

SysEng 6542

Model Based Systems Engineering

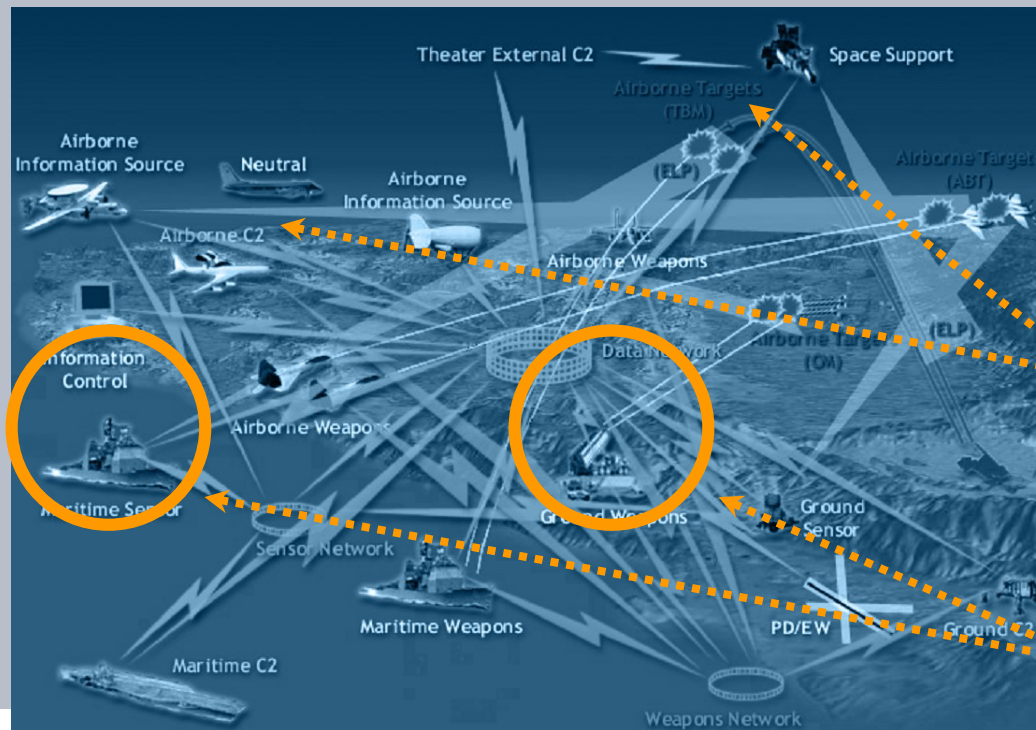
Unified Profile for DODAF and MODAF

Dr Quoc Do

Material provided with courtesy of PTC Software and Matthew Hause

System-of-Systems

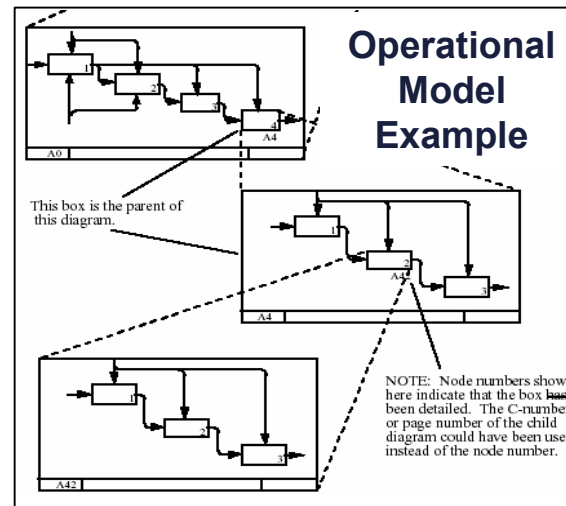
- Modeling Needed to Manage System Complexity



Architecture Models + Data = Architectural Description

- Things
- Individuals
- Types or classes of individuals or things

Architecture
Data + Metadata



Architecture
Models

Fit-for-Purpose (FFP)



Architectural
Description

Fit-for-Purpose describes an architecture that is appropriately focused and directly support customer needs or improve the overall process undergoing change. The models provide **choices**, based upon the decision-maker needs.

Architecture Definitions and Standards

- Architecture: the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time.
 - DoD Integrated Architecture Panel, 1995, based on IEEE STD 610.12, 19903
- The structure of components, their relationships, and principles and guidelines governing their design and evolution over time
 - IEEE STD 610.12
- An architecture is the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment and the principles guiding its design and evolution
 - IEEE STD 1472

Architecture frameworks such as the DoDAF provide a consistent way to organize information about the architecture

Architecture Frameworks Are Essential

- Communicate with others – a wonderful warfighter requirements vetting mechanism
 - Facilitates mutual understanding
 - Becomes the enterprise project tool
- Basis for business process re-engineering
 - Provides the cross mission nature to operational processes
 - Identifies reuse opportunities as we build systems
 - Identifies shortfalls in operations and non value added activities and tasks
 - Demonstrates how system capabilities fit within the warfighter process
- Helps manage change by spiral development and evolutionary acquisition
 - Manage requirements necessary to develop system
 - Develop better policy
 - Streamline organizational relationships both in and outside the enterprise

Architecture Frameworks Benefits

- **Allows**
 - Individuals working on a system to focus their piece while maintaining the big picture context
- **Facilitates**
 - Interoperability, Reuse , Security and Information Assurance
 - Application of Design Patterns
 - Application of Architecture Patterns
 - Modular Open Systems Approach (MOSA)
 - Uniform basis of Trade-off Analysis
- **Defines:**
 - How to structure the presentation of data that is developed in designing the architecture and components of systems
 - Common terms and definitions
 - All areas necessary to completely define the scope
 - Business case (why), timeframes (when), the players involved (who), locations of the players (where), functions of the players (how), data they use to perform their functions (what)

DoDAF defines a way to organize the outputs of system architecture definition activities into a set of standard products

What is UPDM? - Summary

- UPDM is a standardized way of expressing DoDAF and MODAF artefacts using UML and SysML
 - UPDM is **NOT** a new Architectural Framework
 - UPDM is not a methodology or a process
 - UPDM is scheduled to address DoDAF, MODAF, NAF, and DNDAF
- UPDM was developed by members of the OMG with help from industry and government domain experts.
- UPDM has been implemented by multiple tool vendors.
 - May tools supporting UPDM are available now.

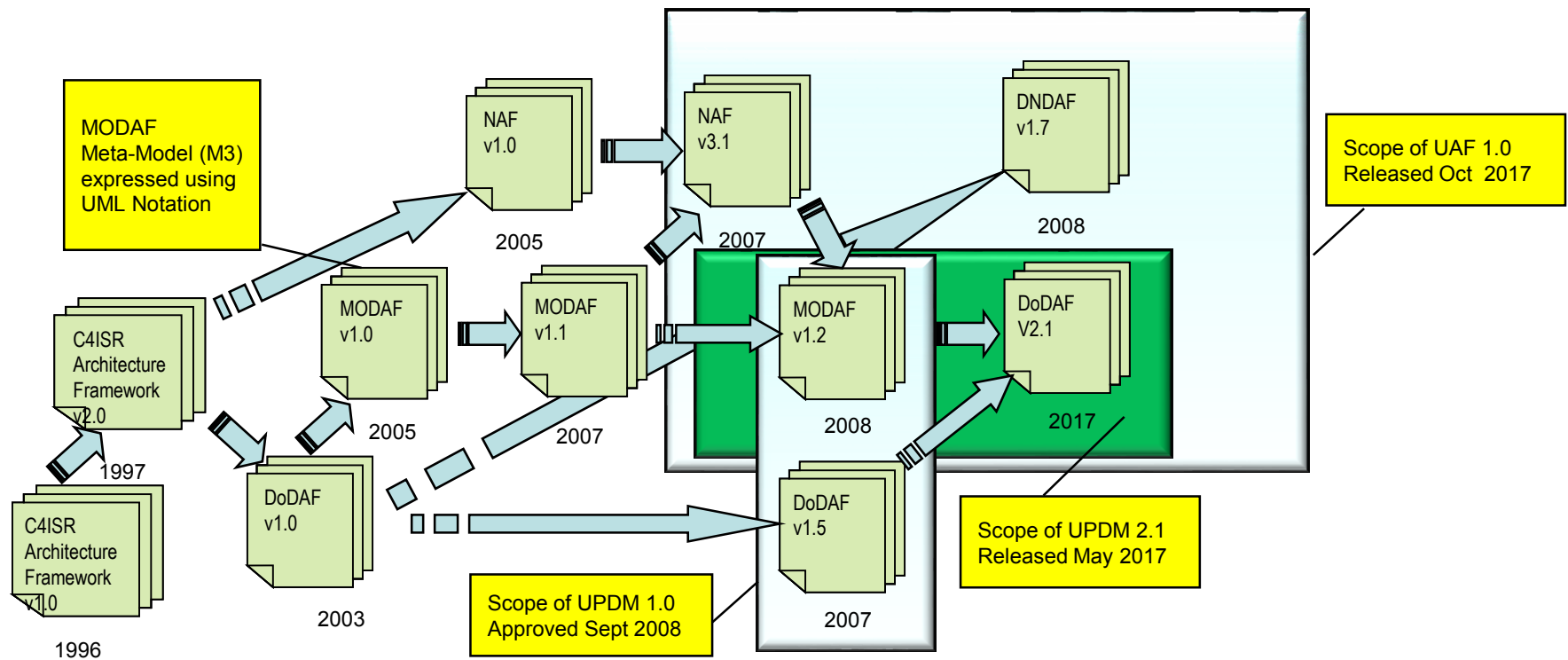
Why? The need for UPDM

- Motivation
 - US DoD and UK MOD interested in leveraging commercial standards for their Military Architecture Framework
 - Military Architecture Framework Tool Interoperability
 - Key Goal for DoD, MOD, Enterprise and System Architects and Engineers
 - Formal MetaModel basis for the Military Architecture Framework
 - Critical to Interoperability Objectives
 - Critical to Understanding Profile Requirements

Why? The need for UPDM

- Proliferation of Military Architectural frameworks
 - DoDAF, MODAF, DNDAAF, NAF, AGATE, ADOAF, MDAF, etc.
 - Defence organizations, contractors and tool vendors are hoping to find a way out of the alphabet soup.

