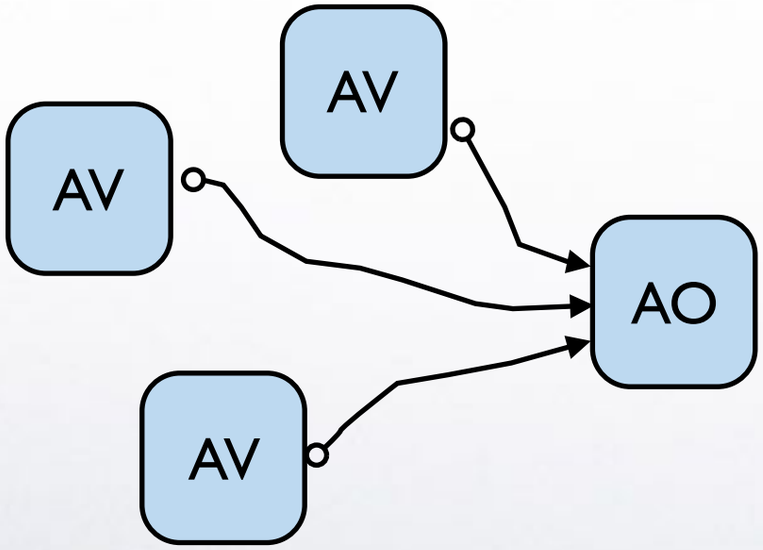
PMR 5020

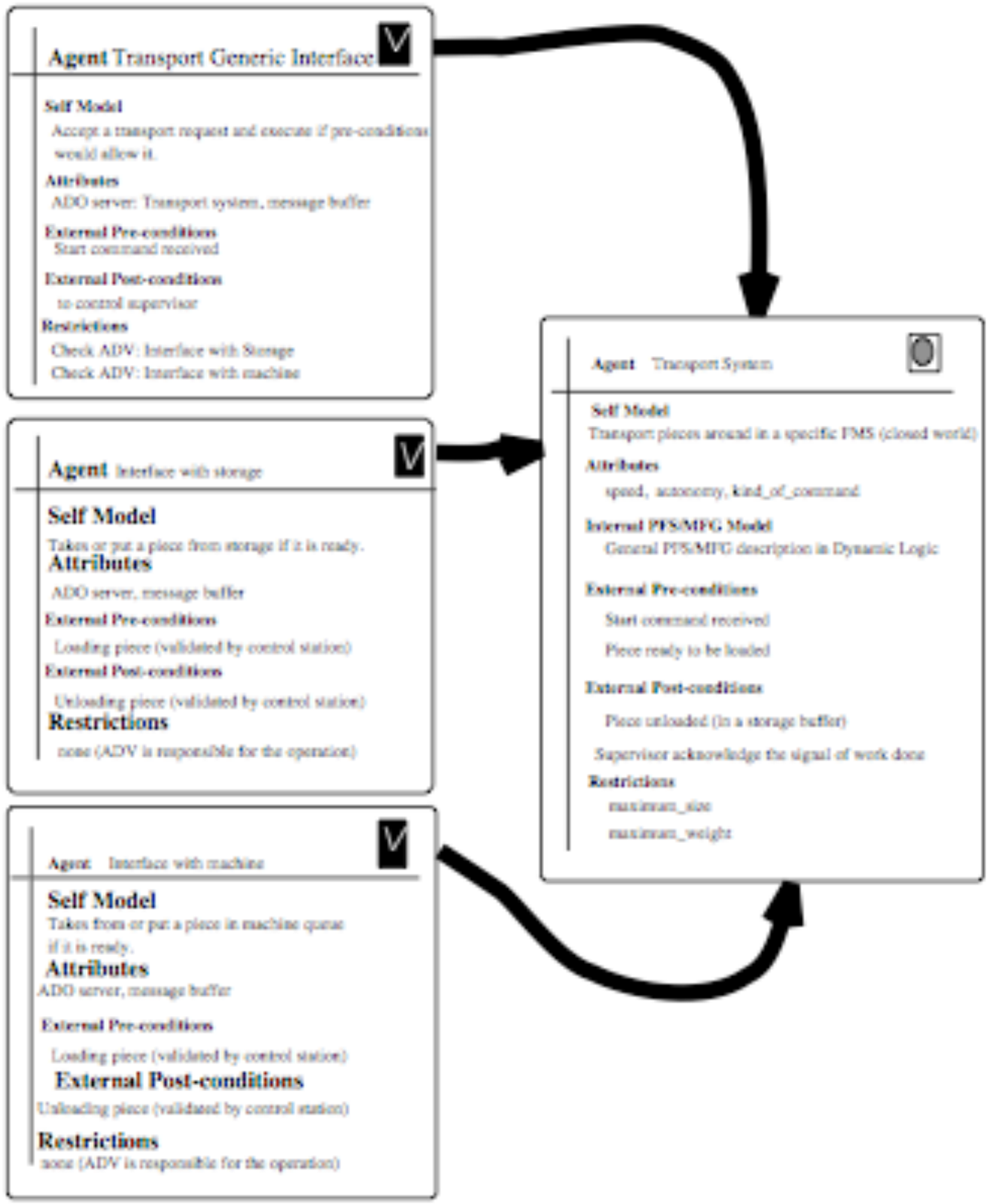
Modelagem do Projeto de Sistemas

