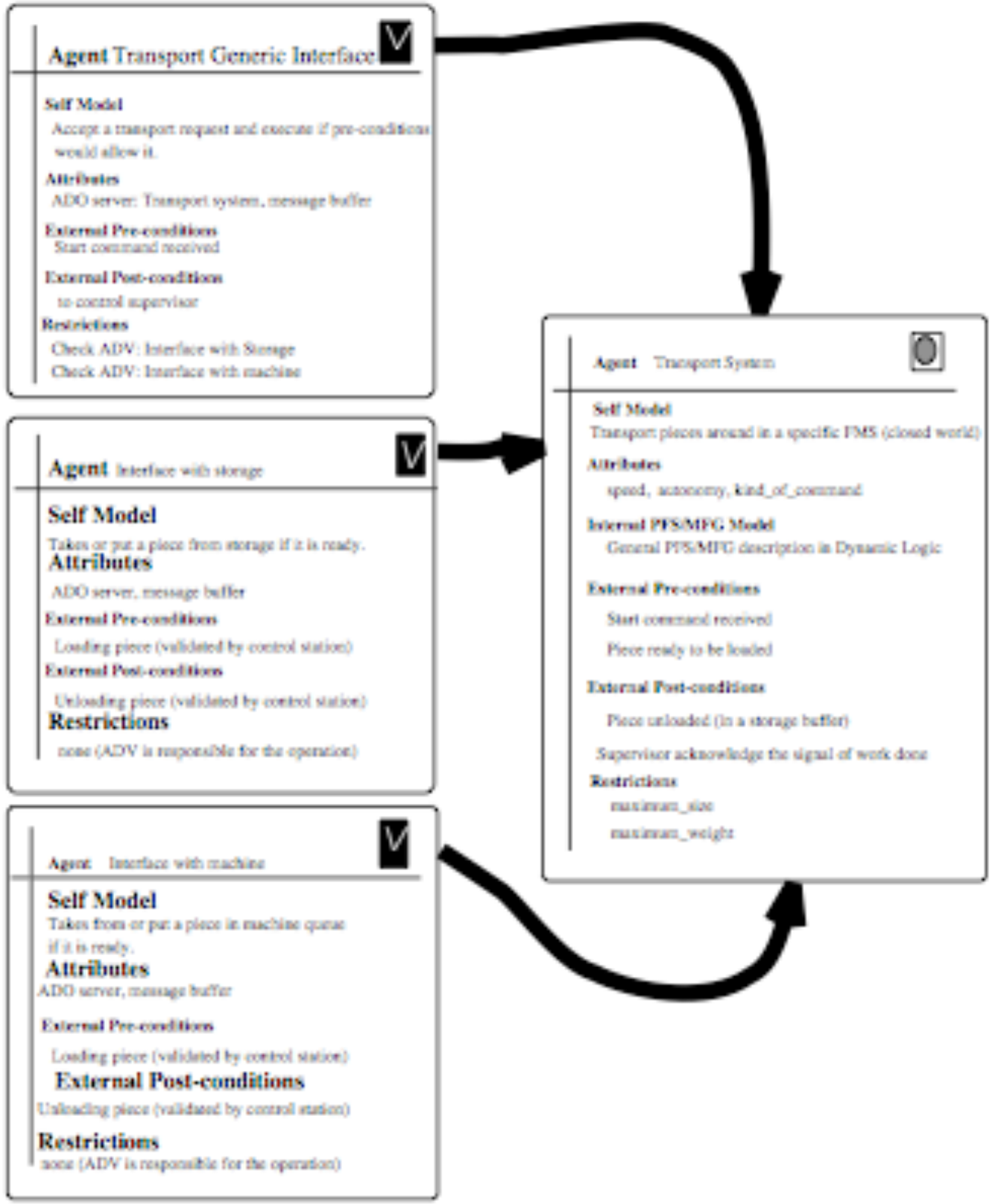
PMR 5020

Metodologia do Projeto de Sistemas

Aula 9: introducing MBSE, features and methods

Prof. José Reinaldo Silva
reinaldo@poli.usp.br

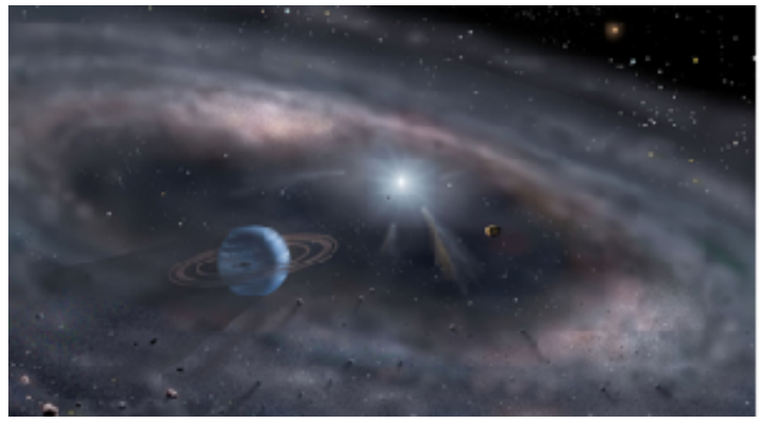
Object interface - service relationship

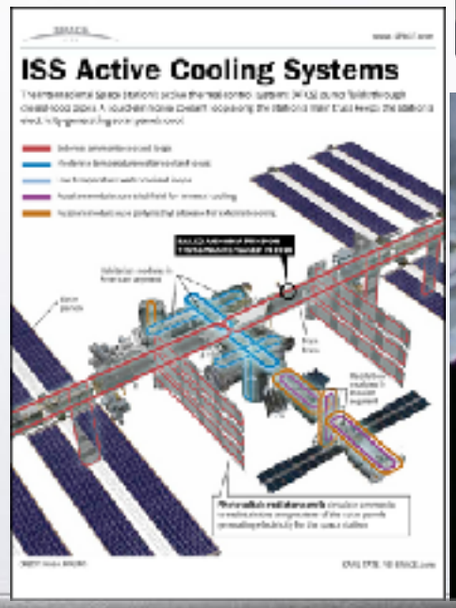


Silva, J.R., Afsarmanesh, H., Cowan, D.D., Lucena, C.J.P. (1995) An Object-Oriented Approach to the Design of Production Systems, in Balanced Automated Systems: Architecture and Design Methods, Camarinha-Matos, L. and Afsarmanesh, H. (eds.), Chapman & Hall, London.

