



COLLEGE *of*
CHARLESTON

Systems Engineering: Design and Development

ENGR 387



Agenda

- **Architecture Definition on the Context of Systems Engineering**
- **Why do we need an Architecture?**
- **Frameworks and Evolution**
- **Unified Modeling Language (UML)**
- **What is SysML**
- **SysML vs UML**
- **Department of Defense Architecture Framework (DoDAF)**
- **Unified Profile for DoDAF/MODAF (UPDM)**
- **Unified Architecture Framework (UAF)**

Architecture Definition on the Context of Systems Engineering

- "The word "architecture" is used in various contexts in the general field of engineering. It is used as a general description of how the subsystems join together to form the system. It can also be a detailed description of an aspect of a system: for example, the Operational, System, and Technical Architectures used in Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), and software intensive developments" (DoD Systems Engineering Fundamentals Manual January 2001).
- "However, Systems Engineering Management as developed in DoD recognizes three universally usable architectures that describe important aspects of the system: functional, physical, and system architectures." (DoD Systems Engineering Fundamentals Manual January 2001).

This presentation will focus on the frameworks that are used today in developing models within MBSE development.

Why do we need an Architecture?

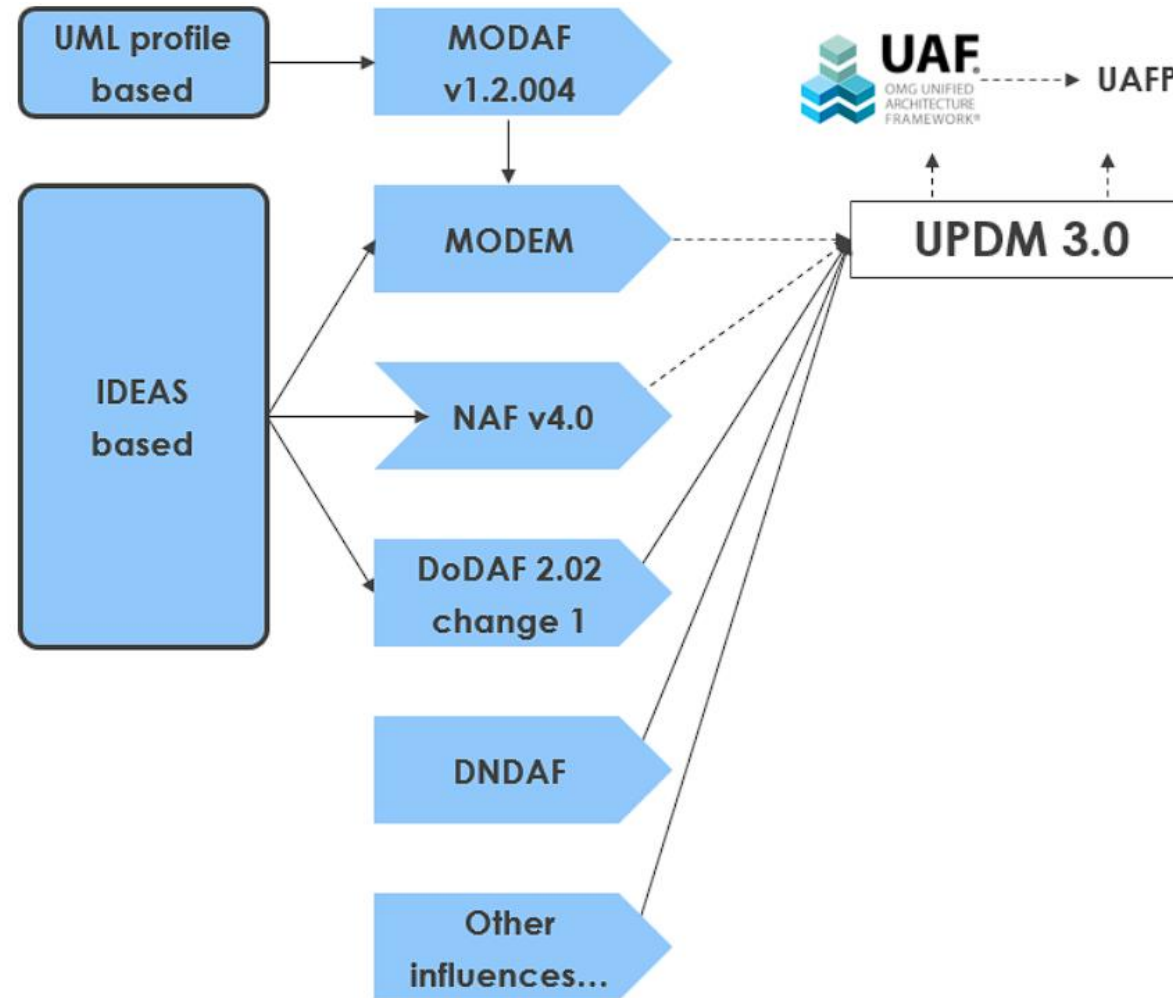
- “Developing the system architecture is one of the most important responsibilities of the systems engineer. It is a creative process, and there is no unique solution to satisfying user requirements. The system architecture is critical because it provides the framework for system development” *.
- “The System Architecture will identify all the products (including enabling products) that are necessary to support the system and, by implication, the processes necessary for”*:
 - Development
 - Production/construction
 - Deployment
 - Operations
 - Support
 - Disposal
 - Training and verification

