PIM/PSM for Space SDR RFP

communications

An New Software Standards Development Promoting A Reusable Communications & Navigational Software Architecture For Space Missions & Services

Key Focus: NASA's Space Telecommunications Radio System (STRS)

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Agenda

- ***STRS Overview***
  - *Objectives*
  - *Architecture*
  - *History*

- ***Standards***
  - *Factoring in The SCA*
  - *Studies & Results*
  - *Applying MDA to Space SDR*
  - *SWRadio = MDA Applied to SCA*

- ***PIM/PSM for Space SDR RFP***
  - *Objective*
  - *Problem Statement*
  - *STRS + SWRadio = Space SDR*
  - *Mandatory Requirements*
  - *Optional Requirements*
  - *Related Activities*

- ***Logistics***
  - *Standards Working Together*
  - *Consortia Working Together*
  - *OMG Process*
  - *Validation*

- ***Summary & Conclusions***

Agenda

- ***STRS Overview***

- *Standards*

- *PIM/PSM for Space SDR RFP*

- *Logistics*

- *Summary & Conclusions*

Architectural Objectives

communications

- **NASA Looking For An Architecture Standard That Can Enable Cost Savings Through Reuse Of Both Hardware And Software Between Missions/Mission Classes**

- **Key Attributes Of The Architecture:**
  - *Scalability - Small To Large Platforms*
  - *Reconfigurability*
  - *Reliability*
  - *Modularity - "Future Proof"*
  - *Extensible - Support Varied Applications And Services*
  - *Enable Application Portability (Including HAL)*
  - **Concern Separation (WF/Platform Abstraction)**

Architecture

- **Hardware Architecture (Functional)**
  - *General Purpose Processing Module*
  - *Signal Process Module*
  - *Radio Frequency Module*
  - *Security Module*
  - *Networking Module*
  - *Optical Module*
  - *Control & Data Interface*
  - *DC Power Interface*
  - *Thermal & Mechanical Interface*
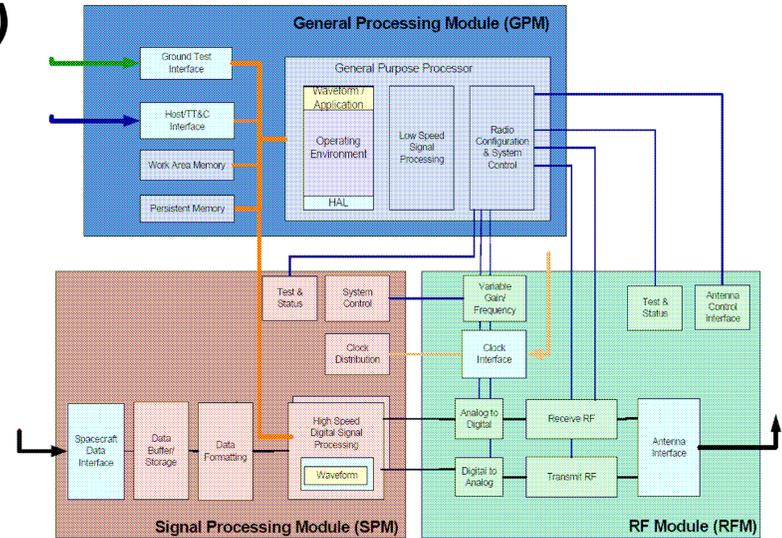
- **Software Architecture**
  - *Layers*
  - *Infrastructure*
  - *Host Spacecraft Interface*
  - *POSIX*
  - *Network Stack*
  - *RTOS*
  - *HAL*

- **Waveform Applications**
- **Mission Classes**
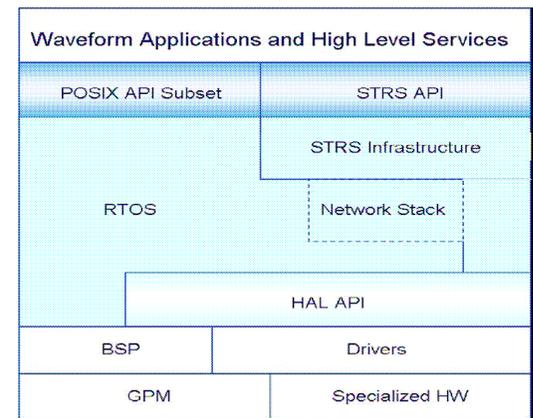
History

- *Q106*
  - *RFI Issued & Industry Responds, Face-To-Face Reston, VA*

- *Q206*
  - *Industry Actions Assigned:*
    1. *Hardware – General Dynamics/John Liebetreu*
    2. *SSP Abstraction – Object Interface Systems/Victor Giddings*
    3. *SCA Leverage – L3/Mark Scoville*
    4. *PIM/PSM — PrismTech/Jerry Bickle*
    5. *API v. Component – Harris/Vince Kovarik*

- *Q306*
  - *SDR Forum / Space WG Face-To-Face (Cleveland) OMG RFP Discussed (Items 3,4, 5 combined)*
 - *Began RFP Development*

Agenda

- *STRS Overview*

- ***Standards***

- *PIM/PSM for Space SDR RFP*

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Why Standards?

- ***Commonality***
  - *Structure, Terminology, Tools, Testing, Training, Understanding (Patterns)*

- ***Cost Reduction***
  - *Risk, Schedule, Cost*

- ***Increased Opportunity***
  - *Choice, Development Speed, Reliability, Quality, Interoperability*
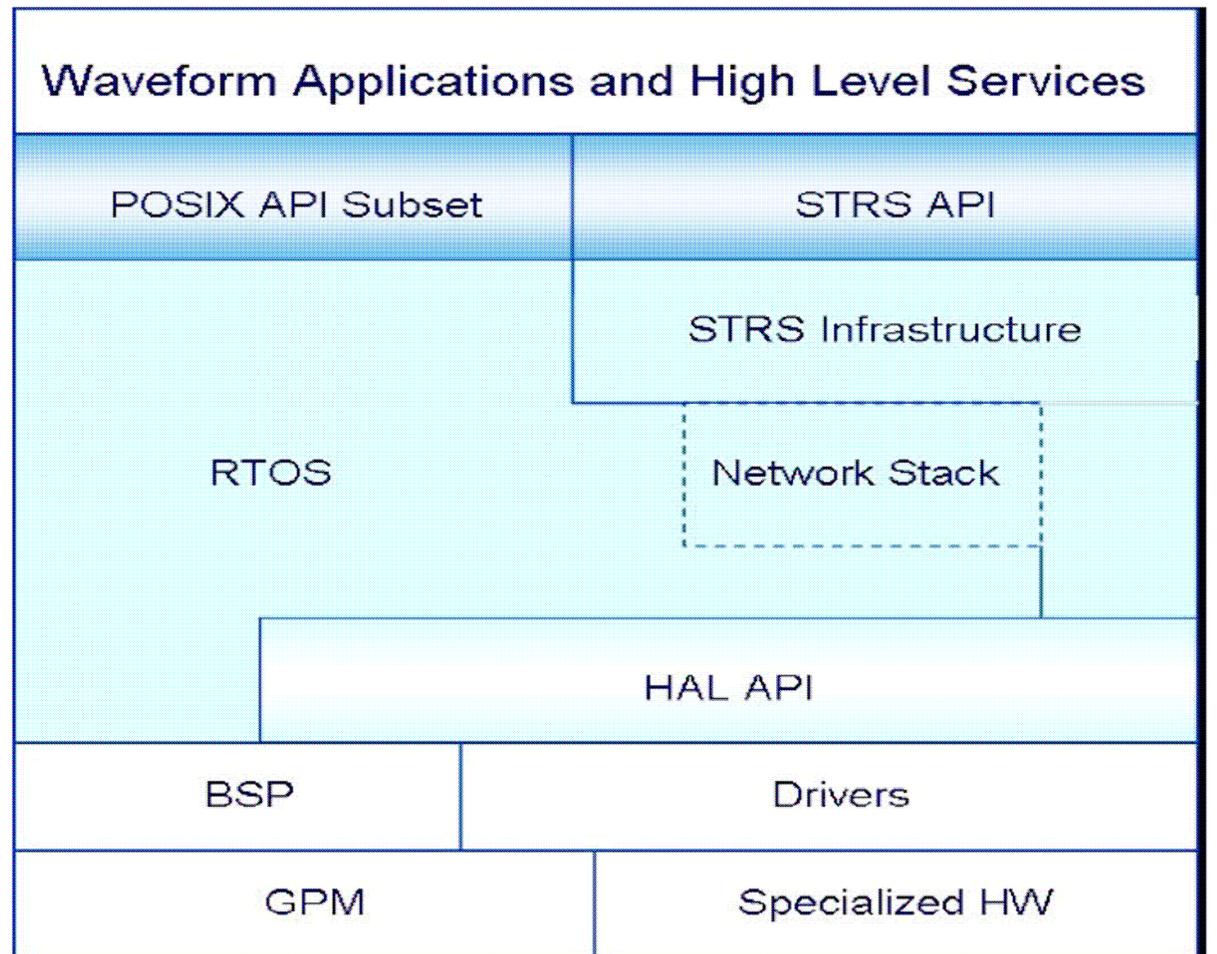

