Systems Engineering

Standards landscape

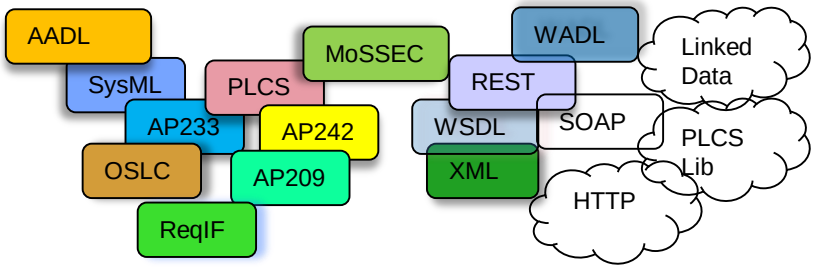
Jay Ganguli
Boeing

Agenda

- **Context & approach**
- **The dimensions of analysis**
- **The sources of information**
  - **SEBok, NSF, INCOSE 2025 SE Vision**
- **Overlap of some standards.**
- **Implications of some current directions**
  - **FutureSTEP, MoSSEC, AP209**
- **Future influencers..disruptors..**
  - **BigData- Distributed Graph databases, InMemory computing**
  - **Research via NSF Systems Engineering grants.**

Context & Approach

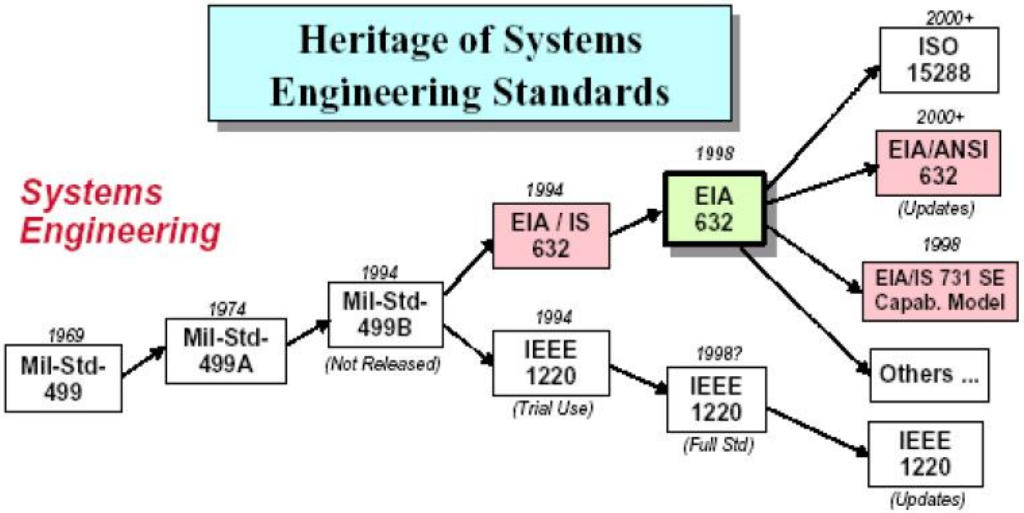
- **The problem…**



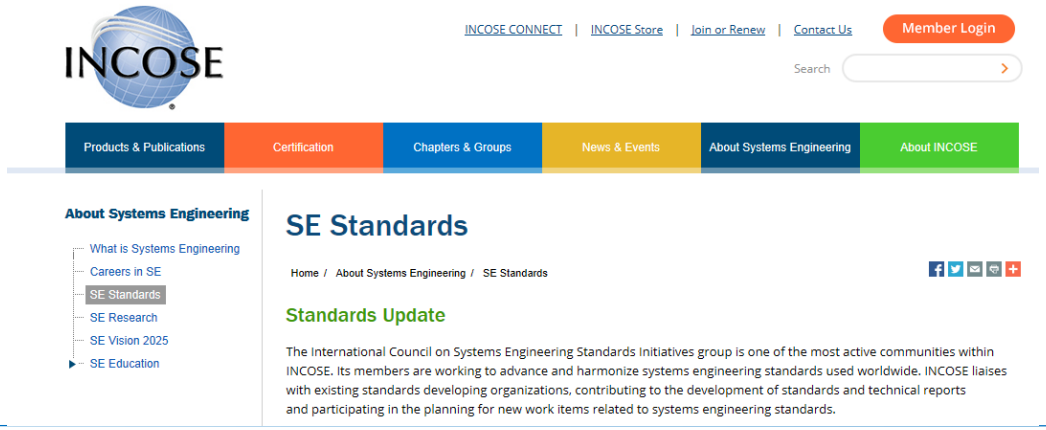
- **Initial discussion at PDES Inc.**
  - **PDES Sytems Engineering team**
  - **Landscape….needs to show multidimensional data.**
  - **Implementation techniques …OSLC…REST, Linked Data**
  - **Product Life Cycle**
  - **SysML, AADL, MoSSEC, AP233, ReqIF, FMI, Modelica……etc**
  - **Standards bodies…PDES..INCOSE, OASIS, ProSTEP..OMG**
  - **How choosing one path…restricts/ opens up other options**

- **Consultancy with Industry Subject Matter Experts**
  - **Sandy Friedenthal- "Father of SysML"**
  - **Axel Reichwein - Koneksys**
  - **Nigel Shaw – Eurostep**
  - **Garry Roedler- Lockheed Martin Fellow, INCOSE Fellow and Founder Recipient;**

Dimension - Evolution over time



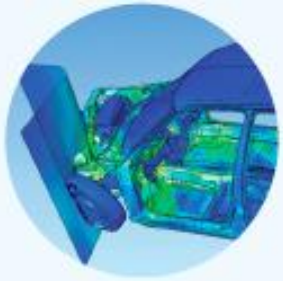
A Review of Systems Engineering Standards and Processes (2008)
by Guey-shin Chang , Horng-linn Perng , Jer-nan Juang



Dimension: The Use Case

MODELING, SIMULATION, AND VISUALIZATION

PRODUCT-FAMILY AND COMPOSABLE DESIGN

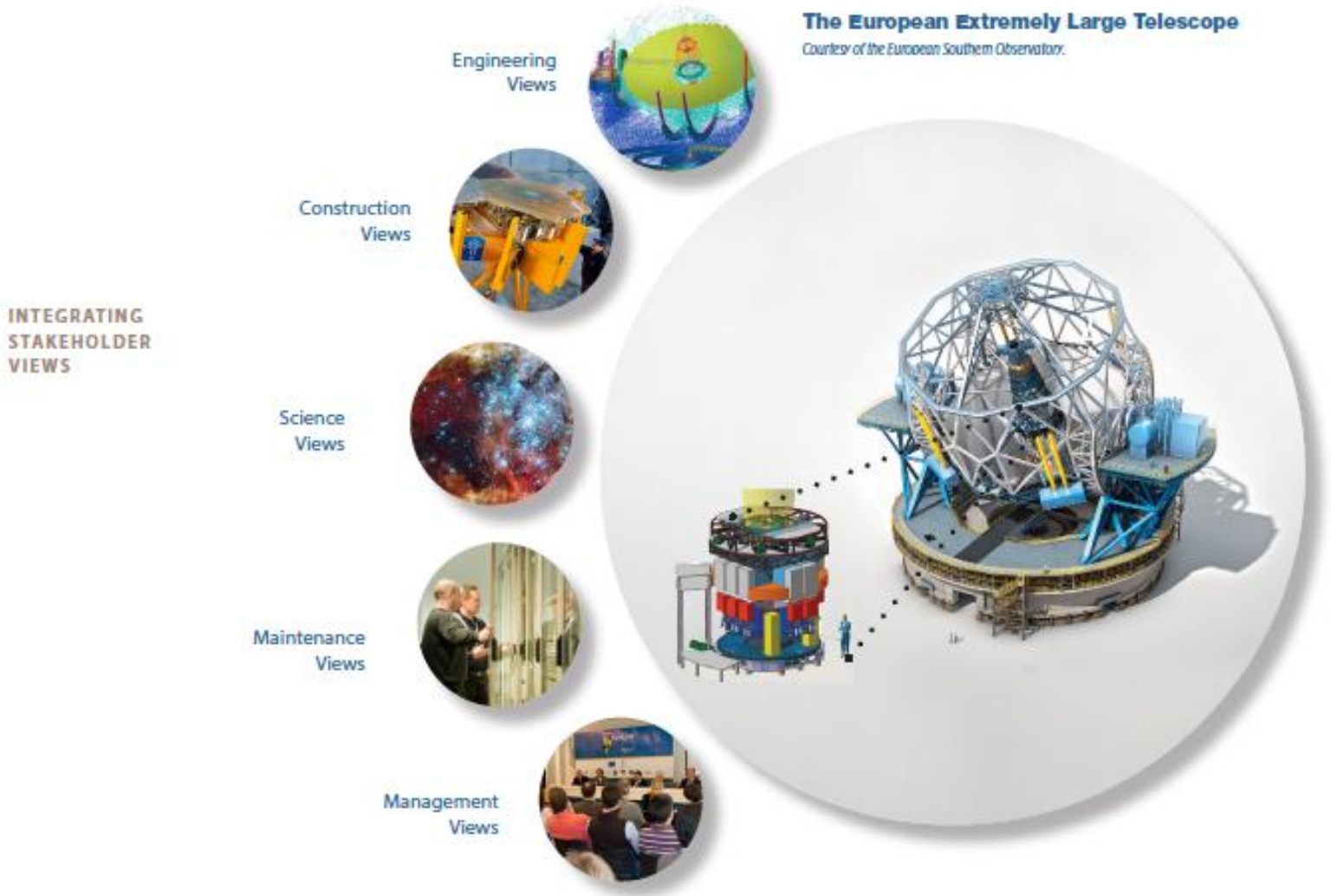


DESIGN TRACEABILITY BY MODEL-BASED SYSTEMS ENGINEERING

SYSTEM OF SYSTEMS ENGINEERING

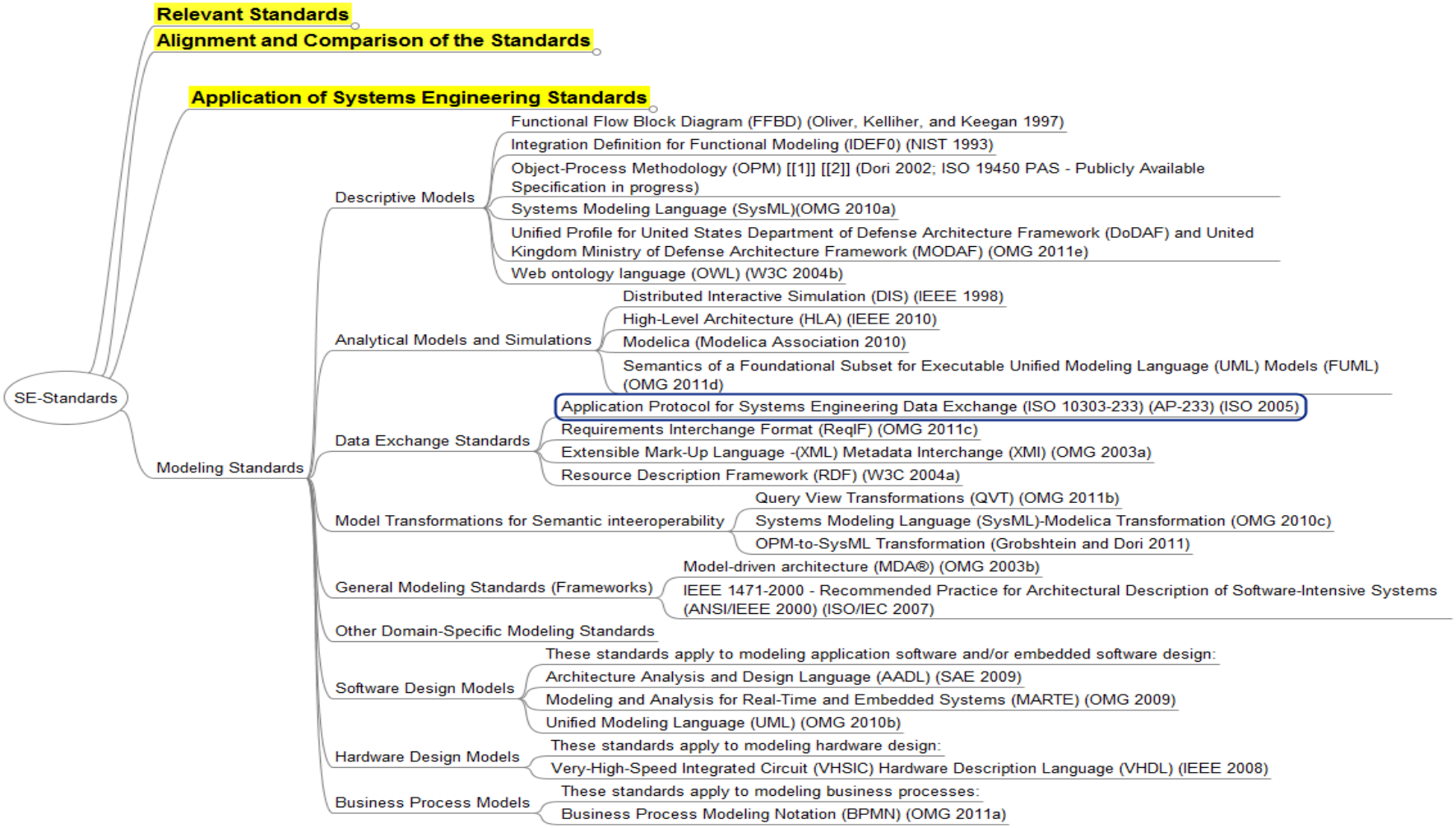
2025- Sys Engg Vision -INCOSE– S.Friedenthal et al..

