Limits to the Use of the Zachman Framework in Developing and Evolving Architectures for Complex Systems of Systems

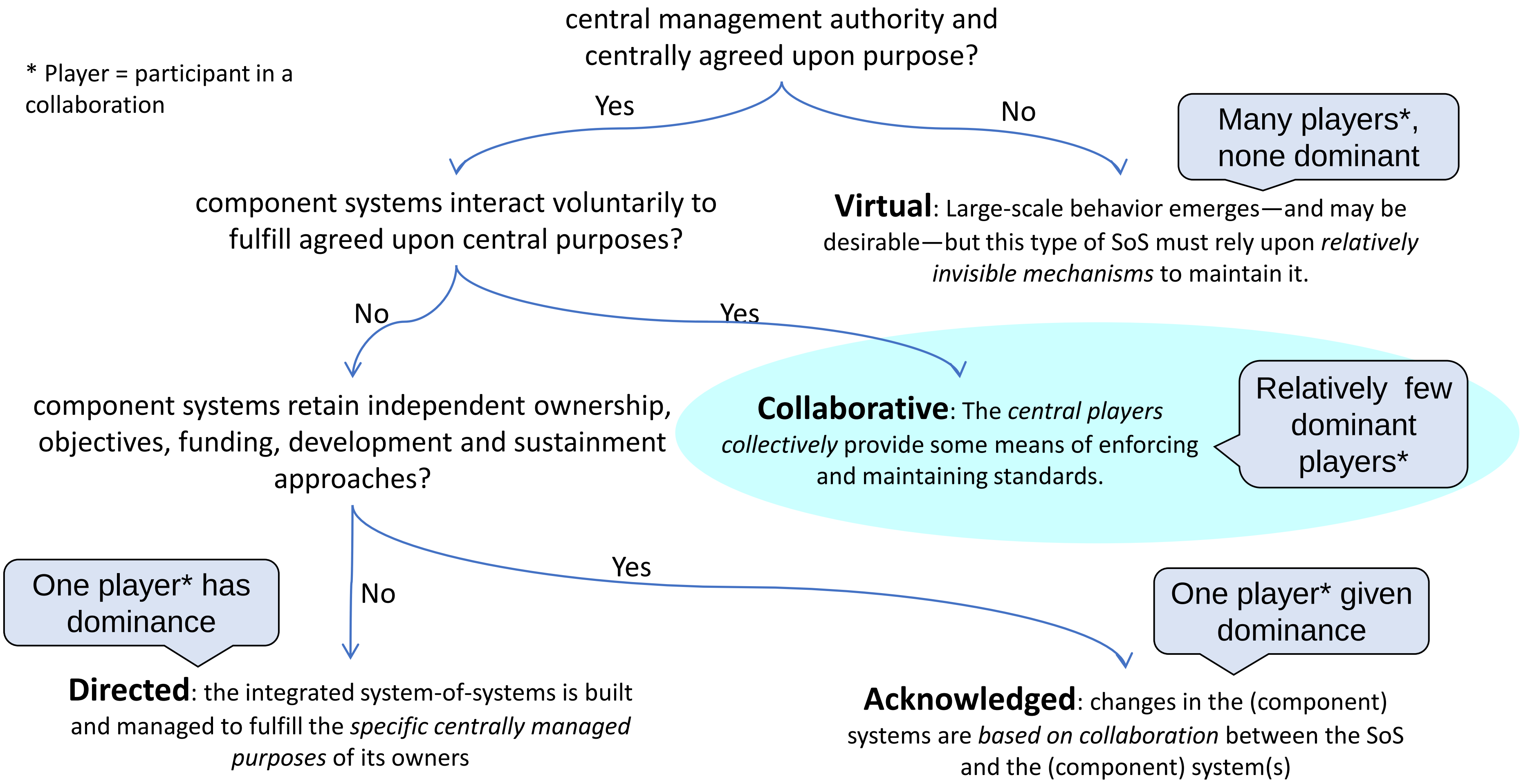
Philip Boxer

May 6th 2009

Agenda

- The Enterprise/Architecture relationship
- The demands of collaborative systems of systems
- Limits to the use of the Zachman Framework & the consequences for DODAF 2.0
- Summary

Systems of Systems: *4 Types defined by OSD SE Guide for Systems of Systems*



* Player = participant in a collaboration

central management authority and centrally agreed upon purpose?

Yes

No

Many players*, none dominant

Virtual: Large-scale behavior emerges—and may be desirable—but this type of SoS must rely upon *relatively invisible mechanisms* to maintain it.

component systems interact voluntarily to fulfill agreed upon central purposes?

No

Yes

Collaborative: The *central players collectively* provide some means of enforcing and maintaining standards.

Relatively few dominant players*

component systems retain independent ownership, objectives, funding, development and sustainment approaches?

No

Yes

One player* has dominance

Directed: the integrated system-of-systems is built and managed to fulfill the *specific centrally managed purposes* of its owners

