Lessons learned on Data, Systems, and Organization modeling in UAF

NDIA Systems and Mission Engineering Conference

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Agenda

- Enterprise Data Projects and UAF
- Organization Modeling
- System Modeling
- Data Architecture and Data Modeling
- Useful Tools

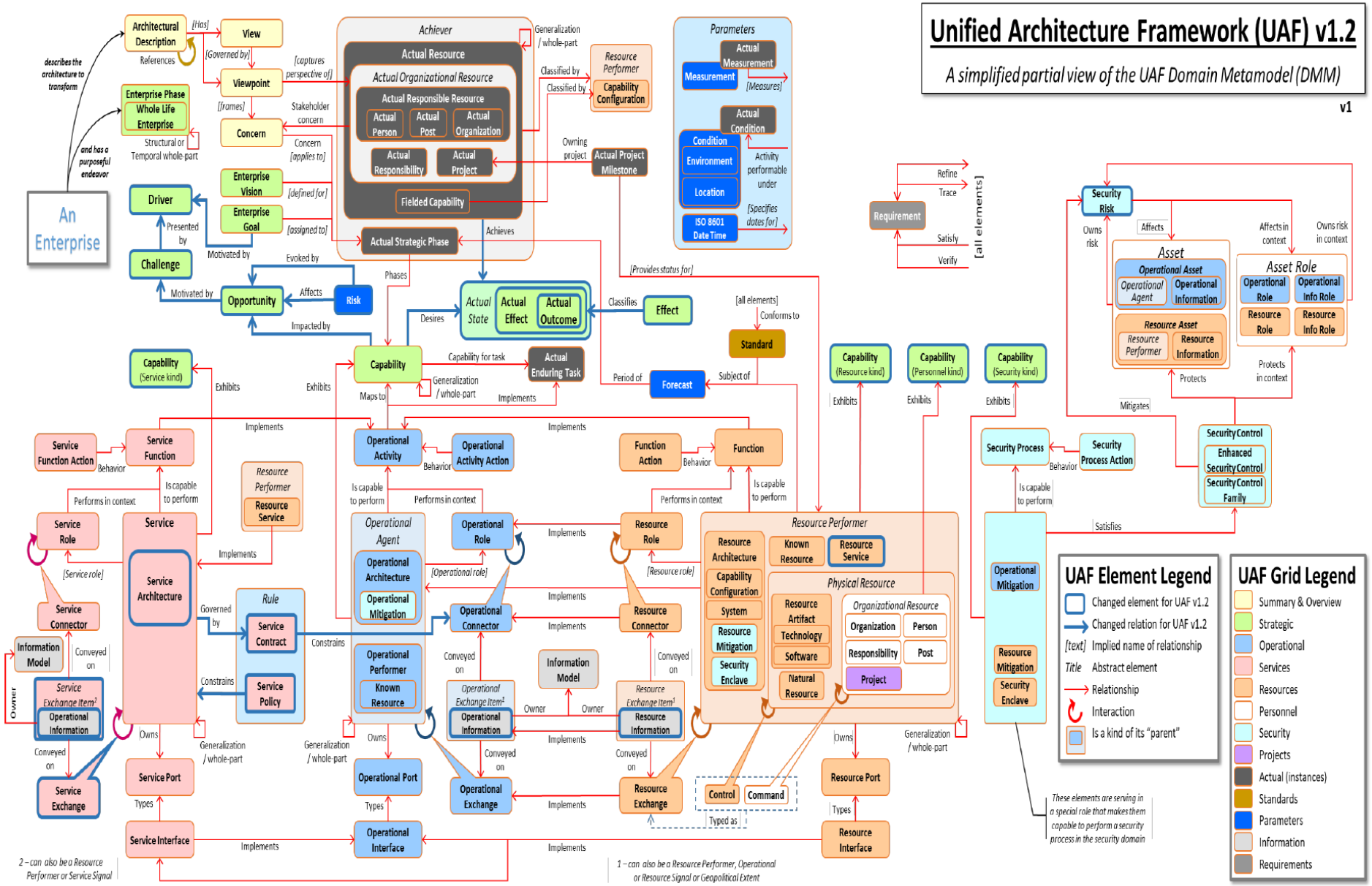
Types of Enterprise Data Architecture Projects

- Within an enterprise information domain
  - E.g. Engineering, Test, Logistics, Contracts, Finance, Human Resources, IT …
  - Many legacy siloed systems and ad-hoc data exchanges
  - New architectures – SOA and common API's/data models
- Cross-domains within an enterprise
  - Domains have different modeling maturity, styles, technology, and documentation
  - Governance and resource commitment/coordination
  - Overlaps support cross-domain analytics, but can lead to unnecessary duplication and redundancy
- Cross-organizations in a supply chain (gov.-prime-supplier tiers)
  - Moving from documents to data models
  - Proprietary data and contractual issues
  - Different tools for the same functions