BREVITY / by Guy & Rodd
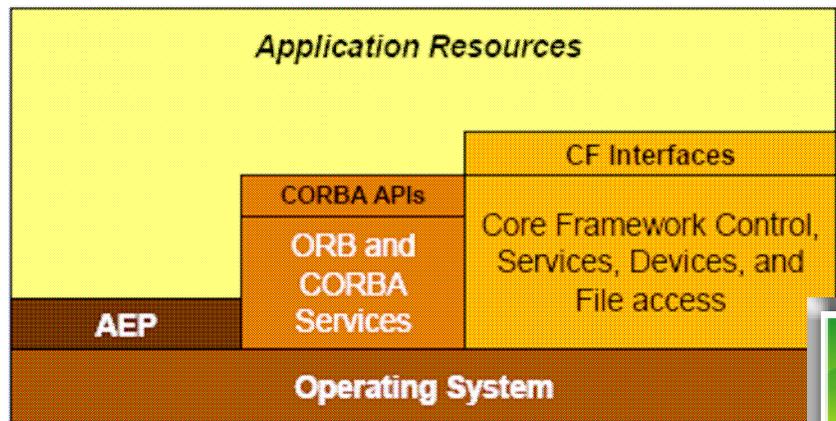
UH-OH.
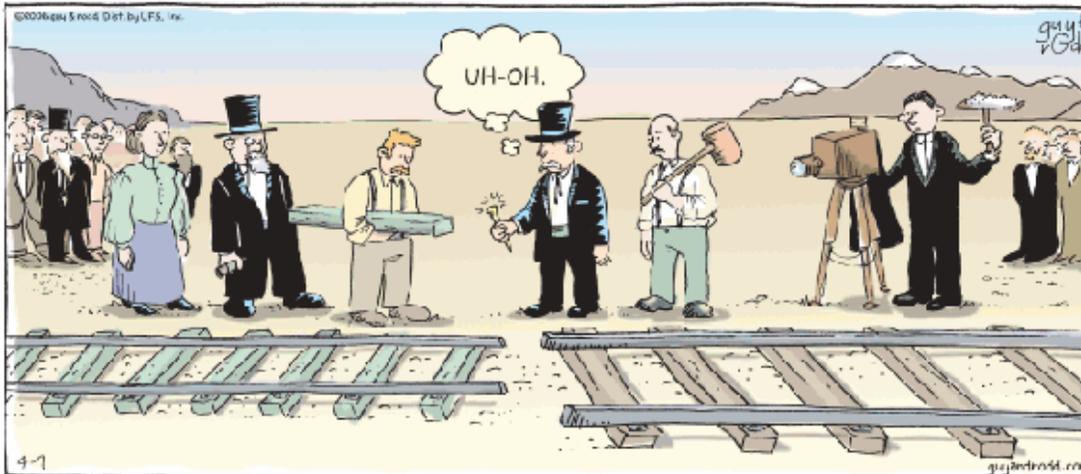
Caveate!!

- ***Requirements***
- ***Process***
- ***Validation***

Factoring in The SCA (a)

Factoring in The SCA (b)

L3 communications

Application Resources

CF Interfaces

CORBA APIs

ORB and CORBA Services

Core Framework Control, Services, Devices, and File access

AEP

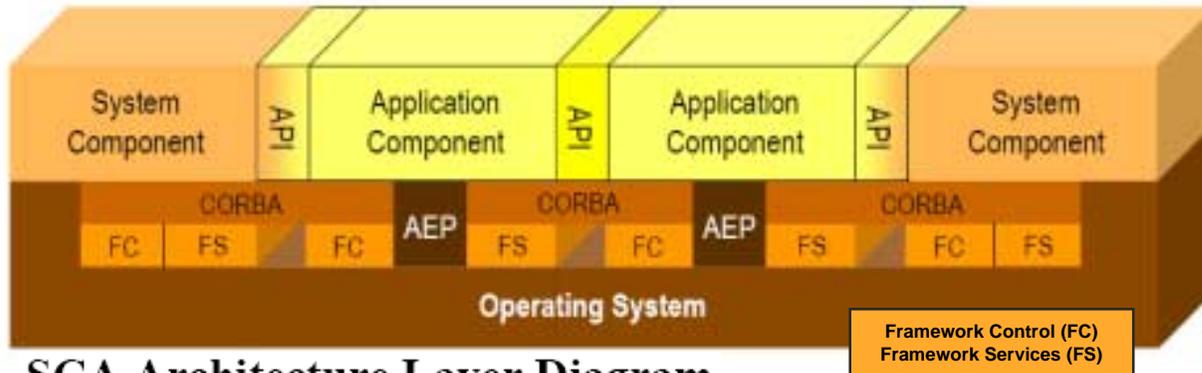**Operating System**

SOFTWARE ARCHITECTURE DEFINITION
SCA version 2.2.2   FINAL / 15 May 2006

Capabilities Consideration

SCA Architecture Layer Diagram

System Component | API | Application Component | API | Application Component | API | System Component

CORBA — FC FS — CORBA — FC AEP FS — CORBA — FC AEP FS — CORBA — FC FS

Operating System

Framework Control (FC)
Framework Services (FS)

Waveform Applications and High Level Services

| POSIX API Subset | STRS API |
| STRS Infrastructure |
| RTOS | Network Stack |
| HAL API |
| BSP | Drivers |
| GPM | Specialized HW |

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Factoring in The SCA (c)

Waveform Applications and High Level Services	
POSIX API Subset	STRS API
	STRS Infrastructure
RTOS	Network Stack
	HAL API
BSP	Drivers
GPM	Specialized HW

Studies & Results (1 of 2)

communications

- ## *Can STRS Leverage From The SCA?*

  - *A Fully SCA Compliant Implementation Requires More Resources Than Is Typically Available On A Space Platform*

    - *RAD Suitable Hardware Technology Lag, Up to 7 Year Delay (Footprint, Performance)*
    - *Current CORBA & XML Technologies Too Heavy for Older Hardware*
    - *SCA Designed to Support WF Reprogrammability*
    - *Space Mission Classes Require "Static" Software Deployment (Reconfiguration is Ok)*

  - *SCA Leveraging For STRS Runs Hybrid Risk*

    - *STRS & SCA Standard Would Diverge Without Strong NASA/JPEO Coordination*
    - *Expensive to Create & Maintain (Including Standards Process Development)*

  - *Correction:*
    - *Availability of JTRS Information Repository To NASA Is Currently Under Discussion*

Studies & Results (2 of 2)

- ## *Can STRS Leverage From The OMG SWRadio?*

  - *SCA Compatibility*
  - *Specification Formation*
    - *UML, MDA, OCL, WF Independence*
  - *Component Definition Flexibility*
    - *Lightweight, Flexible Composition, IDL Partitioning*
  - *Specification Maturity*
    - *Many Years Invested, SCA & MDA Experience, Optimizations*
  - *Extensions*
    - *Functional Equivalence, DTD Backwards Compatibility*
  - *Technology Agnostic (CORBA, XML)*

- ## *Hypothesis*
  - *STRS Could Extend & Specialize The SWRadio for Space Missions*

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Applying MDA to Space SDR

L3 communications

- **Concern Separation**
  - *Software Radio Components*

    vs.
  - *Implementation Technology*

- **Software Radio Components**
  - *Logical Modem*
  - *Logical Antenna*
  - *Logical Security*
  - *…*

    One of these

    vs.
- **Implementation Technology**
  - *CEV*
  - *Orion*
  - *Mars Rover*
  - *…*

    Lots of these

MDA

Platform Independent Model (PIM)

Transformation A

Transformation B

Transformation C

Transformation 'n'

Platform Specific Model (PSM)

Platform Specific Model (PSM)

Platform Specific Model (PSM)

Platform Specific Model (PSM)

Deploy

Radio Terminal
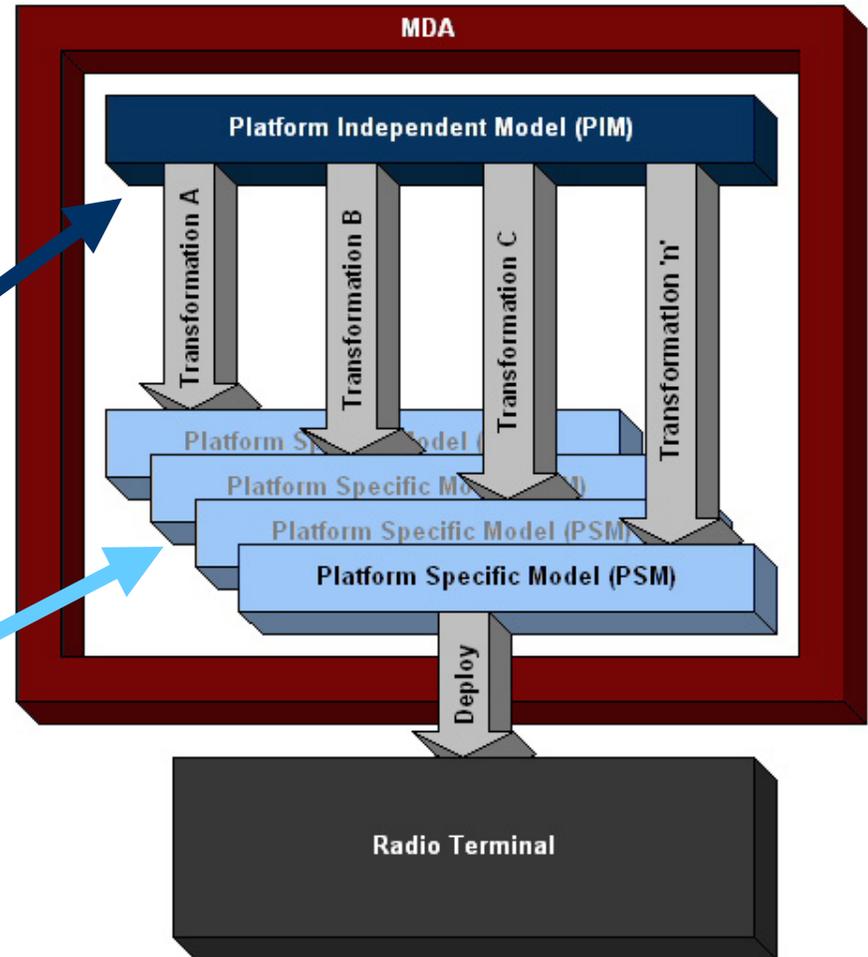
SWRadio = MDA Applied to SCA

