# DoD Architecture Framework


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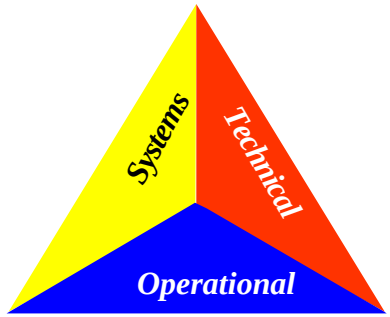

# Outline

- Framework Definitions and Purpose
- Comparability to other Federal Frameworks
- DODAF Applicability Beyond DoD
- Changes In Product Definitions
- Architecture Uses – Capabilities Based Methodology
- Example Architecture - US NORTHCOM Architecture
- Standards Initiatives
- The Way Ahead

# Framework Definitions and Purpose


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# Architecture Framework

- **"An architecture framework is a tool… It should describe a method for designing an information system in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. It should also include a list of recommended standards and compliant products that can be used to implement the building blocks." [TOGAF 8, OpenGroup]**

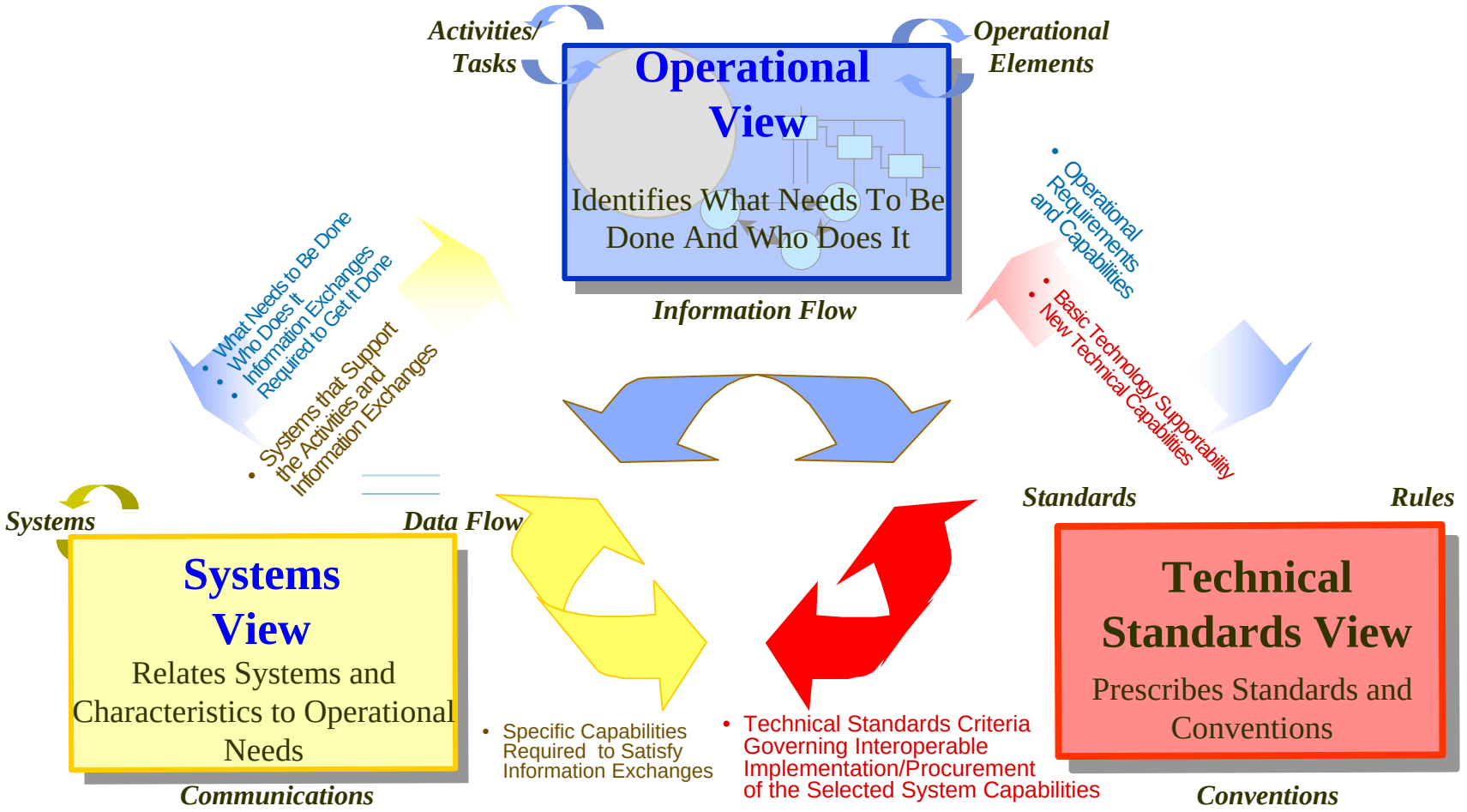
- **The Department of Defense (DoD) Architecture Framework (DODAF)**
  - Defines a common approach for describing, presenting, and integrating DoD architectures

# DoD Architecture Framework 1.0

- **The Department of Defense (DoD) Architecture Framework (DODAF)**
  - Defines a common approach for describing, presenting, and comparing DoD architectures
  - Facilitates the use of common principles, assumptions and terminology

- **The principal objective of the Framework is to**
  - Ensure that architecture descriptions can be compared and related across organizational boundaries, including Joint and multi-national boundaries

# DODAF Basic Principles - An Integrated Architecture with Three Views



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# Architecture Framework Views and Viewpoints*

| TOGAF Views | Kruchten's 4+1 Architecture views | RM-ODP Viewpoints | DoD Framework Views & Applicable Products | View Concerns |
|---|---|---|---|---|
| Business Architecture View | Scenarios | Enterprise Viewpoint | Operational View Stakeholders, Business Process, And Information Flow Models | Describes Enterprise and required capability from the Stakeholder's perspective |
| Data Architecture View | None | Information Viewpoint | Operational/ Systems View Logical Data Models, Physical Schema | Describes information and data needed to provide capability |
| Applications Architecture View? | Logical | Computational Viewpoint | Systems View System Interfaces And Communications Models | Describes distribution of components, networking; developing and integrating the various software components |
| Applications Architecture View | Development | Engineering Viewpoint | Systems View System Functions, Control, And Information Flow Models | Describes architecture of system functionality (software and Hardware) needed to provide capability |
| Technology Architecture View | Process | Technology Viewpoint | Systems Technical Views Performance And Standards Models | Processes in acquisition cycle |

* The Open Group Architectural Framework©, The OpenGroup, www.opengroup.org
* P. Kruchten, "The 4+1 View Model of Architecture," IEEE Software, 12 (6), November 1995, IEEE, pp. 42-50
* Viewpoints are aligned with ISO standard ISO/IEC 10746-1: Reference Model – Open Distributed Processing (RM-ODP)

# Comparability to other Federal Frameworks


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# Federal Architecture Frameworks

| | DODAF | TEAF | FEA Reference Models |
|---|---|---|---|
| General Description | Defines a common approach for describing, presenting, and integrating DoD architectures | Defines a common approach for describing, presenting, and integrating Treasury/bureau architectures | Provides ability to look across federal government projects and identify opportunities to collaborate, consolidate, and identify Information Technology (IT) investments |
| How widespread is its use? | Required across DoD<br>• Adaptations in use by NRO, NATO, multiple foreign countries<br>• In use for eight years<br>• Influenced other Frameworks | Was used by Treasury and Bureaus for 3 years.<br>"No longer supported" | Embryonic, still evolving |
| How much guidance is there for the Architect? | • Prescribes a very high-level process for getting started<br>• Products very specific for detail work<br>• New "Desk Book" (Includes "As-Is" to "To-Be" transition strategy, example processes, reference resources) | • Provides more details than FEAF<br>• Most products borrowed from DoD FW<br>• Adds some IA products to the DoD set | Provides categories into which aspects of individual project proposals can be mapped |

# Federal Architecture Frameworks

| | DODAF | TEAF | FEA Reference Models |
|---|---|---|---|
| Structure | Three Views — Operational, Systems, Technical — with various model types assigned to Views | Zachman-like matrix<br>Functional, informational, organizational, and infrastructure columns<br>DODAF-like products, | Comprised of five reference models — Performance, Business, Service Component, Technical, and Data Reference Models |
| Integration within the Framework | Explicit connections between elements across products | Explicit connections between elements across products | • Business Reference Model (BRM) linked to Budget Function Codes, which can serve as useful starting point to align IT investments to BRM<br>• Simple association rules between models, e.g., each Line of Business (BRM) should have an associated performance measure from the PRM |
| Level of detail addressed | Level of detail captured in each product left to Architect in accordance with purpose and scope of architecture | Level of detail captured in each product left to Architect in accordance with purpose and scope of architecture | Simple hierarchical decomposition within each reference model |