Why and When: Historical Development of AF's



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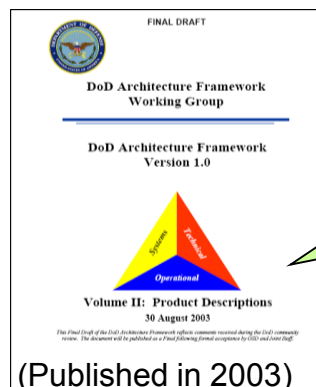
Model Based Systems Engineering

Introduction to UPDM – Part B DoDAF



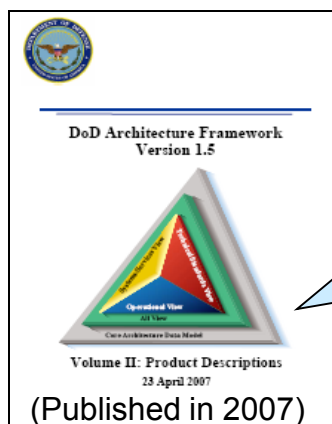
Dr Quoc Do

DoDAF Evolution



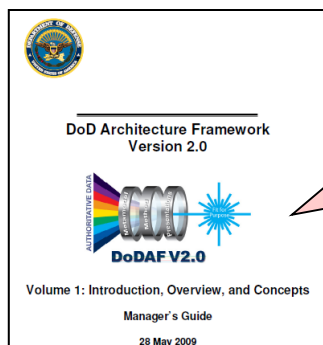
DoDAF 1.0

- CADM Separate
- Baseline For DoDAF 1.5
- Removed Essential & Supporting Designations
- Expanded audience to all of DoD



DoDAF 1.5

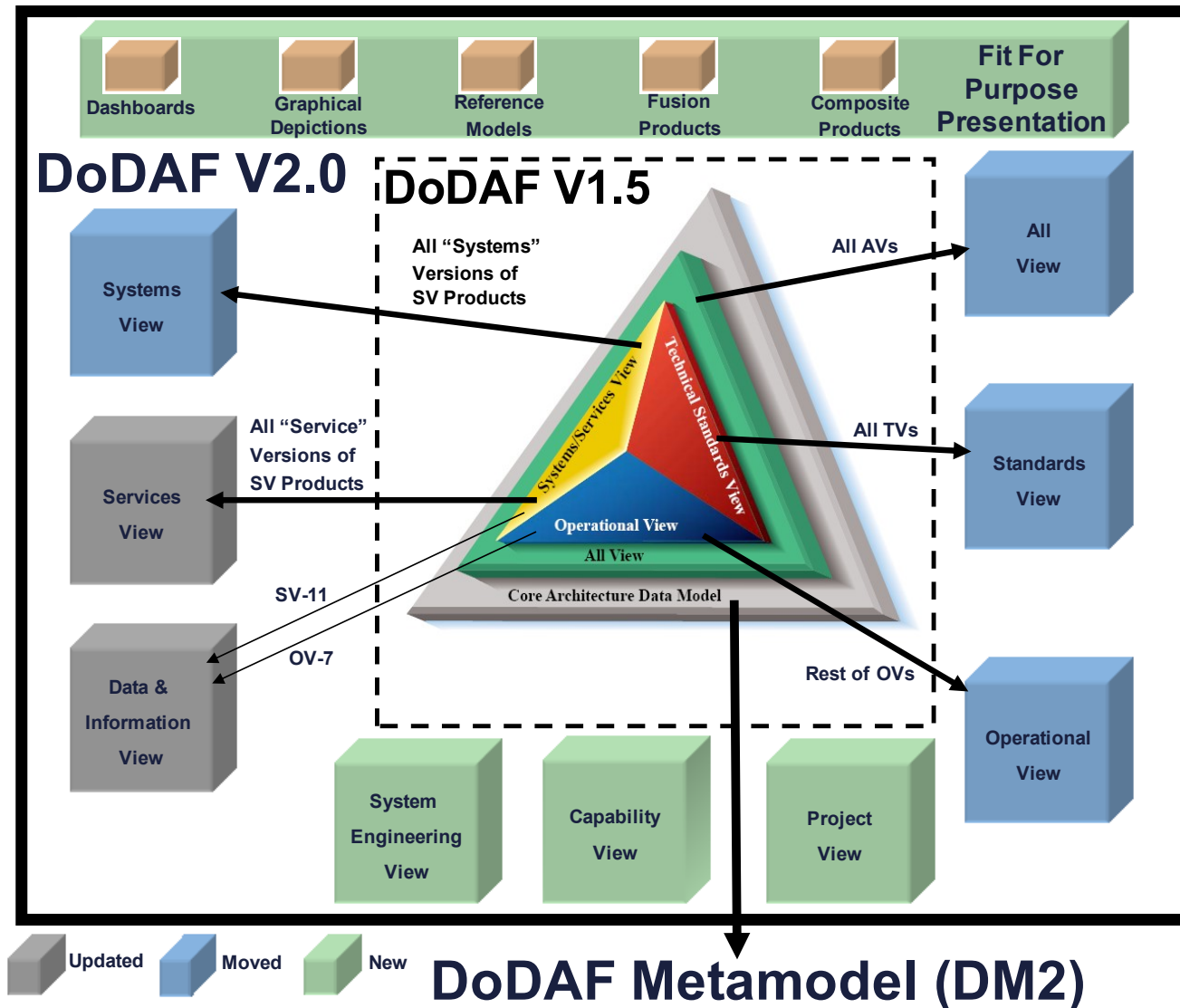
- Addresses Net-Centricity
- Volume III is CADM & Architecture Data Strategy
- Addresses Architecture Federation
- Baseline for DoDAF 2.0
- Shifted away from DoDAF mandating a set of products



DoDAF 2.0

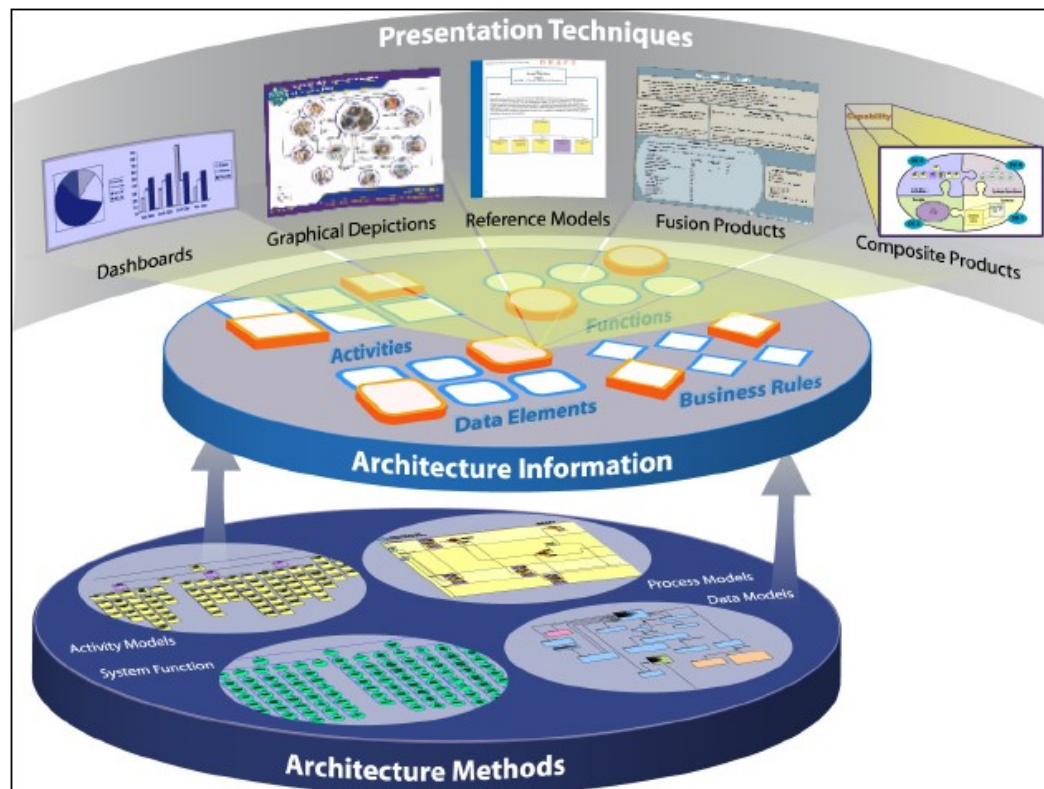
- Cover Enterprise and Program Architecture
- Emphasize Data versus Products
- Tailored Presentation
- DM2 PES

DoDAF Evolution



DoDAF 2.x: A Data-Centric Approach

- Movement from a product-centric approach to a data-centric approach



DoDAF 2.x: A Data-Centric Approach

- Provide decision-making data organized as information for the manager/executive
- Architecture development as a management tool
 - Support the decision-making process of the executive as process owner
 - Ensure a particular process or program
 - Works efficiently
 - Complies with legal and departmental requirements
 - Serves the purpose for which it was created
- Viewpoint selection by the process-owner based upon “fit-for-purpose”
 - Choose the viewpoints that accomplish the objective

DoDAF 2.x: Model, View, and Viewpoint Concepts

- **Model** – a template for collecting data
- **View** – a representation of a related set of information using formats or models
 - Dashboards
 - Spreadsheets
 - Diagrams
 - Data models
 - Any presentation style that conveys the meaning of the data

The architect translates the decision-maker's requirements into a set of data that can be used by engineers to design possible solutions.