Dimension: The Stakeholder view

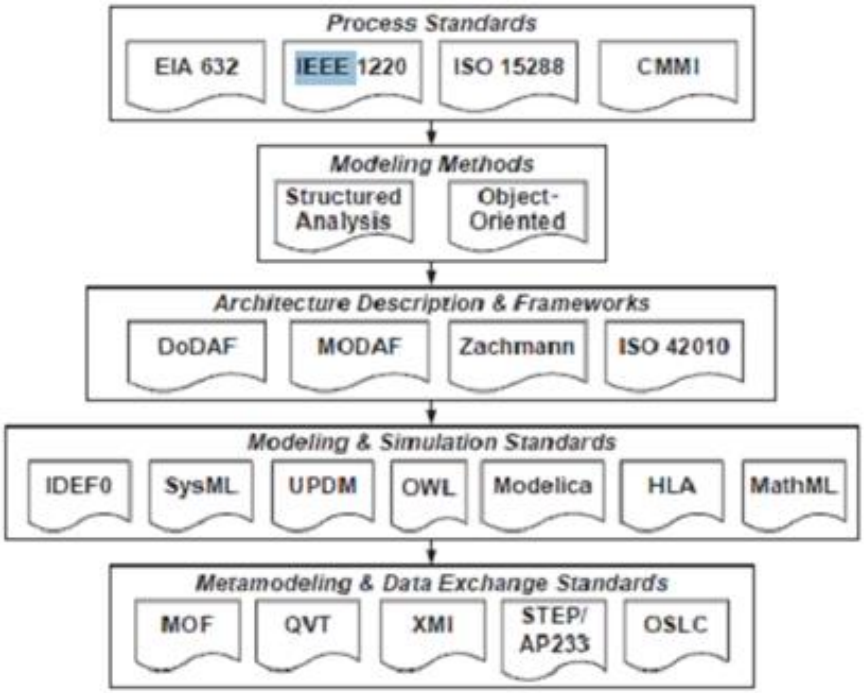


2025- Sys Engg Vision -INCOSE–S.Friedenthal et al..

Dimension : The SE Bok



Dimension : Layered Standards



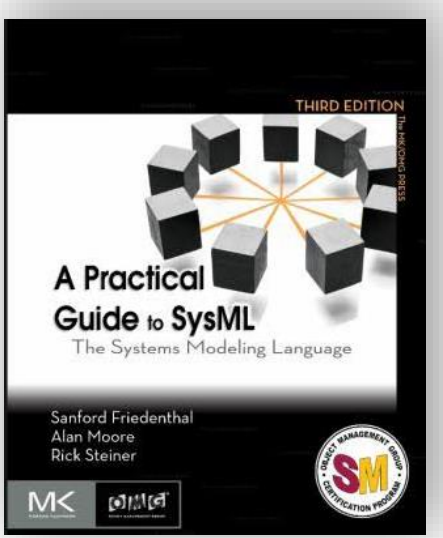
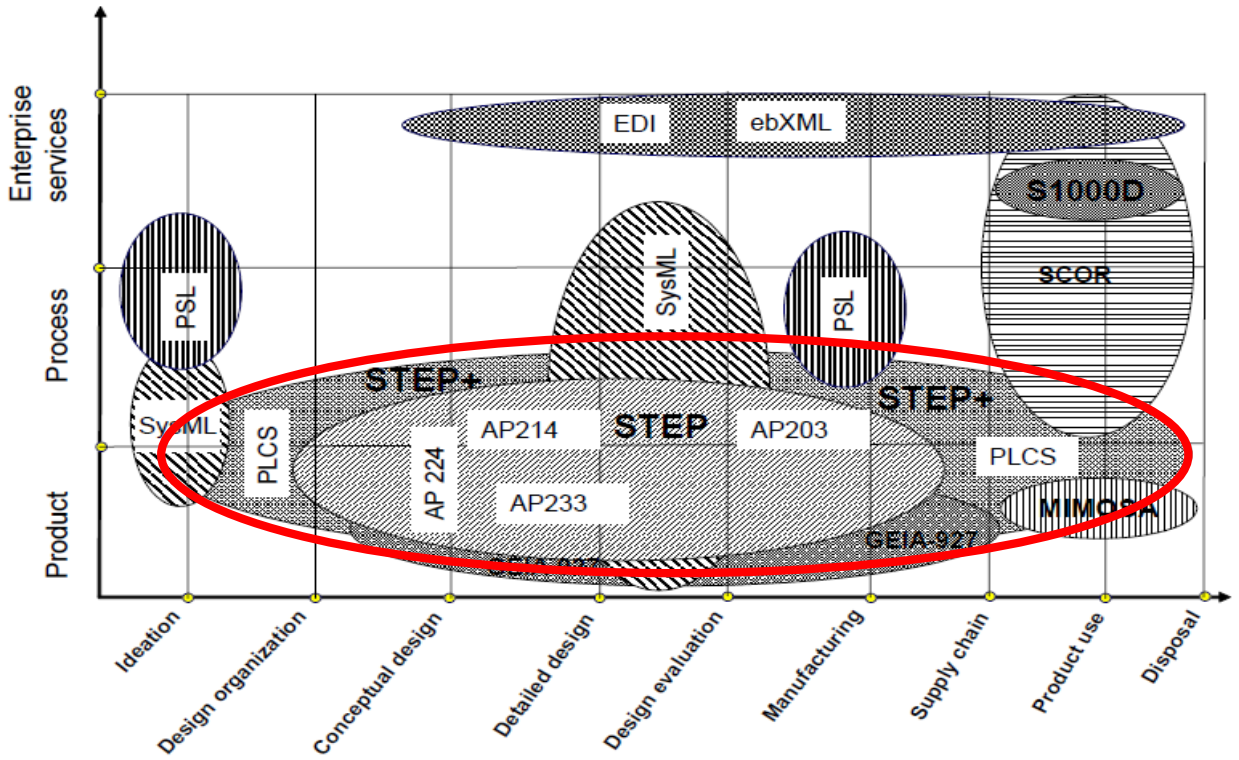


Figure 1.9 – from Sandy's Book

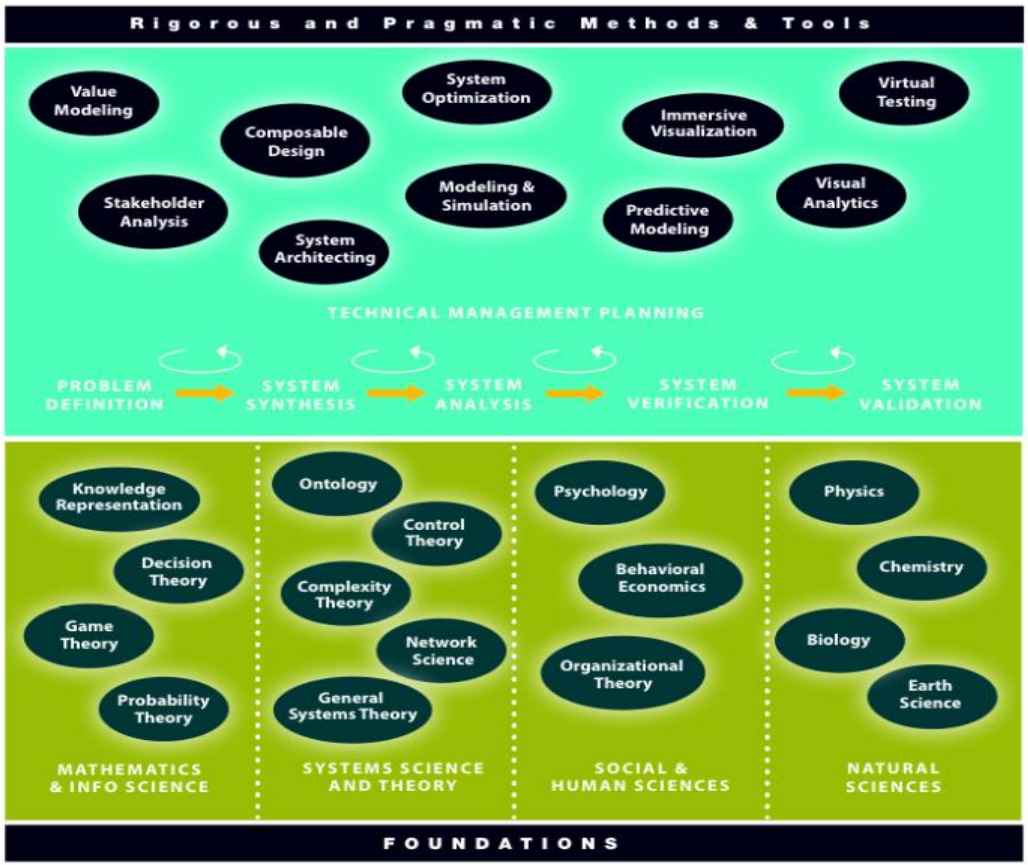
Dimension : Standards influencing each other



SOURCE: Analysis of PLM Standards for US Army- NIST

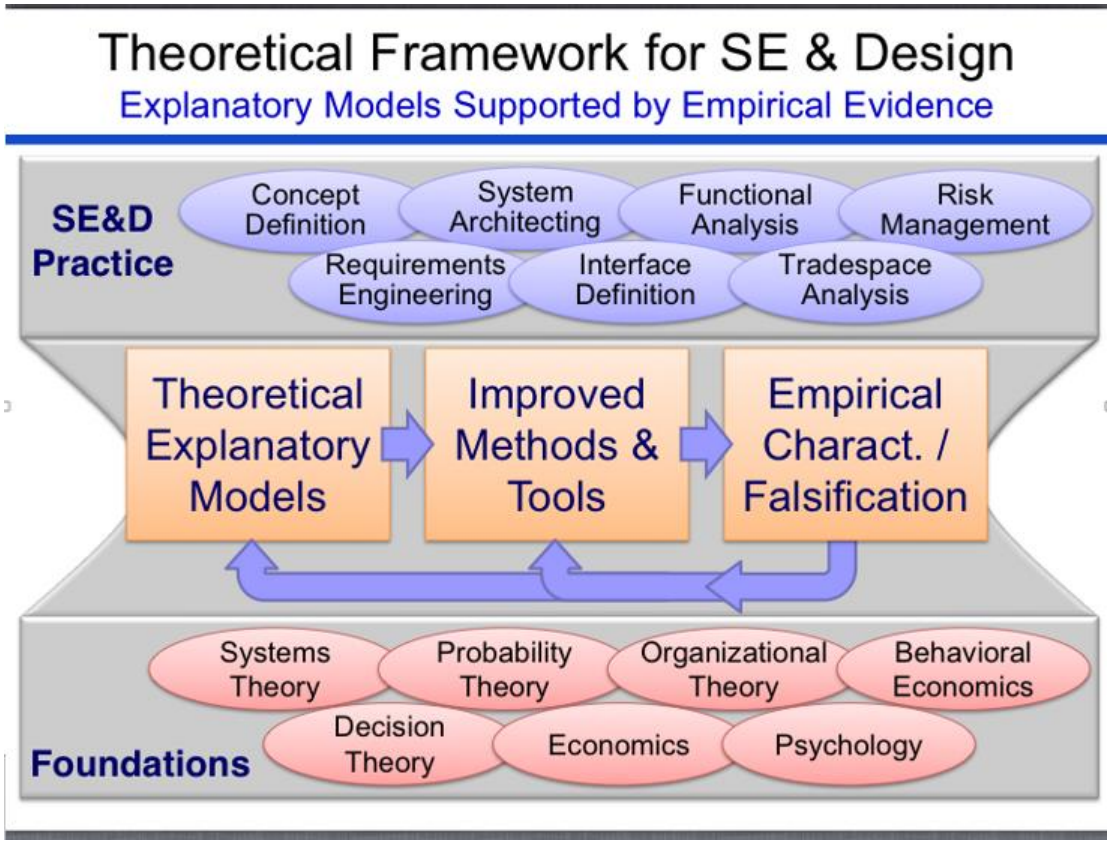
Dimension : Theoretical foundations of Systems Engineering
The INCOSE Vision

SHORING UP THE THEORETICAL FOUNDATION OF SYSTEMS ENGINEERING



2025- Sys Engg Vision-INCOSE –S.Friedenthal et al..

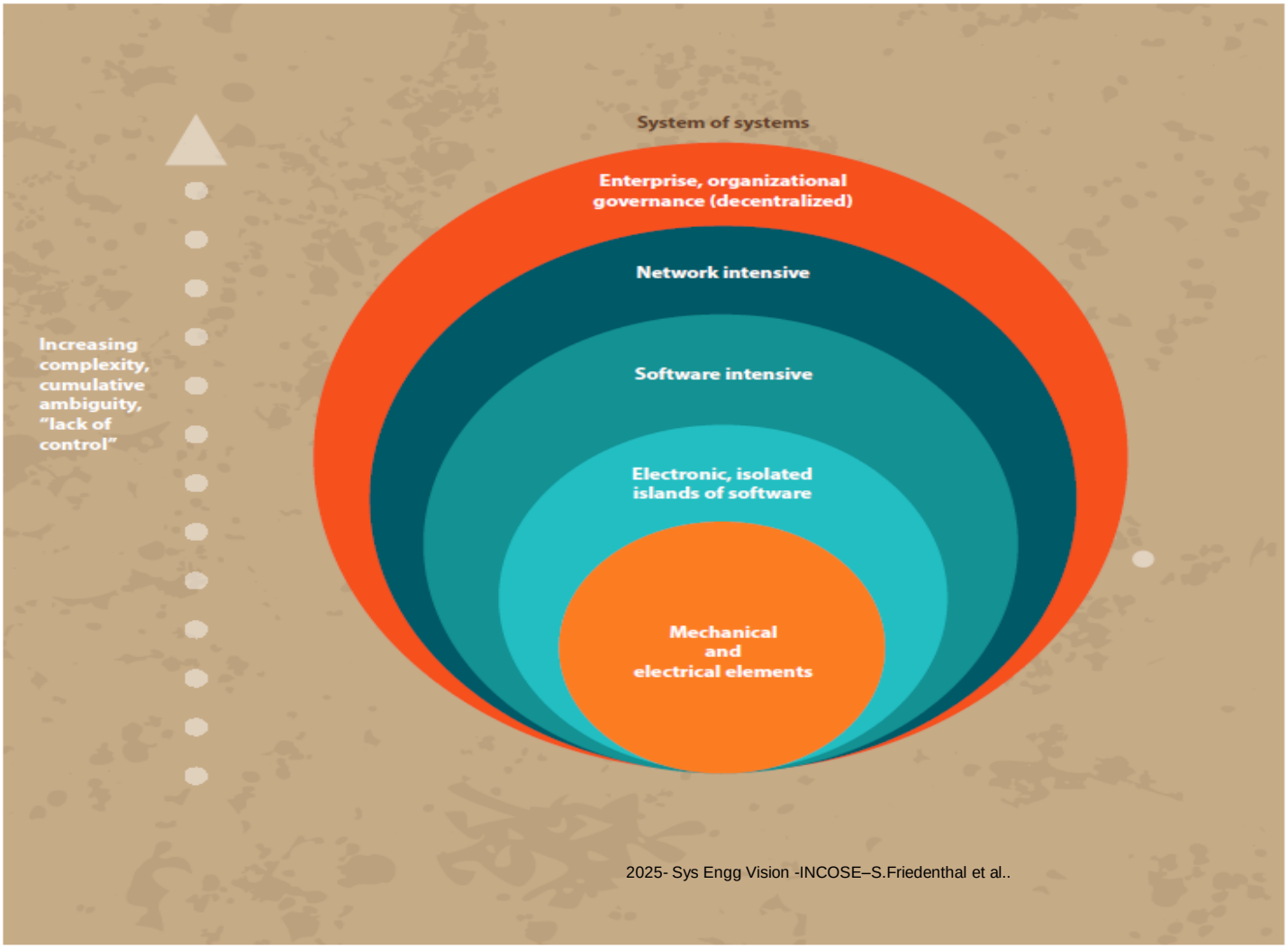
Dimension : Theoretical foundations of Systems Engineering
National Science Foundation –Systems Science



