

SoSECIE Webinar

Welcome to the
2019 System of Systems Engineering Collaborators
Information Exchange (SoSECIE)



We will start at 11AM Eastern Time

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NDIA System of Systems SE Committee

- **Mission**

- To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
- To identify successful strategies for applying systems engineering principles to systems engineering of SoS

- **Operating Practices**

- Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August
- SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
 - Conference Info:
<http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference>

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
 - I will start with questions submitted online via the CHAT window in Skype.
 - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2019 System of Systems Engineering Collaborators Information Exchange Webinars *Sponsored by MITRE and NDIA SE Division*

April 30, 2019

Digital Engineering Transformation

Mr. Thomas McDermott, Georgie Tech Research Institute, SERC

May 14, 2019

Toward Scaling Model-based Engineering for Systems of Systems

Dr. Ryan B. Jacobs, The MITRE Corporation

May 28, 2019

Mission Engineering and Prototype Warfare

Mr. Matthew Horning, US ARMY FUTURES COMMAND

June 11, 2019

TBD

TBD

June 25, 2019

A Tool for Architecting Socio-Technical Problems: SoS Explorer

Dr. Cihan Dagli

July 16, 2019

Modular Online Open SoS Education (MOOSE)

Mr. Kyle Hastings, The MITRE Corporation

Mission Engineering and Operational Architectures

Mark Simons

Principal Systems Engineer, Vitech Corp.



Topics

- Definitions of Mission Engineering
- Major Challenges
- Identifying Missions
- Key Architectural Elements
- Mission Engineering Examples

Start with Definitions

Mission (using Dictionary.com):

- the business with which such a group is charged
- any important task or duty that is assigned, allotted
- an important goal or purpose that is accompanied by strong conviction

Looking further into the meanings of Mission we find:

Military. An operational task, usually assigned by higher headquarters

Aerospace. an operation designed to carry out the goals of a specific program

Other ideas...

- Mission operations are supported by sets of systems (or systems of systems) which work together
- Systems supporting each role in a mission will vary over the course of the operation and be used for multiple missions to achieve mission objectives
 - Individual systems are components of the larger mission 'system'
- Mission engineering goes beyond data exchange among systems to address cross cutting functions, end to end control and trades across systems
- Well-engineered composable mission architectures foster resilience, adaptability and rapid insertion of new technologies

Ref: Mission Engineering, Robert Gold, ODASD, Systems Engineering

Challenges for Mission Engineering

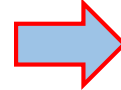
- Challenges of developing integrated analysis capabilities that bridge engineering and mission effects
 - Limits on the available analysis methods to address complexity and dynamics
 - Difficult to link changes in systems or SoS engineering models with impacts on missions in operational or mission simulations
 - Tools address only subset of issues, making complex analysis and engineering trades manpower intensive and time consuming, are difficult to use together
- Need for data on missions, systems, interfaces, interactions and interdependencies
 - Very distributed, maintained in various forms by different organizations
 - Focus on specific system needs and don't address interdependencies and interactions – Even when available, can be hard to locate or access
 - Current system models are developed for different purposes which can challenge their effective use in addressing mission level issues

Ref: Mission Engineering, Robert Gold, ODASD, Systems Engineering

Where do we get Missions?

Based on Strategic Guidance

- National Security Strategy
- National Defense Strategy
- National Military Strategy
- Unified Command Plan
- Quadrennial Defense Review
- Service Strategic Plan
- Defense Planning Guidance
- Doctrinal Publications
- etc....



