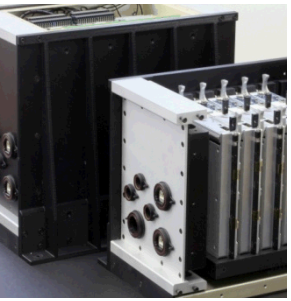
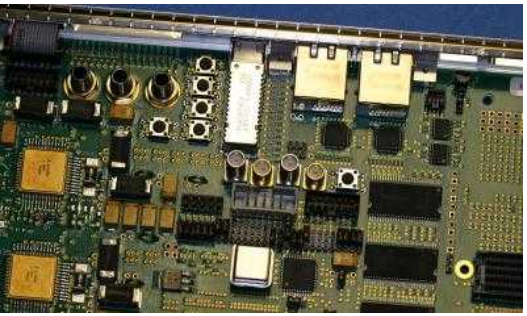
SAND2016-8232PE





Joint Architecture Standard

Overview

SAND2016-3272 M

Sandia National Laboratories

Exceptional service in the national interest

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. Approved for unclassified, unlimited release under SAND 2015-10292PE.

JAS Mission Statement & History

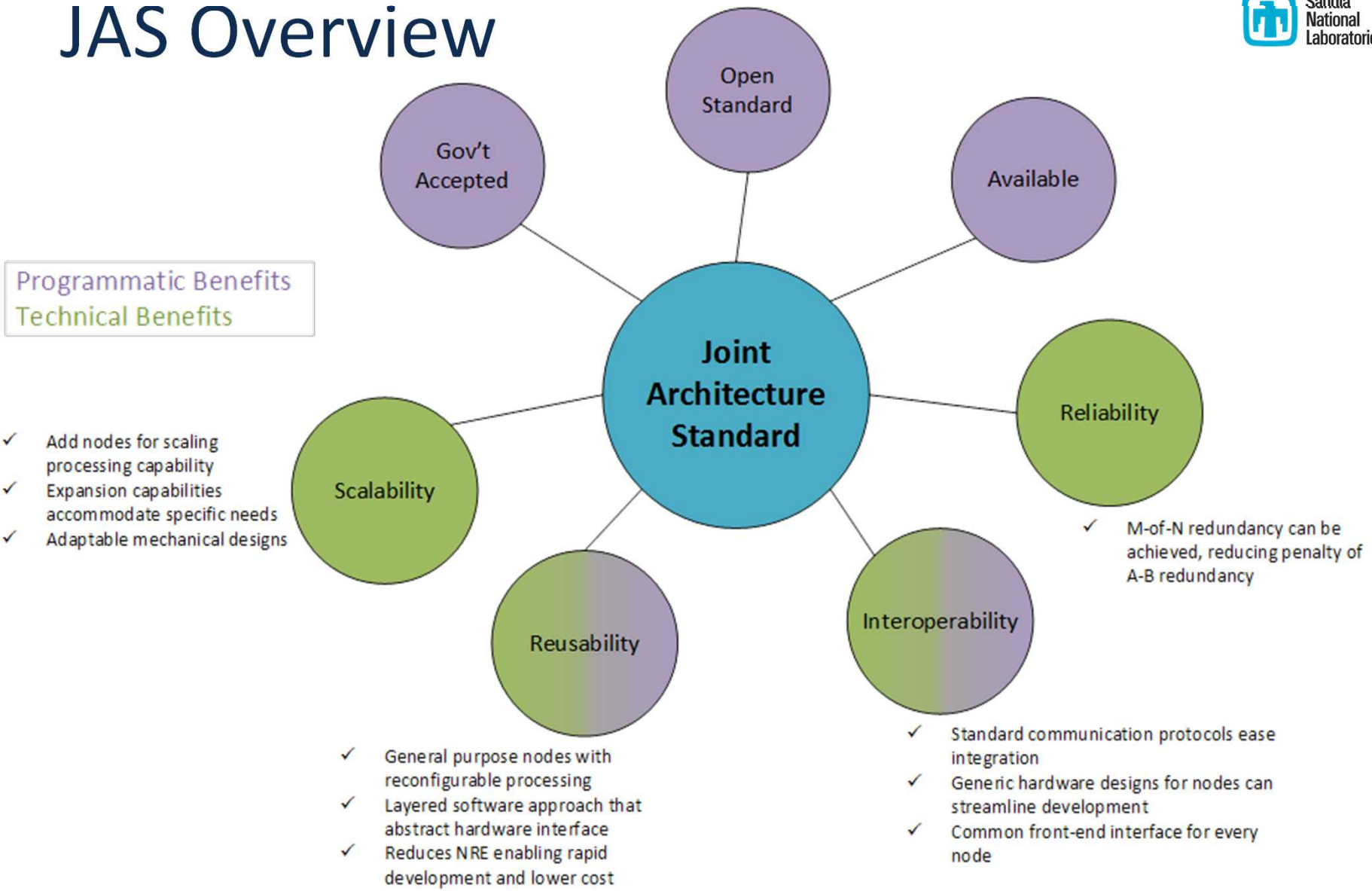
Sandia National Laboratories

- The Joint Architecture Standard (JAS) realizes a reusable set of common hardware and software for space-based processing payloads:
  - Government controlled, open standard, available to all industry, no Proprietary Information (PROPIN) limitations
  - Common infrastructure and processes facilitate significant reuse and rapid development of systems
  - Easily scaled, configured, adapted, interconnected and integrated with industry standards
  - Controlled access to JAS Intellectual Property (IP) providing functionality to support any payload sensor suite
- JAS has been a joint DOE and DoD development effort