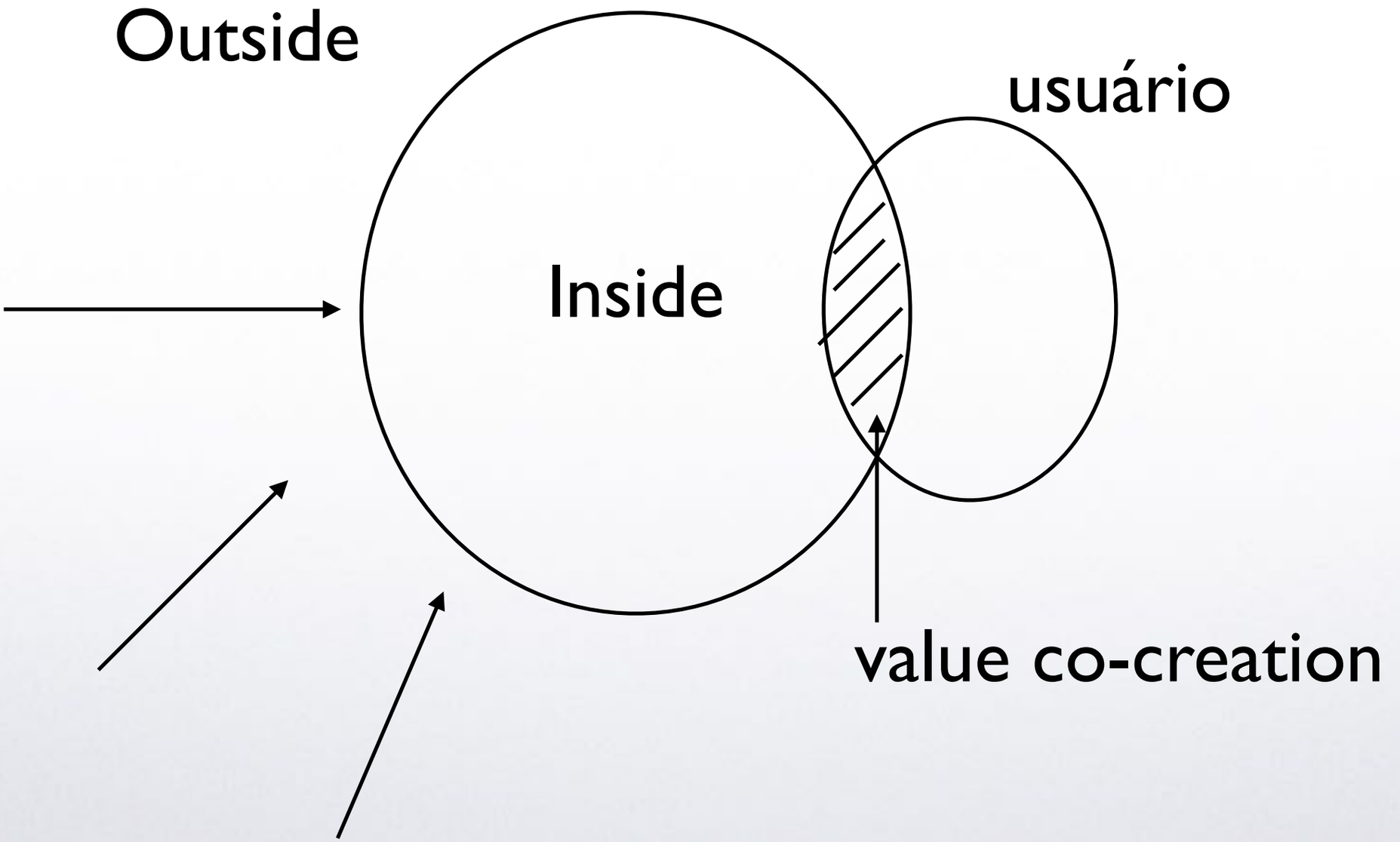
The System of Systems Challenge

A practical obstacle to the formalization of design is the practical effectiveness of this approach, specially in this era of complexity. Generally, formal approaches do not fit the complexity of large systems (of systems).





A System Service Model



The System Engineering Approach

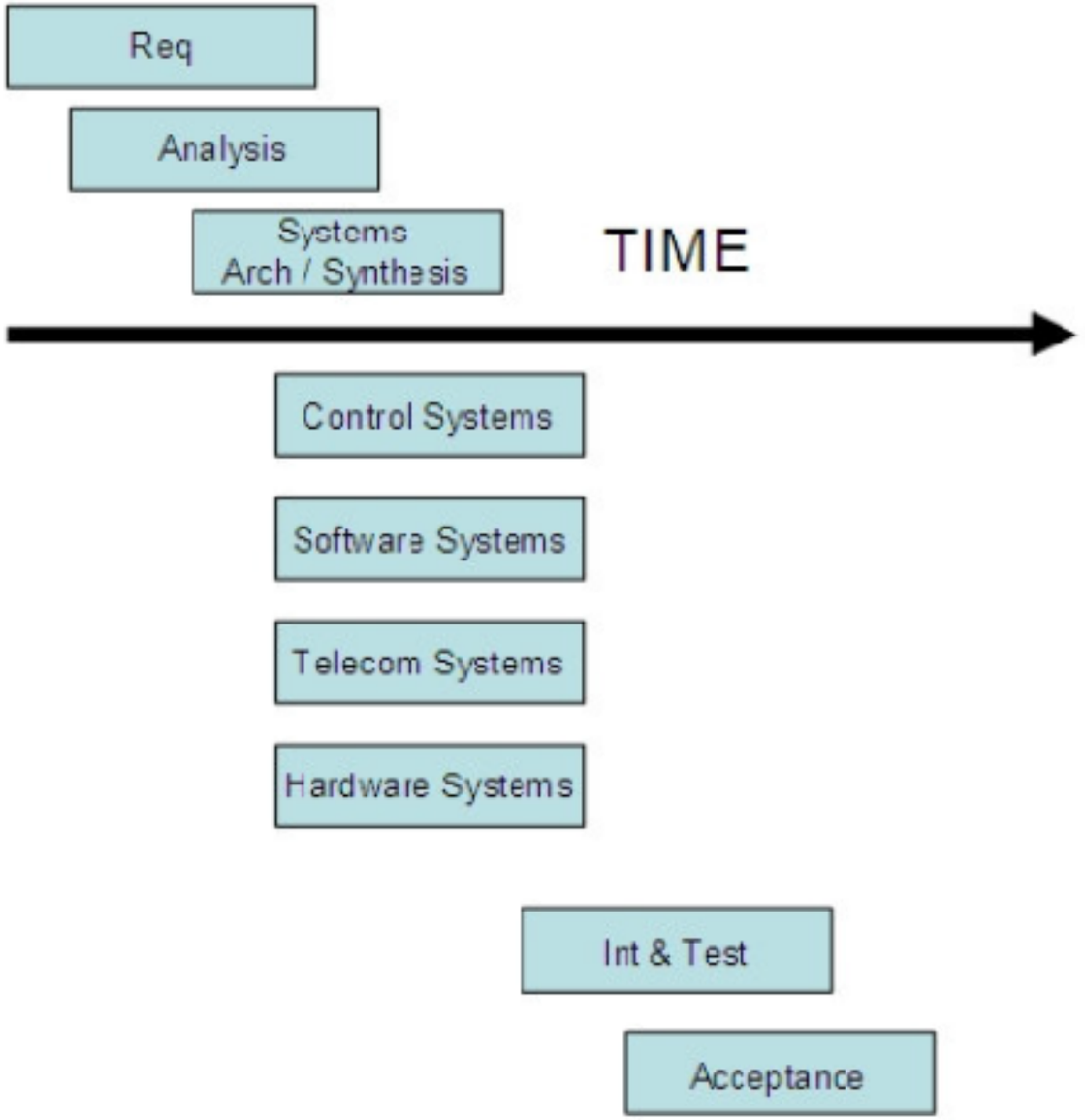
"Systems Engineering (SE) is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal". (INCOSE 2012, modified)

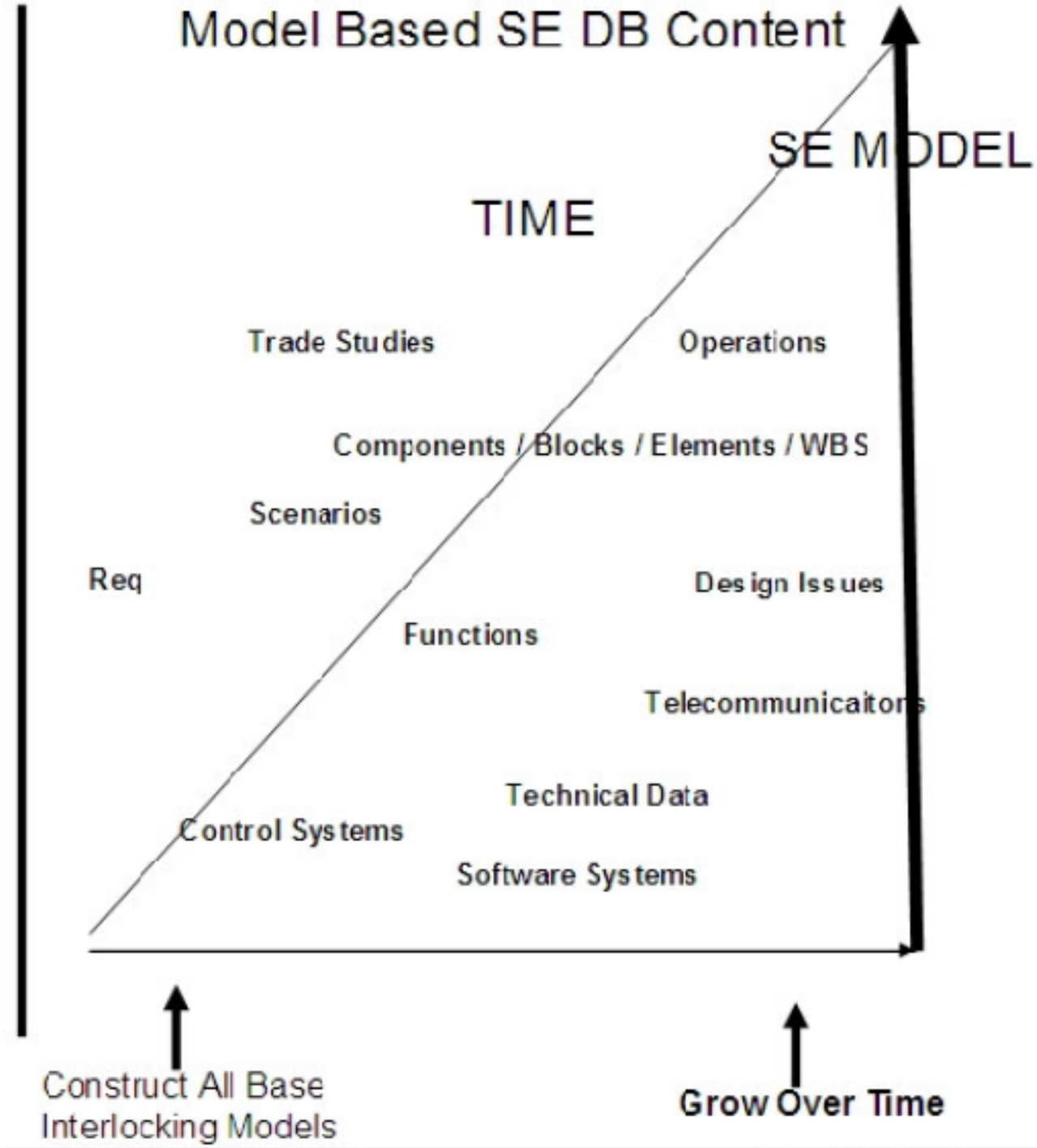
SEBoK-2015

A grande pergunta que permeia a aula de hoje é justamente como vamos resolver o problema de escalabilidade entre os métodos que vimos até aqui (e sem o que a discussão seria inviável) e o problema que temos que enfrentar de projetar grandes sistemas ou sistemas de sistemas.

