Embedded Tech Trends

"The Business and Technology Forum for Critical Embedded Systems"

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VPX and Defense Open Systems Architectures

Applying OSA principles to the VPX standard process, the difficulties, and ongoing efforts

Mark Littlefield

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Standardization and Market Maturity

- Standardization is a natural development as a market matures
- Standardization can either be formal or informal

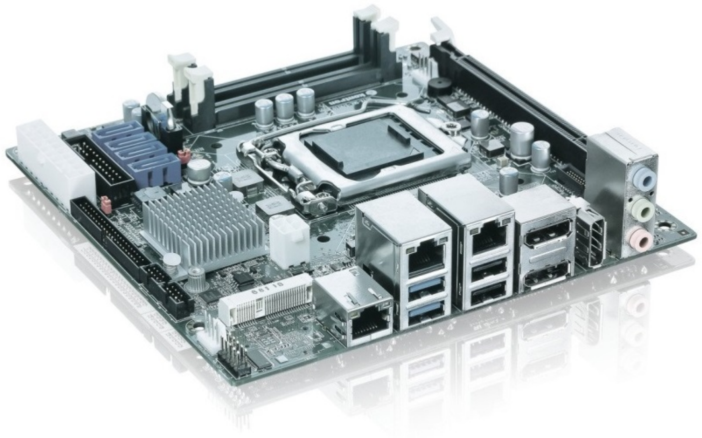
Industry Standard Architecture

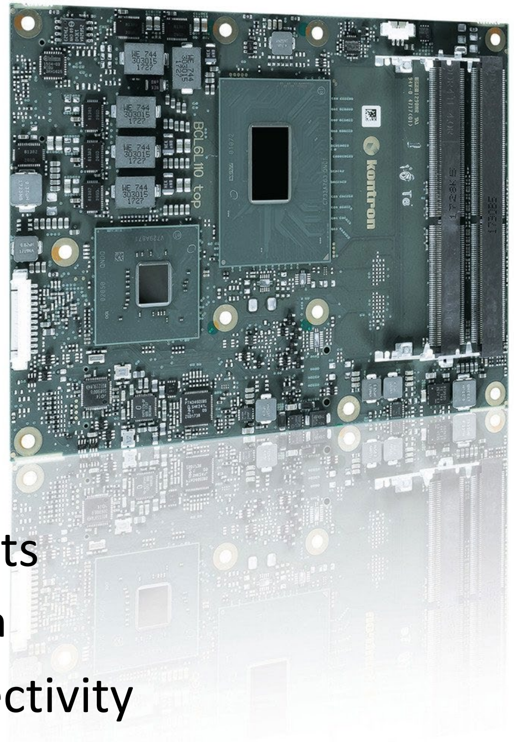
ATX and ITX Family of Standards

Successful Examples

- There are several good examples of Open System Architecture standards in extremely wide use

- ATX/mITX (and variants)
  - Standardized footprint
  - Standardized power
  - Standardized feature set
  - Standardized I/O apertures





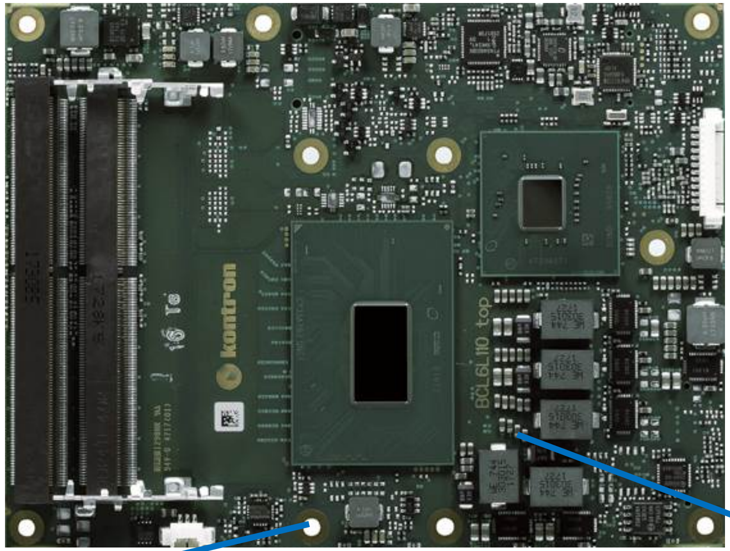
- COMe
  - 4 standard footprints
    - Only three common
  - Standard pin connectivity
    - 8 types, but only three common
    - 100% defined – no user defined pins