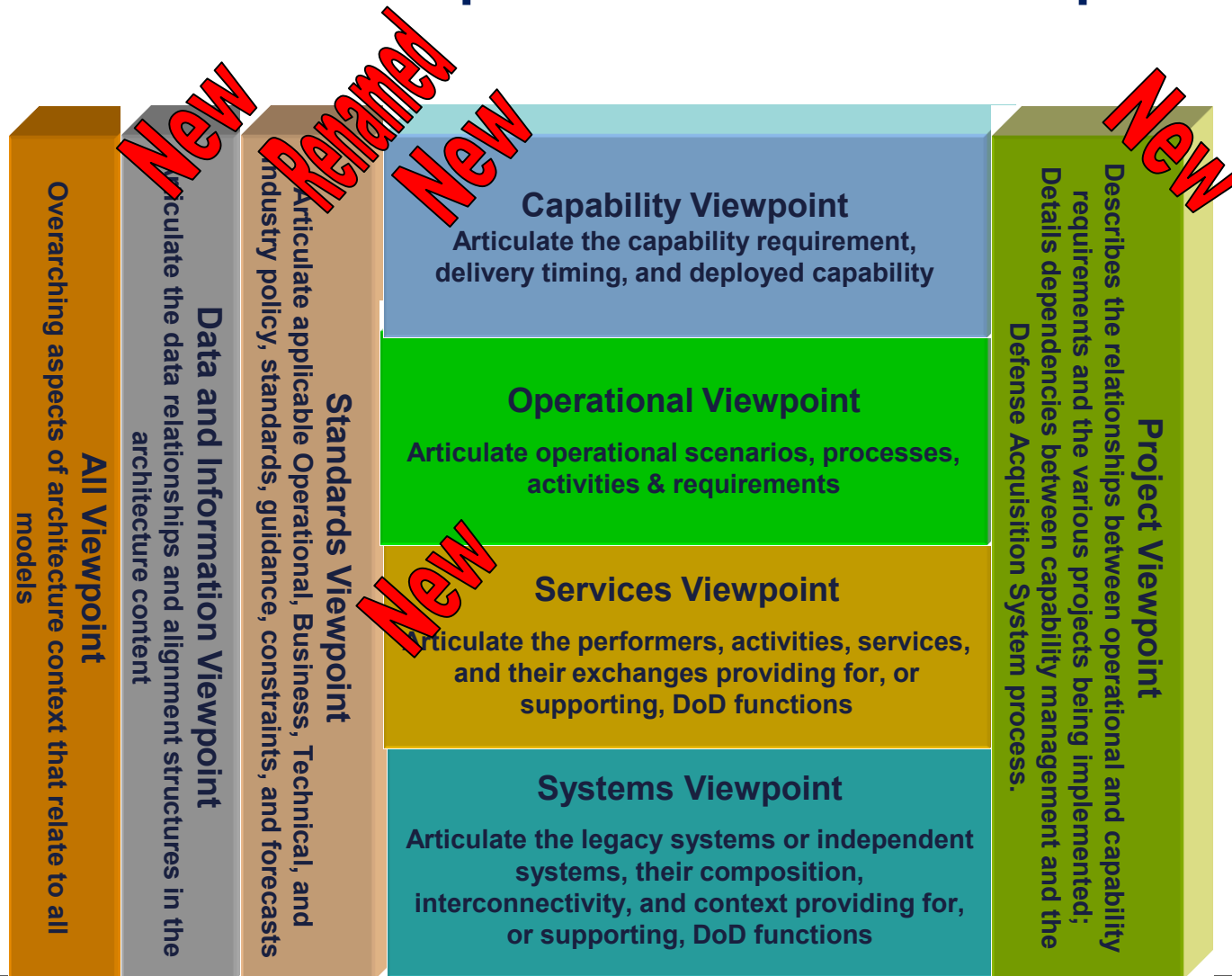
DoDAF 2.0 Model, View, and Viewpoint Concepts, cont.

- **Viewpoint** – one or more organizing perspectives for data useful for supporting management decision-making, including
 - The information appearing in individual views
 - How to construct and use the views (by means of an appropriate schema or template)
 - The modeling techniques for expressing and analyzing the information
 - A rationale for these choices (e.g., by describing the purpose and intended audience of the view)

Architecture Description:

- a collection of products to document an architecture (ISO 42010)
- a collection of views to document an architecture (DoDAF 2.0)

Select the Viewpoints That Fit-the-Purpose



Architecture viewpoints are composed of data that has been organized to facilitate understanding.

DoDAF 2.0 View Definitions

Models	Descriptions
AV-1: Overview and Summary Information	Describes a Project's Visions, Goals, Objectives, Plans, Activities, Events, Conditions, Measures, Effects (Outcomes), and produced objects.
AV-2: Integrated Dictionary	An architectural data repository with definitions of all terms used throughout the architectural data and presentations.
CV-1: Vision	The overall vision for transformational endeavors, which provides a strategic context for the capabilities described and a high-level scope.
CV-2: Capability Taxonomy	A hierarchy of capabilities which specifies all the capabilities that are referenced throughout one or more Architectural Descriptions.
CV-3: Capability Phasing	The planned achievement of capability at different points in time or during specific periods of time. The CV-3 shows the capability phasing in terms of the activities, conditions, desired effects, rules complied with, resource consumption and production, and measures, without regard to the performer and location solutions.
CV-4: Capability Dependencies	The dependencies between planned capabilities and the definition of logical groupings of capabilities.
CV-5: Capability to Organizational Development Mapping	The fulfillment of capability requirements shows the planned capability deployment and interconnection for a particular capability phase. The CV-5 shows the planned solution for the phase in terms of performers and locations and their associated concepts.
CV-6: Capability to Operational Activities Mapping	A mapping between the capabilities required and the operational activities that those capabilities support.
CV-7: Capability to Services Mapping	A mapping between the capabilities and the services that these capabilities enable.
DIV-1: Conceptual Data Model	The required high level data concepts and their relationships.
DIV-2: Logical Data Model	The documentation of the data requirements and structural business process (activity) rules. In DoDAF V1.5, this was the OV-7.
DIV-3: Physical Data Model	The physical implementation format of the Logical Data Model entities, e.g., message formats, file structures, physical schema. In DoDAF V1.5, this was the SV-11.
OV-1: High Level Operational Concept Graphic	The high-level graphical/textual description of the operational concept.
OV-2: Operational Resource Flow Description	A description of the resource flows exchanged between operational activities.
OV-3: Operational Resource Flow Matrix	A description of the resources exchanged and the relevant attributes of the exchanges.
OV-4: Organizational Relationships Chart	The organizational context, role or other relationships among organizations.

DoDAF 2.0 View Definitions

Models	Descriptions
OV-5a: Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in an hierarchal structure.
OV-5b: Operational Activity Model	The context of capabilities and activities (operational activities) and their relationships among activities, inputs, and outputs; Additional data can show cost, performers or other pertinent information.
OV-6a: Operational Rules Model	One of three models used to describe activity (operational activity). It identifies business rules that constrain operations.
OV-6b: State Transition Description	One of three models used to describe operational activity (activity). It identifies business process (activity) responses to events (usually, very short activities).
OV-6c: Event-Trace Description	One of three models used to describe operational activity (activity). It traces actions in a scenario or sequence of events.
PV-1: Project Portfolio Relationships	Describes the dependency relationships between the organizations and projects and the organizational structures needed to manage a portfolio of projects.
PV-2: Project Timelines	A timeline perspective on programs or projects, with the key milestones and interdependencies.
PV-3: Project to Capability Mapping	A mapping of programs and projects to capabilities to show how the specific projects and program elements help to achieve a capability.
SvcV-1 Services Context Description	The identification of services, service items, and their interconnections.
SvcV-2 Services Resource Flow Description	A description of resource flows exchanged between services.
SvcV-3a Systems-Services Matrix	The relationships among or between systems and services in a given Architectural Description.
SvcV-3b Services-Services Matrix	The relationships among services in a given Architectural Description. It can be designed to show relationships of interest, (e.g., service-type interfaces, planned vs. existing interfaces).
SvcV-4 Services Functionality Description	The functions performed by services and the service data flows among service functions (activities)
SvcV-5 Operational Activity to Services Traceability Matrix	A mapping of services (activities) back to operational activities (activities).
SvcV-6 Services Resource Flow Matrix	It provides details of service resource flow elements being exchanged between services and the attributes of that exchange.
SvcV-7 Services Measures Matrix	The measures (metrics) of Services Model elements for the appropriate time frame(s).
SvcV-8 Services Evolution Description	The planned incremental steps toward migrating a suite of services to a more efficient suite or toward evolving current services to a future implementation.

