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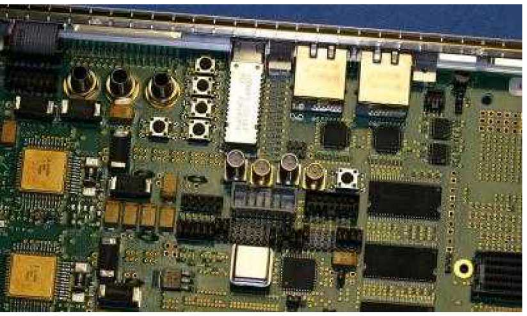

Joint Architecture Standard

Overview

SAND201x-xxxx XX

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Joint Architecture Standard (JAS)

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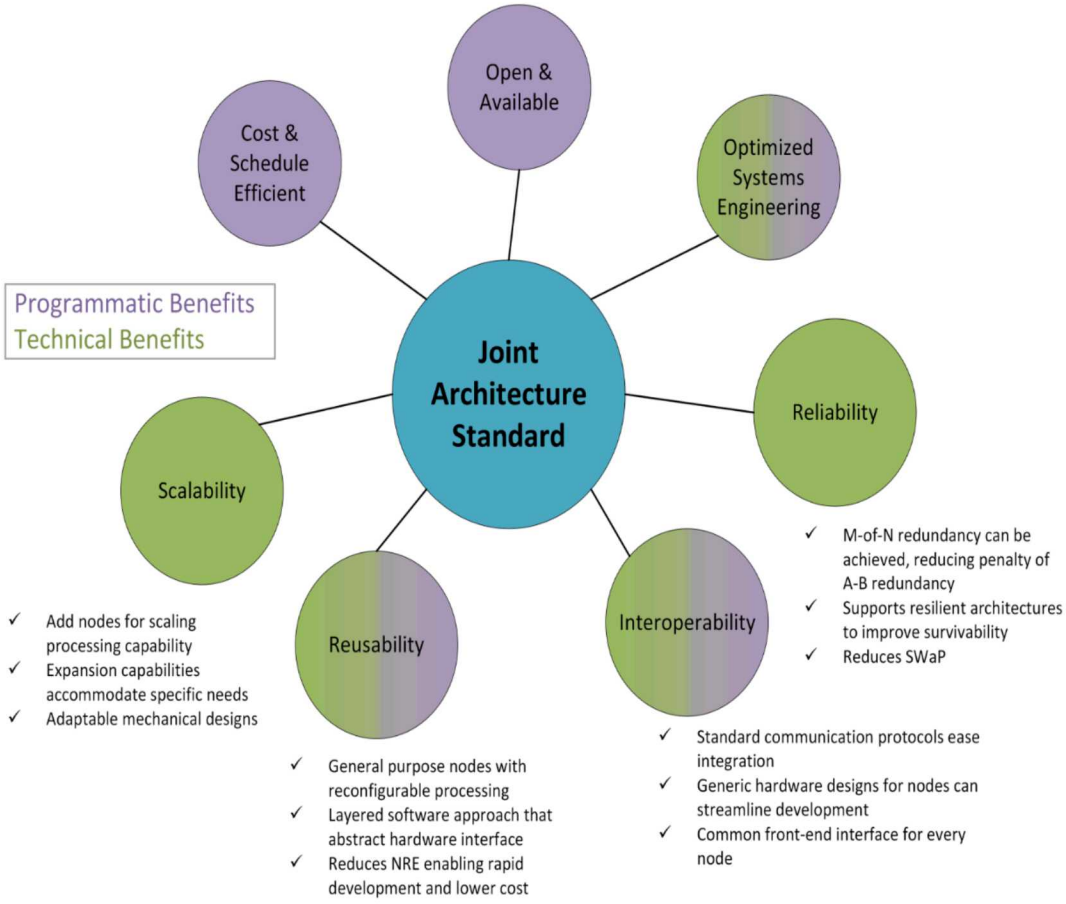
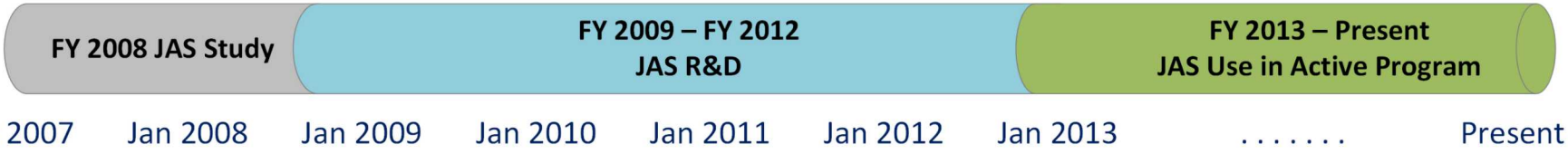
- (JAS) realizes a reusable set of common hardware and software for space-based processing payloads:
  - Government controlled, open standard, available to all industry
  - Common infrastructure and processes facilitate significant reuse and rapid development of systems
  - Easily scaled, configured, adapted, interconnected and integrated with industry standards (SpW, SRIO, Space VPX…)
  - 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

