

# Capabilities in Systems Engineering: An Overview

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# Outline

- Motivation
- Capabilities in Different Areas of Knowledge
  - Capabilities in Economics and Strategic Management
  - Capabilities in Systems and Software Engineering
  - Capabilities in Information Systems
  - Consolidation of Definitions
- Capabilities and Services
- Connecting the Dots
- Conclusions
- Future Work

# Motivation

- Widespread use of the concept of capability
  - Simple, intuitive, powerful
  - Adopted by several areas of knowledge
- How it is applied in the different areas
- What is the relationship of the concept to that of Service

# Motivation

- **Definition of *CAPABILITY***

- 1 : the quality or state of being capable; *also* : ability
- 2 : a feature or faculty capable of development : potentiality
- 3 : the facility or potential for an indicated use or deployment <the *capability* of a metal to be fused> <nuclear *capability*>

<http://www.merriam-webster.com>

- **Definition of **capability****

- **noun (plural capabilities)**
- (often **capability of doing/to do something**)
- the power or ability to do something

<http://oxforddictionaries.com>

# Capabilities In Economics and Strategic Management

- Used to distinguish organizations
- Competitive advantage
  - Differences are based on the differences on the capabilities to deploy resources available to all
  - Firms tend to specialize in activities for which their capabilities offer competitive advantage
- Routines are the building blocks
  - Need for repeatability
- Dynamic capability reconfiguration

# Capabilities in Software and Systems Engineering

- Originated in the military domain
  - A (military) capability is defined as the ability to achieve a determined military objective, through the combination of people, process, and material
- CMM
  - Originally for assessing SW Eng. Processes in the defense domain
  - Segmented in *organization and resource management, software engineering process and its management, and tools and technology*
  - Process as a synonym for capability

# Capabilities in Software and Systems Engineering

- Capability Engineering
  - Using capabilities as the building blocks in engineering efforts
- Capability Patterns (IBM Rational Method Composer)
  - Reusable process which can be applied at any stage of the life cycle and prescribes a work break down structure, allocation of teams, and products

# Capabilities in Information Systems

- DoDAF and MODAF Enterprise Architecture Frameworks
  - Inclusion of the concept in the meta-model offered by the frameworks
  - Combines activities and resources (DoDAF)
  - Can be specified even if it is not achievable (MODAF)
  - Capability Viewpoints
- TOGAF
  - Part of the meta-model
  - Capability based-planning



# Consolidation of Definitions

Domain		Definition	Source
Strategic Management	Enterprise Architecture - Systems Engineering	The ability to perform and sustain a set of routines, involving coordination among the actors of the organization and the usage of skills, organization and technology to respond to the demands of the environment.	(Nelson and Winter, 1985)
		The collective physical facilities and human skills, carefully coordinated and integrated, as a means of achieving economies of scale and scope.	(Chandler, 1990)
		The essence of capabilities lies in the processes of the organization, driven or constrained by the positioning of the internal and external assets of the organization and by the evolutionary path that the firm has chosen to adopt.	(Teece et al., 1997)
		A (military) capability is defined as the ability to achieve a determined military objective, requiring a combination of people, process and material.	(US Department of Defense 2001), (Pagotto 2004)
		A measure of the system's ability to achieve the mission objectives, given that the system is dependable and suitable.	(Bate et al. 1994)
		Involves the attributes of people, technology, and process.	(Electronic Industries Alliance 2002)
		An ability to achieve a desired effect under specified conditions through the combination of activities and resources.	(US Department of Defense 2010)
		An ability that the enterprise possesses, and that it can be specified whether the enterprise is able to achieve it or not. Its configuration involves physical, human, and software re-sources and the interactions between them.	(UK Ministry of Defence 2010)
		An ability that an organization, person, or system possesses, typically requiring a combination of organization, people, processes, and technology.	(The Open Group 2011)
		Capability is divided in three areas: organization and resource management, software engineering process and its management, and tools and technology.	(Humphrey et al. 1987)