One player* given dominance

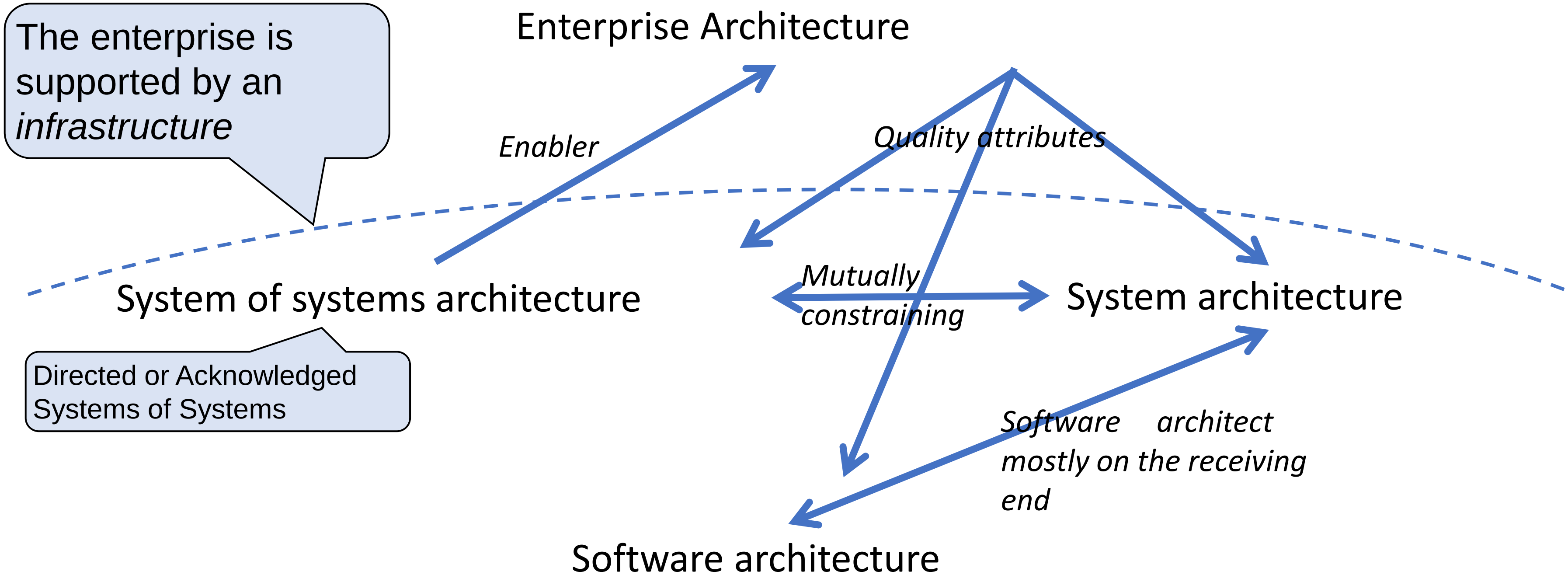
Acknowledged: changes in the (component) systems are *based on collaboration* between the SoS and the (component) system(s)

Source of definitions: Systems Engineering Guide for Systems of Systems, OSD, Version 1.0 August 2008. Brackets added.

Architectural Genres:

different genres for different purposes

- The primary interfaces across genres as evidenced by working group discussions:



The enterprise is supported by an *infrastructure*

Enterprise Architecture

Enabler

Quality attributes

System of systems architecture

Mutually constraining

System architecture

Directed or Acknowledged Systems of Systems

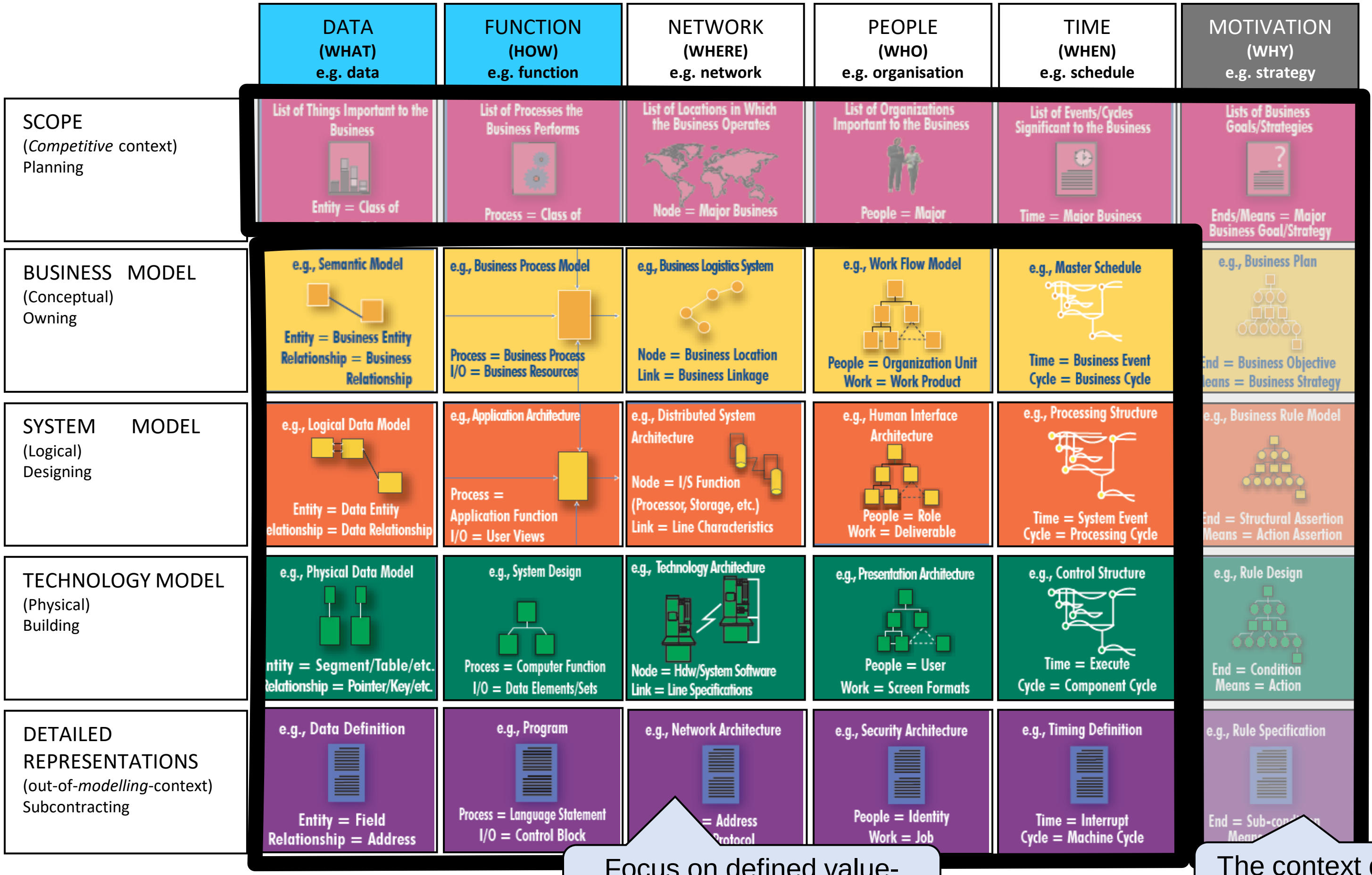
Software architect mostly on the receiving end