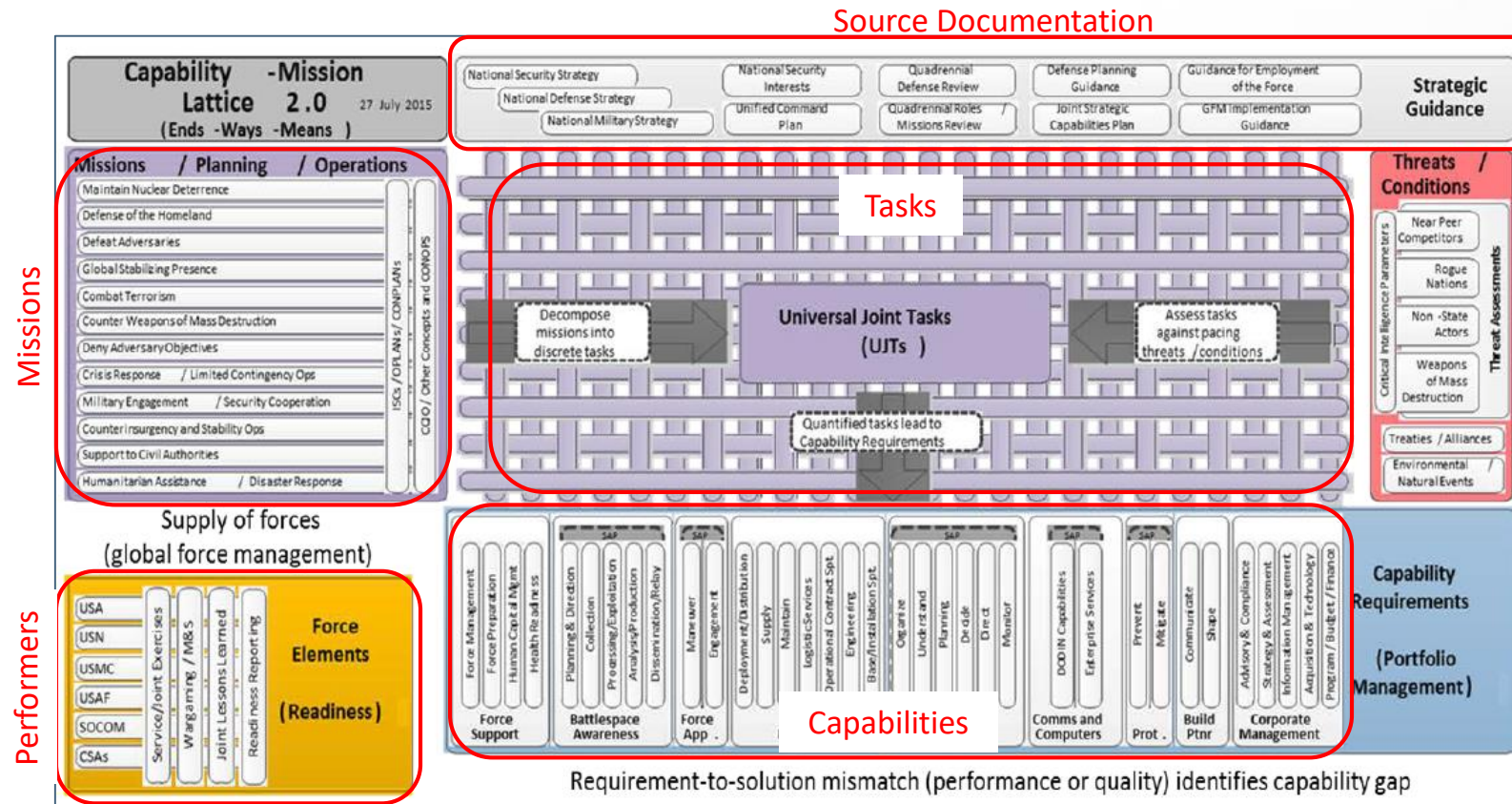
Leads to Mission Identification

- Maintain Nuclear Deterrence
- Defense of the Homeland
- Defeat Adversaries
- Combat Terrorism
- Counter WMD
- Crisis Response / Contingency Ops
- Counter Insurgency and Stability Ops
- etc....