Aula 11: MBSE, features and methods

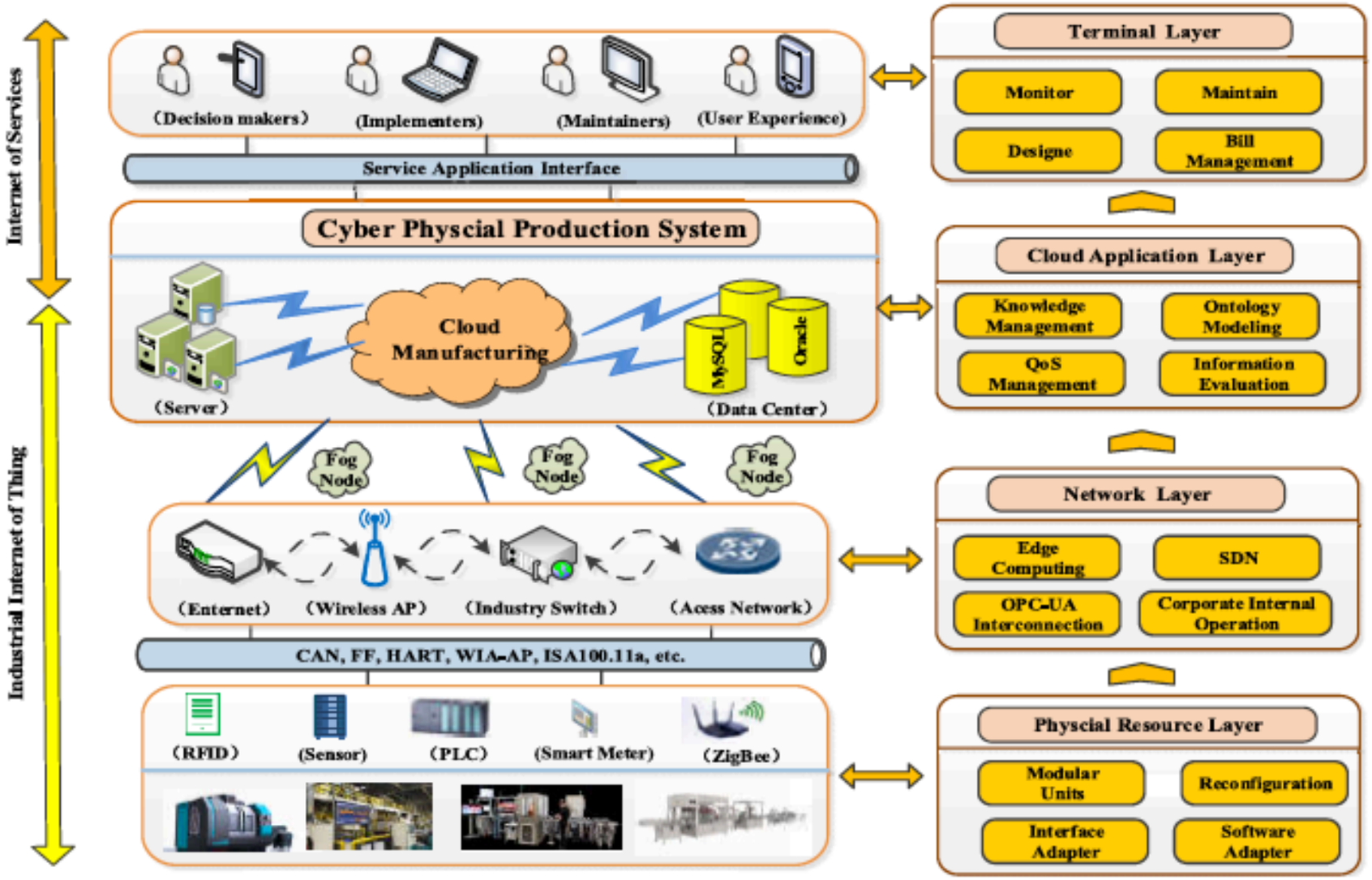
Prof. José Reinaldo Silva
reinaldo@poli.usp.br

