Extending FEA and DODAF
to Support Cost Modeling

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N C S O S E

National Centers for System of Systems Engineering

V M A S C
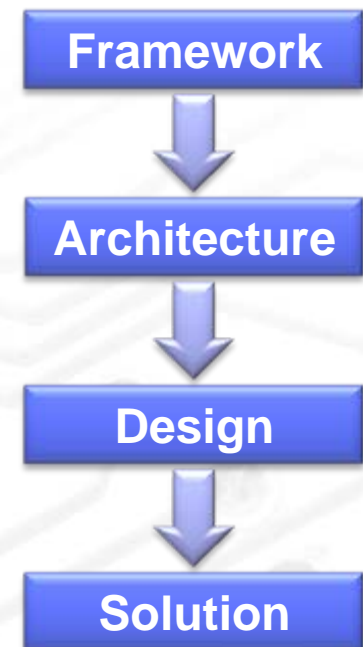
Virginia Modeling Analysis and Simulation Center

Discussion Points

- Frameworks, Architectures, Designs, and Solutions
  - What is an Architecture?
  - Where are the costs?
- Federal Enterprise Architecture (FEA) and the Department of Defense Architecture Framework (DoDAF)
  - Enterprise Capabilities and System Functionalities
  - Define future systems and their interplay with current solutions to close capability gaps with fit for purpose solutions
- Current Research at Old Dominion University
  - Assigning cost to operational functions over the life cycle in the desired resolution
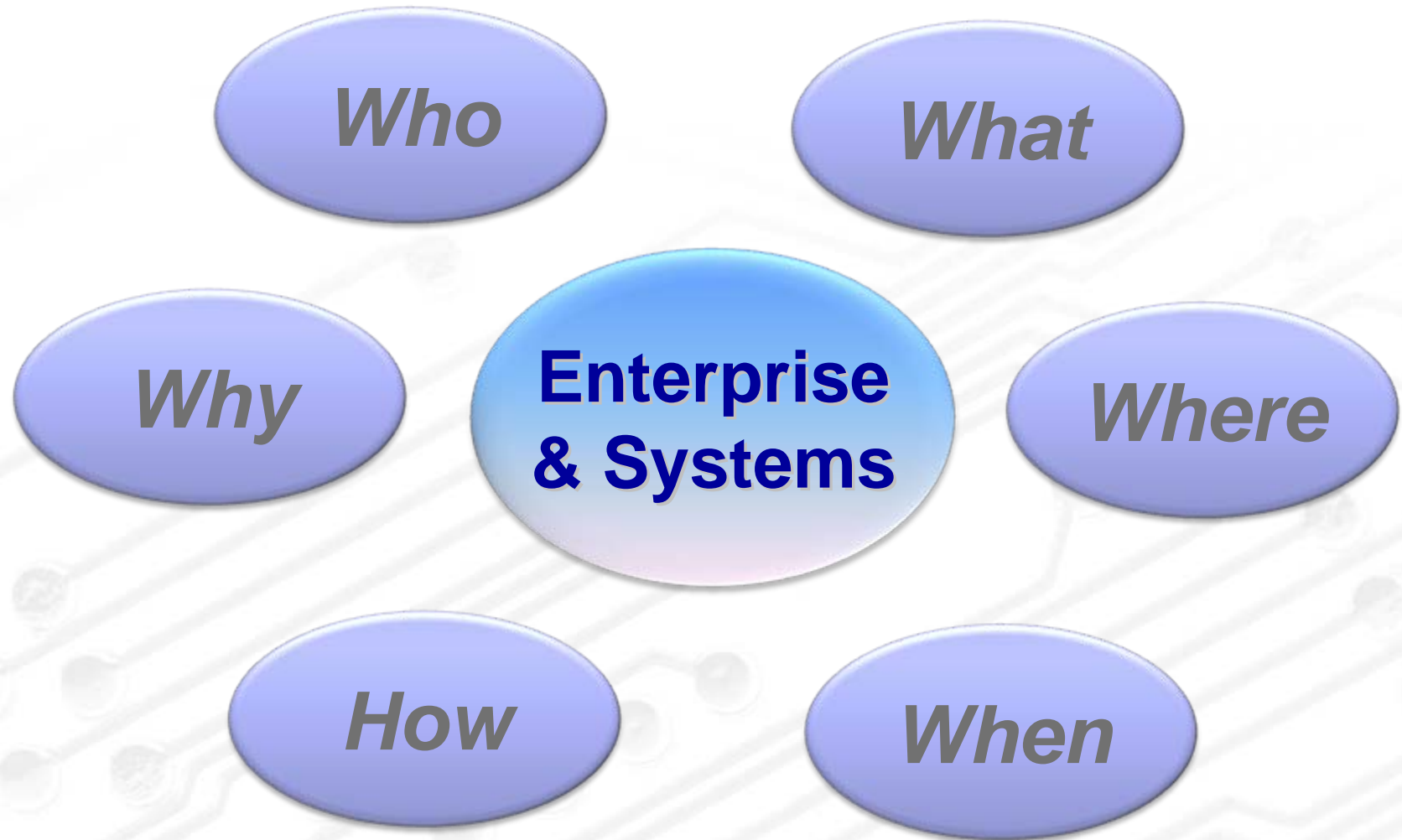 - Extending FEA and DODAF into executable architectures that can be embedded into an operationally validated executable context

