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Connecting the Digital Enterprise

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Model-Based
Sys Eng.

Model-Based Systems Engineering Plan for LOTAR

Mark Williams – Boeing

Nigel Shaw - EuroStep

29 January 2017

AGENDA

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Goal for the INCOSE presentation and discussion:

- Verify the worthiness of the “LOTAR for MBSE” initiative
- Recruit support for the working group (members of PDES/ProSTEP-iViP)

Presentation:

- Review the current thinking from the LOTAR for MBSE meeting
- Contrast the working group’s discussion with John Russell’s AP233 meeting
- Discuss AP233 as an alternative solution set or focus area, versus a LOTAR deliverable
- Solicit ideas on what Systems Architecture/design data needs to be digitally represented and preserved
- What standards are applicable for MBSE and are they suitable for the potential LOTAR artifacts.
- Solicit INCOSE member Use Cases
- Comments on appropriate name: LOTAR for MBSE, Systems Engineering, Product Systems Architecture

Attendees

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Solution Space

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The following discussion applies to the development of the System Architecture (LOTAR for MBSE)

- Data objects not defined in the current NAS9300 standards and justify preservation.
- Requirements, functional, logical, and physical implementation (RFLp). (Small ‘p’ versus large ‘P’ that implies physical-spatial).
- Systems Architecture design artifacts that are generally created prior to and may contribute to the definition of the spatial (ECAD), engineering bill of material (EBOM), and manufacturing (MCAD/MBOM).
- Designs that apply to the mechanical, electrical, network, and loadable/embedded software implementations.

From Nov 16, 2016

LOTAR Parts Structure

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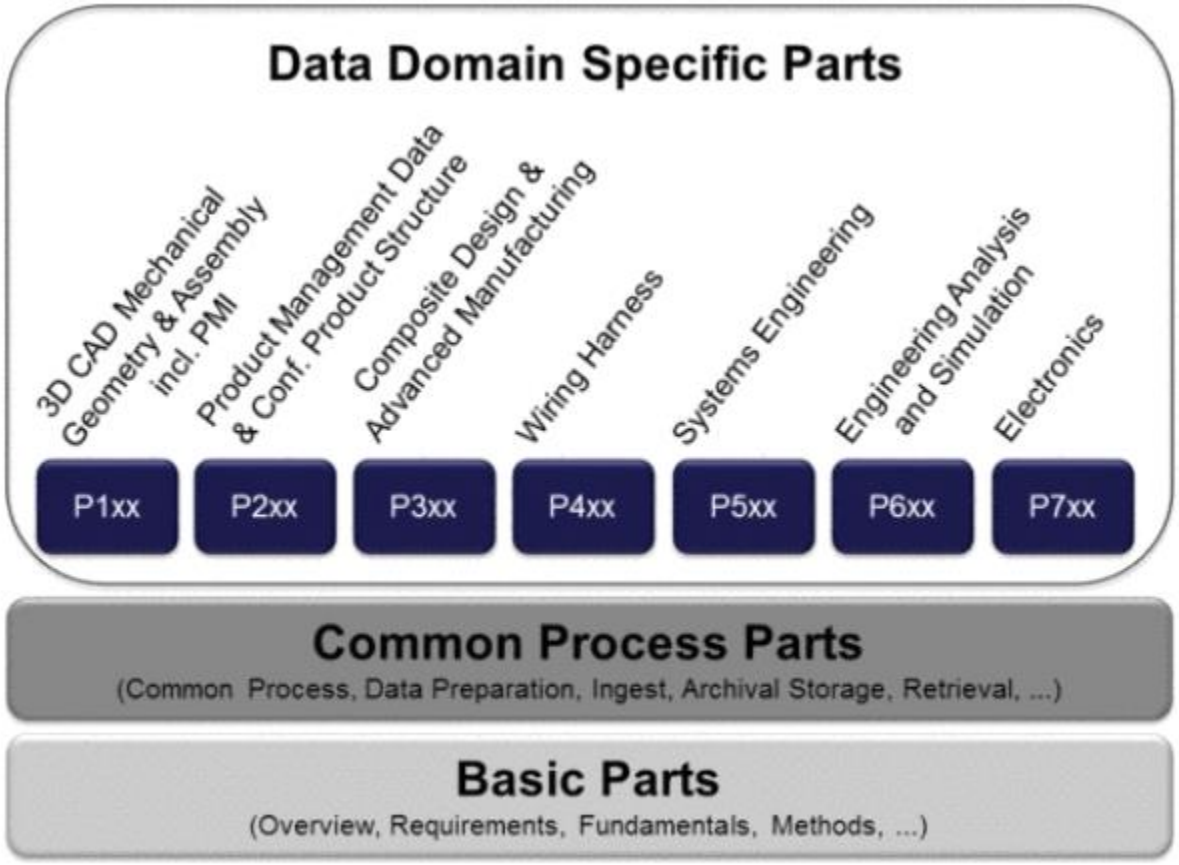

http://www.lotar-international.org

What data is in Scope

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What MBSE data objects justify preservation ?

- Conformance airworthiness documentation that is shared with the Regulator agencies
- Definition data that is used by maintenance and operational services
- Definition data that is used for modifications
- Assembly/Part obsolescence issues
- LSW and OS maintenance (software)
- Functional schematics (How it works)
- Logical Schematics (How it is implemented)

Feedback from Tom Thurman

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History of the digital schematic standards:

- Original focus was on AP210 Elec packaging, rack-based components (above integrated circuit level)
- Other work on schematic exchange includes AP10303-221, 1201-1206. AP221 uses 2D geometry primarily focused on the oil and gas industry.
- The underlying database functional and physical connectivity model exists in STEP. Successful modeling and test of schematic symbol library was accomplished. Waiting for funding to design schematic model.
- There are no approved TC184/SC4 work items for future editions of the APs yet. Once there is agreement, SC4 will work toward a common schematic diagram model.
- Assume that the marketing, external communication, and pilot projects will vastly exceed the expense of model development.