NSF – Theoretical Framework for SysEng – Paredis

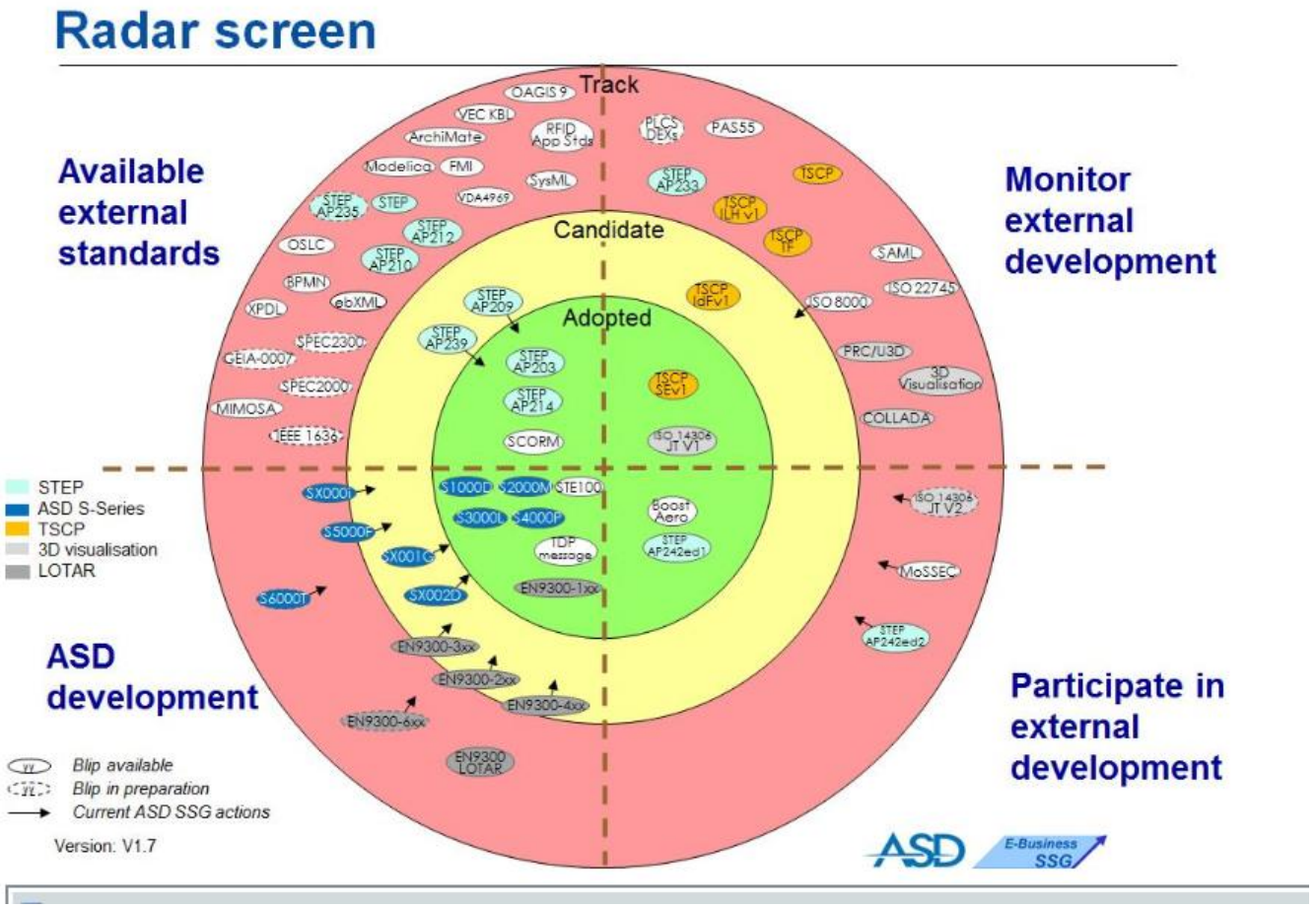
Dimension : Complexity…and its roots

THE ROOTS FOR GROWING LEVELS OF SYSTEMS COMPLEXITY

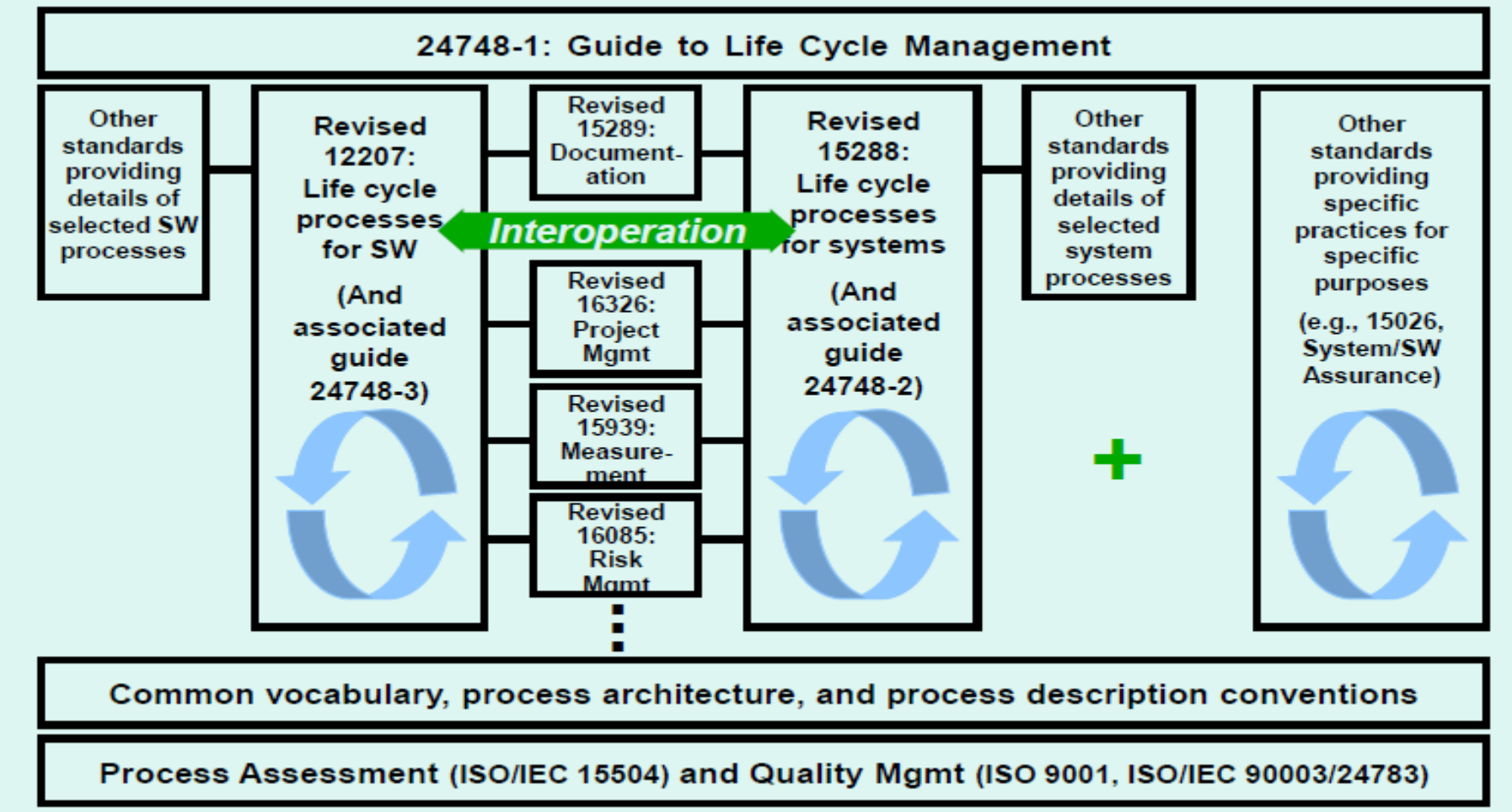


2025- Sys Engg Vision -INCOSE–S.Friedenthal et al..

Dimension : Consortia / Business priorities and drivers

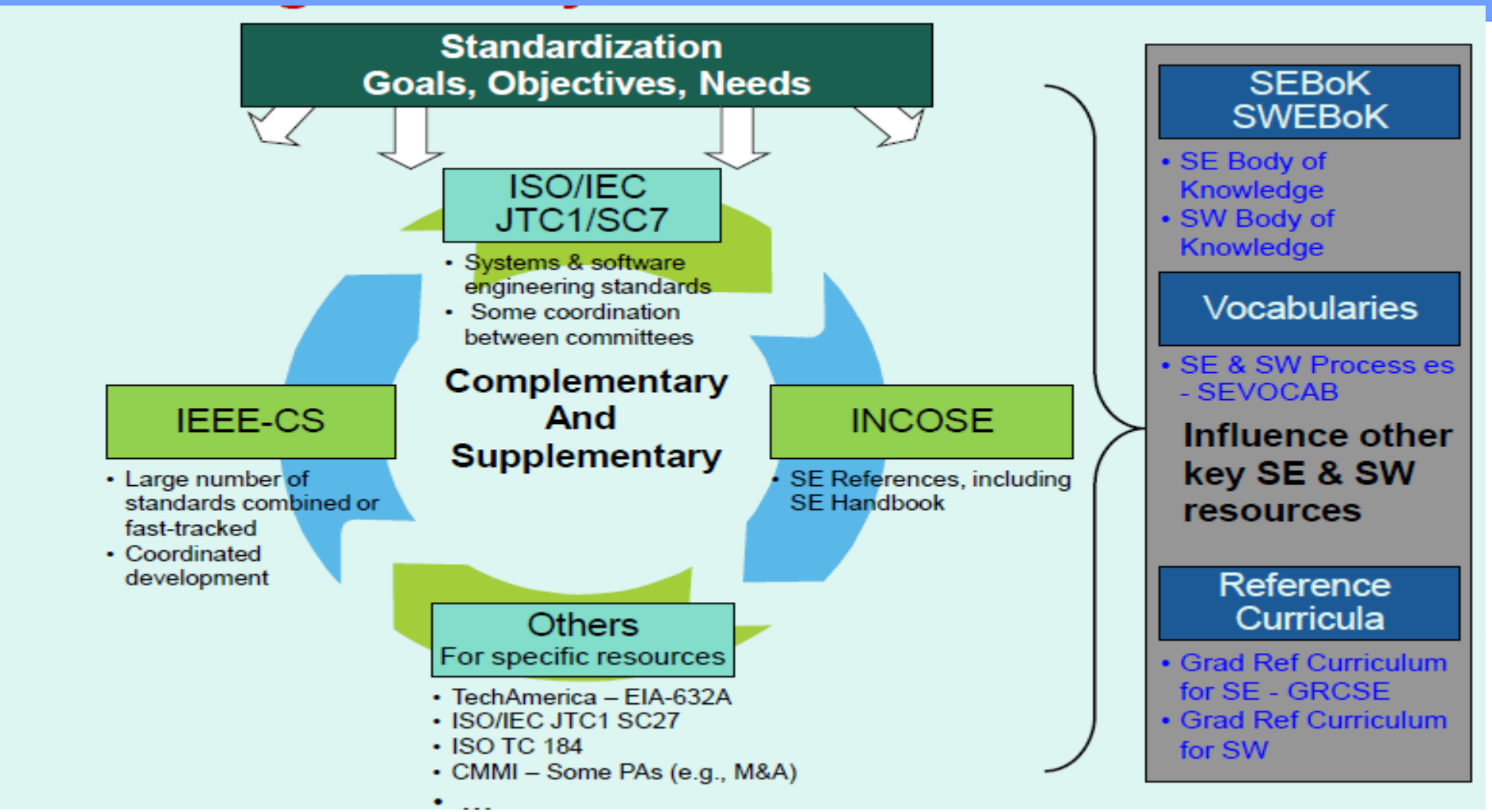


Intended Relationships of Key System & Software Engineering Process Standards After Alignment



Used with permission from Garry Roedler, *LM Fellow / Engineering Outreach Program Manager INCOSE Fellow and Founder Recipient; IEEE Golden Core*

