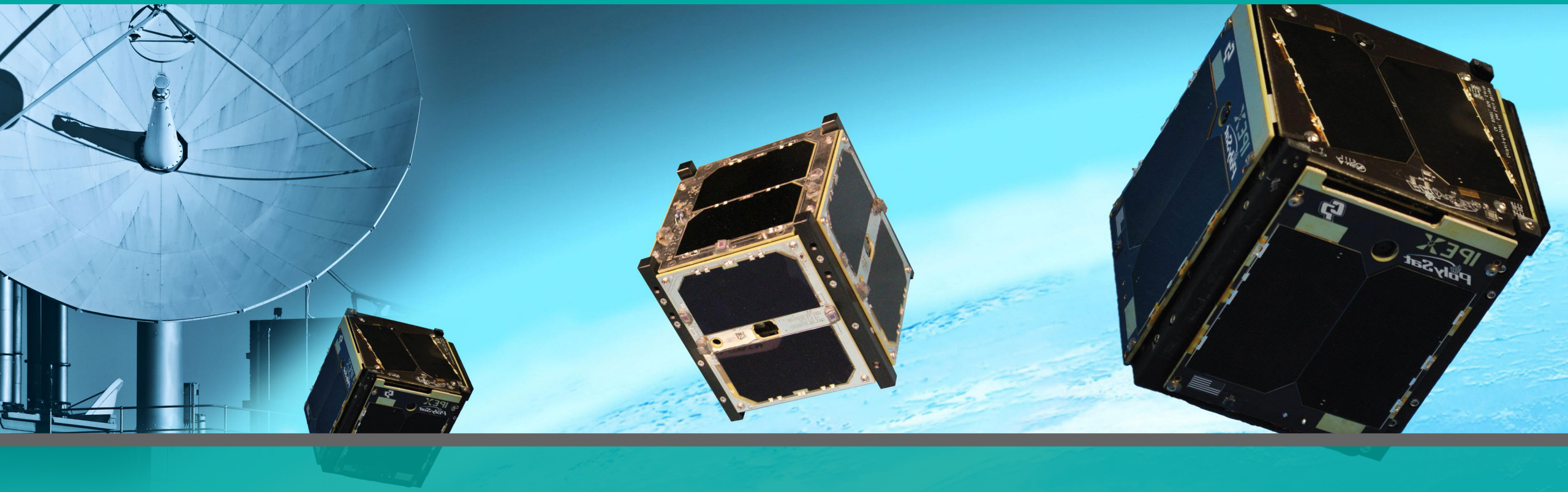
Adapting Critical Operations Through Architectures, Communications, Frameworks, Modeling, Ontology's, & Standards for Mission Engineering



Steven A. MacLaird ("Steve")
Sr. VP, Gov't & Industry Strategy
+ 1 703.231.6335 - maclaird@omg.org

March 12, 2021

Overview

- OMG Introduction Highlights
- Systems Modeling Language® (SysML®) Background & Way Forward
- DoD Architecture Framework (DoDAF) 1.2 and Unified Architecture Framework® (UAF®)
- CubeSat Systems Reference Model (CSRM)
- CSRM Mission Engineering Initiative
- Other OMG Space Standards of Interest

OMG® & OMG Programs

Software / Hardware Standards

319 Organizations; 60+ Universities

Addressing IT standards for more than two dozen verticals, including: C4I, Communications, Finance, Healthcare, E-Government, Space, Industrial Internet of Things, etc.

The mission of the Object Management Group (OMG) is to develop technology standards that provide real-world value for dozens of vertical industries. OMG is dedicated to bringing together its international membership of end-users, vendors, government agencies, universities and research institutions to develop and revise these standards as technologies change throughout the years.

Industrial Internet of Things
147 Organizations

Software Quality
8 Paid Sponsors
4,000 Member Participants

217 Member Participants

37 Member Companies
2,000 Member Participants

About OMG

- Founded 1989
- International standards development organization
- 225+ specifications
- 325+ member organizations worldwide
- 11 specifications ratified as ISO standards

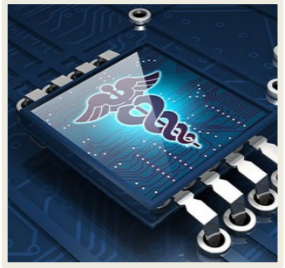
OMG Vertical Markets

Standards are developed by OMG using a mature, worldwide, open development process. With more than 25 years of standards work, the OMG one-organization, one-vote policy ensures that every vendor and end-user, large and small, has an effective voice in the process.

Finance

Government

Healthcare



Manufacturing

Military

Retail

Robotics

Space Exploration

Who Are OMG'ers ?

ACORD
Adaptive
Airbus Group
AIST
Amergint
Appian
ASMG
BAE Systems
Benchmark Consulting
Boeing
Carnegie Mellon Univ.
CA Technologies
CEA
Cisco Systems
Deere & Company
Dell Technologies
Diebold Nixdorf
DoD
European Space Agency
FICO
Ford Motor Company
Fujitsu
Georgia Tech Institute
Genesco
Goldman Sachs
Holocentric
iGrafx
IBM
JARA
Johns Hopkins
Kongsberg Defence
Kratos Real Time Logic
L3 Harris Technologies
Lockheed Martin
Mayo Clinic
MEGA International
MicroFocus
Microsoft
MITRE
NASA
NIST
No Magic
Northrop Grumman
OCI
Oracle
Peraton
Perspecta
Petrosoft
PTC
QualiWare
Salesforce.com
SAP SE
Seiko Epson
Siemens
Software AG
Sparx Systems
State Street
THALES
The Aerospace Corporation
Thematix
Twin Oaks
Ulta Beauty
Vitech Corporation

Teal = Space Domain Task Force Members

MOSA Quad Chart – *Systems Modeling Language® (SysML®) Roadmap to Version 2.0*

Program Description

SysML is a modeling standard that supports an open systems approach.
Enables a common approach for specifying & architecting complex systems.

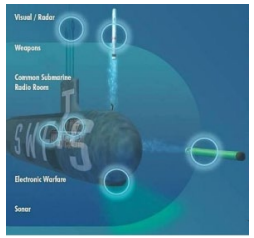
SEBoK GUIDE TO THE SYSTEMS ENGINEERING BODY OF KNOWLEDGE
https://www.sebokwiki.org/wiki/Guide_to_the_Systems_Engineering_Body_of_Knowledge_(SEBoK)

OMG OBJECT MANAGEMENT GROUP®

OMG SYSTEMS MODELING LANGUAGE™ SysML®
http://www.omgsysml.org/

Program Capabilities

- Modeling to automate requirements verification & generate SE products
- Benefits over a traditional document-based approach is that disconnected artifacts become related in the model, enabling the production of consistent model-based documentation.
- Allows req'ts verification analysis to be conducted in the context of MBSE.
- To perform this analysis, the requirements, executable behavior, and models predicting the system's performance is integrated.



Submarine Warfare Federated Systems

Thirty Meter Telescope

Program Modular and Open System Approach

Submarine Warfare Federated Tactical Systems

The submarine combat system SE&I program delivers updated annual production baselines, along with product line variants for each submarine class or subclass being built or upgraded that year.

Thirty Meter Telescope (TMT)

The MBSE approach applied the Executable Systems Engineering Method (ESEM) and the Open-source Engineering Environment (OpenMBEE) to specify, analyze, & verify requirements of TMT's Alignment & Phasing System (APS) and the Narrow Field Infrared Adaptive Optics System (NFIRAOS).

Key Accomplishments/Status

- Production systems implementing this baseline are delivered to new-build submarines, and to in-service submarines being upgraded on a roughly 6-year cycle. The common combat system product line is referred to as the Submarine Warfare Federated Tactical Systems (SWFTS).

- The value proposition for applying this MBSE approach to was to establish precise requirements and fine-grained traceability to system designs, and to verify key requirements using executable SysML models beginning early in development for Large Telescopes.

- **SysML v2 is the Next Generation Systems Modeling Language that provides significant upgrades** and a standardized API for improved interoperability amongst models

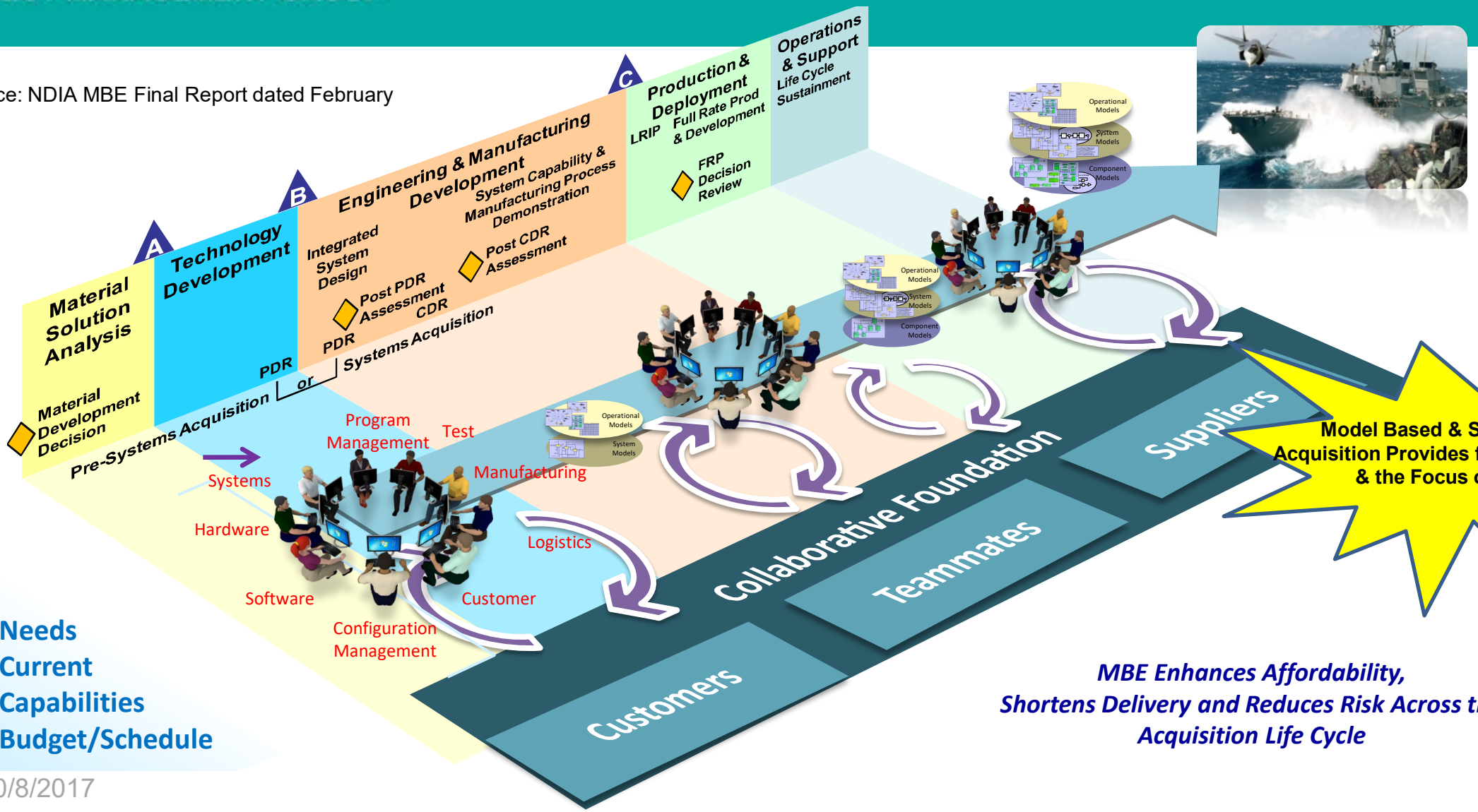
Key Milestones – SysML Historical Updates

SysML 1.0	2007	SysML 1.4	2015
SysML 1.1	2008	SysML 1.5	2017
SysML 1.2	2010	SysML 1.6	2019
SysML 1.3	2012	**SysML 2.0**	**In Development-Final Submission 2021**

MBE To - Be State

Source: NDIA MBE Final Report dated February 2011

Source: NDIA MBE Final Report dated February 2011



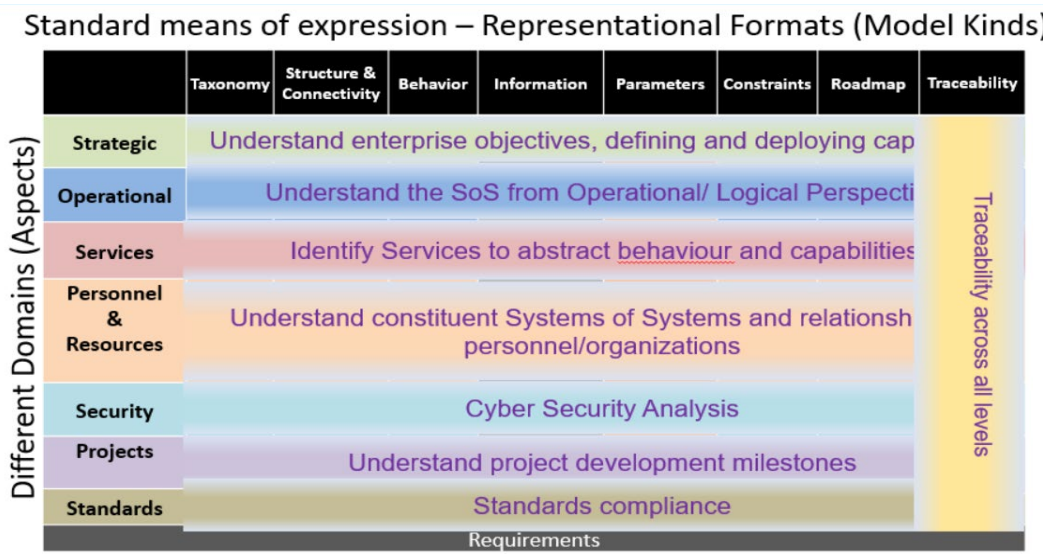
- Needs
- Current Capabilities
- Budget/Schedule

MBE Enhances Affordability, Shortens Delivery and Reduces Risk Across the Acquisition Life Cycle

Why Use Frameworks?