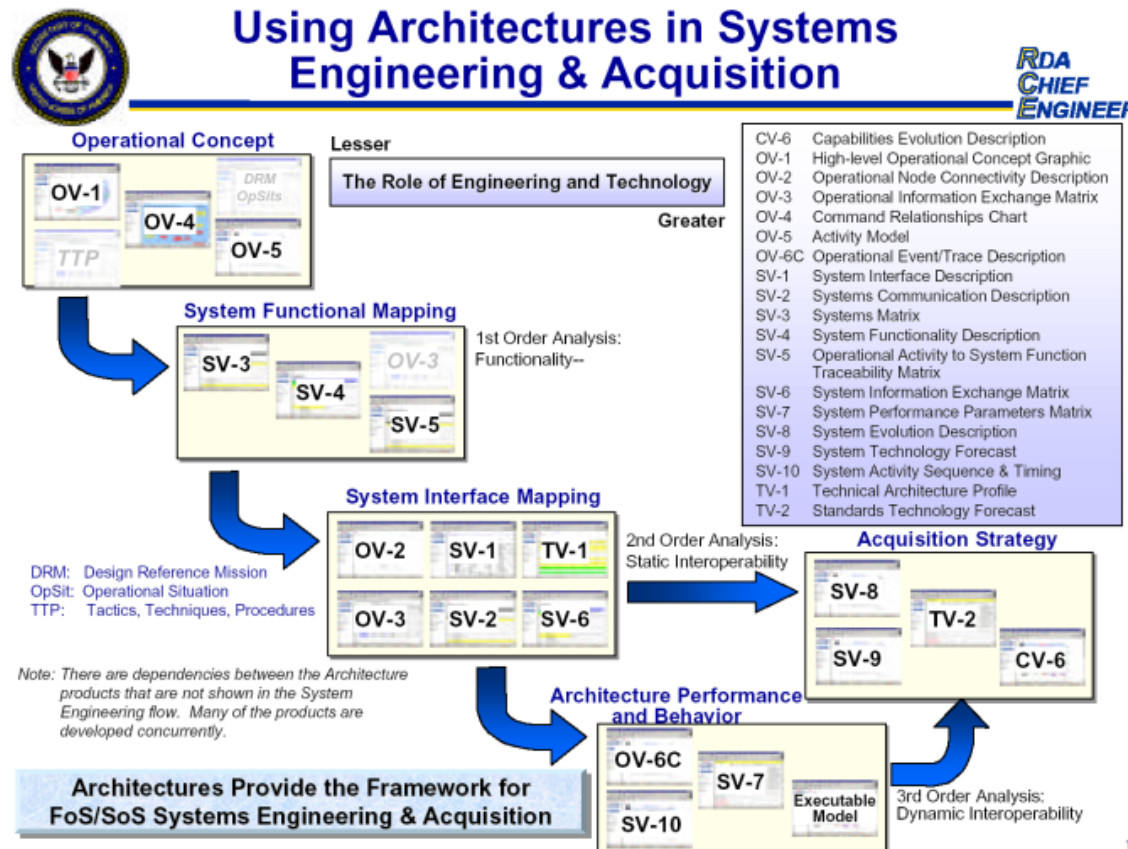
DoDAF 2.0 View Definitions, cont.

Models	Descriptions
SvcV-9 Services Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future service development.
SvcV-10a Services Rules Model	One of three models used to describe service functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.
SvcV-10b Services State Transition Description	One of three models used to describe service functionality. It identifies responses of services to events.
SvcV-10c Services Event-Trace Description	One of three models used to describe service functionality. It identifies service-specific refinements of critical sequences of events described in the Operational Viewpoint.
StdV-1 Standards Profile	The listing of standards that apply to solution elements.
StdV-2 Standards Forecast	The description of emerging standards and potential impact on current solution elements, within a set of time frames.
SV-1 Systems Interface Description	The identification of systems, system items, and their interconnections.
SV-2 Systems Resource Flow Description	A description of resource flows exchanged between systems.
SV-3 Systems-Systems Matrix	The relationships among systems in a given Architectural Description. It can be designed to show relationships of interest, (e.g., system-type interfaces, planned vs. existing interfaces).
SV-4 Systems Functionality Description	The functions (activities) performed by systems and the system data flows among system functions (activities).
SV-5a Operational Activity to Systems Function Traceability Matrix	A mapping of system functions (activities) back to operational activities (activities).
SV-5b Operational Activity to Systems Traceability Matrix	A mapping of systems back to capabilities or operational activities (activities).
SV-6 Systems Resource Flow Matrix	Provides details of system resource flow elements being exchanged between systems and the attributes of that exchange.
SV-7 Systems Measures Matrix	The measures (metrics) of Systems Model elements for the appropriate timeframe(s).
SV-8 Systems Evolution Description	The planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation.
SV-9 Systems Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future system development.
SV-10a Systems Rules Model	One of three models used to describe system functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.

Models	Descriptions
SV-10b Systems State Transition Description	One of three models used to describe system functionality. It identifies responses of systems to events.
SV-10c Systems Event-Trace Description	One of three models used to describe system functionality. It identifies system-specific refinements of critical sequences of events described in the Operational Viewpoint.

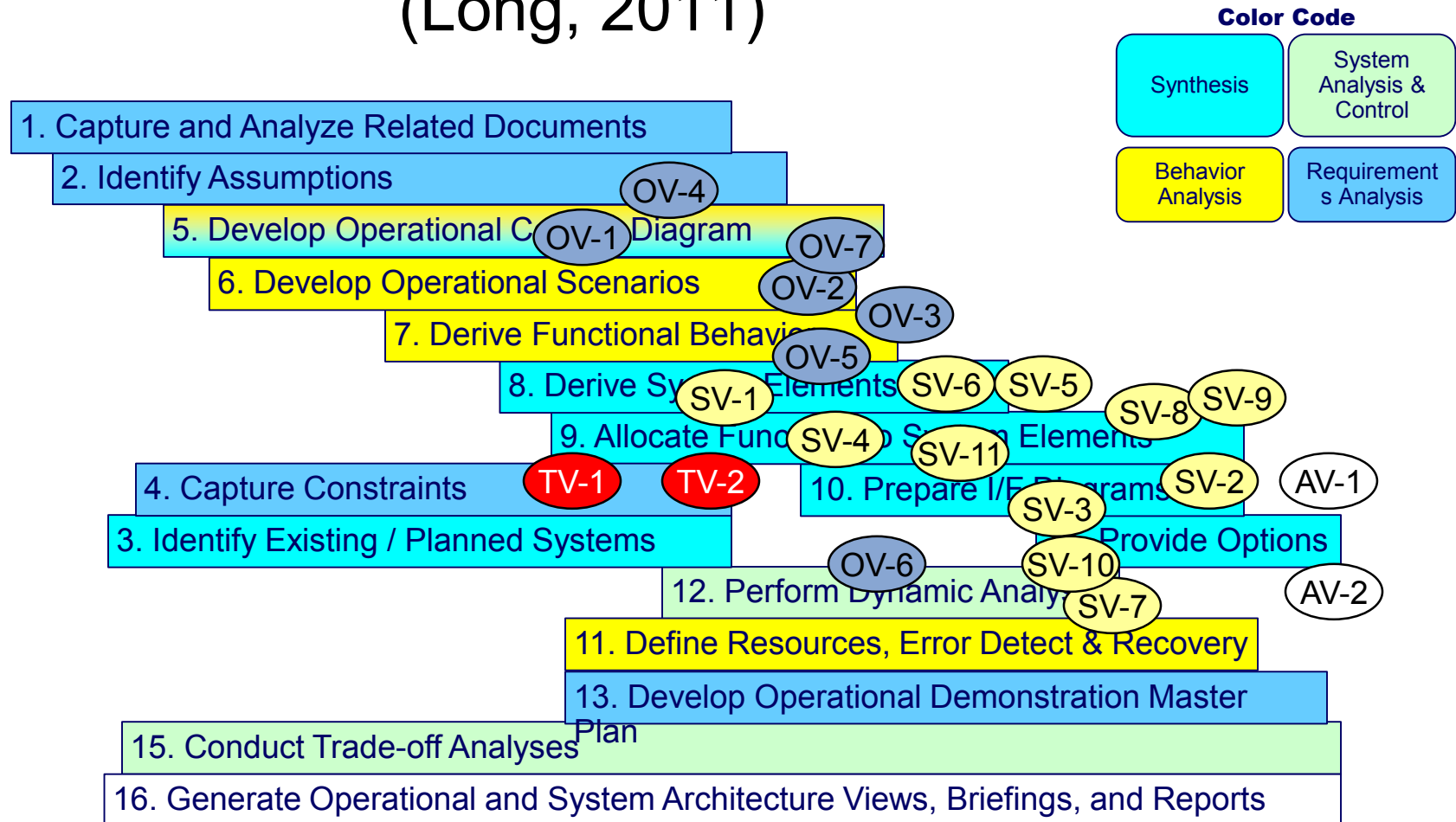
*From "DoD Architecture Framework v. 2.0
Volume I, pp. 23-26*

The MCP Acquisition Strategy Generation Process (Dickerson & Soules, 2002)



The DoDAF views take the place of conventional SE process products.

DoDAF1.5 Views within the Systems Development Timeline (Long, 2011)



Example - Disaster Relief Challenge....Provide Ice

- **Goals and Objectives:** For the challenge, show how today's tools can be used and integrated together to support planning, analysis, decision making, communications, and documentation and reporting while minimizing duplication of effort, or data entry.
- **Challenge:** It is summer time in Pleasantville, a rural US town located in a temperate climate zone currently experiencing temperatures ranging between 70 – 100 degrees Fahrenheit (20-35 C). A recent natural disaster has devastated the area within a 100 mile radius. An estimated 3000 people lost their homes due to the destruction, and need to find shelter. Most roads are impassible by public so there is limited vehicle transportation and the electricity is out in most of the disaster area. As part of emergency response requirements, shelters must be set up within 24 hours from when the evacuations begin to help sustain those who need to relocate. As part of the initial emergency response, ice must be provided to sustain perishables such as medicine and foods, and to support first aid needs. Power and potable water are to be provided with the shelter solution.