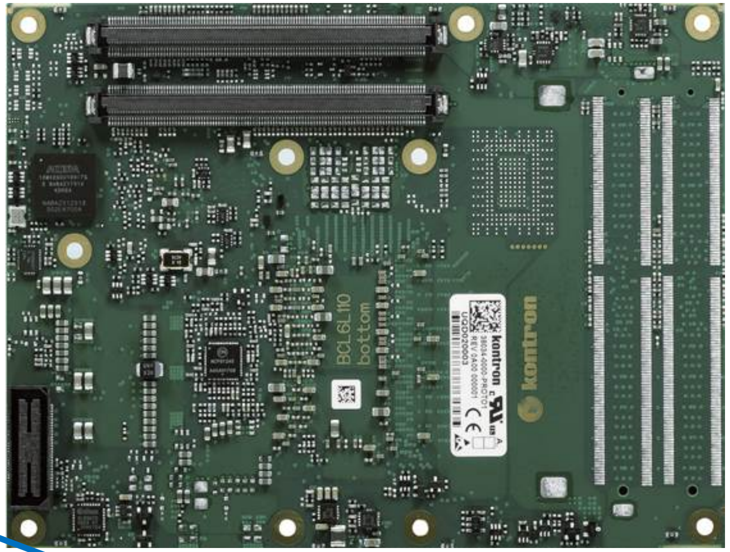
- Rigidly define what makes sense

Footprint

I/O

Power



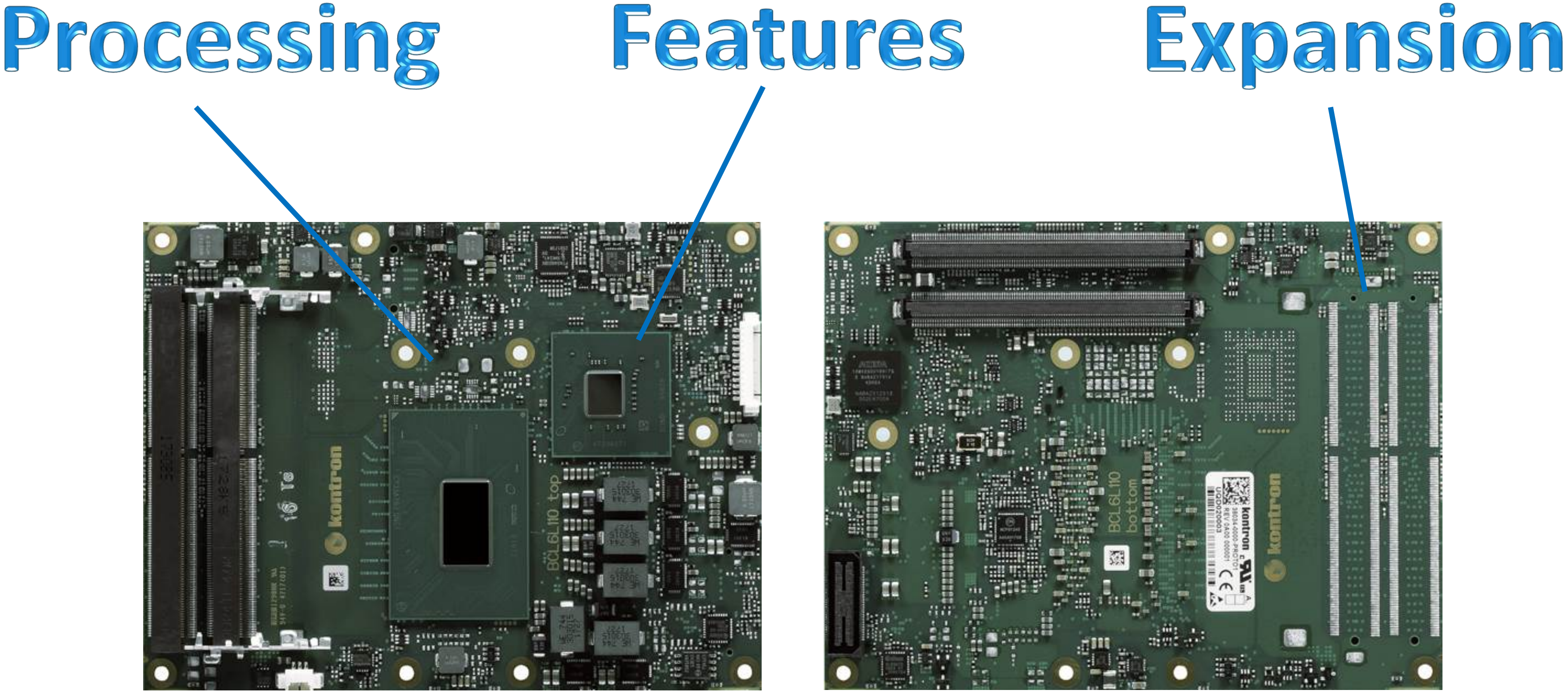


Use cases

Minimum Feature set

Secret to their Success

Application Domain



- Allow for innovation and differentiation within the defined parameters envelope

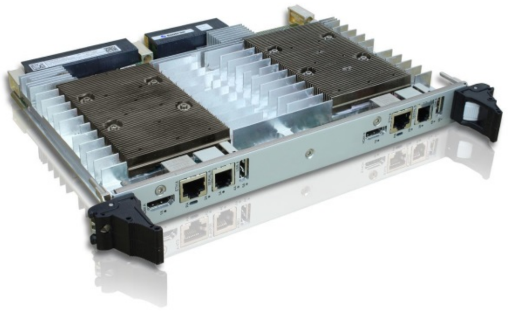
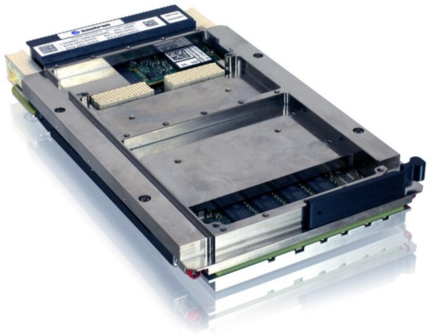
Defense Standardization Difficulties

There are a number of difficulties in trying to establish board-level standards involving defense platforms

- Orders-of-magnitudes differences in bandwidth requirements
- Occasional extremely-small latency requirements
- Different architectures
- Different environmental requirements with occasionally extreme temperature ranges

VPX/OpenVPX

- VPX has become the workhorse for defense embedded systems
- OpenVPX (VITA 65) started in late 2008 to standardize the implementation of VPX products


VPX/OpenVPX

- Pros
  - Introduced communications “planes”
  - Further refined the utility plane
  - Created a standard way to define module, slot, and chassis profiles

- Cons
  - Was not successful in meeting the goal of a “universal” slot definition
  - All profiles contained “user defined pins”
  - Many, many profiles included
    - 30x 6U, 63x 3U in the latest revision

SOSA™: An Attempt To Solve this

- The DoD has a strong desire to enable easy and rapid technology updates/upgrades in fielded defense platforms without system removal
  - Without vendor lock

- How is SOSA doing this?

- The result: an Open Systems Architecture for defense that works!