Frameworks such as Unified Architecture Framework (UAF):

- Supports semantic interoperability through the use of a common vocabulary enabling:
  - Portfolio and capability management
  - SoS Operational planning and Mission Engineering
- UAF is method agnostic (structured, OO, etc.)
- Extends DoDAF 1.2 and UPDM with additional architectural dimensions: Security, Personnel, Requirements, Analysis, Simulation with full cross-cutting Traceability using a common semantic vocabulary



Architecture Framework: Conventions, principles and practices for the description of architectures established within a specific domain of applications and/or community of stakeholders. ISO/IEC/IEEE 42010:2011

DoD Architecture Framework (DoDAF) 1.2 & Unified Architecture Framework® (UAF ®)

DoDAF 1.2

- OMG Developed DoDAF in conjunction with DoD and Service Support, migrated it to 1.2, followed by MoDAF, NAF, Unified Profile for DoDAF and MoDAF (UPDM) – DoD CIO on record to support only DoDAF 1.2
- NATO requested one common architecture framework to aid in coalition warfare – UPDM migrated to UAF
- UAF is DoDAF 1.2 with UML / SysML applications

Unified Architecture Framework (UAF)

- UAF is a **profile extension of UML and SysML** developed by OMG with DoD, MoD & NAT0 involvement
- UAF **provides a common language and notations** for **model elements views** and viewpoints across multiple frameworks for describing an enterprise architecture
- UAF **provides element stereotypes for each domain for concepts** that are not supported by SysML
- UAF **includes elements such as timelines, milestones, and dates**

We need to see if there UAF elements that could/should be "incorporated" into the CSRM – Upcoming Work.

CubeSat Systems Reference Model (CSRM)

The International Council of Systems Engineers (INCOSE)

- Utilized OMG's Systems Modeling Language to Develop
- A CubeSat Reference Model that provides information
  - **For universities, students, businesses and developers of CubeSats**
  - Provides Behavior modeling between subsystems
  - Validation & Verification (V&V) processes
  - Coordination points for launch

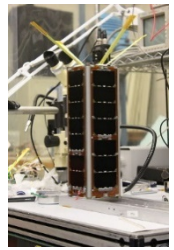
Model Based Systems Engineering (MBSE)

Formalized application of modeling to support requirements, design, analysis, validation, and verification

Systems Modeling Language ™ (SysML™)

A graphical modeling language for modeling complex systems including hardware, software, information, personnel, procedures, facilities and Coordination's

Systems Engineering Methodology	System Modeling Tools	Interfaces with Other Models



Purpose: To Provides a CubeSat Systems Reference Model that CubeSat teams can use as a starting point for their mission-specific CubeSat model

CSRM Attributes

- Provides a CubeSat **logical** **space-ground architecture**
  - Logical components are:
    - **Abstractions of physical components** that perform system functionality w/o imposing implementation constraints.
    - **Starting points** for a mission-specific CubeSat logical architecture, followed by the physical architecture and the CubeSat development
  - **Physical architecture defines physical components** of the system including hardware, software, persistent data, and operational procedures.
- **Integrates five overarching elements**: stakeholders, technical measures, behaviors, requirements, and architecture.
- Provides for **defining and tracing requirements** from stakeholders, to behaviors, technical measures down to subsystems and components to be certified through validation and verification activities.
- **A repository** for systems engineering artifacts. However, it is not pre-populated with specific stakeholders, technical measures, behaviors, and requirements.
  - **It's the CubeSat mission development team's job to populate** based upon their needs and objectives.
  - Development of a mission-specific CubeSat utilizing the CSRM establishes a mechanism to share and reuse components with other design activities.

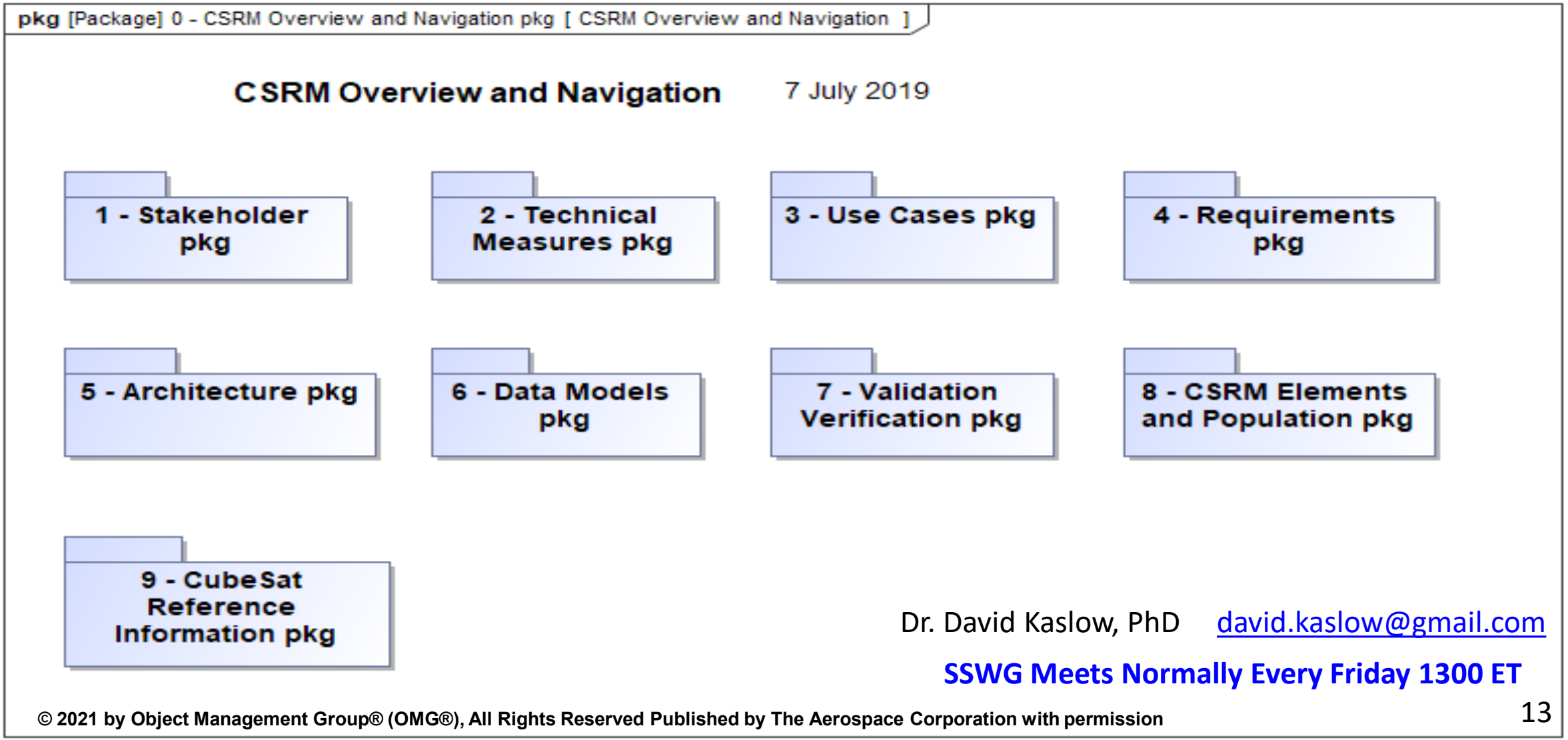
CSRM Attributes (Cont'd)

- A mission-specific CubeSat team **downloads the specification and files from OMG (Free)** for import it into their own graphical modeling tool.
- The mission team identifies the systems engineering methodology to be followed and revises the model, elements, relationships, and diagrams as needed.

- The CSRM is based on MBSE principles, is SysML 1.6 compliant, and is hosted in a graphical modeling tool.
- The CSRM is a Reference Architecture in accordance with the Mission Engineering Approach and Methodology delineated in the DoD Mission Engineering Guide.
- The mission-specific team is free to adopt a different logical architecture and modify the CSRM to accommodate this change.

CubeSat Systems Reference Model (CSRM)