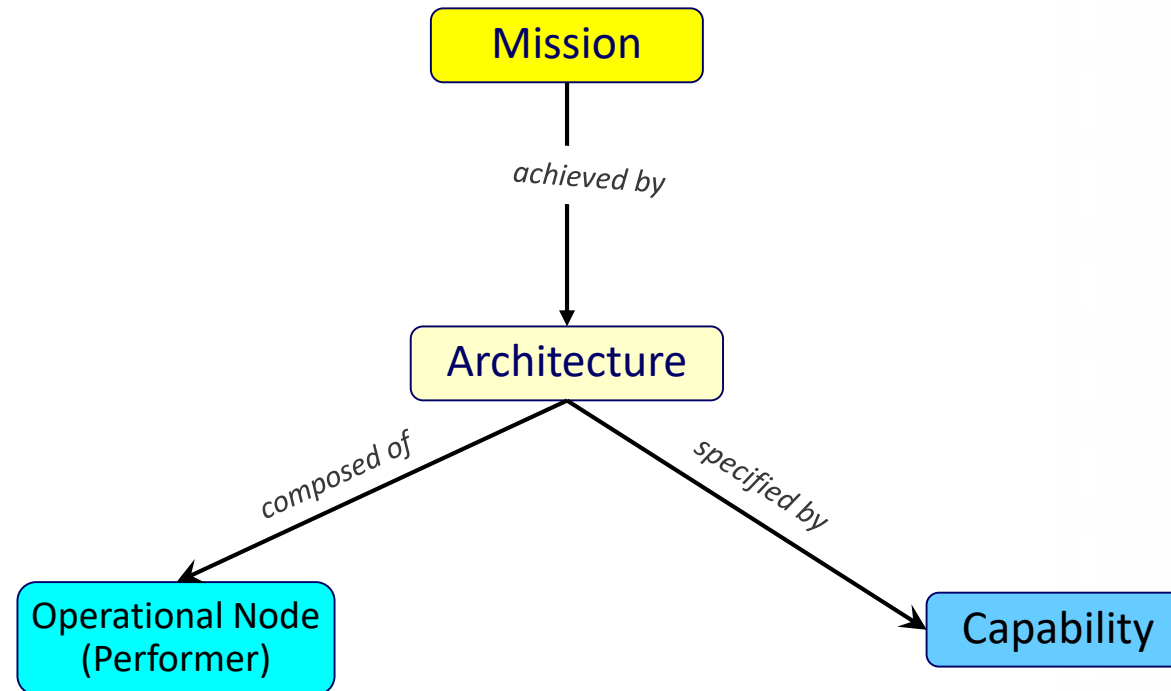
Identification of discrete tasks

Capability Mission Lattice



Ref: Mission Based Analysis in the Systems Engineering Process, William Scott, 18th Annual NDIA Systems Engineering Conference, Oct 27, 2015

Key Elements in Mission Engineering



Operational Architecture for Mission Engineering

If we are going to capture the operational side of the enterprise or systems of system, we need to capture information related to mission or business goals and objectives, required capabilities, and main performers.

Mission

A Mission identifies an overall objective or goal that clearly indicates the action to be taken and the reason therefore.

Architecture

An Architecture is the structure of operational tasks and system components, their relationships and the guidelines governing their design over time.

Operational Node (Performer)

An Operational Node (or Performer) represents an entity of the operational architecture that produces, consumes, or processes information or material.

Capability

The qualities, abilities, features, etc. than can be used or developed to achieve goals.

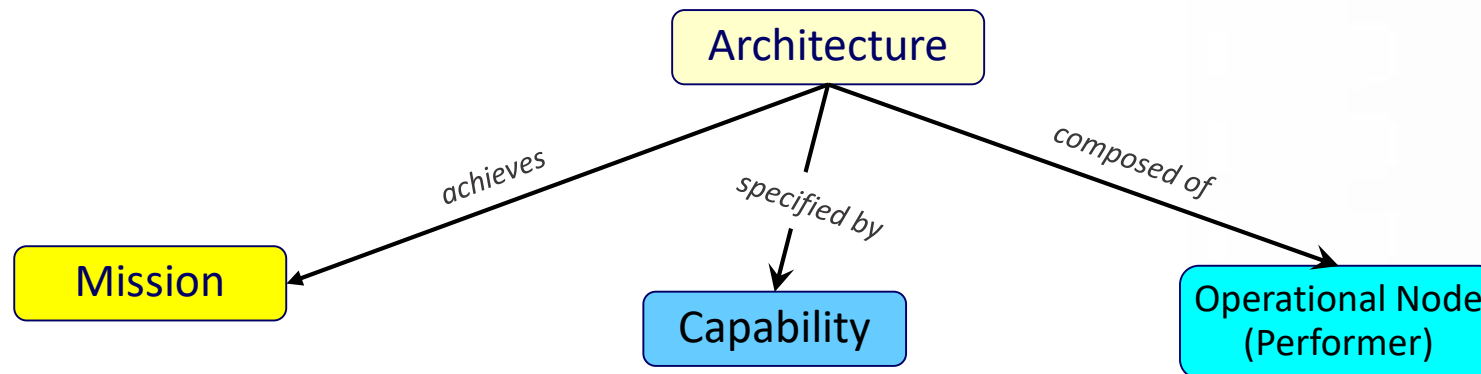
Starting an Operational Architecture...