Colour scheme

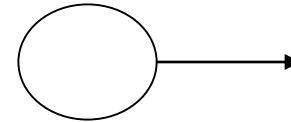
Strategic element

Operational element

System element

Technical element

Acquisition element

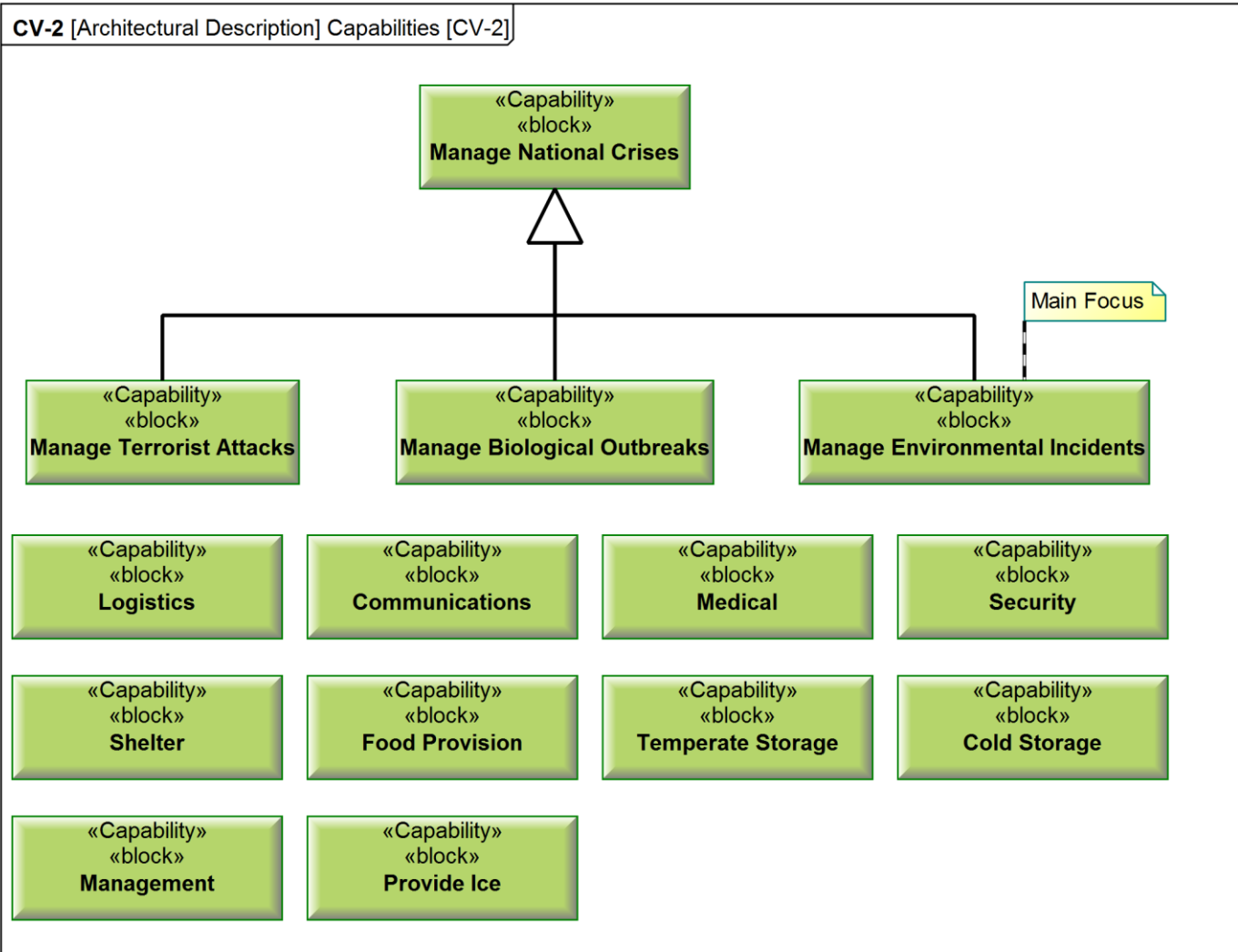


Association (link) entity
shown as lollipop

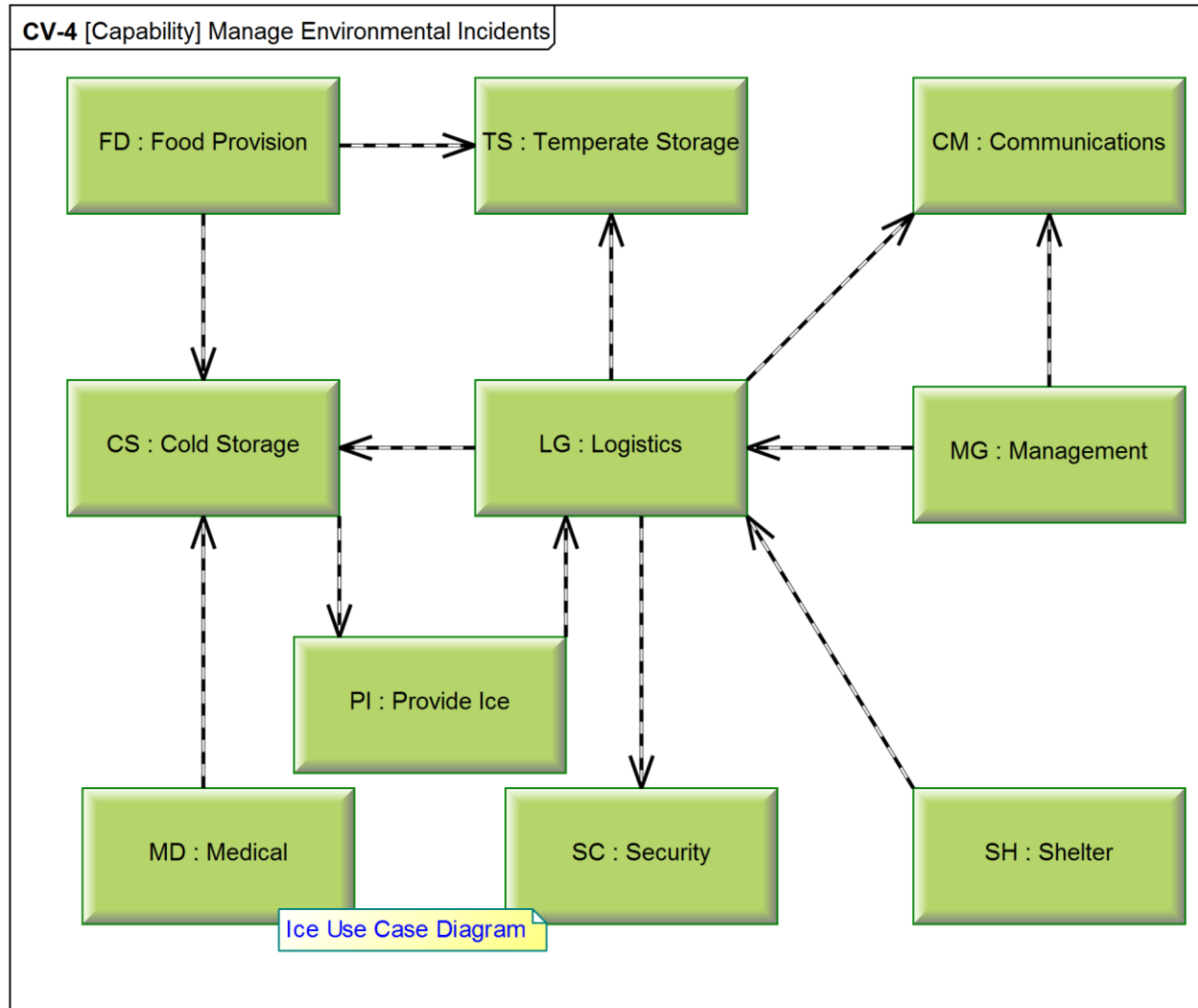
Strategic viewpoint meta-model terms – existing as presented



Dictionary of Project Capabilities



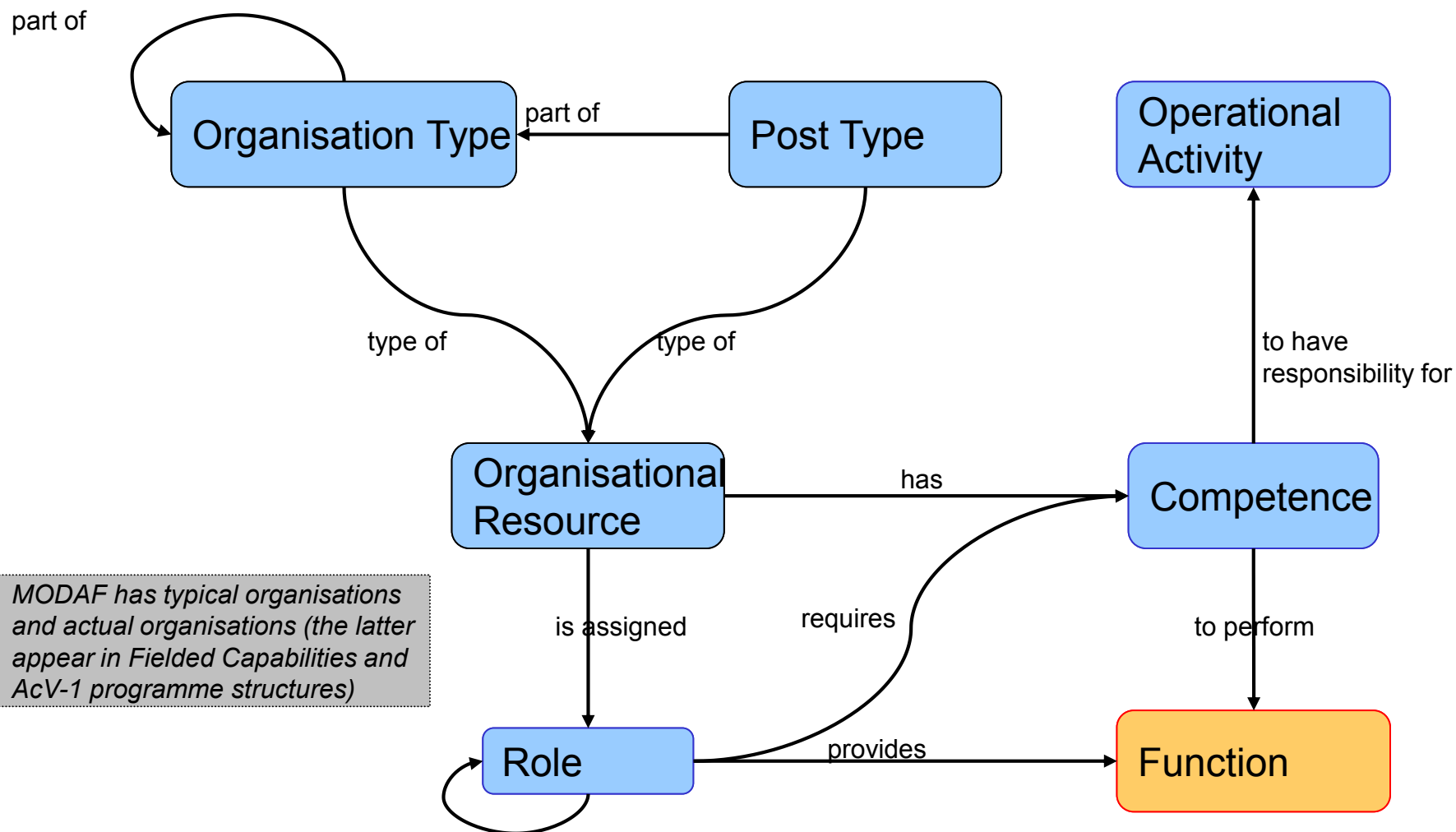
Capability Dependencies for Manage Environmental Incidents