# Consolidation of Definitions

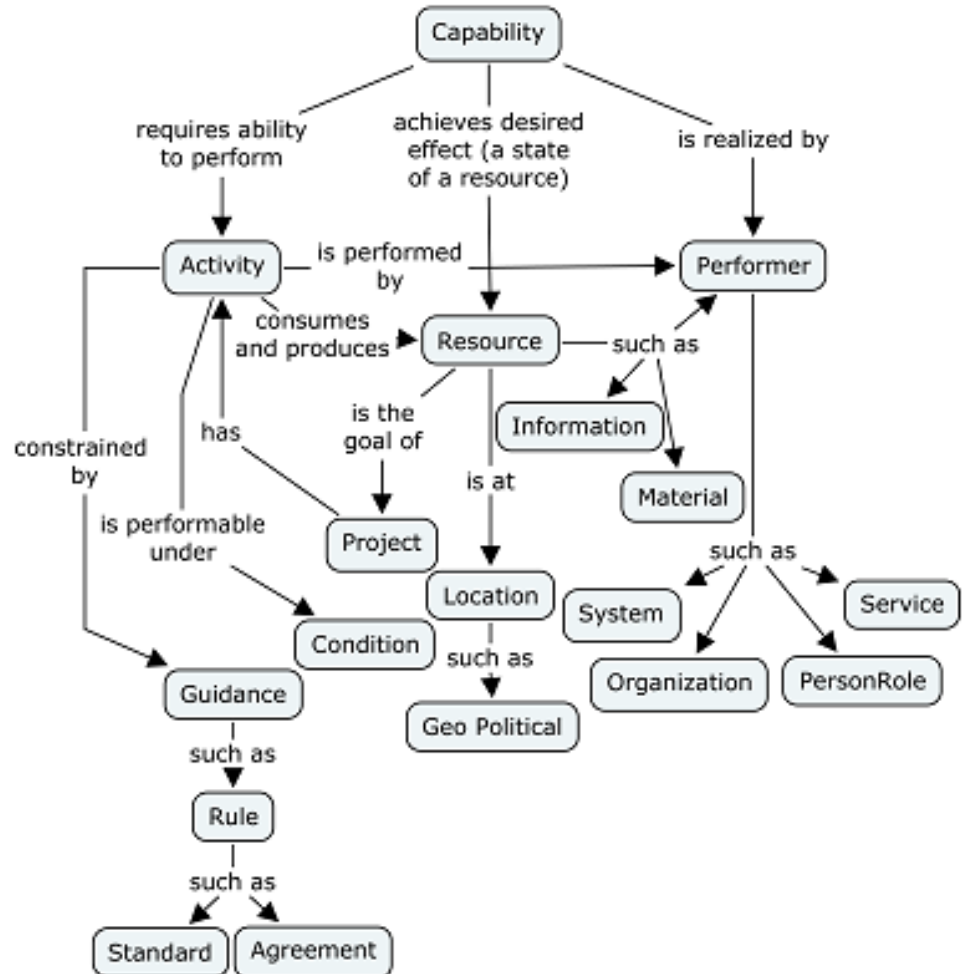
- Factors that characterize capabilities (Teece):
  - Processes (i.e., routines and other activities)
  - Positions (i.e., current technological infrastructure, intellectual property, clients, relation with suppliers)
  - Paths (i.e., strategic alternatives available to the organization)
- The essence of capabilities lies in processes. Competitive advantage is then constrained by the positioning of the internal and external assets (availability) and by the chosen evolutionary path (decisions)

# Capabilities and Services

- SoaML
  - Uses the concept of capability for identifying the set of functions or resources a service provides...
  - ... or the abilities a provider should have to provide a service
- BSDL
  - Capability is a functional concept, representing the function that is performed by a business services

# Capabilities and Services

- DoDAF
  - Capability is realized by a performer which might be a service
  - Services Viewpoint depicts the solutions and relates these to capabilities and operations