We want to put together an Architecture ...

... we are looking at an architecture composed of operational nodes or performers

... which achieves some mission area(s) or business goals

... that is specified by a set of capabilities (i.e. requirements)



Example – Combat Biothreats and Pandemics

- **Mission** – *Combat Biothreats and Pandemics*
 - *Source: National Security Strategy*
- **Architecture** – *Biological Threat Architecture*
- **Capabilities** – *Biological Threat Identification, State and Non-State Actor Identification, Biological Threat Containment, Prevent Catastrophic Loss, ...*
- **Performers** – *First Responders, Biological Security, Hazmat Teams, ...*

Operational Architecture (continued)

We also need to examine how the mission, tasks and, capabilities are aligned with the enterprise or business...

Operational Task

An Operation Task is an action to be performed in support of a mission

Operational Activity

An Operational Activity is an action or process needed to fulfill a mission, task, or role. It may also transform one or more inputs into outputs

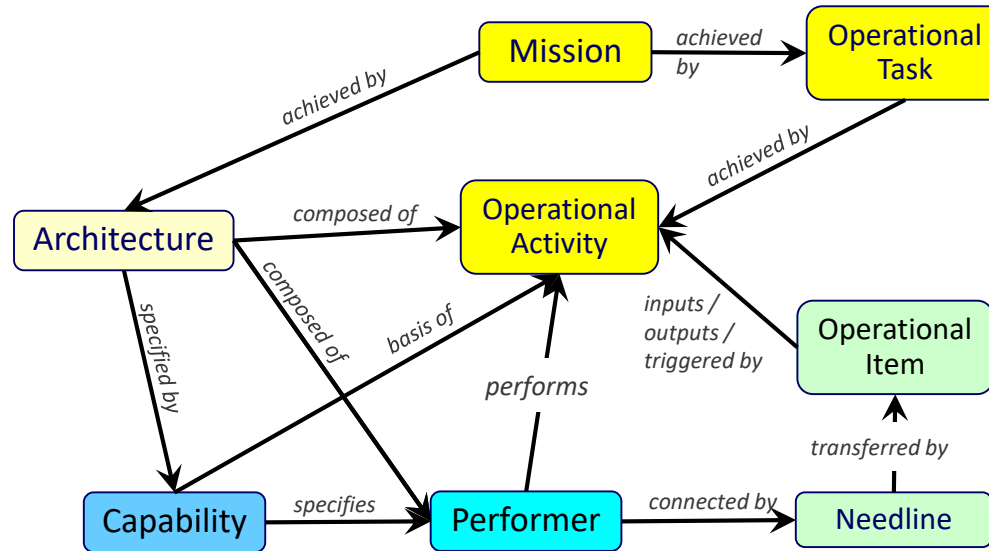
Operational Item

Operational Information / Item is the data or physical entity that is needed to flow between operational activities, and thereby, between operational nodes.

Needline

A Needline identifies the methods to exchange information between operational nodes (performers)

Connecting the Operational Architecture together



- A Mission is achieved by an Operational Task
- Operational Task is related to Operational Activity
- An Operational Activity uses an input (an Operational Item) transforms Operational Items to create outputs and triggers.
- What a Performer does is specified by the Capability(s)
- A Capability is the basis of an Operational Activity
- Operational Item are transferred by Needlines that connect Performers to one another.
- Performer “performs” Operational Activity(s)

DODAF Views

Capability Views

View Number	Name
CV-1	Vision
CV-2	Capability Taxonomy
CV-3	Capability Phasing
CV-4	Capability Dependencies
CV-5	Capability to Organizational Development Mapping
CV-6	Capability to Operational Activities Mapping
CV-7	Capability to Services Mapping