Growing collaboration



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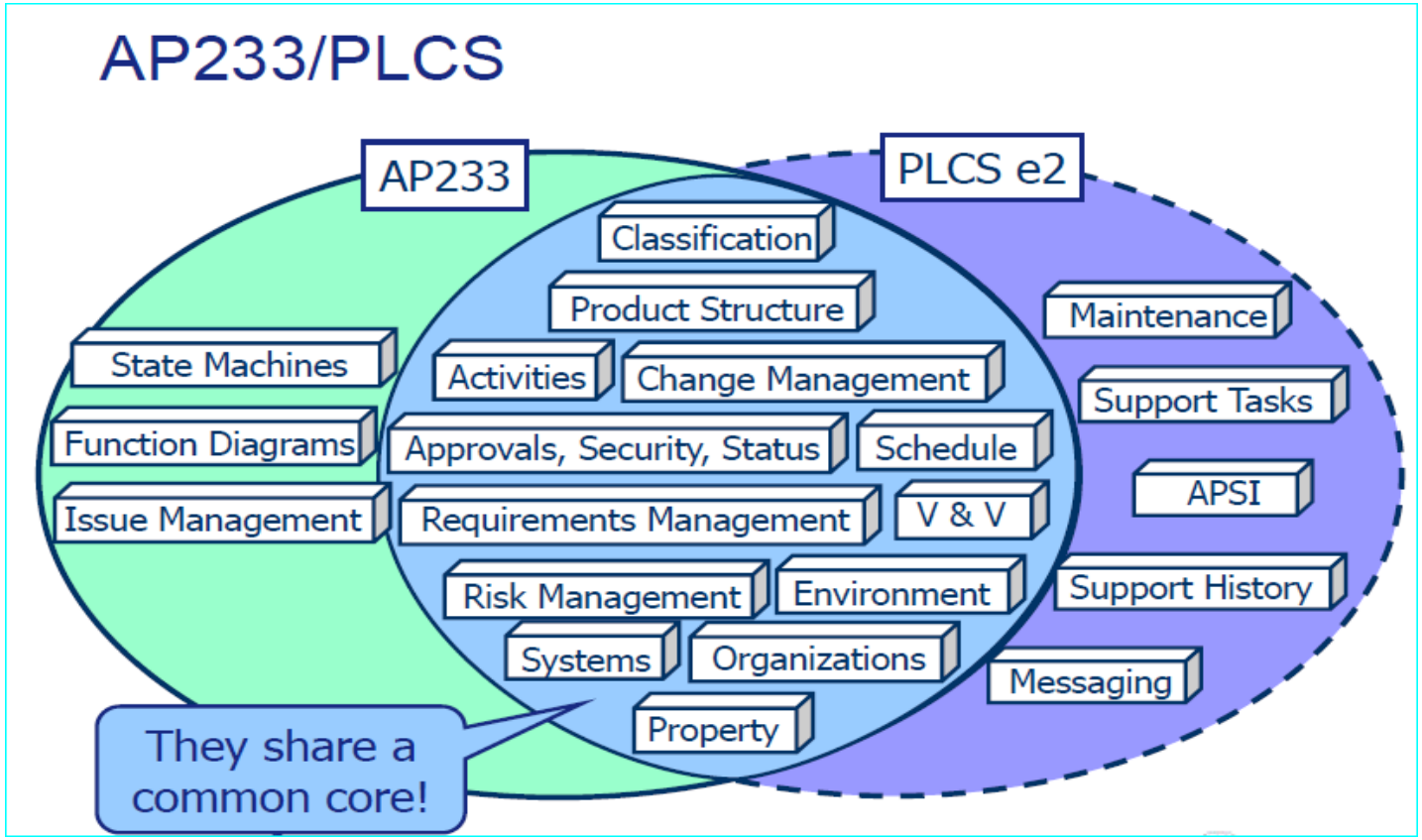
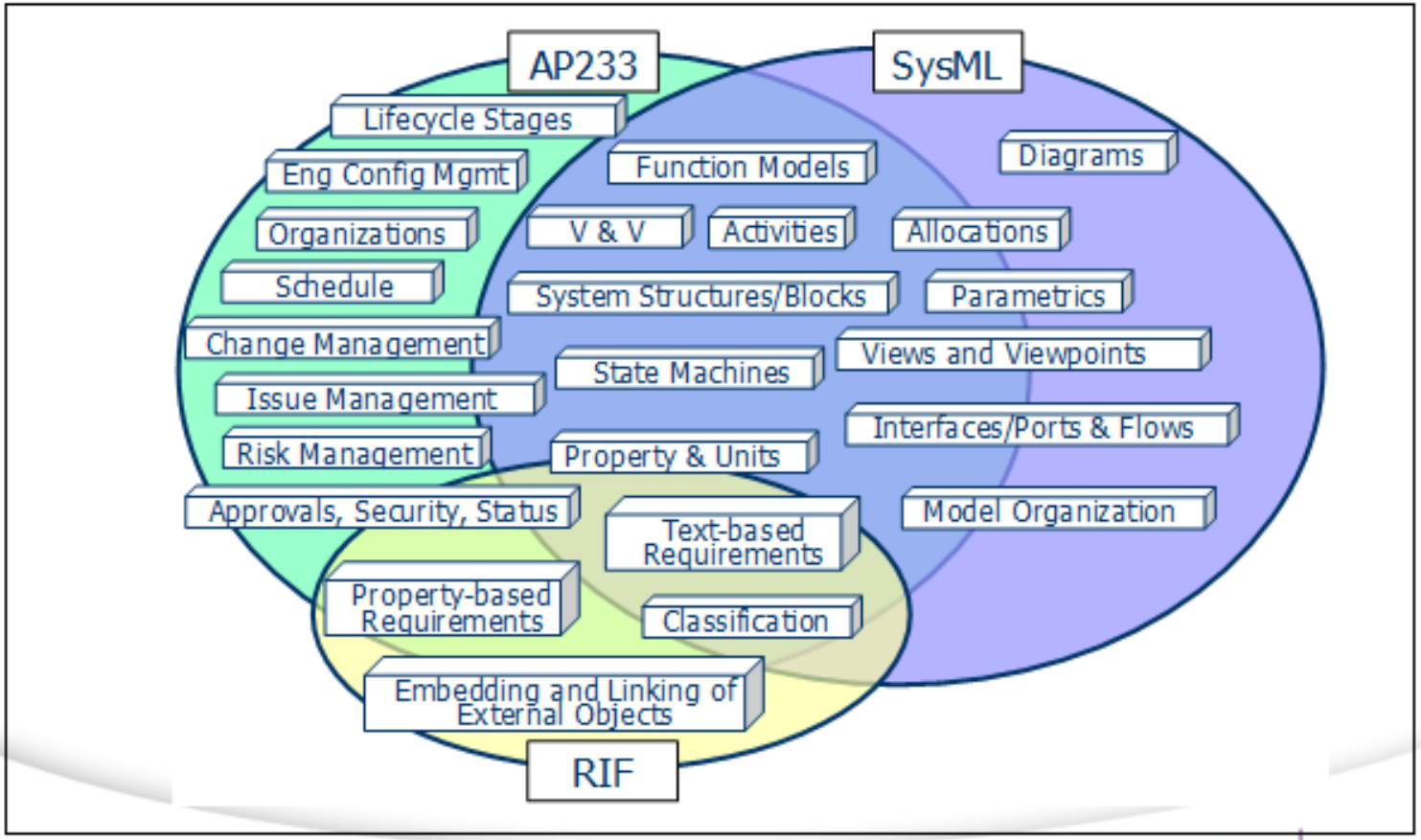
Dimension : Churn in STEP

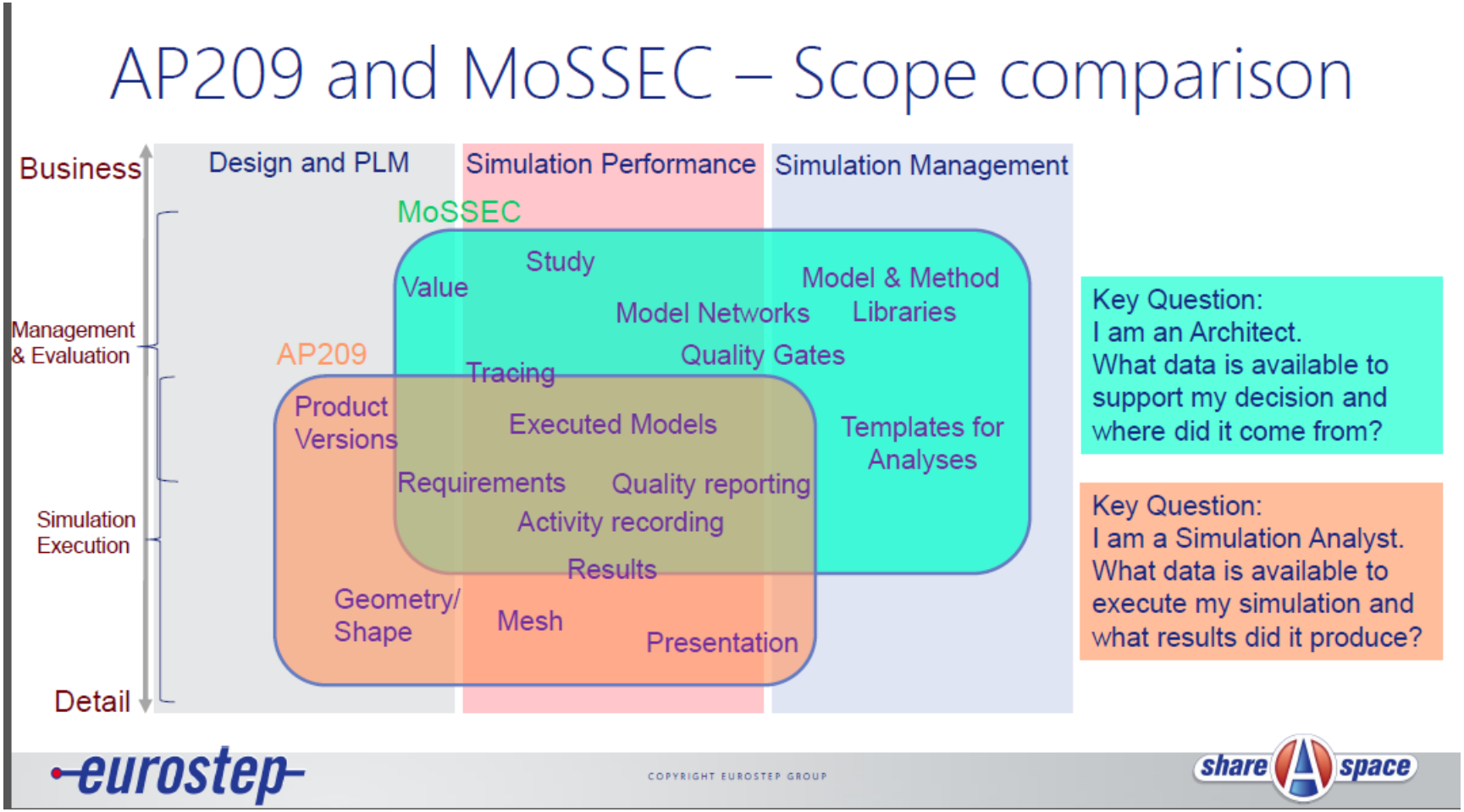


Dimension : Churn in STEP….Requirements domain

Relationship of RIF to OMG Standards (Concepts)

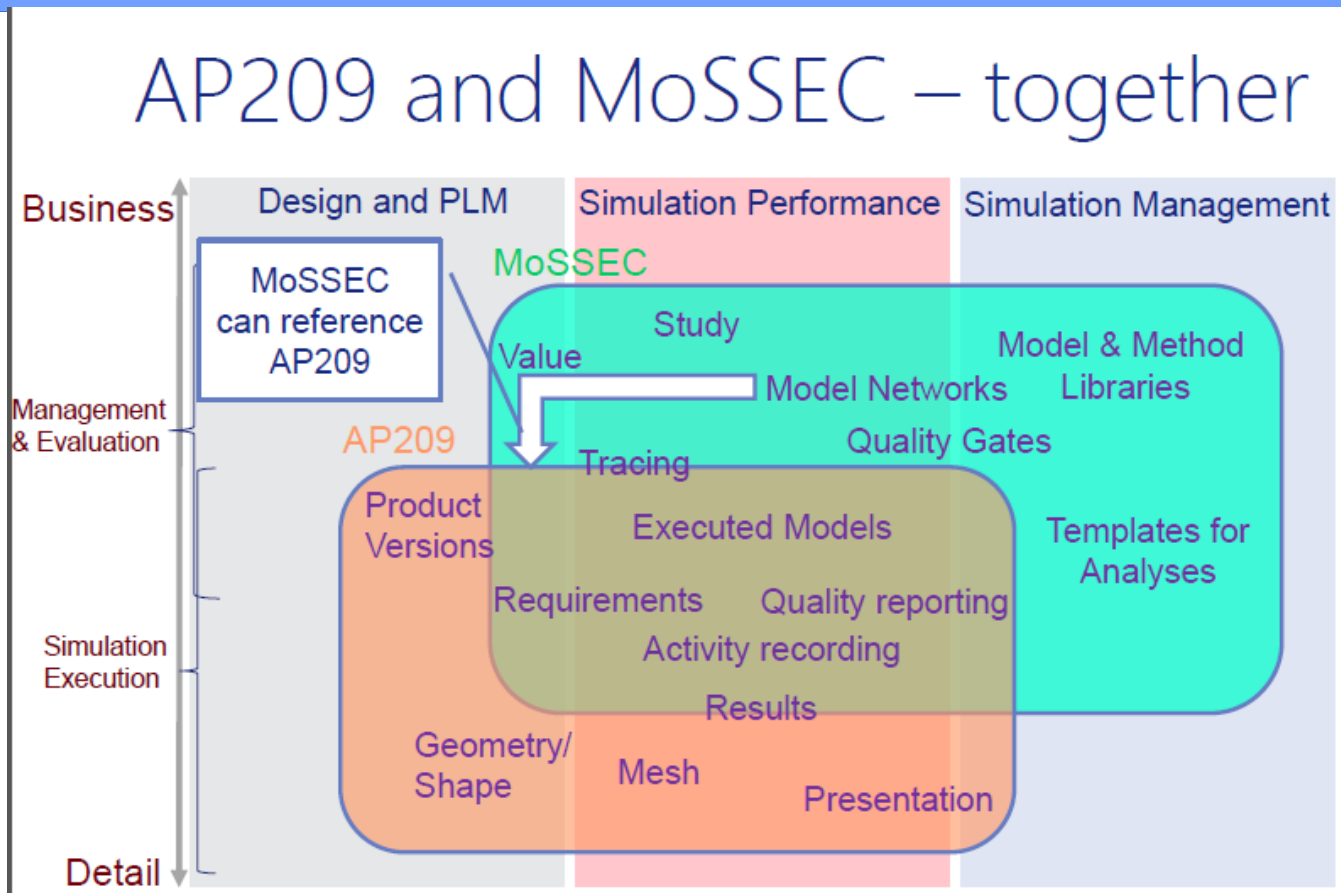


STEP AP209 & MoSSEC



Used with permission from Nigel Shaw, Director EuroSTEP

STEP AP209 & MoSSEC



MoSSEC is analysis type agnostic and only records meta data about Models

The detail can be described using AP209 (and/or other formats including system specific formats)