What data is in Scope?

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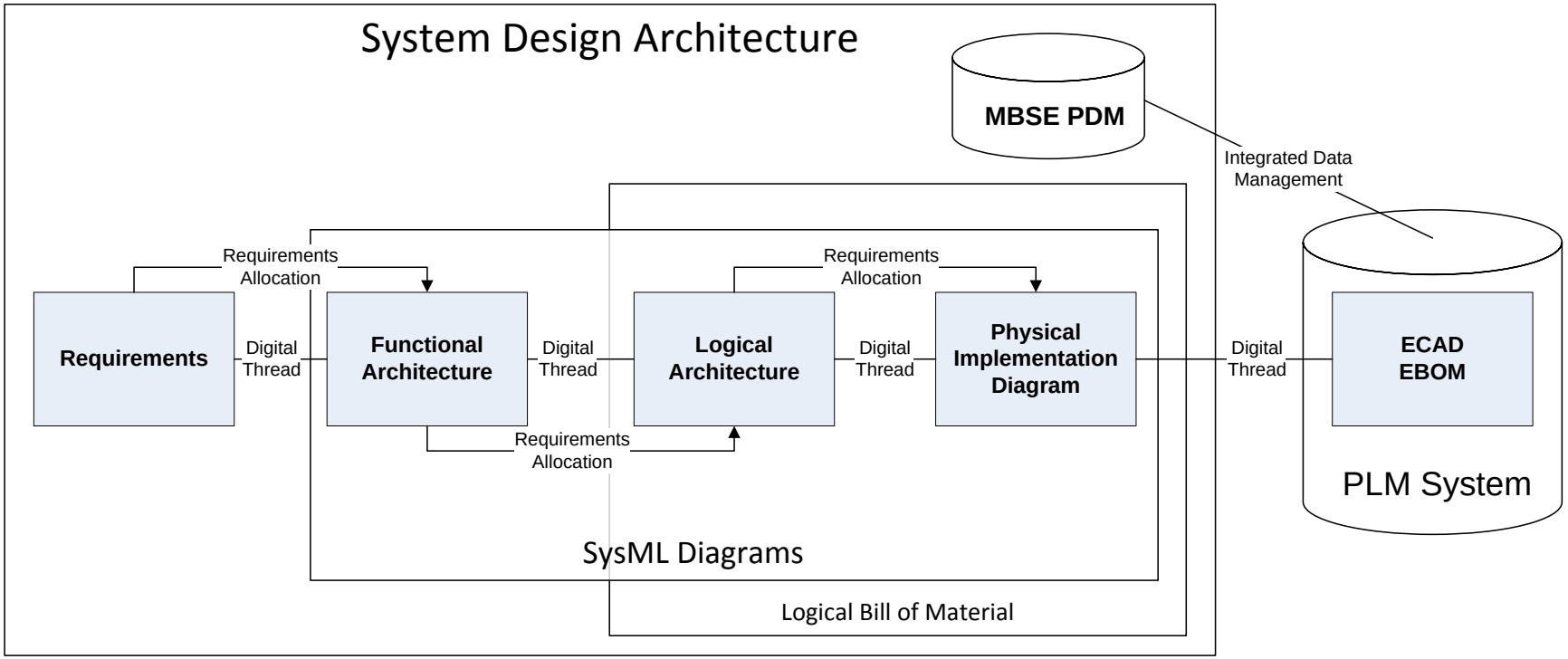
Generic MBSE Design/Business Deliverables



Establish Guidelines

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- Is a diagram generated from a model or derived by hand (need a data view)?
- Is a model adequate or is the problem the maintenance of diagrams?
- Ability to reproduce the logical design and understand the implementation aspects
- Should plan include objects created after certification and point of delivery?
- Can we establish guidelines of how long the product will be supported?

Data Standards Maturity

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LOTAR Specification implies Data Standards

- Modeling Standards
- Data Exchange Standards
- Process Standards
- Domain Standards
- Analysis Libraries/Standards
- Operator Standards

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Boeing Data Standards Radar Chart

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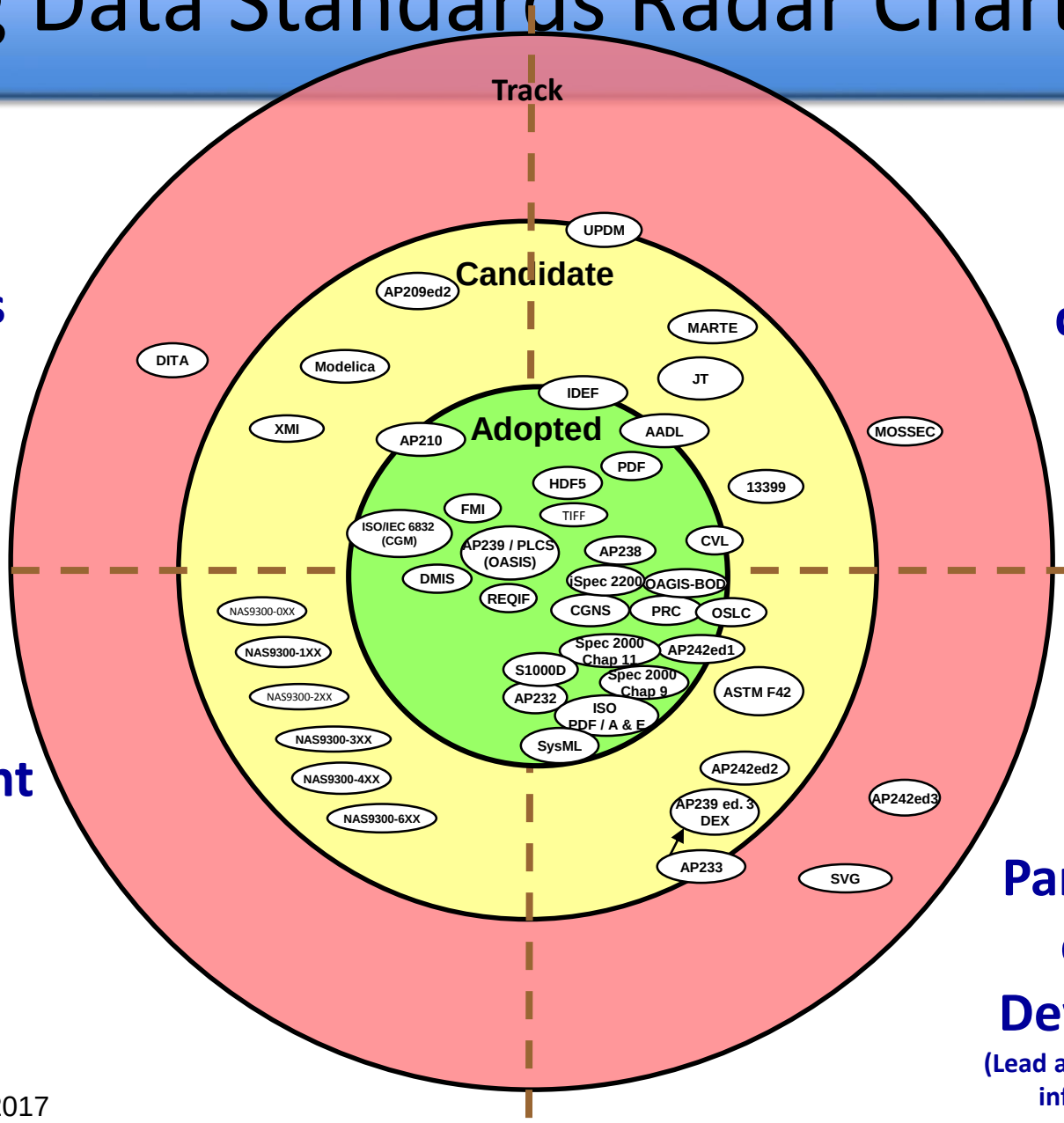

