI.

VITA continues its strong role in promoting and developing open architecture embedded system standards, actively supporting numerous working groups in the VSO, and working with vendors and other organizations to embrace new technology and meet new market requirements.

Open Systems Architecture Directive and Initiatives

In May 2013, the U.S. Under Secretary of Defense issued a milestone memo mandating that all acquisition activity must incorporate DoD Open Systems Architecture (OSA) principles and practices. These include using existing or evolving open standards for well-defined modular hardware and software components that can be sourced from multiple vendors. Once proven, hardware platforms should be reusable for quick-reaction mission needs, feature upgrades, and new technology insertion. Software architectures must be layered and extensible to permit operating system and security upgrades, and to accommodate new applications and user interfaces. These advantages reduce development risks and help ensure significantly longer operational life-cycles.

In response, each of the three primary U.S. service branches (Army, Navy, and Air Force), began developing standards that embraced OSA principles to meet future procurement needs of deployed systems for their respective services.

The Army's CCDC (Combat Capabilities Development Command) in Aberdeen, MD developed CMOSS (C4ISR/EW Modular Open Suite of Standards). These standards include OpenVPX for hardware, VICTORY to share vehicle services (like time and position) for C4ISR/EW interoperability, and MORA (Modular Open RF Architecture) to share antennas and amplifiers. It also uses REDHAWK and SCA software frameworks.

The Navy's NAVAIR (Naval Air Systems Command) in Patuxent River, MD created HOST (Hardware Open Systems Technology), which initially focused on embedded processing for airborne and ground vehicle missions. Its major goal of abstracting hardware and software components aligned well with OSA concepts. HOST hardware definitions include three tiers: Tier 1 defines the deployed platform (airframe, vehicle, UAV, etc.), Tier 2 defines the embedded system enclosure, and Tier 3 the boards, backplanes, modules, and faceplates. Tiers 2 and 3 are subsets of OpenVPX modules and profiles. A registry of Tier 3 products offers an approved catalog of components for sharing across programs.

The Air Force's OMS (Open Mission Systems) initiative incorporates SOA (Service Oriented Architecture) for commercially developed concepts and middleware, and UCI (Universal Command and Control Interface), which standardizes massages and middleware for sharing command and control mission information between airborne system elements. OMS strongly embraces FACE (Future Airborne Capability Environment), a consortium of The Open Group that adopts open software standards for avionics systems, which gained full support of all three armed services.

SOSA Consortium

While each service made significant progress in advancing OSA principles, they did so through different initiatives that often shared common open standards, including OpenVPX and FACE. However, each initiative also included specific mandates tailored for service-specific platform requirements.

After recognizing these facts, administrators within DoD and each of the services perceived a strong need to promote a single, common initiative to define acquisition activities across all three services.

In early 2017, the DoD issued an SBIR solicitation for Sensor Open System Architecture (SOSA) Architectural Research outlining the numerous OSA initiatives and objectives for a unified solution. This resulted in the formation of the SOSA Consortium managed by The Open Group, a large organization with strict and well-defined practices, policies, and procedures for standards development efforts.