# DODAF Applicability Beyond DoD


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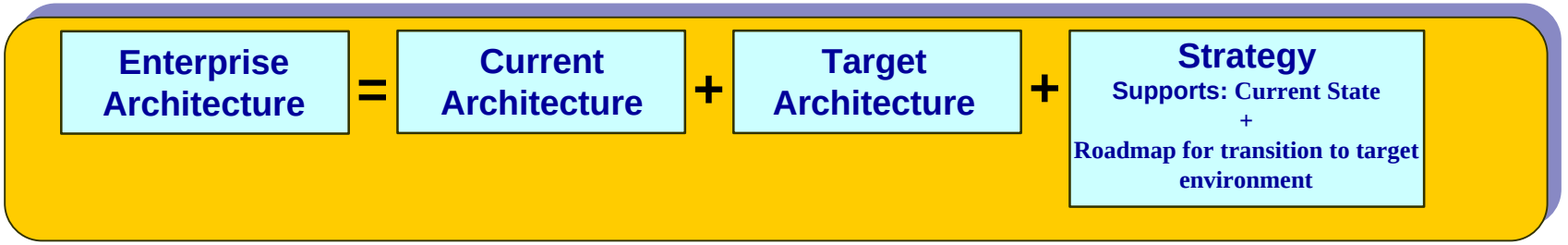
# Enterprise Architecture

- **Elements of an enterprise include:**
  - Business processes
  - Organizations responsible for them
  - Information and systems data they need to inter-operate
  - Information technology (IT) capabilities
  - Systems
  - Infrastructure
  - Specific technical standards that facilitate enterprise inter-operation
- **An Enterprise Architecture (EA) describes these elements, their structures, and inter-relationships to facilitate capital planning and IT development sequencing**



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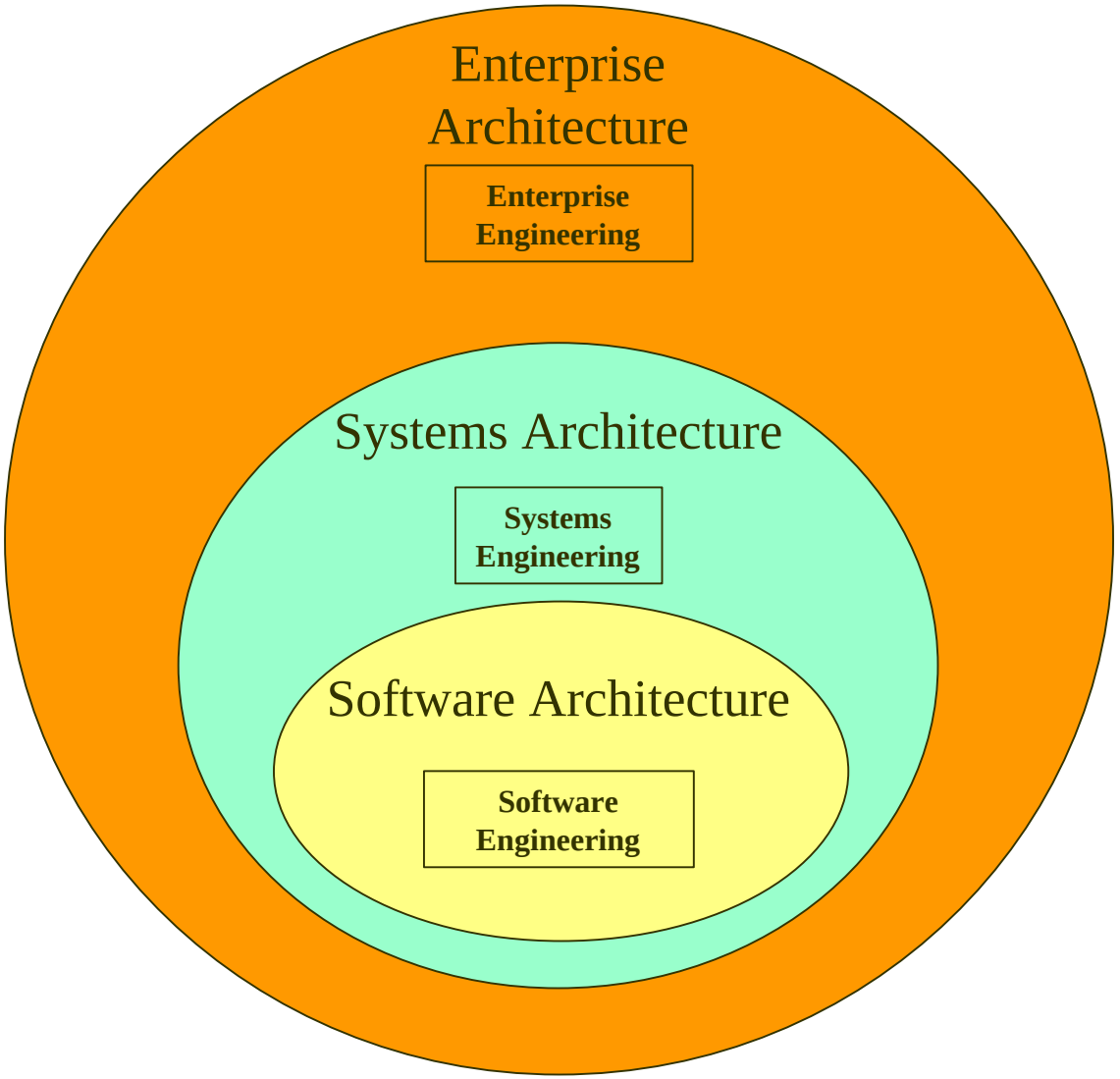
# Relationship of Software to Systems Engineering and to Enterprise Architectures



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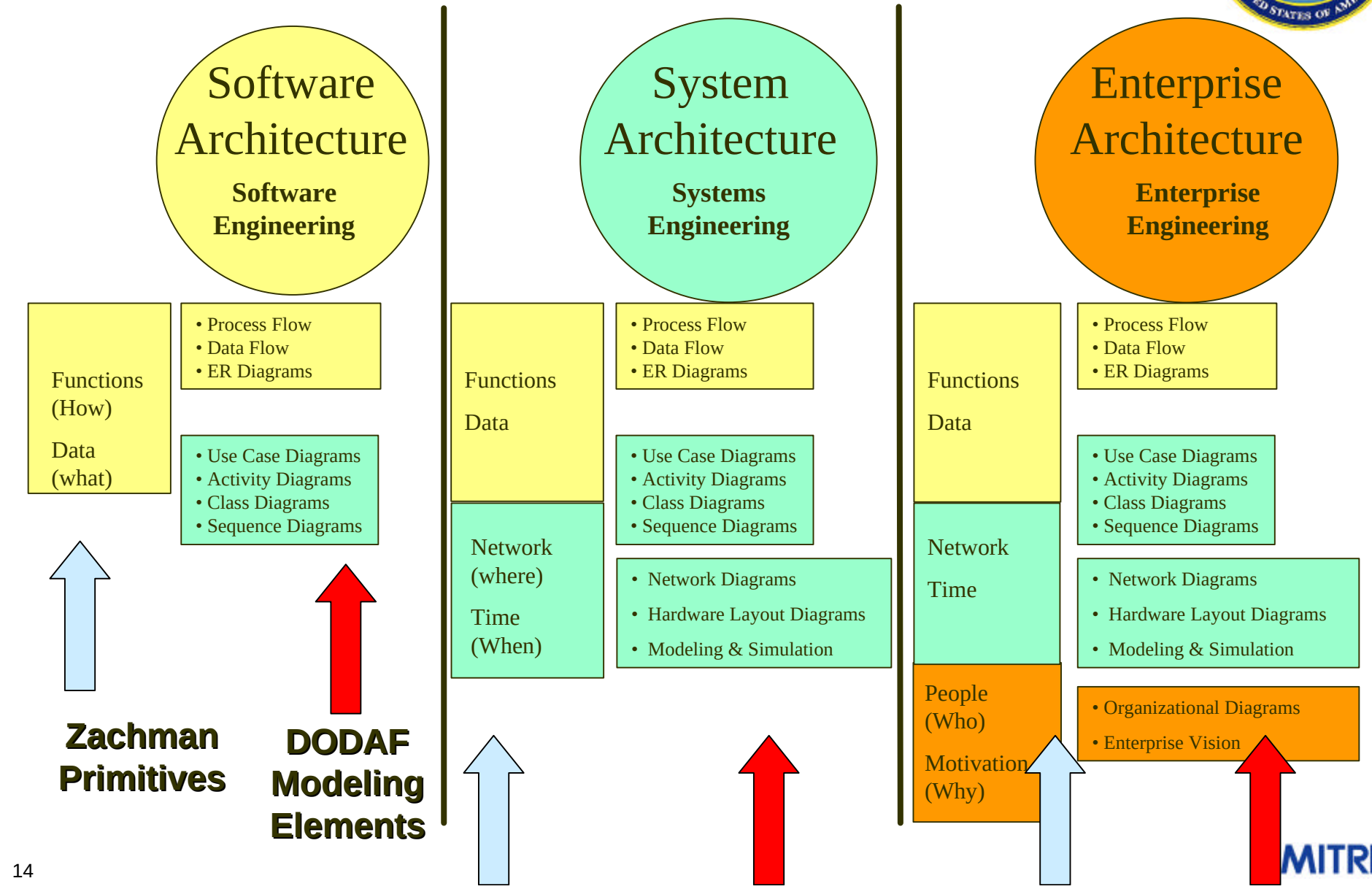
# Aspects of Modeling