Object interface - service relationship

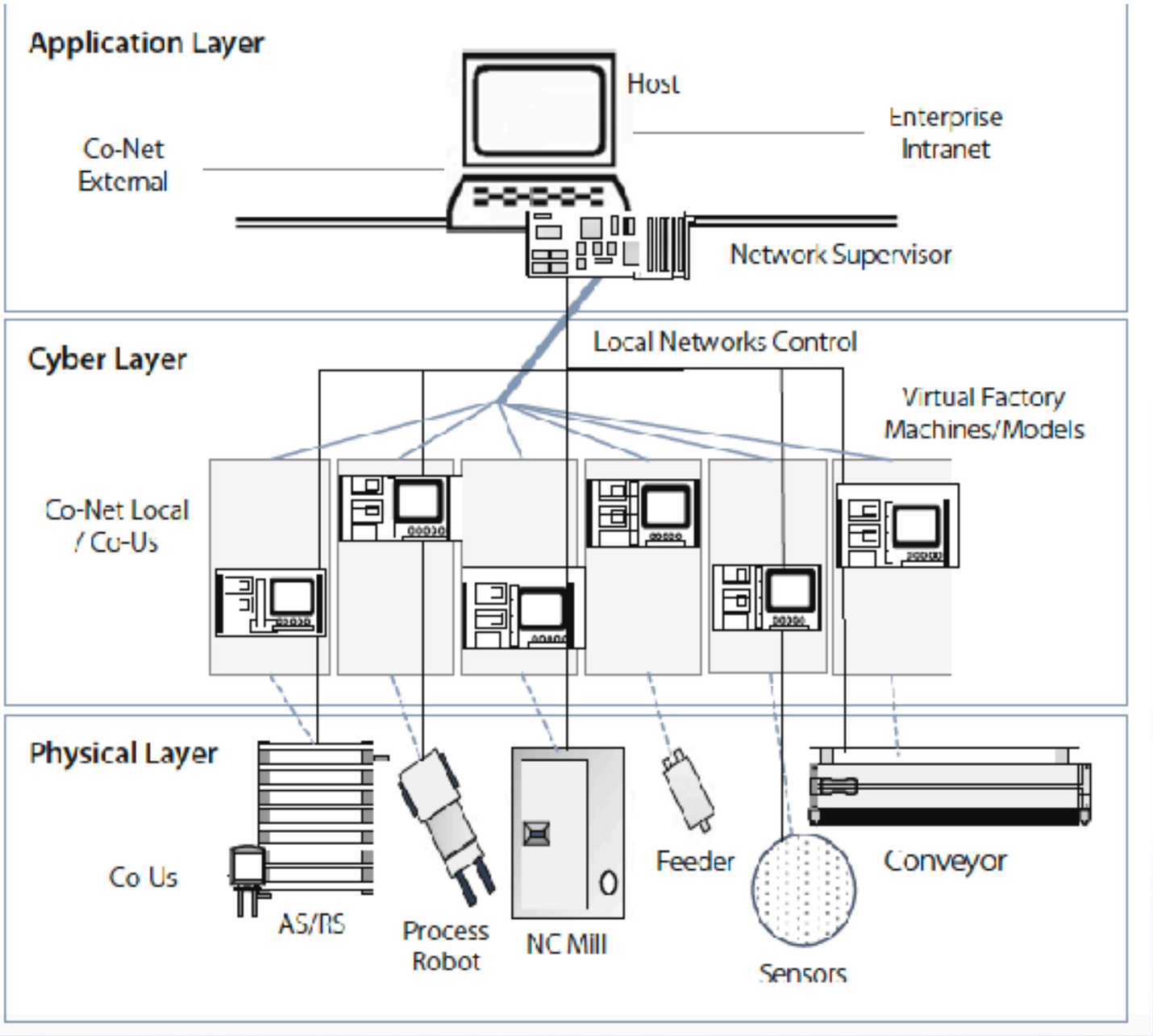




Industry 4.0 Architecture



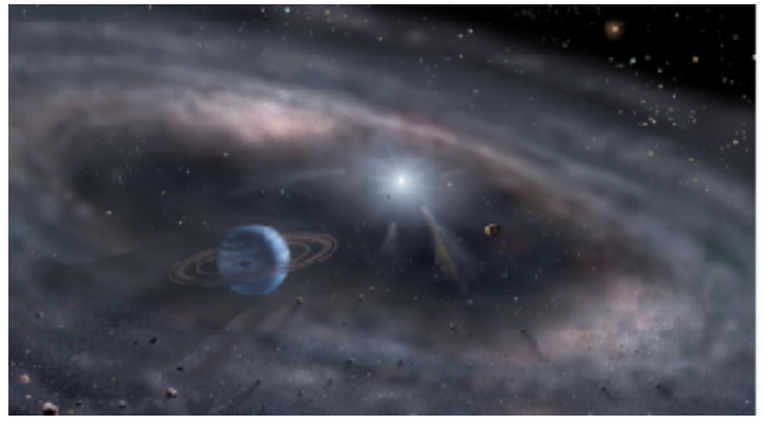
B. Chen et al.: Smart Factory of Industry 4.0: Key Technologies, Application Case, and Challenges, IEEE Access, vol 6, March 9, 2018

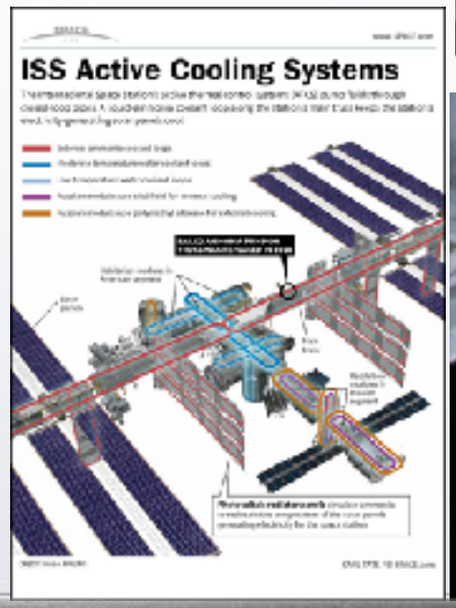


Moghaddam, M., Nof, S.Y.; Best Matching Theory & Applications, ACES (Automation, Collaboration & E-Service) Series, Springer, 2017

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).