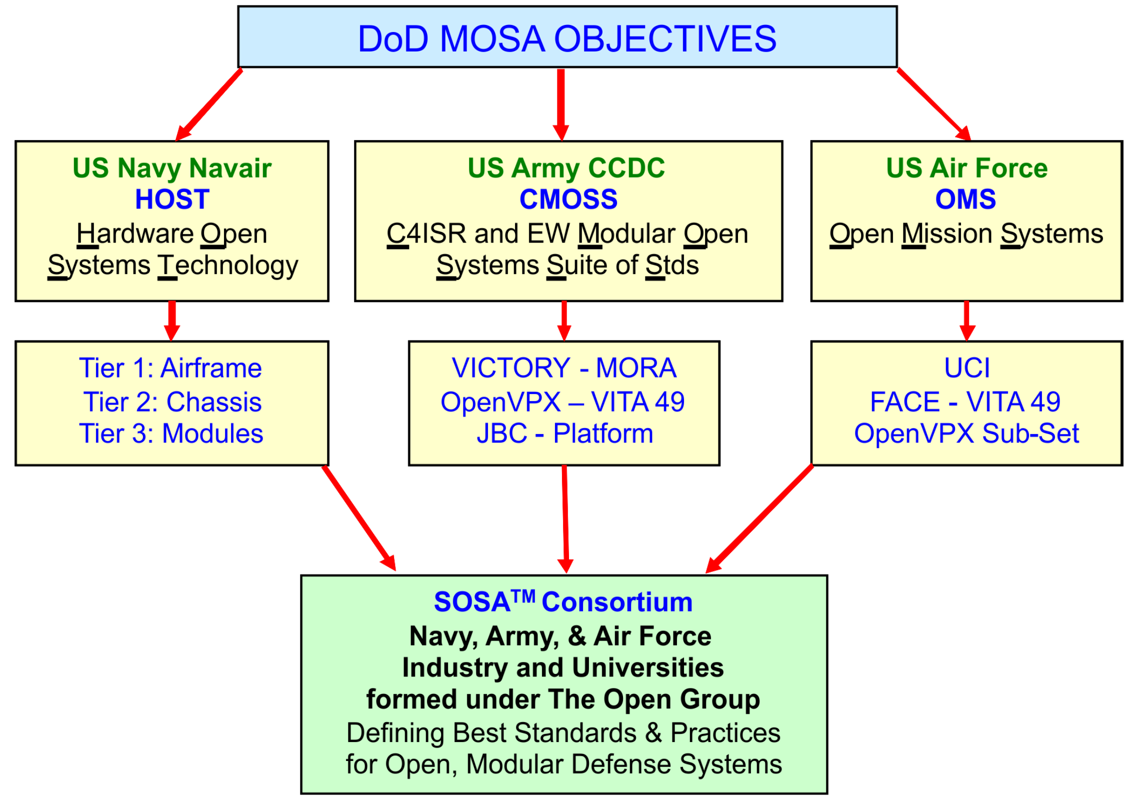


Figure 1. After independently developing standards in response to DoD MOSA objectives, each of the three services joined the SOSA Consortium to develop a unified standard.

A primary mandate of the SOSA Consortium is broad participation, commitment, and contribution from DoD, Army, Navy, and Air Force, as well as industry, academia, and other government organizations. Major objectives include development and adoption of open systems architecture standards for C4ISR to provide a common, multi-purpose backbone for radar, EO/IR, SIGINT, EW and countermeasure systems. Additional objectives include platform affordability, rapid fielding, reconfigurability, new technology insertion, extended life-cycles, and re-purposing of hardware, firmware, and software.

Inside the SOSA Consortium

The SOSA Consortium Organization consists of two primary groups. The Business Working Group (BWG) defines business and acquisition practices, and creates guidance for acquisition programs. The Technical Working Group (TWG) is responsible for defining the SOSA Architecture, and producing the SOSA Technical Standard and SOSA Reference Design.

The SOSA Architecture presents a modular system structure, with tight integration within modules for encapsulating functionality and behaviors, and yet well-defined interfaces. These modules must be based on open, published standards, with consensus-based influence stakeholders directing the evolution, and a strict conformance validation process. The SOSA Architecture protects IP (intellectual property) within the modules to incentivize innovation and competition.

The SOSA Technical Standard documents the SOSA Architecture with detailed rules and requirements drawn and adapted from a collection of open standards. The primary standards defining specifications for plug-in cards, backplanes, chassis, electrical components, and mechanical structures are VITA standards.

The SOSA Conformance Policy, now being defined by the SOSA Conformance Standing Committee, will define processes for qualifying products against the Technical Standard. They include multiple conformance verification processes, a single conformance certification process, and a single SOSA certified conformant product registration process. Until the award of certification, no product can claim to be SOSA conformant.

Membership in SOSA is restricted to US citizens and organizations so that DoD-sensitive or classified requirements can be presented by representatives from the armed services to promote solution strategies within the SOSA Technical Standard. For this reason, technical details of on-going discussions in the SOSA Technical Working Group may not be disclosed to the public. Once the standard is approved and released to the public, it will contain only specifications and rules, free from the underlying, sensitive use drivers.

VITA and SOSA

Because VITA is so central to the SOSA hardware definition, many of the same individuals in the SOSA TWG are also active participants in the VITA Standards Organization (VSO). Because restrictions on technical disclosures imposed on the TWG by SOSA do not apply to VSO, members of VSO must be mindful against referencing on-going SOSA technical topics in their VSO discussions and publications.