An Open Group Standard

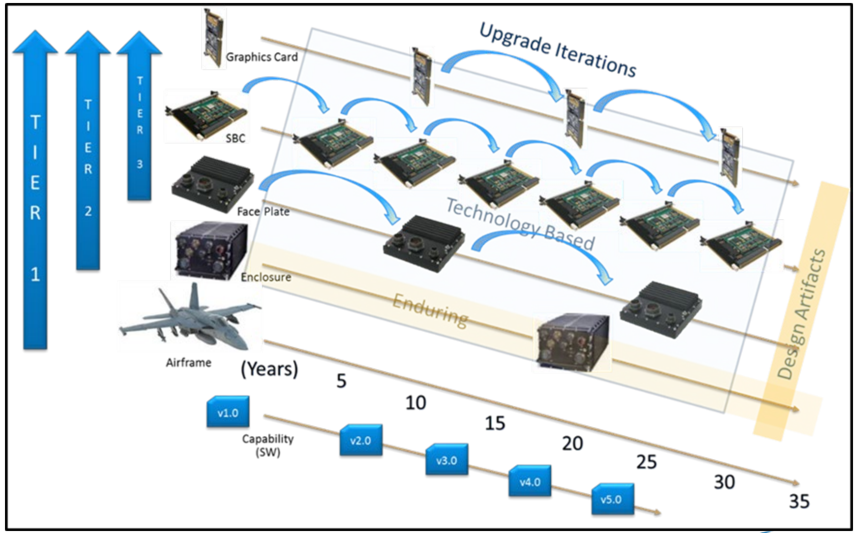
Technical Standard for Sensor Open Systems Architecture (SOSA™) Reference Architecture

SOSA™
Sensor Open Systems Architecture

THE Open GROUP

You have a choice: you can either create your own future, or you can become the victim of a future that someone else creates for you. By seizing the transformation opportunities, you are seizing the opportunity to create your own future.

-VADM Arthur Cebrowski



The Challenges of bringing OSA to VPX

There are definite challenges to turning VPX into a true OSA useful for defense applications

- There are many technical requirements for defense systems that simply don’t exist in the commercial/industrial space

- There are many types of defense applications, each with their own (often contradictory) technical requirements

- There are legacy systems which need to be taken into account in order to maximize adoption
- There are many demonstrated ways to implement systems using VPX
- There is now more than 10 years of VPX adoption

SOSA™ Sensor Open Systems Architecture

VPX: Different than other OSA

VPX has fundamental differences from other form factors that make it more difficult to form an OSA

- There are multiple, very different board classes needed
- Within these classes there are additional board types

Processors

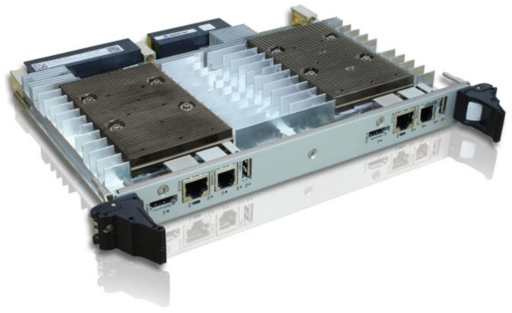
Switches

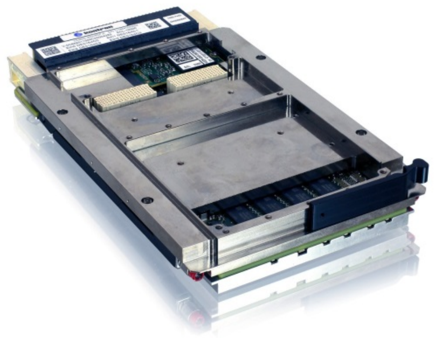
I/O

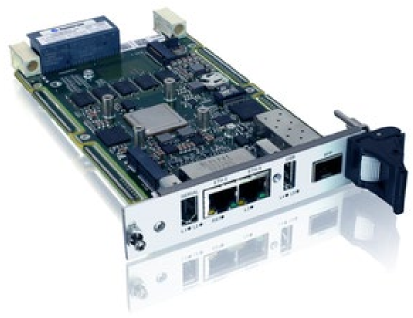
Peripherals

Radial Clocks

Special Hybrids







VPX: Different than other OSA

A universal slot definition is impossible and forming a minimal subset is very difficult

- What is needed is to define a taxonomy for functional board types
- SOSA didn't do this directly, but achieved it through
  - Starting with CMOSS and HOST profiles
  - Collecting all participants product and application needs
  - Crafting solutions by refining CMOSS, HOST, and other existing examples
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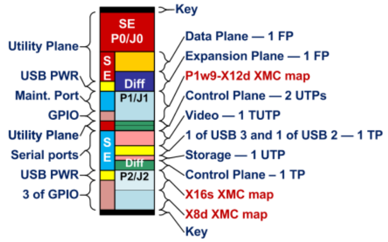

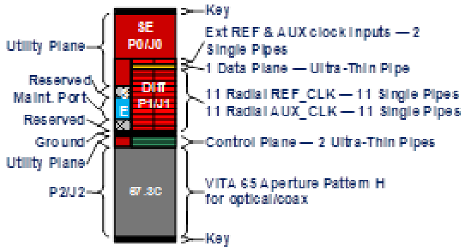

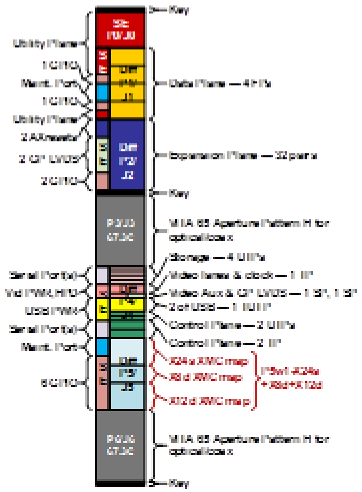

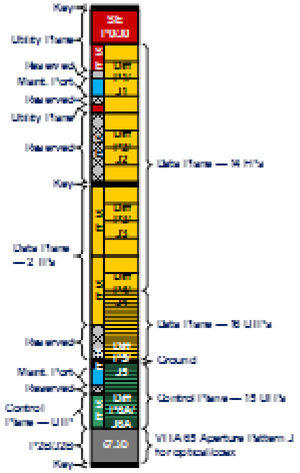

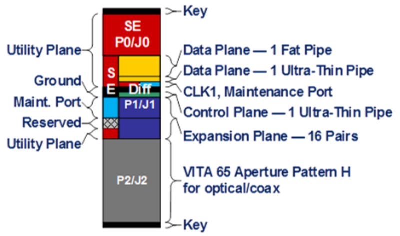

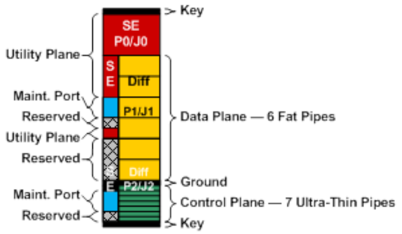

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There are multiple competing requirements that make it impossible to come up with a "universal" 3U SBC slot profile