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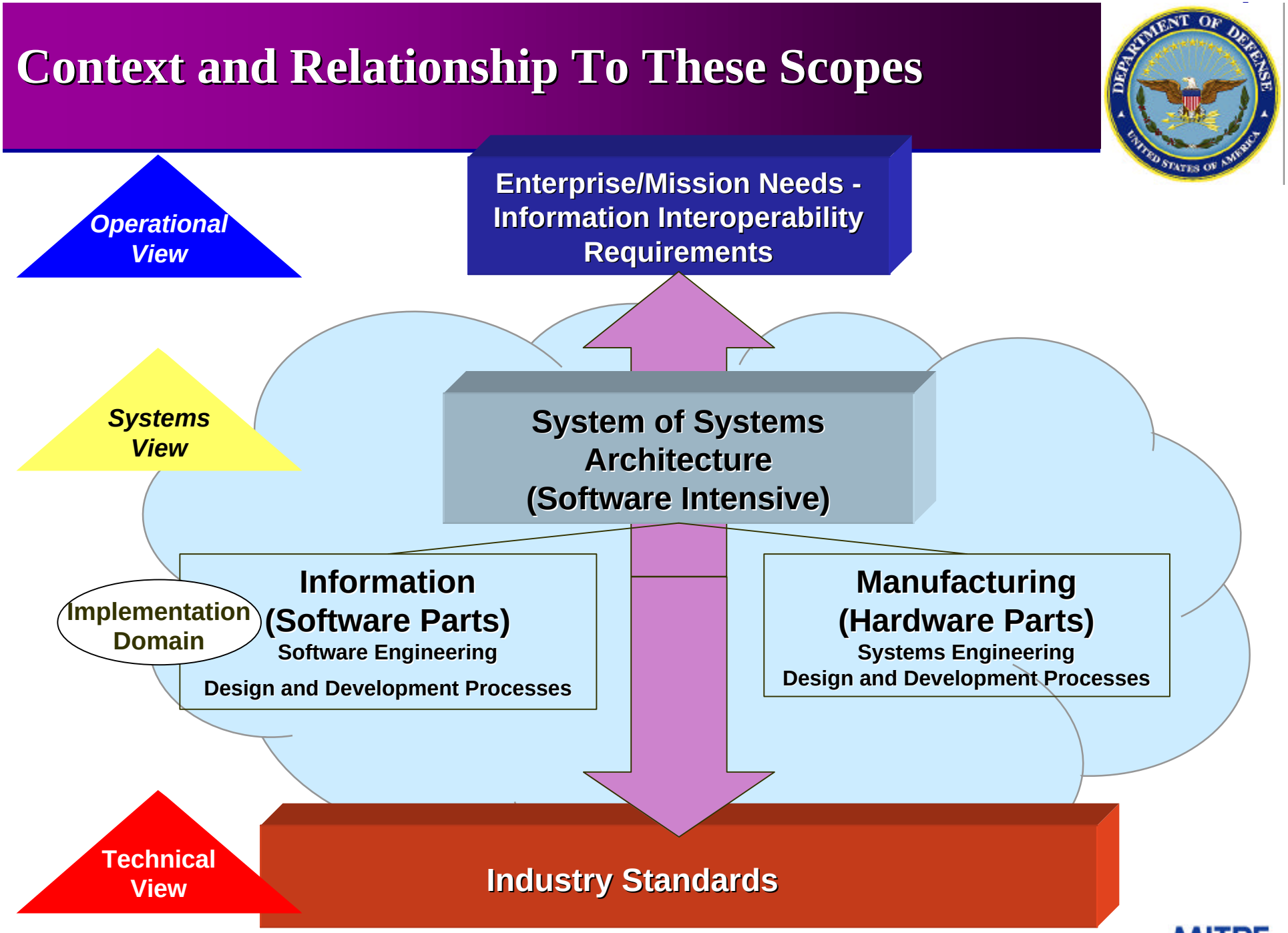
# Context and Relationship To These Scopes



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# Changes In Product Definitions


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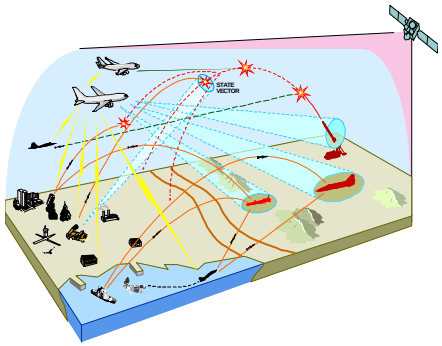
# DODAF Architecture Products

| Applicable View | Framework Product | Framework Product Name |
|---|---|---|
| All Views | AV-1 | Overview and Summary Information |
| All Views | AV-2 | Integrated Dictionary |
| Operational | OV-1 | High-Level Operational Concept Graphic |
| Operational | OV-2 | Operational Node Connectivity Description |
| Operational | OV-3 | Operational Information Exchange Matrix |
| Operational | OV-4 | Organizational Relationships Chart |
| Operational | OV-5 | Operational Activity Model |
| Operational | OV-6a | Operational Rules Model |
| Operational | OV-6b | Operational State Transition Description |
| Operational | OV-6c | Operational Event-Trace Description |
| Operational | OV-7 | Logical Data Model |
| Systems | SV-1 | Systems Interface Description |
| Systems | SV-2 | Systems Communications Description |
| Systems | SV-3 | Systems-Systems Matrix |
| Systems | SV-4 | Systems Functionality Description |
| Systems | SV-5 | Operational Activity to Systems Function Traceability Matrix |
| Systems | SV-6 | Systems Data Exchange Matrix |
| Systems | SV-7 | Systems Performance Parameters Matrix |
| Systems | SV-8 | Systems Evolution Description |
| Systems | SV-9 | Systems Technology Forecast |
| Systems | SV-10a | Systems Rules Model |
| Systems | SV-10b | Systems State Transition Description |
| Systems | SV-10c | Systems Event-Trace Description |
| Systems | SV-11 | Physical Schema |
| Technical | TV-1 | Technical Standards Profile |
| Technical | TV-2 | Technical Standards Forecast |

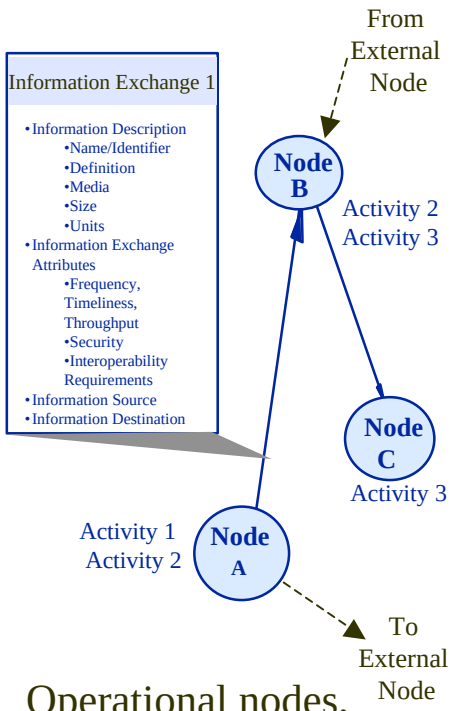
# Operational View Captures Critical Mission Relationships and Information Exchanges

## High-Level Operational Concept Description



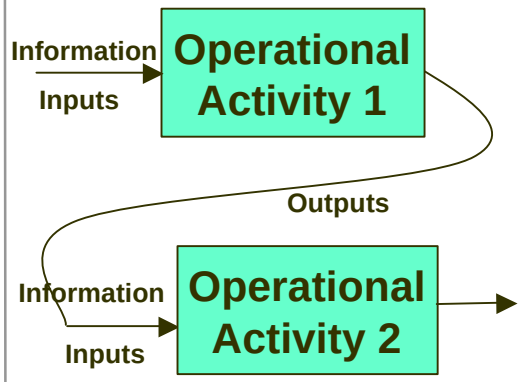
High-level graphical description of the operational concept of interest

## Operational Node Connectivity Description



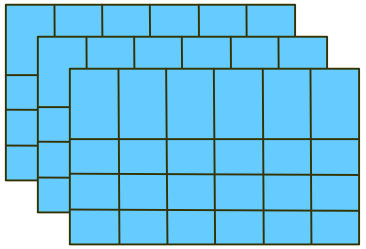

Operational nodes, activities performed at each node, node-to-node relationships, and information needlines