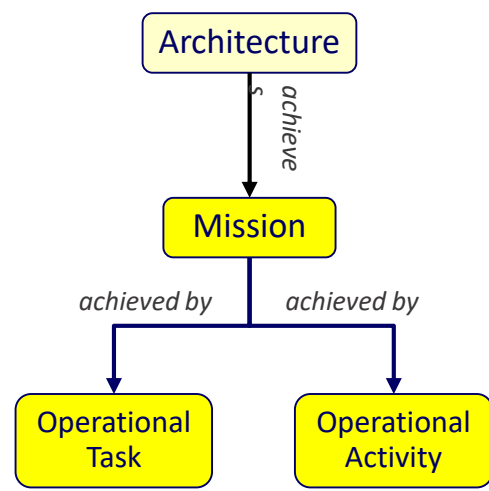
Operational Views

View Number	Name
OV-1	High Level Operational
OV-2	Operational Resource Flow Description
OV-3	Operational Flow Matrix
OV-4	Organizational Relationships Chart
OV-5a	Operational Activity Decomposition Model
OV-5b	Operation Activity Model
OV-6a	Operational Rules Model
OV-6b	State Transition Description
OV-6c	Event Trace Description

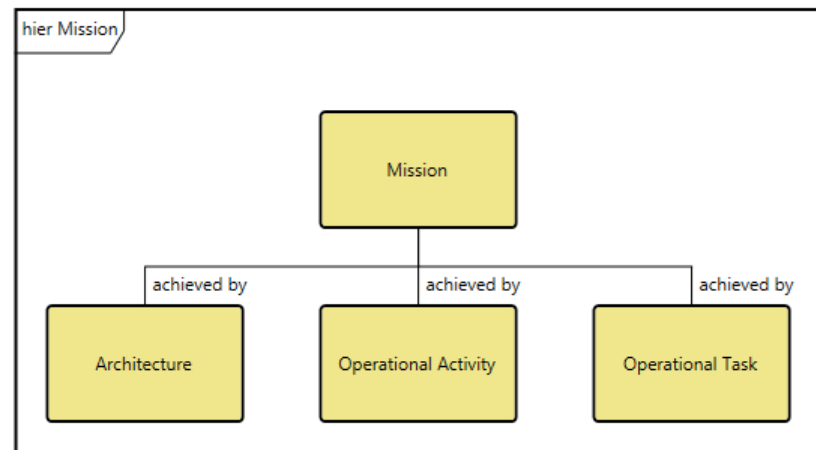
There are NO Mandated Views specifically addressing the enumeration and traceability of the Missions to Operational Tasks and Operational Activities

Mission Area Traceability

Schema Relations provide Traceability



A Hierarchy View from the model



A Table View of the information

Mission Area	Achieves...	Class Name
Mission	New Architecture	Architecture
	New Operational Activity	OperationalActivity
	New Operational Task	OperationalTask

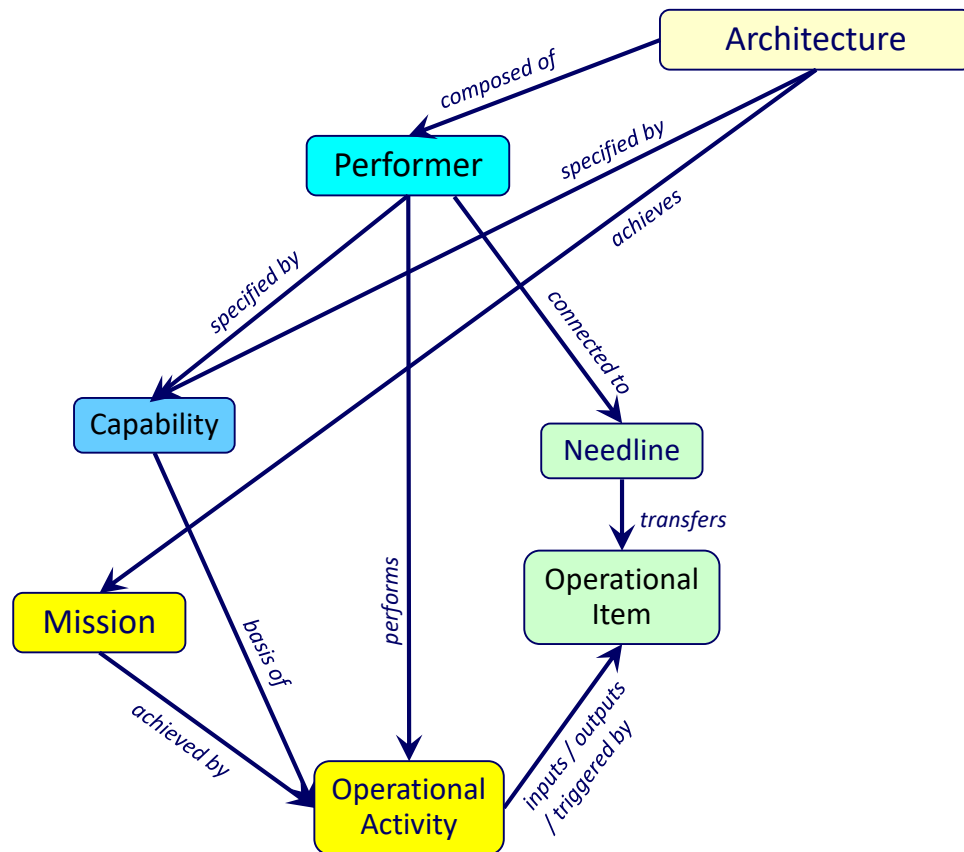
Example – Combat Biothreats and Pandemics