JAS provides capability to meet new emerging mission requirements at reduced NRE

JAS Overview

Sandia National Laboratories



JAS emphasizes methodology without specifying instance

JAS Essential Elements

Sandia National Laboratories

- Mission requirements drive the selection of JAS elements to include within a system instance
- The following essential elements must be included:
  - Communication Interfaces (physical, preferably serial)
  - Protocols to communicate over the physical interface
  - Network-connected nodes that implement the communication interface and protocols
  - Network routing and addressing scheme(s)
- Realization of these elements can be achieved through instances of hardware profiles in the JT
  - Standard node types (e.g., CH, RP, PS)
  - Expansion modules (e.g. mezzanines and rear transition modules)
  - System Monitoring and Communications (SMAC) functions

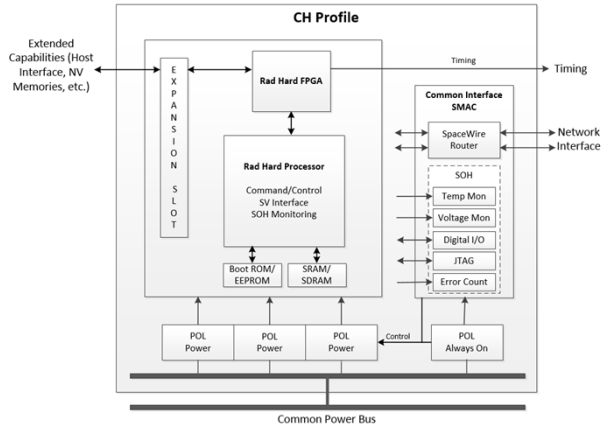
Common Communications is the key to Interoperability,
Networking allows Scalability

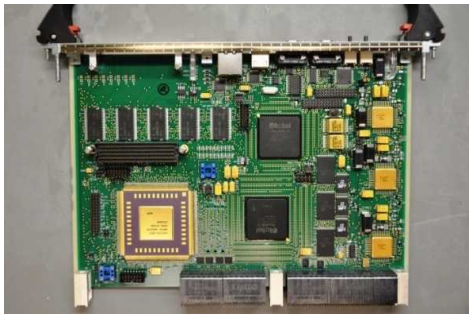
JAS Nodes

Sandia National Laboratories

Configuration and Host (CH)