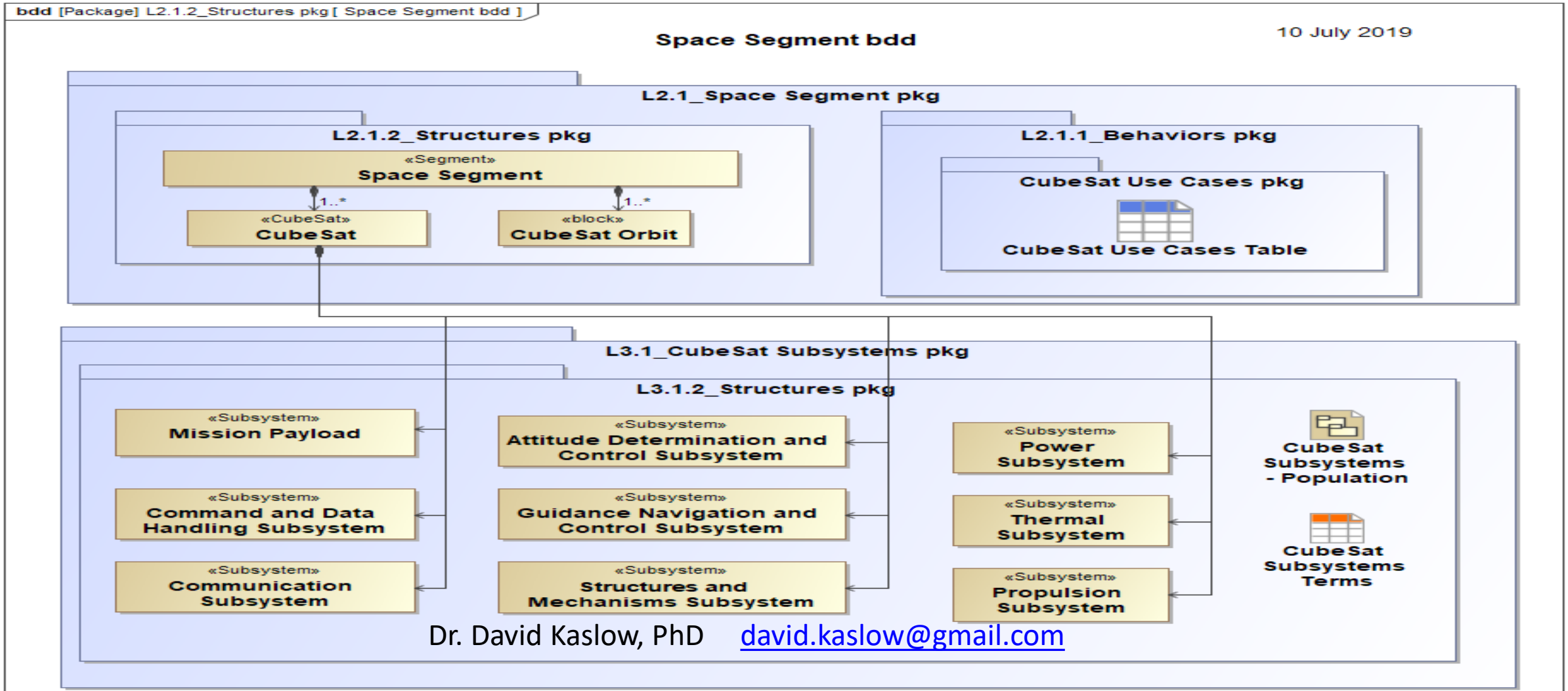
Model Overview & Navigation Package



Dr. David Kaslow, PhD david.kaslow@gmail.com

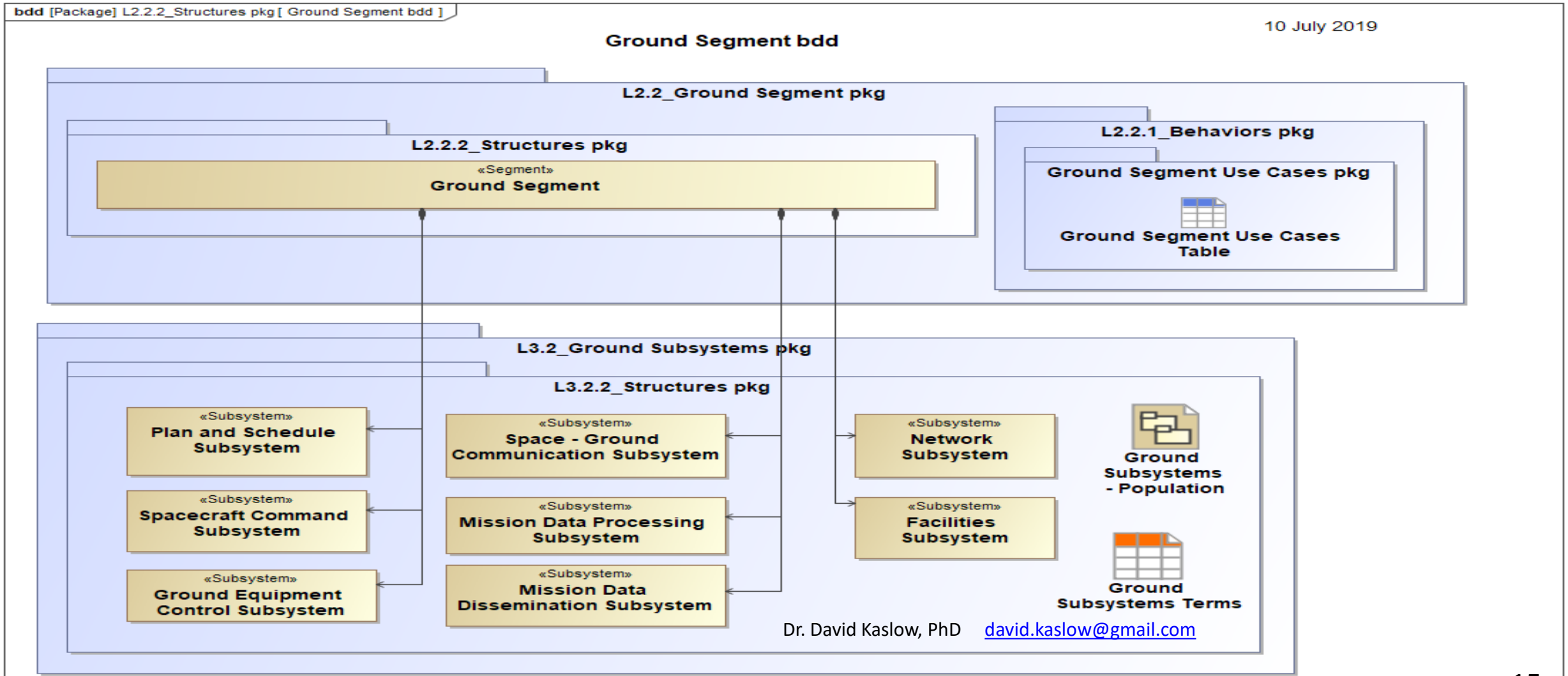
SSWG Meets Normally Every Friday 1300 ET

CubeSat Systems Reference Model (CSRM) Space Segment Structures Package

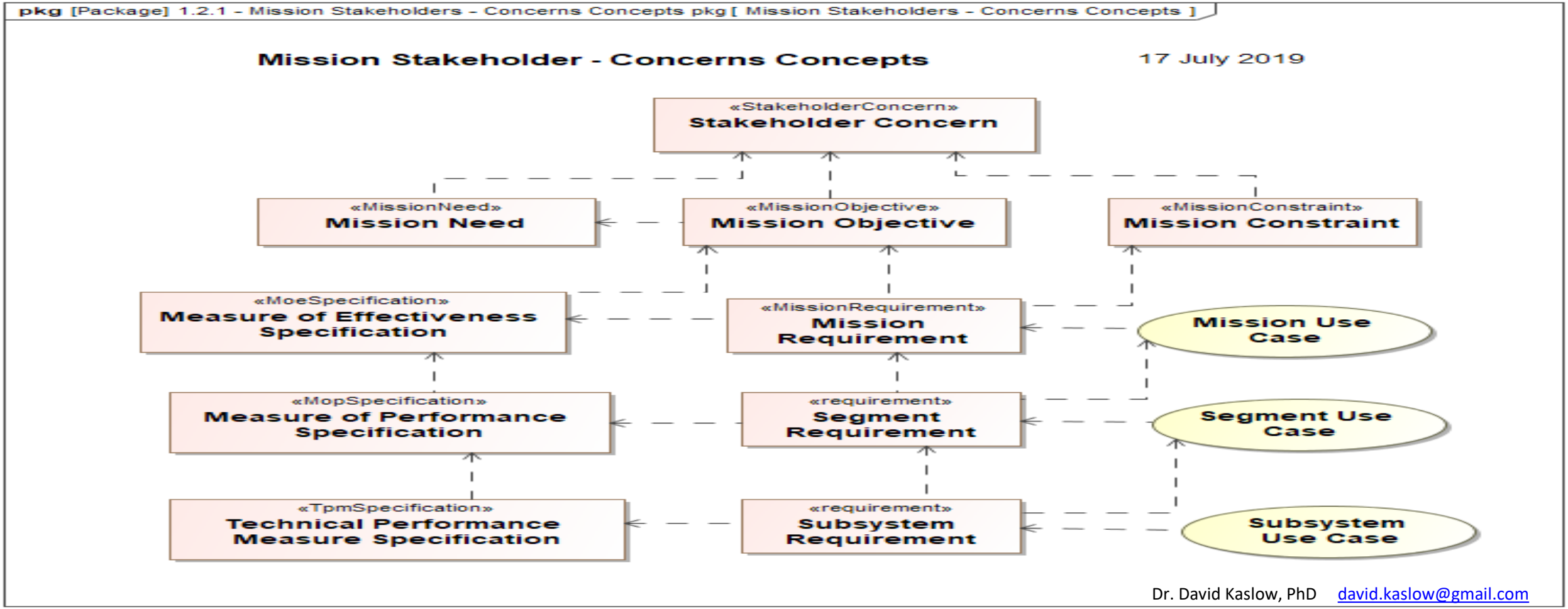


Dr. David Kaslow, PhD david.kaslow@gmail.com

CubeSat Systems Reference Model (CSRM) Ground Segment Structures Package



CubeSat Mission Stakeholders & Req'ts



Dr. David Kaslow, PhD david.kaslow@gmail.com

OMG Members (DoD, NASA, Industries & Universities) Utilizing this Model on Missions Now Prior to Adoption & Publishing

CSRM Mission Engineering Model

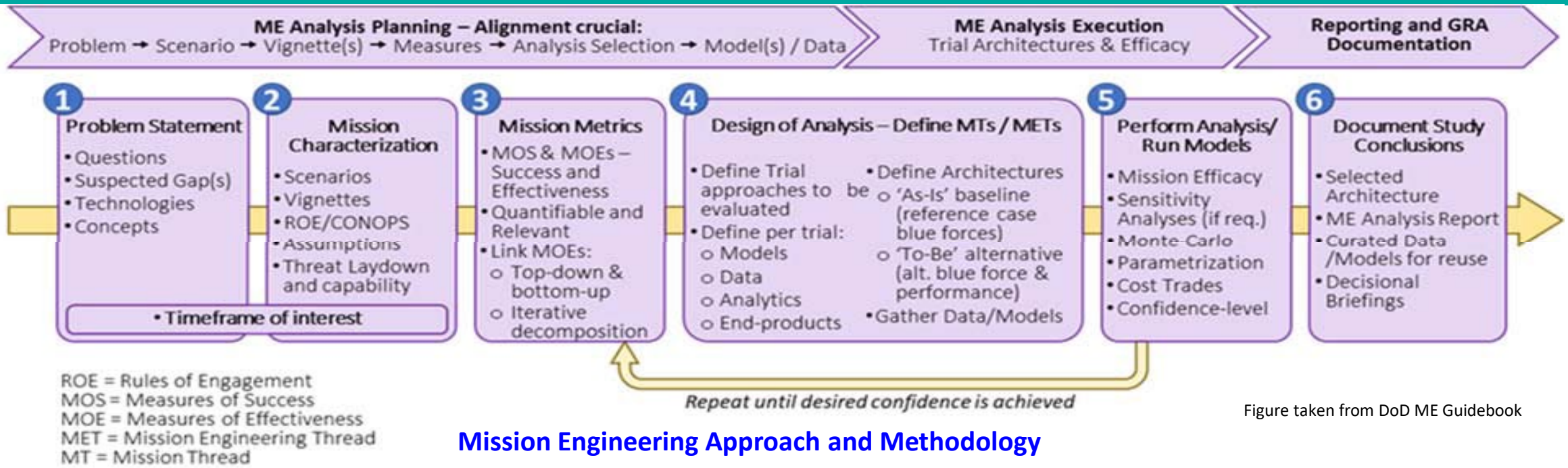


Figure taken from DoD ME Guidebook

Mission Engineering Approach and Methodology

Step 1. **Problem Statement Artifacts** includes stakeholders and their needs and objectives.

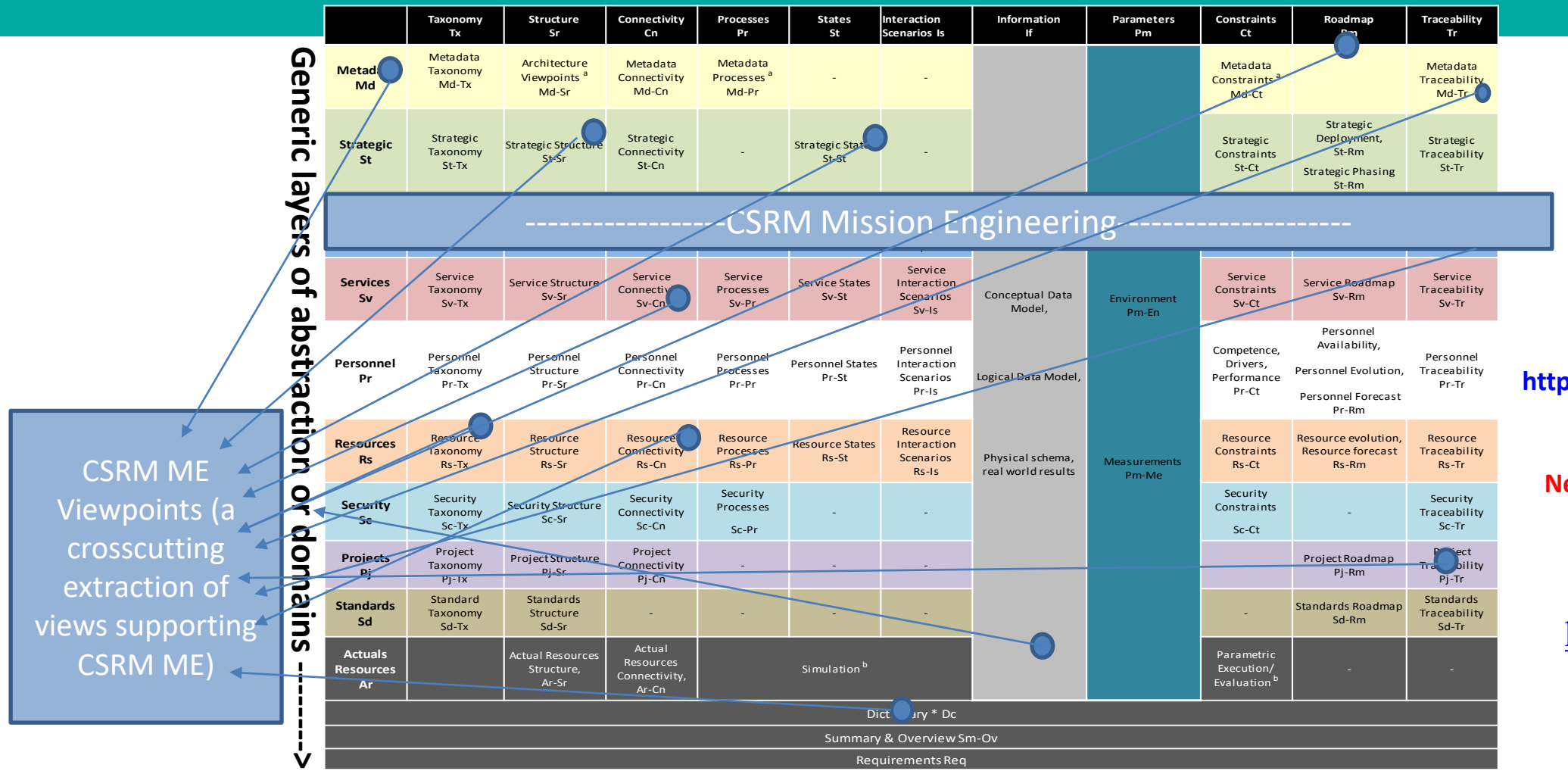
Step 2. **Mission Characterization Artifacts** include mission, segment, and subsystem use cases. in support of mission data tasking, collection, and distribution thread.