Software architecture

These genres reflect a *supply-side perspective* on the enterprise

Source: U.S. Army Workshop on Exploring Enterprise, System of Systems, System, and Software Architectures, John Bergey, Stephen Blanchette, Jr., Paul Clements, Mike Gagliardi, John Klein, Rob Wojcik, Bill Wood, March 2009 TECHNICAL REPORT CMU/SEI-2009-TR-008

The Enterprise Architecture defines the way it creates value: *Zachman roots to DODAF*



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Focus on defined value-creating relationships

The context defining that focus is the Enterprise

Source of coloured squares: Zachman Framework, www.zifa.com

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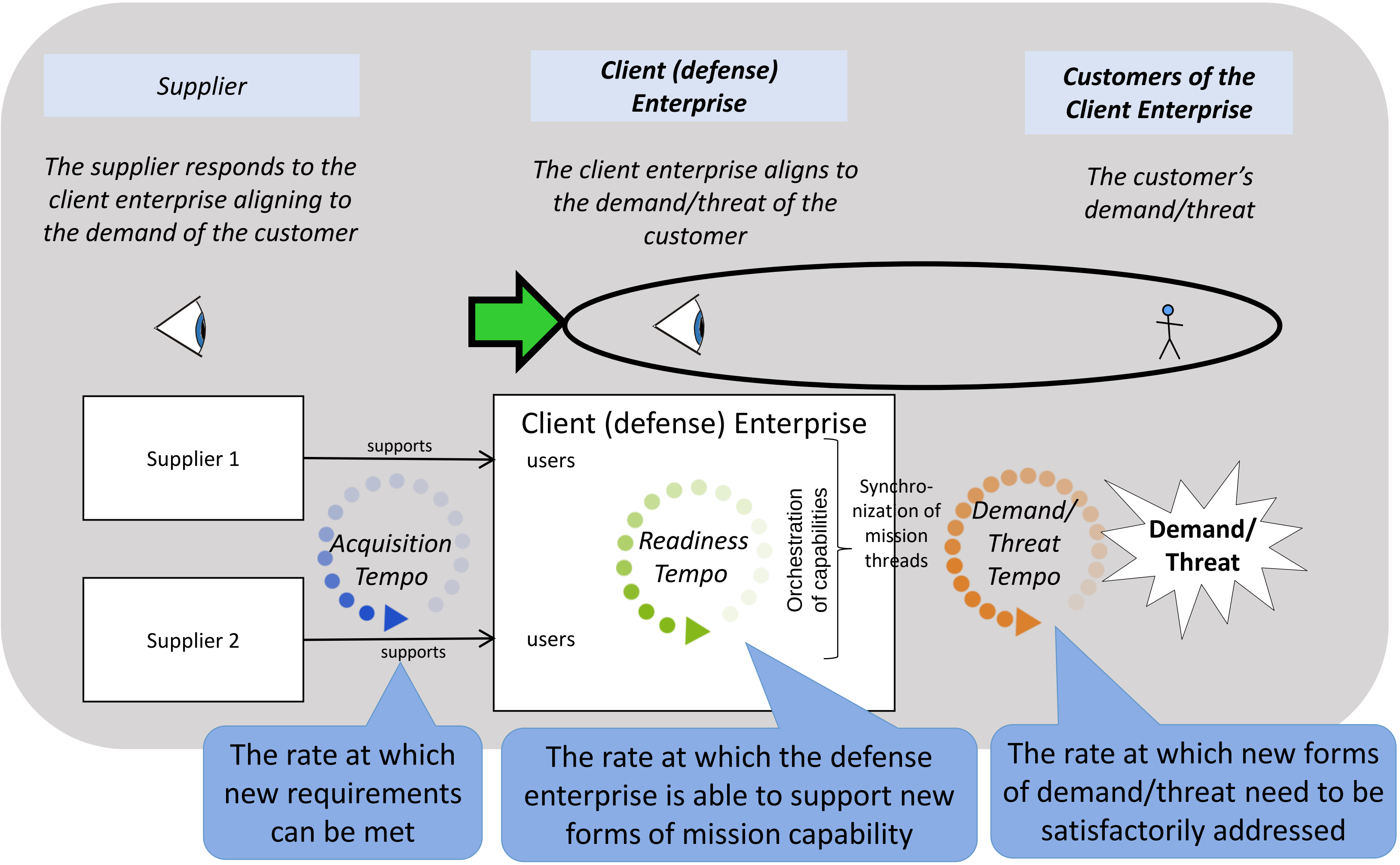
Speech by Secretary Gates:

There are two paradigms that must coexist

- The need for state of the art systems – particularly longer range capabilities – will never go away…
- We also need specialized, often relatively low-tech equipment for stability and counter-insurgency missions.
  - How do we institutionalize rapid procurement and fielding of such capabilities?
  - Why do we currently have to go outside the normal bureaucratic process?
- Our conventional modernization programs seek a 99% solution in years.
- Stability and counter-insurgency missions require 75% solutions in months.
  - The challenge is whether in our bureaucracy and in our minds these two different paradigms can be made to coexist.