- A modern general-purpose SBC has a broad range of I/O requirements
- A high-performance SBC may sacrifice some of these requirements for numerous pipes for high-performance I/O
- Specialized processors like a high-end receiver have even different requirements

Primary Data Paths

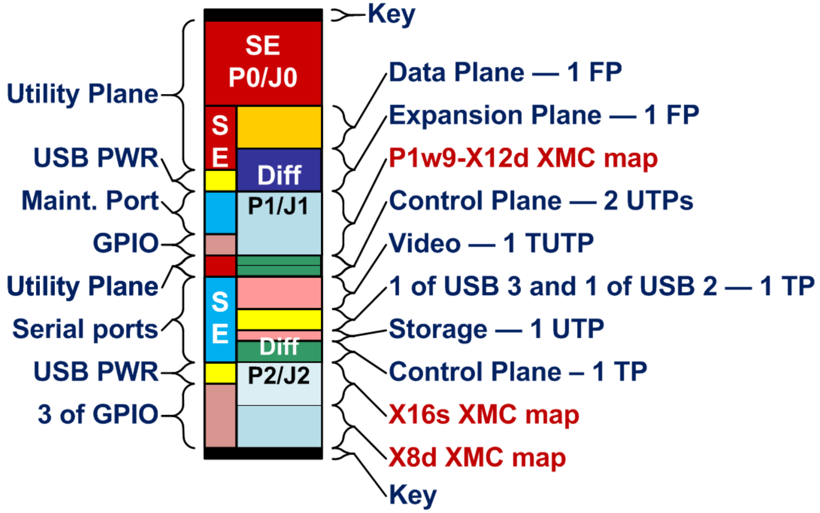
Industry Standard I/O

What is the solution?

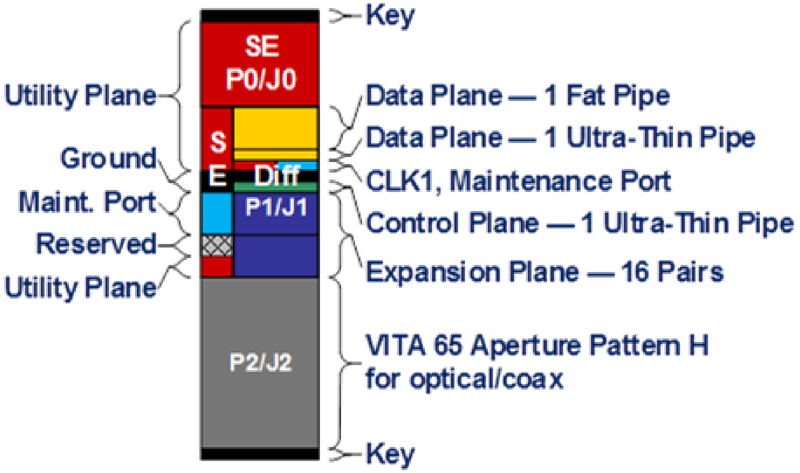
Examples: 3U Processors Modules

There are two primary 3U SBC profiles and one secondary defined in SOSA

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



Primary RF/Compute Intensive
SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-0



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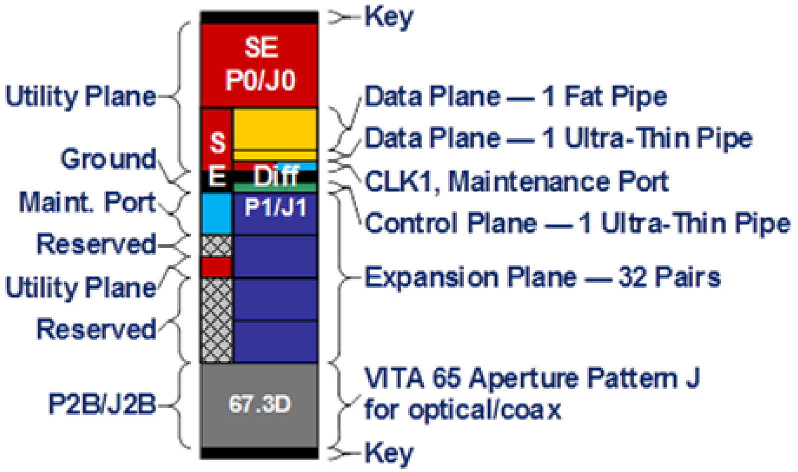
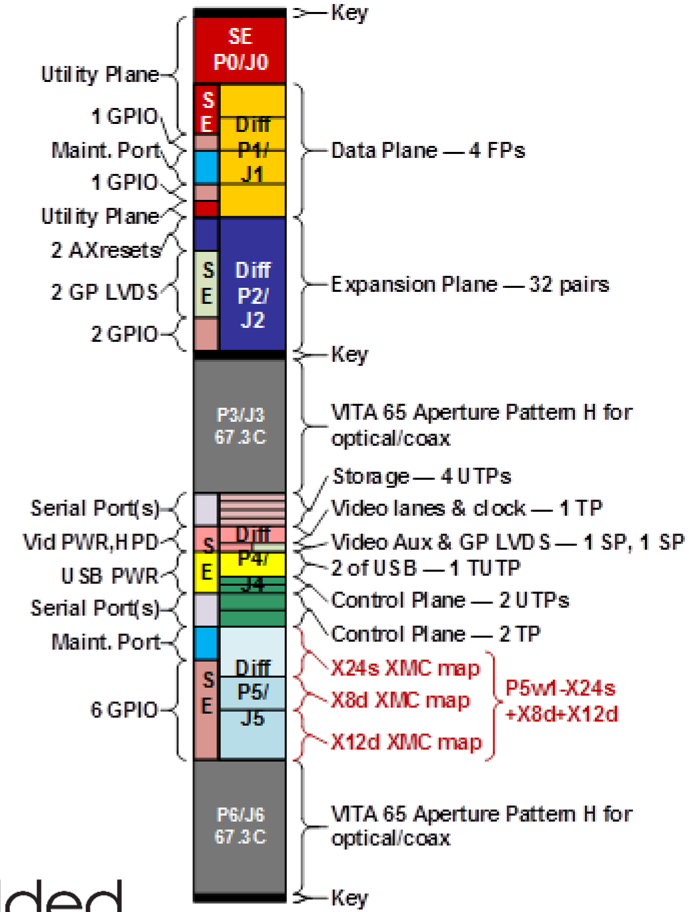