## Operational Activity Model




Operational activities, information inputs and outputs, conditions

## Operational Information Exchange Matrix



Summary of Information exchanged between nodes with attributes, such as security, timeliness



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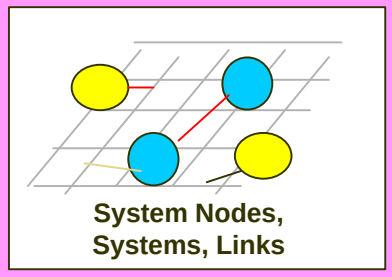
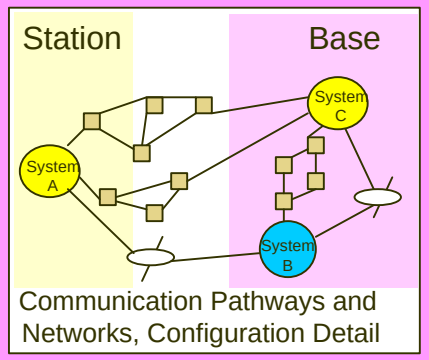
# Systems View Captures Systems, Functions Performed, Data, and Network Layout



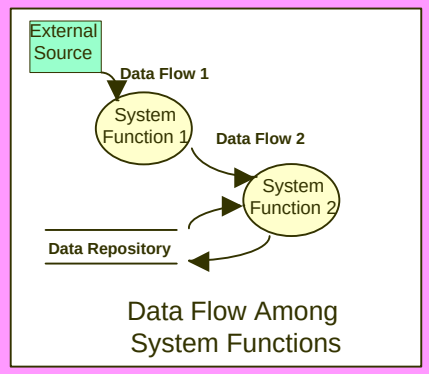

Can include systems, H/W & S/W Items, Interfaces (conceptual), System Functions

**Systems Interface Description SV-1**



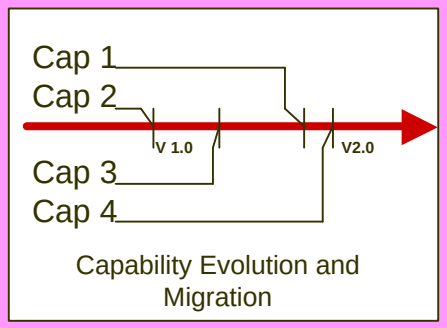

Can include systems, communications nodes, networks, paths, Links forming path, protocols supported

**Systems Communications Description SV-2**




Includes data sources and sinks, repositories, data flows between system functions

**Systems Functionality Description SV-4**




Describes planned systems evolution over time

**Systems Evolution Description SV-8**



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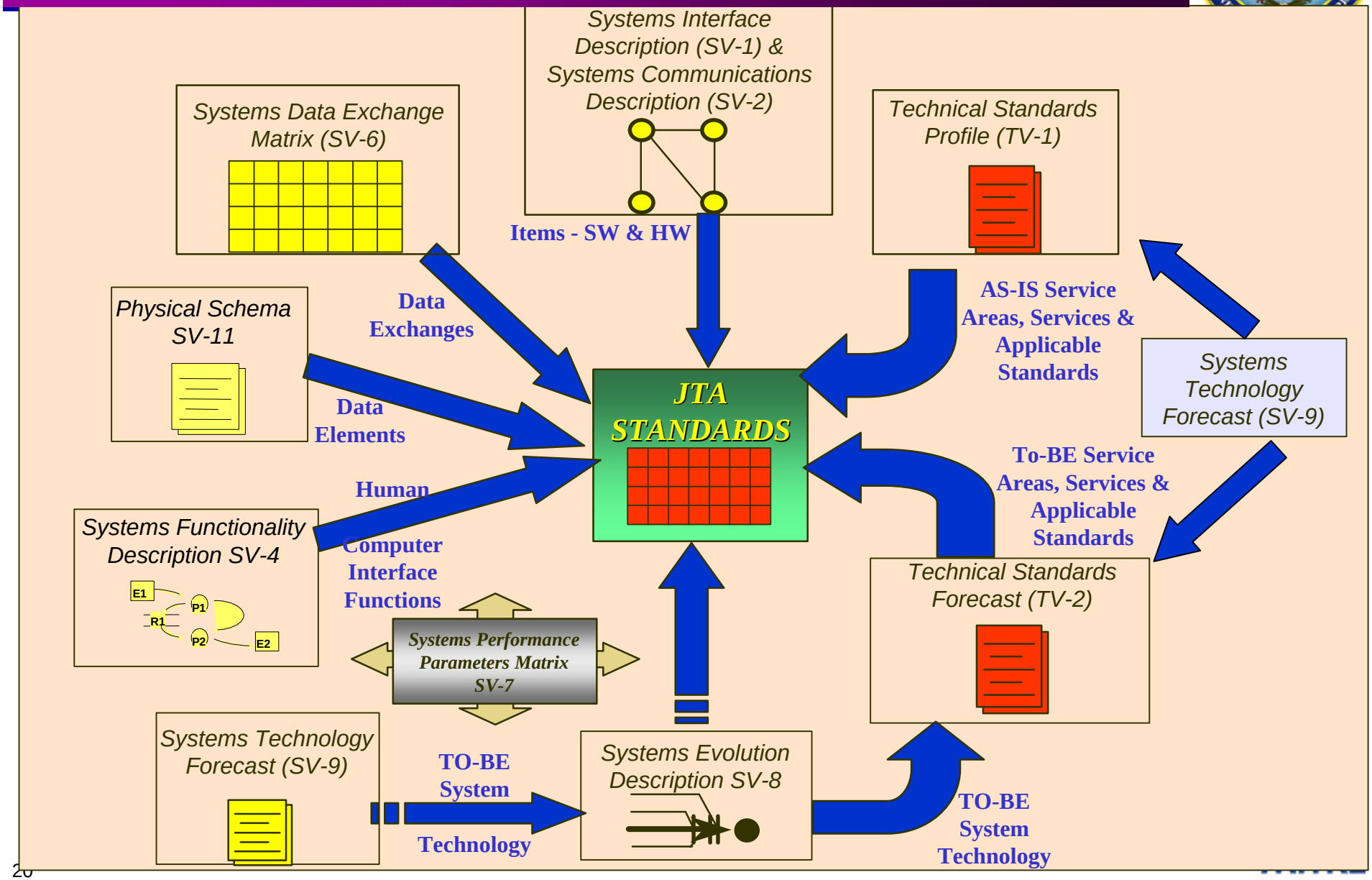
# TV-1 Correlates Standards To Systems View Architecture Elements



# Architecture Uses


## Capabilities-Based Methodology

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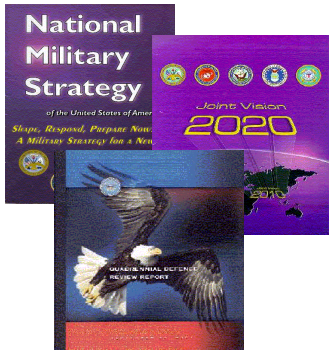
# Capabilities-Based Methodology*

- **The new Capability-Based Methodology:**
  - Drive “jointness” from the top-down, strengthening joint warfighting capabilities
  - Links strategic direction to strategic investment decision making and acquisition policy
  - Enables a more responsive acquisition system
  - Integrates materiel and non-materiel solutions to capability gaps and shortfalls
  - Frames discussions of alternatives using common language of metrics
  - Provides an engine for force transformation

***Source: J8**

# Today's Process

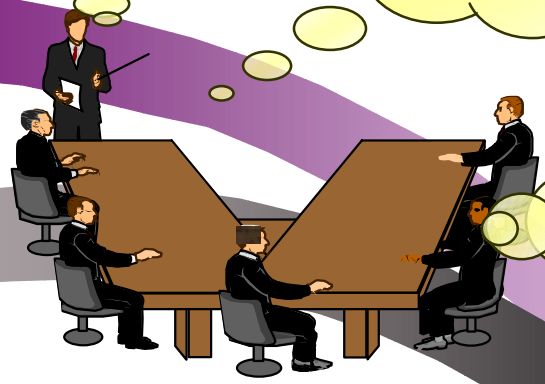
## Guidance



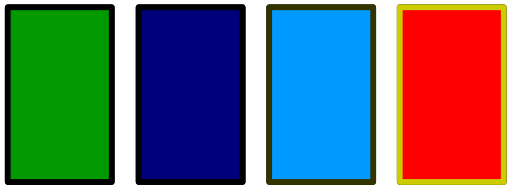

Interoperability?

Requirements Based?