Why is JAS Needed?

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Industry Issues/Concerns	How does JAS Solve the Need
Legacy space architectures were predominantly implemented without system collaboration and with little thought for reuse	Tools and standards available online to all programs for collaboration and reuse ▪ JAS Toolbox, Systems Engineering Toolbox
Payloads were designed with custom "one-off" architectures ▪ Significant NRE for every system, resulting in long schedules, high costs and PROPIN design	Flexible architectures support many different payloads ▪ Node-based and service-oriented architectures ▪ Standard communication protocols
Aversion to introducing new technology leads to large-scale redesigns or performance limitations	Ability to on-ramp new technologies without redesigning the whole system ▪ Cost-effective NRE cycles amortize risk ▪ Layered architecture abstracts applications from lower-level implementation
Systems engineering tends to be decoupled from technical implementation ▪ Requirements are met but system does not satisfy functional intent ▪ Lack of crosscutting design	Methodology includes both the process and architecture ▪ Model-based design ensures coherence between the three aspects of systems engineering: requirements, functions, and physical architecture

Customers and stakeholders cannot afford to do business as they have in the past

JAS Value Proposition

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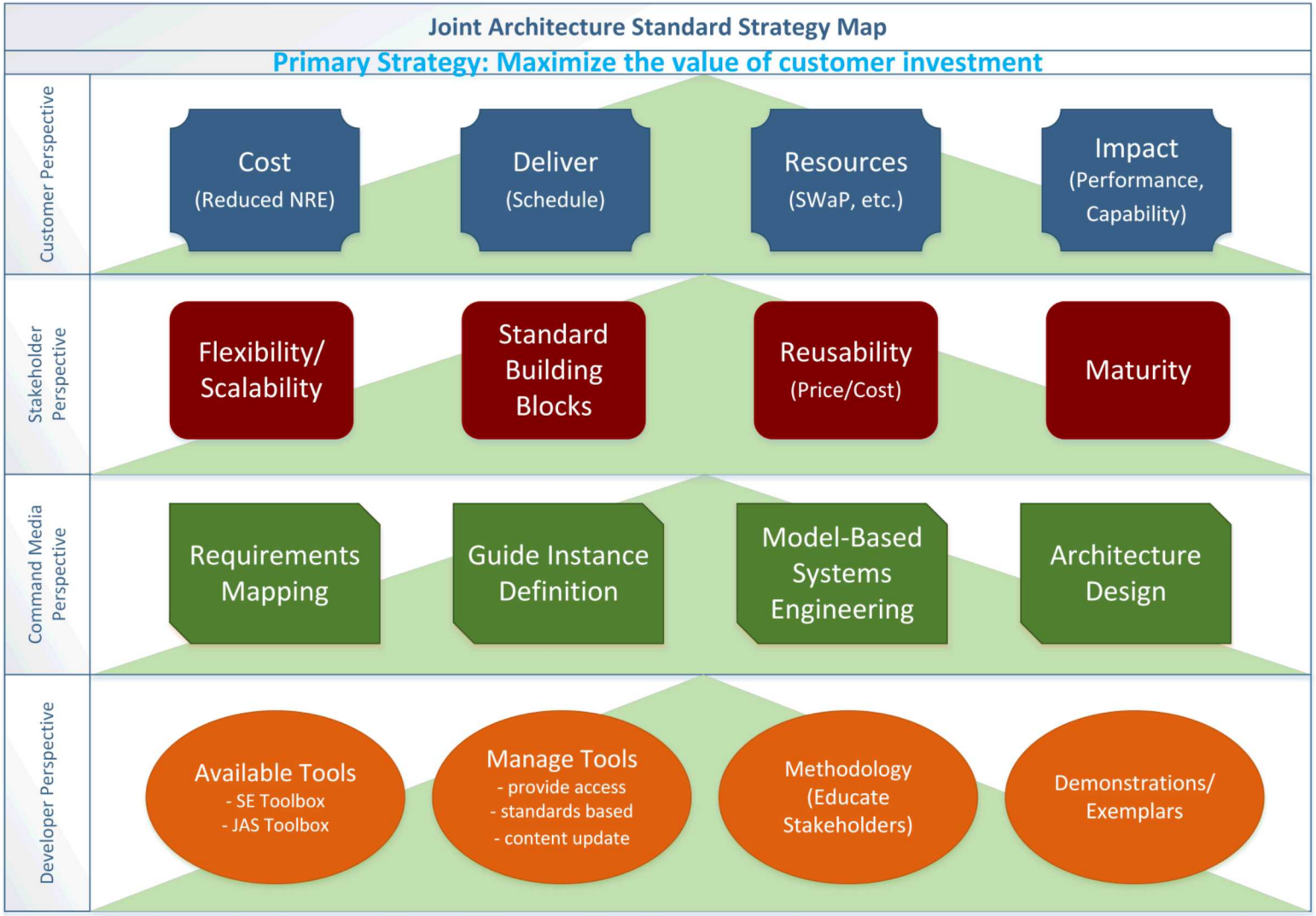


Roles Definitions:
Customer: paying for and acquiring product
Stakeholder: manage the development of the product
Developer: realizes the product

Perspective Definitions:
Customer: what do customers expect from JAS?

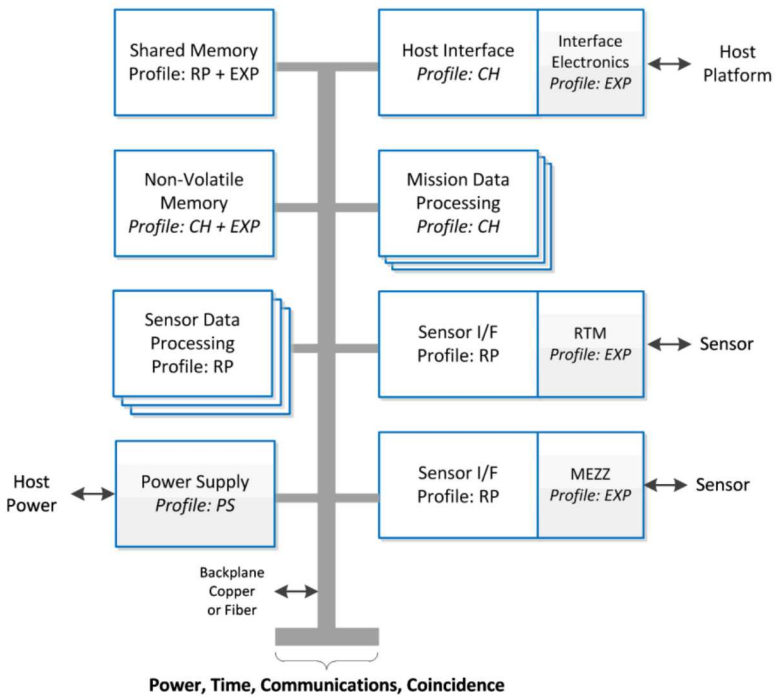
Stakeholder: who are the stakeholders? What do they value from JAS?

Command Media: what documented processes must JAS follow to deliver value to our stakeholders?