UAF 1.2 Views - Domains (Rows) and Model Kinds (Columns)

UAF	Motivation Mv	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Sequences Sq	Information[c] If	Parameters[d] Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Architecture Management[a] Am	Architecture Principles Am-Mv	Architecture Extensions Am-Tx[e]	Architecture Views Am-Sr	Architecture References Am-Cn	Architecture Development Method Am-Pr	Architecture Status Am-St		Dictionary Am-If	Architecture Parameters Am-Pm	Architecture Constraints Am-Ct	Architecture Roadmap Am-Rm	Architecture Traceability Am-Tr
Summary & Overview Sm-Ov												
Strategic St	Strategic Motivation St-Mv	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	Strategic Processes St-Pr	Strategic States St-St		Strategic Information St-If	Environment En-Pm and Measurements Me-Pm and Risks Rk-Pm	Strategic Constraints St-Ct	Strategic Deployment, St-Rm-D Strategic Phasing St-Rm-P	Strategic Traceability St-Tr
Operational Op	Requirements Rq-Mv	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Sequences Op-Sq	Operational Information Op-If		Operational Constraints Op-Ct		Operational Traceability Op-Tr
Services Sv		Services Taxonomy Sv-Tx	Services Structure Sv-Sr	Services Connectivity Sv-Cn	Services Processes Sv-Pr	Services States Sv-St	Services Sequences Sv-Sq			Services Constraints Sv-Ct	Services Roadmap Sv-Rm	Services Traceability Sv-Tr
Personnel Ps		Personnel Taxonomy Ps-Tx	Personnel Structure Ps-Sr	Personnel Connectivity Ps-Cn	Personnel Processes Ps-Pr	Personnel States Ps-St	Personnel Sequences Ps-Sq	Resources Information Rs-If		Competence, Drivers, Performance Ps-Ct	Personnel Availability Ps-Rm-A Personnel Evolution PS-Rm-E Personnel Forecast Ps-Rm-F	Personnel Traceability Ps-Tr
Resources Rs		Resources Taxonomy Rs-Tx	Resources Structure Rs-Sr	Resources Connectivity Rs-Cn	Resources Processes Rs-Pr	Resources States Rs-St	Resources Sequences Rs-Sq			Resources Constraints Rs-Ct	Resources evolution, Resources forecast Rs-Rm	Resources Traceability Rs-Tr
Security Sc	Security Controls Sc-Mv	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Pr					Security Constraints Sc-Ct		Security Traceability Sc-Tr
Projects Pj		Project Taxonomy Pj-Tx	Project Structure Pj-Sr	Project Connectivity Pj-Cn	Project Processes Pj-Pr						Project Roadmap Pj-Rm	Project Traceability Pj-Tr
Standards Sd		Standards Taxonomy Sd-Tx	Standards Structure Sd-Sr								Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actual Resources Ar			Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation[b]					Parametric Execution/ Evaluation[b]		

Information is of Services, Operations, and Resources



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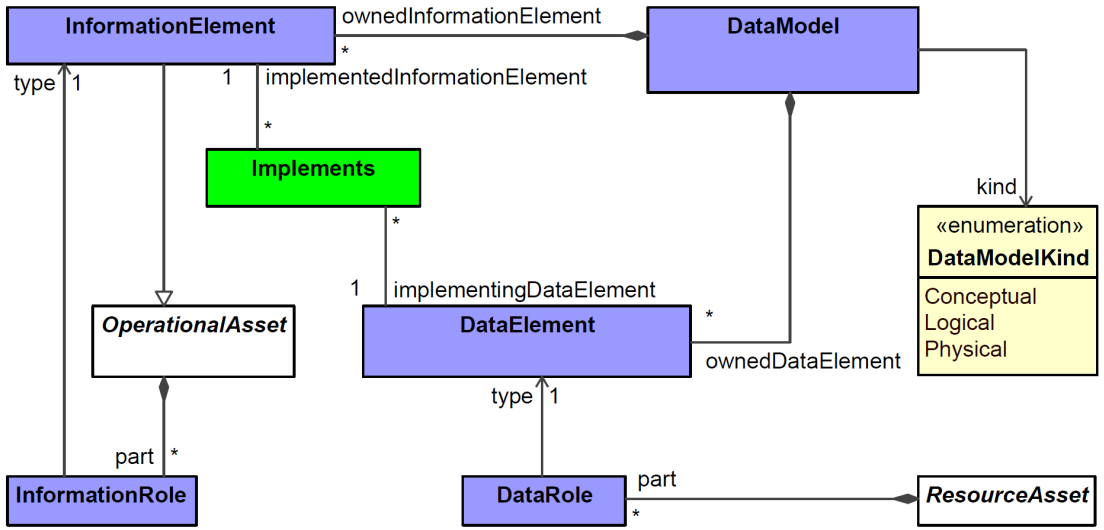
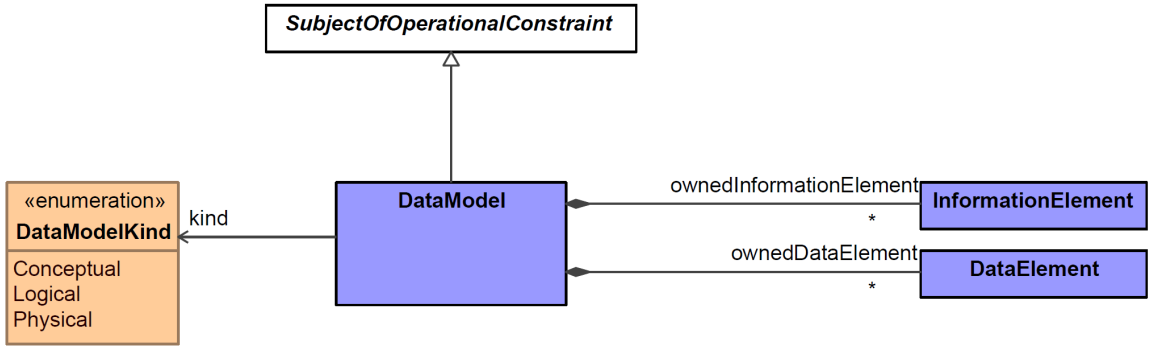
UAF Information