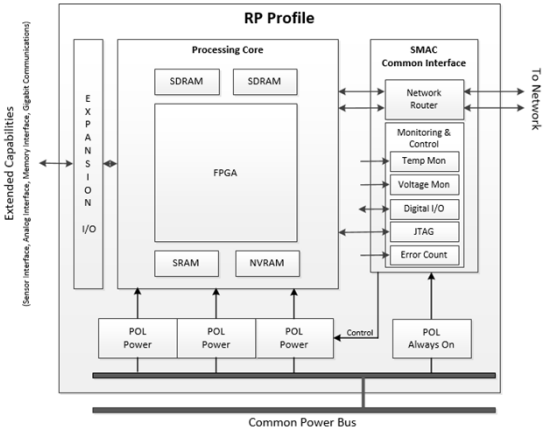
Microprocessor-based processing



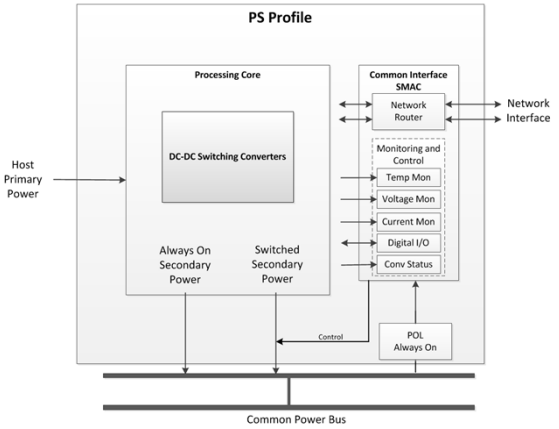


Reconfigurable Processing (RP)

FPGA-based processing



Power Supply (PS)



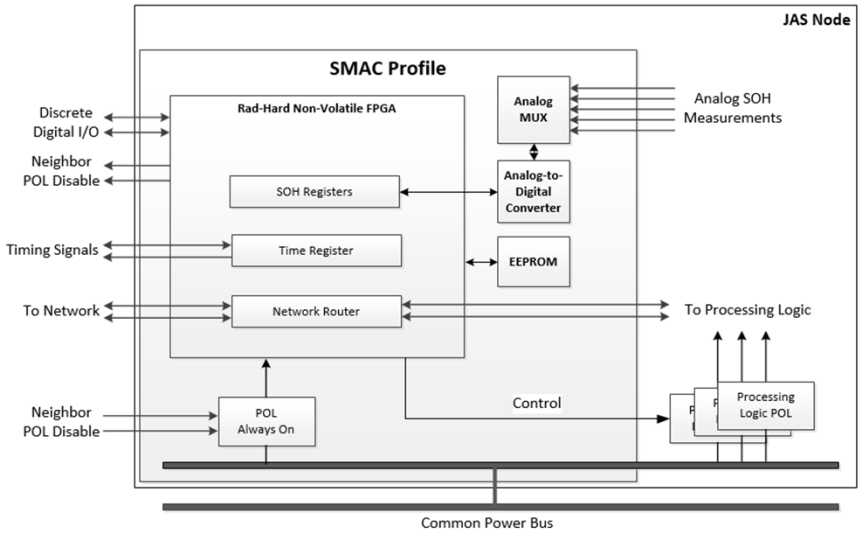
Note: The example nodes shown here utilize the VPX standard, but any interconnect standard may be used.