- **Operational Tasks** – *Detect and Contain Biothreats at Their Source, Support Biomedical Innovation, Improve Emergency Response*
- **Operational Activities** – *Rapid Characterization of Outbreaks, Implement Containment Measures, Provide Surge Medical Care*
- **Operational Items** – *Bioagents, Emergency Coordination*
- **Needlines** – *Air, Water, Emergency Communications*



Missions to Systems Traceability

Another Perspective of the Architecture



In an **Operational Architecture** we think of what we want to achieve in terms of:

- Performers
- What Performers “Need”
- “Abilities” we need accomplish
- “Activities” supporting the “Ability”
- Input and Outputs of Activities

... **And**, we do this without specifying (or determining) a specific system solution

... Given the information in the Operational Architecture, we want to understand what systems (or systems architecture) supports this operational architecture.

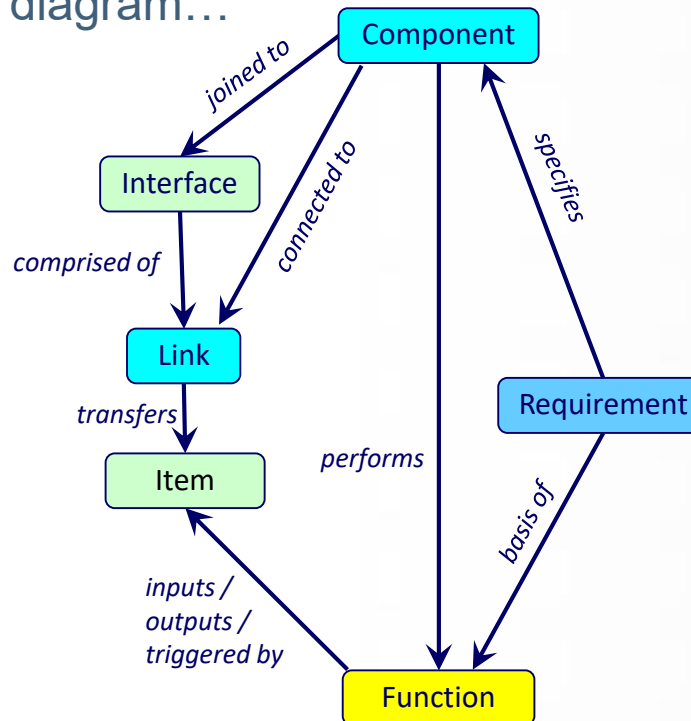
System Architecture

Which can be represented by the following diagram...