L3 communications

- **Specification (Multi-Volume)**
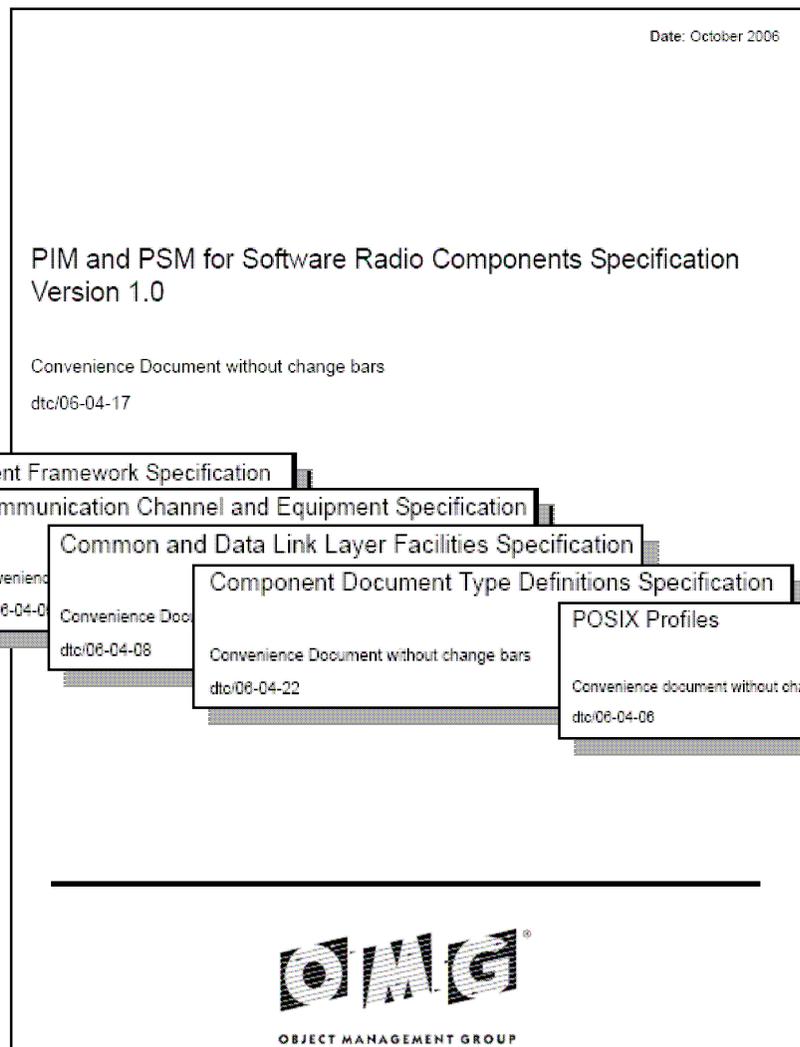 - *Software Radio Specification*
  - *Component Framework*
  - *Communications Channel & Equip*
  - *Common & DLL Facilities*
  - *Component DTD's*
  - *POSIX Profiles (AEP)*

- **PIM Facilities**
  - *Component Framework*
  - *Common Layer*
  - *Common Radio*
  - *Data Link Layer*
  - *Physical Layer*
  - *Radio Control*

- **PSM**
  - *CORBA*
  - *XML*

Date: October 2006

PIM and PSM for Software Radio Components Specification
Version 1.0

Convenience Document without change bars

dtc/06-04-17

Component Framework Specification

Conven

dtc/06-0

Communication Channel and Equipment Specification

Convenienc

dtc/06-04-0

Common and Data Link Layer Facilities Specification

Convenience Doc

dtc/06-04-08

Component Document Type Definitions Specification

Convenience Document without change bars

dtc/06-04-22

POSIX Profiles

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dtc/06-04-06

OMG

OBJECT MANAGEMENT GROUP

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Agenda

- *STRS Overview*

- *Standards*

- **PIM/PSM for Space SDR RFP**

- *Logistics*

- *Summary & Conclusions*

Objective

"Space communications places Software Defined Radio (SDR) systems into environmental conditions where unique provisions must accommodate communication services for space missions operating anywhere in the Solar System and beyond, featuring clustered networking services at the Earth, Moon, and Mars that are connected to Earth via long-haul links.* To accommodate these provisions, this RFP solicits proposals for a Space SDR specification that will specialize or add to the PIM and PSM for Software Radio Components specification, utilizing the STRS architecture provided by NASA".

* Including global interests (government, defense, commercial)

- *One Architecture – Many Missions*
- *Unique Environmental Conditions*
- *Power Efficiency (Features Flexibility vs. Power)*
- *Compliance Testing*

Problem Statement

- ***The SWRadio Specification Lacks Communications & Platform Requirements Imposed By The Space Domain, Such As:***

  1. *Radiation Suitable Processing*
  2. *Spacecraft Resource Constraints*
  3. *Reliability (fault tolerance, guaranteed delivery) and Availability*
  4. *Specialized Signal Processing Abstraction*
  5. *Static Deployment*
  6. *Long Mission Development Times*
  7. *Space Waveforms*
  8. *Small Space Market*

- ***Industry + Standards + STRS = Long-Term Path as Capabilities & Constraints Increase***

STRS + SWRadio = Space SDR

L3 communications

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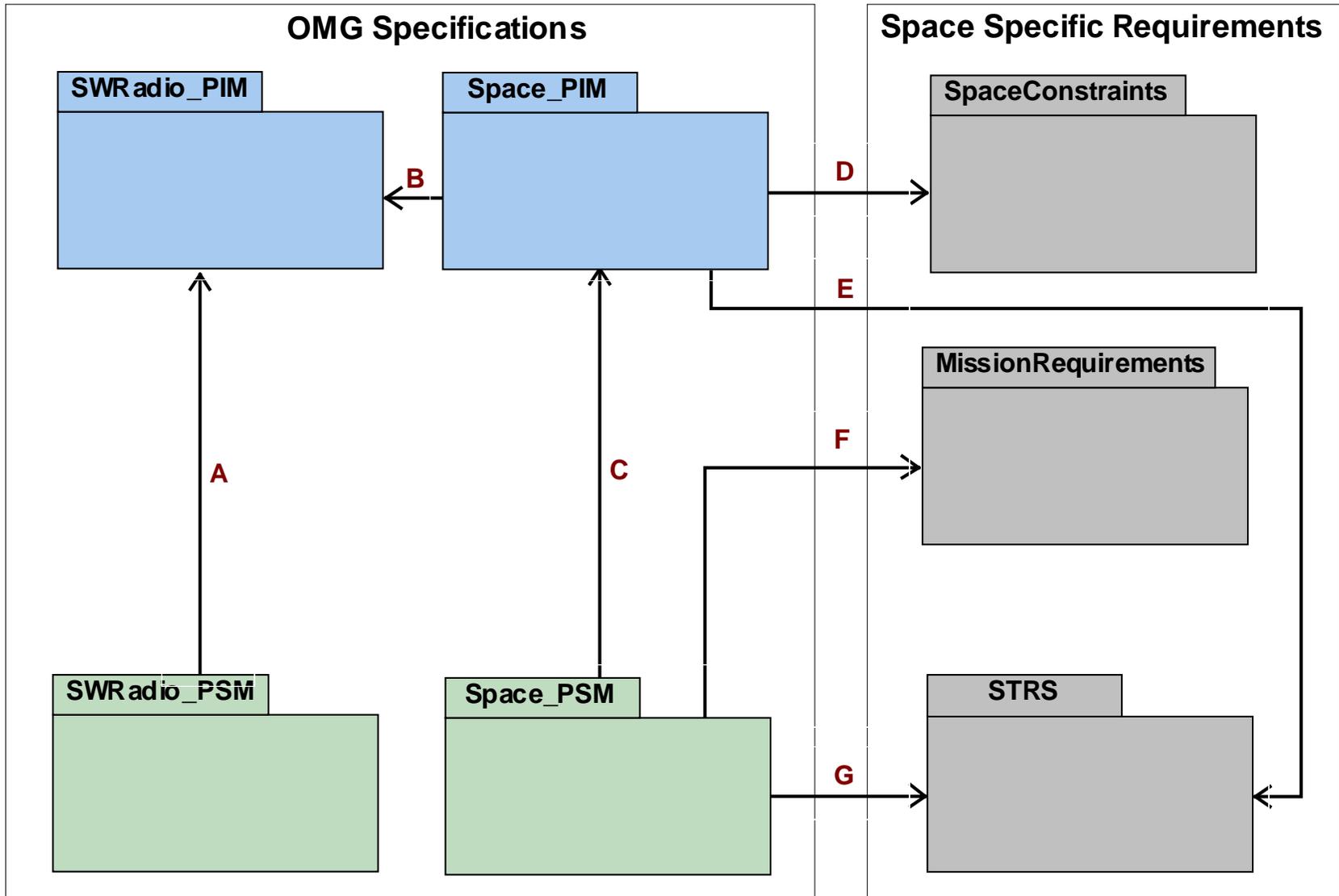
Mandatory Requirements

communications

1. *Proposals shall use the UML Profile for SWRadio (PIM and PSM for SWRadio Components) to accommodate special Space SDR constraints (see Problem Statement) for communication equipment and physical layer facilities of the solicited PIM.*