Model Driven Systems Engineering

General Process:
All Methodologies shows
EMPHASIS (not waterfall tasks)





Fundamentação matemática para o MBSE

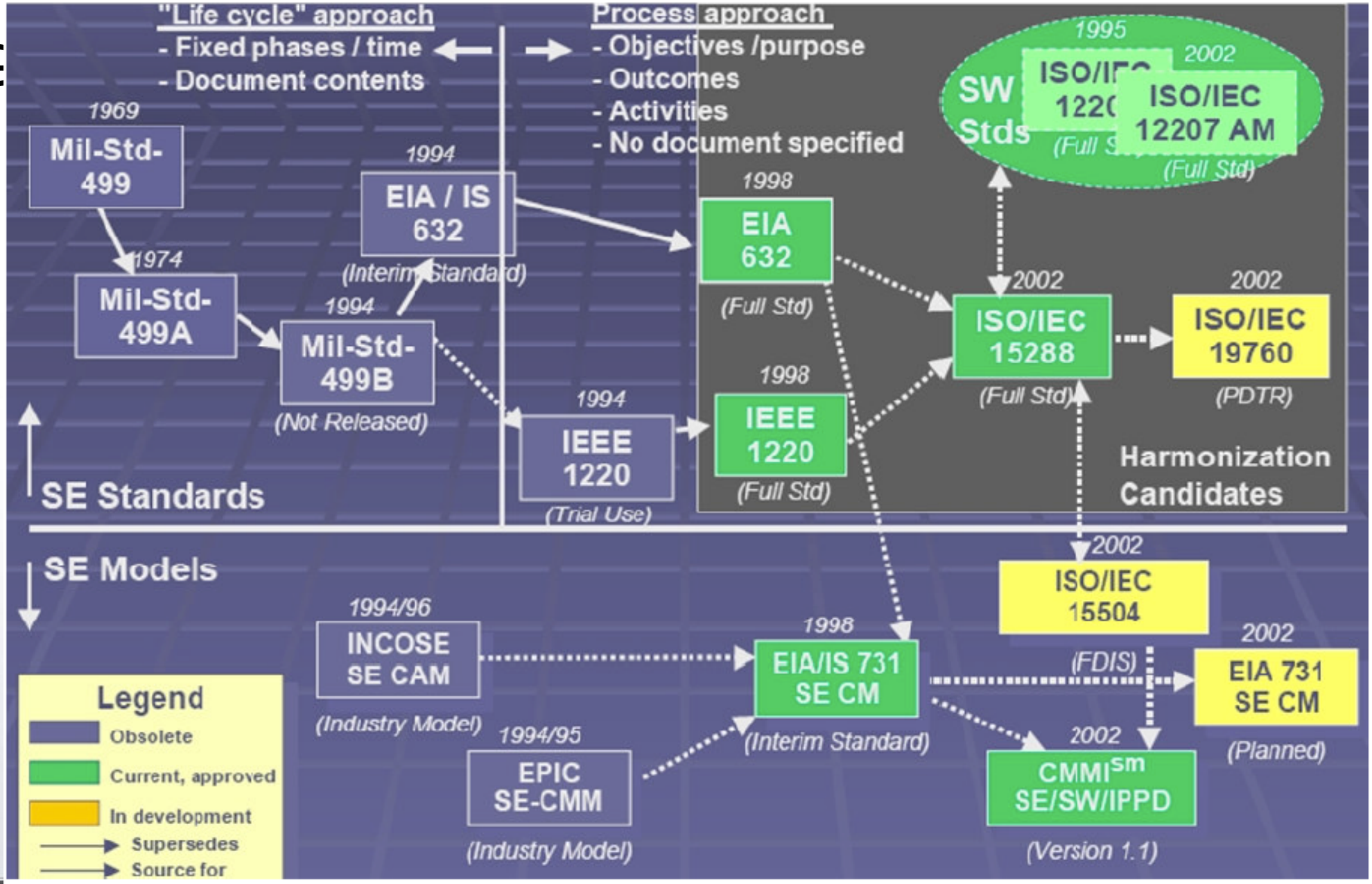
A. Wayne Waymore (T3SD)

Wymore, A. Wayne, A Mathematical Theory of Systems Engineering: The Elements , John Wiley & Sons: New York, NY, 1967.

Wymore, A. Wayne, Model-Based Systems Engineering , CRC Press, Inc.: Boca Raton, FL, 1993.

Wymore, A. Wayne, “Contributions to the Mathematical Foundations of Systems Science and Systems Engineering,” Systems Movement: Autobiographical Retrospectives, The University of Arizona, Tucson, AZ, 2004.

G


"Life cycle" approach
- Fixed phases / time
- Document contents
Process approach
- Objectives /purpose
- Outcomes
- Activities
- No document specified
1969
Mil-Std-499
1974
Mil-Std-499A
1994
EIA / IS 632
(Interim Standard)
1994
Mil-Std-499B
(Not Released)
1994
IEEE 1220
(Trial Use)
1998
EIA 632
(Full Std)
1998
IEEE 1220
(Full Std)
1995
SW Stds
2002
ISO/IEC 12207 AM
(Full Std)
2002
ISO/IEC 15288
(Full Std)
2002
ISO/IEC 19760
(PDTR)
Harmonization Candidates
SE Standards
SE Models
1994/96
INCOSE SE CAM
(Industry Model)
1994/95
EPIC SE-CMM
(Industry Model)
1998
EIA/IS 731 SE CM
(Interim Standard)
2002
ISO/IEC 15504
(FDIS)
2002
EIA 731 SE CM
(Planned)
2002
CMMI sm SE/SW/IPPD
(Version 1.1)
Legend
Obsolete
Current, approved
In development
Supersedes
Source for

Uma Norma para o Design de Sistemas

A norma ISO/IEC 15.288 foi lançada em Novembro 2002, editada por Stuart Arnold e arquitetada por Harold Lawson;

Em 2004 foi adotada pelo IEEE e passou a ser uma norma ISO/IEC/IEEE;

A última revisão foi publicada em Maio de 2015.

Uma Norma para o Design de Sistemas

Até aqui olhamos o Projeto de Sistemas do ponto de vista técnico, sempre privilegiando a formalização do processo após a fase de requisitos. Para chegar a um "projeto real" teremos que incluir a aspecto de negócios (business process) assim como os aspectos de gestão do próprio processo.

Technical processes

- Business or mission analysis process
- Stakeholder needs & requirements definition process
- System requirements definition process
- Architecture definition process
- Design definition process
- System analysis process
- Implementation process
- Integration process
- Verification process
- Transition process
- Validation process
- Operation process
- Maintenance process
- Disposal process

Technical management processes

- Project planning process
- Project assessment and control process
- Decision management process
- Risk management process
- Configuration management process
- Information management process
- Measurement process
- Quality assurance process

Agreement processes

- Acquisition process
- Supply process

Organizational project-enabling processes

- Life cycle model management process
- Infrastructure management process
- Portfolio management process
- Human resource management process
- Quality management process
- Knowlcdgc management process

Definition of Systems

real

"…are man made, created and utilized to provide products or services in defined environments for the benefit of users and other stakeholders"

model

"…an integrated set of elements, sub-systems, or assemblies that accomplish a defined objective. These elements include products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements." (INCOSE)

System and System of Systems

A system-of-systems is an assemblage of components which individually may be regarded as systems, and which possess two additional properties:

1. Operational Independence of the Components: If the system-of-systems is disassembled into its component systems, the component systems must be able to usefully operate independently. That is, the components fulfill customer-operator purposes on their own.

2. Managerial Independence of the Components: The component systems not only can operate independently, they do operate independently. The component systems are separately acquired and integrated but maintain a continuing operational existence independent of the system-of-systems. (Maier 1998, 271)

Maier, M. W. 1998. "Architecting Principles for Systems-of-Systems". Systems Engineering, 1(4): 267-84.

Classification of SoS: US Dept. of Defense

According to US DoD systems of systems could be classified into:

Virtual
Collaborative
Acknowledged
Directed

DUS(AT). 2008. Systems Engineering Guide for Systems of Systems," version 1.0. Washington, DC, USA: Deputy Under Secretary of Defense for Acquisition and Technology (DUS(AT))/U.S. Department of Defense (DoD).