Used with permission from Nigel Shaw, Director EuroSTEP

AP209 & MoSSEC

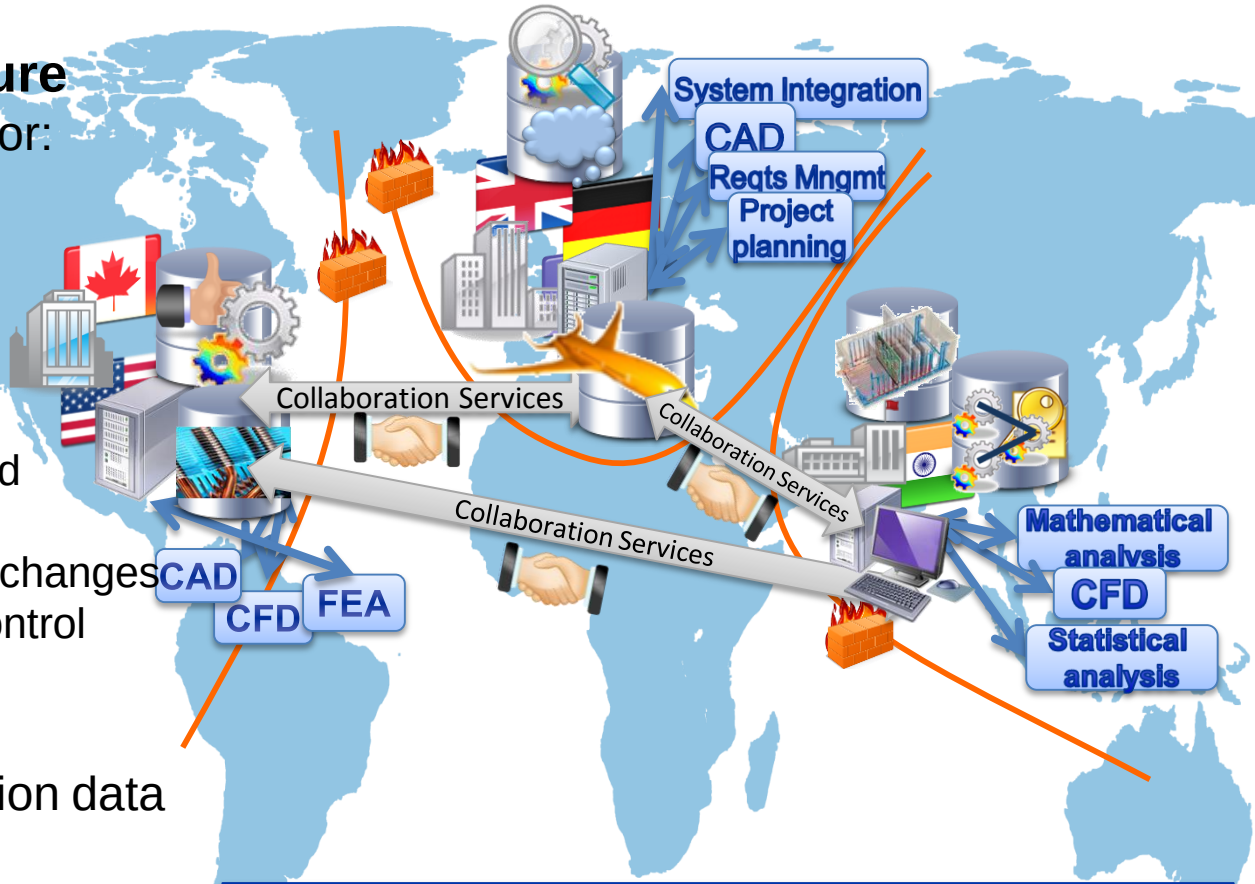
The "Why" and the "What"

- AP209 has no concept of why the analysis is being performed or even if it needs to be performed or not.
  - AP209 has all the details for What analysis is/was to be performed
- MoSSEC deals with recording everything is that has been or will be done and where the data used came from
  - MoSSEC has little of the details for What analysis is/was to be performed except by reference to associated documents
    - Which can be AP209 datasets

Used with permission from Nigel Shaw, Director EuroSTEP

Challenges for distributed systems engineering : MoSSEC

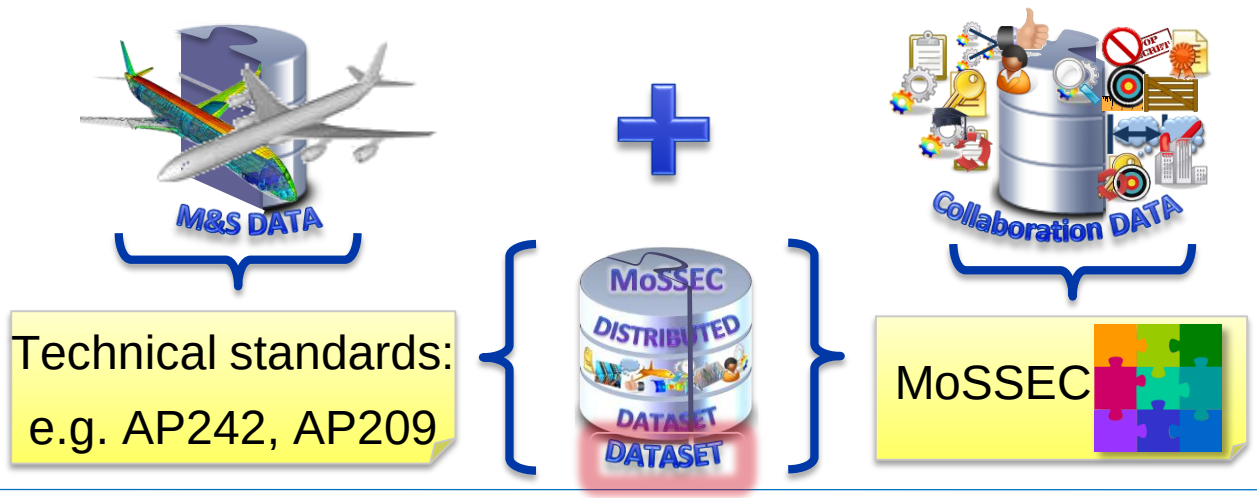
- **Distributed Infrastructure**
  - Secure Collaboration for:
    - Locations
    - Organisations
    - Software Platforms
- **Distributed Processes**
  - Multitude of Modelling and Simulation tools
  - Simulation driven design changes traced and under PLM control
- **Distributed Data**
  - Modelling and Simulation data
  - V-cycle meta-data
    - (who what when where how why etc)
  - Efficient sharing, synchronisation and integration



Remain Compliant with existing Standards (e.g. AP233, AP239, AP242)

Collaboration vs Modelling & Simulation Data

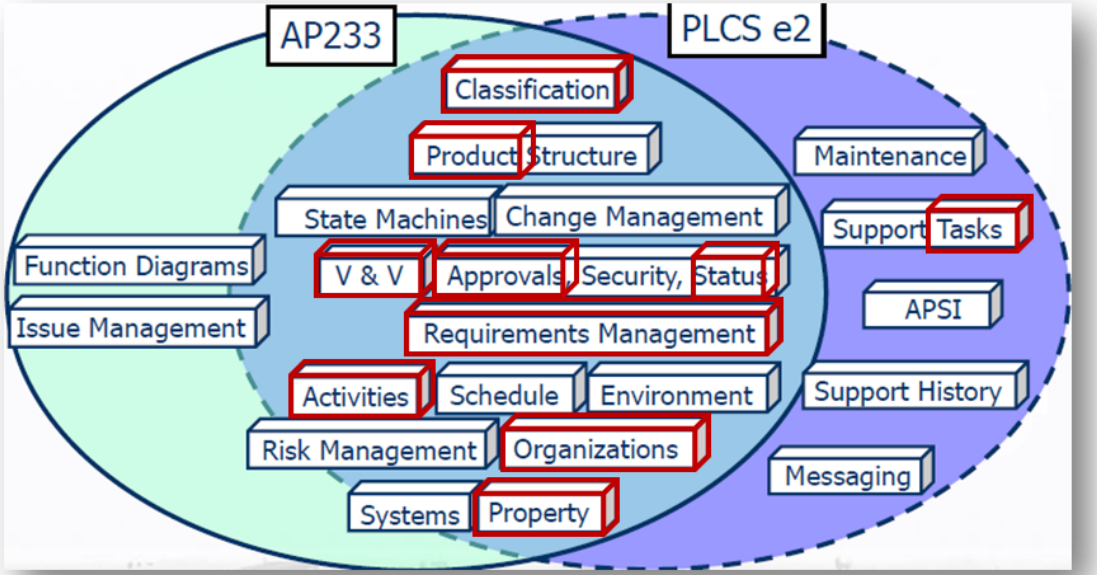
- **Modelling and Simulation data**
  - **Managed in the PLM/M&S systems**
  - **Exchanged with technical standards**
- **Collaborative SE context data**
  - **Managed by MoSSEC Compliant Tools**
  - **Exchanged with MoSSEC services**
- **Together they enable the distributed dataset**



MoSSEC & AP233, and PLCS

AP239 templates used

- What templates used in plcs_psm mapping are for planned v1 of MoSSEC



Evolution of “interoperability” in the Product Data space (STEP context)