2. *Proposals shall capture system level constraints (SysML recommended) that have bearing on software interfaces.*

3. *Software interfaces and hardware interfaces (as applicable) between the STRS architecture and the SWRadio specification shall be integrated.*
   a. *If conflicts arise in merging STRS and SWRadio technologies, proposals shall create formal issues against the SWRadio specification, and recommend resolutions per the OMG issue process.*

4. *As this RFP focuses on software APIs in the context of MDA, the STRS HID is considered an aspect of transformation from the PIM to the Space PSM (in that it is more technology and implementation specific. Proposals, therefore, shall allocate the technology agnostic aspects of the HID to the PIM and PSM(s) recommendation(s) appropriately.*

5. *Proposals shall specify a PIM and at least one PSM for Space SDR interfaces*

6. *The specification shall define compliance points to which COTS vendors ca_____*
   a. *Control: Including parameter configure and query, and event & fault handling.*
   b. *Other certification criteria: …*

7. *Proposals shall extend and/or add to the SWRadio specification (including t_____nication equipment and physical layer facilities of the SWRadio specification (PIM and PSM for SWRadio Components [dtc/04-05-04] as applicable)).*

8. *Proposals shall respond to the "shall" requirements specified in the documents described in section 6.1.3.*

9. *The Space PIM/PSM(s) shall identify services required for waveform deployment and management.*

10. *Proposals shall provide for scalability to support a range of small to large systems*

11. *Proposals shall use UML for this RFP to express all concepts of the solicited PIM and the solicited PSM(s).*

12. *Proposals shall use OMG XMI, OMG IDL, as outlined in section 5.1 of this document, to express the concepts of the solicited PSM.*

13. *Proposals shall provide a recommendation for integrating the resulting specification into the existing PIM and PSM for Software Radio Components document set.*

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Optional Requirements

communications

1. **Proposals may provide additional PSMs with mappings of the PIM to additional technologies**

2. **Proposals may provide a design for the component decomposition, management and deployment of waveforms applications. This can include "Best Practice" recommendations for aggregating, extending, specializing, connecting, etc. components in the SWRadio and Space PIM and PSM(s) to form the following waveforms (this will become a separate volume):**

   a. *<List WFs here>*

3. **Proposals may recommend Hardware Abstraction Layer designs and/or guidelines. This would include integration management guidelines. For example:**

   a. *Deliverable documentation listings from waveform developers that would be required by system developers to integrate a provided waveform on to their system*

   b. *Deliverable documentation listings from system developers that would be required by waveform developers to integrate their waveform on to the provided system.*

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Related Activities

- ***PIM & PSM For SWRadio Components***

- ***CCSDS***
  - *Recommends Standards For Radio Interoperability By Defining Radio Frequencies, Modulation Schemes, And Space Link Protocols*

- ***OMG***
  - *Smart Antenna RFP*
  - *Digital IF RFP*
  - *Generic Device Control of Space Domain Related Devices RFP*
  - *Power Conservation Services*

- ***NASA***
  - *STRS: Open Architecture Description*
  - *STRS: Architecture Requirements Document*
  - *Reconfigurable Transceiver Architecture & Tech. For NASA Space Communications CFD (Overview of NASA Requirements)*
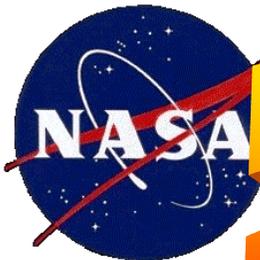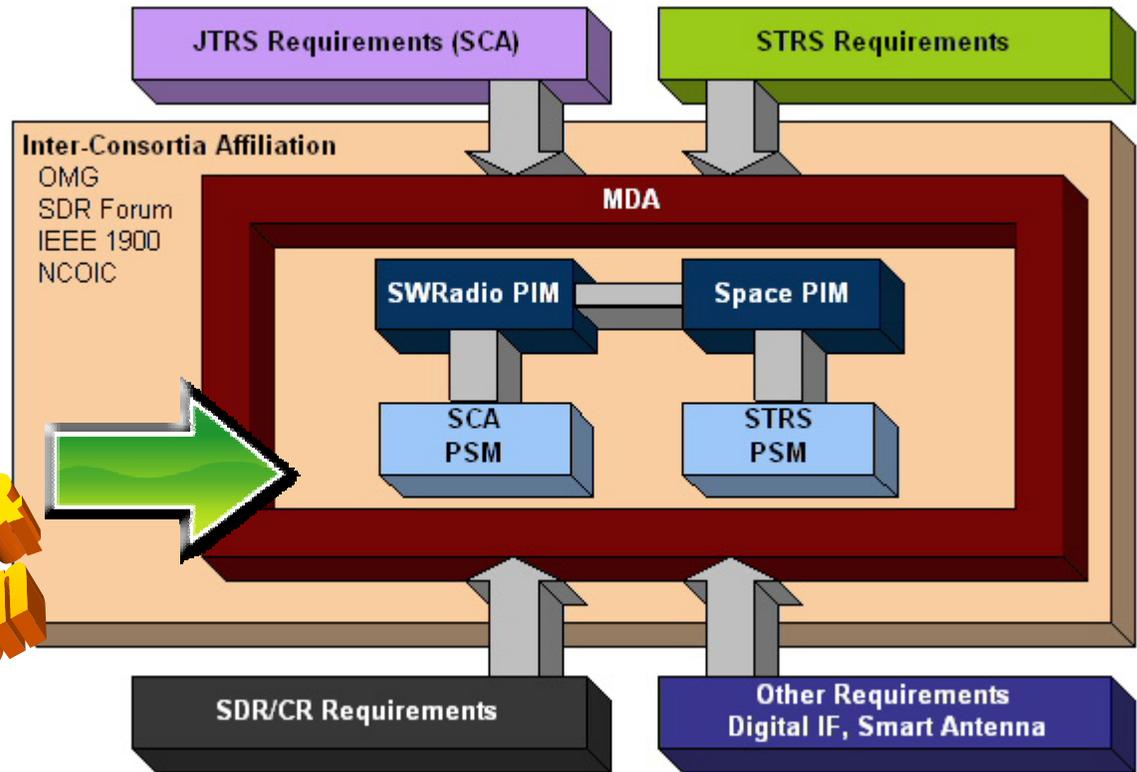 - *Mission Requirements*

Agenda

- *STRS Overview*

- *Standards*

- *PIM/PSM for Space SDR RFP*

- ***Logistics***

- *Summary & Conclusions*

Standards Working Together (1 of 2)

- ***Inter-Consortia Affiliation***
  - *SCA*
  - *MDA PIM (SWRadio)*
  - *STRS Reqs*
  - *SA/DIF*
  - *Select PSM(s)*

Standards Working Together (2 of 2)

L3 communications

Organization	Current Specification Documents	Collaborative Standards Processes	Specification Products	Implementation	Mission Deployment

JPEO

OMG

SDRF

NASA

JTRS SCA

SW Radio

STRS

SDRF Space WG

OMG, SBC WG

Space SDR Specification

Systems

Waveform

Infrastructure

Implementation

Mission Requirements

Mission Deployment

Time

Consortia Working Together (1 of 2)