Other System Architectures

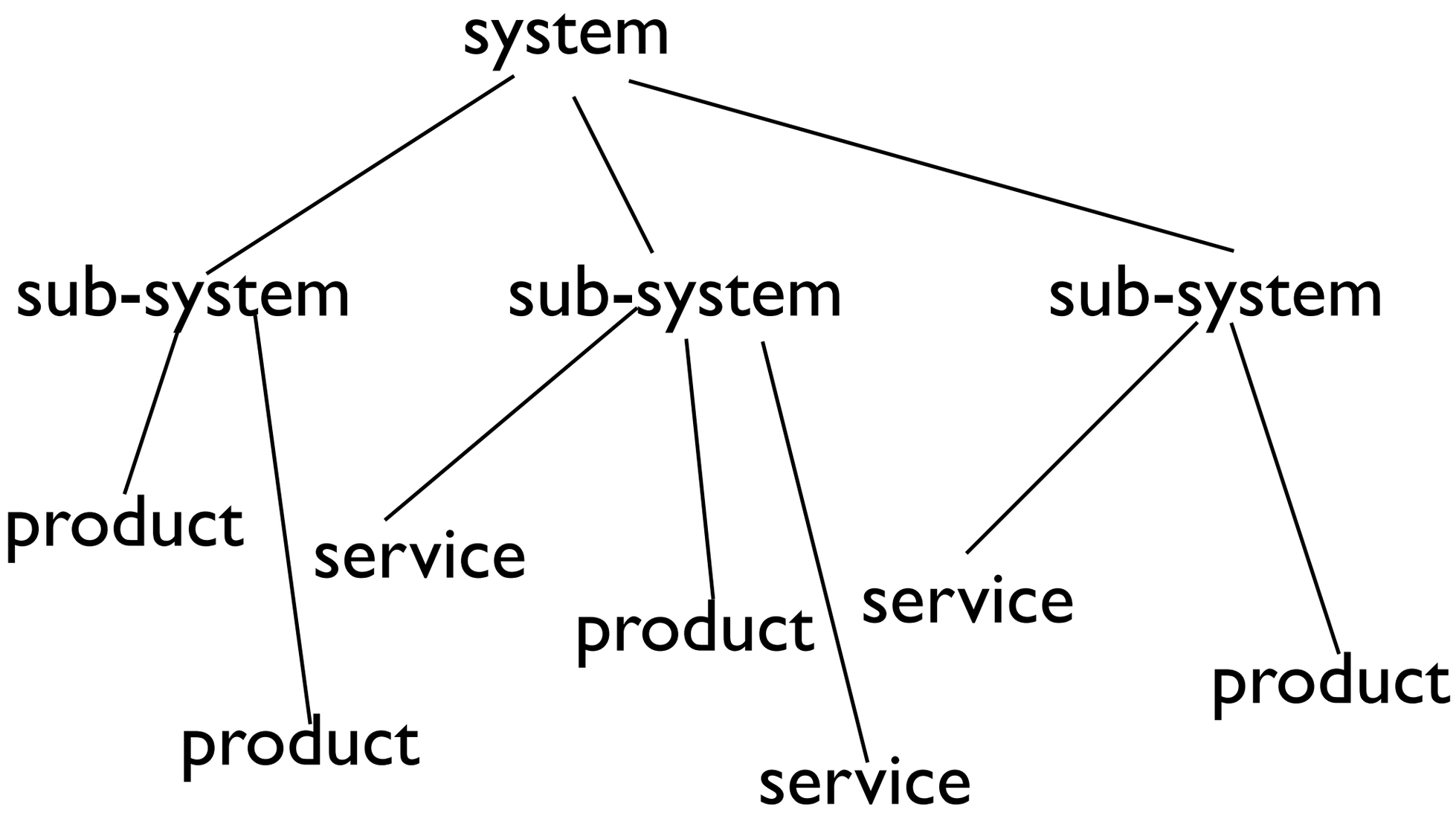
Federation of Systems

A Federation of Systems (FoS) is a loosely coupled set of collaborative and distinct institutions (systems) with a week structuring control that "voluntarily" contributes to some social goal. This set could be closed or open.

Family of Systems

A family of systems is set of systems that have some common characteristics and also a loosely coupled association but that could collaborate to achieve some social goals and share facilities.

Current tendency



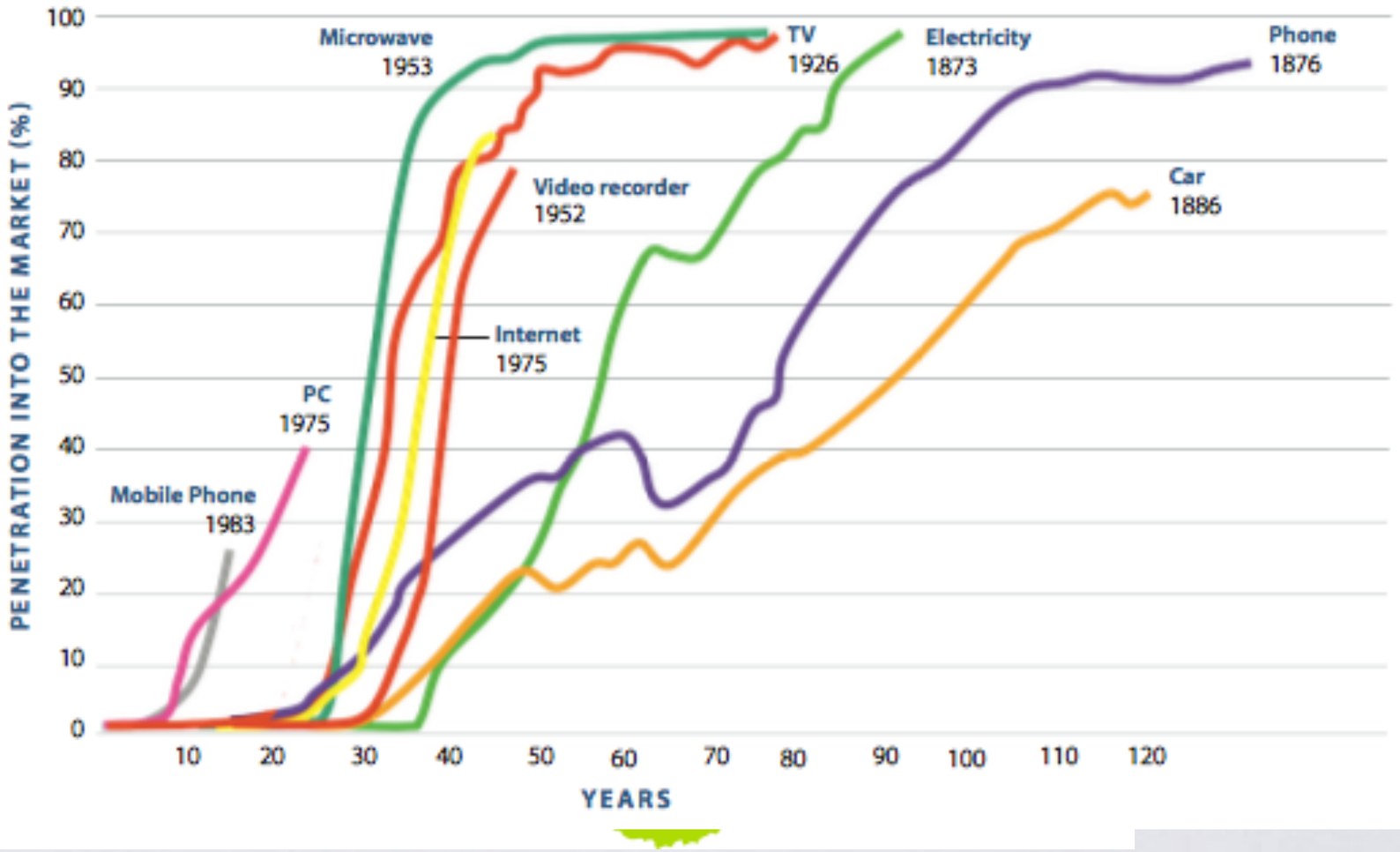
Characteristics of the Systems Engineering *Process*

- **Starts** with the "Big Picture"
- **Transforms** from Ambiguity to Discrete Structure
- **Leads** to Best Decision / Trade Among Alternatives
- **Entails** Process Discipline
- **Features** Process Coordination/Orchestration
- **Involves** Integration of Elements / Right Side of Vee
- **Manages** Technology Maturity / Readiness

Characteristics of Systems Engineering Align with the Characteristics of Innovation