Step 3. **Mission Metrics artifacts** include measure of effectiveness, measures of performance, and technical performance measures.

Steps 4-6 are carried out using:

- **Mission Specific Model (MSM)** based on the CSRM descriptive model
- **Time-Based Dynamic Model (TBDM)** needed for trade studies

CSRM Mission Engineering Using UAF



Work IN Progress

INCOSE IW
https://www.incose.org/iw2021
January 31, 2021

Need Results/Rec's ID'd here

Big Sky IEEE
https://aeroconf.org/

March 4, 2021

The INCOSE / OMG Mission Engineering Work and will follow a 3 Stage project plan. Stage 1 was initiated at the January 2021 INCOSE International Workshop (IW) and will be presented at the March 4, 2021 IEEE Aerospace Conference.

CSRM Mission Engineering Process

1 Identify Mission Engineering Methodologies

Space Mission Analysis and Design

Space Mission Engineering is the refinement of requirements and definition of mission parameters to meet the broad objectives of a space mission in a timely manner at minimum cost and risk

DoD Mission Engineering Handbook

Mission Engineering is the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to achieve desired warfighting mission effects

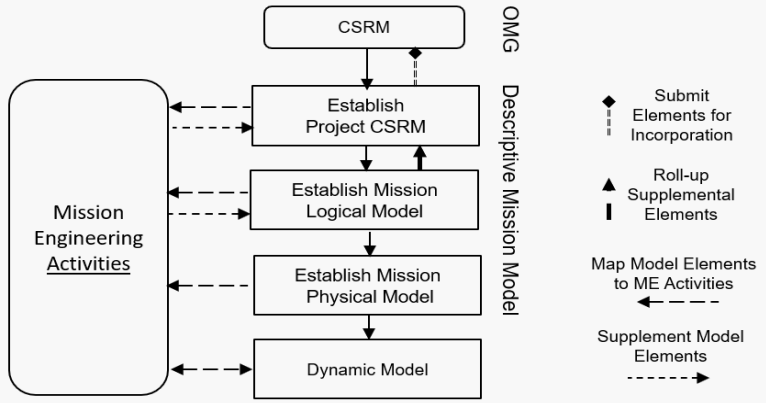
INCOSE Systems Engineering Book of Knowledge

Mission Engineering describes the application of systems engineering to the planning, analysis, and designing of missions where the mission is the System of Interest

Mission Engineering analyzes the mission goals and threads, analyzes the available as well as emerging operational and system capabilities, and designs a mission architecture to achieve the mission goal

Different domains have different mission engineering methodologies

2 Mission Engineering Scope



Architecting for Mission Engineering

3 Map and Supplement CSRM Elements

INCOSE ME Activities

- Mission Capability Analysis and Definition
- Mission Thread Definition
- Tradeoff Analysis
- Mission Architecting
- Requirements Engineering
- Interoperability Analysis
- Mission-oriented SoS Implementation
- Mission Verification and Validation

Map

Supplement

CSRM Elements

- Stakeholders
- Mission Objectives
- Mission Constraints
- Requirements
- Behaviors
- Technical Measures
- Architecture
- Validation Activities
- Verification Activities

The focus is on logical model that will be populated as a physical model

OMG's Space Domain Task Force (SDTF)

What is it ?
And What does it Do?

Specifically chartered to foster the development of space-related standards

The OMG Space Domain Task Force

- Space professionals committed to greater interoperability, reduction in costs, schedule, and risk for space applications through increased standardization
- The SDTF works cooperatively with the CCSDS to ensure consistent space standards are developed.
- OMG's Space DTF is Fast but not too fast : 9-24 months to deliver a standard
- Final result will be specifications and interfaces NOT products
  - Implementations of OMG specifications by users
  - Those implementing specifications need not be OMG members
  - Specifications are *freely* available
- Collective wisdom - broad range of input
- Standards/Specifications based upon Gov't & Industry consensus

Specifications Freely Available

OMG Space Domain Task Force (DTF) Delivered Specifications

- XTCE (XML Telemetry and Command Exchange) (1.1)
- GEMS (Ground Equipment Monitoring Service)
- SOLM (Spacecraft Operations Language Metamodel)
- C2MS (Cmd & Control Mission Services)

Work-In-Process

- CubeSat Systems Reference Model (CSRM) (INCOSE & OMG Initiative)
- Display Page Exchange
- CubeSat Mission Engineering

Space & Other Relevant Specifications Being Initiated

Future Work being Considered

- Ontology, archiving, display, cyber
- Ground Station Ontology (Spacecraft Operations Language Metamodel),
  - http://www.omg.org/hot-topics/spacecraft-ground-systems-rfi.htm
- Data Archiving
- Cyber Security
- Telescope Reference Model

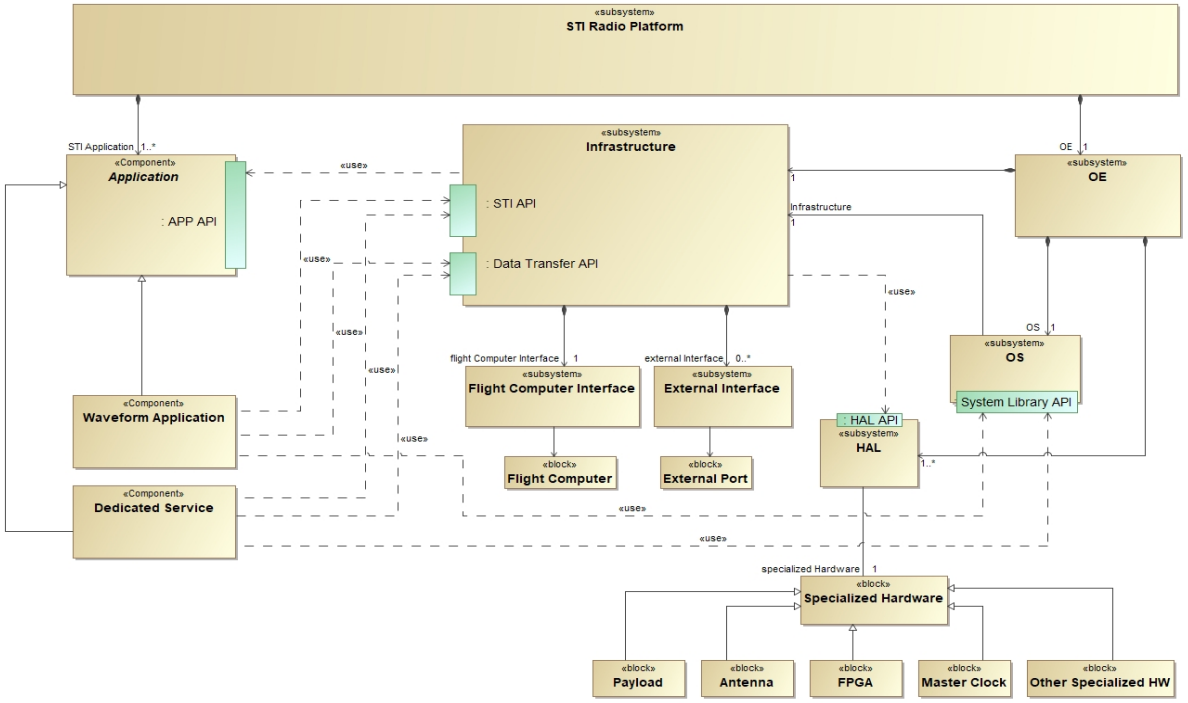
Other OMG Relevant Specifications to Consider

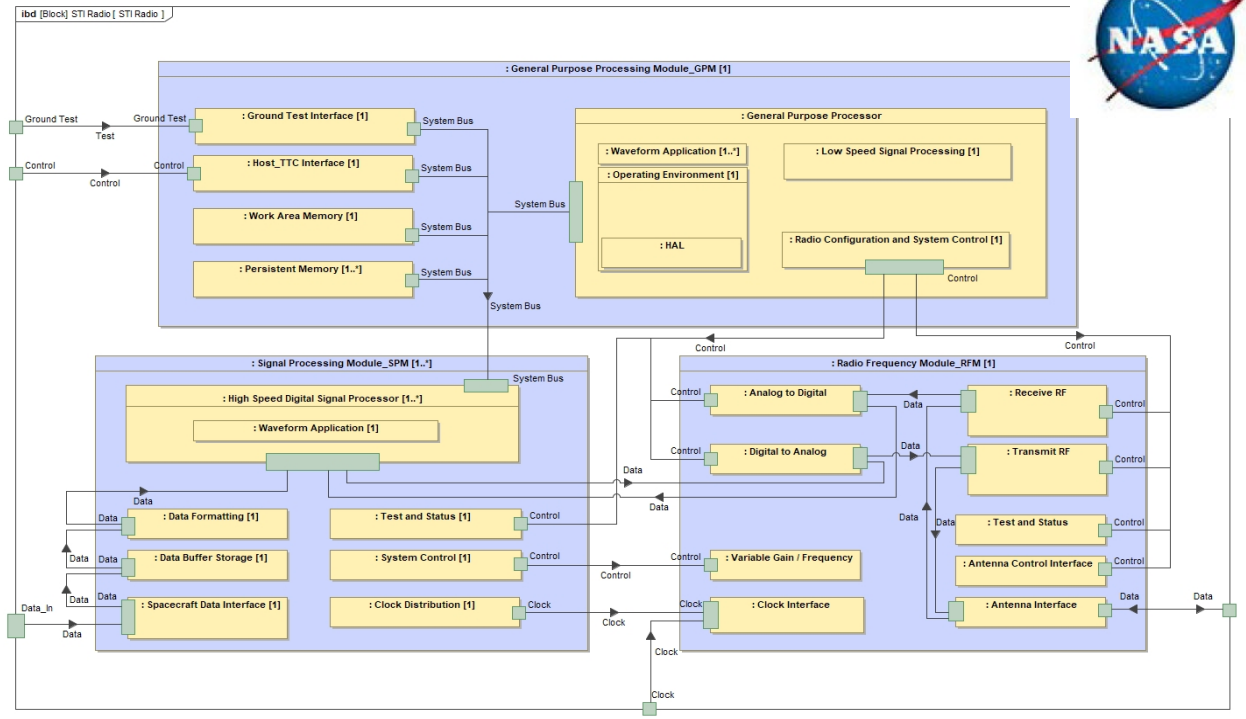
- Data Delivery Services (DDS)
- Information Exchange Framework (IEF)
- Cyber Security for Front Line Systems
- **Alarms & Event Notification and Scheduling**
- Secure Networking Communications (SNC)
  - **Space Telecommunications Interface – OMG MARS & AB Approved 12/2020**
  - **Hybrid Adaptive Networking - 2021**

Space Telecommunications Interface (STI)

OMG Middleware and Related Services (MARS)
Platform Task Force (PTF)

STI System Architecture Overview – Extends SCA from UML to SysML 1.6





STI defines fundamental blocks of a generic SDR platform

- General Processing Module (GPM) hosts the control plane
- Signal Processing Module (SPM) hosts the data plane
- Radio Frequency Module (RFM) provides the radio interface