Adopt Existing standards

Monitor external development

Boeing Development

Participate in external Development

(Lead activity, team member, influence std policy)

Released January 2017

Application of Standards: To-Be-View

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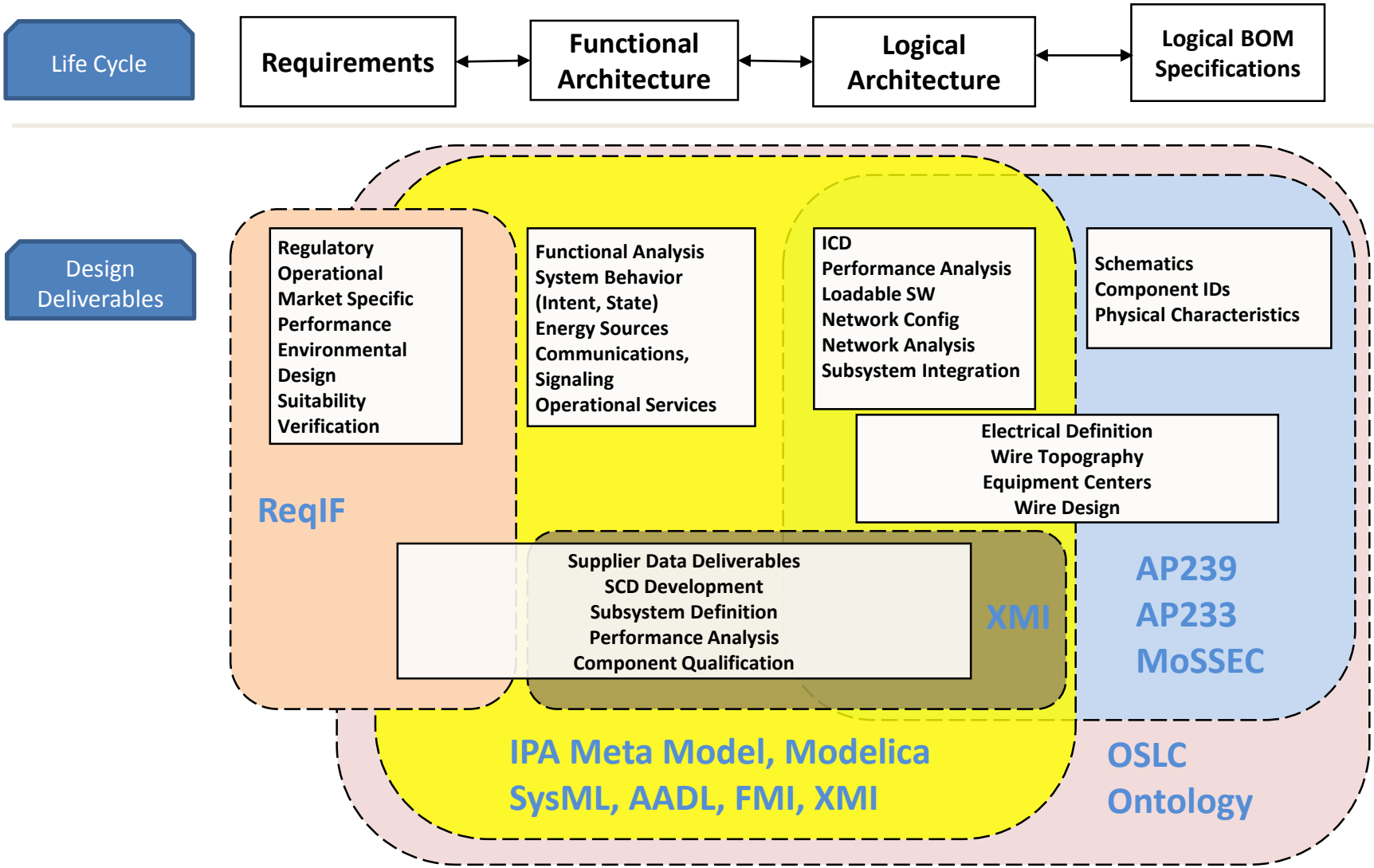

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Interoperability of Standards