Developer: what must JAS provide to enable the developers?

JAS will maximize the value of customer investment

JAS Building Blocks



Essential Elements:

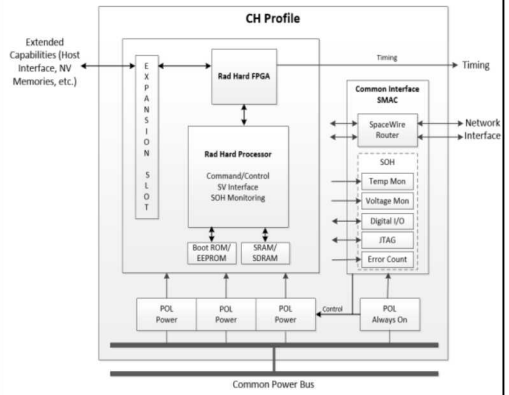
- Communication Interfaces (physical, preferably serial)
- Protocols to communicate over the physical interface
- Network-connected nodes that implement the communication interface and protocols
- Network routing and addressing scheme(s)

Essential Building Blocks:

- Primary Functional Nodes (CH & RP)
- Personality Expansion Modules (EXP)
- System Monitoring and Control (SMAC)
  - Provides network connectivity between processing elements,
  - Consistent front-end interface that reduces software complexity

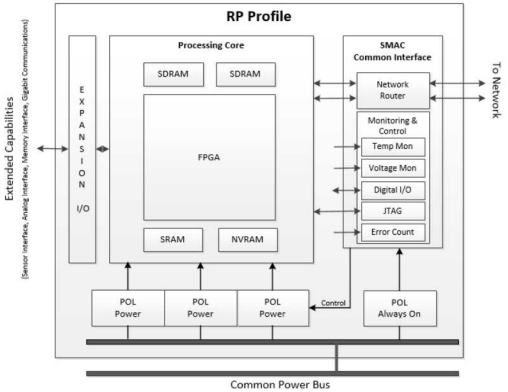
Configuration and Host (CH)

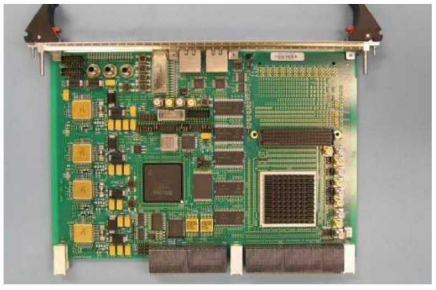
Microprocessor-based processing



Reconfigurable Processing (RP)