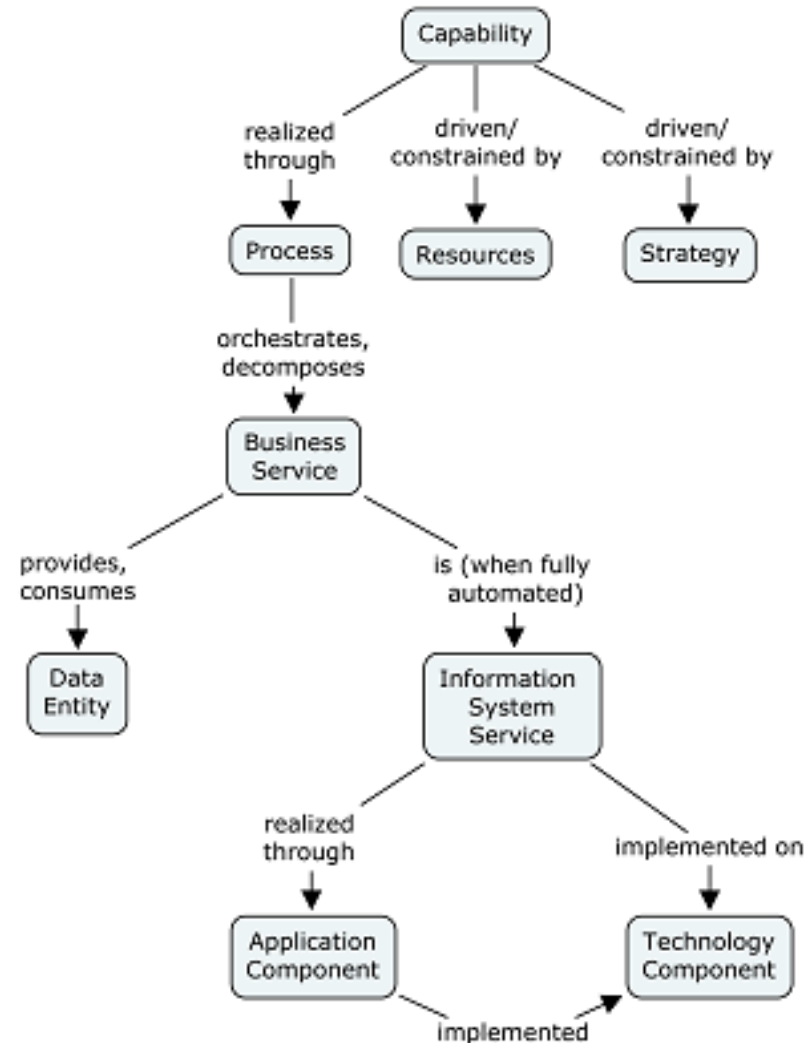


# Connecting the Dots

- The concept of service seems to rest between that of capability and those directly related to the implementation
  - Capabilities are easier to link to the drivers and motivation of the business
  - Concept of capability creates an anchor model that does not change in face of changes
- Service allows for the consideration of different implementation options, so do capabilities in relation to services
  - E.g., considering a phone book application, the capability of providing contact information might be delivered via a browsing service or a querying service

# Connecting the Dots

- Both concepts could contribute to business/IT alignment
- Services provide an uniform and abstract interface from the business to IT
- Capabilities provide an uniform and abstract interface from strategy to business
  - Full potential of an organization will only be provided if the service strategy is aligned with the business strategy



# Conclusions

- Overview on usages of the concept of capability
  - Used in different areas of knowledge
  - Delivered by a determined configuration of the organization's resources and it is influenced (driven or constrained) by the surrounding environment
- Relationship between the concepts of capability and service is also described
- Concept of service seems to rest between that of capability and those directly related to the implementation

# Future Work

- In methodological terms
  - Approach for engineering and governing services that takes advantage of the concept of capability would better promote the alignment of service implementation with the business strategy
- WRT techniques
  - Identification and representation of the capabilities and respective association with services and organizational goals would complement this work



# Thank you!!!

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