Extracted from speech delivered by Secretary of Defense Robert M. Gates,
National Defense University, Washington, D.C. September 29, 2008
http://www.defenselink.mil/speeches/speech.aspx?speechid=1279

The three tempos: *analyzing the impact of the enterprise's relation to customers' changing demands*



Supplier

The supplier responds to the client enterprise aligning to the demand of the customer

Client (defense) Enterprise

The client enterprise aligns to the demand/threat of the customer

Customers of the Client Enterprise

The customer's demand/threat

The rate at which new requirements can be met

The rate at which the defense enterprise is able to support new forms of mission capability

The rate at which new forms of demand/threat need to be satisfactorily addressed

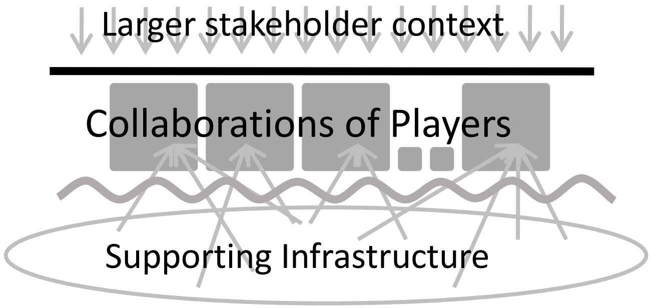
Managing diverging tempos: *the readiness tempo has to be managed in its own right*

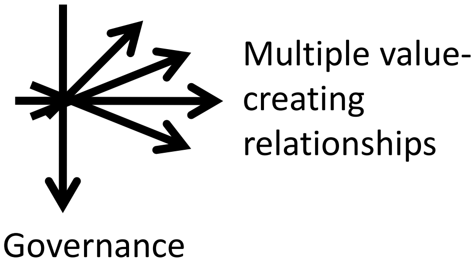
- Needing both of Gates' paradigms is about dealing with the consequences of diverging acquisition and demand/threat tempos
  - Their coexistence depends on managing the readiness tempo in its own right

- Managing the readiness tempo means:
  - sustaining *multiple collaborations* between players able to address *concurrent* types of demand/threat
  - building *organizational agility* into the supporting socio-technical infrastructures

Governance of a Collaborative SoS: *involves multiple collaborations with a supporting infrastructure*

- The players in a collaboration can be spread across multiple enterprises and/or different parts of a single enterprise


Larger stakeholder context
Collaborations of Players
Supporting Infrastructure



It is the players participating in a particular collaboration who will define

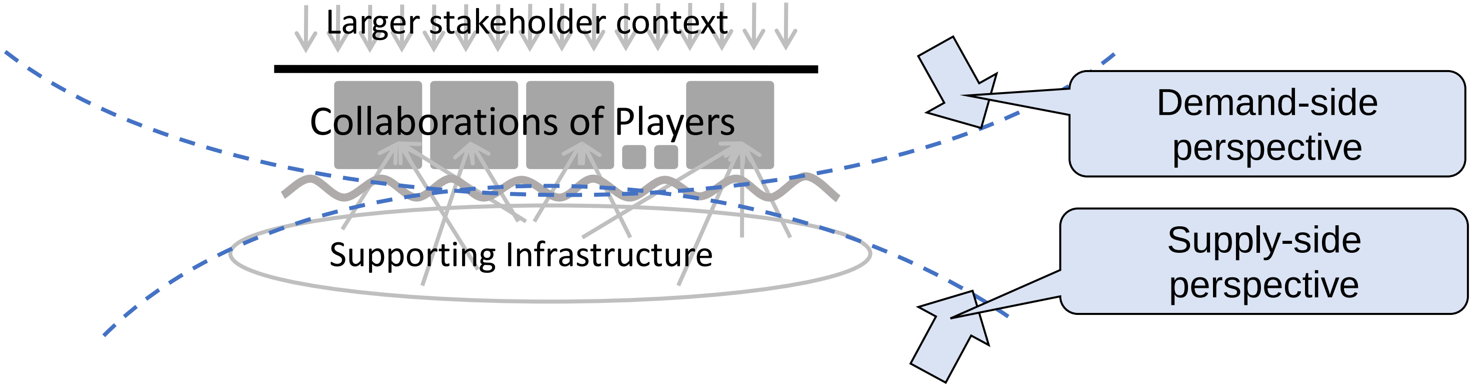
- Their system-of-interest and its environment
- The stakeholders they judge to be relevant
- The way they want their collaboration supported by the infrastructure