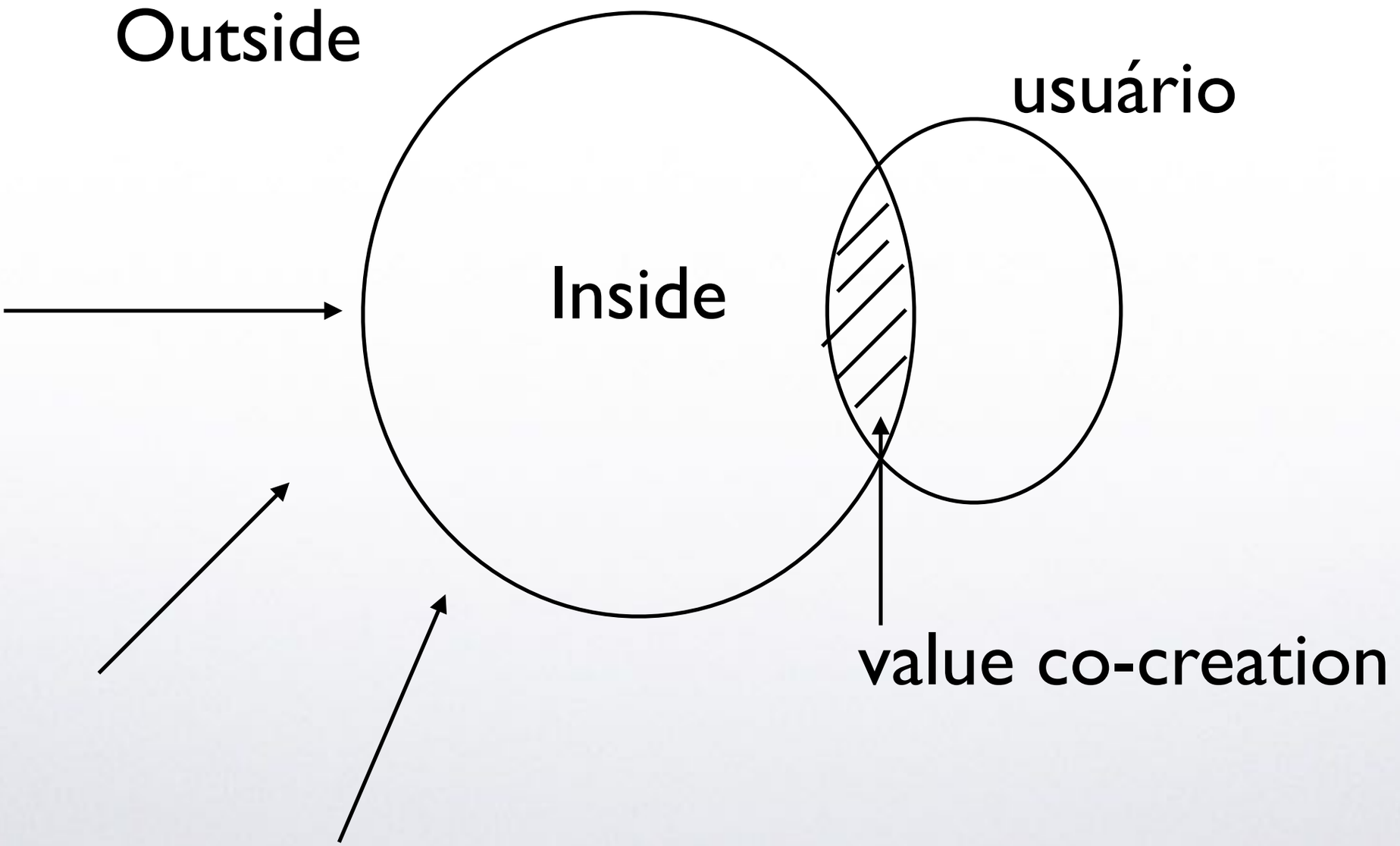
Designing large Service Information Systems

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.

A System Service Model



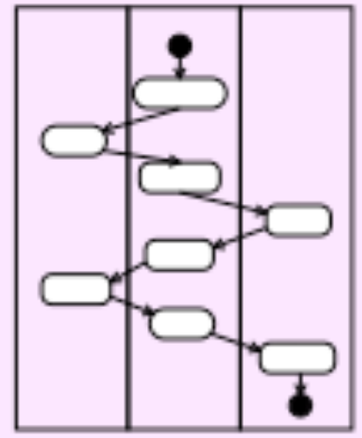
SE Practices for Describing Systems

Past

Text

- Specifications
- Interface requirements
- System design
- Test plans
- Analysis & Trade-off