Examples: 6U SBC

There are two 6U SBC profiles defined in SOSA

Primary
SLT6-PAY-4F1Q1H4U1T1S1S1TU2U2T1H-10.6.3-n



Secondary
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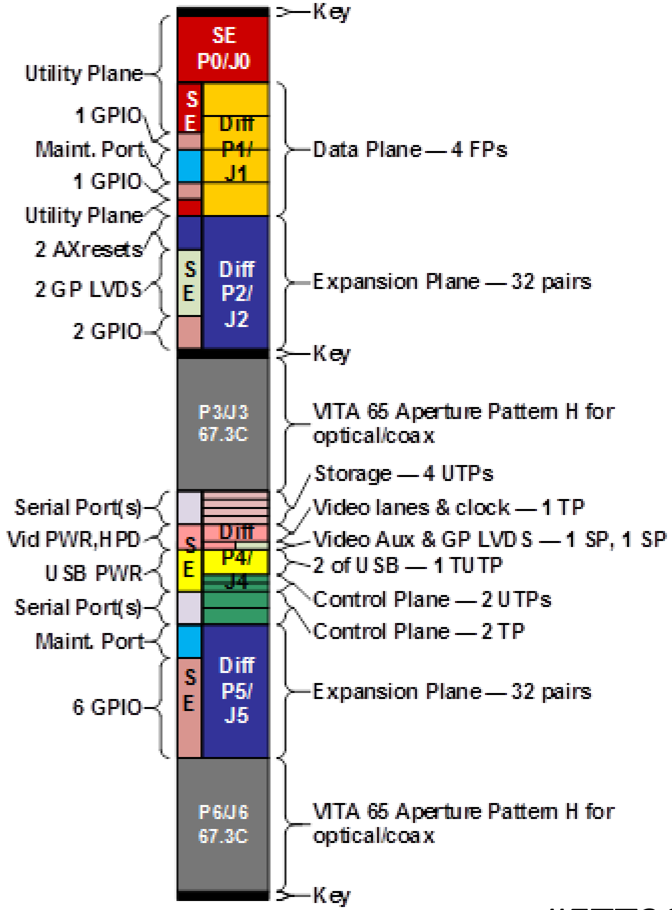
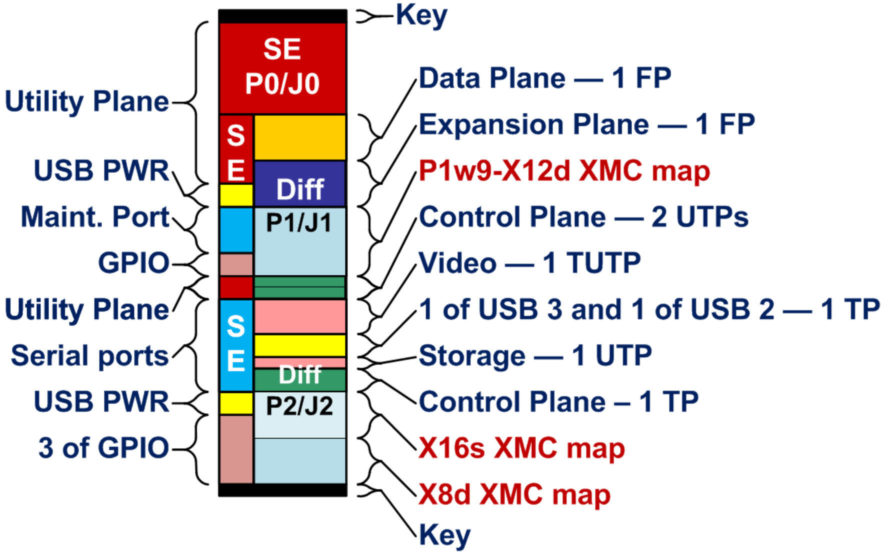


SOSA Module Profiles are Also Limited

- OpenVPX Module Profiles define what exact signaling is happening on each Pipe
- SOSA has a minimum set of module profiles defined
- Primary definitions include
  - 10 or 40GBase-KR(4) for the Data Plane
  - 10GBase-KR for the Control Plane
  - PCI Express Gen3 for the Expansion Plane
  - User I/O is defined as USB 3.0, DisplayPort, TIA-232/422/485, SATA 3
- Provisions to support PCIe Gen2 and more specialized protocols like Aurora are also included



SOSA: Much More than Slot Profiles

- SOSA is actually much more than a set of defined and approved slot profiles – SOSA working groups include:
  - Electro-Mechanical
  - Architecture
  - Software
  - System Management and Security
  - Business and Conformance
  - Application Domain Sub-Groups

- The result will be:
  - A complete common infrastructure for developing (and maintaining over technology generations) high-performance defense sensor systems
  - A market for supplying components to this infrastructure

The Benefits to the Market

SOSA will have impacts both within and beyond the defense sensor platform community

- Certain classes of products will become commoditized
- Other types of products will still be specialized, but adoption of new board-level product will be easier due to standard profiles
- Easier (cheaper) sensor upgrades will drive a faster upgrade cycle, driving more board-level business
- Any VPX system can benefit from adopting SOSA design principals

SOSA standard development efforts continue

- SOSA Snapshot 2 is released
- Work on Snapshot 3 (or perhaps straight to Version 1.0) is underway
- Kontron, along with other module suppliers, are working on 1st generation products "developed in alignment with the SOSA™ Technical Standard"
  - VX305C-40G I/O Intensive SBC already announced
- Conformance program expected to be launched later this year
  - Will provide a mechanism for testing and certifying that products meet the SOSA standard
- "Plug Fest" events are being planned for 2019
  - Intended to demonstrate the effectiveness of the SOSA standard and to raise confidence within the community

Finally, the SOSA standard is expected to evolve over time to address next generation technologies and to incorporate lessons learned