And so… *a demand-side perspective needs to be added*

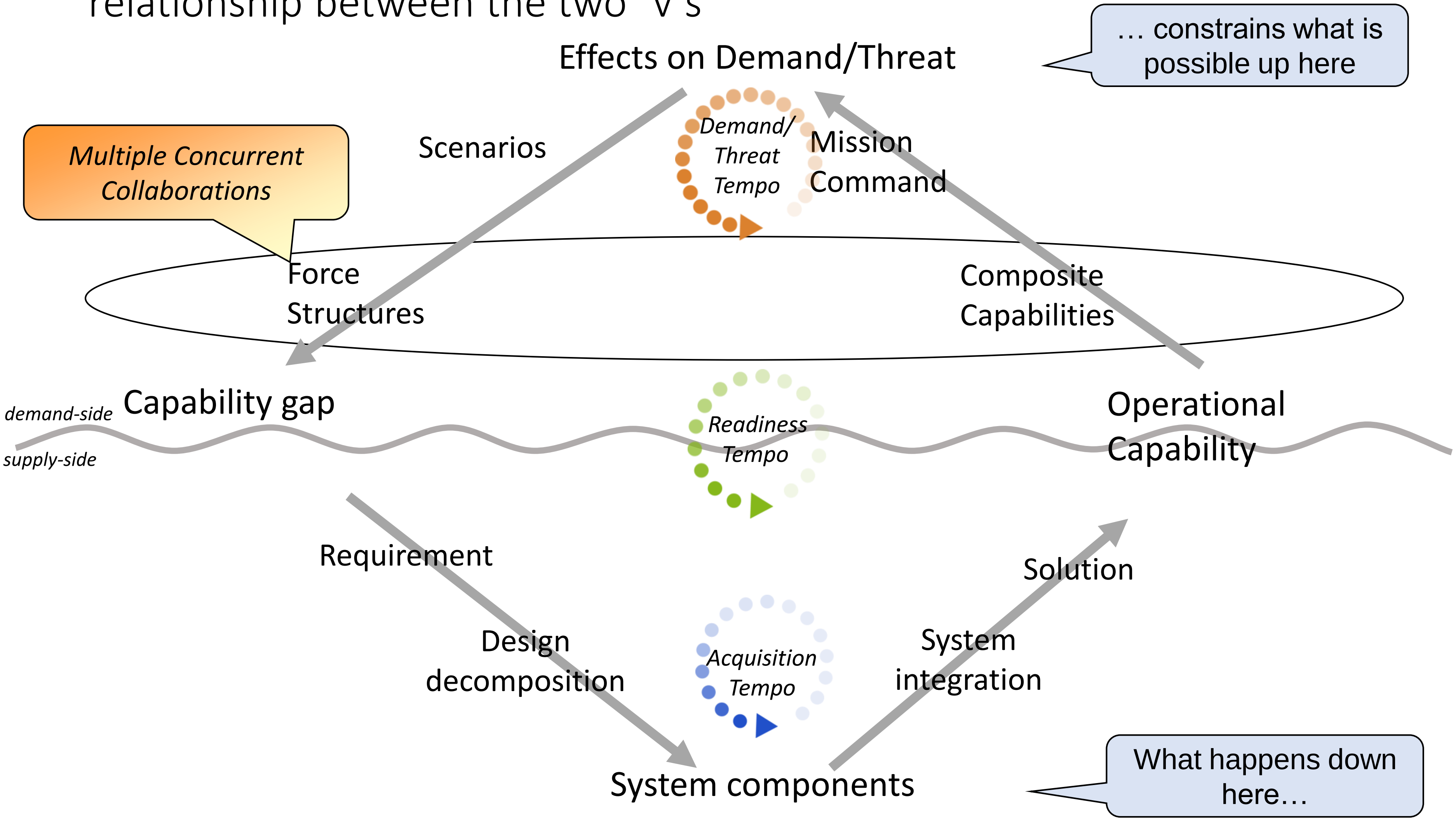
- Collaborative SoS present a different order of complexity

- This complexity arises because
  - multiple collaborations between players exist concurrently,
  - each with its own relationship to demand/threat, and
  - supported by a shared infrastructure

- It means adding a demand-side perspective on the collaborations


Larger stakeholder context
Collaborations of Players
Supporting Infrastructure
Demand-side perspective
Supply-side perspective

Managing both paradigms: means managing the relationship between the two ‘V’s



… constrains what is possible up here

Effects on Demand/Threat

Multiple Concurrent Collaborations

Scenarios

Demand/ Threat Tempo

Mission Command

Force Structures

Composite Capabilities

demand-side

Capability gap

supply-side

Readiness Tempo

Operational Capability

Requirement

Solution

Design decomposition

Acquisition Tempo

System integration

System components

What happens down here…

Boxer, P.J. (2007) Managing the SoS Value Cycle, January 2007, http://www.asymmetricdesign.com/archives/85