- Proposes a SW Interface structure similar to existing SDR standards (NASA STRS, SWRADIO, **SCA 4.1**)
- Software written for these other environments should be usable without extensive rewrites or refactoring

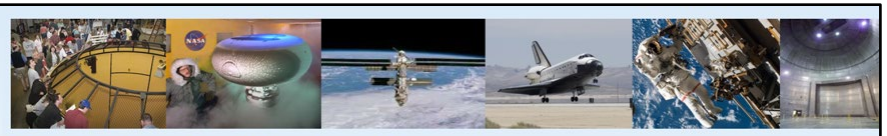
NASA to utilize this new OMG STI Standard on Upcoming 2021/22 CubeSat Mission

OBJECT MANAGEMENT GROUP®

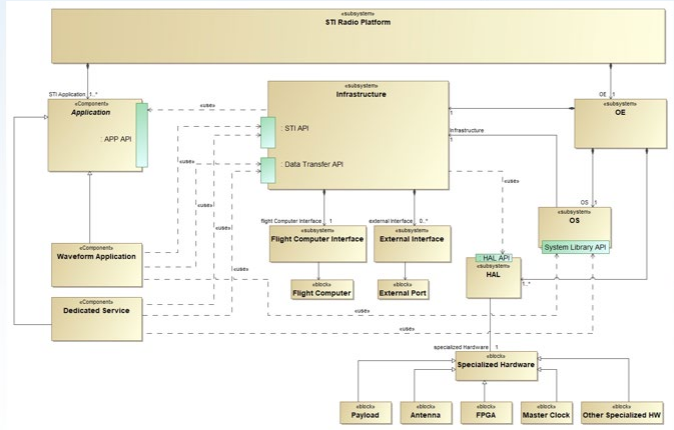
DDS FOUNDATION

Space Telecommunications Interface (STI) (Beta)

- **STI is Developed to be Software Communications Architecture (SCA) 4.1 Compliant – Developed from NASA's Space Telecommunications Radio Service (STRS)**
- **Moves from UML based SCA to SysML based (backward Compatible**
- **Dec 2020 – OMG Architecture Board (AB) Approved STI for Finalization**
- **The Finalization Task Force (FTF) is expected to Complete by Dec 2021**
- **Beta version is available on OMG Website:**



STI System Architecture Overview



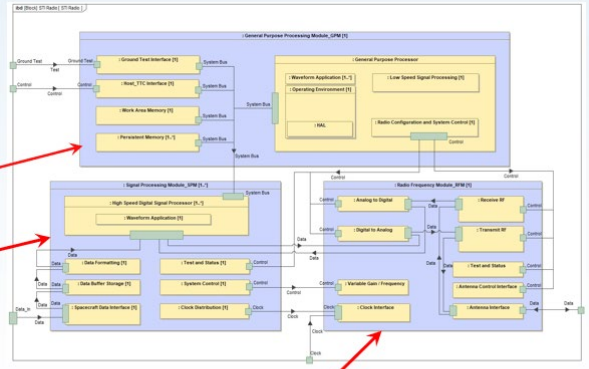
System Architecture

- STI defines the various roles and responsibilities of the stakeholders
  - Defined roles and integration points allows for more parallel development efforts, vendor independence
- Emphasis of standard is different for different system roles
  - Focus on a specific software interface (i.e. API) to ensure portability
  - Focus on documentation of system capabilities rather than prescribing a specific set
- This approach allows some component re-use while still allowing the overall system to be tailored to the specific deployment environment and requirements

STI Overview – Hardware Architecture

STI defines fundamental blocks of a generic SDR platform

- General Processing Module (GPM) hosts the control plane
- Signal Processing Module (SPM) hosts the data plane
- Radio Frequency Module (RFM) provides the radio interface



Space Telecommunications Interface (STI) (Beta) (Cont'd)

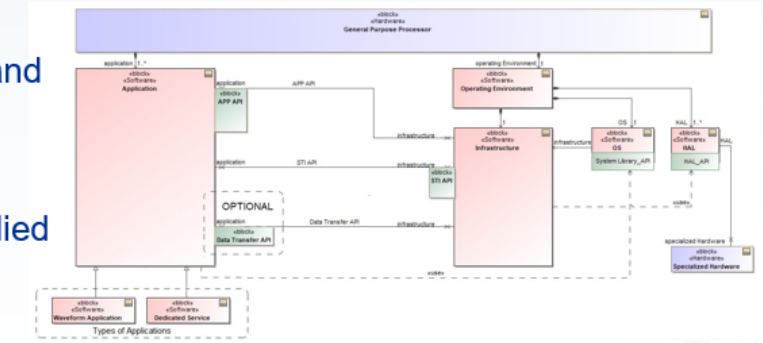
STI Software Operating Environment Model

Proposal prescribes specific API requirements for items between the STI Infrastructure and waveform/application services layers

- Allows portability of software elements between different OE implementations

Proposal prescribes documentation requirements for layers below the STI Infrastructure

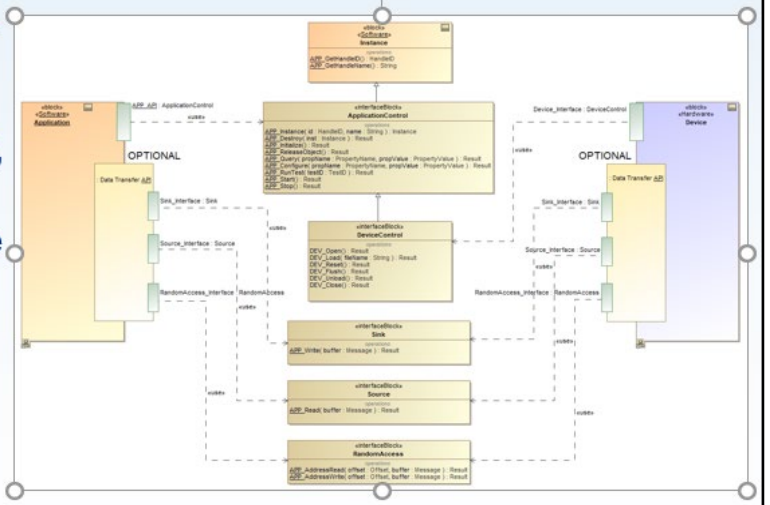
- Specialized hardware and hardware system limitations/capabilities defined in vendor-supplied documentation.



National Aeronautics and Space Administration

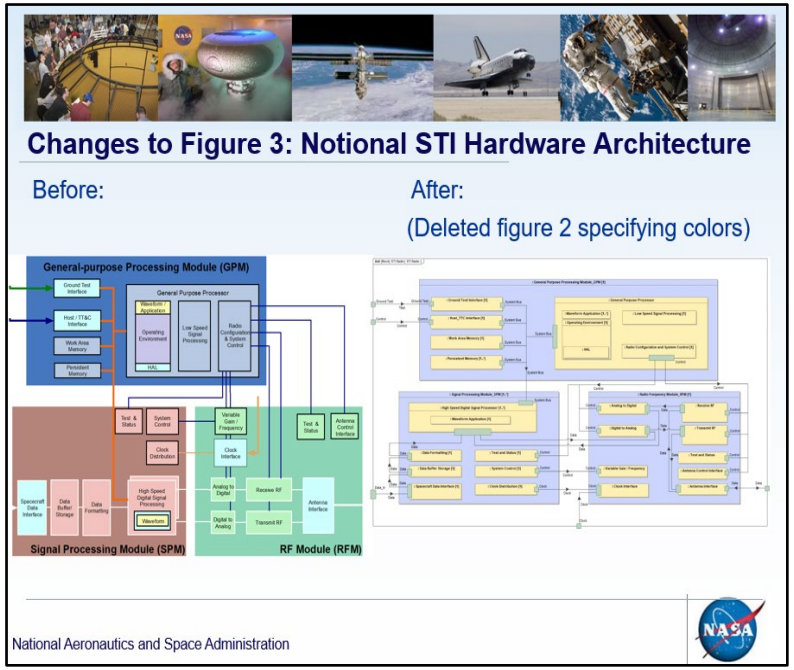
STI Application Software Interface Structure

- Proposes a SW Interface structure similar to existing SDR standards (NASA STRS, SWRADIO, SCA)
- Software written for these other environments should be usable without extensive rewrites or refactoring

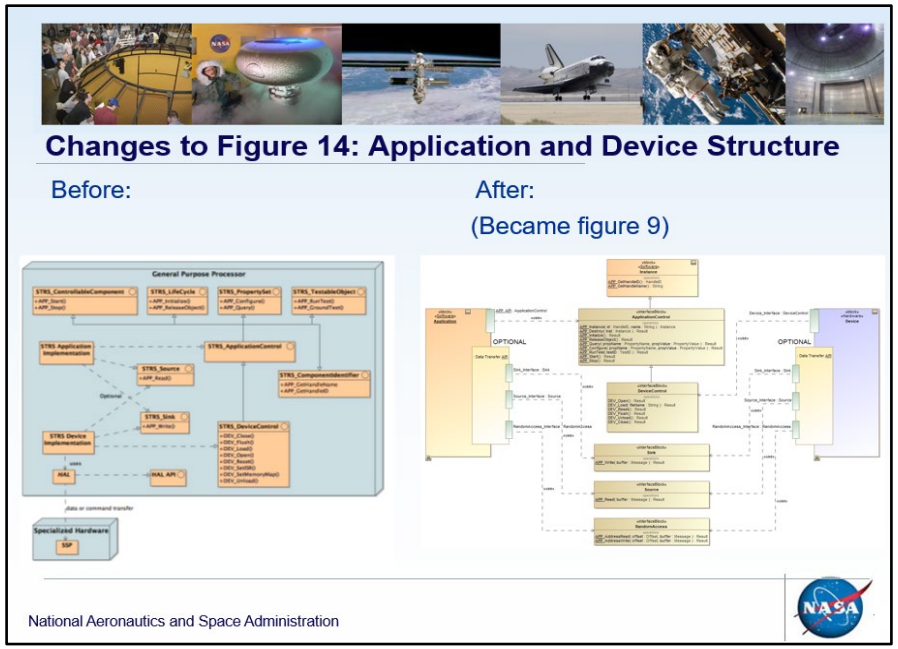


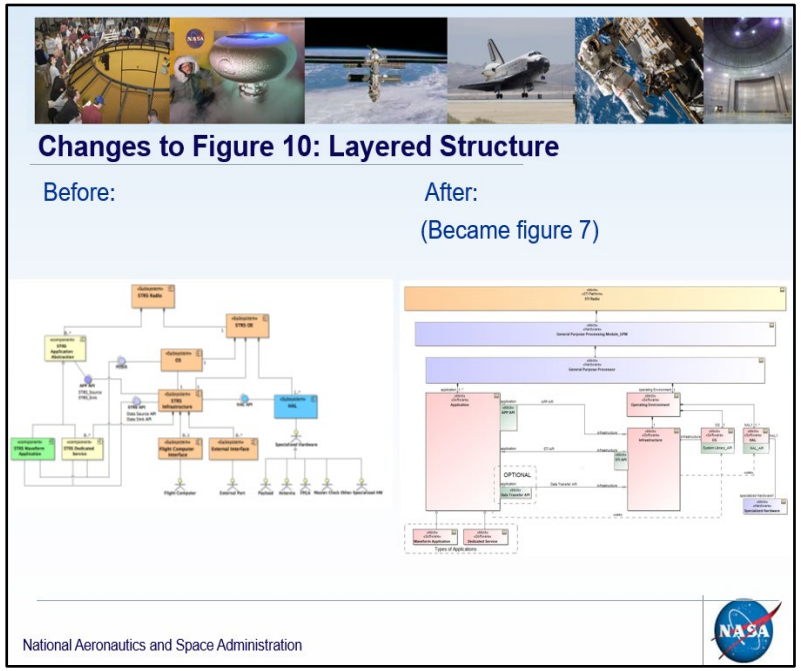
National Aeronautics and Space Administration

Changes Made from STRS to STI



Changes Made from STRS to STI





Software Based Communications (SCA)
DoD's SCA & NASA's STRS becomes
OMG's Space Telecommunications Interface (STI)

If Any of You Space Cat's Have Questions - You Can Be Directed To:

Steven A. "Steve" MacLaird
(aka Da Dawg)
SVP Government & Industry Strategy
Tel: +1-703-231 6335
OMG HQ – Needham , MA
Tel: +1-781-444 0404
Fax: +1-781-444 0320

maclaird@omg.org
https://www.omg.org
https://www.iiconsortium.org
http://www.it-cisq.org

Note Pages Available Upon Request

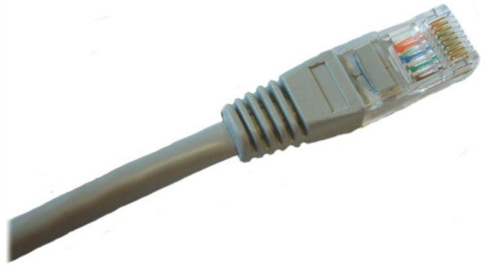
Back Ups

Who is OMG?