- View Specification
- Data and Information View (DIV)
  - Conceptual DIV-1
  - Logical DIV-2
  - Physical DIV-3
- Domain Metamodel Elements





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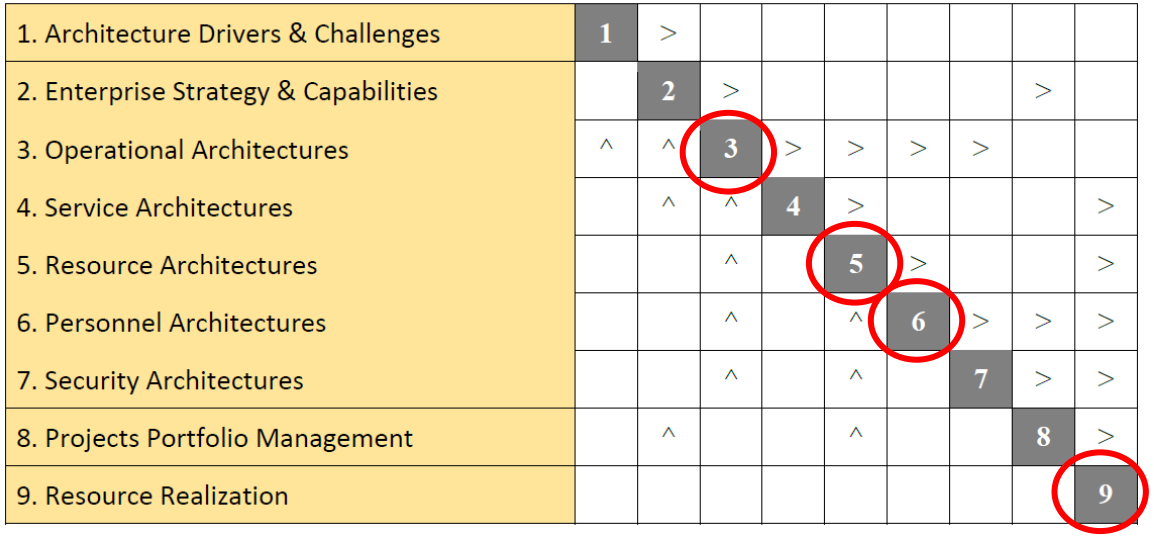
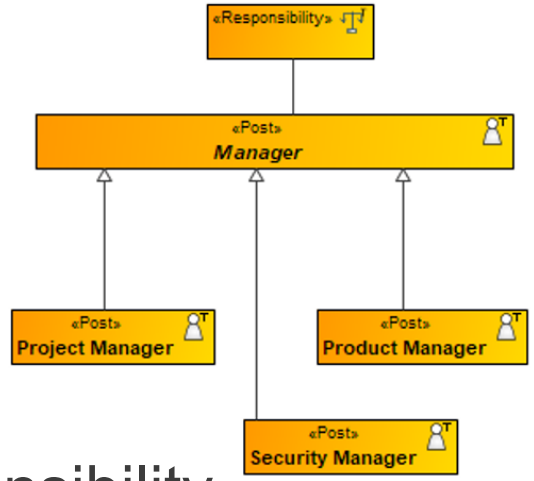
Starting a Data Architecture Project