FPGA-based processing





JAS Communications Standard

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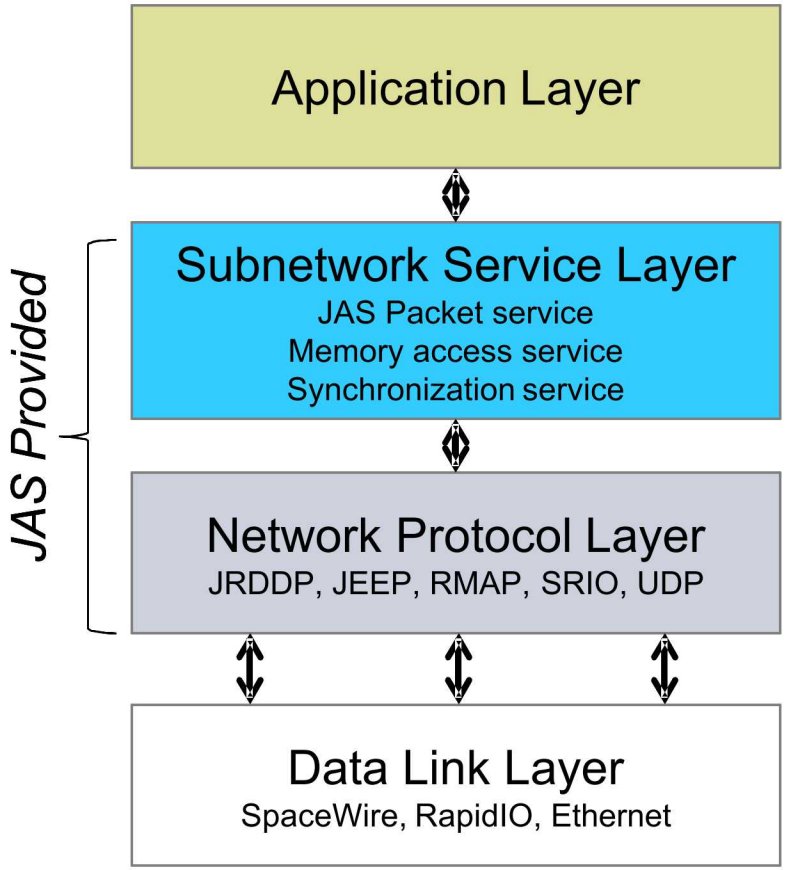
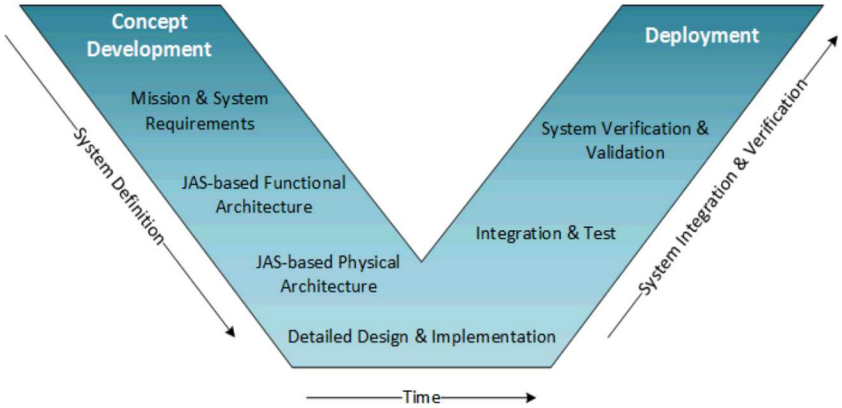
- A standard set of services, protocols, and data types that allow applications to communicate with each other
- Uses a layered architecture to abstract applications from data links, making them reusable on different hardware
- Applications interface to software services based on communication needs
  - JAS packet service for sending messages between applications
  - Memory access service for remote access to hardware
  - Synchronization service for broadcasting events such as time
- Services communicate with protocols based on the data link type and Quality of Service (QoS) parameters