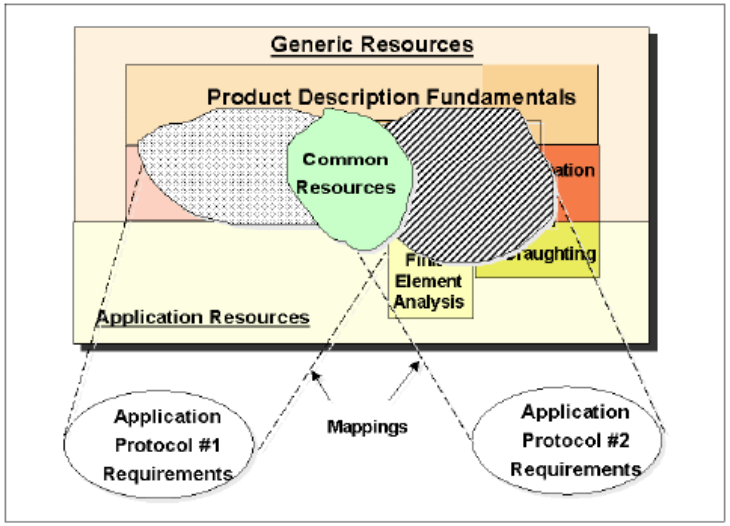


Figure 4-8: Mapping AP #1 requirements to AP #2 requirements

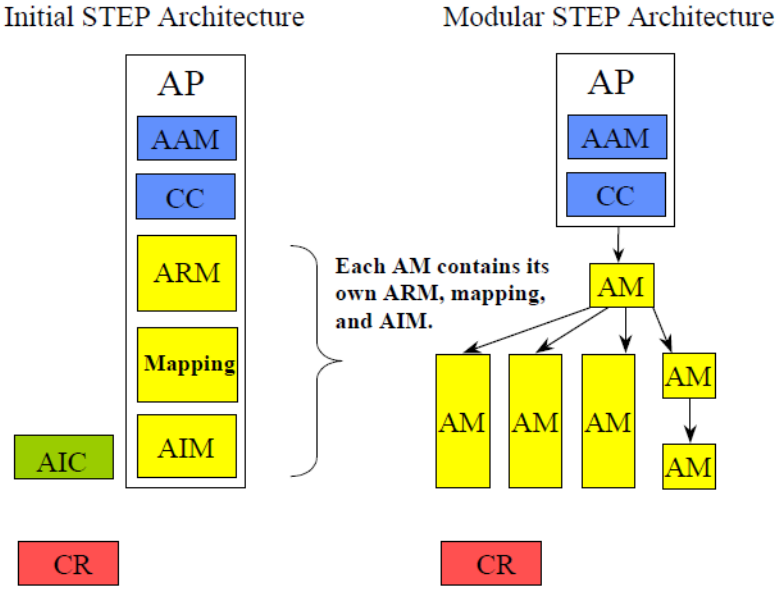
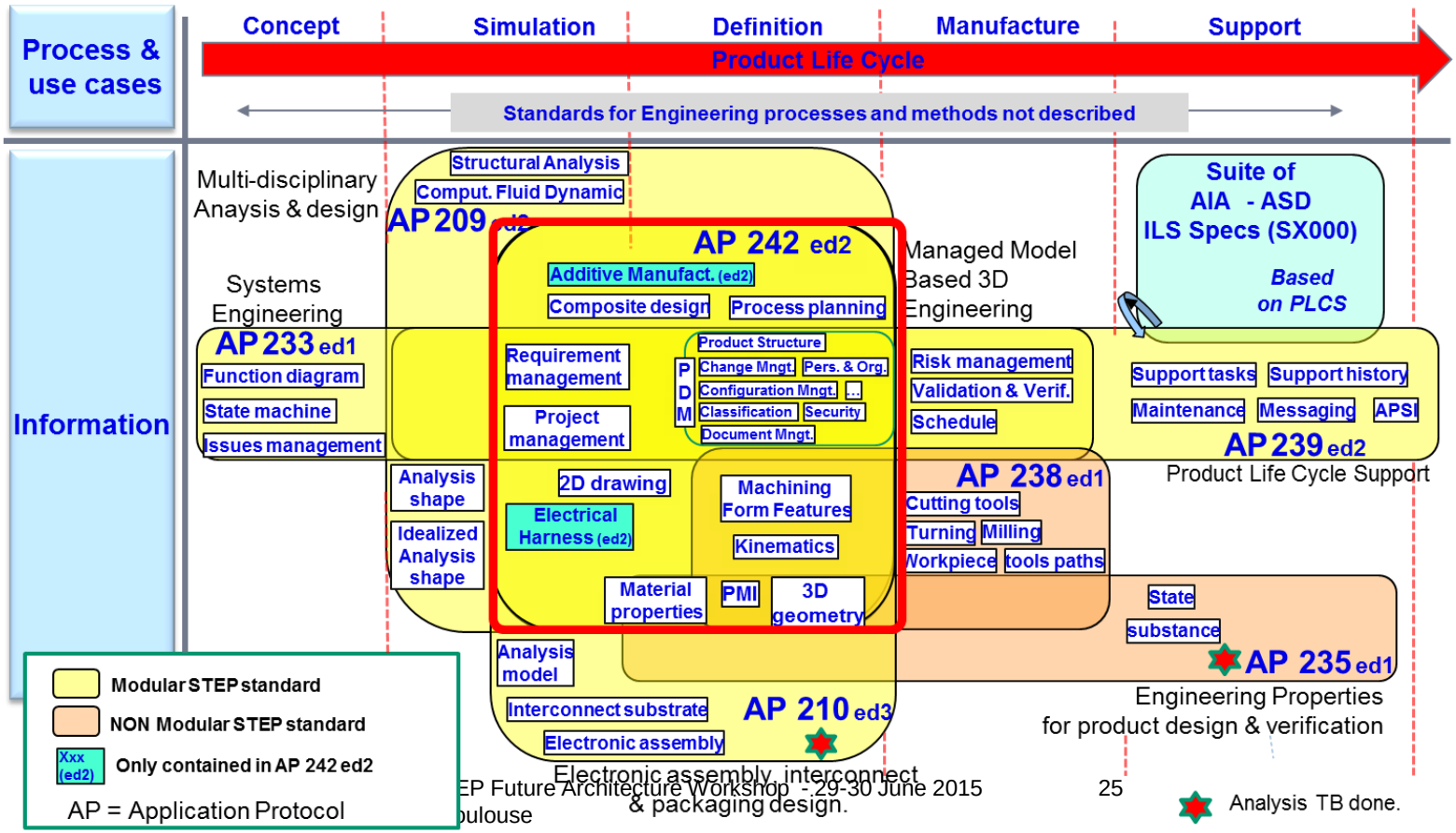


Fig. 2 Modular Architecture vs. Initial STEP Architecture

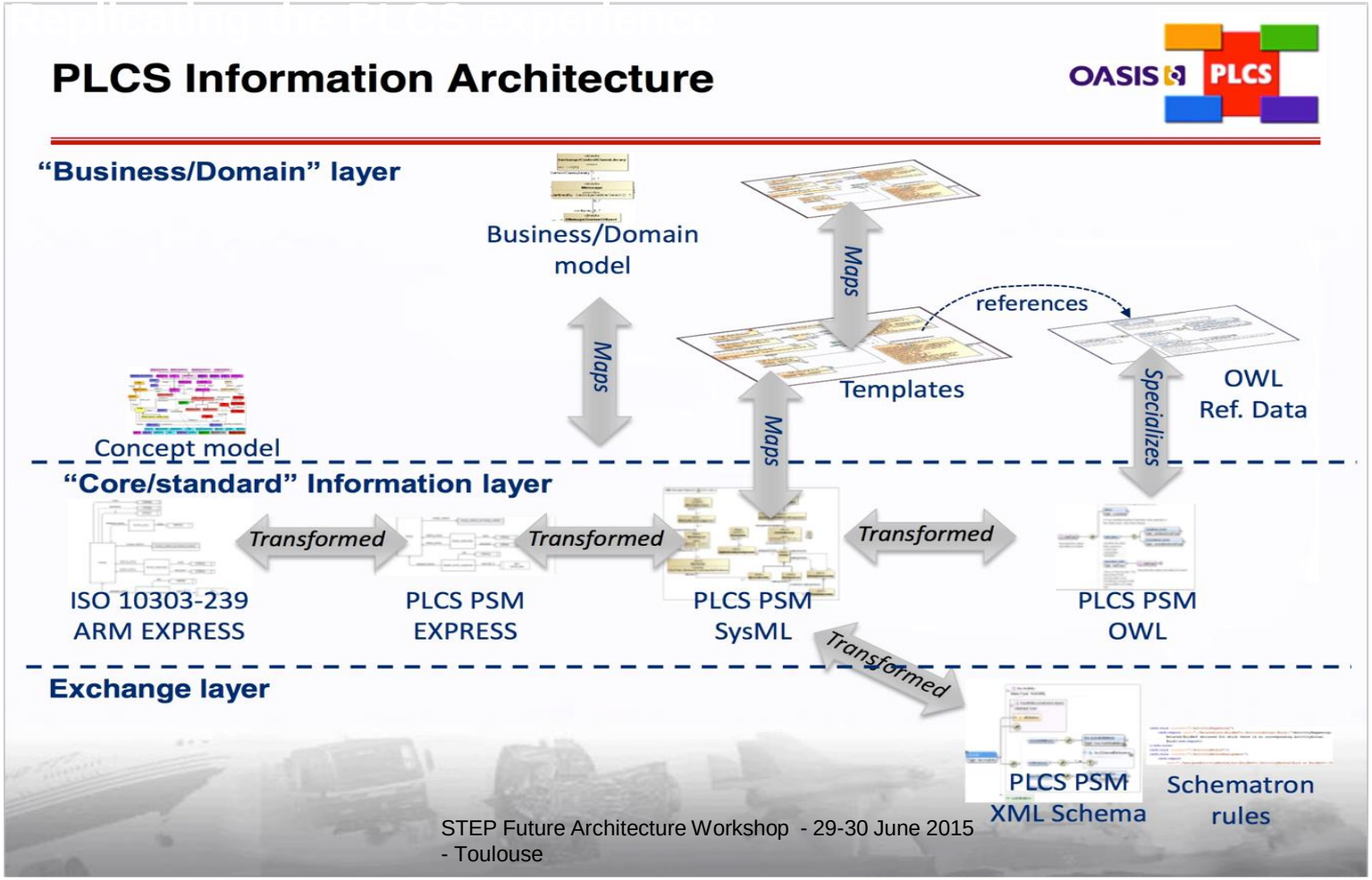
The primary driver for interoperability in the STEP world was aimed at building new APs faster.

STEP on the Lifecycle

DRAFT (May 2015)

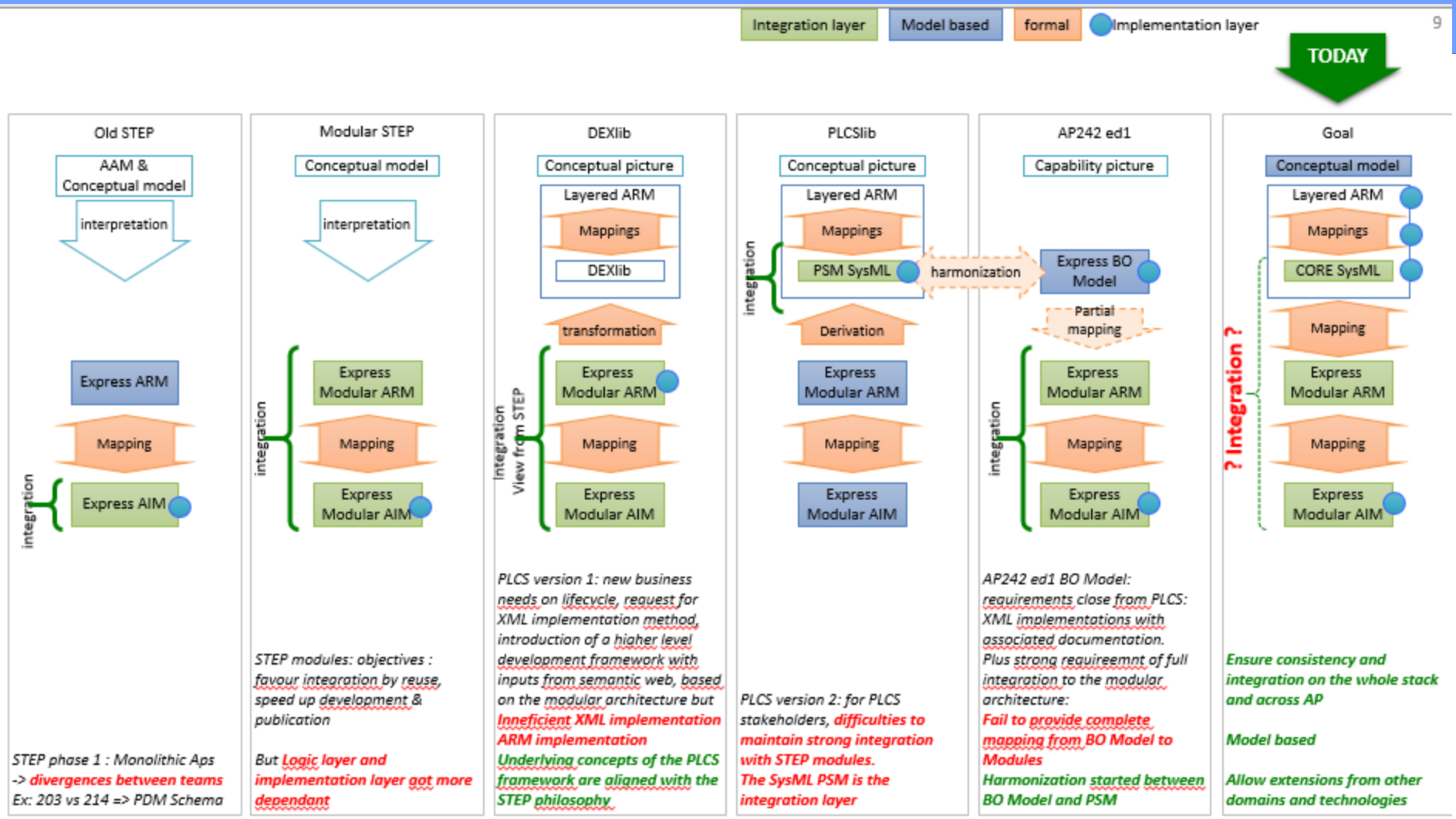


Multi-layered information models..based on Standards –



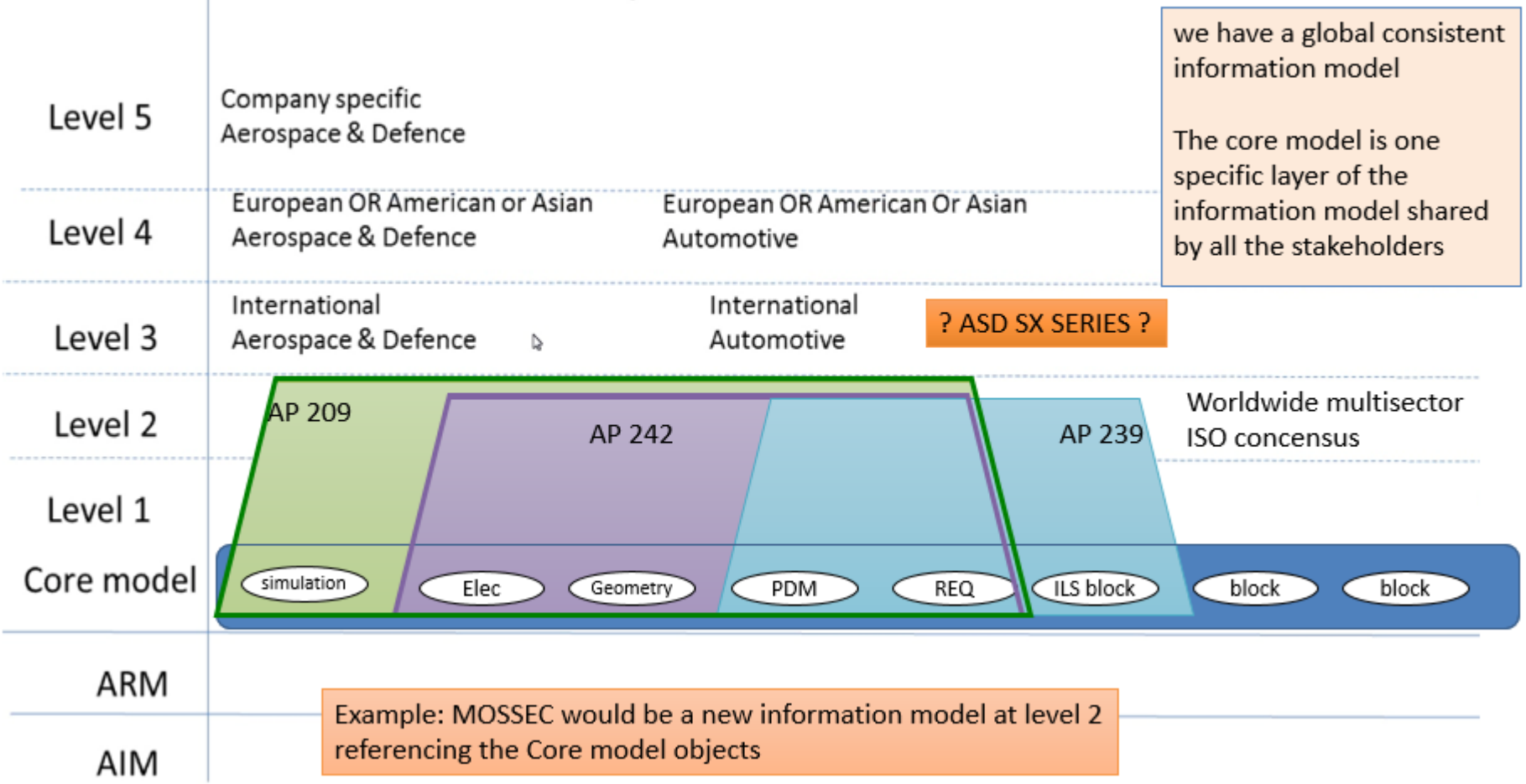
STEP Future Architecture Workshop - 29-30 June 2015 - Toulouse