Nevertheless, the TWG does release period "snapshots" of the evolving SOSA Technical Standard that are publicly available for review, the latest being Snapshot 2 released in January 2020. While no conformance to these snapshots may be claimed, they illustrate the direction and underlying principles guiding the final standard.

In some cases, SOSA adopts only carefully selected subsets of existing VITA specifications. For example, the TWG adopted only a handful of the more than one hundred 3U and 6U OpenVPX slot and module profiles, based on an analysis that they could accommodate the majority of system requirements.

User-defined backplane pins defined in OpenVPX pose a nemesis for standardization efforts because they allow custom assignment of signals with interface standards, directions, and voltages. Profiles with user-defined pins are being deprecated in SOSA. Instead, work is underway to assign a minimum set of specific I/O standards to each group of legacy user-defined pins for each of the OpenVPX control, data, and expansion planes.

SOSA restricts the primary VPX power supplies to +12V only, prohibiting +5V, and +3.3V. This greatly simplifies the previous OpenVPX issue of balancing among three voltages to simplify chassis power supplies and standardize the plug-in cards.

Unlike most OpenVPX systems, SOSA requires hardware platform management leveraging the HOST 3.0 system management architecture, which itself is highly leveraged from VITA 46.11. A system manager module accesses all SOSA system elements for census taking, health monitoring, troubleshooting, new firmware/software upgrades, and reset/recovery operations.

Backplane I/O for RF signals and optical interfaces in OpenVPX have gained significant traction in CMOSS, MORA, and HOST systems over the last six years, all enabled by VITA 66 and VITA 67 specifications. Eliminating front panel cable harnesses wins high

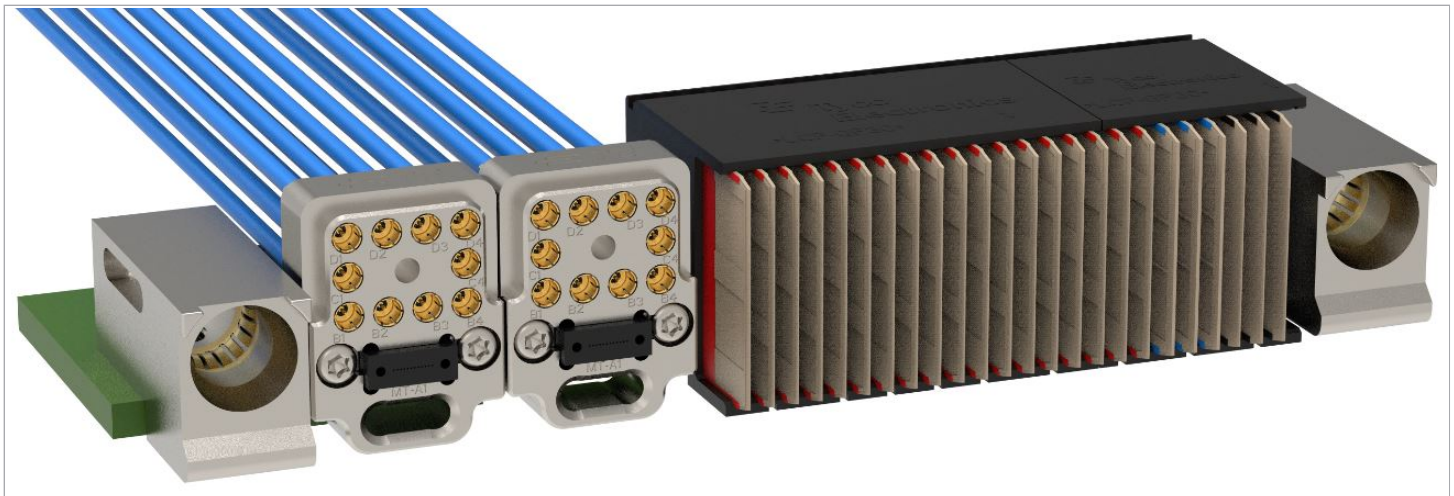


Figure 2. Rear view of 3U OpenVPX Module with two VITA 67.3D backplane connectors, each with 10 coaxial RF signals and 24 optical lanes. Courtesy TE Connectivity