Impact on:
Doctrine?
Organizations?
Training?
Leadership?
Facilities?
(DOTLPF)



**JROC**



**Bottom up, Proposed Materiel (M) Solutions**

**Decisions Based on**

- Experience
- Staff Support
- Judgement
- Intuition

## Platforms

*Source: J8



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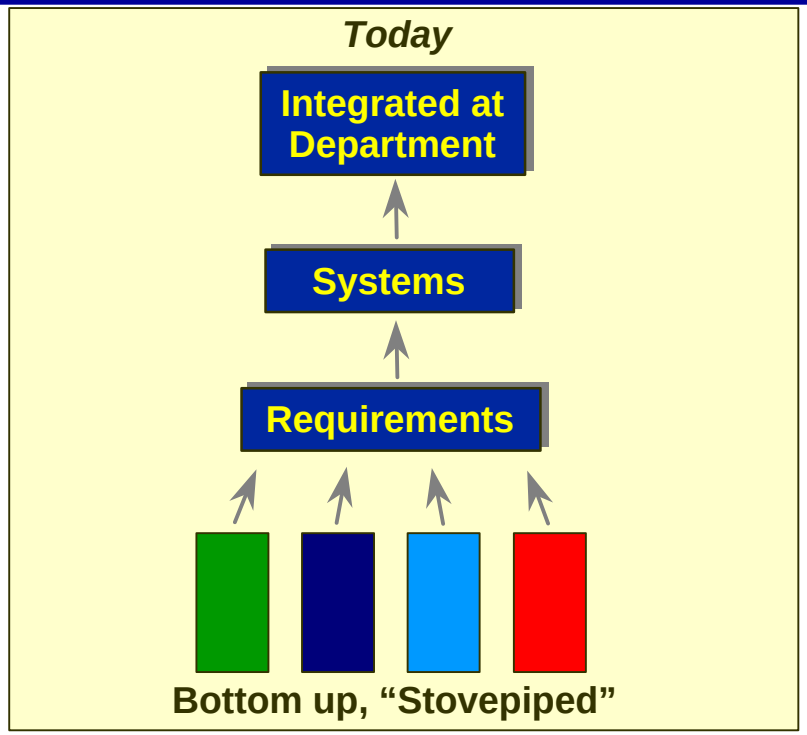
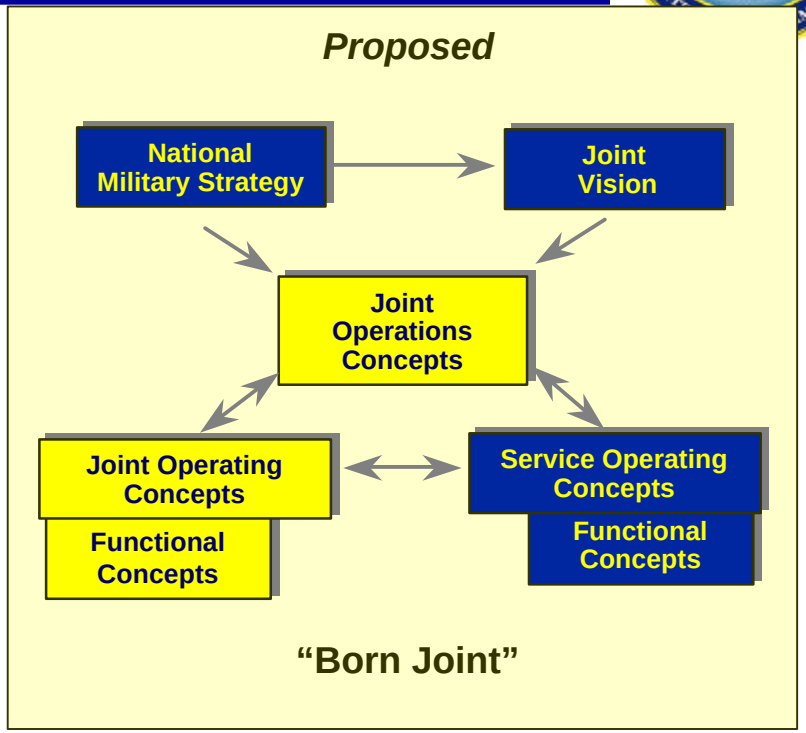
# Capabilities-Based Methodology*




- ✓ Improved analytical rigor will better define the capabilities we need and those we no longer need.
- ✓ Capabilities-based planning counters threats that pose the greatest danger without predicting specific contingencies.
- ✓ Scenarios illuminate possible outcomes of potential contingencies and test capability needs.
- ✓ Resource constraints impact implementation plans, not capability needs determinations.
- ✓ Focusing leadership earlier in the decision process ensures a more coordinated implementation effort within resource constraints.

*Source: J8



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# Capabilities-Based Methodology

- **Capability-based analysis:**
  - A capability is described by Operational Activity Model + DOTMLPF Attributes + Operational Activity Sequence and Timing Descriptions
  - New SV-5 Matrix relates Operational Activities to System Functions, Operational Activities (in an operational thread) to Capabilities, and Capabilities to Systems

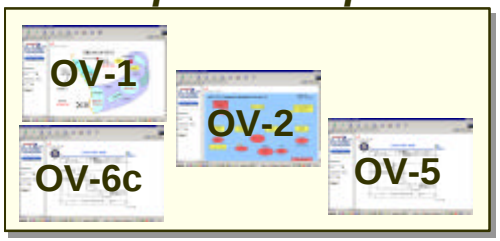
# SV-5 Maps Capabilities to Systems

| | | Capability 1 | | | Capability 2 | | | | Capability 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operational Activity A | Operational Activity B | Operational Activity C | Operational Activity D | Operational Activity E | Operational Activity F | Operational Activity A | Operational Activity E | Operational Activity G | Operational Activity H |
| System 1 | System Function A | ● | | ● | | | | ● | | ● | |
| | System Function B | | | | | ● | | | ● | | |
| | System Function C | | ● | | | | | | | | ● |
| System 2 | System Function B | | | | ● | | | | | | |
| | System Function D | | | | | | ● | | | ● | |
| | System Function E | | | | ● | | | | | | |
| | System Function F | | | | | | | | | | ● |

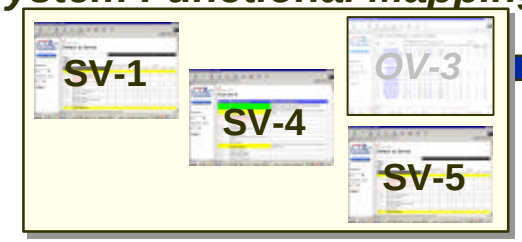
# Architecture Development and Assessment*

There are dependencies between the architecture products that are not shown. Many of the products are developed Iteratively