What is an Architecture
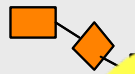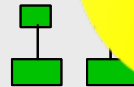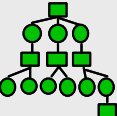
- *The **fundamental organization of a system**, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.*
  [ANSI/IEEE 1471-2000]

- *An architecture describes the most important, pervasive, top-level, strategic inventions, decisions, and their associated rationales about the overall **structure** (i.e., essential elements and their relationships) and associated **characteristics** and **behavior**.*
  [OPEN Process Framework (OPF) Repository]

- *A **formal description of a system**, or a detailed plan of the system at component level to guide its implementation. The structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time.*
  [TOGAF]

Framework

↓

Architecture

↓

Design

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Solution

Interrogatives

Who

What

Why

Enterprise & Systems

Where

How

When

abstractions / perspectives	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE	TIME	MOTIVATION *Why*
SCOPE *Planner* contextual	List of Things - *Important to the Business* Entity = Class of Business Thing	List of Processes - *the Business Performs*	List of Locations *in which*	List of	List of	List of Business Goals and Strategies Major Business Success Factor
ENTERPRISE MODEL *Owner* conceptual	e.g., Semantic Model Entity = Bus... Rel. = Busi...					...n ...ctive ...ategy ...odel
SYSTEM MODEL *Designer* logical	e.g., Logic... Entity = Data En... Rel. = Data Re...					...al Assertion ...tion Assertion
TECHNOLOGY CONSTRAINED MODEL *Builder* physical	e.g., Physical ... Entity = Tables/Se... Rel. = Key/Pointe...	...Proc... =D...			...at Cy... ...ponent Cycle	...Rule Design End = Condition Means = Action
DETAILED REPRESEN-TATIONS *Subcontractor* out-of-context	e.g. Data Definit... ...ty = Field Rel. = Address	...Progra... Process= Language Statement I/O = Control Block	...e Node = Addresses Link = Protocols	People = Identity Work = Job	e.g. Timing Definition Time = Interrupt Cycle = Machine Cycle	e.g. Rule Specification End = Sub-condition Means = Step
FUNCTIONING ENTERPRISE	DATA Implementation	FUNCTION Implementation	NETWORK Implementation	ORGANIZATION Implementation	SCHEDULE Implementation	STRATEGY Implementation

But where are the costs?

John A. Zachman, Zachman International

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Research Effort Category One

TAGGING FUNCTIONS WITH ASSIGNED COSTS

FEA and DODAF

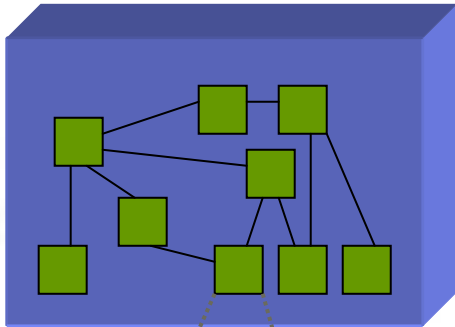## Federal Enterprise Architecture (FEA)