NEW TECHNOLOGIES CHANGE OUR DAILY LIFE AT AN EVER INCREASING RATE

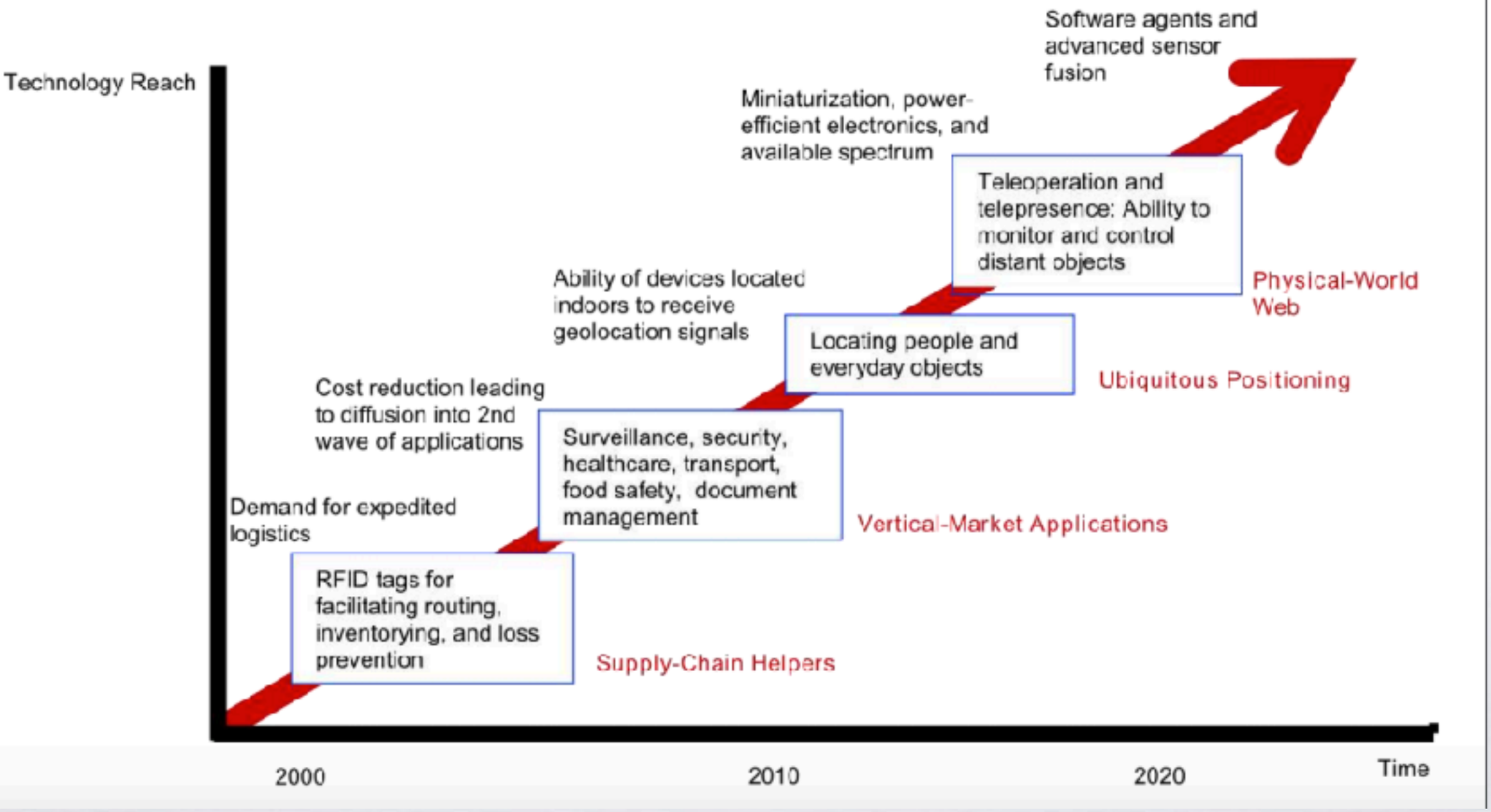
Source: Forbes magazine



From Stand-Alone to Interconnected to IoT

INCOSE

TECHNOLOGY ROADMAP: THE INTERNET OF THINGS



Improving Systems: Resilient Systems Concepts

Model Based Engineering

- Virtual designed products
- Product Lifecycle Management
- Immersive Design Centers
- Virtual Manufacturing
- Integrated Global Supply Chain
- Simulated Operational and Design Concepts

Platform Based Engineering

- Open Architecture principles
- Architectural, quality attribute driven patterns
- Reuse of Product Line assets
- Agile Software
- Architected and planned variant assets to support new missions and new products

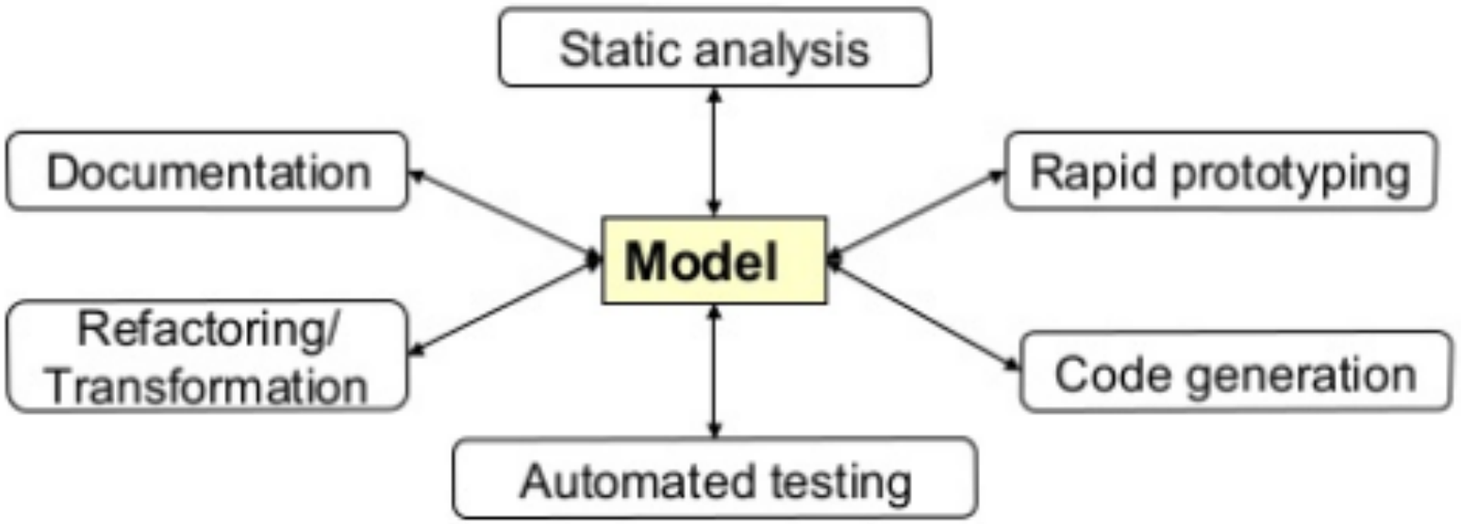
Capability on Demand

- Autonomous Systems
- Context Aware
- Integrated Health Management
- Self Adaptive Concepts
- Field Adaptive (Modular Payloads)

Trusted Systems Design

- Enterprise Network Security
- Infrastructure Operations Support
- Intrusion and Virus Detection
- System Integration
- Information Assurance
- Cyber Concepts applied from Enterprise IT

Innovative Systems Engineering Approaches



- Related terms
  - Model Driven Engineering (MDE),
  - Model Driven [Software] Development (MDD/MDSD),
  - Model Driven Architecture (MDA)
  - Model Integrated Computing (MIC)

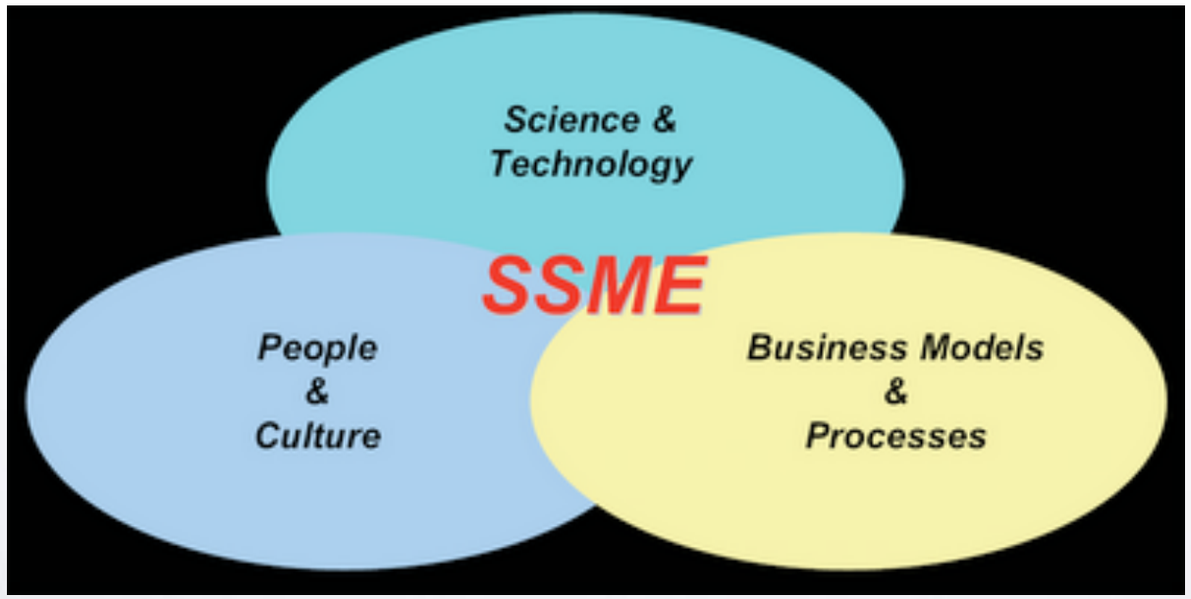
Designing large Service Information Systems