Operational viewpoint meta-model terms – existing as presented

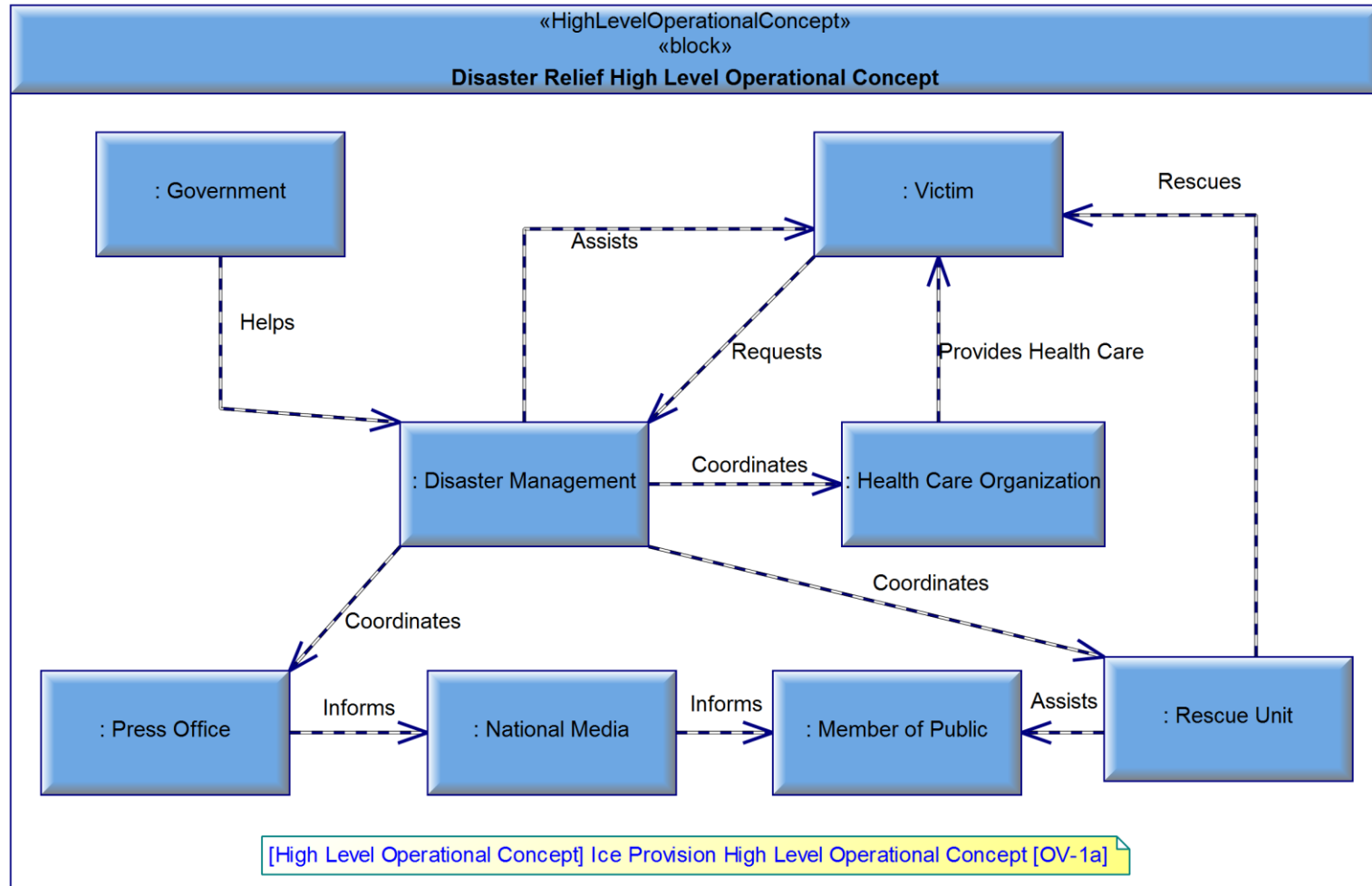


Operational viewpoint meta-model terms – focus on organisations



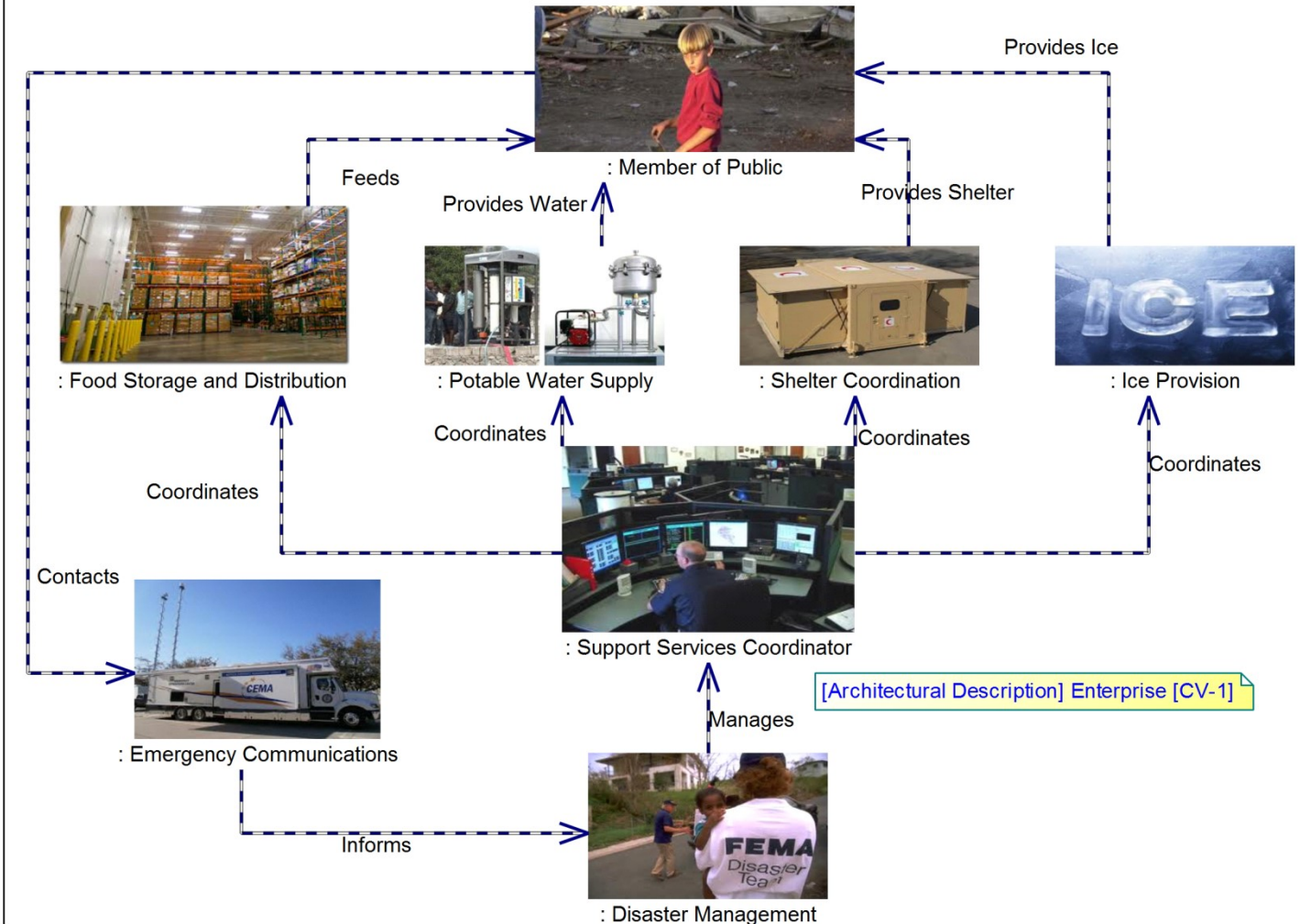
Operational Concept for Disaster Relief

OV-1a [Disaster Relief High Level Operational Concept] High Level Operational Concept [OV-1a]