- Enterprise Architecture Guide for UAF is nominal, idealized workflow
- Actual projects are
  - Fast-paced with interim deliverables
  - Parallel across UAF layers (grid rows)
  - Mixed maturity (UAF grid columns)
- As-is scenario for data projects
  - Legacy systems and applications (Resources)
  - Existing organizations and personnel
  - Data models and exchanges
- To-be scenario and roadmap often iteratively refined by learning

Information Relationships Between Major Steps



Robust UAF Organizational Modeling



- UAF organizational models
  - General and specific Organization attributes by layer/echelon
  - Posts also have structure and connectivity
- Generic and Actual- and –Organization, -Post, -Person, -Responsibility
  - Generic are reusable patterns and Actual are specific instances
  - Relate Organization and Project Views
- Person, Roles, Responsibilities and Competencies
  - Rapid changes in these affect Projects and drive Roadmaps
  - Slower evolution in Organizations and Posts
- Linking of concepts is overly complicated
  - ActualPost > Project > ProjectMilestone > ActualResource
  - Could use “responsible for” relation to link ActualPost > ActualResource

Data Architecture

- Interface Control Agreement (ICA)
  - Contract between sender and receiver of data
  - Interface control document (ICD) is not a structured form with validation
- Data architecture includes DIV, Operational, Service and Resource views
  - Diagram views should be built from ICA forms (different syntax, same semantics)
  - Diagrams in a portfolio across different systems, information domains, or enterprises need common syntax, semantics, and validation
- Authoritative sources and data sets
  - Identify unnecessary duplication and redundancy
  - Shadow IT (unacknowledged systems and data sources)
  - Some data sets are composite across systems

Middle-Out Approach to Data Architecture

- Start with DIV's and work toward Operations, Services and Resources
- Layers and traceability enable flexible model evolution
  - Systems, Information Domains, Enterprise, and Supply-chain
- Alternate working toward top and bottom
  - Start Information Domain at dominant systems
  - Start cross-domain at Information Domain DIV-1's, work up to enterprise and down to DIV-2
  - Start supply-chain at top-tier for data exchanges and composite models
- Overlaps and data exchanges define common data models
  - Use/extend existing standards and specifications as appropriate
  - Beware of redundancy and shadow IT (outside ownership or control)

Data, Information, Knowledge Model Evolution

- Data models evolve like UAF grid columns (model kinds)
  - Data as a UAF domain (horizontal rows)

- Conceptual DIV-1
  - Taxonomy (concept generalization/specialization)
  - Structure (concept association relationships)
  - Correspond to data elements in Operational models

- Logical DIV-2
  - Taxonomy (conceptual-logical and logical-logical generalization/specialization)
  - Structure (aggregation, composition, multiplicity relationships)
  - Connectivity (defined in Operational processes, states, interaction scenarios)
  - Constraints (syntactic/semantic model validation rules, ontology inference rules, transformation rules)
  - Correspond to Standards Profile or Forecast

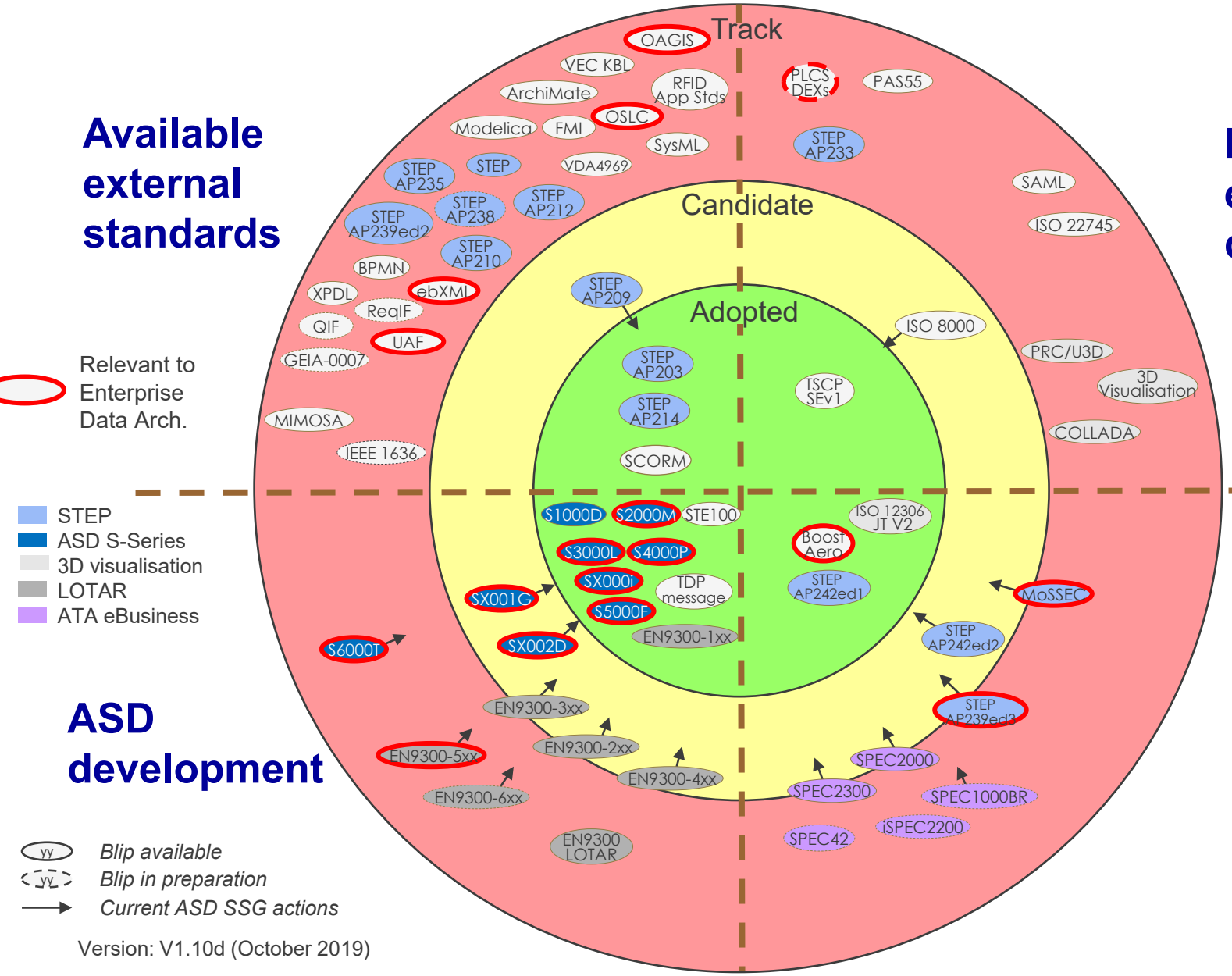
- Physical DIV-3
  - Taxonomy, Structure as above
  - Connectivity (defined in Services processes, states, interactions)
  - Constraints (validation, inference and translation implementation)