Novo SIS

Sistemas de informação conjugam flexibilidade e capacidade de integração, fundamental para inovação e automação.[1]
Convergência entre sistemas de serviço e sistemas de informação. [2]

[1] Stair, R.; Reynolds, G. "*Information Systems*", 9th ed., *Course Technology*, 2010.
[2] Bardhan, I. ; Demirkan, H.; Kannan, P.; Kauffman, R.; Sougstad, R. "*An Interdisciplinary Perspective on IT Services Management and Service Science*". *Journal of Management Information Systems*, v. 26, n. 4, p. 13-64, 2010.

Service Science, Management and Engineering

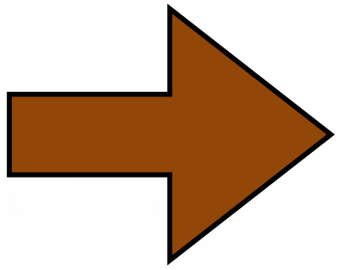


SSME is a new research field that aims to formalize and control the relationship between humans and (cognitive) information systems to establish a new paradigm of associative interaction.

A mudança de paradigma

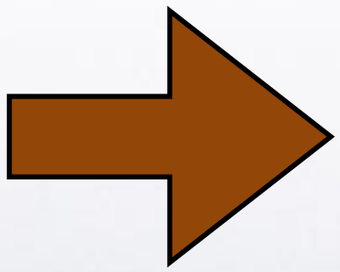
produto

sistema



mesmo desenvolvimento orientado a produto

produto & systema



opção por um desenvolvimento orientado a modelos

New tendencies in production

70

20

10

20

50

30

10

20

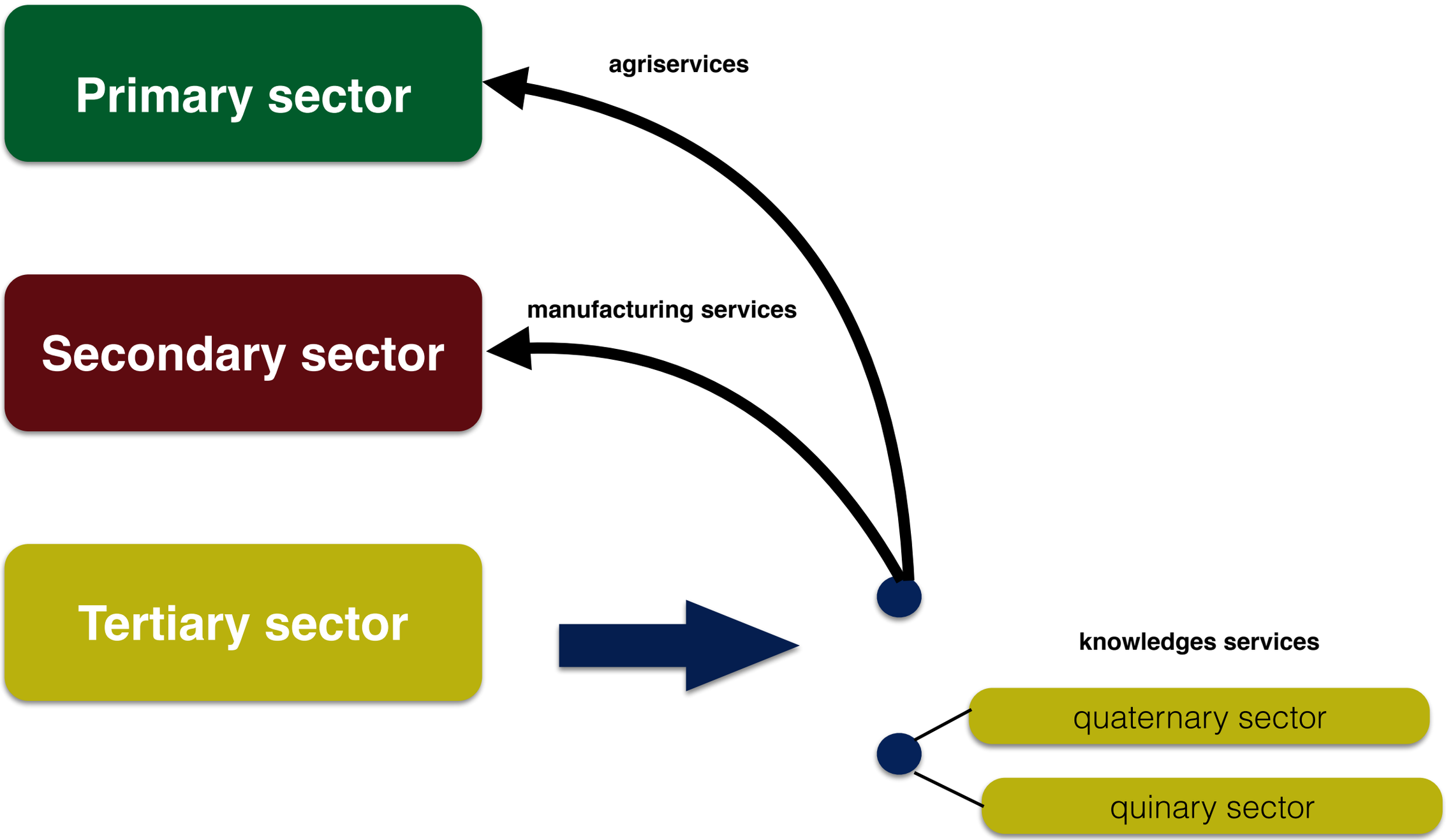
70

primary sector

secondary sector

tertiary sector

t


Primary sector
Secondary sector
Tertiary sector
agriservices
manufacturing services
knowledges services
quaternary sector
quinary sector

Tendencies towards manufacturing services

Amazon Project

Ford Motors Suppliers

resp.: Luc de Ferran

4 levels in supply chain:

"Systemistics"