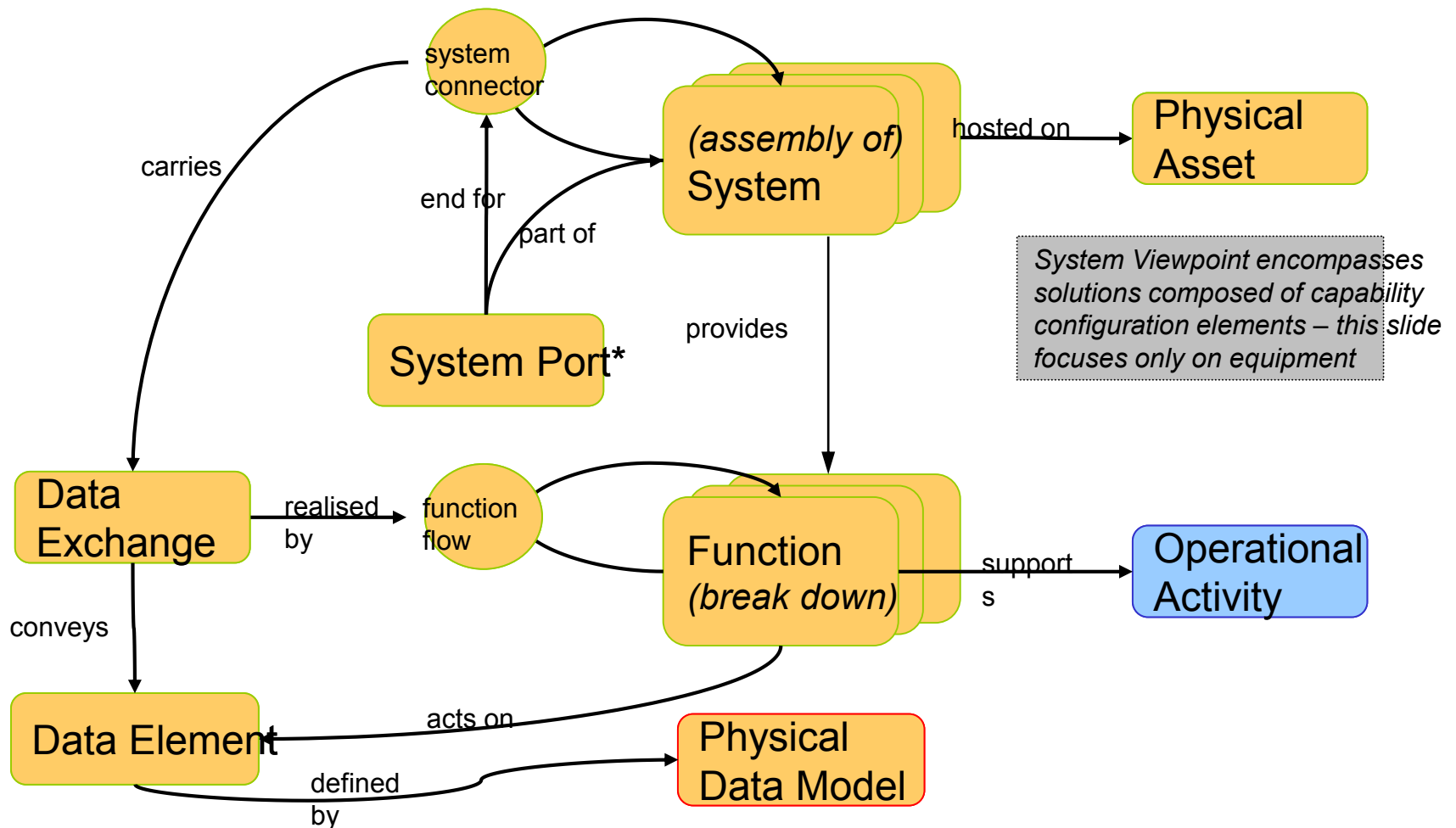


Operational Concept for Disaster Relief Internals

OV-1a [High Level Operational Concept] Ice Provision High Level Operational Concept [OV-1a]