- Business and operational model

- Sets strategic goals

- Defines capability needs

- Constraints the portfolio

- Agile and in flux

DoD Architecture Framework (DODAF)

- Operational-tactical systems

- Defines the systems to accomplish the goals

- Defines the functionality to provide capabilities

- System architectures over the whole life cycle

Enterprise and System Architectures

- **An Enterprise Architecture (EA) Framework describes or prescribes the overall style and structure of an enterprise or organization. It is a blueprint for the organization.**

  It includes the functional components (operational view), the applications or systems that make up the organization (systems view), and enabling technology and standards (technical view).

  Organization Master Plan
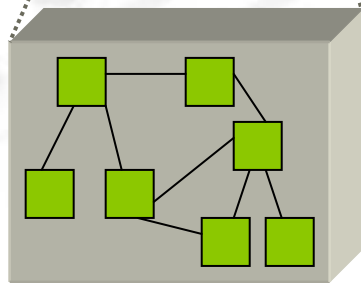
- **A System Architecture describes or prescribes the overall style and structure of a particular system or application within that organization that supports it in accomplishing its goals or mission.**

  This architecture is in accordance with the enterprise architecture framework, and constrains and shapes the detailed design of the system needed to realize it.

  System Master Plan

Federal Enterprise Architecture Framework
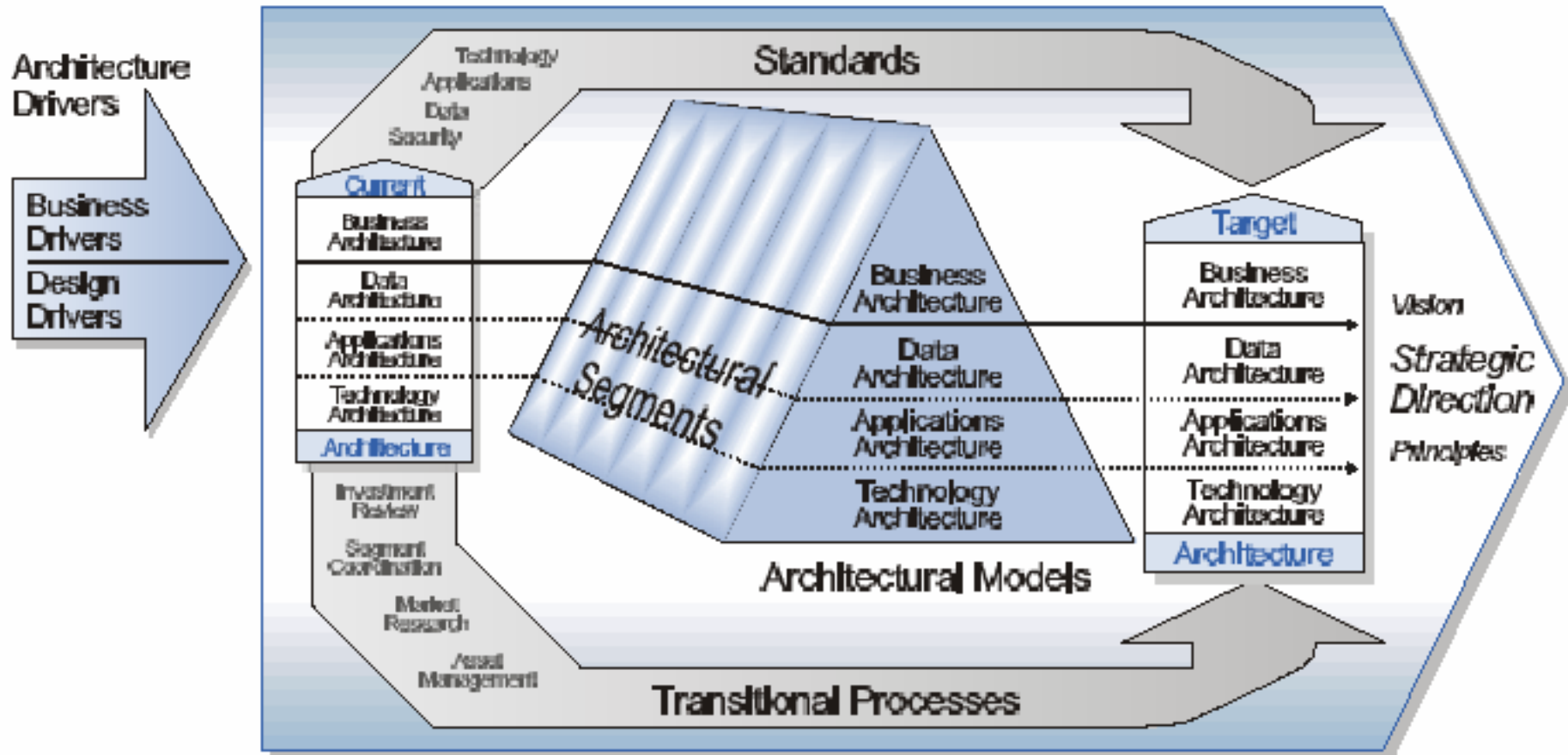
DoD Architecture Framework 2.0
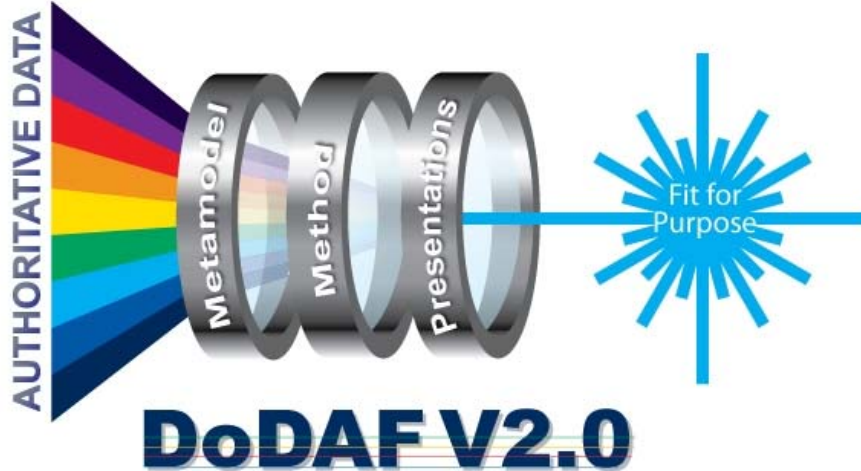
DoDAF V2.0 is the overarching, comprehensive framework and conceptual model enabling the development of architectures to facilitate DoD managers at all levels to make key decisions more effectively through organized information sharing across Department, Joint Capability Areas (JCAs), Component, and Program boundaries.