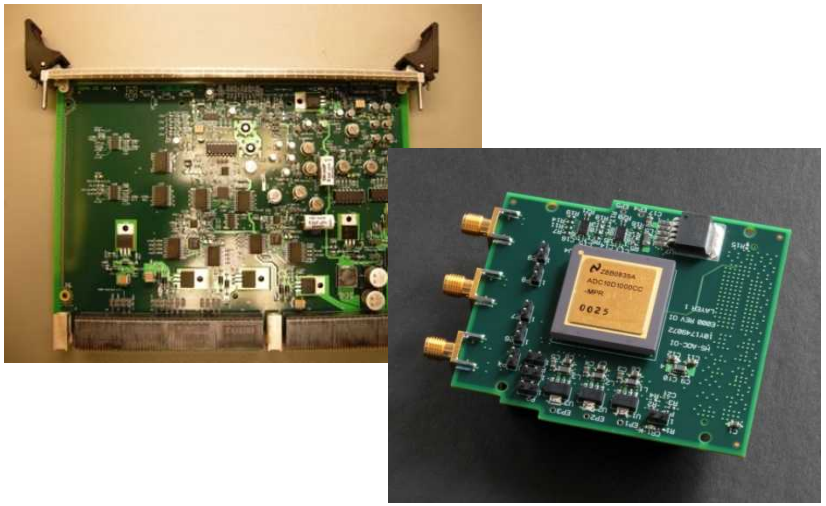
Nodes and expansion capabilities are the building blocks for any JAS-based system

JAS SMAC and Expansion Capabilities

Sandia National Laboratories

- The System Monitoring and Communications (SMAC) functions are implemented on every node
  - Provides network connectivity between processing elements, controls node power and discrete signals, and provides state of health for node hardware
  - Having a common SMAC design on every node provides a consistent front-end interface that reduces software complexity
  - SMAC functions can be implemented in either hardware or software
- Expansion capabilities provide mission-specific hardware and interfaces to standard nodes
  - Expansion boards may take the form of mezzanines, Rear Transition Modules (RTMs)[1], backplane-integrated cards, etc.
- Systems can be instantiated using two or three node types and expansion capabilities for specialized functions





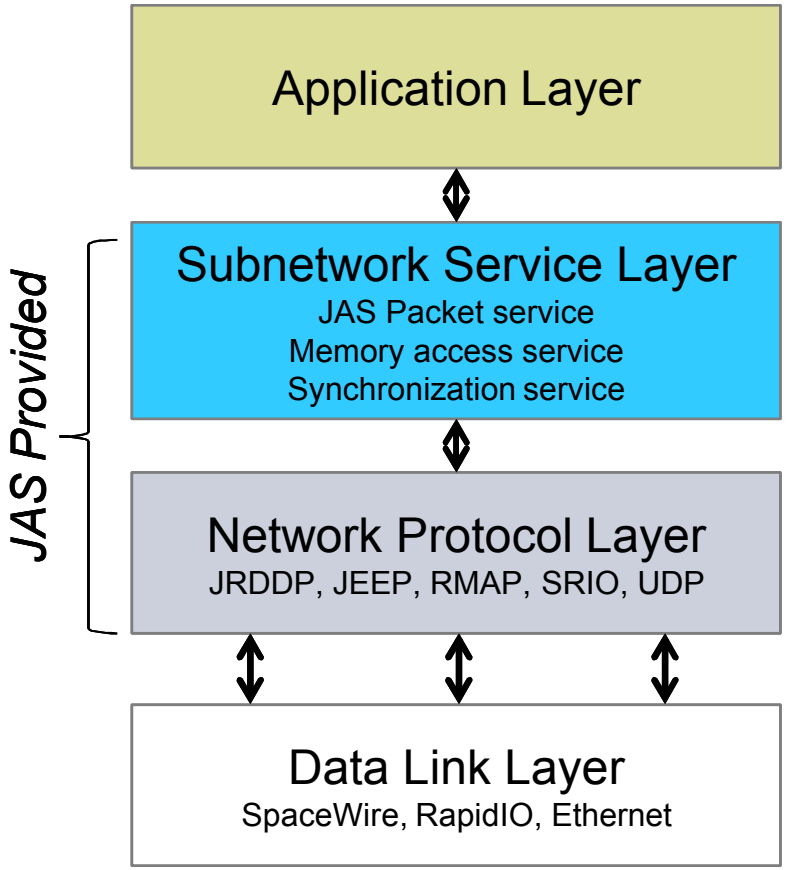
SMAC is the common front end interface; Expansion enables enhanced functionality