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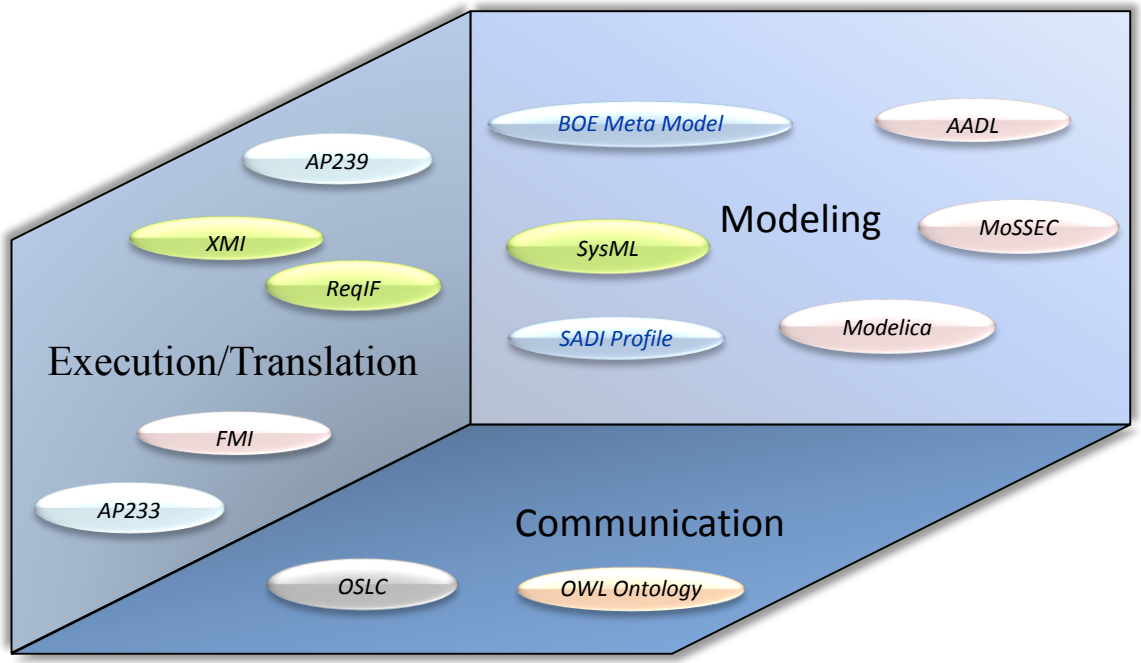

Standard Body Legend

BOEING | OMG | OASIS | W3C | PDES | SAE/std.org

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Modeling Method Example

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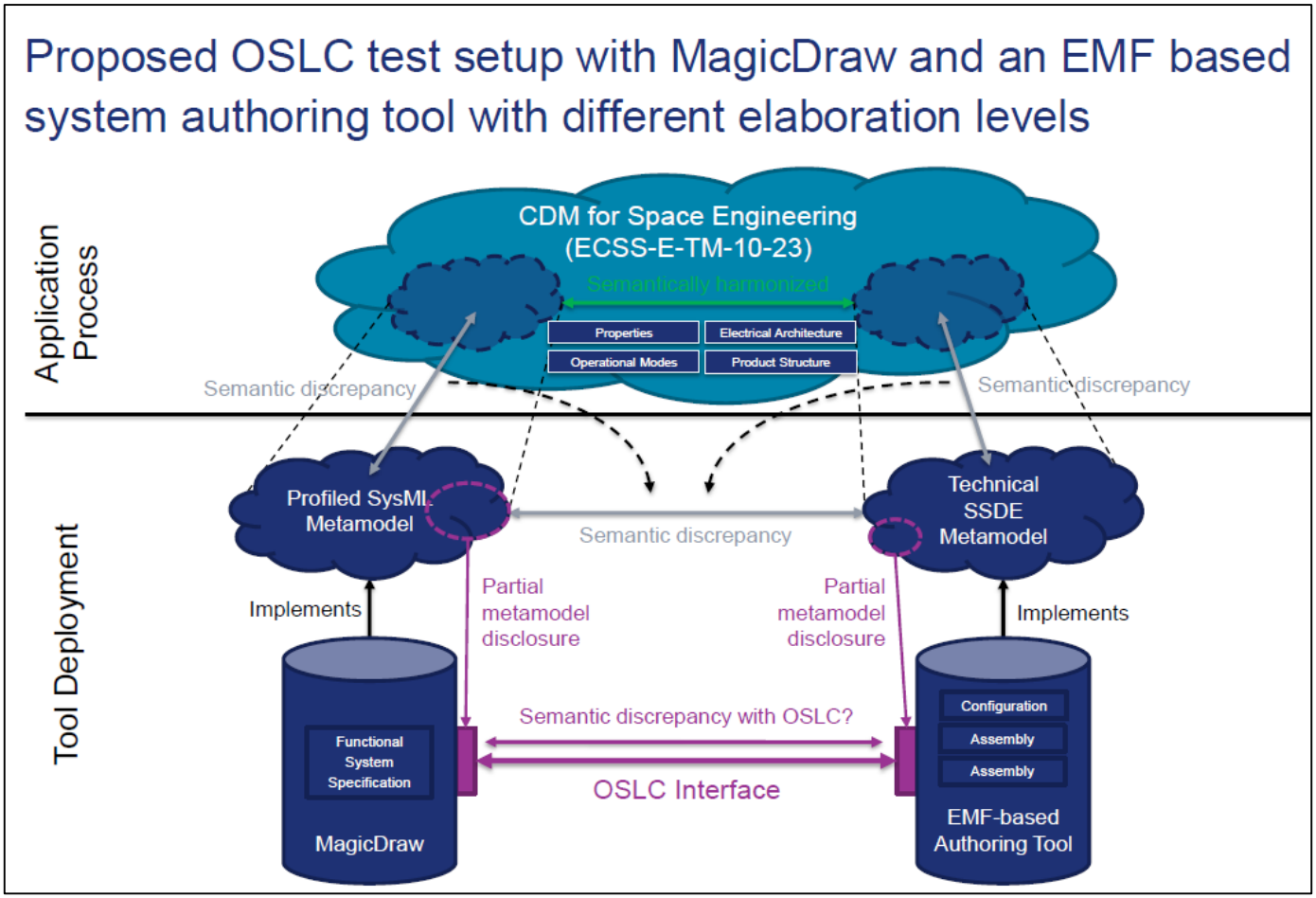
Integrating models from different data repositories