Support the Department's core processes:
1. Joint Capabilities Integration and Development (JCIDS)
2. Planning, Programming, Budgeting, and Execution (PPBE)
3. DoD Acquisition System (DAS)
4. Systems Engineering (SE)
5. Operations Planning
6. Capabilities Portfolio Management (CPM)

DoDAF Evolution To Support "Fit For Purpose" Architecture

(Published in 2003)

(Published in 2007)
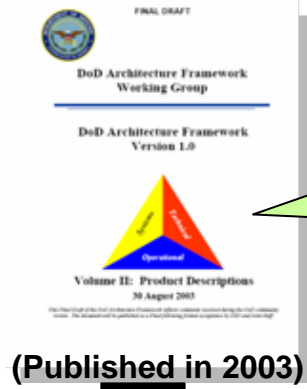
(Published in 2009)

DoDAF 1.0
- CADM Separate
- Baseline For DoDAF 1.5
- Removed Essential & Supporting Designations
- Expanded audience to all of DoD
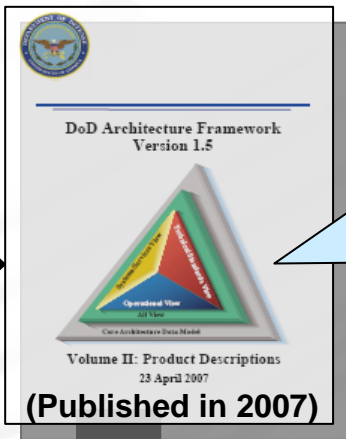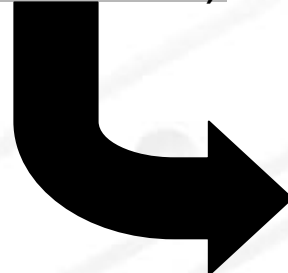
DoDAF 1.5
- Addresses Net-Centricity
- Volume III is CADM & Architecture Data Strategy
- Addresses Architecture Federation
- Baseline for DoDAF 2.0
- Shifted away from DoDAF mandating a set of products
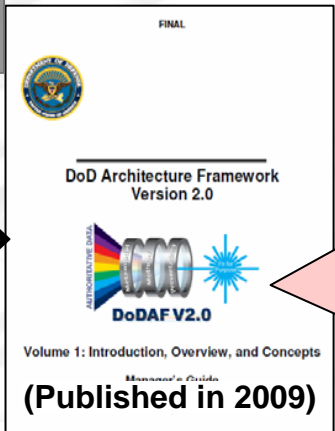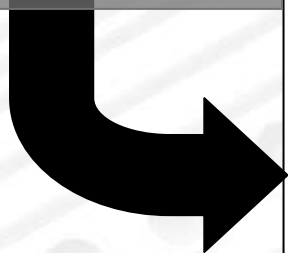
DoDAF 2.0
- Cover Enterprise and Program Architecture