- One of the largest and longest-standing not-for-profit, open-membership consortia developing and maintaining computer industry specifications.
- Continuously evolving to remain current while retaining a position of thought leadership.
- Long-term maintenance of proven standards

Open Standards & Modeling Provide Savings & Focus

What's the Value?



Workforce flexibility	Interoperability	Process optimisation
Standard, best practice methods, inputs, and outputs ↓ Flexible distribution of tasks around workforce	Standard interfaces ↓ Flexible distribution of processes and information + Commodity services	Best practice, repeatable processes ↓ Optimisation (time, quality, cost) of flow of components and tooling
DoDAF (aka Unified Architecture Framework (UAF)) in EA practice	**CORBA, DDS, SCA, etc.**	**Modelling in service delivery (BPMN, UML, SysML) Ground Stations (XTCE, XUSP, GEMS, SOLM, C2MS)**

Attributed to: **Chris Frost** Fujitsu Distinguished Engineer

Open Standards & Modeling Provide Savings & Focus

Ways to Value from Standards & Standards Bodies

Standards Body offers:	Business gets value by:	Example:	Actions to take:
Access to latest industry standards, techniques, etc.	Using IP from standards bodies internally, and visibility of new industry trends	UAF used in internal EA framework and EA skills development.	• Active engagement by internal process owners • Promotion to internal technical communities
Publication and presentation platforms	Demonstrating capability and influencing the marketplace	Presentations delivered to conferences Own IP becomes industry best practice	• Present at conferences and other events • Propose IP to standards, white papers etc.
Networking opportunities	Visibility and knowledge of customers and partners	Working group membership maintains a relationship with important customer or partner	• Meet stakeholders • Ensure company engagement is visible

Industry Research Findings:

ISO study [1]: Profit contribution from standards ranges from 0.15% to 5%
BSI study [2]: increase in turnover from using standards of between 1.7% and 5.3%

1. ISO, 2014, "Economic benefits of standards", http://www.iso.org/iso/ebs_case_studies_factsheets.pdf
2. British Standards Institution, June 2015, "Economic benefits of standards – research reports", http://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/research-reports/

Attributed to: **Chris Frost** Fujitsu Distinguished Engineer

Open Standards & Modeling Provide Savings & Focus

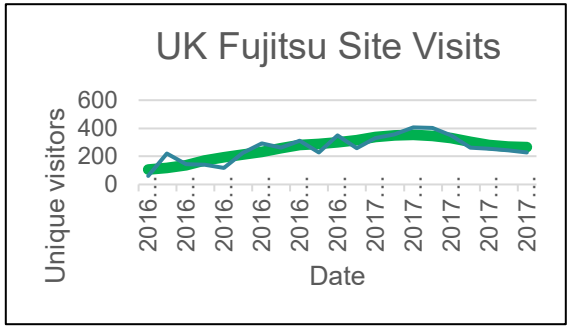
Measuring Value

1 – Practical Things Can be Counted

Business gets value by:	What to count:
1. Using IP	• Number of internal methods, guidelines, templates etc. • Number of projects using the standards or methods • Number of people trained / certified
2. Demonstrating business capability	• Number of presentations • Number of IP submissions (white papers etc.)
3. Networking with customers and partners	• Number of stakeholders met • Number of opportunities / suspects

Cost model Item	Purpose		Forecast GBP		Forecast JPY
Staff 1	Headcount cost	£	243,529	¥	31,658,770
Staff 2	Headcount cost	£	102,126	¥	13,276,338
Develop BP Collateral	SME Project costs for funding r&d development	£	32,386	¥	4,210,193
Support rollout BP	Project costs for funding rollout & promotion	£	6,000	¥	780,000
BP promotion	Travel and accommodation costs for promotion	£	12,140	¥	1,578,210
SME meetings - travel and accommodation	SME Travel and accommodation costs for r&d	£	8,171	¥	1,062,221
Miscellaneous expenses	Any other expenses	£	57,367	¥	7,457,726
Sub total	Sub total	£	461,719	¥	60,023,458
Contingency	Contingency	£	46,627	¥	6,061,480
TOTAL	Total	£	508,346	¥	66,084,939

2 – Estimate the ROI Case Study



Benefits model	
Site visits	3570
Use rate	50%
Savings per use	7.5h
Hourly rate	7000 Yen/hr
Benefits (Yen)	93.7 M Yen
Benefits (GBP)	0.72 M GBP

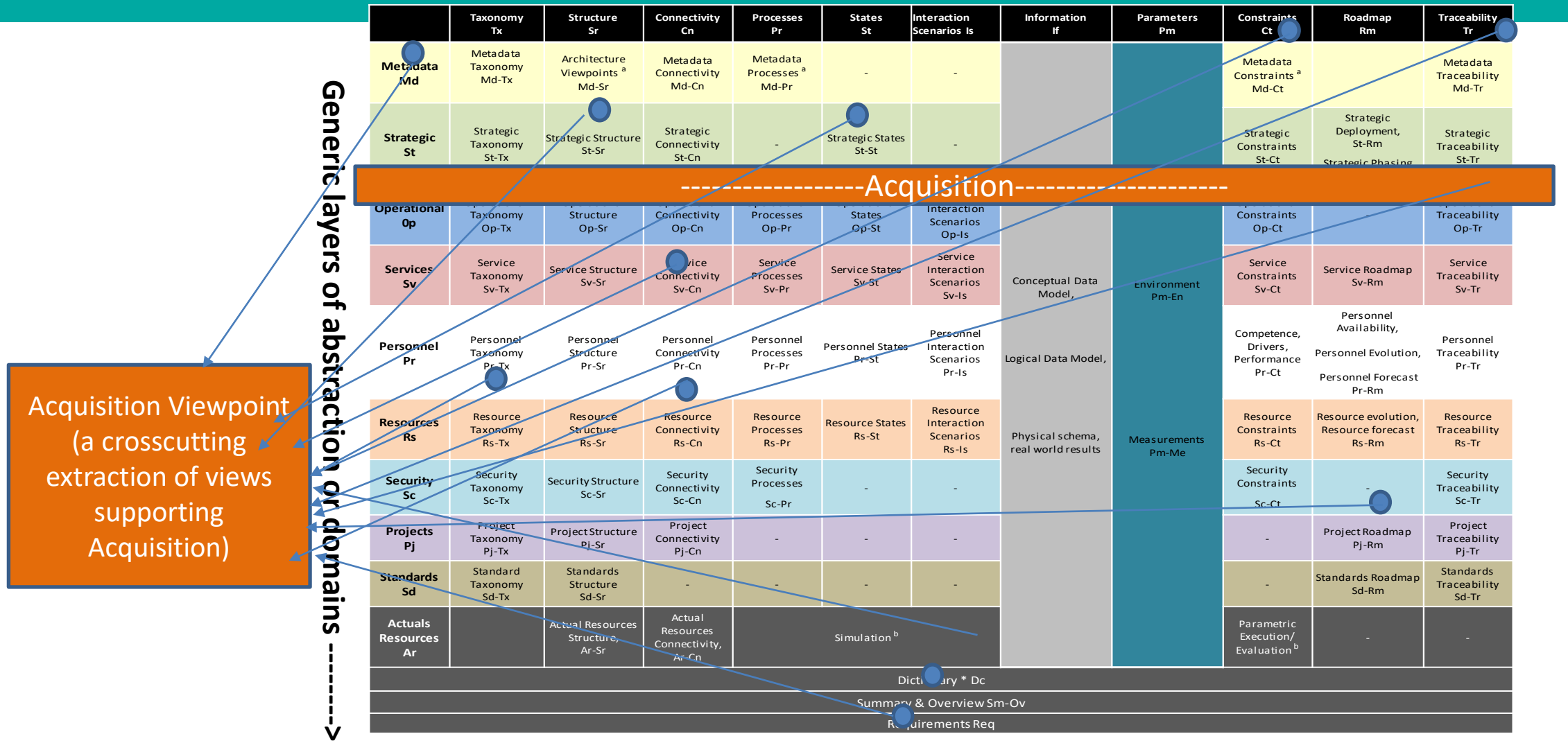
What's the ROI:

Benefits 0.72 GBP (0.93 US $)
Cost 0.51 GBP (0.66 US $)
ROI 41%

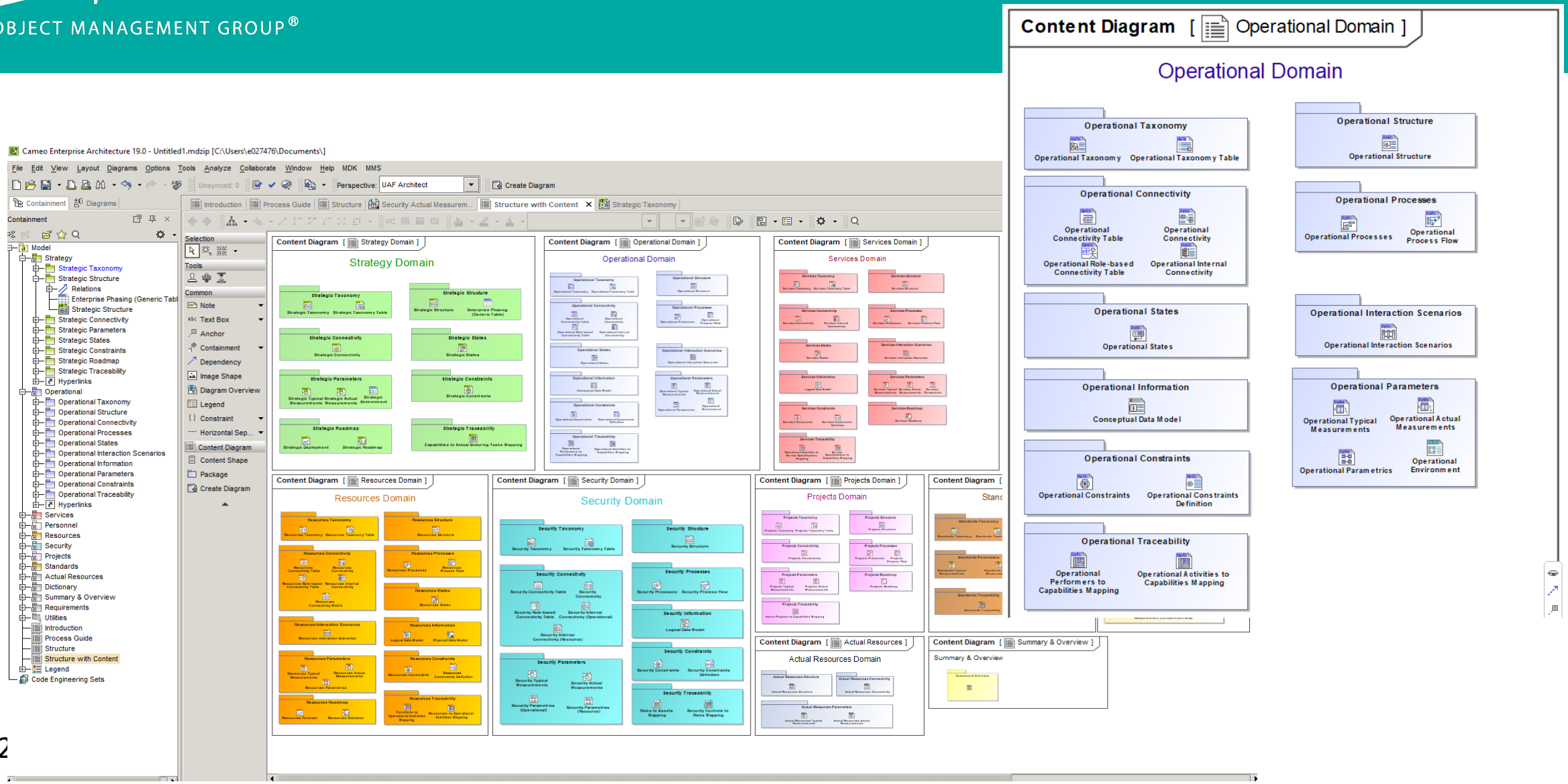
Attributed to: **Chris Frost** Fujitsu Distinguished Engineer