FutureSTEP..recent developments



FutureSTEP..recent developments

Multi Information Model layer and associate stakeholders

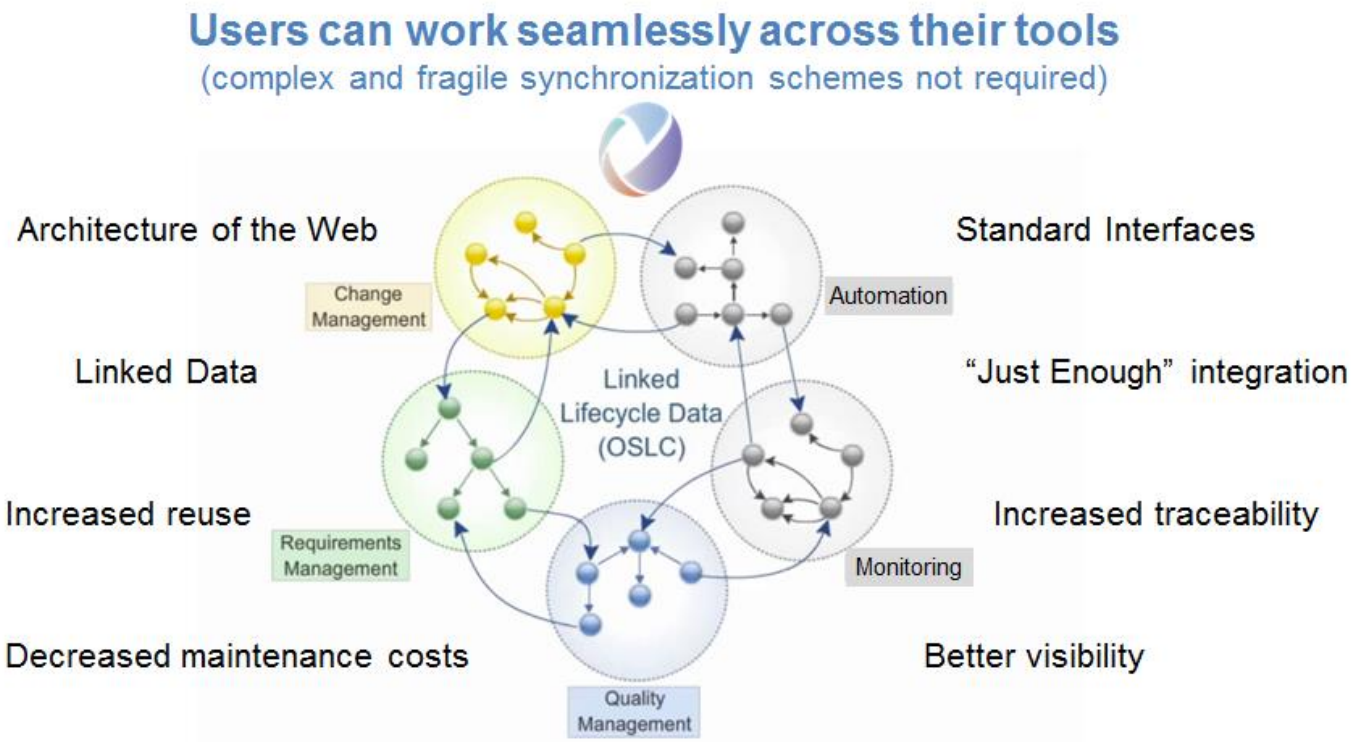


Dimensions- what does a Pragmatic user need?

- Scope of standards
- Ease of adoption by vendors + users + developers
  - Vendors attends standards mtgs…
- Existing tool support
- Existing adoption
- Alignment with technical trends – Linked data. Is the std compatible with linked data, communication protocol
- Documentation quality, accessible, examples to get started
- Stds :
  - Std ways to access info: AP233, SysML, AADL, FMI, Modelica, Simulink,
  - Std protocol: OSLC is domain independent..
- Quantify the complexity…the number of relationships
- Assess the impact..is it in a domain used by 90% of engineers.
- W3C: Dublin Core, RDFontologies,

Courtesy : Axel Reichwein - Koneksys

OSLC



OSLC is an open and scalable approach to lifecycle integration. It simplifies key integration scenarios across heterogeneous tools

http://www.w3.org/DesignIssues/LinkedData.html

OSLC & STEP… possible patterns of interaction

What co-existence may mean…

- Mapping conceptual notions of APs – ARM (Application Reference Module) ,AM (Application Module) to linked data
- OSLC resource structure, maps to STEP notions of modularity?
- How does OSLC influence Future STEP architecture?
- Can OSLC domain linking features be used to test STEP AP modularity?
- How have others traversed this path..
  - An example from the Library

Preparing for the future: supporting the transition to Linked Data in Libraries

As a research assistant at OCLC, I have had the opportunity to be involved in a variety of industry initiatives to help modernize library infrastructure and prepare them for the eventual coming of Linked Data. Two of these projects help underscore the fundamental changes that the library industry needs to undergo in order to support the adoption of Linked Data. The first is the redevelopment of the MODS data model as an RDF ontology and the second is the conversion of the Getty vocabularies from a traditional controlled string-based thesaurus into a Linked Data dataset that uses URIs as identifiers for people, organizations, places, concepts etc. The two projects each address different but equally important types of changes that will need to occur in order for libraries to create Linked Data and integrate it into their everyday workflows.

…ars, Linked Data has been a buzzword …or library conferences around the world. …en the subject of paper presentations, …nd project reports at conferences such …SIS&T. The themes of these talks …e discussion revolves around the …d Data for libraries and how the … Data will finally help facilitate the …

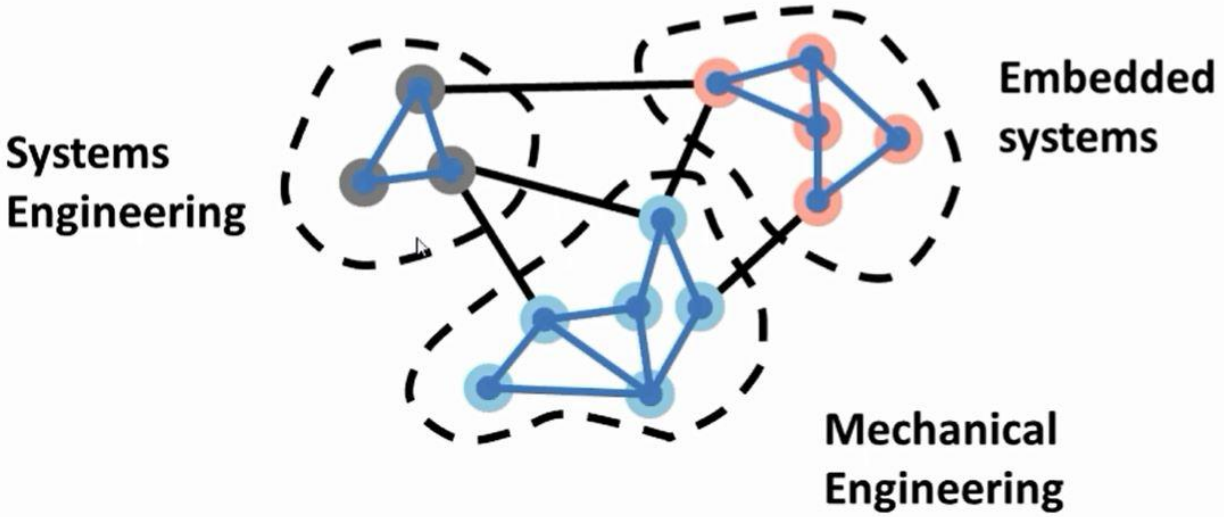
the future soon / k rupp [Flickr]

Source: http://hangingtogether.org/?p=4096

OSLC & SysML experience

Interoperability beyond SysML

- From linked Data user perspective: SysML concepts can be used to define cross-domain relationships

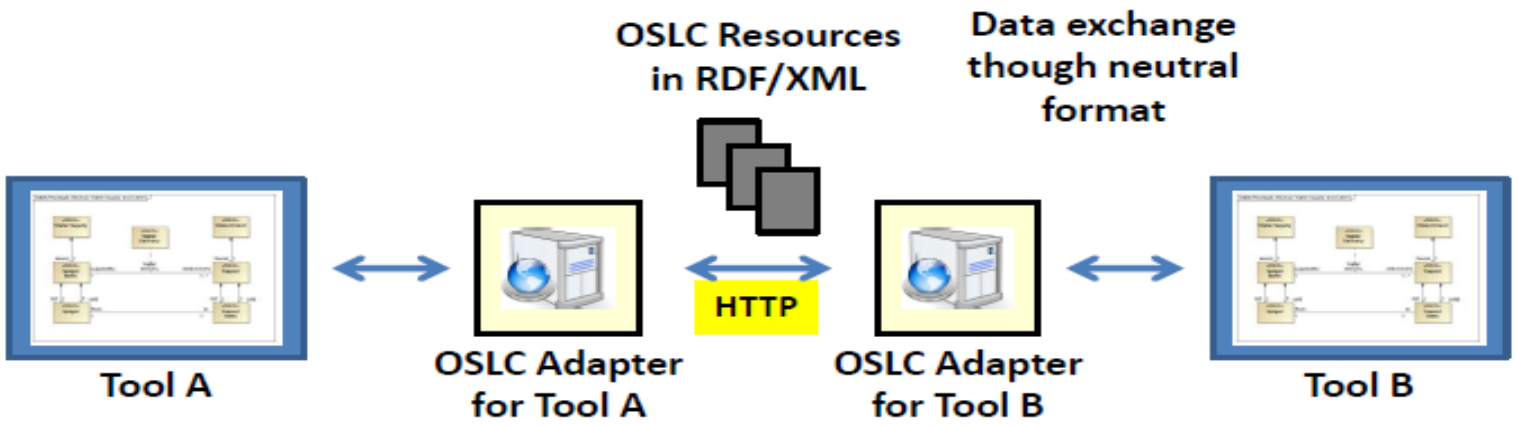


Courtesy : Axel Reichwein, Koneksys

OSLC Tool Interoperability

Tool Interoperability through Standardized RDF Vocabularies

- Interoperability between tools is based on common standards
- OSLC specifications provide RDF vocabularies for specific domains for the purpose of supporting interoperability



Courtesy : Axel Reichwein, Koneksys

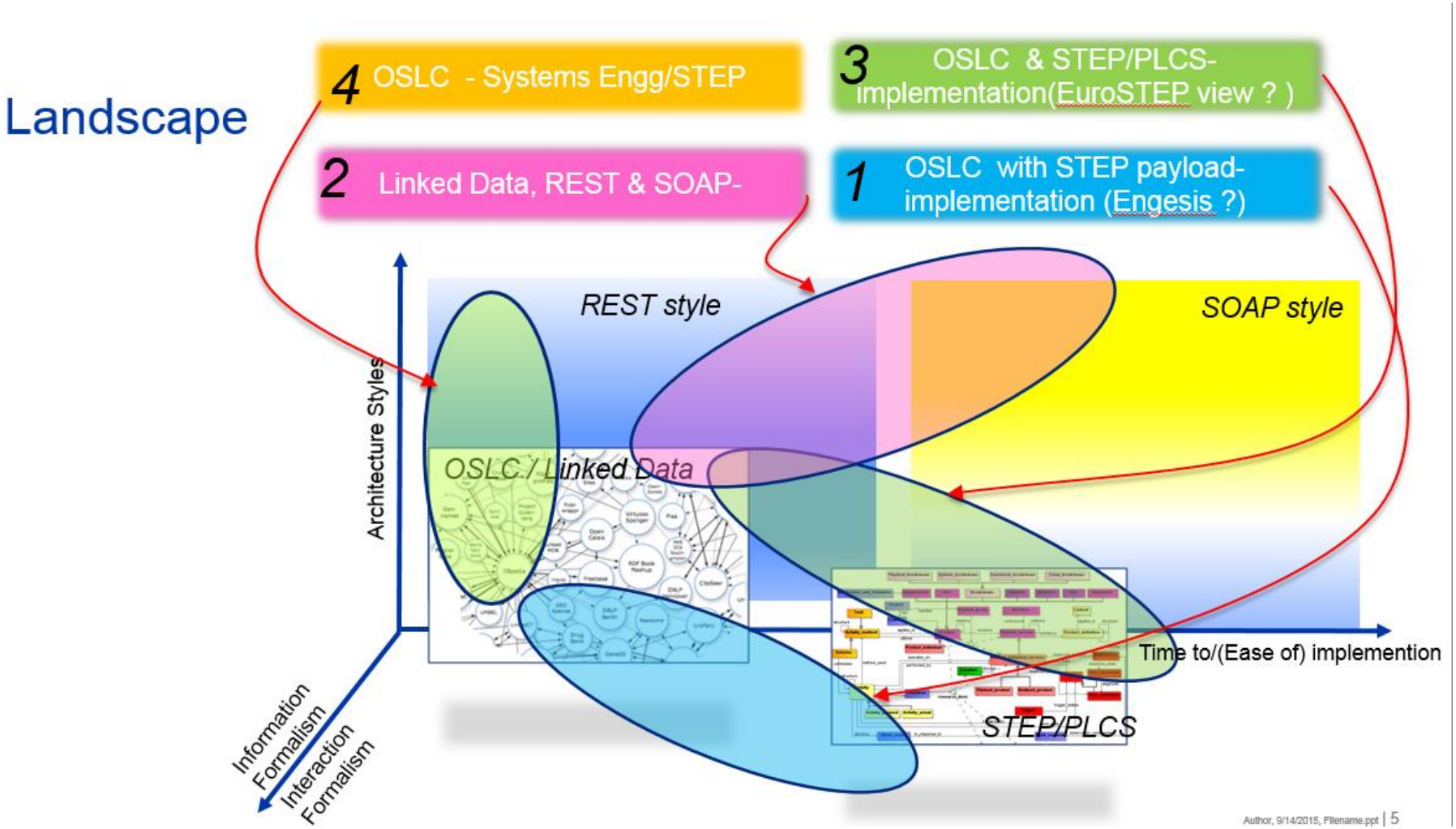
OSLC Resource and Resource Shapes

Additional RDF resources for defining constraints on RDF resources: OSLC Resource Shapes

- **RDFS Vocabulary** cannot define constraints on RDF data
- **OSLC Core vocabulary** includes additional RDFS classes and RDF properties for defining constraints on RDF data such as:
  - RDFS class oslc:*ResourceShape*
  - RDFS class oslc:*AllowedValues*
  - RDF property oslc:*occurs*
  - RDF property oslc:*allowedValue*
- **OSLC resource shapes** are RDF resources that define constraints on RDF data by using the OSLC Core vocabulary

Courtesy : Axel Reichwein, Koneksys

One way to think of the landscape

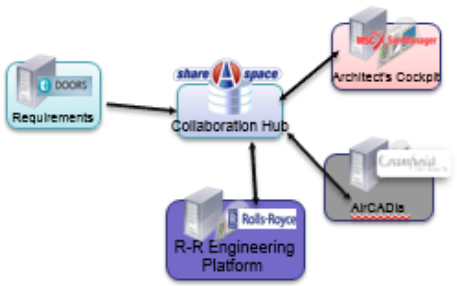


The Positive influence of Consortia Projects: UK's CONGA: PLCS/MoSSEC/OSLC

Conga

Configuration Optimisation of Next Generation Aircraft

- OSLC supported Conga in the sharing of requirements in the Conga Tool Net.
- OSLC was demonstrated to work well with another standard (BDA) which was already being use for requirements.
- The delegated UI allowed other tools to access requirements in DOORS.