[1] *Note: The example expansion modules shown here utilize VITA standards, but any standard may be used.*

JAS Software and Communications

Sandia National Laboratories

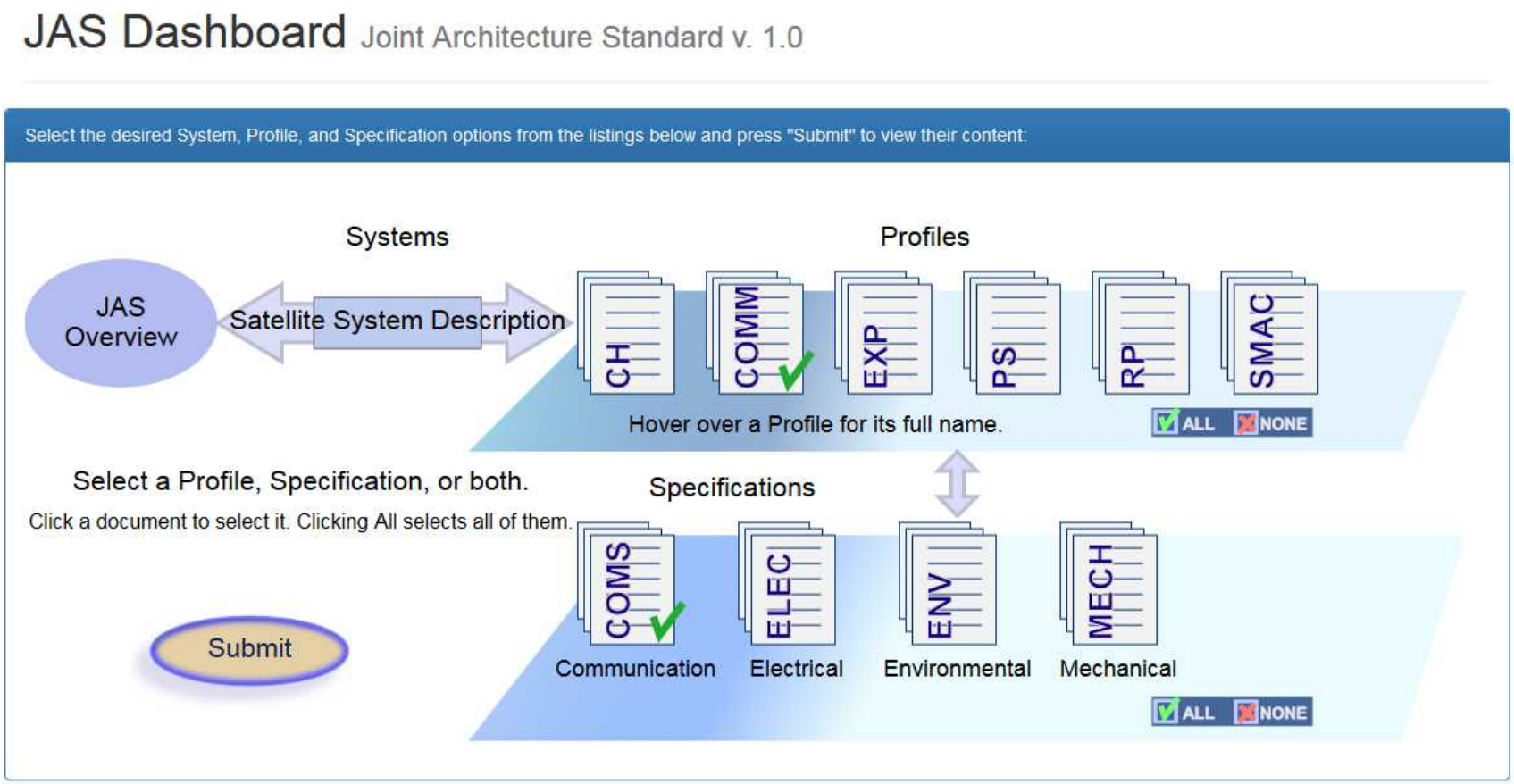
- JAS provides a standard set of software and communication services to applications
- A layered architecture abstracts applications from data links, making them more reusable
- Software services interface to network protocols based on communication needs
  - JAS packet service for sending messages between applications
  - Memory access service for remote access to hardware
  - Synchronization service for broadcasting events such as time