* INCOSE Systems Engineering Handbook v.3

Frameworks and Evolution

- Frameworks provide for the logical constructs of the system data in visualization model that appropriate for the given stakeholders.
- Systems engineers, enterprise architects and program managers have overlapping needs for information.
- The framework provides the definitions, references, guidance and rules for structuring, classifying, and organizing architectures.
- Complexity in a model-based environment is significantly reduced by separating and characterizing systems issues into various data-driven viewpoints and views.
- The framework should be extended to include data that is relevant across the system lifecycle.

Frameworks and Evolution

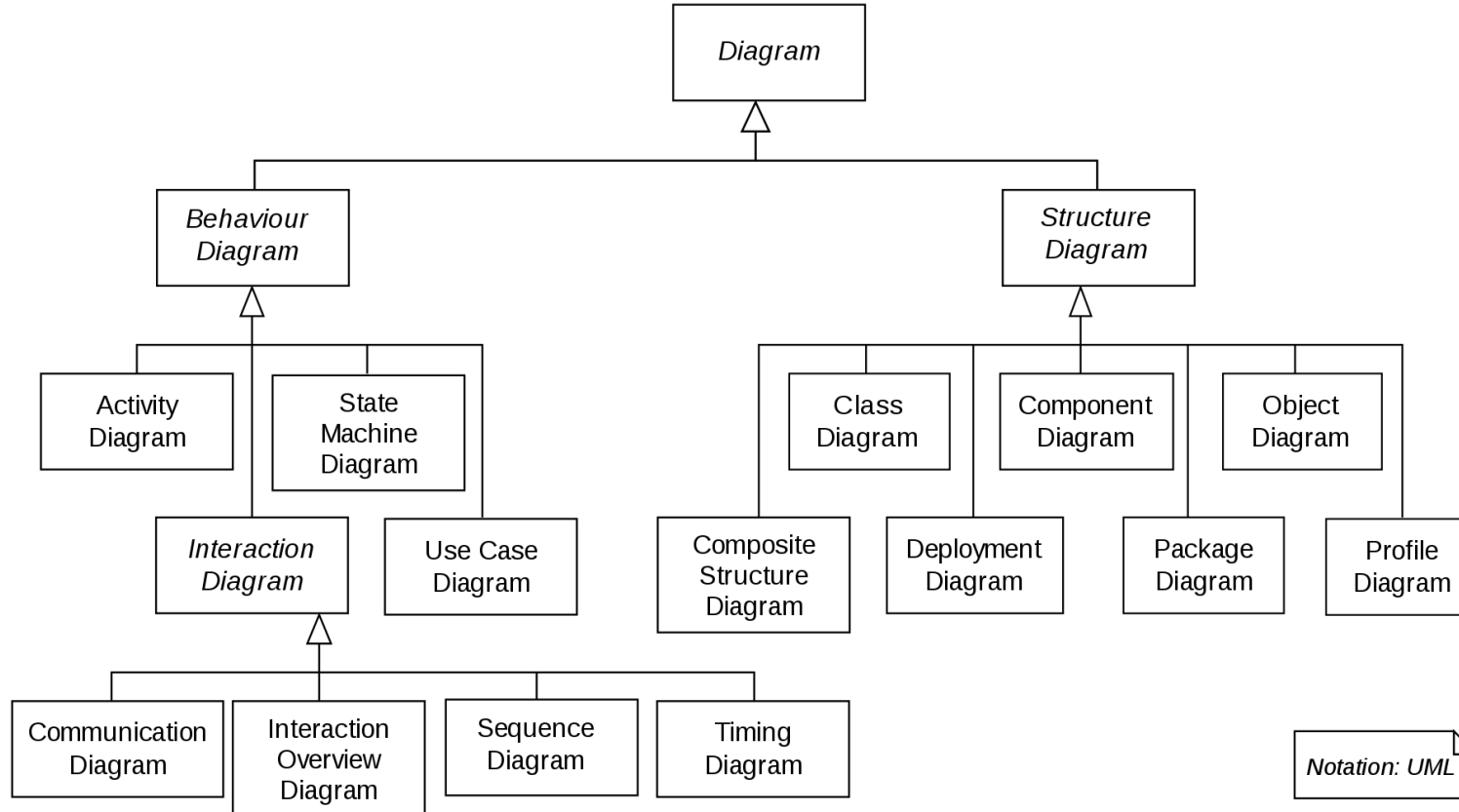


Unified Modeling Language (UML)

- The Unified Modeling Language (UML) is a general-purpose, developmental, modeling language in the field of software engineering that is intended to provide standard way to visualize the design of a system.
- The creation of UML was originally motivated by the desire to standardize the notational systems and approaches to software design. It was developed at Rational Software in 1994-1995, with further development led by them through 1996.
- In 1997, UML was adopted standard by the Object Management Group (OMG), and has been managed by this organization ever since. In 2005, UML was also published by the International Organization for Standardization (ISO) as approved ISO standard.

Unified Modeling Language (UML)

This diagrams may all contain comments or notes explaining usage, constraint, or intent.



What is SysML

- A graphical modeling language developed in response to the UML for Systems Engineering RFP developed by the OMG, INCOSE, and AP233a
- Supports the specification, analysis, design, verification, and validation of systems that include *hardware, software, data, personnel, procedures, and facilities*
- Is a visual modeling language that provides
 - Semantics = meaning, connected to a metamodel (rules governing the creation and the structure of models)
 - Notation = representation of meaning graphical or textual
- Is not a methodology or a tool (SysML is methodology and too independent)