UAF Grid Overview

Model Kinds or viewpoints -------->



UAF Profile Implementation

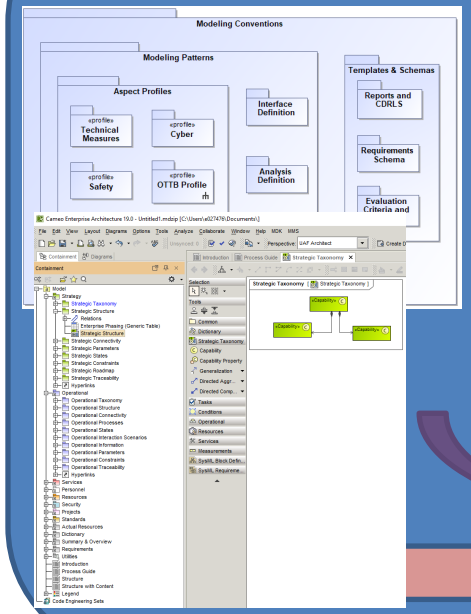


Acquisition Reference Model Contents

OBJECT MANAGEMENT GROUP®

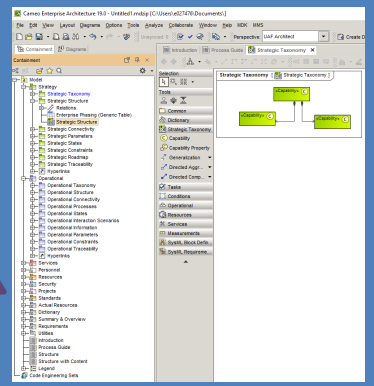
Model-based RFP Process

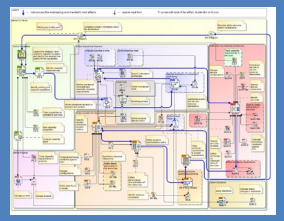
1. Acquisition Reference Model (ARM)Template



ARM Template
+
GRM Template

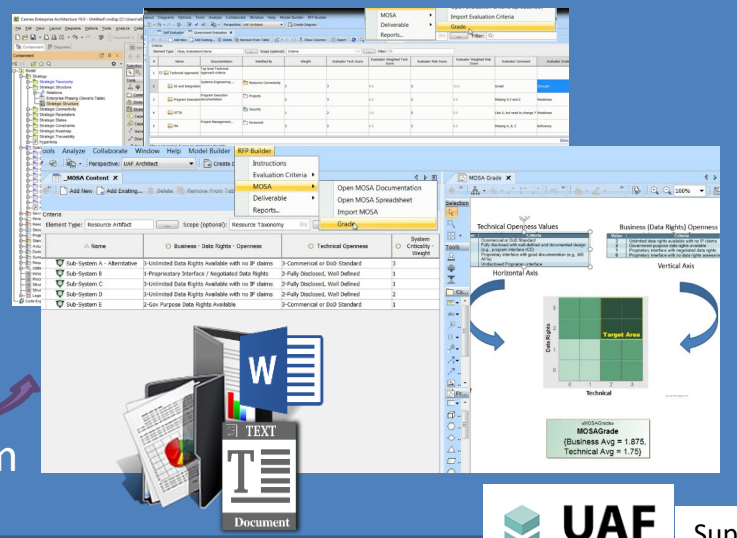
2. Government Reference Model (**GRM**)





Populated with Program & contract Data

3. Model-based RFP Model



← 4. Unified Architecture Framework (UAF) Process Guide for Acquisition →

UAF OMG UNIFIED ARCHITECTURE FRAMEWORK ™

Supports DoDAF 2.1

1. The Acquisition Ref Model Template provides model structure for RFP content and evaluation tools:
- Modeling Patterns
  - Aspect Profiles (i.e. MOSA, Data Rights, certs)
  - Interface & Analysis Definitions
- Templates & Schemas
  - Evaluation Criteria & Scoring (Section K, L, M)
  - Reports & CDRLS

2. The **GRM** is a descriptive model containing the program requirements, & constraints
- High-level Capabilities, mapped to Operational scenarios, traced to requirements (e.g. CDD, SRD, Conops)
- Technical performance measures (i.e. KPPs, KSAs, MOEs..)
- Any required architectural partitioning including structural and functional

(Based on UAF acquisition process guide and template)

3. The Model-based RFP model contains the populated GRM and ARM template providing RFP evaluation content, CDRL definitions for documentation generation and scoring tools for solution validation and evaluation

4. UAF Process Guide provides the Acquisition Guidance for using the UAF Framework for GRM and ARM template to create, respond and evaluate a Model-based RFP.

XTCE & XUSP Status

XCTE

- XTCE 1.2 RTF has dispositioned 244 of the issues submitted.
- ALL of the remaining issues closed in ballot on Feb 12th and resolved.
- The resulting revised schema will be largely forward compatible with existing XTCE 1.1 documents and members of the RTF are developing tools to transform forward incompatibilities, e.g. element name changes
- RTF report submitted and OMG Architecture Board Approved Sep 2018
- XTCE 1.2 Specification Published Oct 2018
- XTCE 1.1 is being used by military, space agency, and commercial space programs as an open exchange format and upgrading to 1.2.

XUSP - a tailored version of XTCE to support CCSDS formats and typical field constraints

- XUSP RTF is awaiting publication of XTCE 1.2, since it is a defined subset profile of the XTCE specification. XUSP is a tailored version of XTCE to support CCSDS formats and typical field
- No pending issues, but after publication of XTCE 1.2 an issue will be submitted to address compatibility.

Command & Control MessageSpecification (C2MS)

What is it?

- A set of standard message formats for the exchange of information for C2 functions
- About 30 messages covering areas like events, telemetry frames or parameters, directives, navigation, commanding, and more.
- Aligned with key interfaces normally found in today's commercial C2 system products

Where did it come from?

- NASA's Goddard Mission Services Evolution Center (GMSEC) Interface Specification document provided the primary source material
- NASA will retire its ISD when C2MS is published
- Note: ONLY the message formats are being standardized, not the API or components

What is the status?

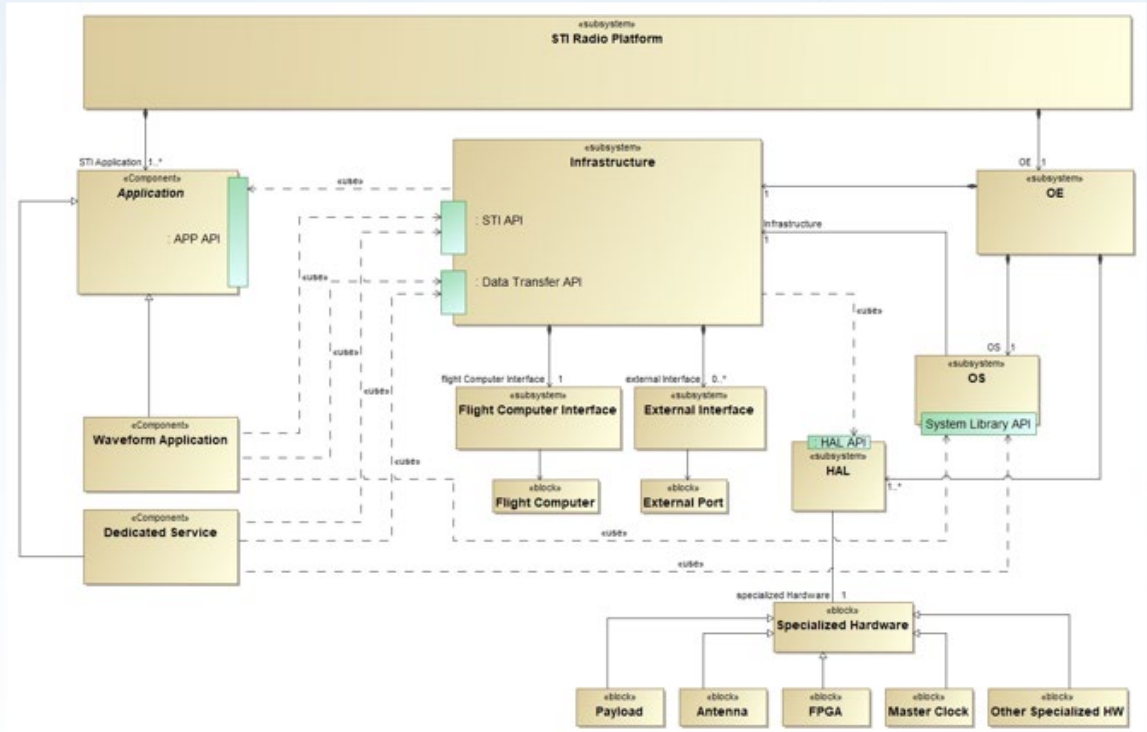
- NASA has worked with the Space Domain Task Force on C2MS for the past year and submitted the required materials for consideration in mid-February 2018
- OMG Architecture Board Approved in Sep 2018 and in Finalization Task Force for Completion
- Should be an available for Specification download by March 2019

OMG Space DTF (SDTF) Future Backlog

- Telemetry Display Page Definition Exchange
  - No draft RFP exists, yet, just conceptual. Some interest, but this is a difficult problem.
- Ground Data Delivery Interface
  - No draft RFP exists, yet, but has been discussed as a companion spec to GEMS for delivering binary mission and housekeeping data within a ground station.
- Alert Management System
  - US Air Force EGS adopted the OMG C4I Alert Management Service (ALMAS) specification rather than request a specific space domain specification
- Goddard Core Flight Services (Cfs)
  - Goddard has several technologies with more general space industry applicability that are waiting for the results of the C2MS RFC from NASA for a possible path forward.
- Spacecraft Operations Ontology
  - In works, tough to do, about 10 ontology's being worked on now.

STI Back UP

STI System Architecture Overview



National Aeronautics and Space Administration

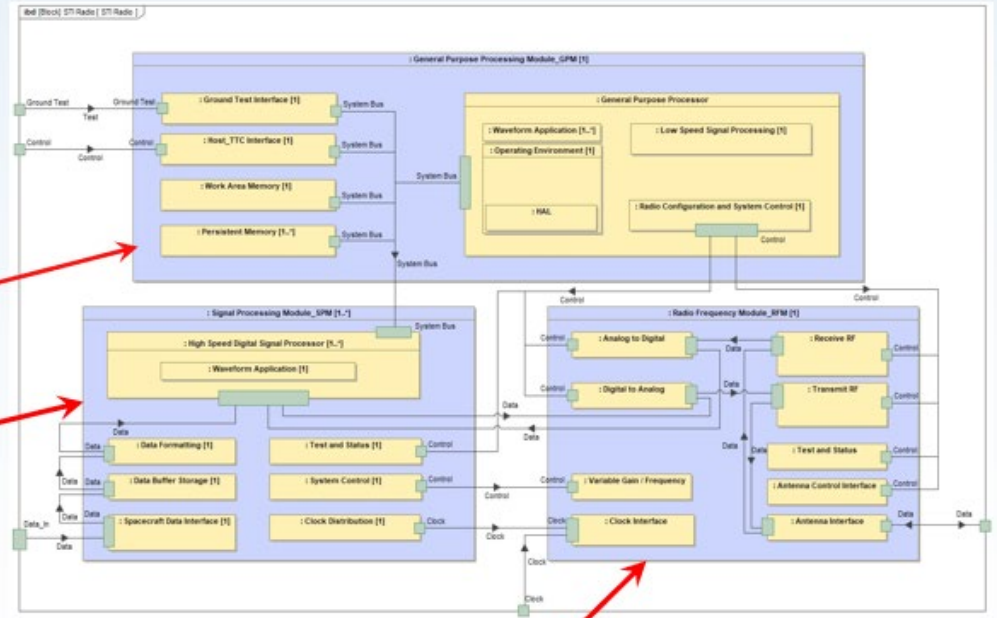
OBJECT MANAGEMENT GROUP®

STI Back UP

STI Overview – Hardware Architecture

STI defines fundamental blocks of a generic SDR platform

- General Processing Module (GPM) hosts the control plane
- Signal Processing Module (SPM) hosts the data plane
- Radio Frequency Module (RFM) provides the radio interface