- Emphasize Data versus Products
- Tailored Presentation
- AV-1 to capture federation metadata
- Quality Support to Decision Processes
- FEA & Allied/Coalition Support
- Journal: Errata & Interim Releases

Viewpoints That Fit-the-Purpose

All Viewpoint
Overarching aspects of architecture context that relate to all models

Data and Information Viewpoint
Articulate the data relationships and alignment structures in the architecture content

Standards Viewpoint
Articulate applicable Operational, Business, Technical, and Industry policy, standards, guidance, constraints, and forecasts

Capability Viewpoint
Articulate the capability requirement, delivery timing, and deployed capability

Operational Viewpoint
Articulate operational scenarios, processes, activities & requirements

Services Viewpoint
Articulate the 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.

Data Driven Perspective
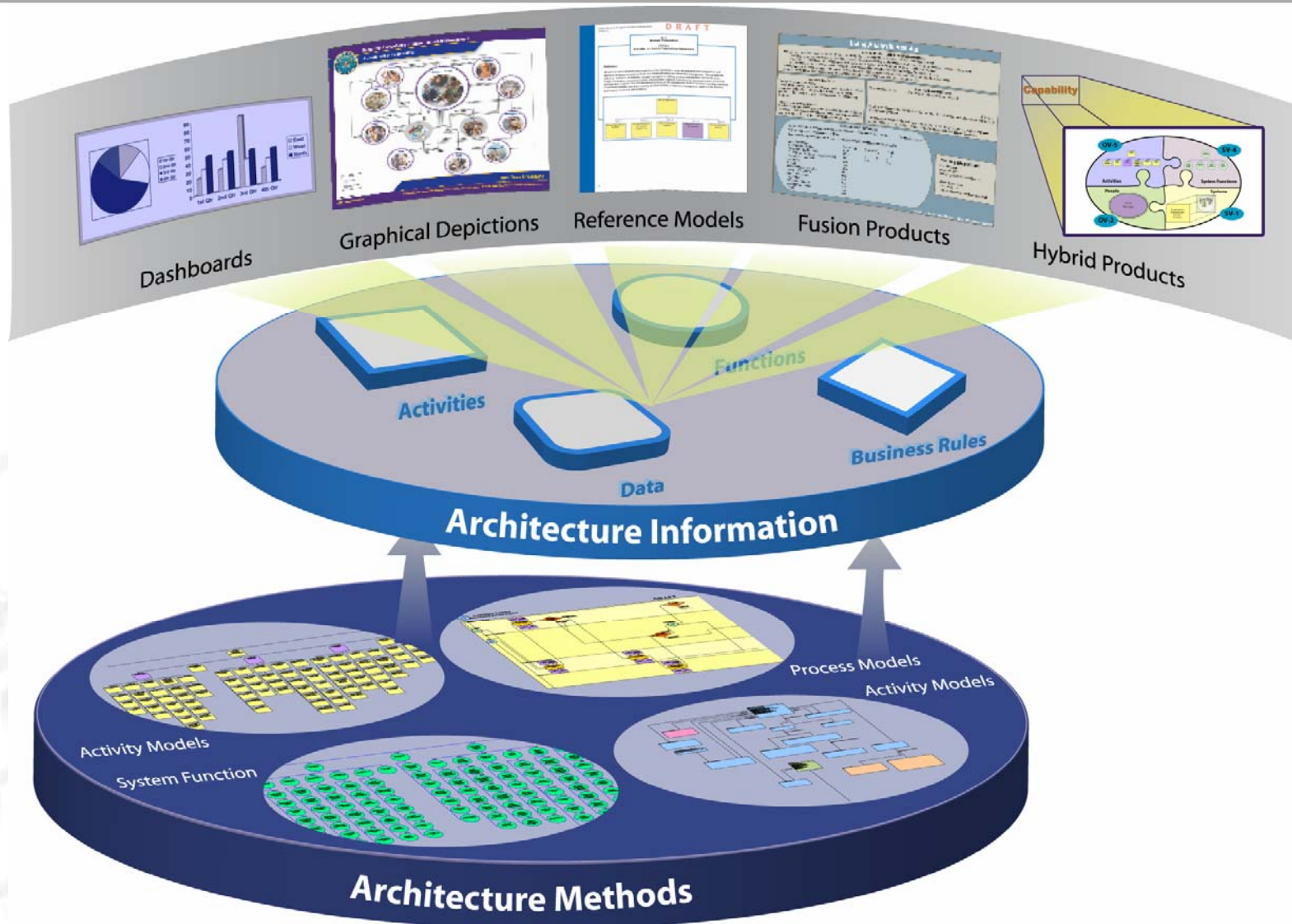
Notional Operational Concept for Strike