- All DIVs have Metadata, Roadmaps, Standards, and Traceability (Operations, Services, Resources, Personnel, Projects, Security, Strategic Capabilities, and Requirements)

Long Term Archiving and Retrieval (LOTAR)

- Consortium between AIA, ASD-Stan, AFNeT, ProSTEP, PDES
- Aircraft manufacturers driven by FAA type certification (and European ESA)
- Workgroups
  - 3D Mechanical CAD with Product Manufacturing Information (PMI)
  - 3D Visualization
  - Metadata for Archive Package
  - Product Data Management
  - Composites
  - Electrical Harness
  - Engineering Analysis and Simulation
  - MBSE (AADL, SysML, UML etc.)
- Works with MBx-IF, PDM-IF, NAFEMS, INCOSE, OMG, ISO …

ASD Strategic Standardization Group Radar Screen



Available external standards

Monitor external development

ASD development

Participate in external development

Relevant to Enterprise Data Arch.

- STEP
- ASD S-Series
- 3D visualisation
- LOTAR
- ATA eBusiness

yy *Blip available*

yy *Blip in preparation*

Current ASD SSG actions

Version: V1.10d (October 2019)

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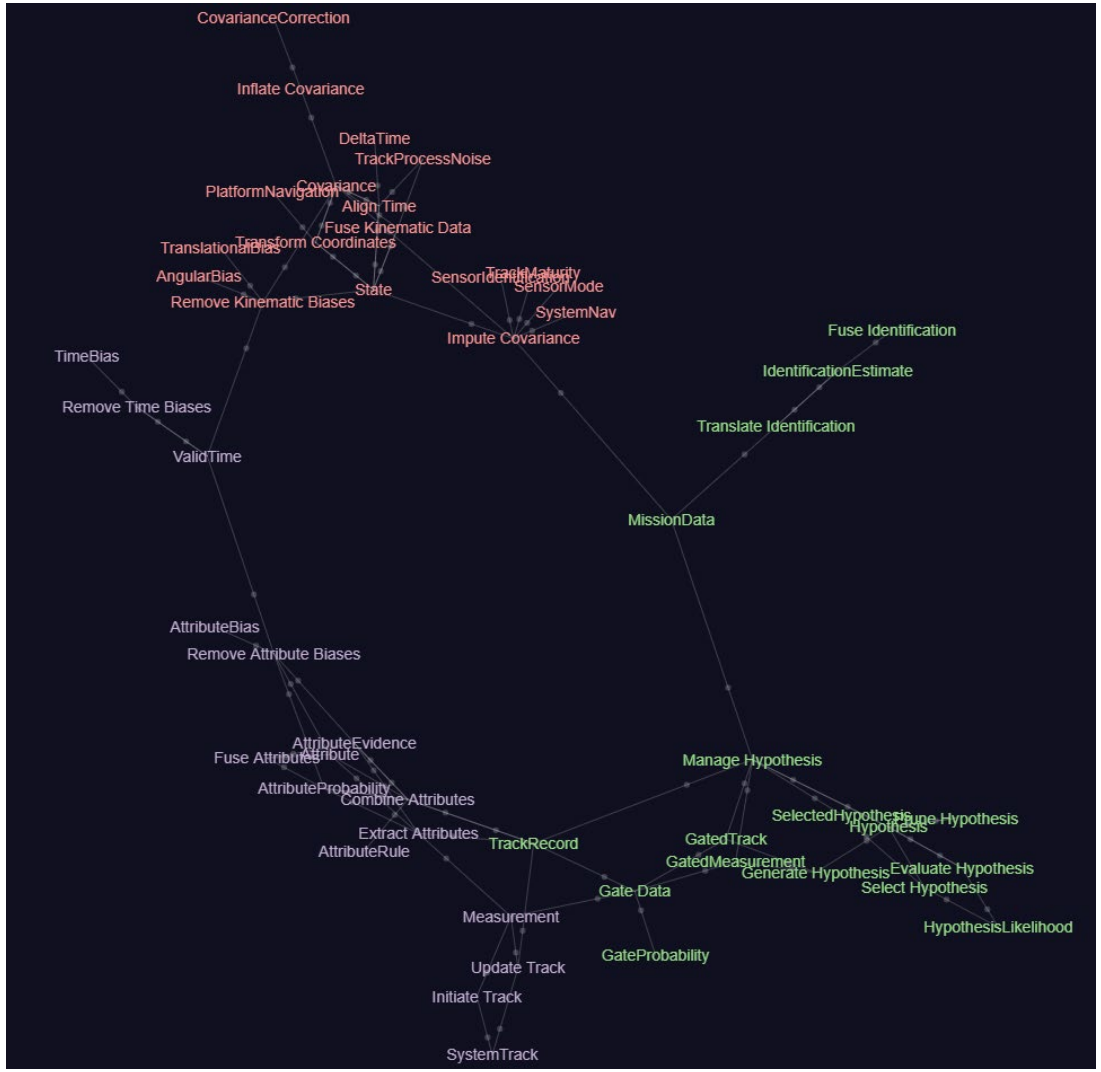
Data Exchanges and Functions

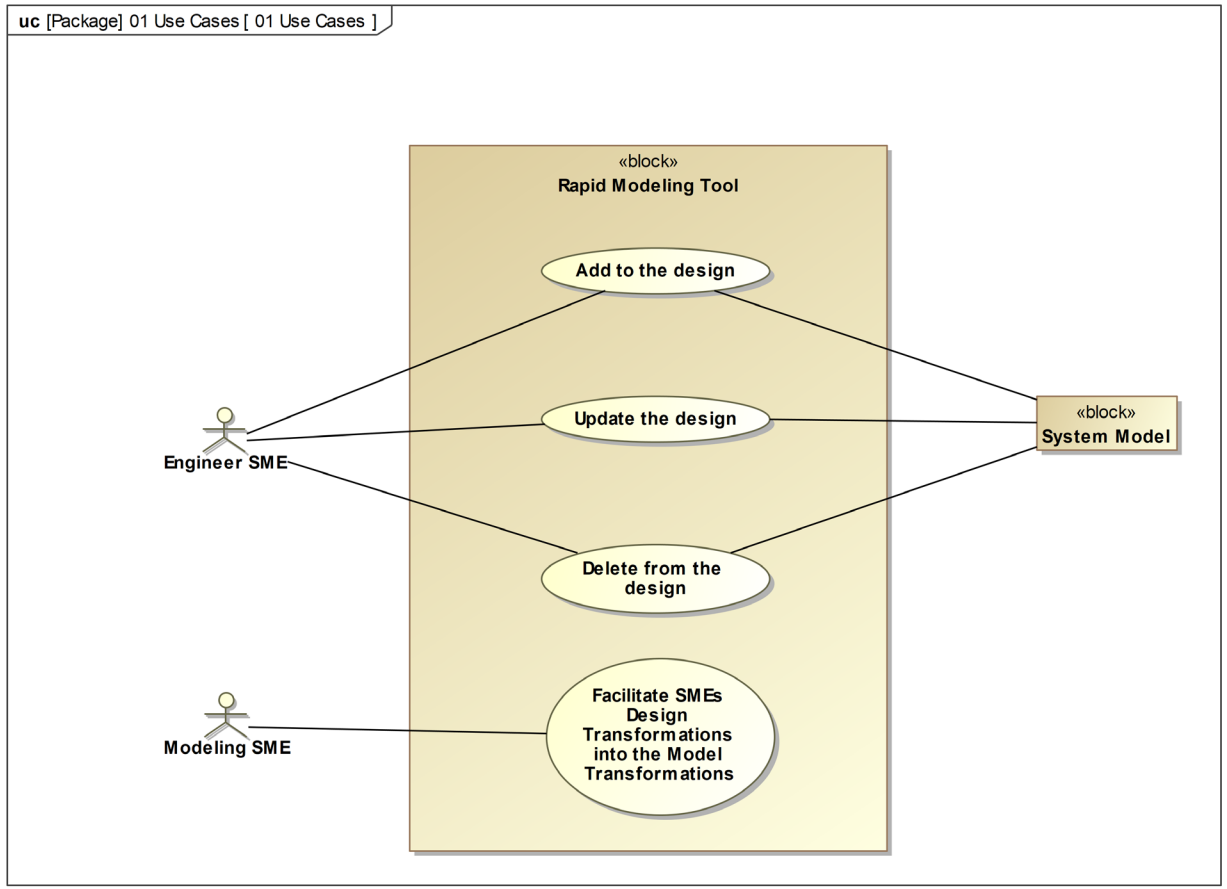
- REaCT – Redundancy Evaluator and Clustering Toolset
  - GTRI developed tool
  - Evaluates functional decompositions for coupling and cohesion
  - Functions and interfaces (Data I/O) as connected graph
  - Origin in FASTR (Functional Architecture for Strategic Reuse)