SysML vs UML

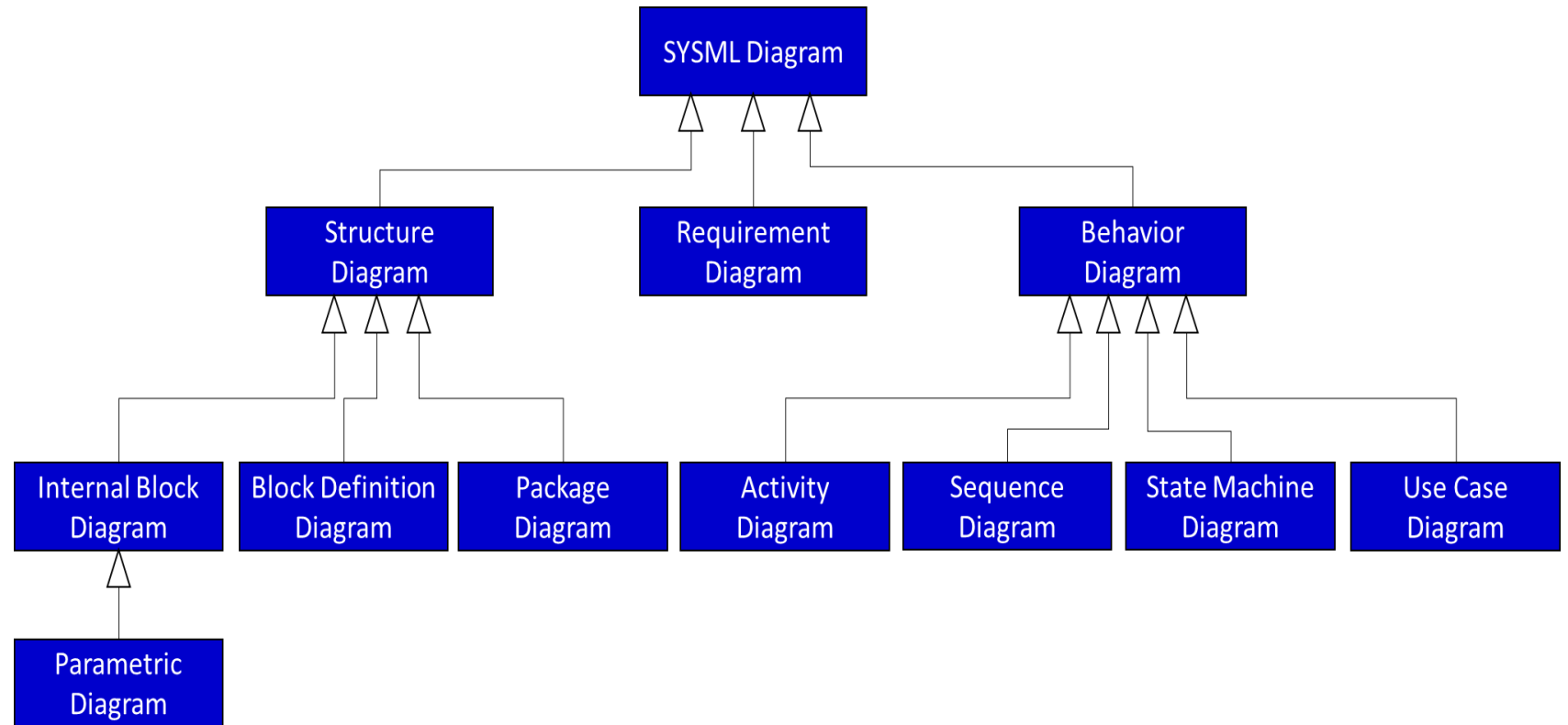
- UML is a general-purpose graphical modeling language aimed at Software Engineers
- Diagrams not used
 - Object diagram,
 - Deployment diagram,
 - Component diagram,
 - Communication diagram,
 - Timing diagram and
 - Interaction overview diagram
- Diagrams from UML
 - Class diagram (Block Definition Diagram - Class - Block)
 - Package diagram,
 - Composite structure diagram (Internal Block Diagram)
 - State Machine Diagram
 - Activity Diagram
 - Use Case Diagram
 - Sequence Diagram

SysML vs UML Cont.

- In addition, SysML adds some new diagrams and constructs
 - Parametric diagram,
 - Requirements diagram,
 - Flow ports,
 - Flow specifications,
 - Item flows,
 - Allocation