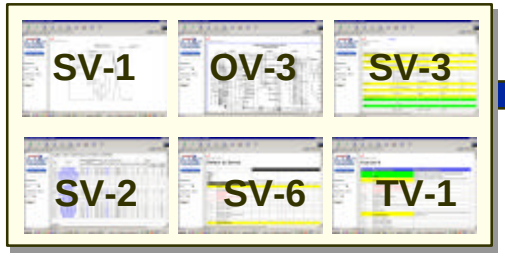
***Concept Development***



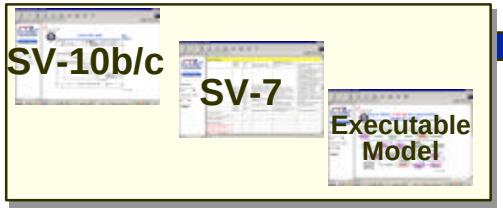

***System Functional Mapping***




***System Interfaces & Data Flow***




***System Performance & Behavior***




**1st Order Analysis: System Functionality**

**Functional Assessment**

**2nd Order Analysis: Connectivity & Interoperability**

**Static Interoperability Assessment**

**3rd Order Analysis: Dynamic Interoperability**

**Dynamic Performance Assessment**

**Capabilities**

***Gaps Duplications***

***Interoperability***

***Mission Area Performance***

*Source: J8



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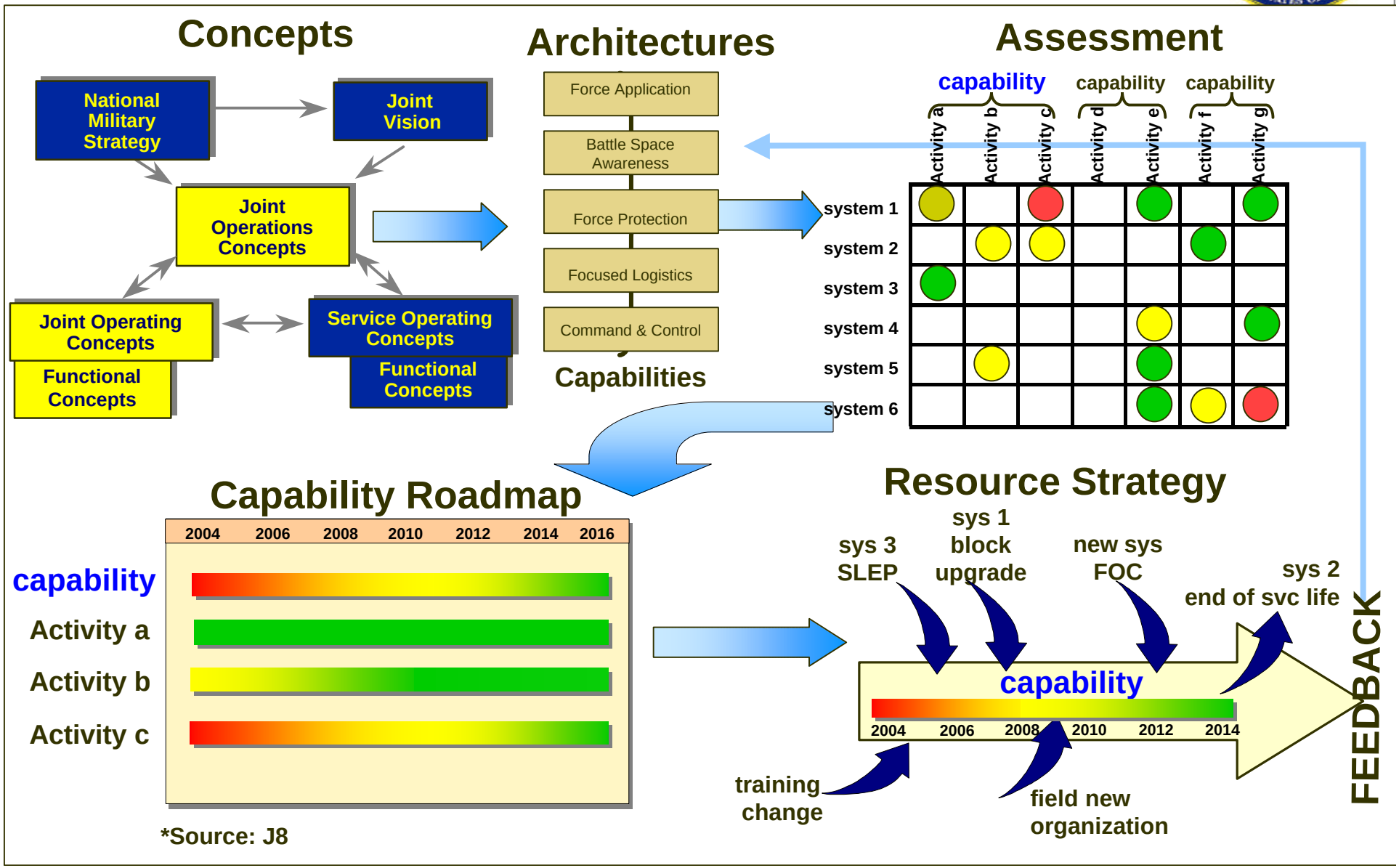
# Capabilities-Based Methodology



# Example Architecture


## NORTHCOM Architecture

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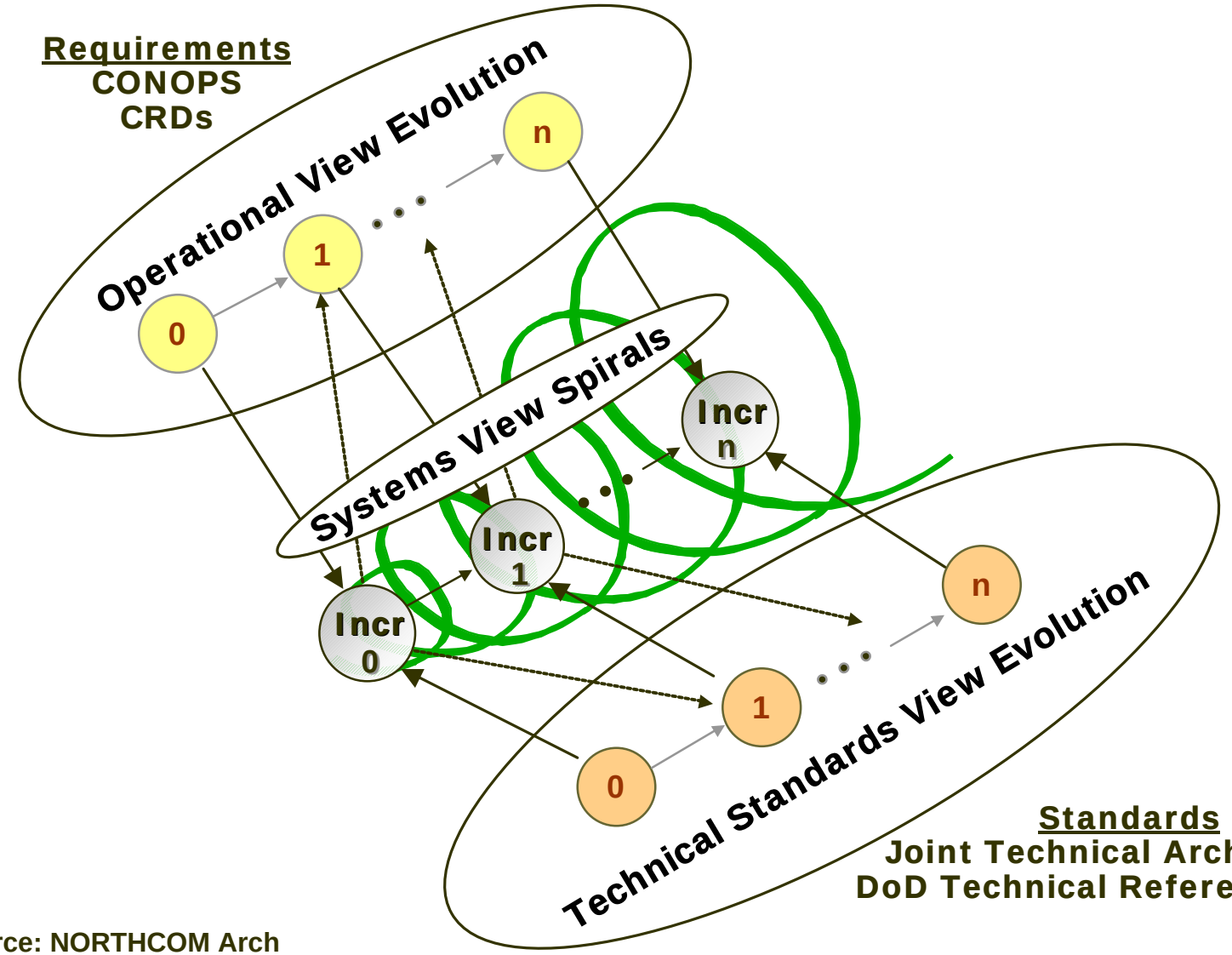
# NORTHCOM Architecture Approach*




*Source: NORTHCOM Arch



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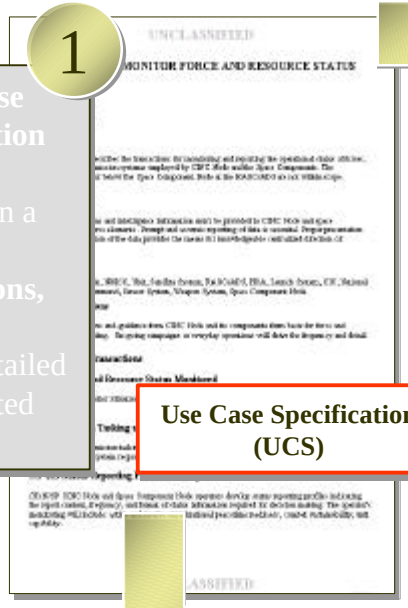
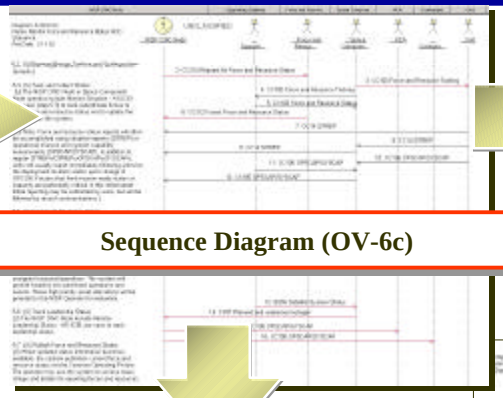
# NORTHCOM Architecture Approach*

1

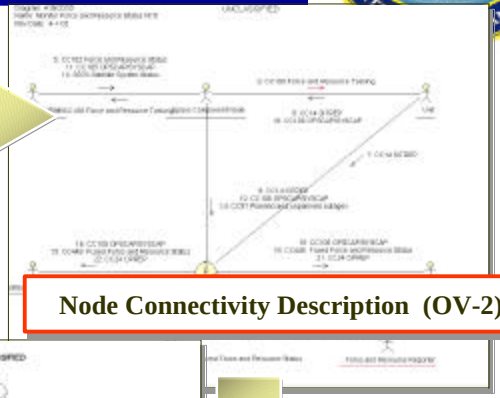
A **Use Case Specification** discusses behavior in a series of **transactions,** which are further detailed in associated artifacts.