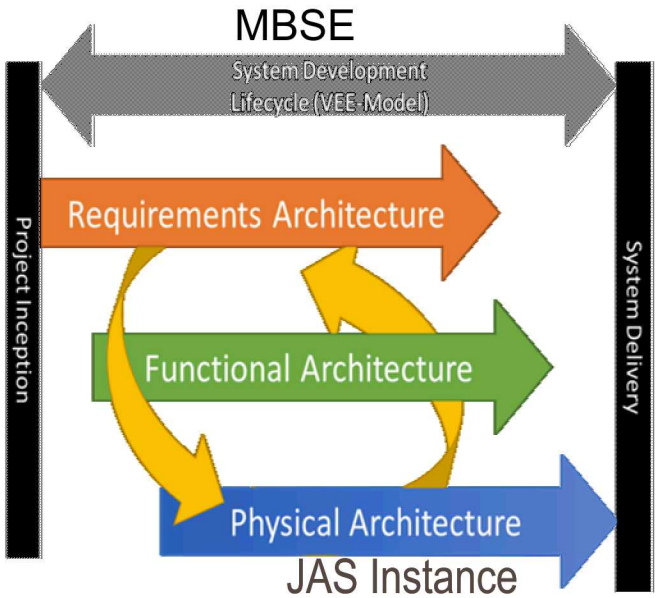


JAS supports a layered architecture that facilitates application reuse

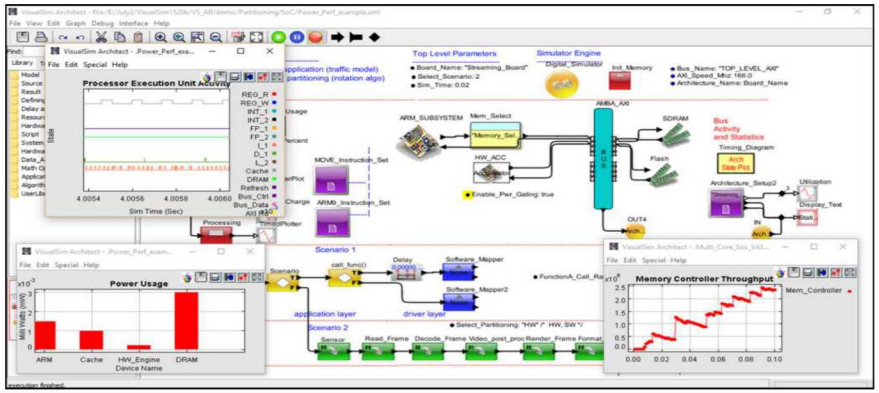
JAS Implementation Methodology

- JAS Implementation Methodology supports the product/payload life cycle.
- Model-Based Systems Engineering (MBSE) is a process for decomposing customer requirements down to the functional and physical architecture
- MBSE focuses on developing three primary architectures and capturing their relationship
  - Requirement Architecture
  - Functional Architecture
  - Physical Architecture
- Mod/Sim JAS Essential Element/Building blocks w/ Visual Sim
  - Enable rapid capability assessment; performance, reliability, resiliency….
  - SWAP vs Performance characterization
  - Model application specific algorithms





VisualSim



JAS Toolbox

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JAS Dashboard Joint Architecture Standard v. 1.0

Home | SE Tools | Quick Start Guide | JAS Overview | Contact | Help

Search Fields

Domain(s):* ☑ Air ☑ Land ☑ Sea ☑ Space ☑ **ALL**

System(s):* ☑ Satellite ☑ **ALL**

Type(s):* ☑ Other ☑ Profile ☑ Specification ☑ **ALL**

+ Show advanced meta-data filters

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Showing 263 results:

- Satellite System Description
- Joint Architecture Standard Overview
  - JAS Rationale and Motivation
    - Characteristics
    - Advantages of IAS

JAS Toolbox: Comm Profile Example

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Communication Profile

Profiles ▾ Specs ▾ Dashboard

- Selected Contents
  - System
  - Profile
    - Reconfigurable Processing Profile
    - Power Supply Profile
    - Expansion Profile
    - Communication Profile
      - Functional Description
        - JAS CCSDS SOIS
        - SOIS Applied to JAS
      - Interconnect Technologies
      - Subnetwork Services
    - Command and Host Processor Profile
    - System Monitoring and Communication Profile
  - Specification

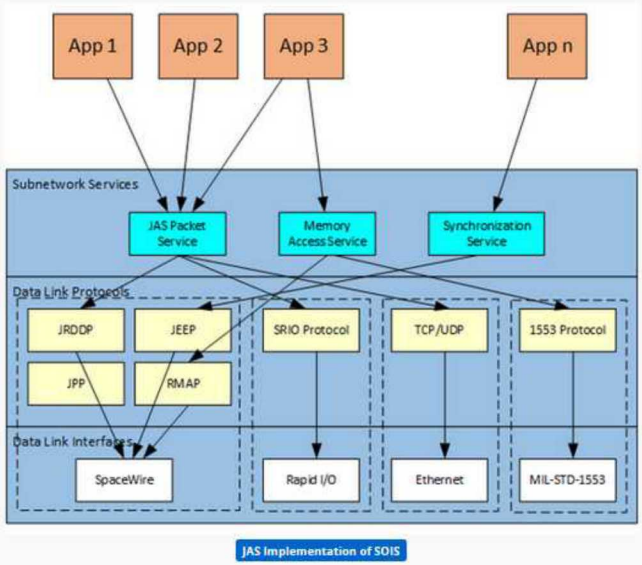
SOIS Applied to JAS

JAS-PR-COMM-SOAptoJA

« »

Domain(s)	Space
System(s)	Satellite
Profile(s)	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