National Aeronautics and Space Administration

STI Back UP

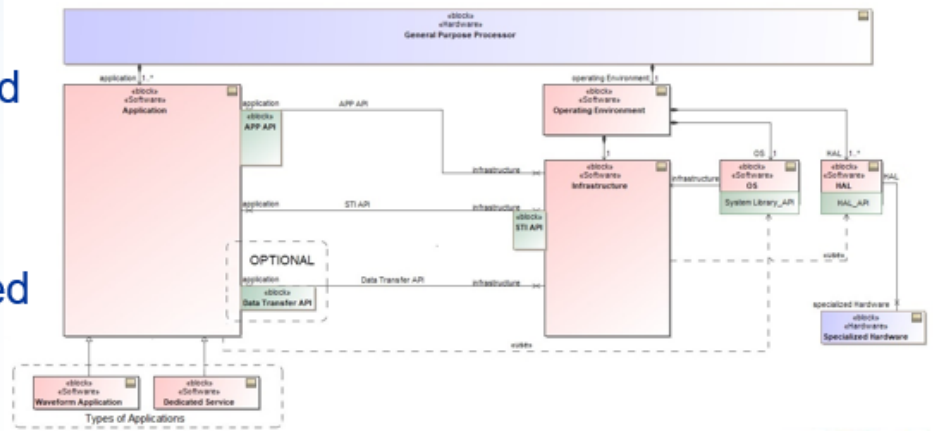
STI Software Operating Environment Model

Proposal prescribes specific API requirements for items between the STI Infrastructure and waveform/application services layers

- Allows portability of software elements between different OE implementations

Proposal prescribes documentation requirements for layers below the STI Infrastructure

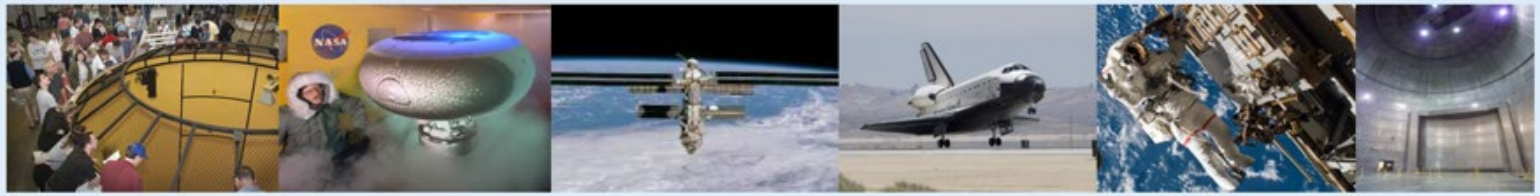
- Specialized hardware and hardware system limitations/capabilities defined in vendor-supplied documentation.



National Aeronautics and Space Administration

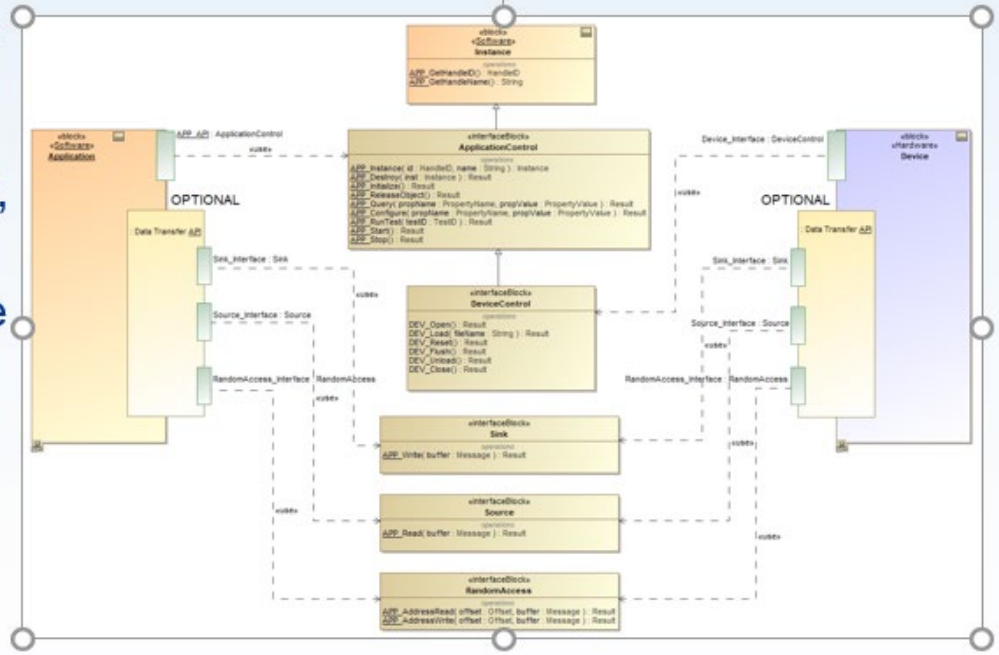
OBJECT MANAGEMENT GROUP®

STI Back UP



STI Application Software Interface Structure

- Proposes a SW Interface structure similar to existing SDR standards (NASA STRS, SWRADIO, SCA)
- Software written for these other environments should be usable without extensive rewrites or refactoring



National Aeronautics and Space Administration

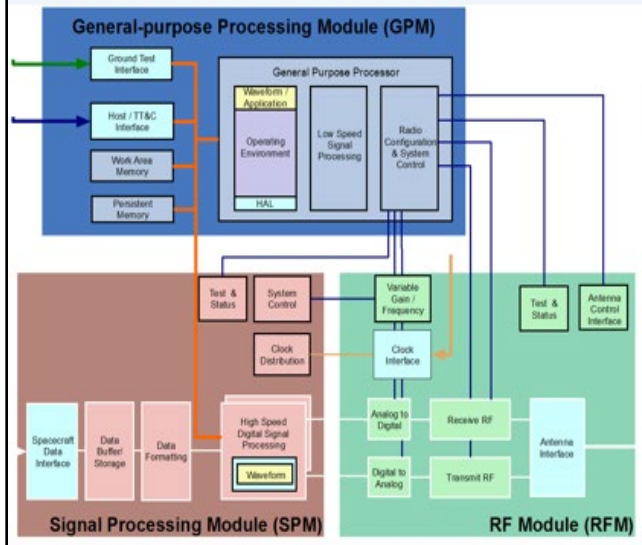
STI Back UP

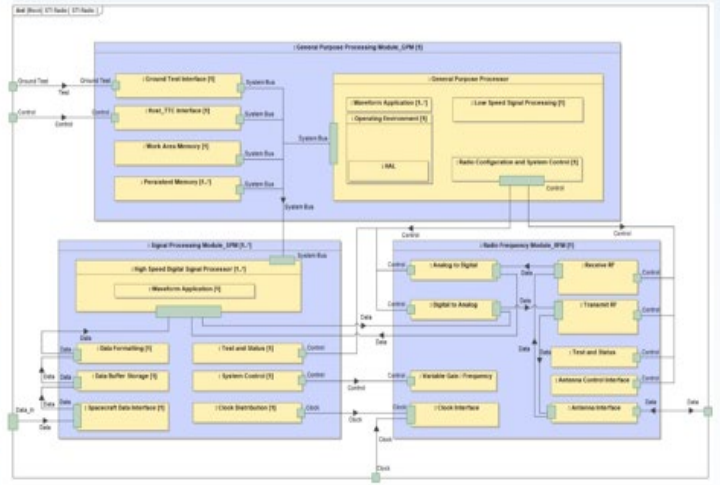
Changes to Figure 3: Notional STI Hardware Architecture

Before:

After:

(Deleted figure 2 specifying colors)



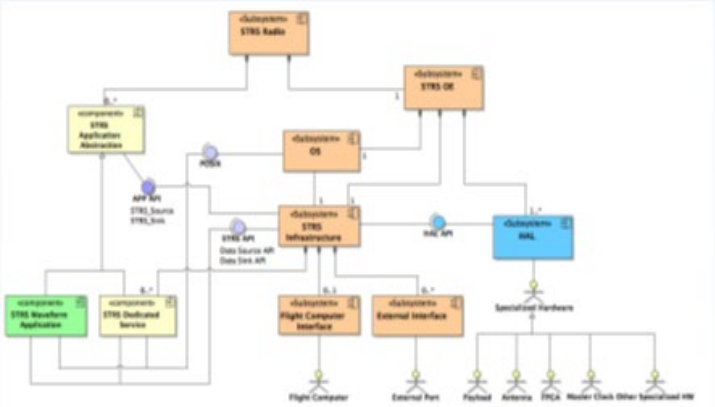


National Aeronautics and Space Administration

STI Back UP

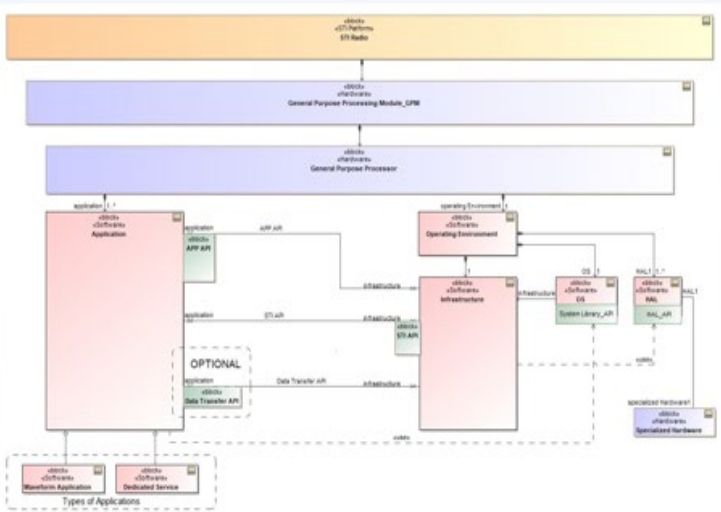
Changes to Figure 10: Layered Structure

Before:



After:

(Became figure 7)

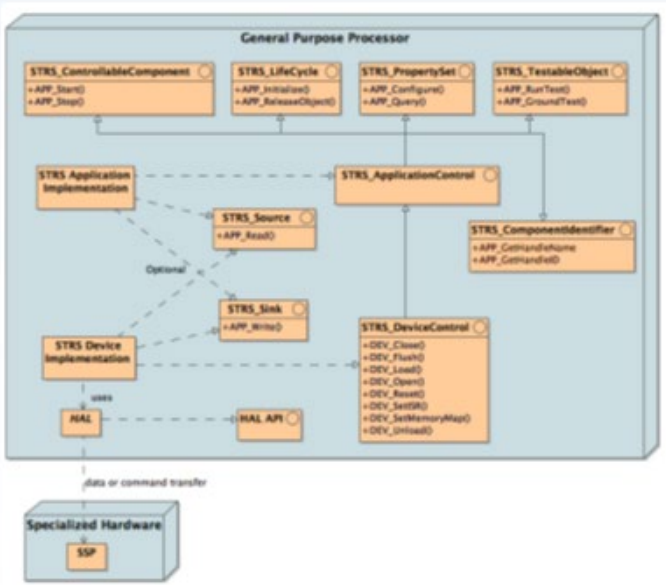


National Aeronautics and Space Administration

STI Back UP

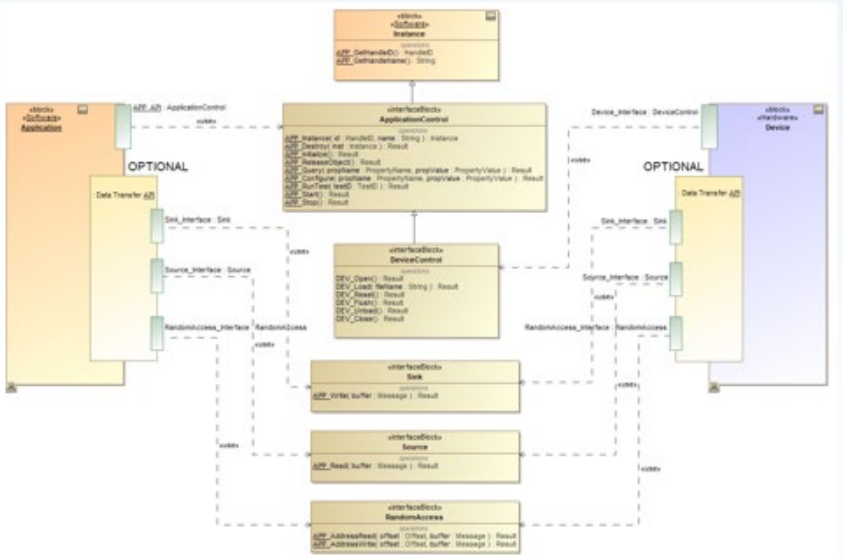
Changes to Figure 14: Application and Device Structure

Before:



After:

(Became figure 9)



OBJECT MANAGEMENT GROUP®

STI Back UP