communications

NASA Leadership & Participation
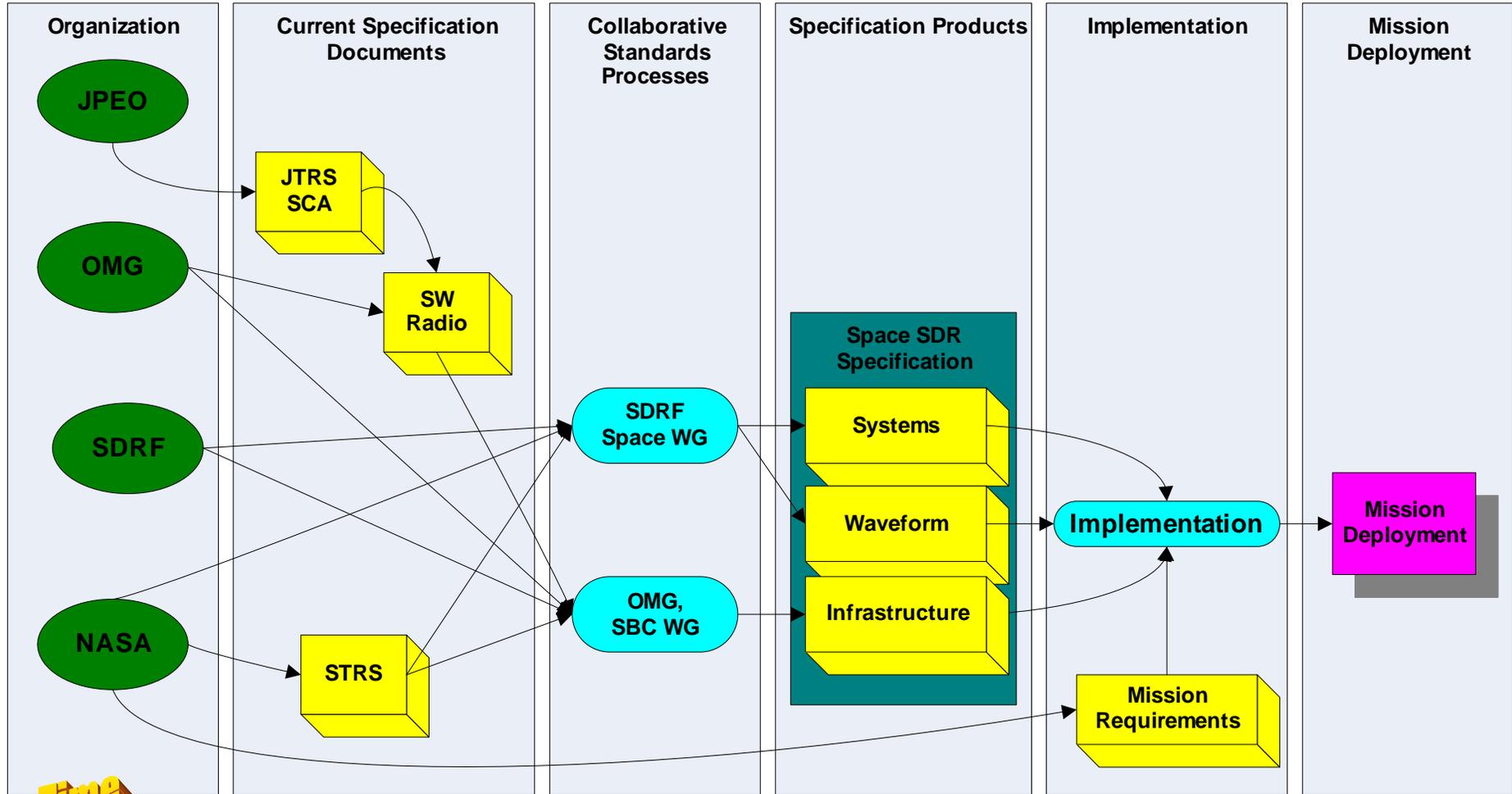
- ## *SDR Forum – The Requirements Driver*
  - *(1) Space WG Writes the Space SDR RFP*
    - *To Be Submitted to OMG for Formal Issuance*
    - *Defines Mandatory & Optional Requirements*
  - *(3) Proposes an RFP Response (Submission)*
    - *SDR Forum & Other OMG Industry Members Can Submit Separately*
  - *SDR Forum Space WG & TC Approvals Required for 1 & 3*

- ## *OMG – The Process Driver*
  - *(2) SBC-DTF, AB Reviews RFP, Approves & Issues*
    - *SDR Forum Has 1 Vote (Albeit Highly Influential)*
  - *(4) OMG FTF, RTF, Process Ensues for Ultimate Spec Approval & Maintenance*

- ## *IEEE 1900.1 – Taxonomy Coordination*

Consortia Working Together (2 of 2)

L3 communications

Implement the Standard

Model the Business Cases

Underlying Goal: Develop SDR standards that will provide Radio Set and Waveform Application interoperability, resuibility, and portability to end-users locally and internationally.

- Core SDR components
- SDR Business Case Extensions (See User Community)
- Waveform Applications
- Cert./Regulatory/Testing Rqmts
- Portability Rqmts
- ...

Define Requirements

Standards Support

SDR Forum

OMG

IEEE 1900

Develop SDR Standards

Perform Requirements Analysis

NCOIC

NARTE

Other Candidate Partners

Certification Agencies

Model the Architecture

Test & Certify the Implementation

Approve & Release the Standard

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OMG Process

- ***OMG Hitchhikers Guide – Doc#: omg/06-12-05***
  - *RFP (Approval & Issuance)*
    - *LOI*
  - *RFP (Submissions)*
    - *Initial Submissions*
    - *Revised/Final Submissions: Presentations, Evaluations*
    - *Approvals: TF, AB, OMG Membership, BC, BoD*
    - *Finalization Task Force (FTF)*
    - *Revision Task Force (RTF)*
    - *Testing Task Force (TTF)*
  - *RFI*
    - *Approval & Issuance*
    - *Response & Presentations*
  - *RFC*
    - *Fast Track RFP (Technology Exists)*
  - *Technology Tracking*

Validation (1 of 2)

Quality Standards Require Quality...

- *Requirements*
- *Process*
- *Validation*

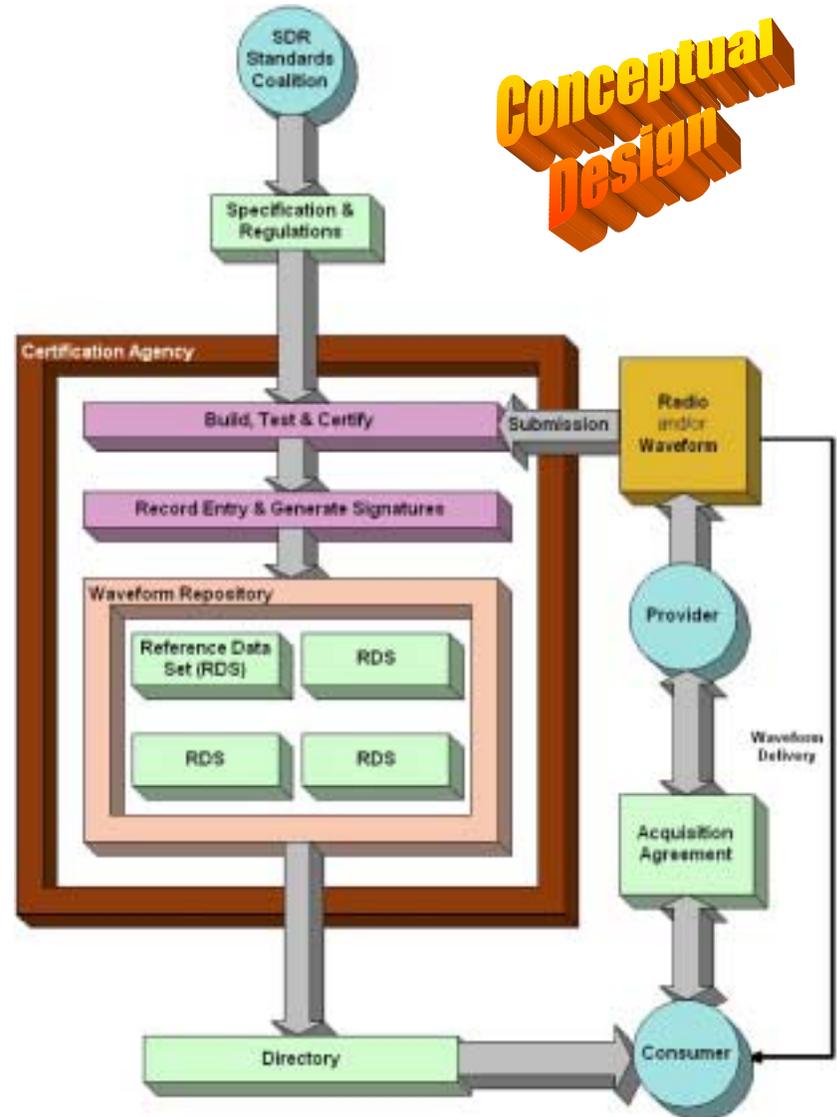# Certification & Validation (2a of 2)

L3 communications

Procedure is Based on NIST/NSRL*

Certification & Validation (2b of 2)