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Full-Text Version

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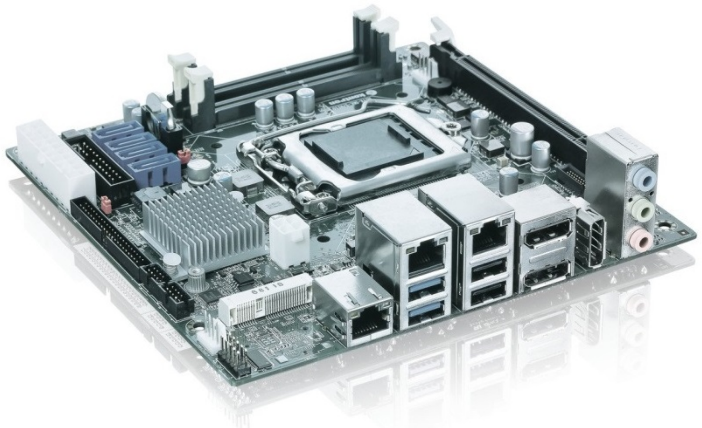
Standardization and Market Maturity

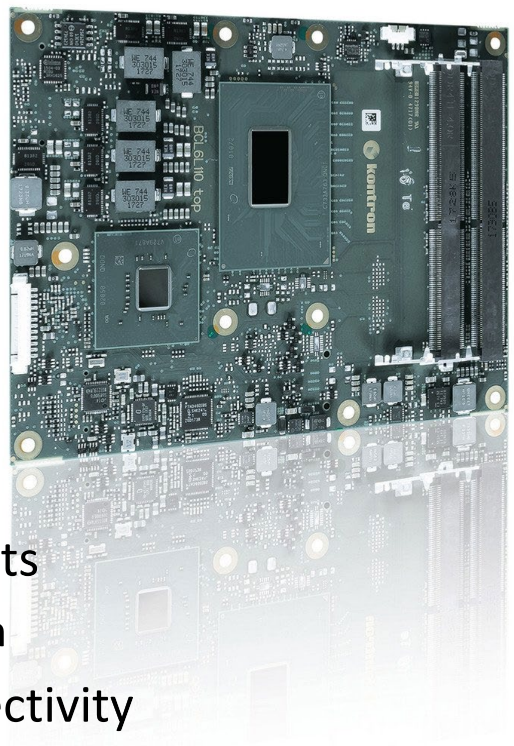
- Standardization is a natural development as a market matures
  - Early growth period is marked by product differentiation and differing design approaches
  - Standards emerge as the market discovers what “works” and what doesn’t
- Standardization can either be formal or informal
  - Formal standardization through an industry body drafting a standards document
  - Informal by simple market demand or a dominant player’s approach
  - And sometimes even a combination of the two

Successful Examples

- There are several good examples of Open System Architecture standards in extremely wide use

- ATX/mITX (and variants)
  - Standardized footprint
  - Standardized power
  - Standardized feature set
  - Standardized I/O apertures





- COMe
  - 4 standard footprints
    - Only three common
  - Standard pin connectivity
    - 8 types, but only three common
    - 100% defined – no user defined pins

Secret to their Success

- Rigidly define what makes sense
  - Footprint
  - Power connectivity
  - Minimum feature set
  - I/O
  - Use cases

- Allow for innovation and differentiation within the defined parameters envelope
  - Allows products to be tailored for different price points or market needs
  - Allows vendors to develop specializations

Defense Standardization Difficulties

There are a number of difficulties in trying to establish board-level standards involving defense platforms

- Orders-of-magnitudes differences in bandwidth requirements
- Occasional extremely-small latency requirements
  - Sometimes in the microsecond range
- Different architectures
  - Processing pipelines versus high-performance parallel computing with intense interprocessor communications
- Different environmental requirements with occasionally extreme temperature ranges
  - A high-performance radar in the nose of a fast jet at 50,000 ft or a UAV at 80,000 ft
  - A ground vehicle communications platform operating in a desert at noon
  - An EW system mounted near a jet nozzle

VPX/OpenVPX

- VPX has become the workhorse for defense embedded systems
  - Introduced by VITA 46 in the mid 2000's
  - Updated in 2013 and further amended and expanded by multiple dot standards
  - Focused mainly on mechanical definition, electrical characteristics, and the definition of a set of "utility" pins/functions
- OpenVPX (VITA 65) started in late 2008 to standardize the implementation of VPX products
- Pros
  - Introduced communications "planes"
  - Further refined the utility plane
  - Created a standard way to define module, slot, and chassis profiles
- Cons
  - Was not successful in meeting the goal of a "universal" slot definition
  - All profiles contained "user defined pins"
  - Many, many profiles included
    - 30x 6U, 63x 3U in the latest revision

SOSA™: An Attempt To Solve this

- The DoD has a strong desire to enable easy and rapid technology updates/upgrades in fielded defense platforms without system removal
  - Without vendor lock
- How is SOSA doing this?
  - By defining functional slot profiles
  - By removing all user-defined pins
  - By creating minimum mandatory feature sets and refining pin behaviors (like GPIO, serial maintenance ports, USB Power, AUX_CLK/REF_CLK, chassis management, etc.)
  - By limiting the variability in design, like adopting 12V only and limiting backplane connectivity rules to maximize commonality
  - By defining specific supported use cases
  - By focusing on the 80% solution and avoiding corner cases

- The result: an Open Systems Architecture for defense that works!

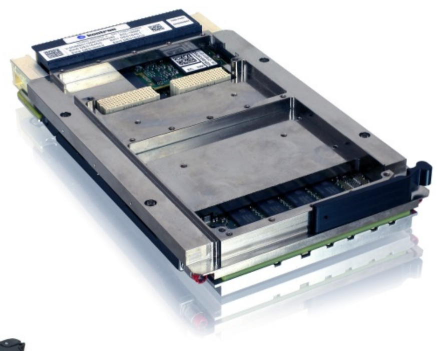
The Challenges of bringing OSA to VPX

There are definite challenges to turning VPX into a true OSA useful for defense applications

- There are many technical requirements for defense systems that simply don't exist in the commercial/industrial space
  - Ruggedization, extreme bandwidth and latency requirements, security, etc.
- There are many types of defense applications, each with their own (often contradictory) technical requirements
  - Radar, EW, SIGINT, EO/IR, etc.
  - Many different use cases to consider
  - Many types of dataflows, and orders of magnitude differences in latency requirements
- There are legacy systems which need to be taken into account in order to maximize adoption
- There are many demonstrated ways to implement systems using VPX
  - That is, it's flexibility is also a detriment
- There is now more than 10 years of VPX adoption – with resistance to move to a new solution space