- Benefits for Data Modeling
  - Identify coverage gaps, commonality, redundancy, model errors/incomplete



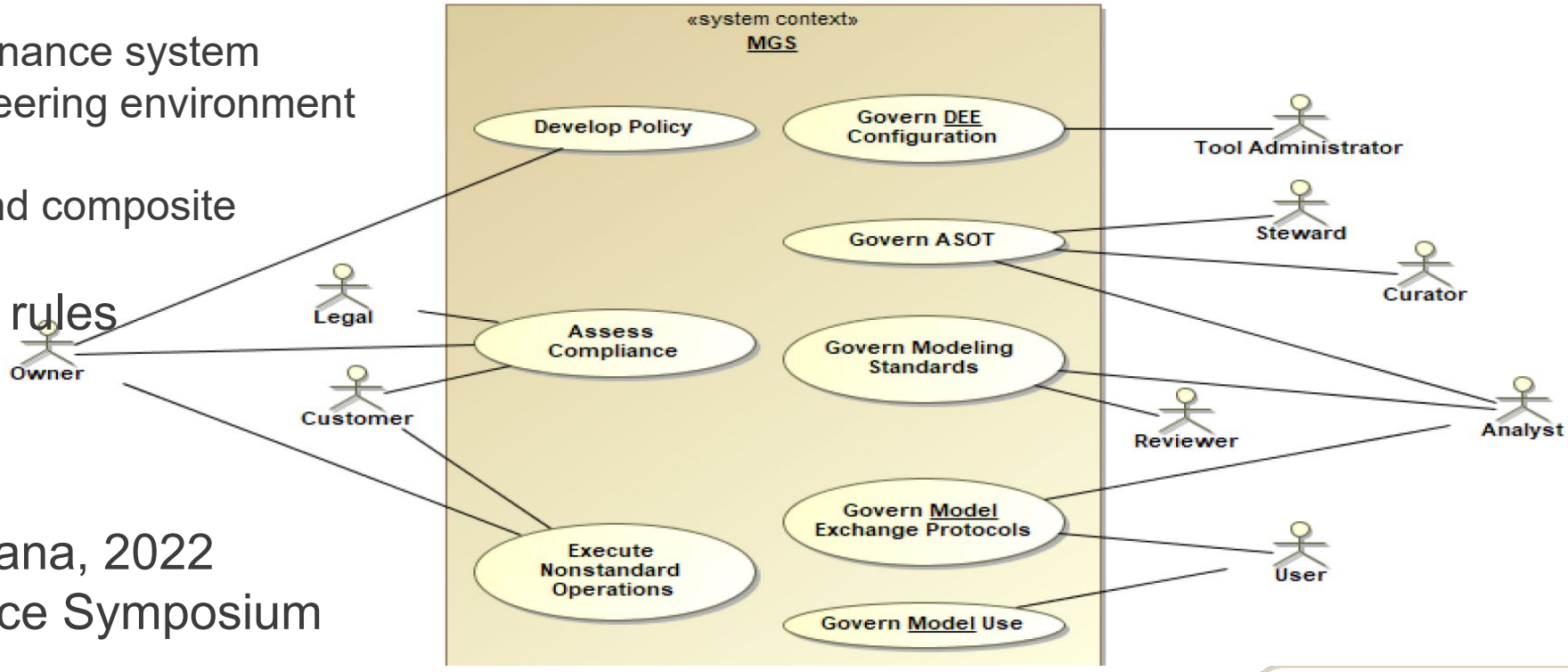
Automating Import and Diagram Creation

- Rapid Modeling Tools
  - GTRI developed Cameo plugin
  - Open sourced on Github
  - Import data from Excel files
  - Columns match SysML diagram patterns
  - Patterns can be composed
  - Load rows into diagrams
  - Update matching capability
- Used to load volumes of data from other sources into Cameo models
  - Database tables
  - Other enterprise architecture tools