- Modeling Methods
- PLM Vendors
- RDF (W3C)
- IP
- LOTAR Context



Credit: **OMG – OSLC for MBSE Working Group**

Potential LOTAR Priorities

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Objects that Require Preservation

- Conformed/Maintained Requirements
  - Design, Manufacturing, Test, Service Mgmt
  - Shared committed requirements that are shared with regulatory agencies
  - During the development process, derivative requirements
  - Post-Delivery new requirements/constraints (from Supply Chain, Customers)
  - V&V features, information to support accident investigations. What is needed for supplemental certifications
  - Info needed to resolve Parts Obsolescence issues
- Schematic Diagrams (extend AP210 work, or AP239-242 future)
- Performance Analysis Models
- Operation Constraints, Limits, Intent
- Loadable/Embedded Software functions (separate LOTAR book?)
- Software Architecture
- Test Equipment (procedures: execution/acceptance), calibration, scales
- Properties, design role, behaviors, transfer, transformations, budgets, connectivity, messages, logical ports, pub/sub, requests, modes, gates, PLM data links

Team Suggestions for INCOSE Presentation

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- Easier to define what already exists in the LOTAR specs and standards, versus gaps
- Electrical schematic is planned to be covered (after AP242ed3?), but what info is missing and makes it consistent with other data that is managed?
- What tools for authoring, plus V&V?
- Simulation features from the models and meta data – recreated from the logical and physical domains
- Discussion on Supply Chain and Intellectual Property (Nigel)
- How Data that can be kept current (more than storage)
- How to pay the bills? (the archive, and the maint shops)
- LoadableSW (FirmWare) (ASICs, FPGAs, Foundry Libraries) scope and if part of MBSE domain (ILS issues) or need another LOTAR book? Impacts automotive and medical industries. Features of redesign, replacement, procedures, configuration, diagnostics, repairs.
- Possible solutions in non-Aerospace context

INCOSE
International Council on Systems Engineering

Illustrative Example – Digital Networks Evolution

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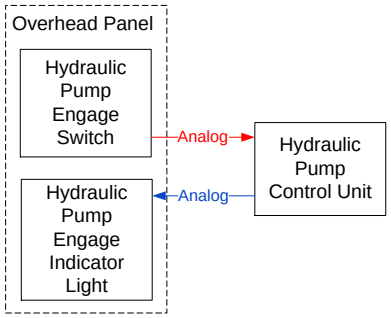
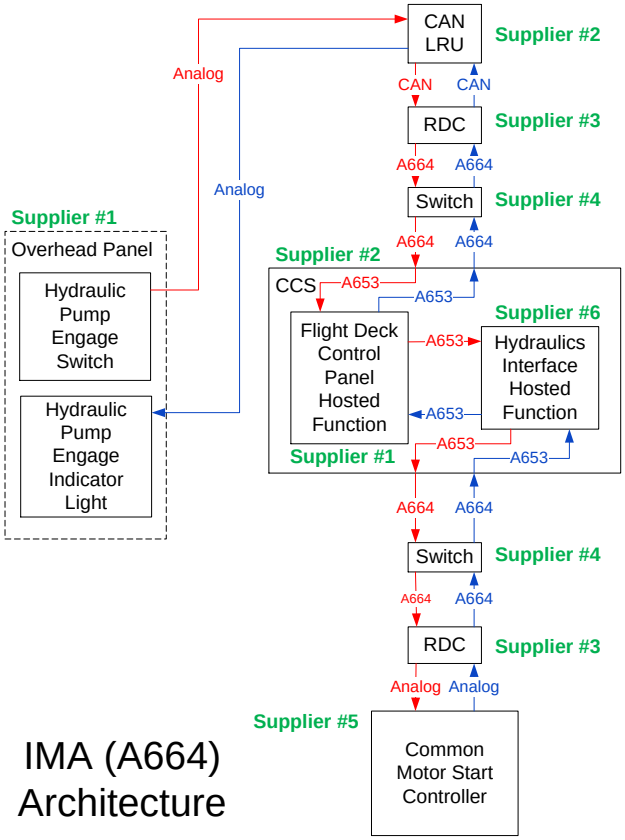


Legacy Architecture



IMA (A664) Architecture

Insights from Large Scale Model Based Systems Engineering at Boeing
INCOSE 2016 Annual Conference, Scotland

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A Simple Integrated System Architecture Model