VPX: Different than other OSA

VPX has fundamental differences from other form factors that make it more difficult to form an OSA



- There are multiple, very different board classes needed
  - Processing boards
  - Switch boards
  - I/O boards
  - Peripheral boards
  - Special hybrids
- Within these classes there are additional board types
  - Processors: general-purpose SBCs, high-performance SBCs
    - Very different I/O requirements
  - Switches: Data Plane, Control Plane, Expansion Plane, combinations/multi-switch
    - Different network technologies, different topologies
  - Various specialty boards like RF receivers, high-performance GPUs, bulk storage, etc.
    - Each has unique requirements for I/O and connectivity/control
  - Array of connectivity needs – copper, fiber optic, RF/Coax

VPX: Different than other OSA

A universal slot definition is impossible, and forming a minimal subset is very difficult

- What is needed is to define a taxonomy for functional board types
- SOSA didn't do this directly, but achieved it through
  - Starting with CMOSS and HOST profiles
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Example: 3U SBC

There are multiple competing requirements that make it impossible to come up with a "universal" 3U SBC slot profile

- A modern general-purpose SBC has a broad range of I/O requirements
  - Primary data paths – data plane, control plane, expansion plane, XMC mapping to the backplane
  - Industry standard I/O – USB, "BASE-T" style Ethernet, SATA, video, serial ports, general purpose I/O, etc.
- A high-performance SBC may sacrifice some of these requirements for numerous pipes for high-performance I/O
  - Serial lanes, either as multiple independent lanes or linked to a very wide pipe
  - Fiber optic
- Specialized processors like a high-end receiver have even different requirements
  - Need for multiple RF connectors
  - Similar need for multiple high-speed serial lanes

What is the solution?

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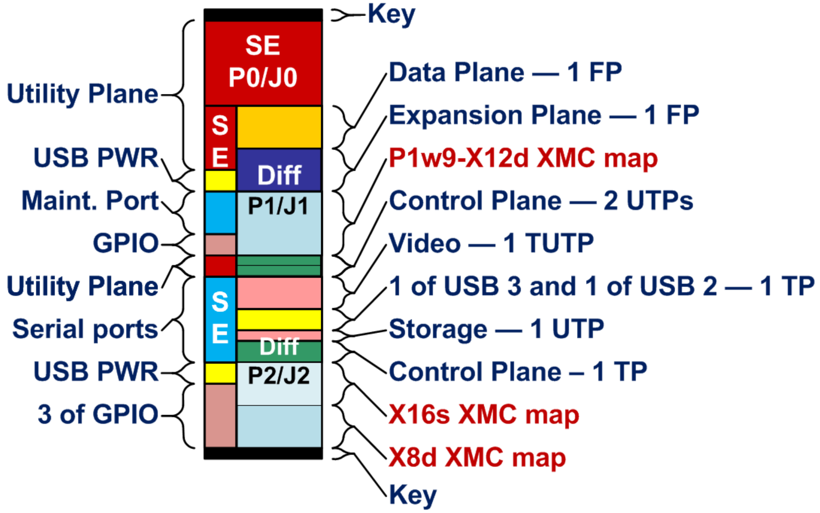

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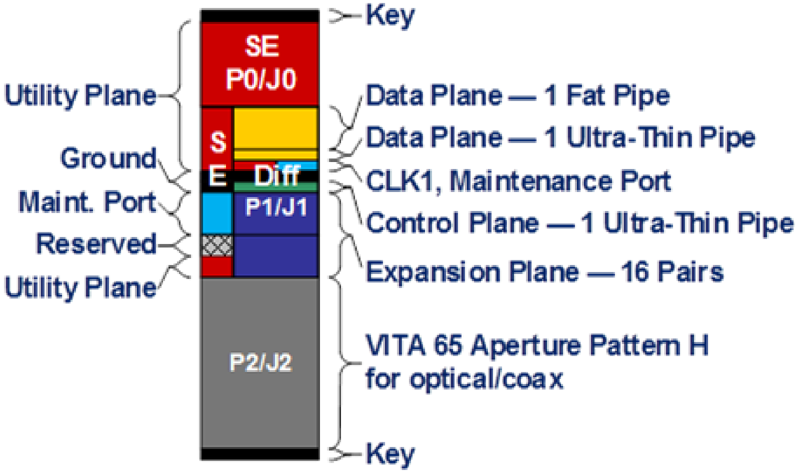

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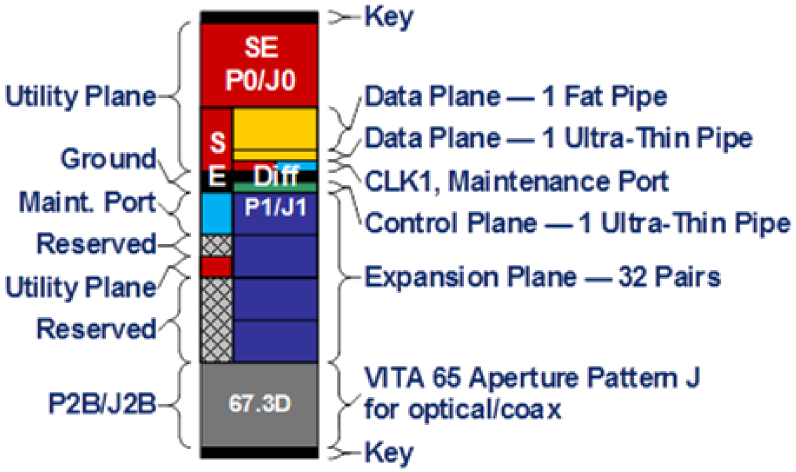