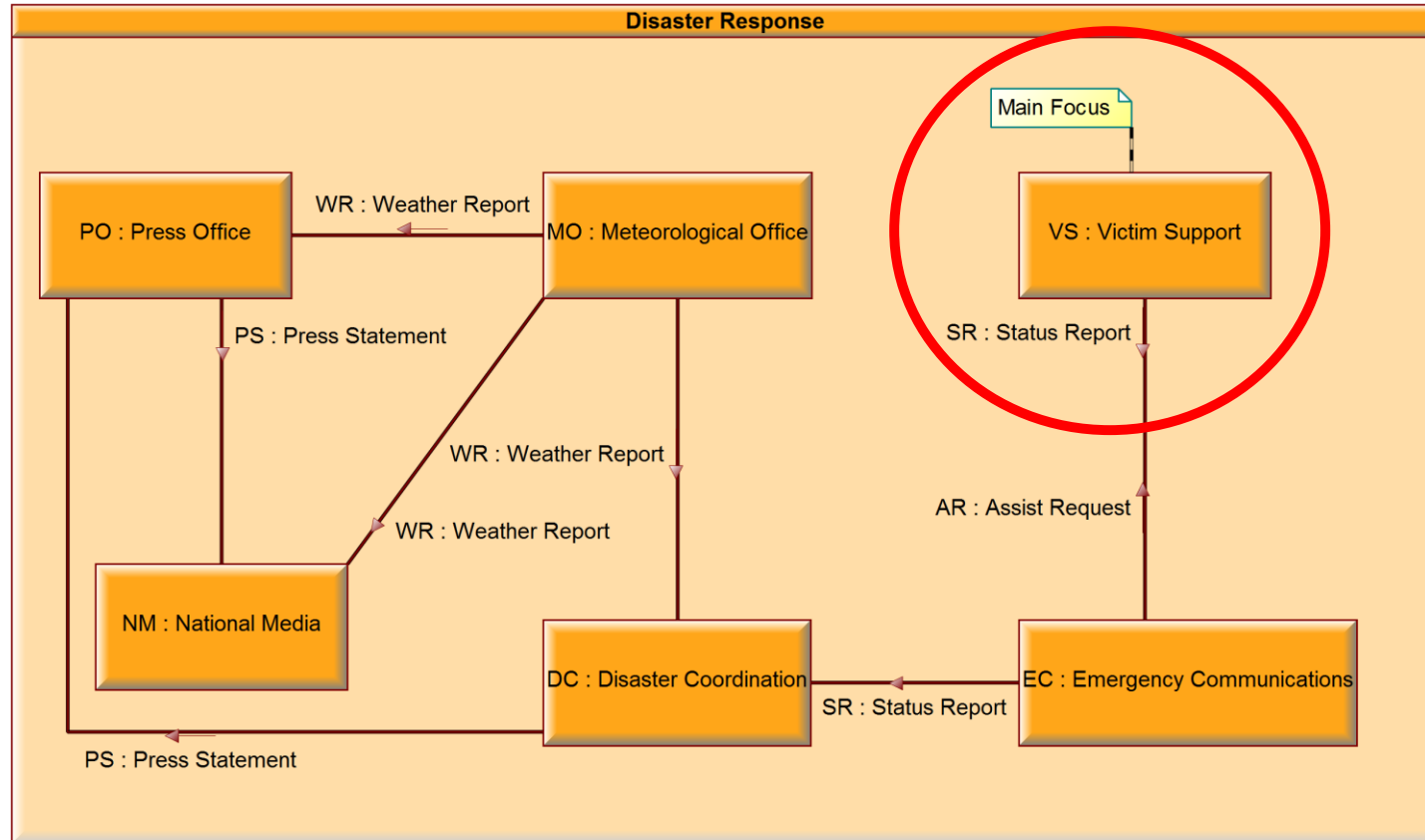


System viewpoint meta-model terms – existing as presented

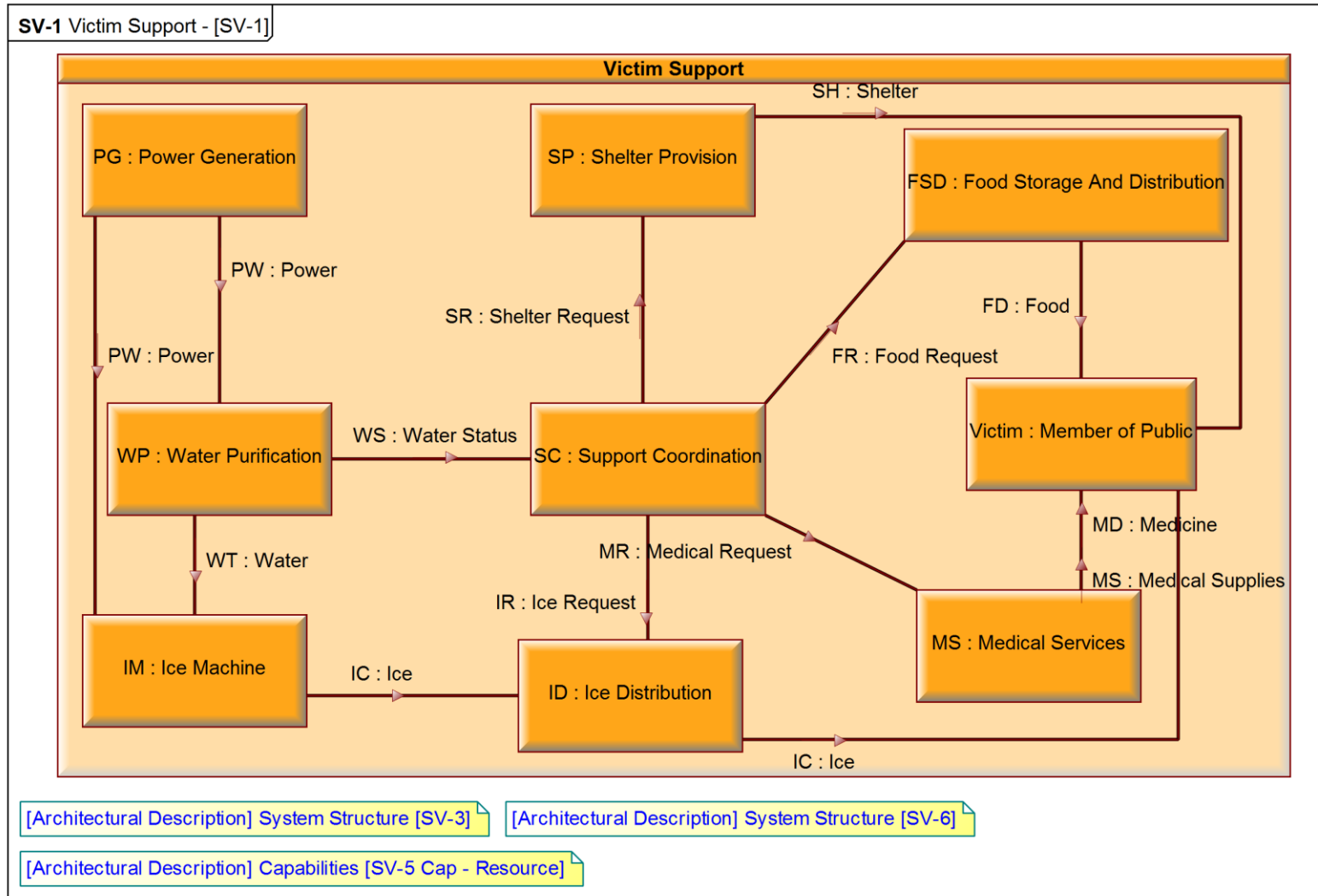


System Structure for Disaster Response

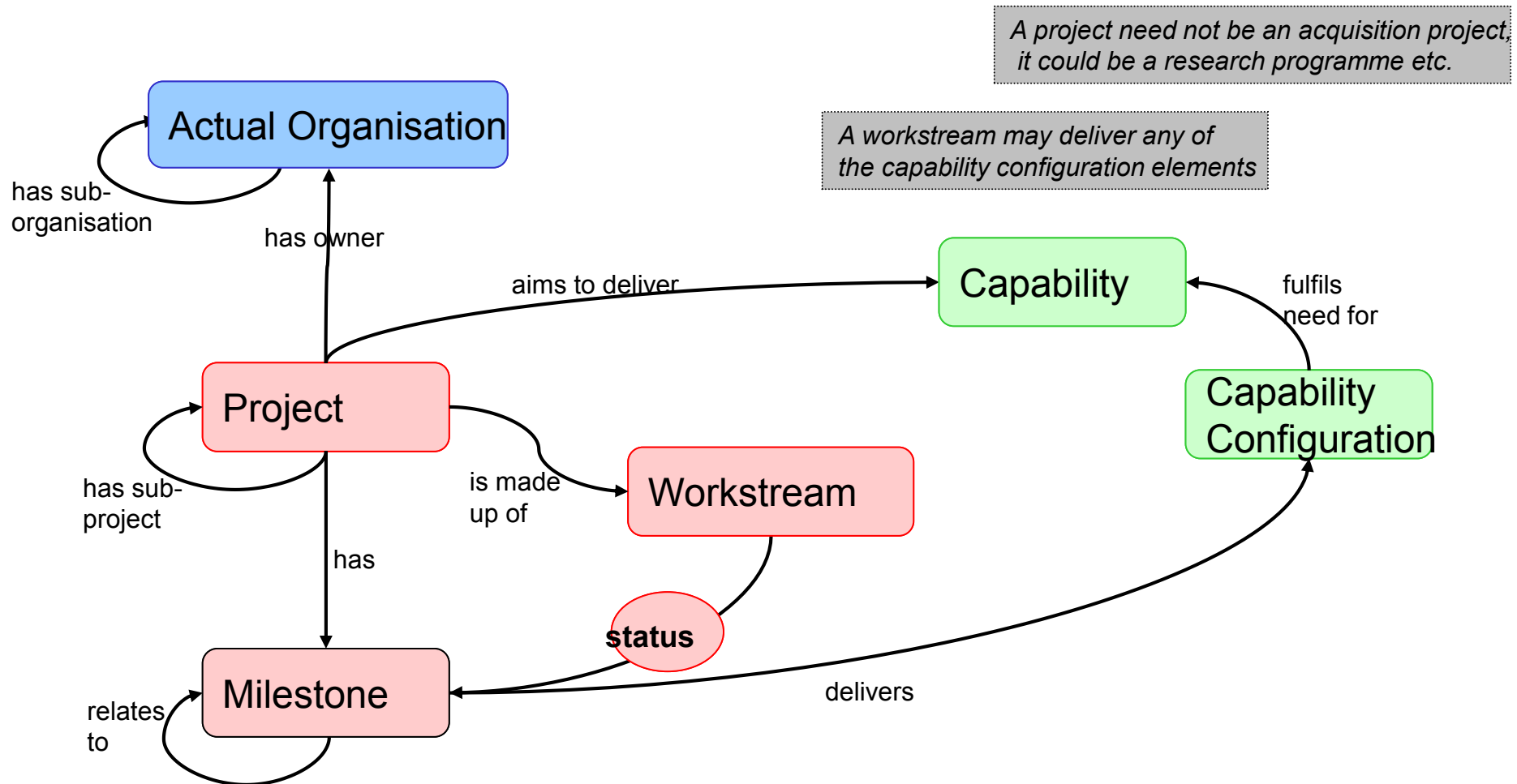
SV-1 Disaster Response - [SV-1]



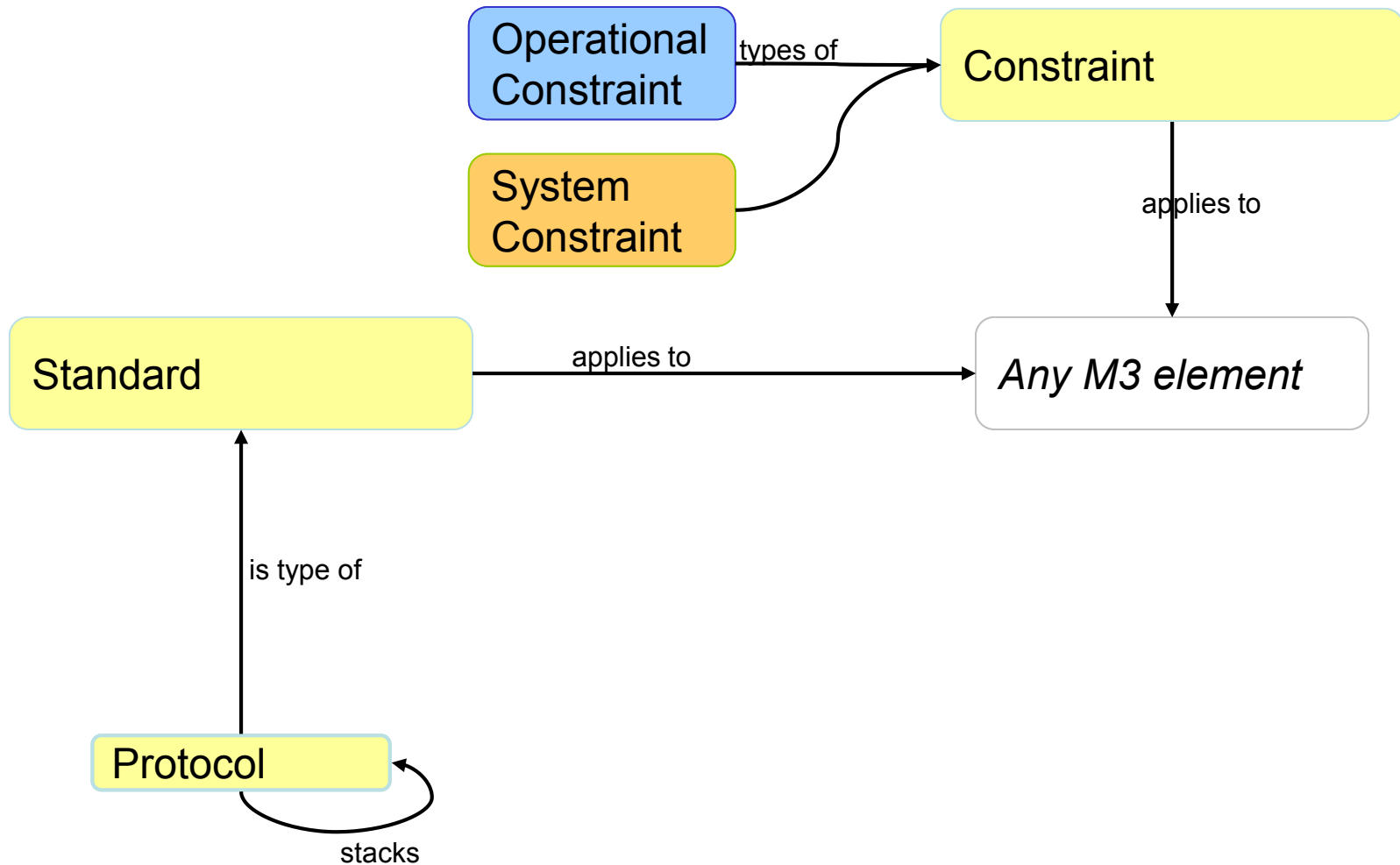
System Structure for Victim Support



Acquisition viewpoint meta-model terms – existing as presented



Technical standards viewpoint meta-model terms – existing as presented



Program Completed

Missouri University of Science &
Technology