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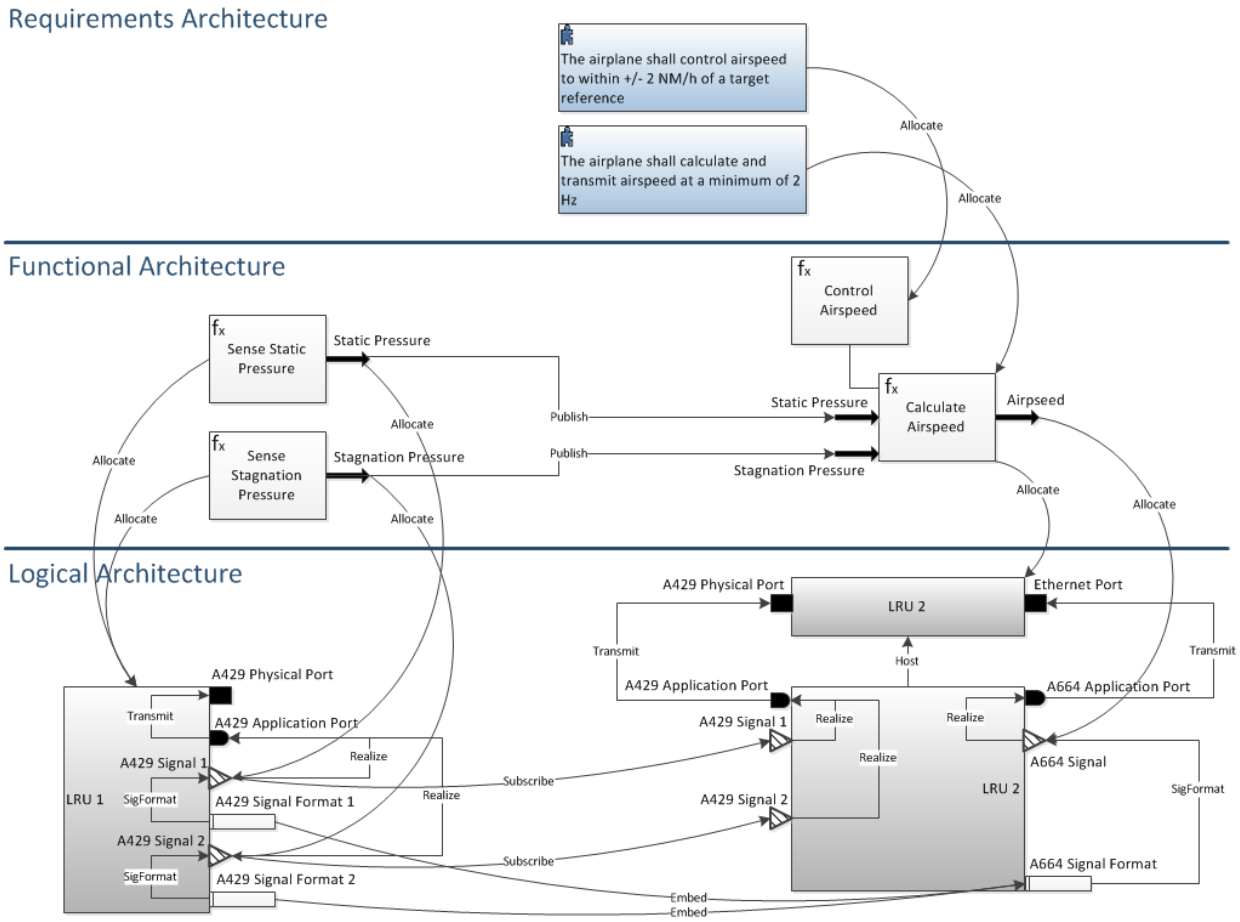
Which view is most appropriate for a LOTAR standard?



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Future Agenda

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- Provide the PDES Technical Advisory Committee (TAC), and then the Executive Board, a project proposal (use template) with scope and size commitment for this working group.
- Evaluate the go-forward status of AP233 as a consideration for the scope of this working group. AP233 to be discussed following the March 9-10 PDES face2face meetings

Refine the Problem Space

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Discussion led by Yves Baudier

Technical landscape

- Product data
  - “product”: “on paper” product or physical product?
  - Data is related to product “views”
  - Data life-cycle and Life-cycle data
- Architecture
  - Conciliation of expectations (functional) with real (physical) through an organised set (logical)
  - Structural architecture, thermal architecture, electrical architecture, etc.
- Role of SysML, AP233 and Architecture Frameworks in this landscape

Illustration

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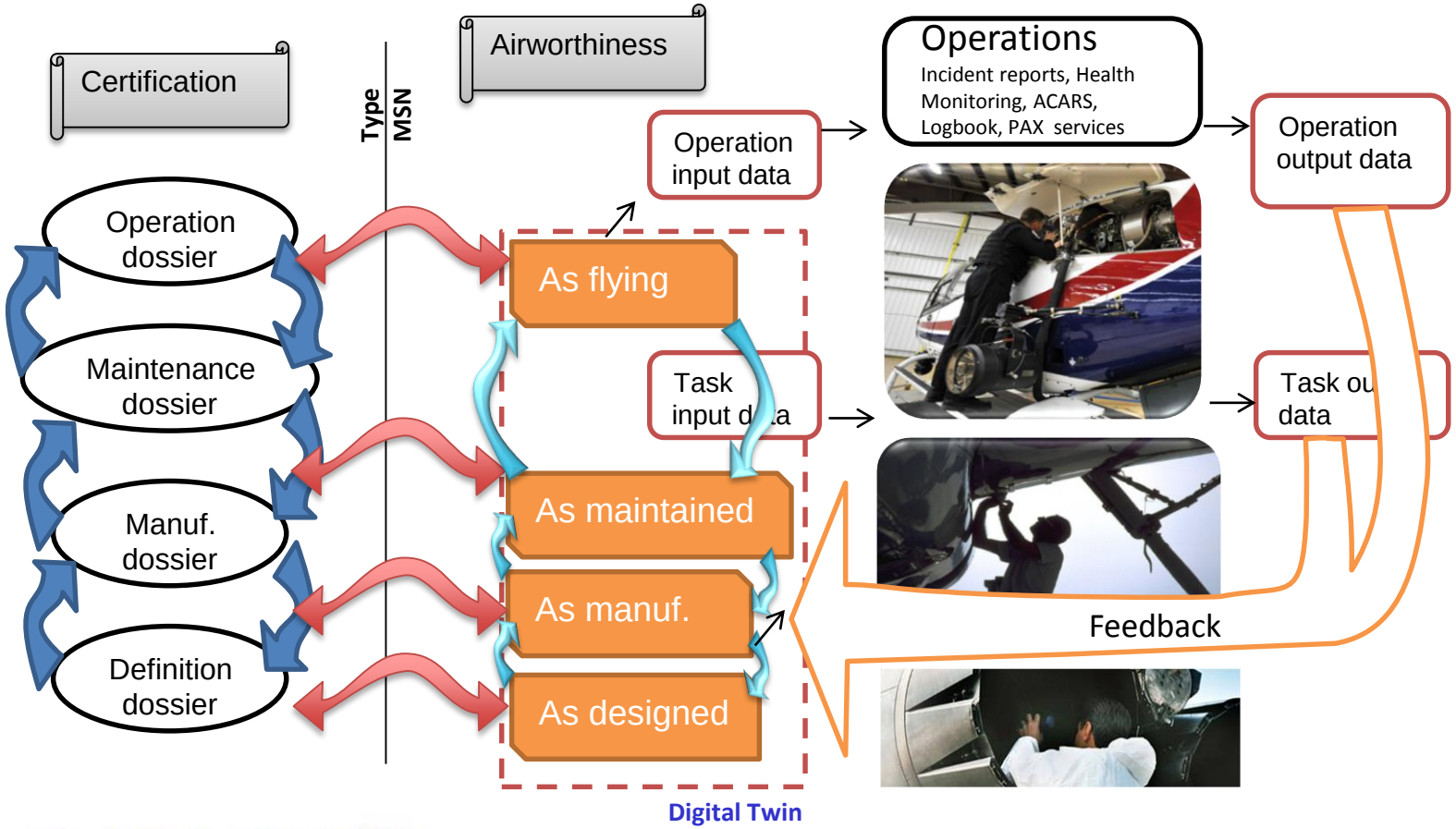