Navy Concept for Strike

Use Case Diagram *CombatPower*

Activity Diagram

Information Recipient

Process Mission Updates

Information Source

: ObjectUpdate

<<trigger>>

: DisseminationRule

Determine Mission Processing Needs

: AlertEstablishment

: TrackedTypeList

[alert not required]

[alert required]

[message distribution required]

stored : ObjectUpdate

[message not required]

Present Alerts and Notifications

: CombatPower

: Alert

Sequence Diagram

: Information Source

: DDS

1: update object item (ObjectUpdate)

2: update object item (ObjectUpdate)

3: determine alerts (ObjectUpdate)

4: determine dissemination needs (ObjectUpdate)

Determine Mission Processing Needs

Sequence Diagram

: Information Recipient

: DDS

1: present alerts and notifiactions (Alert, CombatPower)

Present Alerts and Notifications
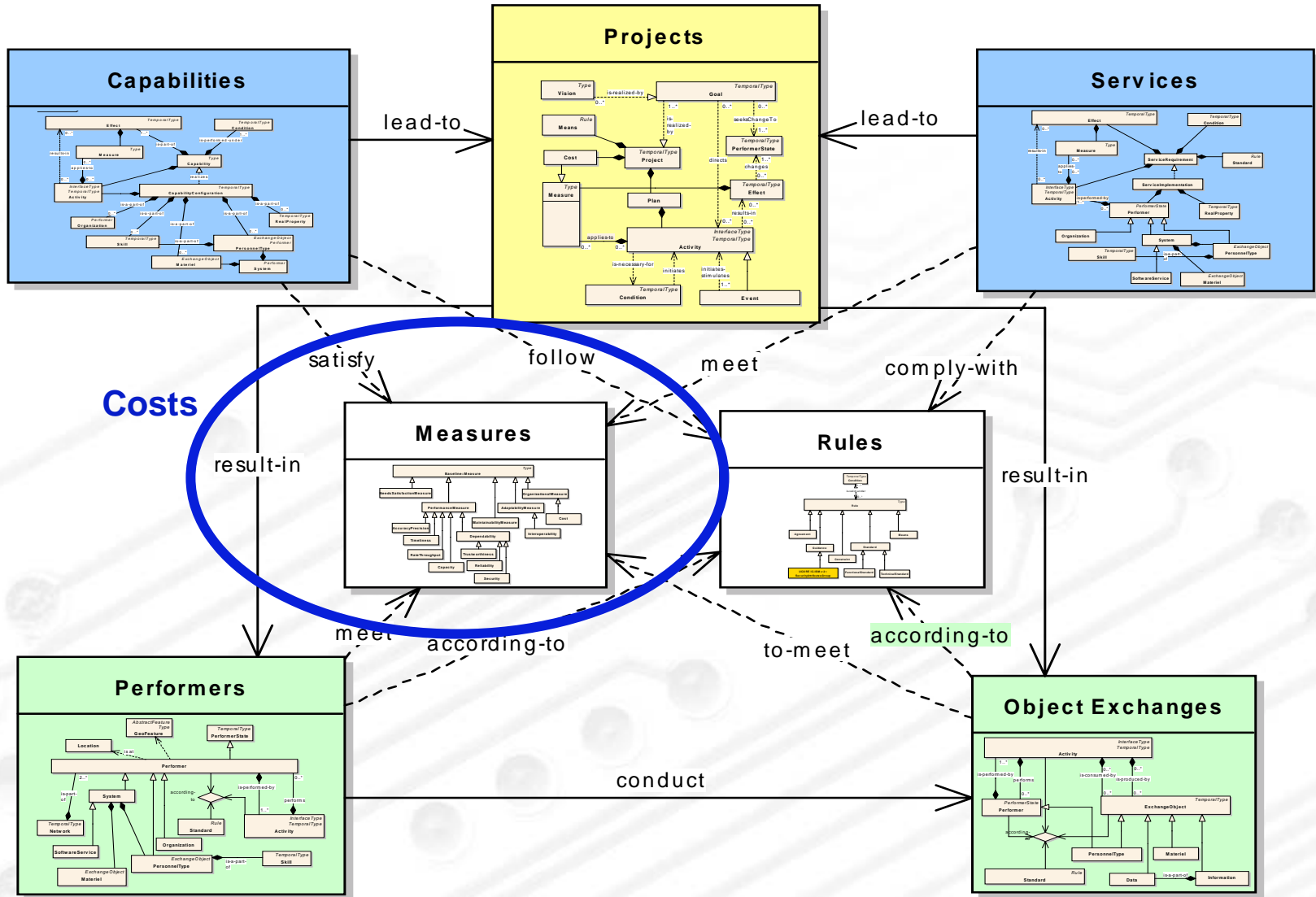
Conceptual View on the DODAF Metamodel

Summary Research Effort One

- FEA defines the operational constraints, including length of life cycles, likelihood of operations, etc.

- DODAF defines portfolios of systems that provide the functions delivering the capabilities

- Operational need and engineering means are captured in mapped data elements

- DODAF allows and encourages the definition of metrics to be associated with all activities

**We can define costs for all activities and use them as metrics in DoDAF!
This allows to not only evaluate for operational efficiency,
But also for budgetary implications of applying the system!**

Research Effort Category Two

EXECUTING ARCHITECTURES IN OPERATIONAL CONTEXTS

Executable Architectures

- So far, we have the cost of each function in the blueprint as the metrics
- Executing the architecture allows to "sum the individual costs up"
- Executing the architecture in the operational context given by FEA allows to realistically evaluate the costs for the system

Why Executable Context?

- Current State of the Art
  - Static Measures support *WHO, WHAT, WHERE*
  - Executable Architecture support *WHEN*
  - Open question: ***WHY*** and ***HOW***
- **System will interact with other (external) system in** the context of the operation
  - Metrics to measure the success of an operation
  - Metrics to measure the contribution of the system
  - Effectiveness and Efficiency based on operational means need to be part of the V&V