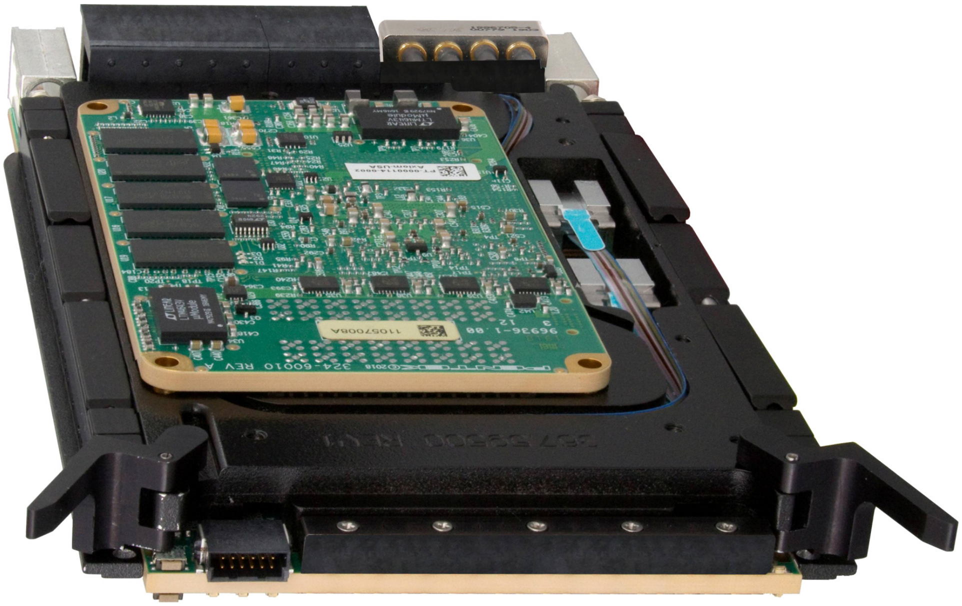


Figure 3. Pentek Quartz® Model 5550 3U VPX 8 Channel A/D and D/A RFSoC SOSA-Aligned Processor incorporates RF and optical backplane using VITA 66 or VITA 67 connectors. The top cover has been removed to show details.

scores for maintenance and reliability. Some of the latest modular backplane standards offer extremely high density and even mixed RF/optical interfaces as shown in Figure 2.

In summary, when critical needs arise from SOSA customers (DoD services), SOSA TWG members can promote innovation for new standards within the VSO to accommodate them, while still complying with SOSA restrictions.

Next Steps

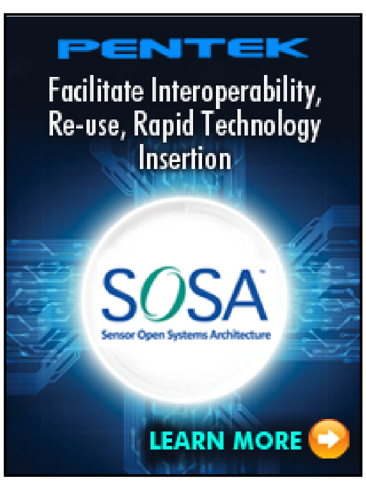
The Technical Standard Snapshot 3 was released in July 2020. It is expected that the release of the SOSA Technical Standard 1.0 will be completed in Q1 2021. At that point, product vendors may begin the processes leading to full certification.

Nevertheless, vendors are now offering products that were "developed in alignment with SOSA" like the one shown in Figure 3. A key difference in the SOSA architecture from earlier open standards is the well-defined protection of IP, which encourages numerous examples of supplier innovation and investment.

The DoD is now issuing requests for proposals and information clearly favoring respondents that offer OSA-based solutions. The active participation in SOSA by the DoD, all three armed services, embedded industry vendors, universities, and research facilities gives evidence of their substantial commitments of resources and personnel. These clear signals ensure that SOSA is well on its way to revolutionize the future of embedded military electronics systems. □

Learn More About SOSA

For more information about SOSA, click on the resources below.



Pentek's SOSA web pages

SOSA articles from *Electronic Design Magazine*

A McHale Report podcast about SOSA