AIRBUS

Dec 14, 2016, from Yves Baudier

Product views: DoDAF

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All Viewpoint Overarching aspects of architecture context that relate to all views.	**Data and Information Viewpoint** Articulate data relationship and architecture content.	**Standards Viewpoint** Articulate applicable Operational, Business, Technical, and industry policy, standards, guidance, constrains and forecasts.

Capability Viewpoint Articulate the capability requirement, delivery timing and deployed capability
Operational Viewpoint Articulate operational scenarios, processes, activities & requirements
Services Viewpoint Articulate performers, activities, services and their exchanges providing for, or supporting, DoD functions.
Systems Viewpoint Articulate the legacy systems or independent systems, their composition, interconnectivity and context providing for, or supporting, DoD functions.

Project Viewpoint Describes the relationships between operational and capability requirements and the various projects being implemented; Details dependencies between capability management and the Defense Acquisition System process.

Ref: http://dodcio.defense.gov/Portals/0/Documents/DODAF/DoDAF_v2-02_web.pdf

Product views: NAF

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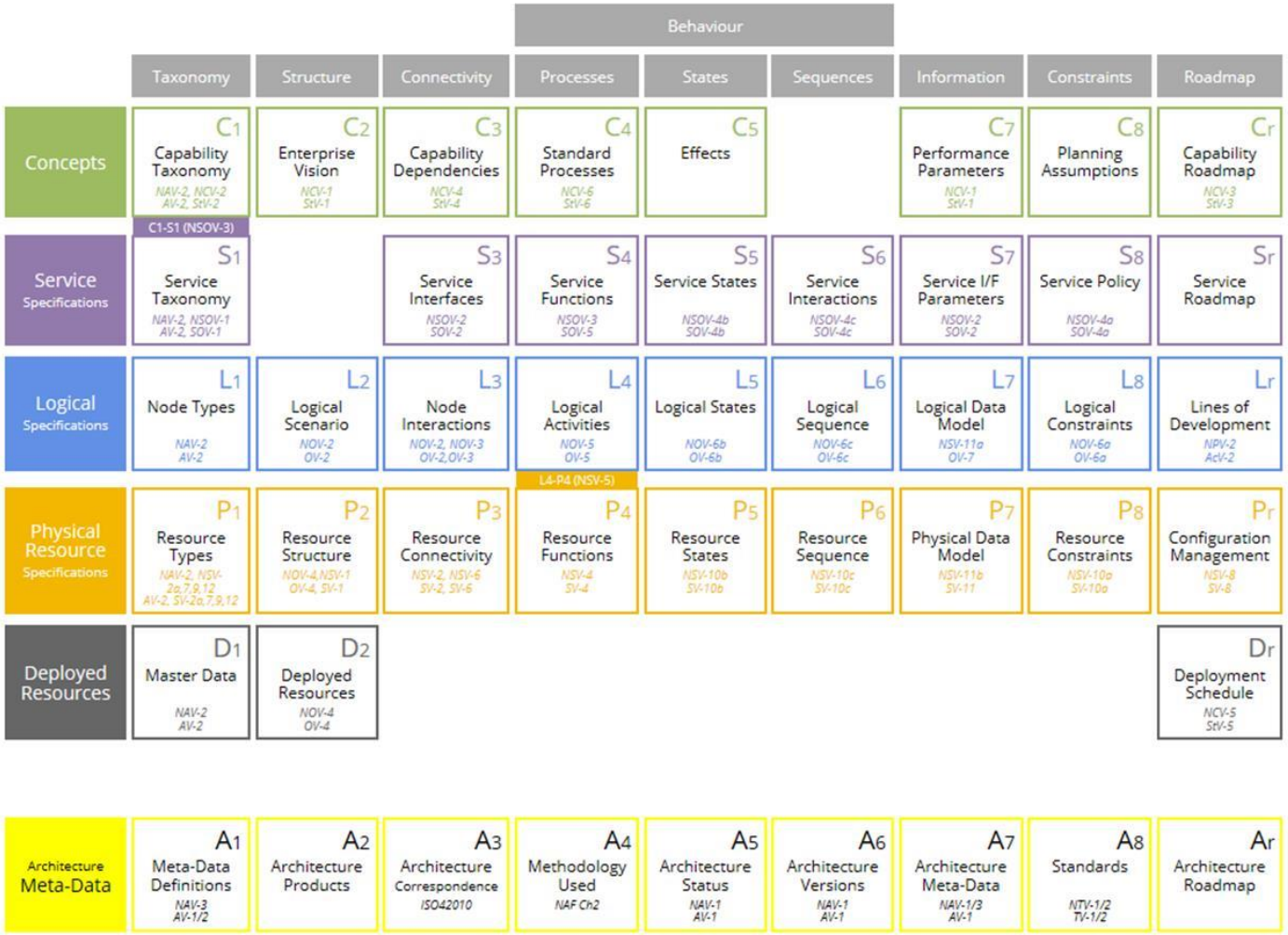

NATO Architecture Framework

Ref.: http://nafdocs.org/viewpoints/

Dec 14, 2016, from Yves Baudier

AP233, SysML and AF

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Putting the Standards Together

The principle for combining the standards is relatively obvious. SysML provides the modelling notation, backed with the formal semantics of its meta model. The various DoDAF views and products are used to classify and present the operational and system descriptions. AP233 provides a neutral data exchange format for the data presented in the architecture framework including –the operational and systems modelling information, and the supporting text.