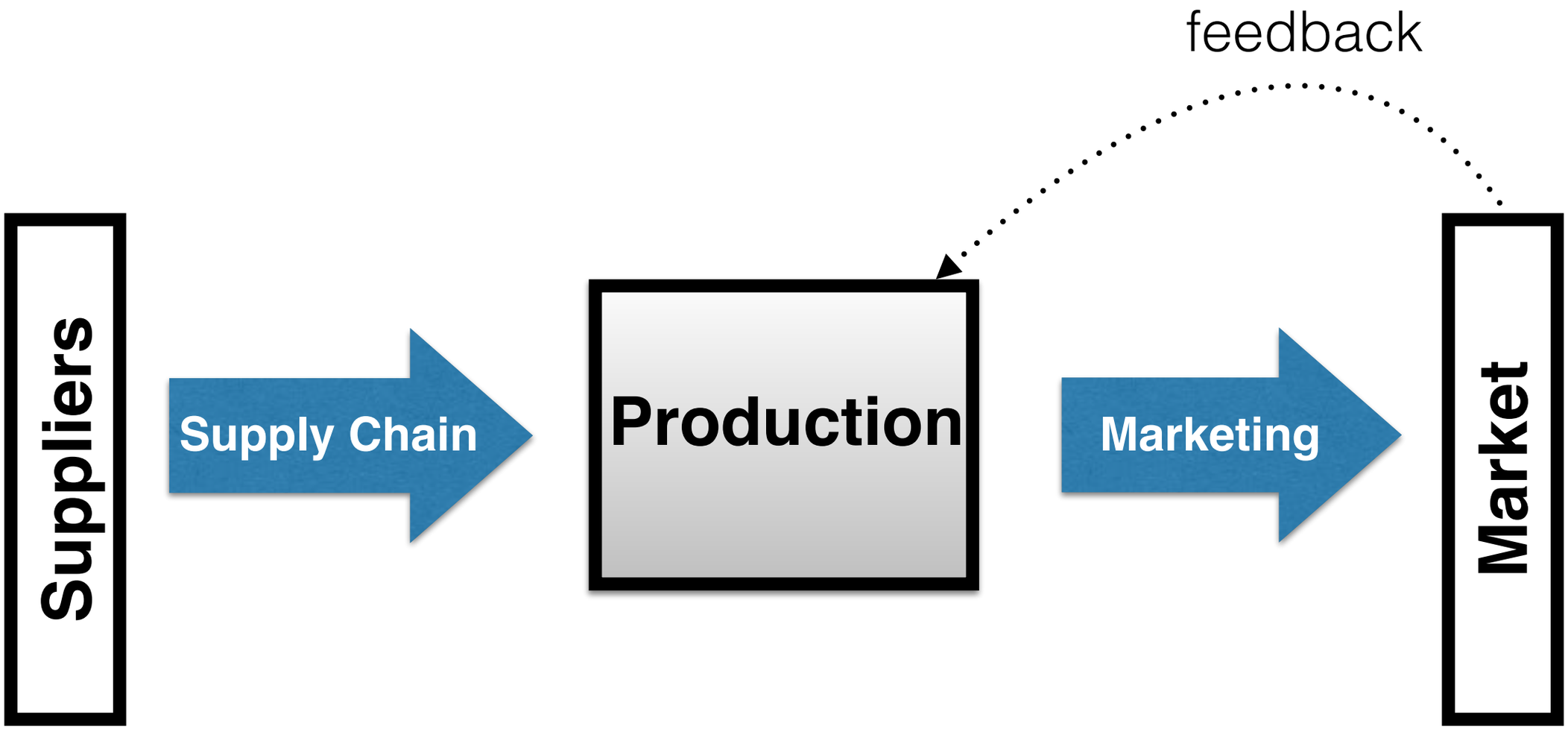
Suppliers of components

Sporadic suppliers

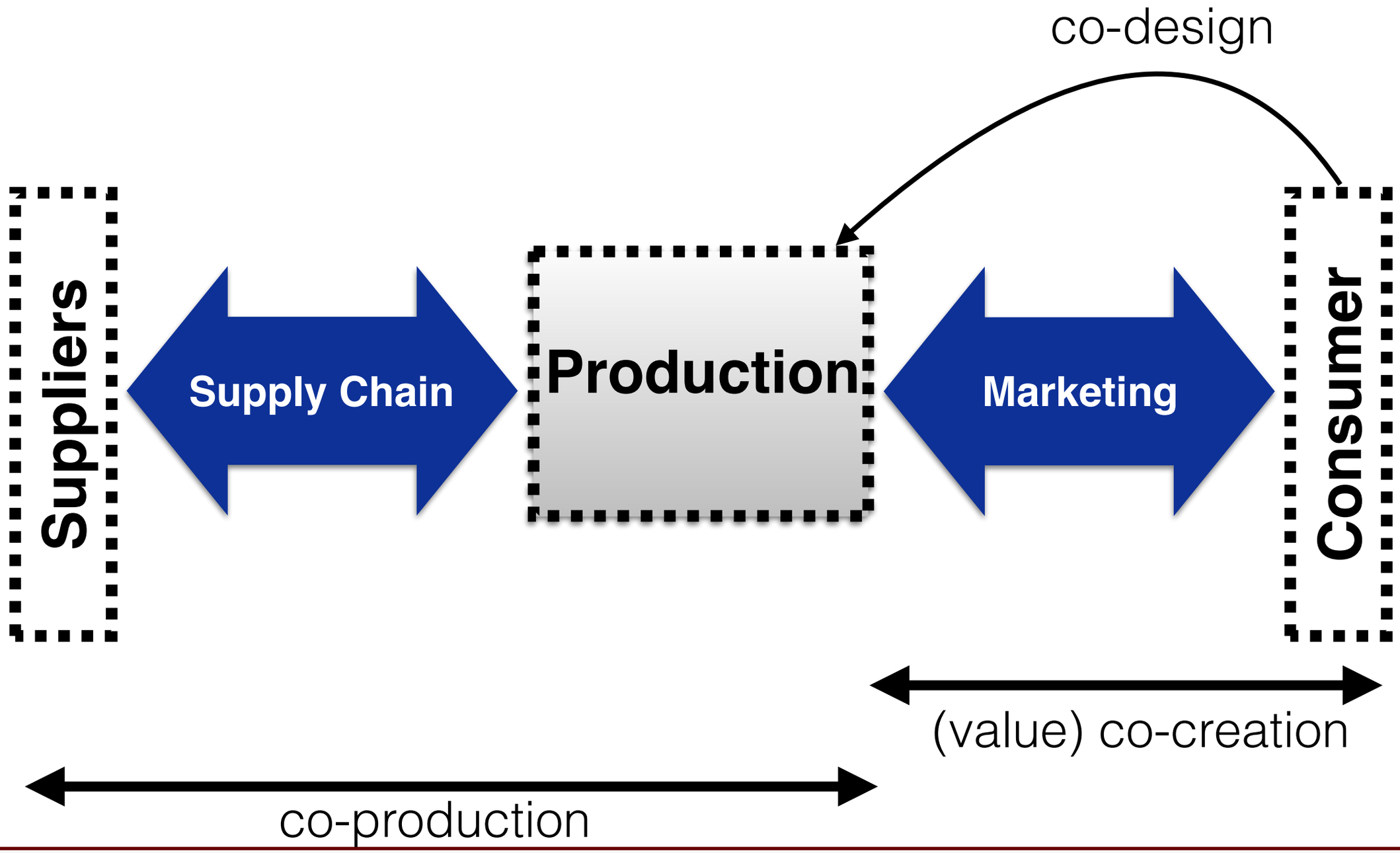
Accessories

supply chain → **production**

Abstract Context of manufacturing



Converging to service and intelligent systems



Introducing manufacturing services

Even if manufacturing will be still devoted to products (good-oriented) we claim that the general production system could be based on services maintained by independent players with which we should co-create this product.

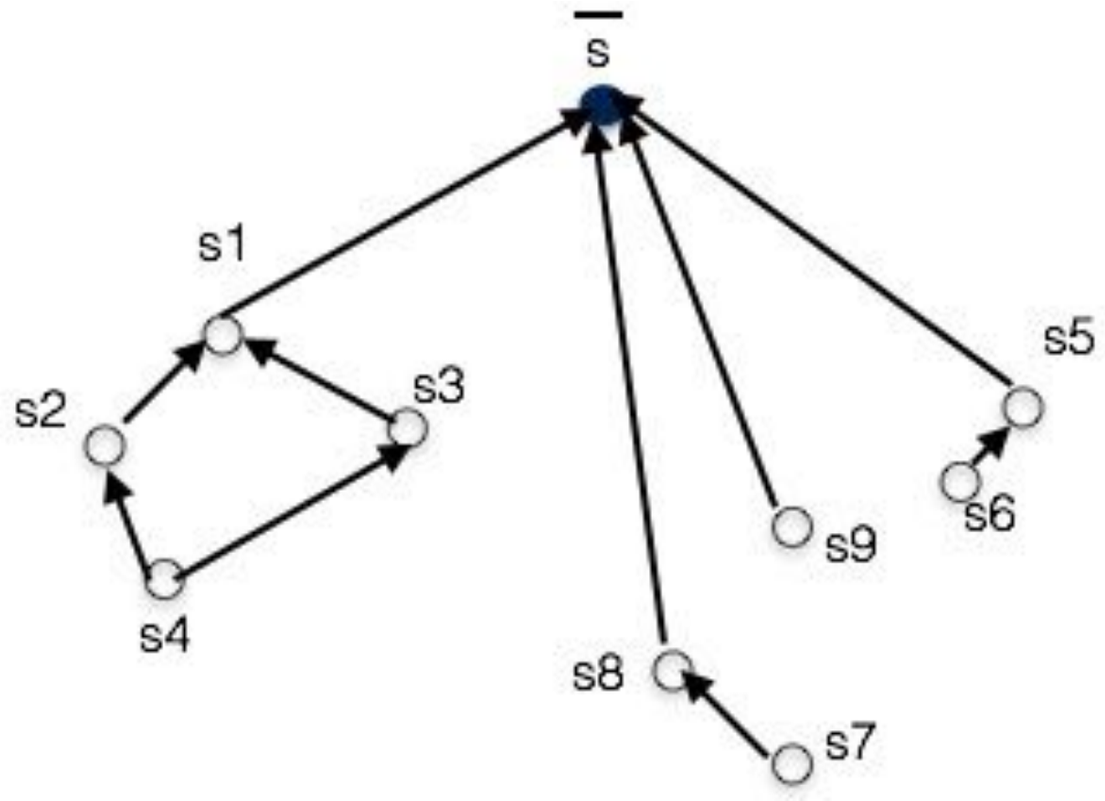
Strong focus on the early phases
Model driven
Strongly focused on viewpoints

PSA: Introducing a Service Manufacturing Architecture

Let be a finite set of *system agents* as describe above. A manufacturing service can be defined as , where is a set of relations among the service agents in. The relations could be the delivering of goods, service or a hybrid artifact composed of product and service.

A PSA architecture is a connected arrangement of collaborative service agents that could be represented as a graph, where each service agent is a node and the possible delivers are represented by arcs. There is a special node denoted by which represents the service agent responsible for the main business strategy and also to deliver the whole service to the costumer.