Model Governance

- Model Governance Guide
  - Developed by Mantech Intelligent Systems Engineering organization
  - SysML profile and model to build a governance plan
    - Design model governance system
    - Design digital engineering environment infrastructure
    - Govern individual and composite models
  - Automated validation rules

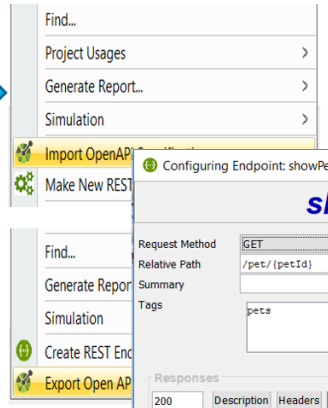


H. Davidz and D. Orellana, 2022
MBSE Cyber Experience Symposium

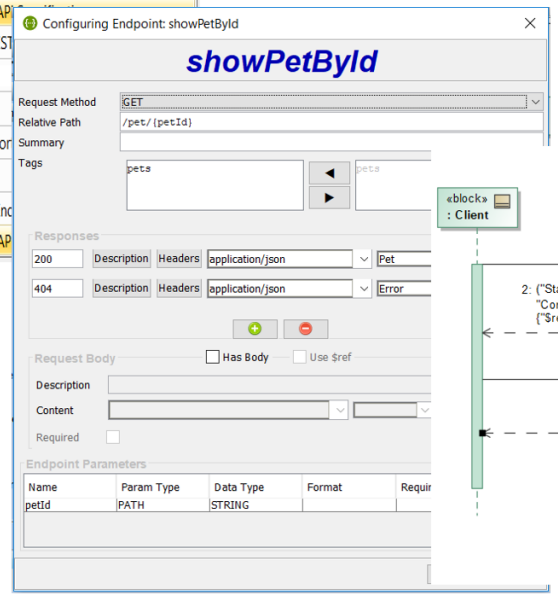
OpenAPI Generation from SysML Data Models

- API Toolkit developed by MITRE Corp.
  - SysML profile for OpenAPI specification for REST API's
  - Cameo plugin that imports/exports OpenAPI specification files

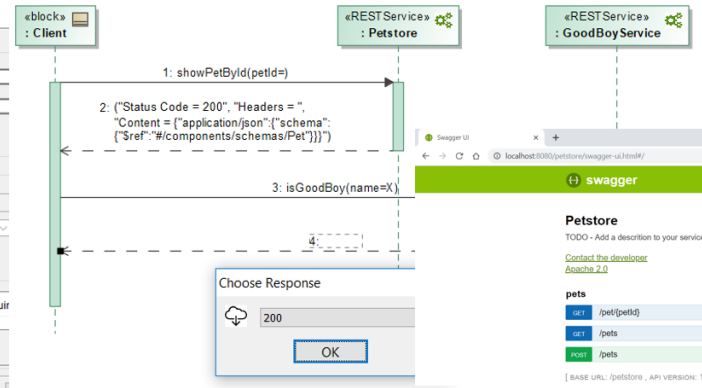
Bi-Directional data exchange with industry standard OpenAPI Specification files for defining REST Interfaces



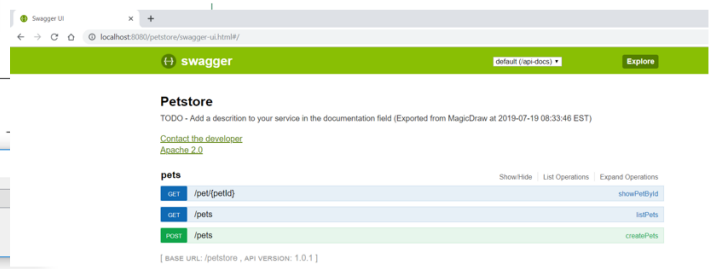
Wizard Driven GUI to capture next level of interface detail according to OpenAPI meta-modal



Service orchestration with sequence diagram using defined API Endpoint operations and Responses



Integration with Swagger CodeGen and Swagger UI



N. Norwood and J. Hurvitz, API Toolkit Plugin, NIWIC PAC MBSE COP, 2019

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Summary and Conclusions

- Data architecture for information domain, enterprise, and supply-chain projects have unique challenges that can partly be addressed by UAF
- DIV's can be organized as UAF domains that evolve
- Data architecture projects start in DIV's, and proceed in parallel across Operations, Services, Personnel and Resources
- Models need common syntax and semantics with validation
- Enterprise projects emphasis on commonality, redundancy and composite models
- Standards can jump-start and tools can accelerate projects