L3 communications

Procedure is Based on NIST/NSRL*

1. **Organizations Deliver Specs & Regs**

Conceptual Design
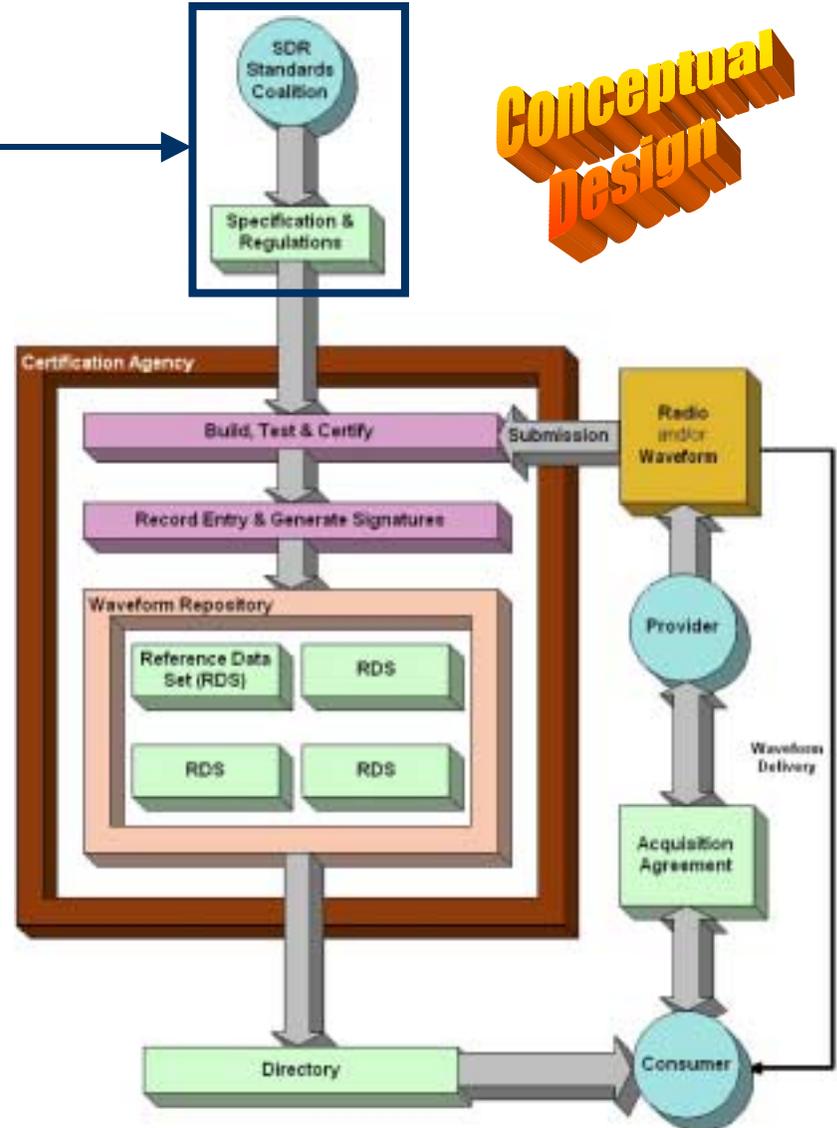
Certification & Validation (2c of 2)

communications

Procedure is Based on NIST/NSRL*

2.   Providers Implement & Deliver to Agency

Conceptual Design
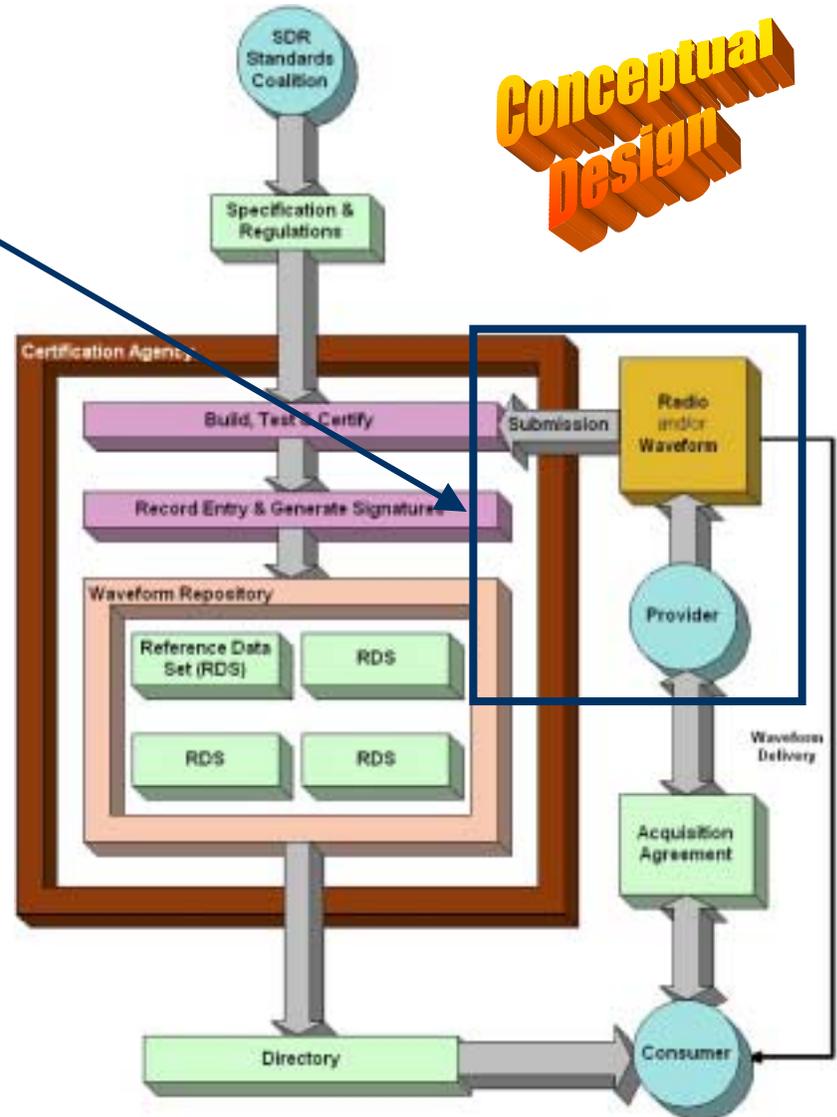
Certification & Validation (2d of 2)

L3 communications

Procedure is Based on NIST/NSRL*

Conceptual Design

3. Agency Build, Tests, Certs
- Create Repository Record & Signatures
- Signatures Become the Reference Data Set (RDS)
- Put RDS in Repository
- Publish Updated Standard Reference Data Group (SRDG) Directory
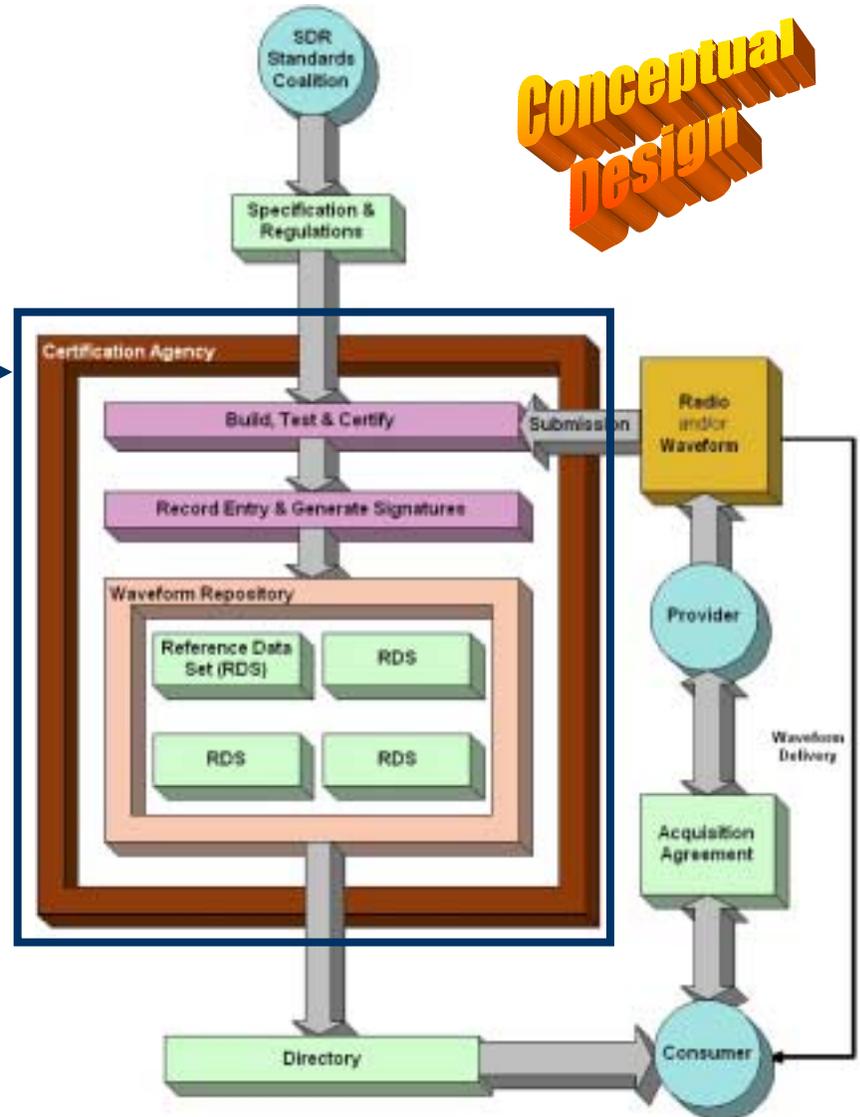
Certification & Validation (2e of 2)