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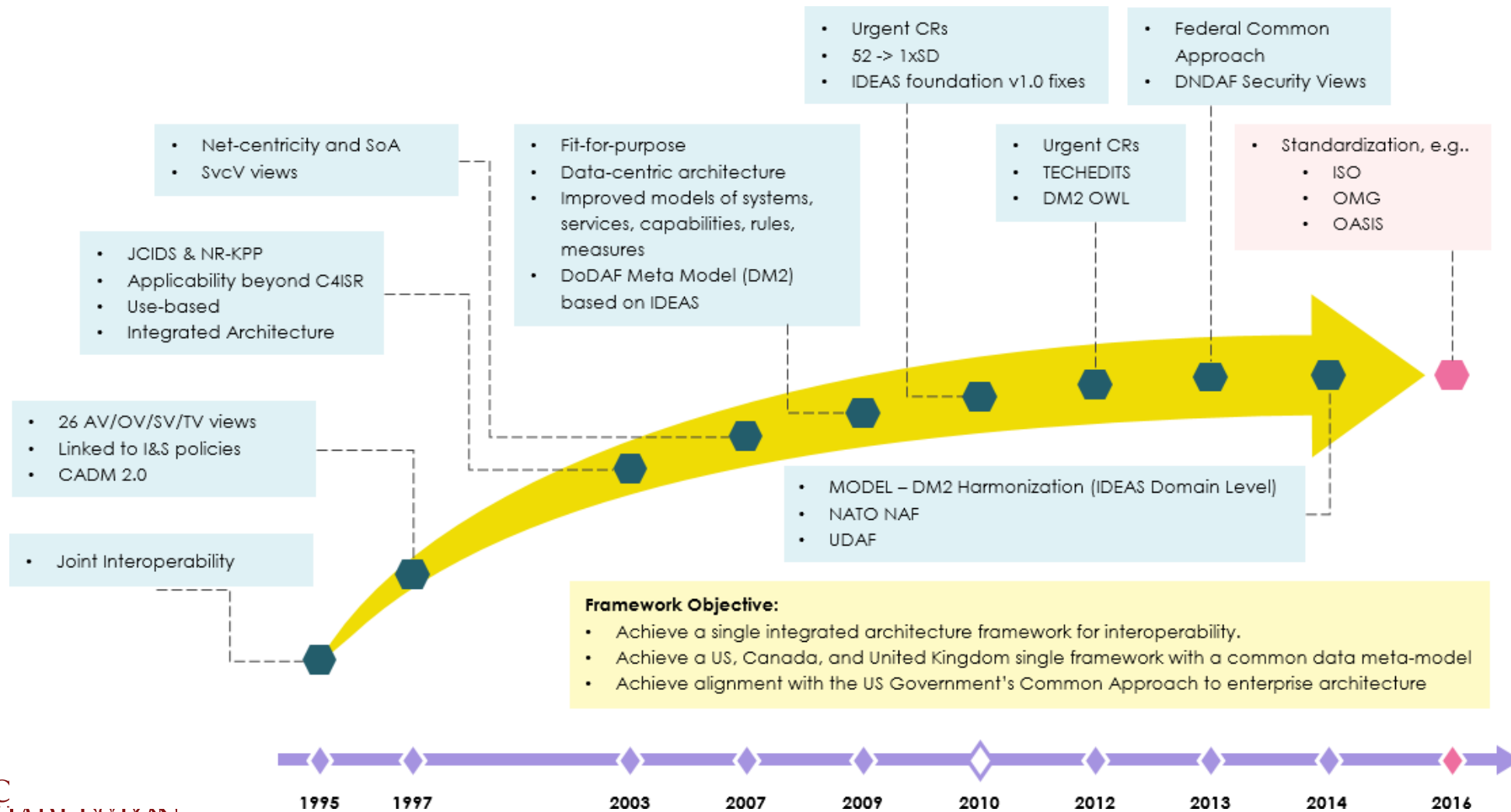
Department of Defense Architecture Framework (DoDAF)

- The Department of Defense Architecture Framework (DoDAF) is an Architecture framework for the United States Department of Defense (DoD) that provides visualization infrastructure for specific stakeholders concerns through viewpoints organized by various views. These views are artifacts for visualizing, understanding, and assimilating the broad scope and complexities of an architecture description through tabular, structural, behavioral, ontological, pictorial, temporal, graphical, probabilistic, or alternative conceptual means. The current release is DoDAF 2.02.
- This Architecture Framework is especially suited to large systems with complex integration and interoperability challenges, and it is apparently unique in its employment of “operational views”. These views offer overview and details aimed to specific stakeholders within their domain and in interaction with other domains in which the system will operate.