PSA Example: From Factory to Service



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IFAC-PapersOnLine 48-3 (2015) 1628–1633

Manufacturing Service: From e-Work and Service-Oriented Approach towards a Product-Service Architecture

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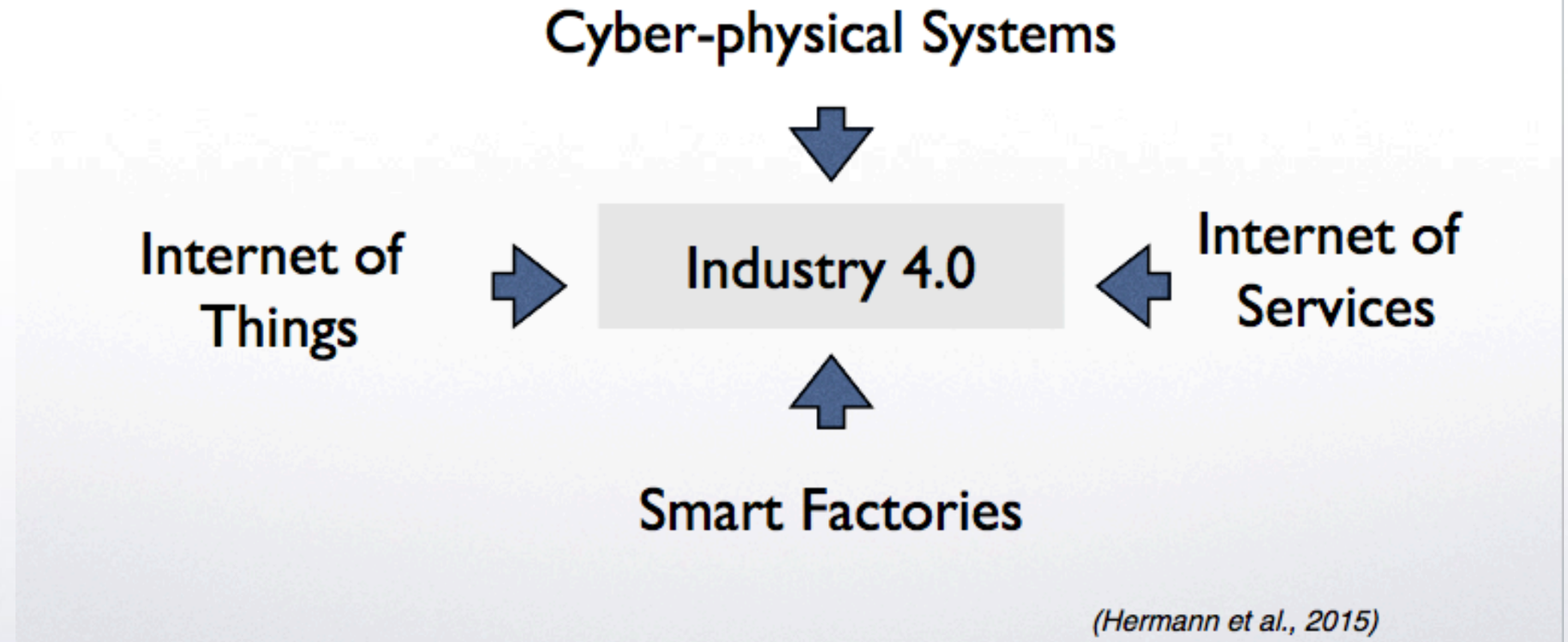
***PRISM Center and School of IE, Purdue University, West Lafayette, IN 47907, USA (e-mail: nof@purdue.edu)*

Abstract: From classic process- and product-oriented production lines, several alternative production arrangements have been tried and modeled. Exploring new features such as non-linearity, integration, supply-chaining and flexibility, more recently focus has been on distributed and collaborative holonic and multi-agent approaches. This production evolution reflects the evolution in manufacturing design and the integration of manufacturing with the ubiquitous culture introduced by e-Work, communication and information systems. More recently, there is another influential vector, typically not considered in the technological analysis of manufacturing advances: the tendency to move from the traditional process- and product-oriented approaches to service-oriented approaches. Such tendency is being spread in research labs and increasingly, in current management decisions, especially in computer and cyber industries. In this article, we analyze closely the coalition between e-Work and service-oriented approach towards a new manufacturing architecture composed by a grid of services which operates in parallel to a main process that defines the manufactured artifact—targeting an interesting blending of product and service. The need to explore and provide different design approaches for this emerging product-service architecture (PSA) is discussed as a future challenge, which demands multidisciplinary tools for analysis

A new scope for systems design



Industry new era

Service Science

Good-dominant

vs

Service-dominant

↓

"Servitization"

Industry 4.0

Embedded Systems

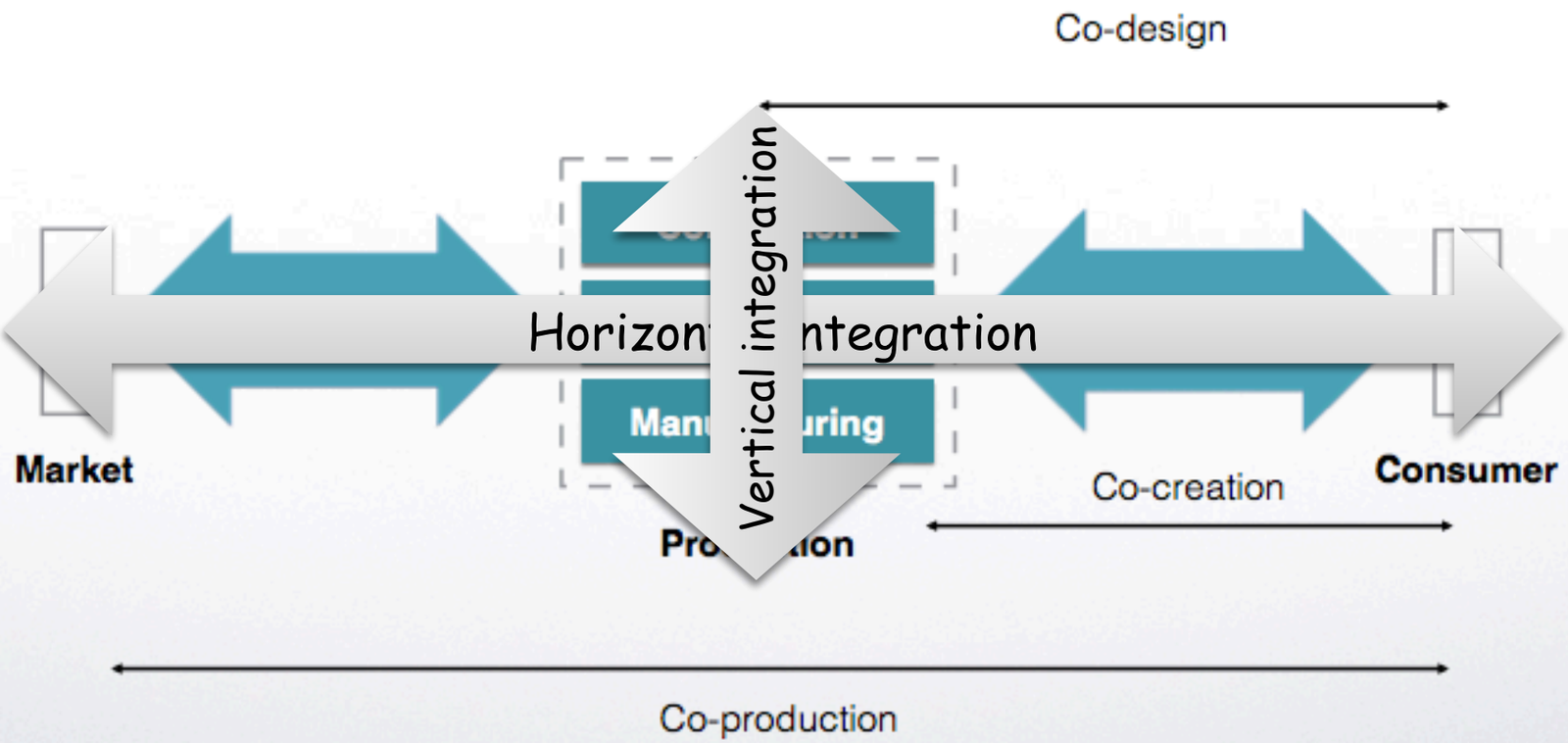
↓

Networked Embedded Systems

↓

Cyber-Physical Systems

Service-Engineering



A grande pergunta que permeia a aula de hoje é justamente como vamos resolver o problema de escalabilidade entre os métodos que vimos até aqui (e sem o que a discussão seria inviável) e o problema que temos que enfrentar de projetar grandes sistemas ou sistemas de sistemas.

Model Driven Engineering

Leitura da semana será definida no site da disciplina

Obrigado

Reinaldo