Examples: 6U SBC

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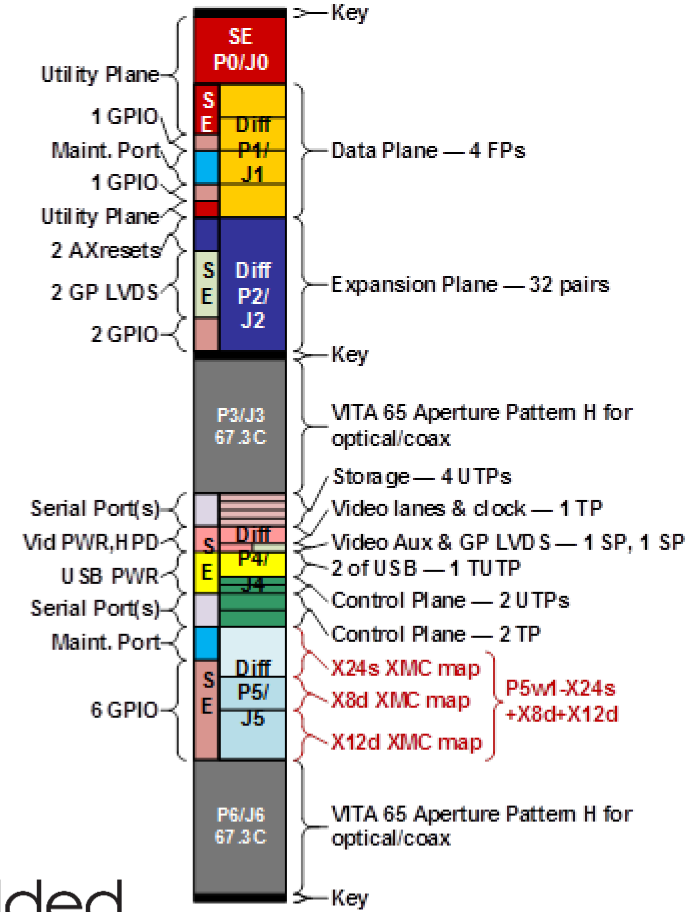

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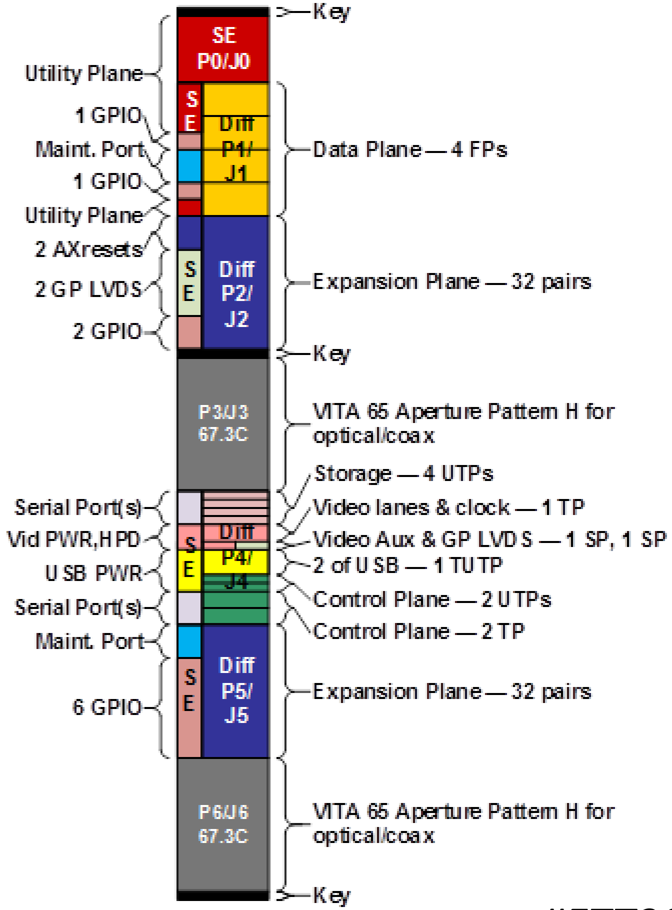

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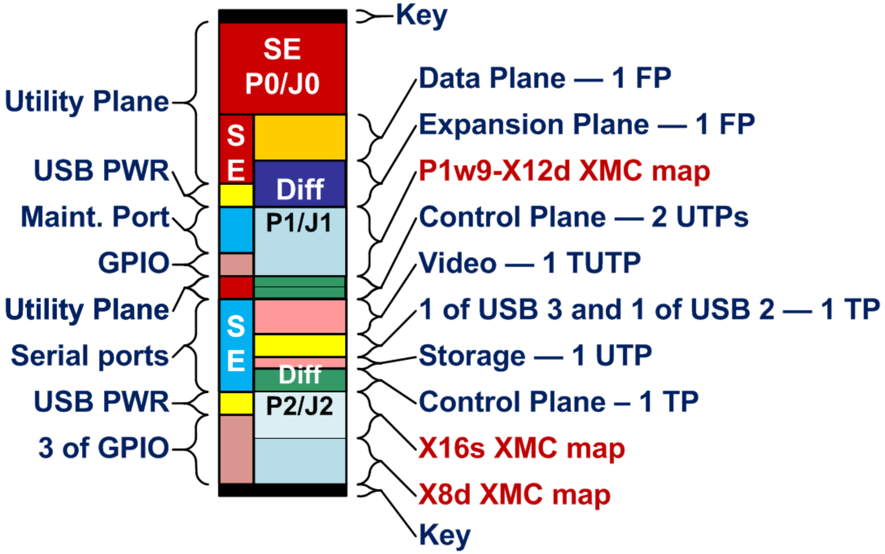

SOSA: Much More than Slot Profiles

- SOSA is actually much more than a set of defined and approved slot profiles – SOSA working groups include:
  - Electro-Mechanical: defining internal and external system connectivity and other physical aspects of systems
  - Architecture: defining how integrators approach system design
  - Software: defining common frameworks and toolchains
  - System Management and Security
  - Business and Conformance: defining how SOSA will be used in defense acquisitions and how suppliers will certify conformance to the standard

- The result will be:
  - A complete common infrastructure for developing (and maintaining over technology generations) high-performance defense sensor systems
  - A market for supplying components to this infrastructure

The Benefits to the Market

SOSA will have impacts both within and beyond the defense sensor platform community

- Certain classes of products will become commoditized
  - Basic SBCs, basic switches, perhaps others like GPUs or more-or-less general purpose I/O devices
  - Vendor lock will evaporate with these more-or-less commodity products
- Other types of products will still be specialized, but adoption of new board-level product will be easier due to standard profiles
- Easier (and thus cheaper) sensor upgrades will drive a faster upgrade cycle, driving more board-level business
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