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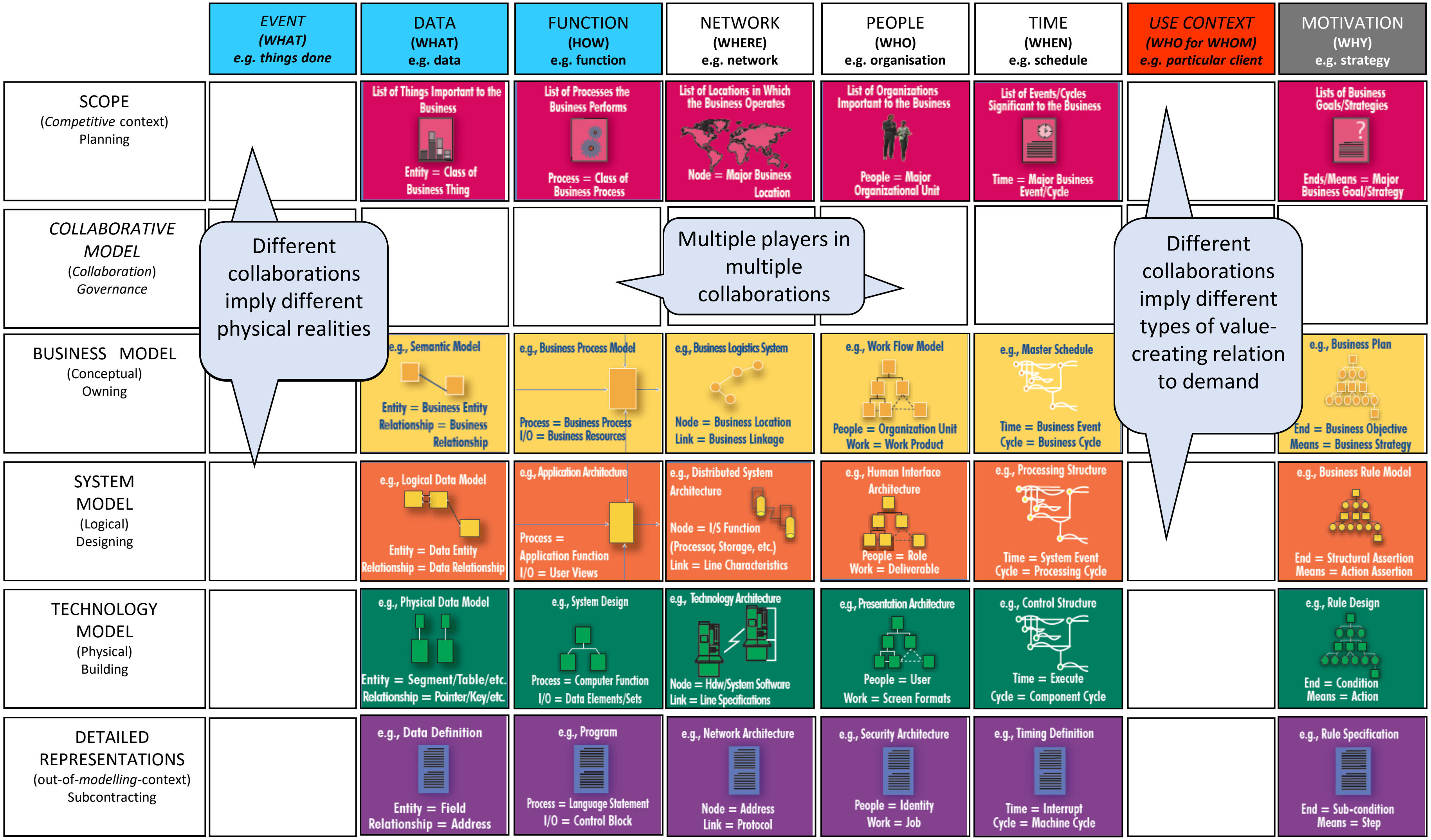
The demand-side perspective: *creates gaps in Zachman*



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Different collaborations imply different physical realities

Multiple players in multiple collaborations

Different collaborations imply different types of value-creating relation to demand

Source of gaps: Philip Boxer, Modeling structure-determining processes, http://www.asymmetricdesign.com/archives/59, December 2006

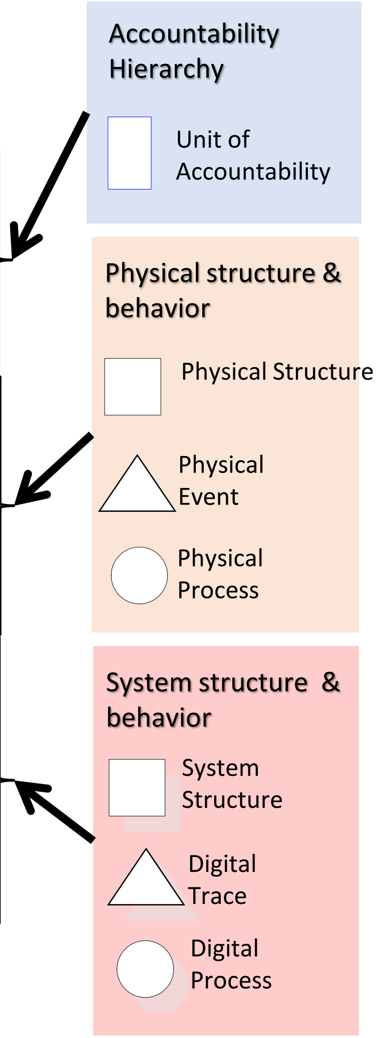
DODAF 2.0 Entities and Views:

what gets modeled?

Modeling Elements

DODAF TAXONOMY TYPES and CADM 2.0 PRINCIPAL INDEPENDENT ENTITIES	All Views (AV)		Operational View (OV)							System View (SV)											Tech View(TV)	
	1	{2}	1	{2}	{3}	{4}	{5}	{6}	{7}	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{1}	{2}
Operational Nodes *Organizations, Types of Organizations, and Operational Roles*	🗎	●	🗎	●	●	●	●	●														
Performance Attributes	🗎	●	🗎		◉		◉	◉					◉		●	●	◉	◉	◉		◉	◉
Technical Standards *Info Processing, Info Transfer, Data, Security, and Human Factors*	🗎	●	🗎						◉	◉	◉		◉		◉		◉	◉		◉	●	●
Technology Areas	🗎	●	🗎															●				◉
Physical Nodes *Facilities, Platforms, Units, and Locations (including Features)*	🗎	●	🗎							◉	◉	◉			◉	◉	◉	◉			◉	◉
Triggers/Events	🗎	●	🗎		●			●							●				●			
Operational Activities *(and Tasks)*	🗎	●	🗎	◉	●		●	●						●								
Technology Areas	🗎	●	🗎															●				◉
Systems *Families-of-Systems, Systems-of-Systems, Networks, Applications, Software, and Equipment*	🗎	●	🗎							●	●	●	●	◉	●	●	●	●	●		◉	◉
Information Elements *(and Data Elements)*	🗎	●	🗎	◉	●		●		●				●		●				◉	●	◉	◉
System Functions	🗎	●	🗎										●	●	◉	◉	◉	◉	●		◉	◉