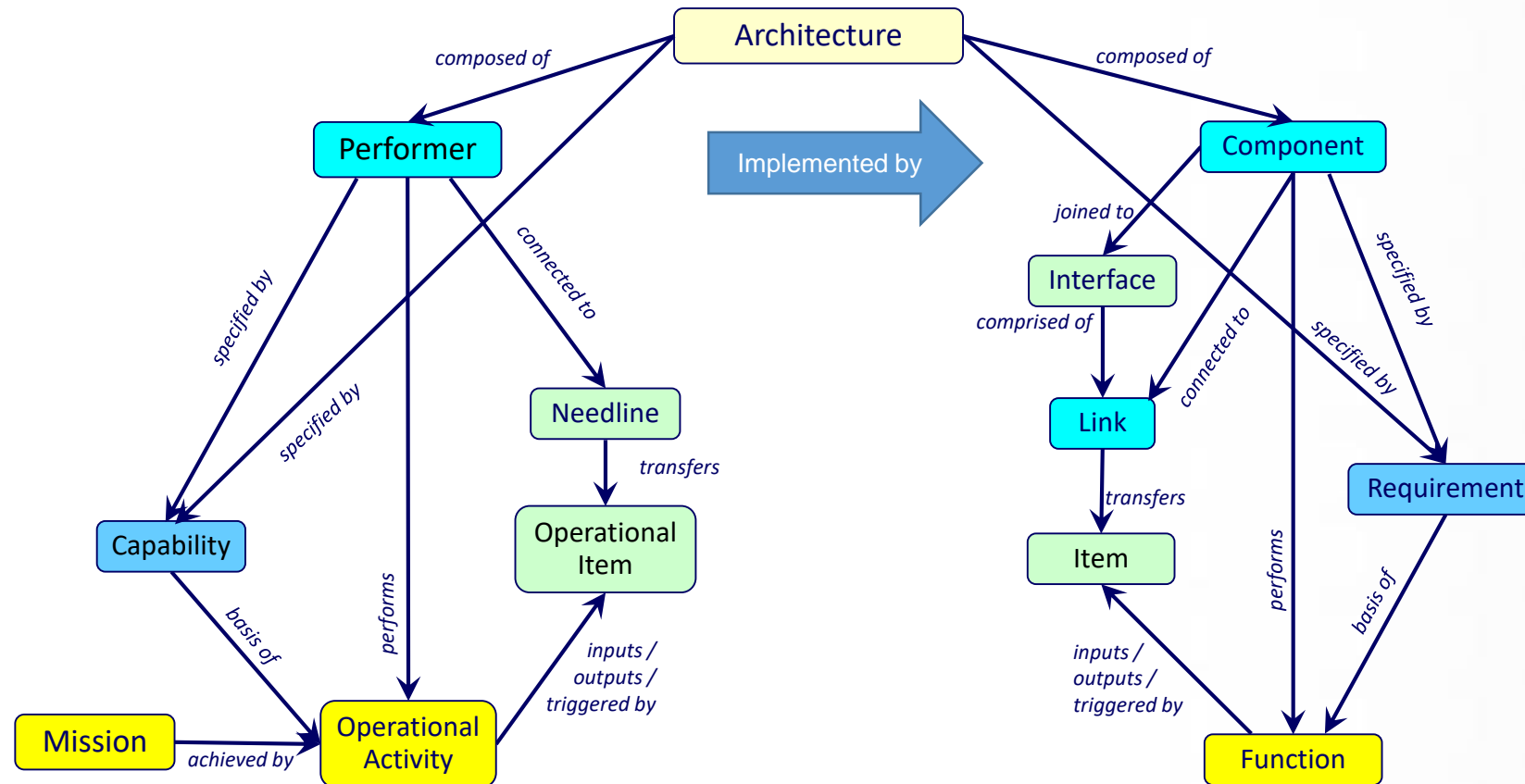
As Systems Engineers, we know how to do Systems Architecture.

We think of “Systems” in terms of:

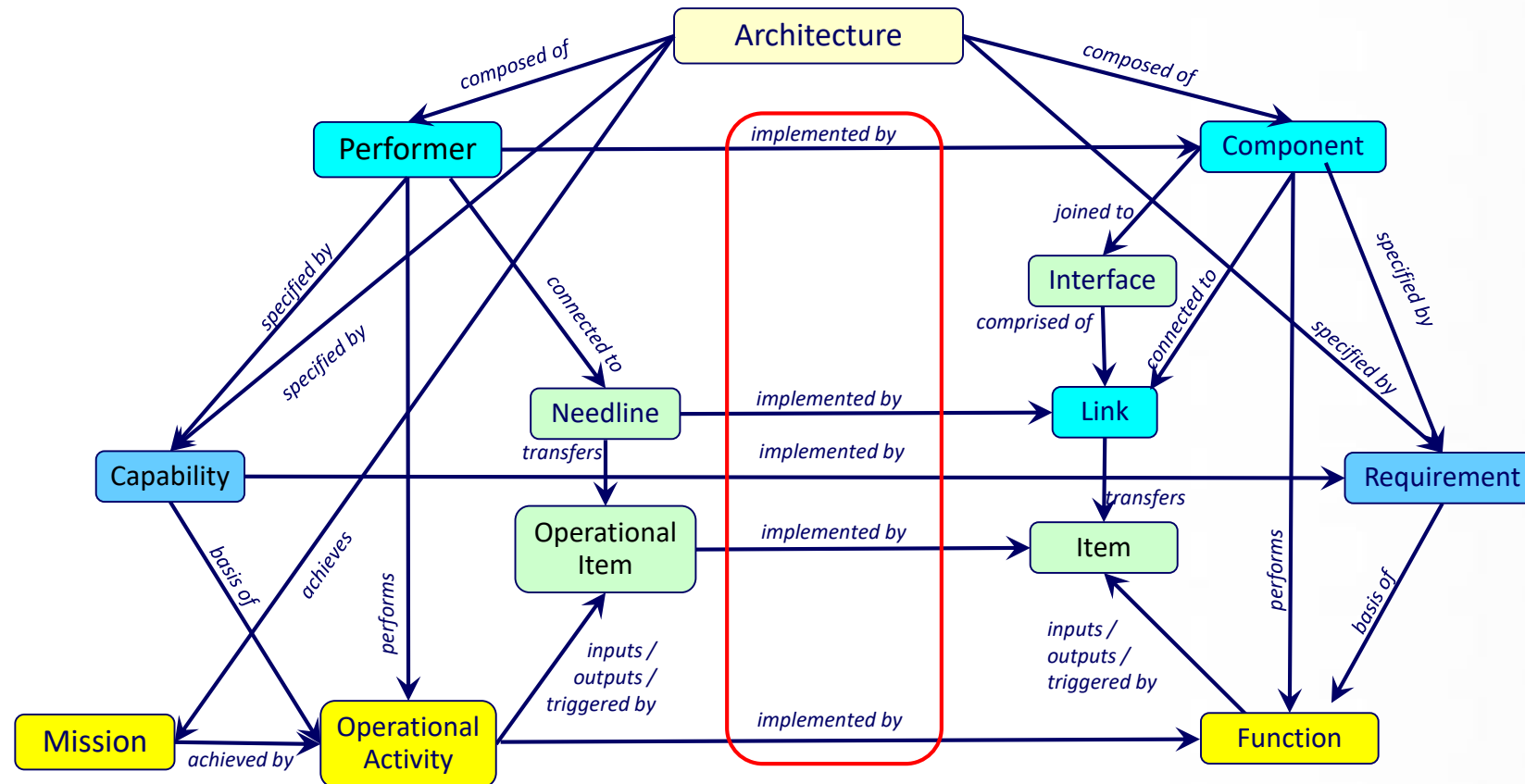
- Requirements
- Physical entities
- Functions (what a system does)
- Connection between Components



Operational ... to ... System Architecture



Operational ... to ... System Architecture



Example – Combat Biothreats and Pandemics

- **Components** – *Training Processes, Emergency Radios, Hazmat Suits*
- **Links** – *Atmosphere, Ventilation Ducts, Radio Frequency*
- **Items** – *Sarin, Ebola, Anthrax*
- **Functions** – *Air, Water, Emergency Communications*

Summary

A “flat” 2-D traceability of the relations between Architecture, Missions, Capabilities, Operational Nodes is not sufficient for providing completeness and consistency. An MBSE model can provide the need ability.

The concept of Operational Architecture development may include Missions and accomplishment of missions as a key part of the analysis.

DoDAF, as a “standard framework” does not require development of Mission views. Therefore, an Architect should develop additional views to show this traceability.

Once the Mission areas are captured and related to the Operational Architecture, you can then examine Systems Views to identify the systems architectures needed.

Questions?



Mark Simons
Principal Systems Engineer

2270 Kraft Drive
Suite 1600
Blacksburg, VA 24060
USA
+1.703.883.2270 x302

www.vitechcorp.com
msimons@vitechcorp.com