L3 communications

Procedure is Based on NIST/NSRL*

4. **Consumer Reviews SRDG Directory For Available Product Fitting the Need**
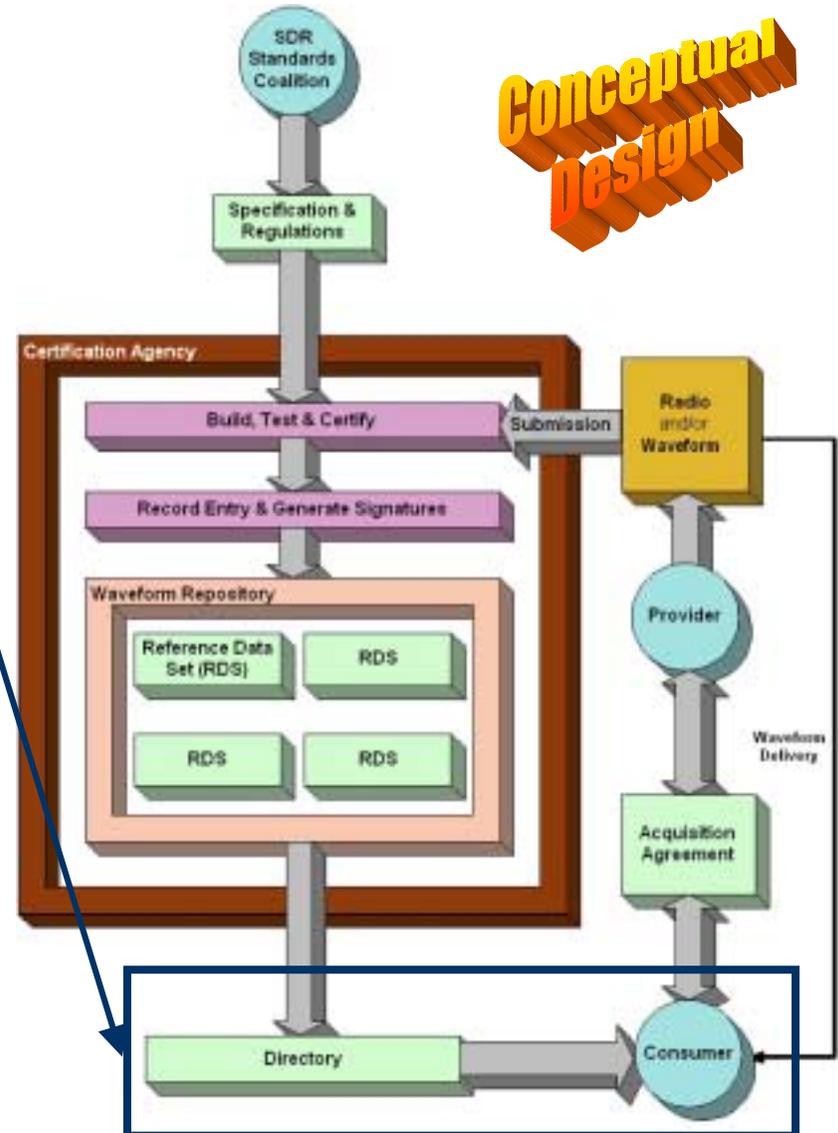
Certification & Validation (2f of 2)

L3 communications

Procedure is Based on NIST/NSRL*

Conceptual Design

5. **Consumer Contacts Associated Provider**
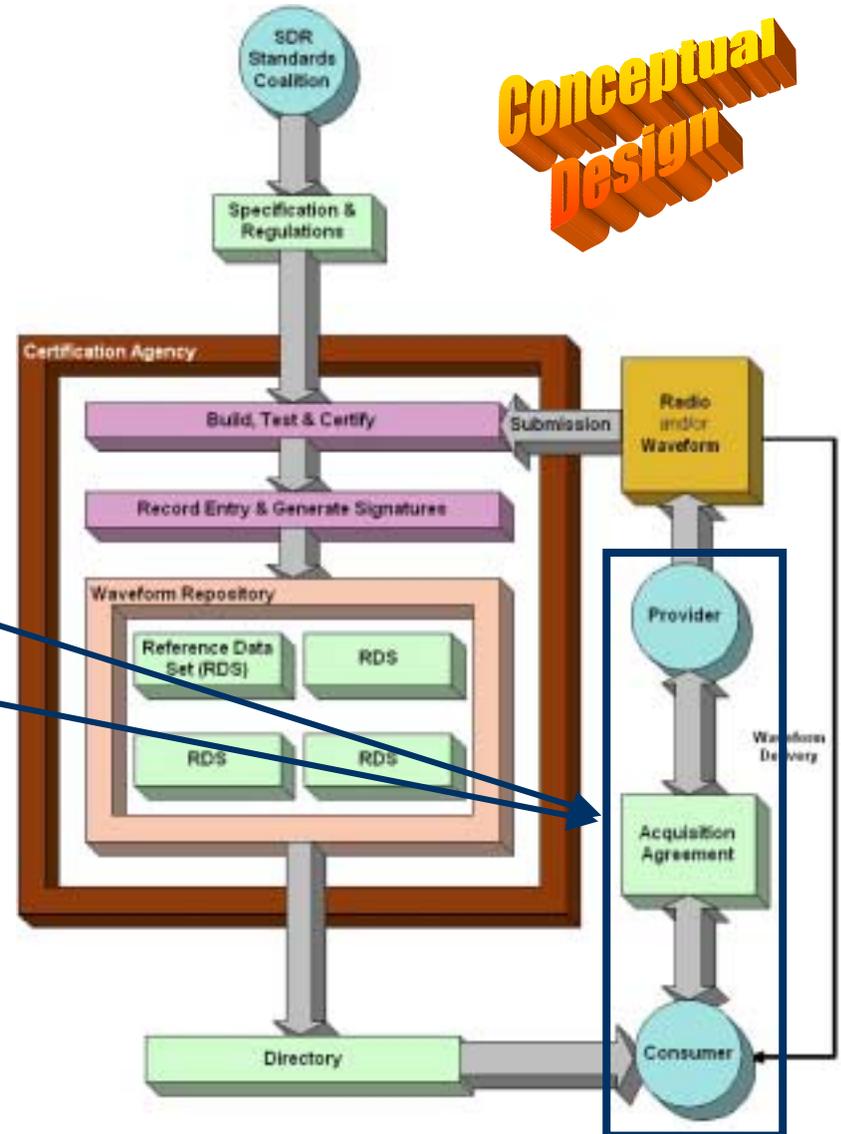
6. **Consumer & Provider Reach Agreement**

Certification & Validation (2g of 2)

L3 communications

Procedure is Based on NIST/NSRL*

Conceptual Design

SDR Standards Coalition

Specification & Regulations

Certification Agency

Build, Test & Certify — Submission — Radio and/or Waveform

Record Entry & Generate Signatures

Waveform Repository

Reference Data Set (RDS) | RDS

RDS | RDS

Provider

Waveform Delivery

7.   Agreement is Executed & Product is Delivered

8.   Product is Verified Against the RDS

Acquisition Agreement

Directory — Consumer
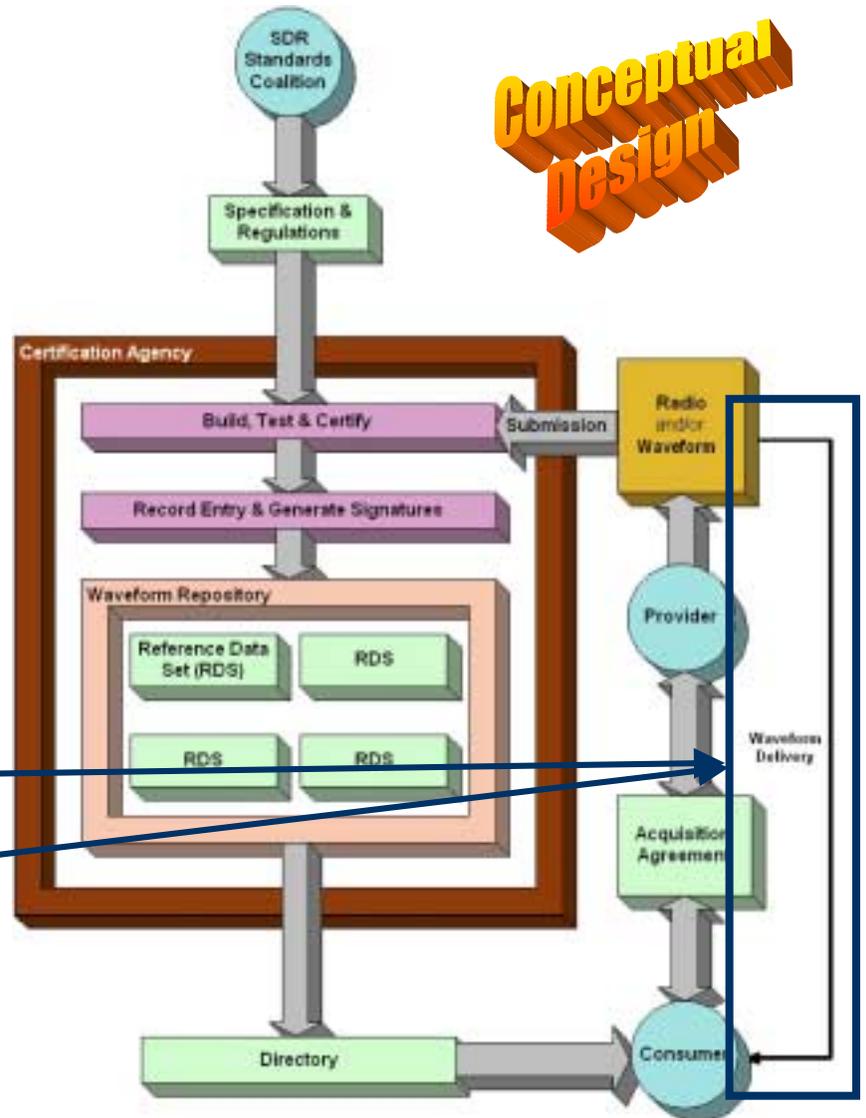
Certification & Validation (2h of 2)

L3 communications

Procedure is Based on NIST/NSRL*

1. **Organizations Deliver Specs & Reqs**

2. **Providers Implement & Deliver to Agency**

3. **Agency Build, Tests, Certs**
   - Create Repository Record & Signatures
   - Signatures Become the Reference Data Set (RDS)
   - Put RDS in Repository
   - Publish Updated Standard Reference Data Group (SRDG) Directory