Executable Architecture & Context
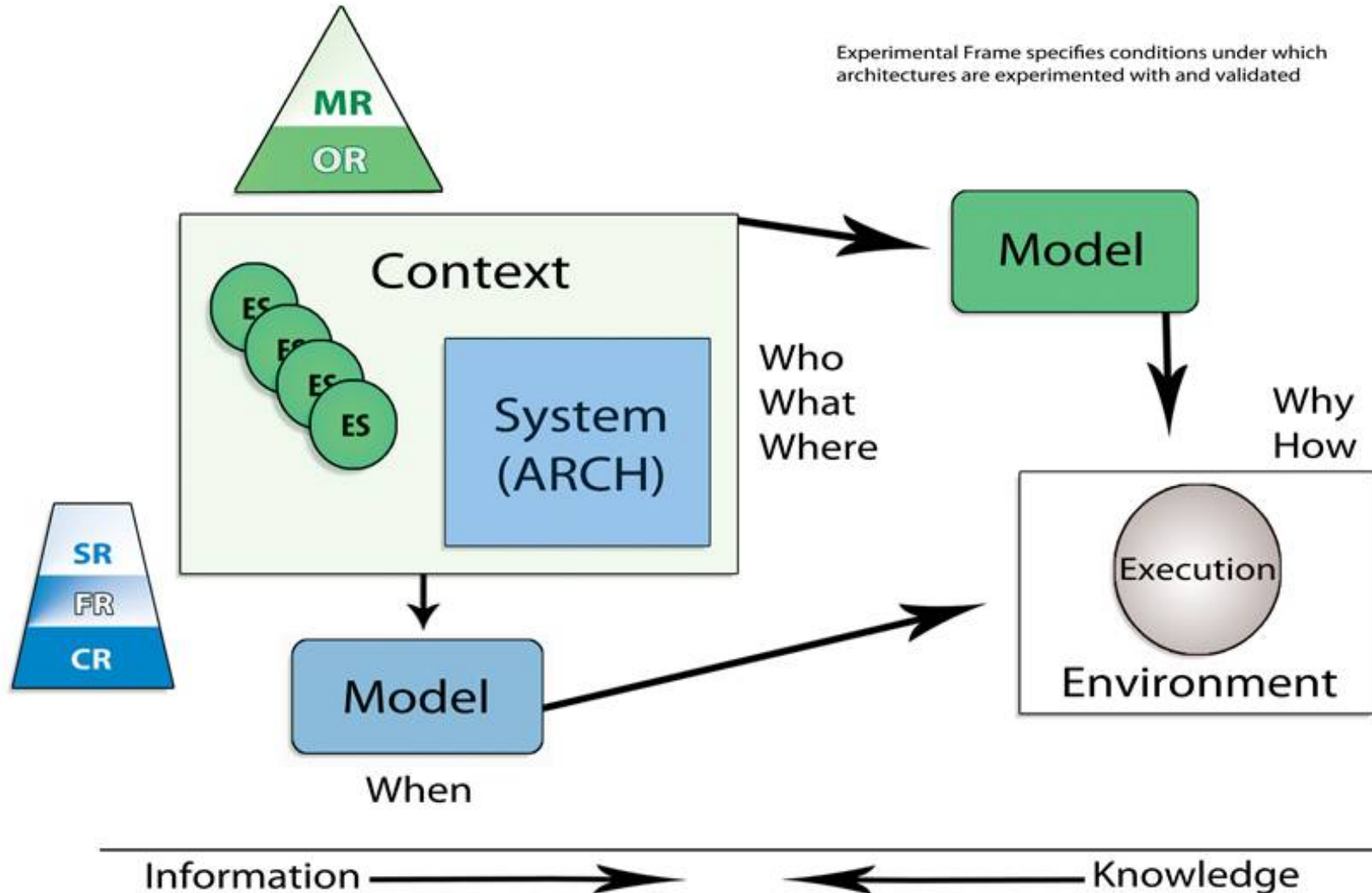
Summary Research Effort Two

- Several system architectures (of systems under development) can be taken into account

- FEA sets parameters for scenarios, DODAF sets cost parameters for the system functions

- Work can be enriched by validated M&S systems embedding the executable systems

- PhD research of **Johnny J. Garcia (SimIS, Inc)** did set the frame for this research efforts

By executing the *Augmented DODAF Architecture* in *FEA Defined Contexts*, we can generate realistic costs in the context of desired scenarios. Life cycle can take more constraints into consideration.

Action Items

- Enrich DODAF (DM2) with cost data for functions
- Enrich operational evaluation with cost evaluation
- What-if analysis possible
  - Constraint function by budgets
  - Optimize operational effectiveness with given budget
  - Show effect of budget costs
- **FEA and DODAF and Cost Estimation can be synchronized!**