JAS supports layered architecture that facilitates Reusability of software

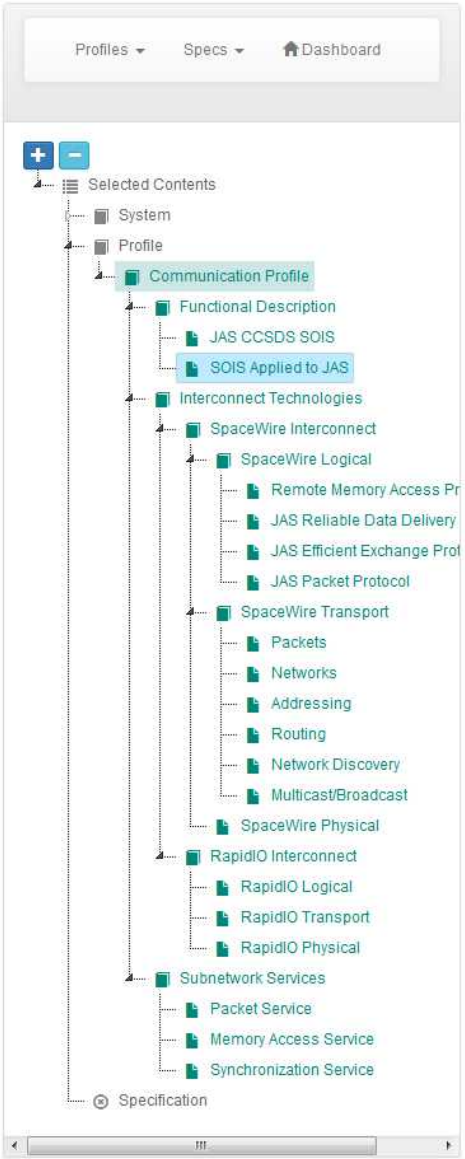
JAS Toolbox

Sandia National Laboratories



Comm Profile Example

Sandia National Laboratories

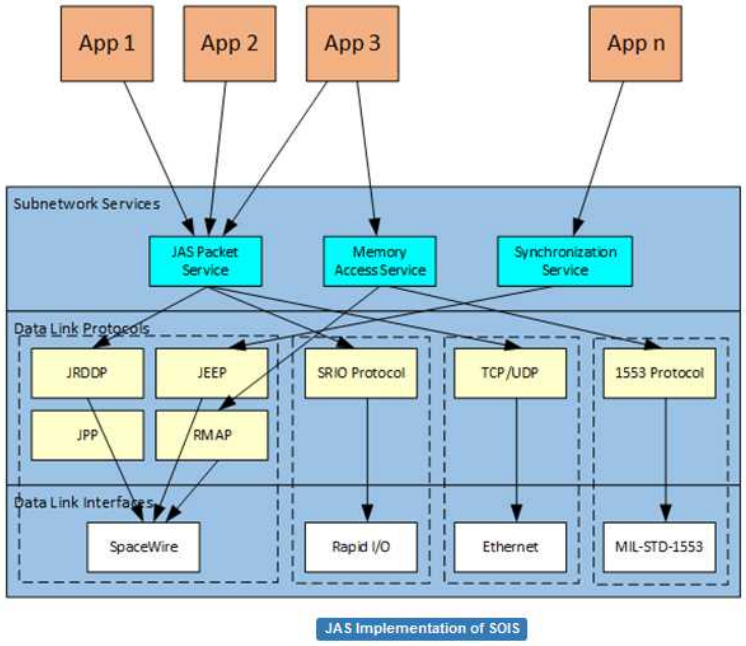


SOIS Applied to JAS

JAS-1.1-PR-COMM-SOAptoJA

Profile COMM

A simplified version of the SOIS architecture as applied to JAS is shown in the figure below. The subnetwork services are used by applications to encapsulate and describe the data that needs to be communicated regardless of the underlying physical layer. The subnetwork services are JAS-specific implementations of the respective SOIS services, which bridge the application interfaces to the underlying JAS protocols.