4. **Consumer Reviews SRDG Directory For Available Product Fitting the Need**

5. **Consumer Contacts Associated Provider**

6. **Consumer & Provider Reach Agreement**

7. **Agreement is Executed & Product is Delivered**
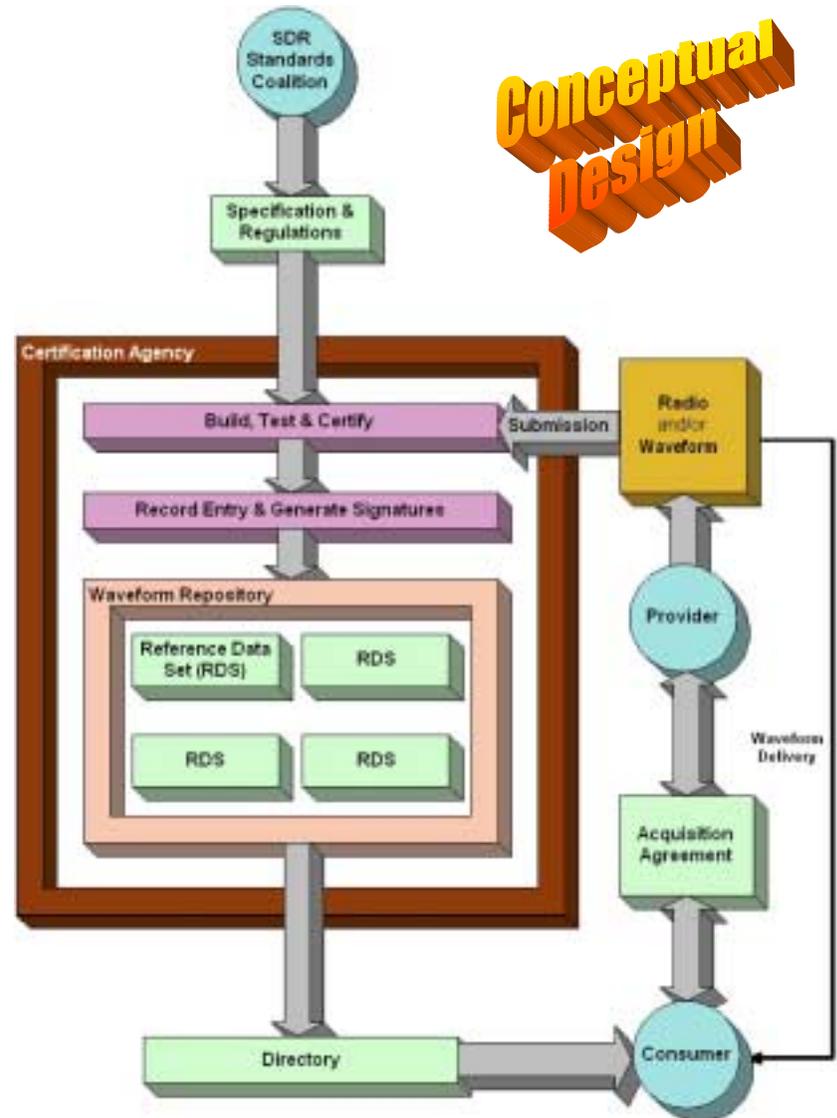
8. **Product is Verified Against the RDS**

- **Considerations:**
  - JTRS Information Repository (IR) Objectives & Corporate IP Objectives -- Can Objectives Be Negotiated?
  - Multiple Agencies with Collaborated Governances?

See http://www.nsrl.nist.gov/Project_Overview.htm

Conceptual Design

SDR Standards Coalition

Specification & Regulations

Certification Agency

Build, Test & Certify — Submission

Record Entry & Generate Signatures

Waveform Repository

Reference Data Set (RDS) | RDS

RDS | RDS

Radio and/or Waveform

Provider

Waveform Delivery

Acquisition Agreement

Directory — Consumer

Agenda

- *STRS Overview*

- *Standards*

- *PIM/PSM for Space SDR RFP*

- *Logistics*

- ***Summary & Conclusions***

Summary & Conclusion

- ***Summary***
  - *STRS Background*
  - *Standards*
  - *PIM/PSM for Space SDR RFP*
  - *Logistics*

- ***Next Steps***
  - *STRS/SWRadio API Merge Strategy*
  - *RFP Completion, Approvals, & Issuance*
  - *SDR Forum/Industry Space SDR Proposal Submission*
  - *Ongoing Coordination With NASA's STRS Standards Development*
  - *NASA's STRS Reference Implementation Deployment*

- ***Conclusion (SDR In Space)***
  - *NASA STRS is Step 1*
  - *What is Step 2?*
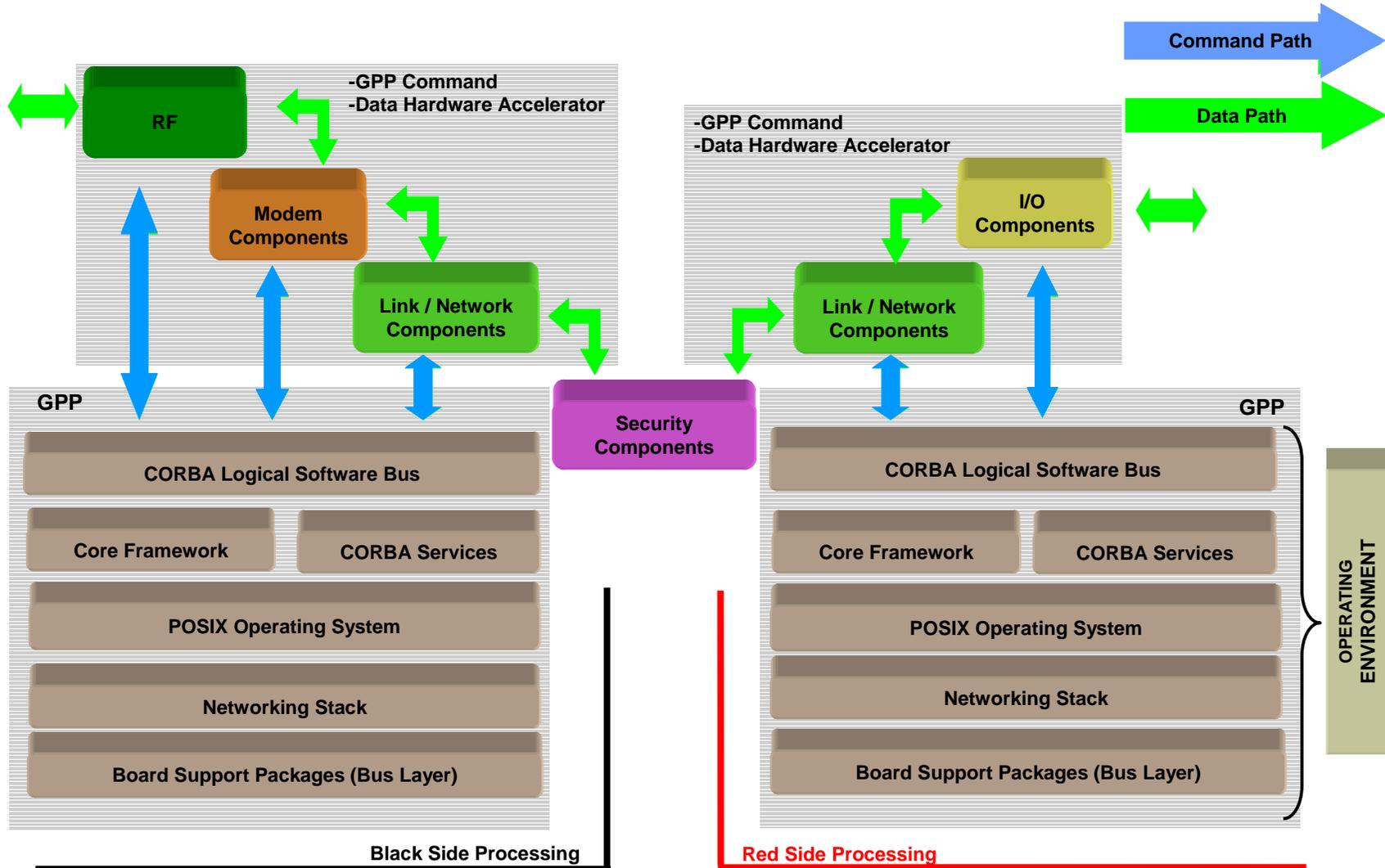   - *CCSDS/Members Plus US DoD & other International Stakeholders*

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BACKUP SLIDES

Dual Path Implementation

L3 communications

Command Path

Data Path

-GPP Command
-Data Hardware Accelerator

RF

Modem Components

Link / Network Components

-GPP Command
-Data Hardware Accelerator

I/O Components

Link / Network Components

Security Components

GPP

| CORBA Logical Software Bus |
| Core Framework | CORBA Services |
| POSIX Operating System |
| Networking Stack |
| Board Support Packages (Bus Layer) |

GPP

| CORBA Logical Software Bus |
| Core Framework | CORBA Services |
| POSIX Operating System |
| Networking Stack |
| Board Support Packages (Bus Layer) |

OPERATING ENVIRONMENT

Black Side Processing

Red Side Processing

Separate Data/Command Paths to Meet Throughput and Latency Requirements