**Use Case Specification (UCS)**

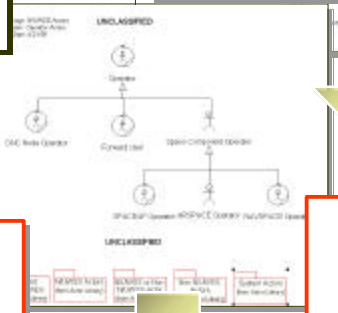


**Sequence Diagram (OV-6c)**

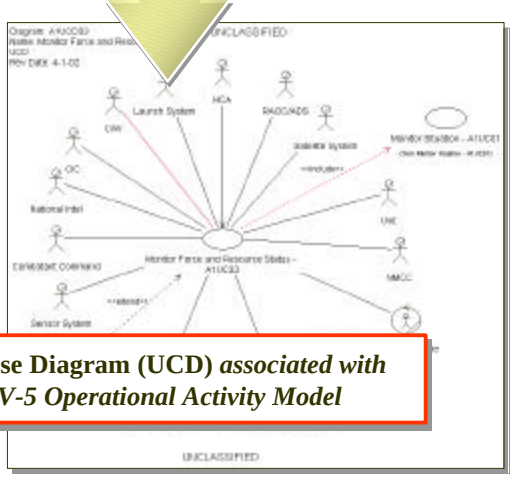


**Node Connectivity Description (OV-2)**

**Information Exchange Requirement (IER) Matrix *associated with OV-3 Operational Information Exchange Matrix***



**CCIC2S Actor Library *associated with OV-4 Command Relationships Chart***

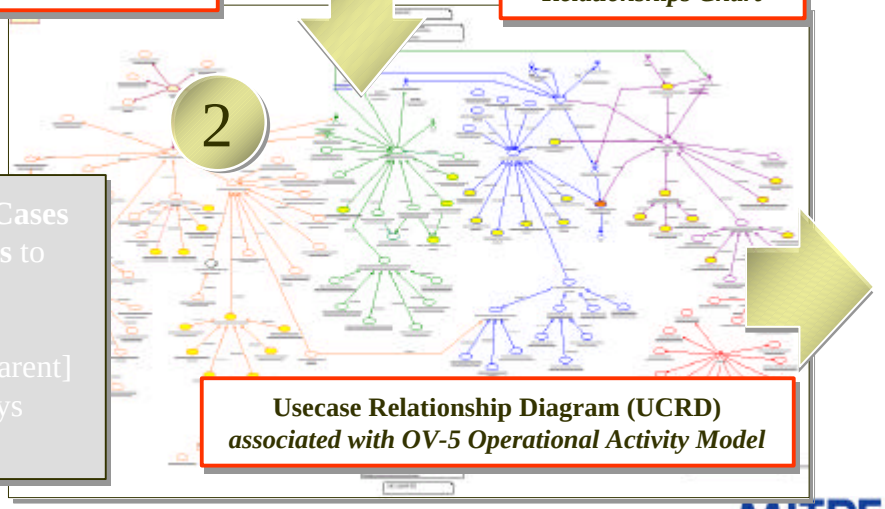


**Usecase Diagram (UCD) *associated with OV-5 Operational Activity Model***

2

OA develops **Use Cases** and **relationships** to each other

- extend [do on a condition from parent]
- include [do always with parent]



**Usecase Relationship Diagram (UCRD) *associated with OV-5 Operational Activity Model***

***Source: NORTHCOM Arch**



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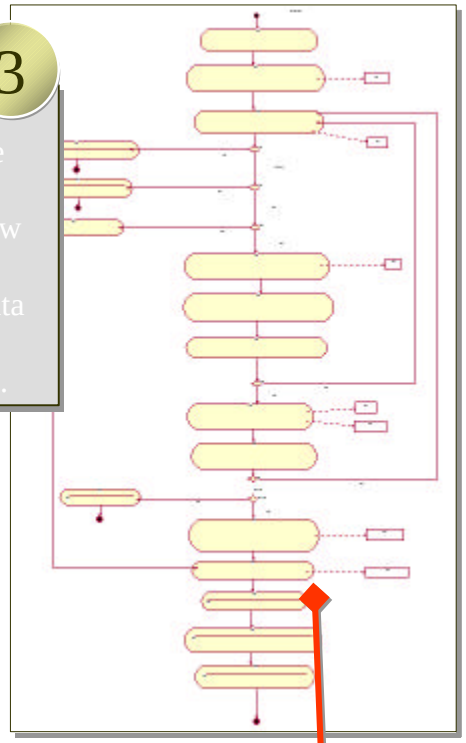
# NORTHCOM Architecture Approach*

3

Use Case **transactions** are modeled and expanded to show flows, decision logic and key data elements in an activity diagram.



**inputs**

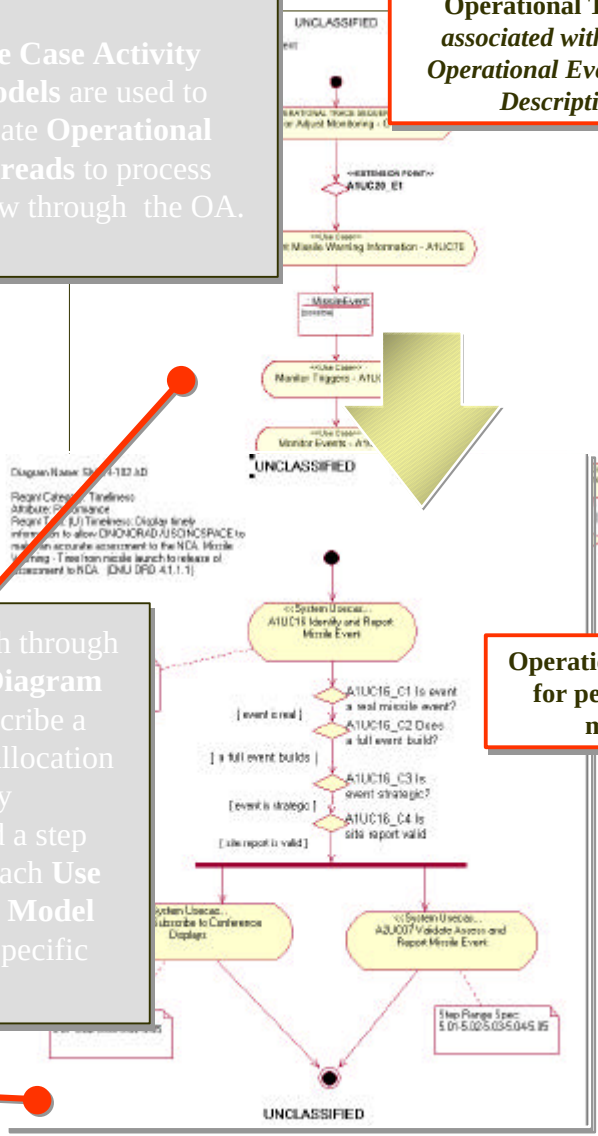
4

**Use Case Activity Models** are used to create **Operational Threads** to process flow through the OA.

**Operational Threads *associated with OV-6c Operational Event/Trace Description***

5

A specific path through the **Activity Diagram** is made to describe a performance allocation identifying key conditions and a step range across each **Use Case Activity Model** identifying a specific behavior.




**Operational Threads for performance metrics**

These items are:
- operationally significant elements
- system stressing elements
- critical data elements

**AFOTEC/17TS Test Planning support**

***Source: NORTHCOM Arch**



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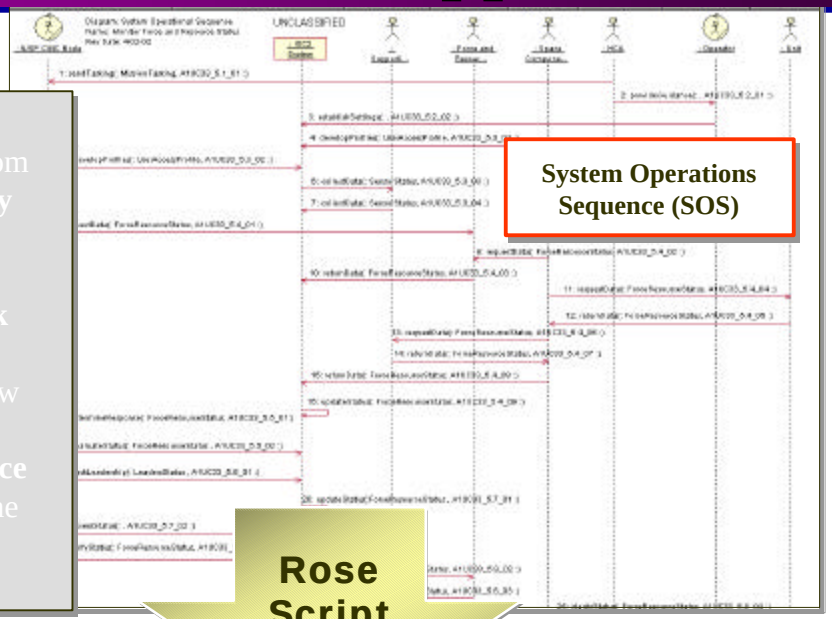
# NORTHCOM Architecture Approach*