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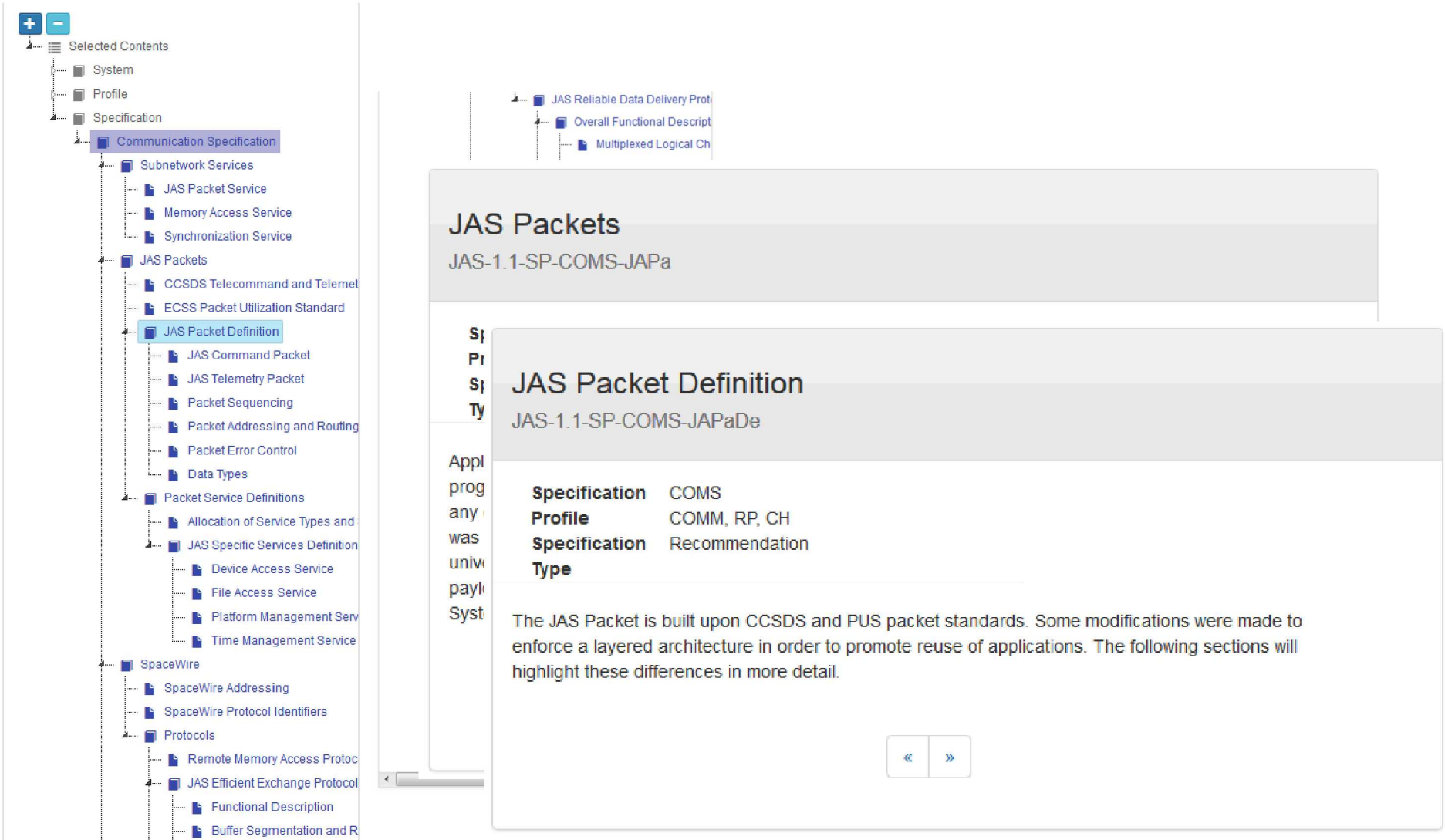
JAS Toolbox: Comm Specification



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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

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- 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

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- JAS is a scalable, interoperable, reliable, and reusable architecture
  - Progressive methodology enables the use of current and future electronics standards
- 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