Figure 2 illustrates a simple case of three DoDAF views which are modelled in SysML, and exchanged from one tool to another as an AP233 file.

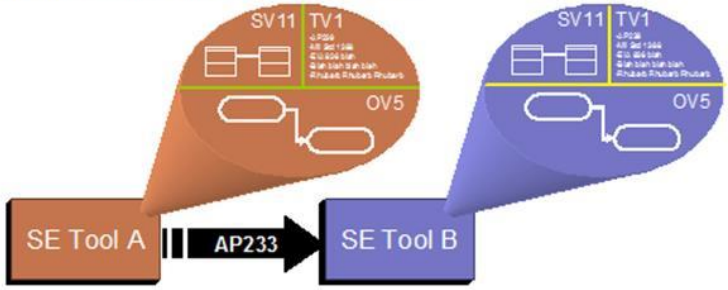

Figure 2 – AP233, DoDAF and SysML together

NOTE: REPLACE AP233 with AP233 FORMAT

Ref.: Using Systems Engineering Standards In an Architecture Framework
Ian Bailey, Eurostep; Fatma Dandashi and Huei-Wan Ang, Mitre Corp ;
Dwayne Hardy, American Systems Corp

AP233, DoDAF and SysML are complimentary standards

Dec 14, 2016, from Yves Baudier

Airbus example

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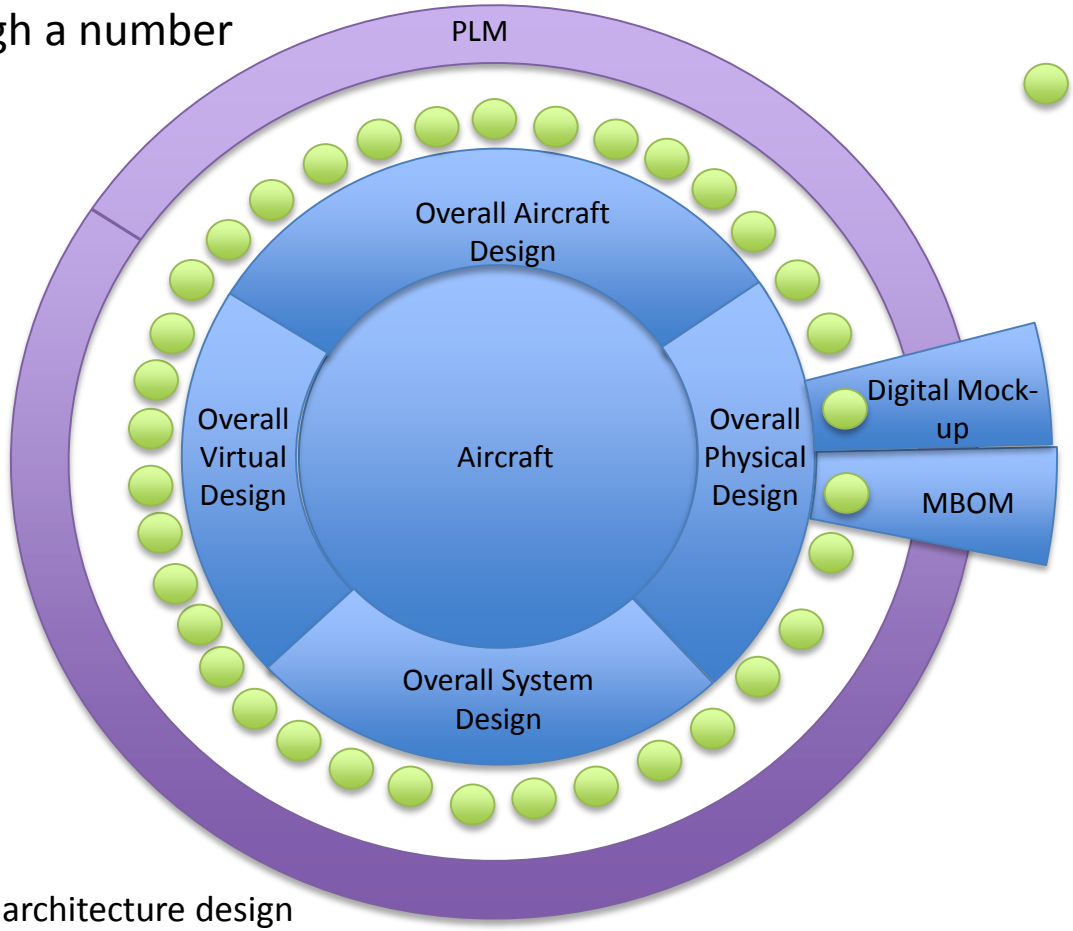
A number of architectures to be managed through a number of views



SysML: supports architecture design
AF (NAF): supports views and their relationships
AP233: supports data exchanges between views
– or between various levels of the same view

Dec 14, 2016, from Yves Baudier

Architecture Summary Discussion

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- Data (MSN - Mfg Serial Number)
- Architecture and role of AP233
- DoDAF/NAF Viewpoints
- Aircraft Design – Physics, energy,
- Physical Design
- System Design – integration of physical elements
- Virtual Design – integration of data
- All joined together by the different architectures

Dec 14, 2016

Team discussion following
Yves Baudier presentation