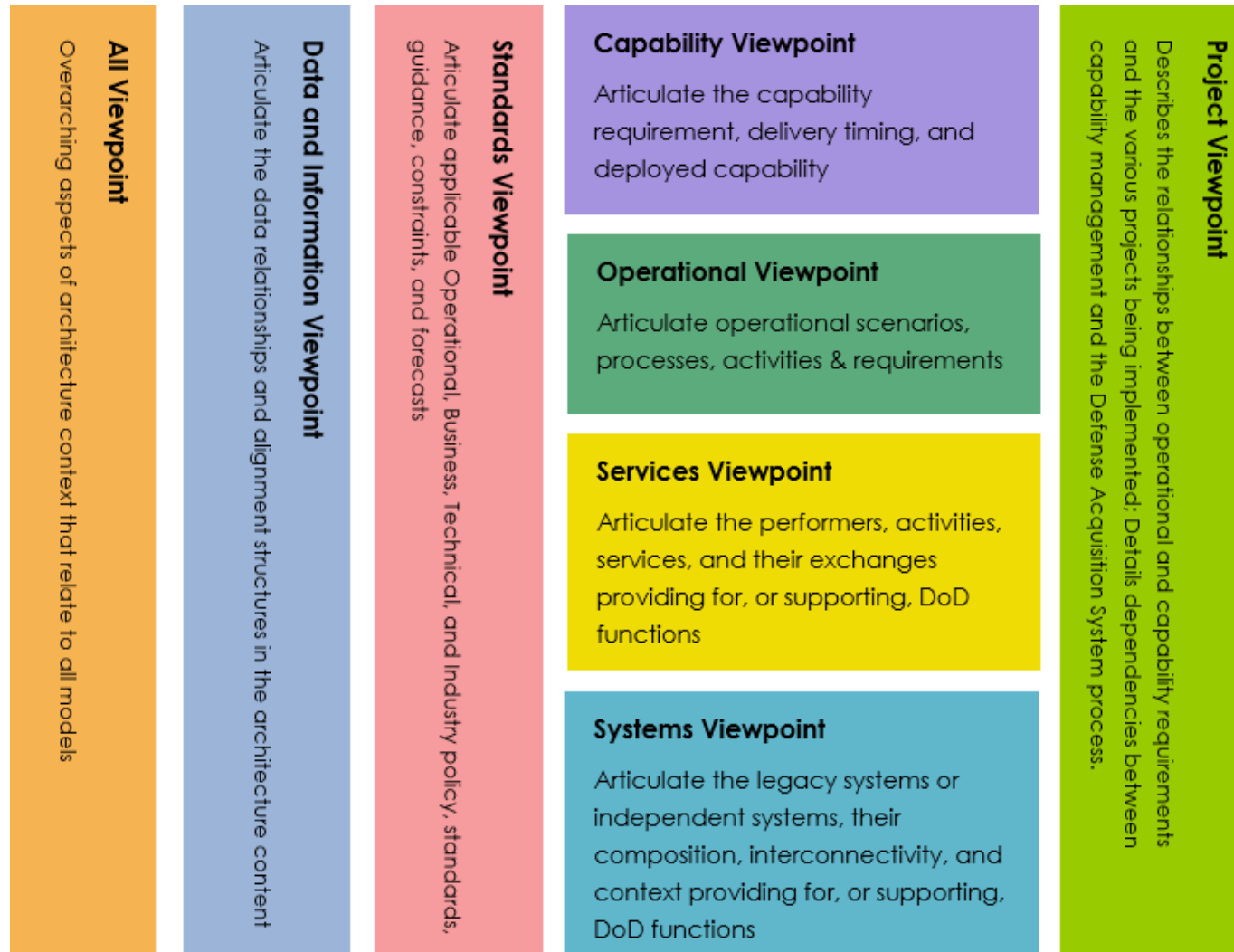
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