6

Use case transactions and decision logic from the **Use Case Activity Diagram** are further decomposed and allocated in the **Black Box (System Responsibilities)** view called the **Systems Operational Sequence** diagram to identify the system boundary

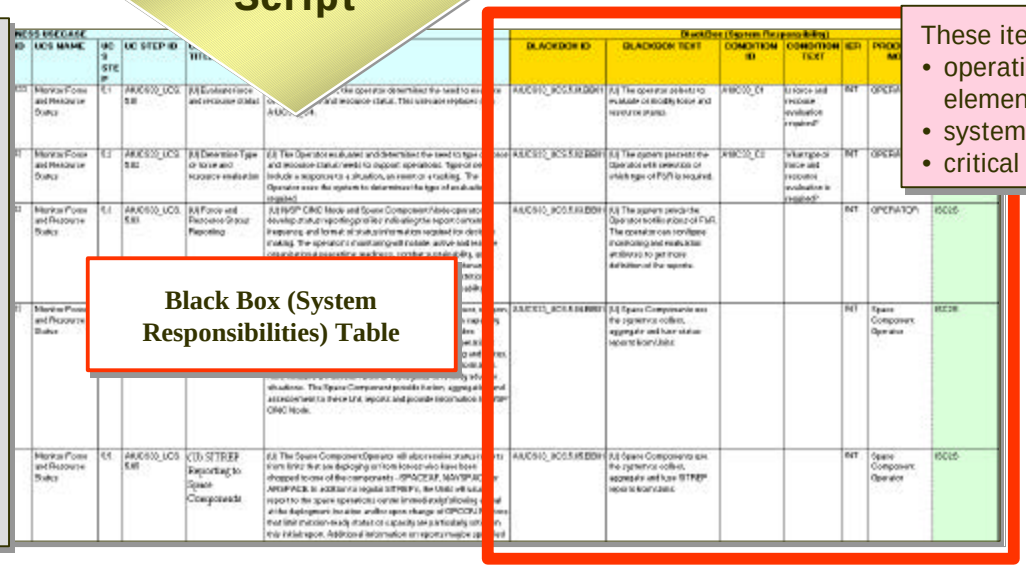


**System Operations Sequence (SOS)**

**Rose Script**

7

The **Black Box (system responsibilities)** are extracted from Rational Rose and synchronized with developer's requirements tool to show traceability across originating business use case transaction, IER association and real-world actor/role



**Black Box (System Responsibilities) Table**

These items are:
- operationally significant elements
- system stressing elements
- critical data elements



***Source: NORTHCOM Arch**

# Architecture Uses Summary

**Architectures Provide the Framework for FoS/SoS Systems Engineering & Acquisition**

# Standards Initiatives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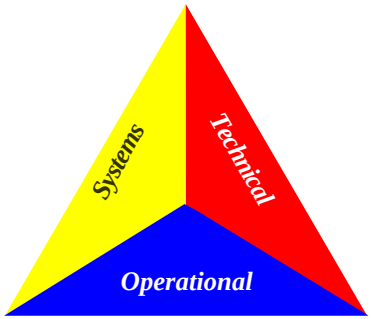
# Pillars for a Common Approach for Developing Architectures




## DoD Architecture Framework (DODAF)

Common approach for developing an architecture description

## Common Underlying Meta Model

Common underlying structure for capturing architecture data & Relationships



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# Benefits of Architecture Meta-Data Standardization

- **Reuse of data**
- **Consistency that facilitates integration**
- **Flexibility in partitioning of data from different points of view**
- **Ability to use automated architecture and modeling tools interchangeably**
- **Better support for analysis and decision-making**

Increased emphasis on development of *integrated architectures*

De-emphasis of an architecture product-by-product approach

# Architecture Modeling Standards

- **Architecture modeling standards are still evolving, chance to help define and contribute**
- **Initiatives underway to address this need**
  - ISO 10303 (AP-233) standards effort for SE data interchange and tool interoperability
  - INCOSE / OMG effort to extend UML to modeling of systems

*** Sanford Friedenthal, 2003**

# The Way Ahead


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# Areas for Possible Research

- **Validate and Clarify the *information* definitions provided by the DoDAF**
  - To capture the architecture data elements (object and relationships) described by DoDAF
  - Use DoDAF definitions to define an object model
- **Validate and Clarify the *notation* definitions intended by DoDAF**
  - Adjust the object and relationship definitions to include graphics (e.g., modeling notation) and/or formatting characteristics that are required to be common
- **Facilitate the common usage of such a model**
  - Define an ontology: identify the generalizations / specializations (supertypes / subtypes) that are appropriate
  - Provide clear, concise descriptions for all the data elements

# Areas for Possible Research (Cont'd)

- **Benefits - A DODAF model will:**
  - Provide a common set of objects and relationship definitions (requirements) that can be used by tool vendors to supply software tools that support the development of DoDAF-Compliant architectures
  - Provide a common set of objects and relationship definitions against which a standard interface can be defined to:
    - Enable the sharing of architecture model / products between different tools
    - Enable the implementation of a common repository for architecture data

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# Deskbook


W900

CI2

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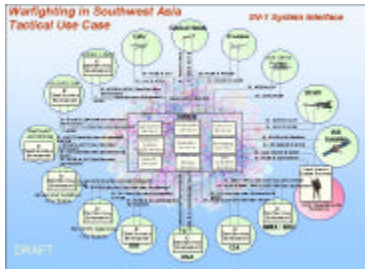
# Deskbook: Supplementary Material Areas Addressed

- **Several techniques for developing architectures**
  - Two architecture development processes
  - Notional examples of selected products portraying Network Centric Operations Warfare (NCOW)
  - Representing the role of humans in architectures
  - Description of a Capability Maturity Profile
  - Security and Information Assurance Architecture
  - Developing architecture descriptions at increasing levels of detail



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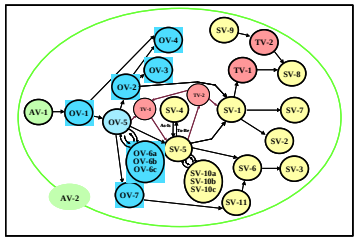
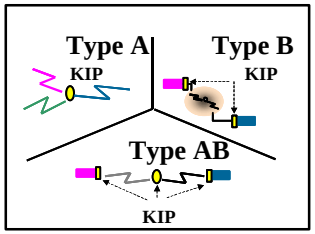
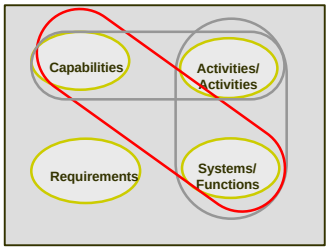
# Deskbook: Supplementary Material Areas Addressed

- **Analytical techniques for using architecture information to support DoD processes**
  - Air Force's Task Force capability-based analysis
  - Navy's Mission Capability Package analysis approach
  - OASD(NII)/J6 Key Interface process for addressing interoperability at interfaces
  - Architecture input to C4I Support Plans
  - The role of architectures in Capital Planning and Investment Control





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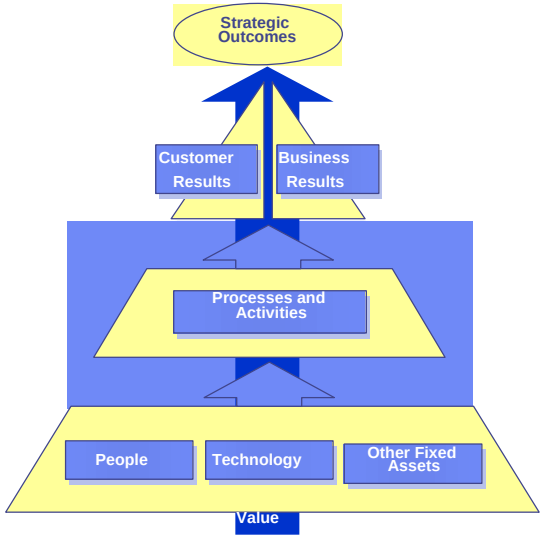
# Deskbook: Supplementary Material Areas Addressed

- **Additional information**
  - CADM support of architectural concepts
  - Criteria and approach for assessing architecture tools
  - Alignment with The Federal Enterprise Architecture (FEA) Reference Models
  - Updated Universal Reference Resources



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