AIRBUS GROUP INNOVATIONS

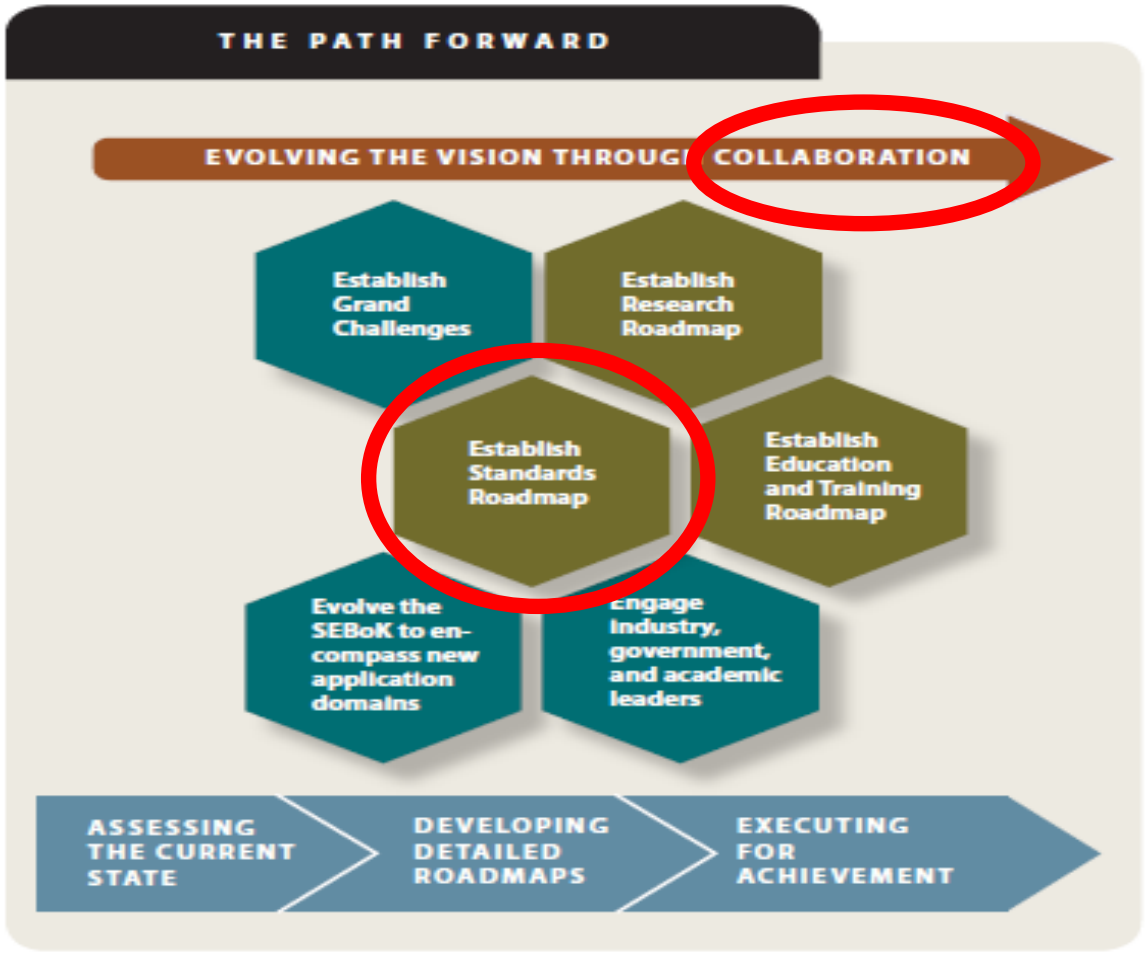
CONGA

"The aim was to identify how requirements in OSLC could be made available to other partners.
The other tools in the tool net were already BDA compliant and so a re-work to OSLC consumers wasn't desirable . "

". The solution was to create BDA requirement objects on the collaboration hub and embed the link to the DOORS requirement inside. Using the link to the delegated UI it was possible for existing consumers of BDA resources to access the requirements in DOORS without having to develop their own OSLC consumer adapters. "

(Source: OSLC Community Update – OSLC with PLCS and MoSSEC (June 10,2015)

The need to Collaborate..



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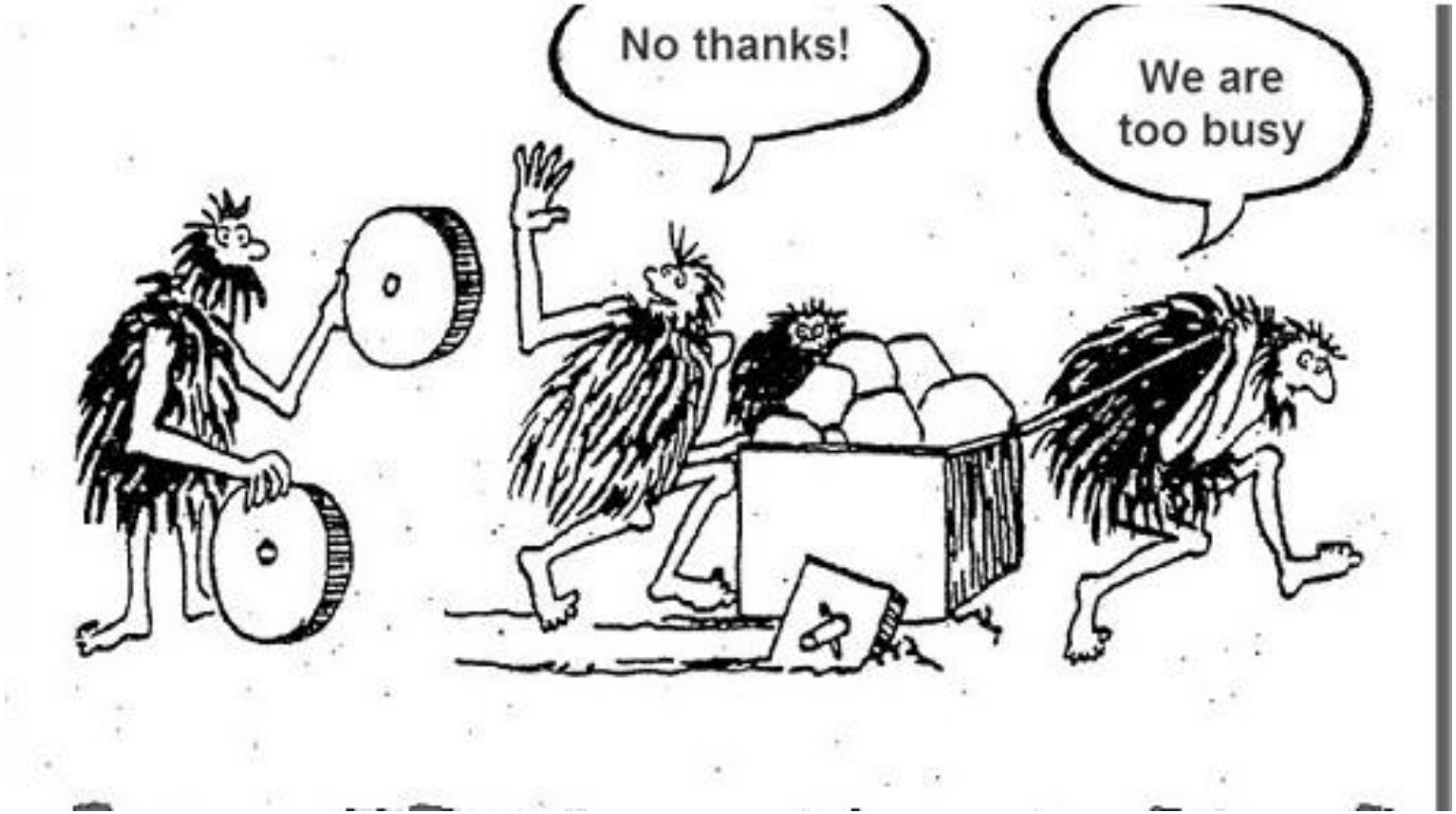
People…



People…. INCOSE & PDES

- Standards Lead At INCOSE(Ken Zemrowski) & Sandy Friedenthal working on 2 near term task
  - Focus on developing a domain specific SE vision for automotive
    - INCOSE will encourage other domains to do something similar.
  - NSF – Theoretical Framework for SysEng engagement. The standards roadmap is critical here too.
- INCOSE engagement with standards bodies like PDES, OASIS- OSLC
  - 'MBSE for OSLC 'working group is working with OSLC. (Mark Sampson and Sandy F – Co-Chairs)
  - 'Tools Interop WG' is also collaboration on standards .
- INCOSE's new strategy 'Accelerate the Transformation to a MB Discipline' has a 'Technical objective that requires engagement with other standards bodies.
- MBSE wiki would be a good place to show links to other standards working groups

People ..FutureSTEP and OSLC-ALM-PLM

- **ALM-PLM working group leaders invited to FutureSTEP sessions**
  - **Axel Reichwein to present OSLC view at PLCS meet.**
- **Importance of Standardizing Interaction patterns and Webservices**
- **Linked Data…Resource Shapes..**
- **Could provide early clues on Interoperability needs for STEP.**

OSLC Community Update (June 10,2015)

Collaboration with other Organizations

A cornerstone to make OSLC a success is to collaborate with other organizations

- Recently announced: Partnership with ProSTEP iViP (www.prostep.org)
- ProSTEP iViP Association is an international association committed to develop innovative approaches for modern standards for product data management and virtual product creation
- ProSTEP iViP has created the CPO initiative (Code of PLM Openness) to establish a common understanding on openness for IT systems in PLM between IT customers, IT vendors and IT service providers; OSLC and associated standards are seen as the approach to implement CPO.
- Joint activities are planned, e.g. 1st ProSTEP iViP – OASIS OSLC Conference October 20th, 2015 hosted by Daimler AG in Stuttgart http://www.prostep.org/en/events/topic-specific-events/oslc.html
- Relaunch of the ALM-PLM Interoperability Working Group on open-services.net http://open-services.net/workgroups/alm-plm-interoperability/

ProSTEP and OSLC

ProSTEP iViP – OASIS OSLC Conference

Seamless Lifecycle Integration - based on open Standards

Held jointly with: 4th Interoperability Conference

Location: Daimler Auditorium, Stuttgart-Möhringen
Epplestraße 225, 70567 Stuttgart
Date: 20 October 2015 / 10:00 – 16:00

One day full of information under the lead-theme ALM – PLM Interoperabili
Impulses for enabling information flows between different engineeri disciplines will be given. In industry-relevant talks possibilities of OSLC will discussed and demonstrated. Target-audience are people interested in solvi systems engineering challenges in smart ways – experts and new-comers.

The keynote will be held by Prof. Martin Eigner, TU Kaiserslautern.

Registration and more Information at
http://www.prostep.org/en/events/topic-specific-events/oslc.html

Seamless Lifecycle Integration

20 October 2015

Time	Topic
10:00	**Welcome** Dr. Steven Vettermann, ProSTEP iVIP & Rainer Ersch, Siemens AG
10:15	**OSLC: Introduction & Overview** Rainer Ersch, OASIS-OSLC Steering Committee Member
10:30	**Keynote: OSLC - Bridge between Model-based Systems Engineering and PLM?** Prof. Dr. Martin Eigner, University Kaiserlautern
11:15	**OSLC as an Opportunity to Compose IT Solutions in an existing Application Landscape** Frank Wegenknecht, Bombardier Transportation
11:45	**Co-simulation in technical software development** Gernot Eggen, Philips Healthcare
12:15	Lunch Break
13:30	**Aerospace: Industrial Use Case Demonstrator** Andreas Kelx, Airbus
14:20	Coffee Break
14:40	**Automotive: Industrial Use Case Demonstrator** tbd., Daimler
15:30	**Questions & Answers from the Audience Closing Remarks & Outlook** Rainer Ersch, Siemens AG & Dr. Steven Vettermann, ProSTEP iVIP
16:00	Anticipated end

BACKUP

Transformation: SysML to/from AADL

- Ensures consistency between the system model and domain models
- AADL profile enables import of SysML elements into AADL model.