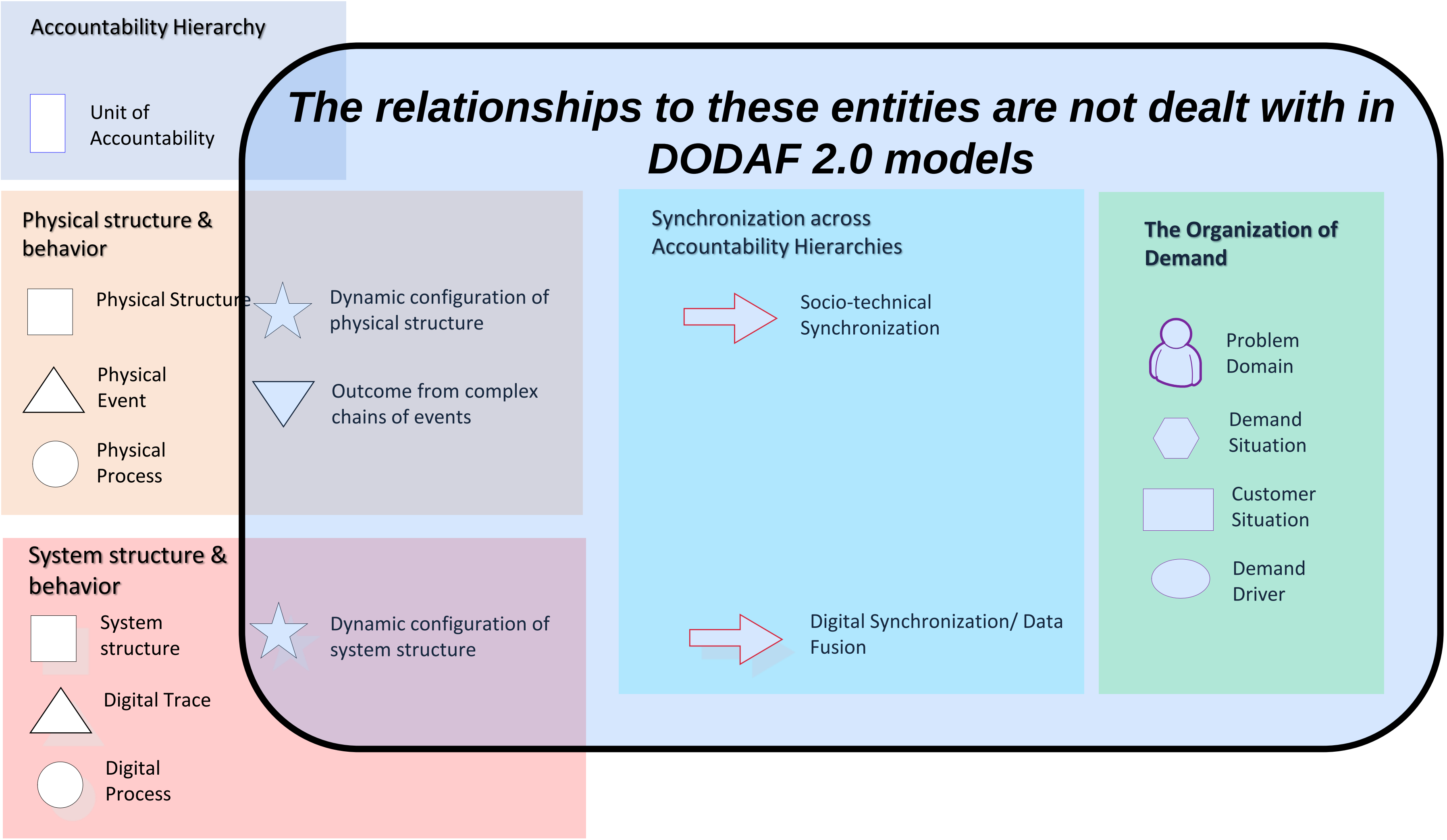
● = Taxonomy element plays a primary role   ◉ = element plays a secondary role   🗎 = unstructured text or graphics



Source: Fig 3-2, DoD Architectural Framework version 2.0 Volume III: Architecture Data Description, DOD Architecture Framework Working Group, July 2006

Entities not modeled by DODAF 2.0:

the demand-side perspective is not included



Accountability Hierarchy

Unit of Accountability

The relationships to these entities are not dealt with in DODAF 2.0 models

Physical structure & behavior

Physical Structure

Physical Event

Physical Process

Dynamic configuration of physical structure

Outcome from complex chains of events

System structure & behavior

System structure

Digital Trace

Digital Process

Dynamic configuration of system structure

Synchronization across Accountability Hierarchies

Socio-technical Synchronization

Digital Synchronization/ Data Fusion

The Organization of Demand

Problem Domain

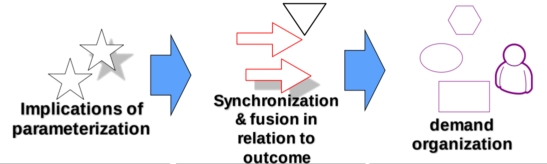
Demand Situation

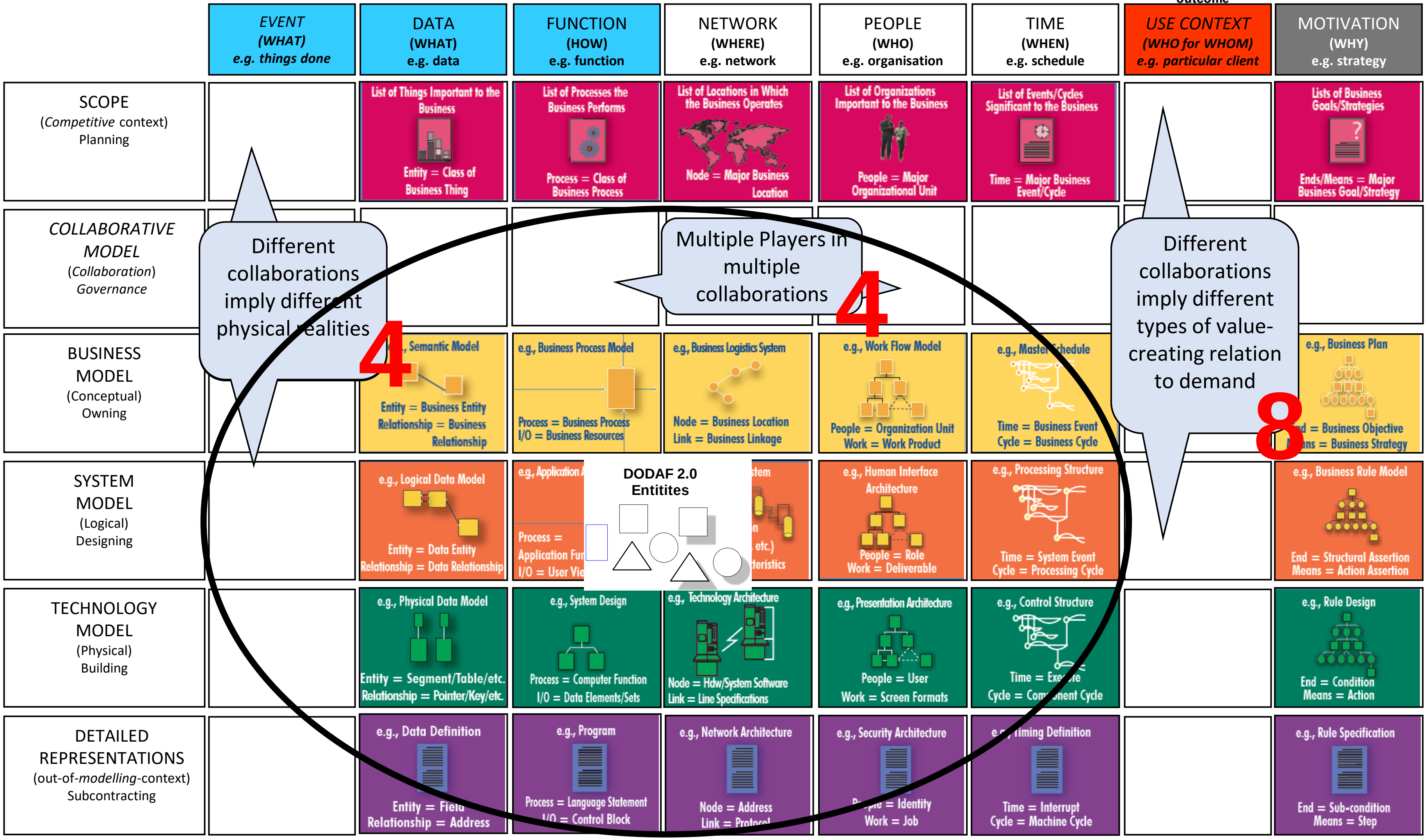
Customer Situation

Demand Driver

Describing the demand-side:

bridging the gaps


Implications of parameterization
Synchronization & fusion in relation to outcome
demand organization



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4

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Source of gaps: Philip Boxer, Modeling structure-determining processes, http://www.asymmetricdesign.com/archives/59, December 2006

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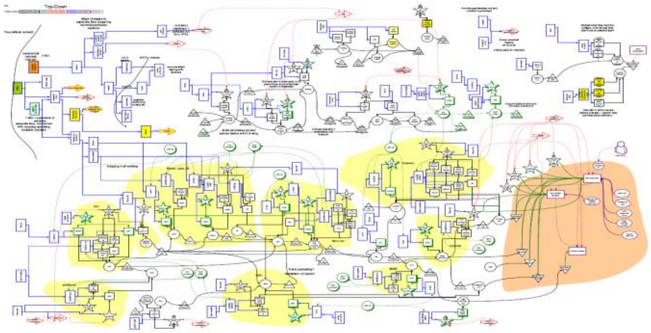
Summary: *both supply-side and demand-side perspectives need to be modeled*

- Supporting the development of collaborative systems of systems involves modeling more than the supply-side entities in Zachman-rooted representations like DODAF 2.0
  - Including a demand-side perspective means being able to account for
    - cross-cutting synchronization, not just hierarchical accountability
    - multi-enterprise development and co-evolution
    - inherent variation in the way user's demands emerge and evolve
    - the resultant tempo of the ongoing development of systems of systems



If you’re a software architect…so what?

- If you think/know you’re involved in a SoS collaboration,
  - It is likely that the requirements you are working to do NOT account for sufficient demand-side variety
    - Don’t over-constrain your software architecture too early
    - Look for architectural mechanisms that can accommodate later information on interfaces and implementations
  - Try to find out the level of awareness of SoS issues that is present on the part of your systems engineers
    - The more they are aware of their lack of control over organizational and technical interactions across the collaboration, the less likely they will be to pass down over-constraining architecture requirements to the software
    - If awareness of SoS issues is low, find out how they are planning to deal with some of the demand-side constructs discussed here
  - Start thinking about your customers’ “operations architecture” – the components and interfaces that they are operating with and that you are supporting with your software
    - Look for points of complementarity and conflict between your software architecture and your customer’s “operations architecture”