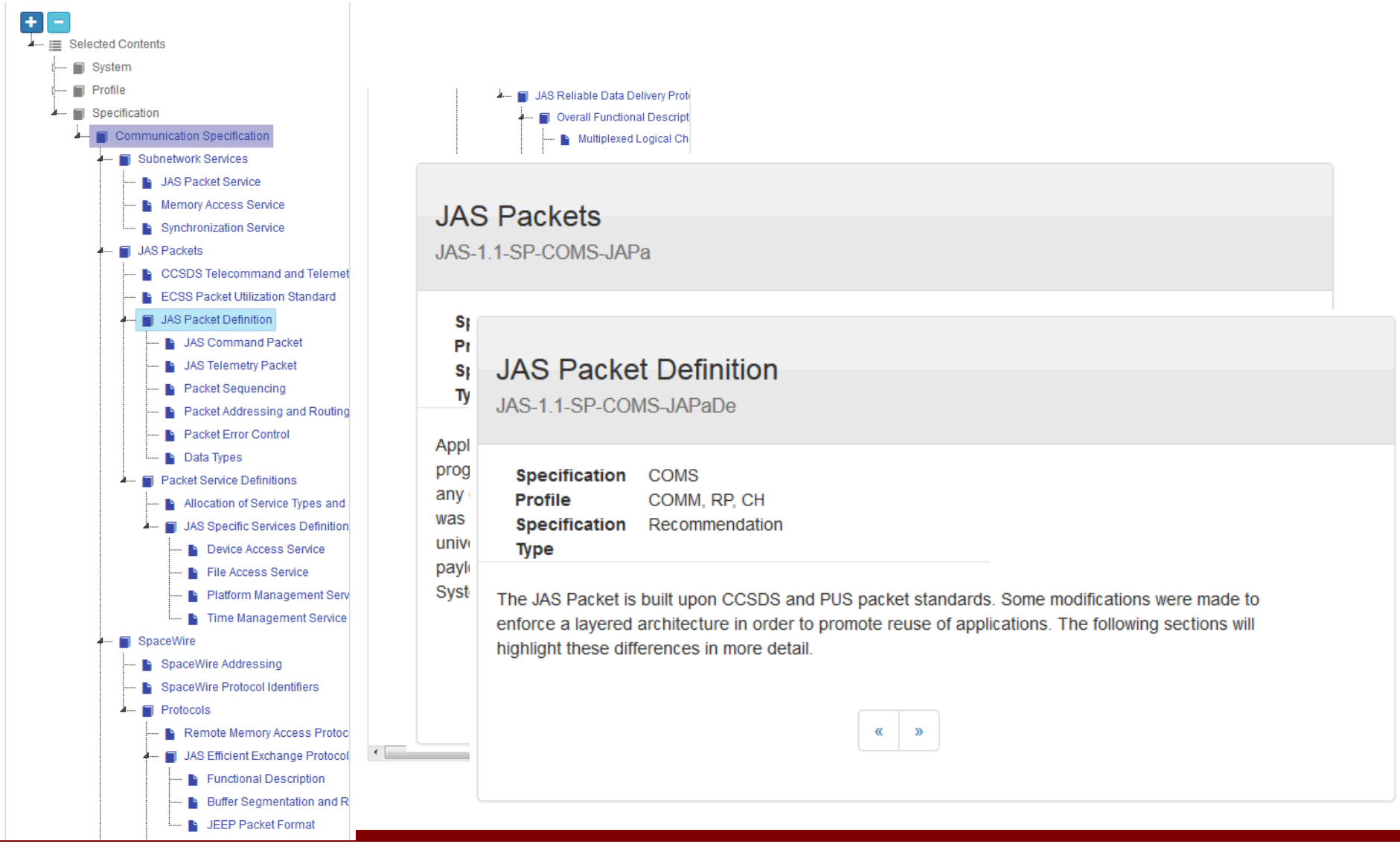


JAS Implementation of SOIS

« »

Sandia National Laboratories

Comm Specification



JAS vs. PROPIN

Sandia National Laboratories

Advantage	Budget	Schedule	Performance
Scalable processing systems	✓	✓✓✓	✓✓✓
Standard processing elements	✓✓✓	✓✓✓	✓
Standard communication interfaces	✓✓✓	✓✓✓	✓
Reduce SWaP	✓✓	✓	✓✓✓
M-of-N redundancy	✓✓✓	✓	✓
Utilizing industry standards	✓✓✓	✓✓✓	✓
Future-Proof	✓✓✓	✓✓✓	✓✓✓

There is no disadvantage of utilizing JAS versus PROPIN approach

Sandia National Laboratories

Optical Payload Trade: Legacy PROPIN vs. JAS Solution

Item	PROPIN	JAS	Savings	Notes
Processing Elements	40	19	52%	JAS –3 nodes, 16 MEZ/RTM designs PROPIN – 40 unique board designs
Communication Interfaces	14	7	50%	JAS –SpaceWire & SRIO network, external interfaces PROPIN – All internal interfaces custom
Communication Protocols	20	5	75%	JAS – 5, significant reuse of flight software PROPIN – 20 custom communication links
Flight Boxes	17	7	59%	JAS – 7 boxes (3 node stacks w/ common electronics) PROPIN - 17 unique boxes
Flight Cables	132	65	51%	JAS – ~65 (45 Electrical, 20 Fiber) PROPIN - +132 (+122 Electrical,10 Fiber)
Payload Weight	750lbs	500lbs	33%	JAS – Optimized electro-mechanical design PROPIN – Large number of independent designs
Payload Budget (Equivalent Year)	~$500M	~$350M	30%	JAS – significant REC in electro-mechanical design PROPIN – Large NRE cost
Payload Schedule	84 mo.	48 mo.	42%	JAS – significant reuse of hardware and software IP PROPIN – Fully custom due to mission requirements

Significant programmatic savings between PROPIN custom and JAS-based solutions

Available Resources

Sandia National Laboratories

- Utilize the JAS Toolbox to implement your mission requirements into a JAS-based instance
  https://jastoolbox.sandia.gov

- Contact for access, questions, and/or feedback:
  - JASToolboxContact@sandia.gov

Web-based JAS resources are available for education and development

Summary

Sandia National Laboratories

- JAS is a scalable, interoperable, reliable, and reusable architecture
- General-purpose node designs minimize unique hardware
  - Reduces NRE and maximizes reuse both system-to-system and within a given system instance
  - Common interfaces achieved by standardized communications infrastructure
- Efficiently supports external interfaces and node expansion capabilities
  - Facilitates customization to specific instantiations
  - Enables rapid prototyping and path to flight
- Several current programs developing JAS