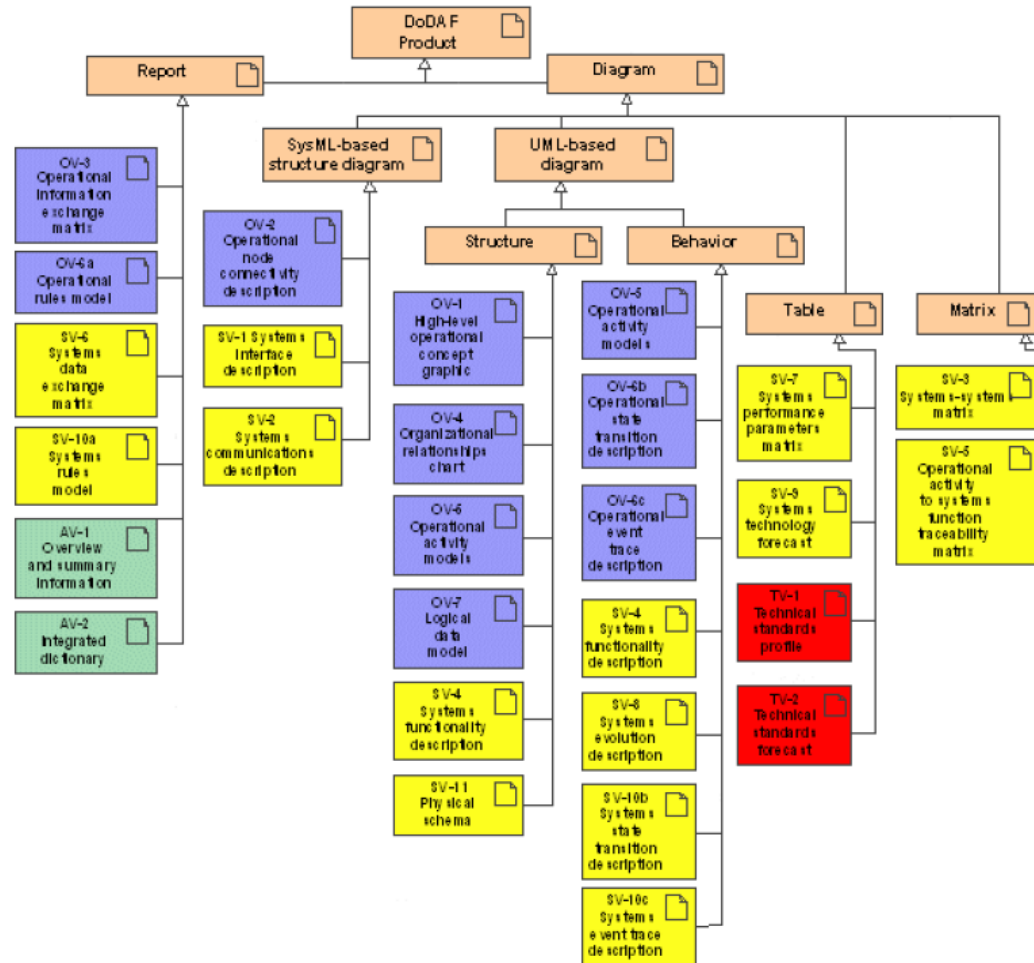
Department of Defense Architecture Framework (DoDAF)



Department of Defense Architecture Framework (DoDAF)



Department of Defense Architecture Framework (DoDAF 1.5)



Product Taxonomy

Unified Profile for DoDAF/MODAF (UPDM)

- UPDM is based on OMG's Unified Modeling Language (UML) 2.0, Systems Modeling Language (SysML), and Service-Oriented Architecture Modeling Language (SOAML), ensuring widespread implementation by multiple tool vendors. Although DoDAF and MODAF were initially developed for the military domain, the Enterprise Architecture issues they address are equally applicable to many general business and public service systems. Therefore, UPDM is also finding widespread use amongst companies and government organizations that implement DoDAF and MODAF.
- The goals of UPDM are to significantly enhance the quality, productivity, and effectiveness associated with enterprise and system of systems architecture modeling, promote architecture model reuse and maintainability, improve tool interoperability and communications between stakeholders, and reduce training impacts due to different tool implementations and semantics.

Unified Architecture Framework (UAF)

- UAF architecture models provide a means to develop an understanding of the complex systems and the relationships that exist between organizations, systems, and systems-of-systems and enable the analysis of these systems to ensure that they meet the expectations of the user community.
 - produce standard DoDAF/MODAF/NAF products as well as commercial extensions
 - leverage cross-industry, standards-based approaches (e.g., MDA, UML, SysML) to enhance tool and architecture data interoperability
 - MDA foundation enables UAF to evolve with DoDAF v2 and beyond (i.e, security, human factors)
 - UAF is methodology-agnostic (structured, OO, etc.)
 - UAF provides a set of rules to enable users to create consistent enterprise architectures (as models) based on generic enterprise and system concepts with rich semantics. These models then become the repositories from which various views can be extracted.

Summary

- The OMG UAF is the next stage in the development of UPDM; it takes the principles of UPDM and extends it to reach a wider audience. As well as encompassing DoDAF, MODAF, and NAF, UAF also includes views that can capture human-machine interface and human factors concerns, security analysis, and systems-of-systems lifecycle concepts. Because of this expansion in scope, it became necessary to change the way views were represented in UPDM.

References

Transitioning UPDM to the UAF, OMG UAF

Systems Engineering Fundamentals Manual - DoD Systems Management College, January 2001

INCOSE Systems Engineering Handbook V.3

International Council on Systems Engineering Webinar February 20th, 2019