Future



Model

AUCOTEC
Create Synergy – Connect Processes

Top 10 Engineering Document and Data Management Challenges

1. Finding the right documents
2. Version control
3. Change management
4. Scalability and flexibility

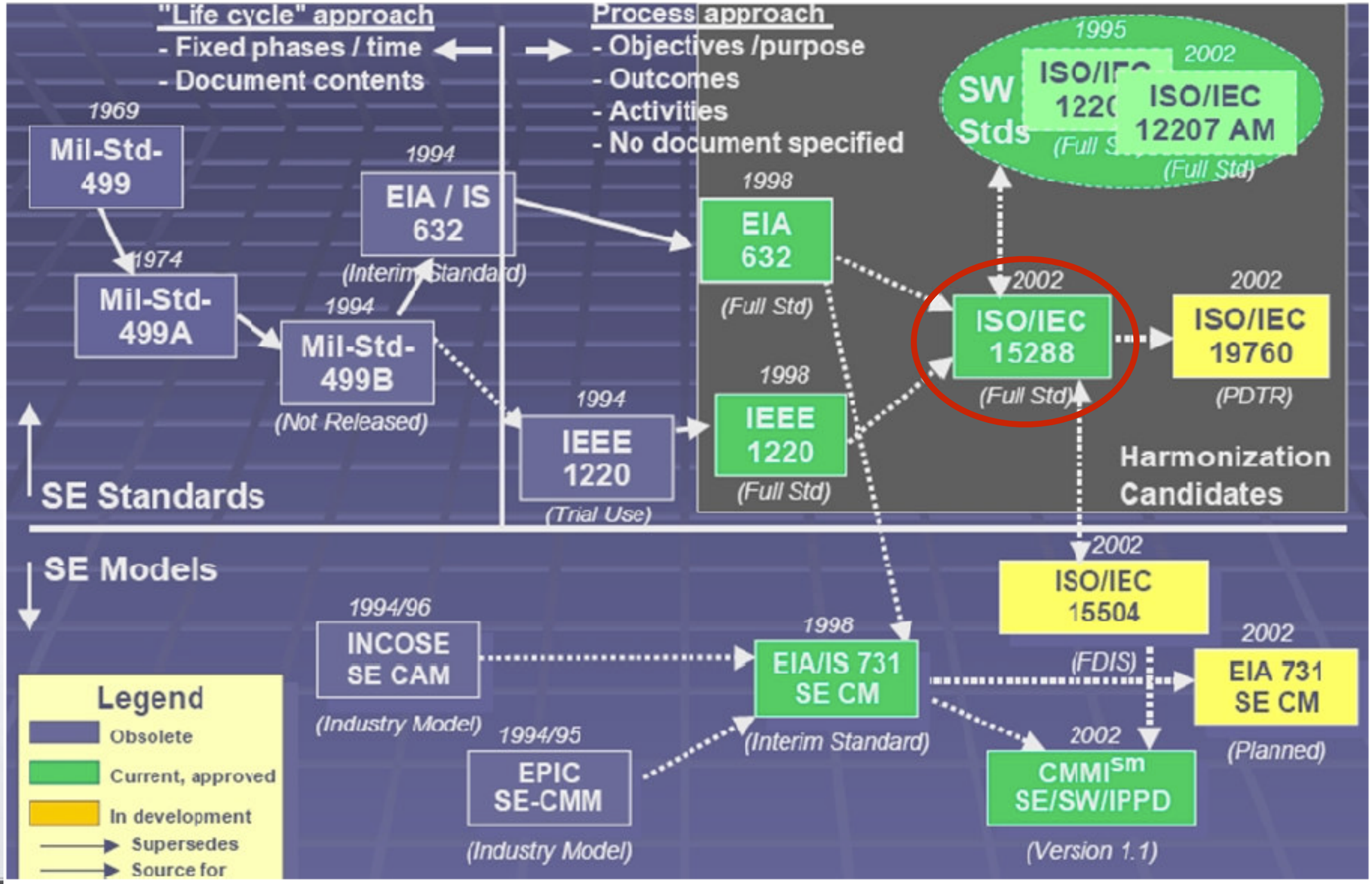
One of our customers told us about a project that involved 290 spreadsheets that contained somewhere close to 8,000 wires. One spreadsheet alone had 1,000 instruments and 169 columns for data entry!

5. Multi-user collaboration
6. Multiple database
7. Backup and security
8. Management across the project life cycle
9. Compliance with various standards
10. Reinventing the wheel (reusability)

The System Engineering Approach

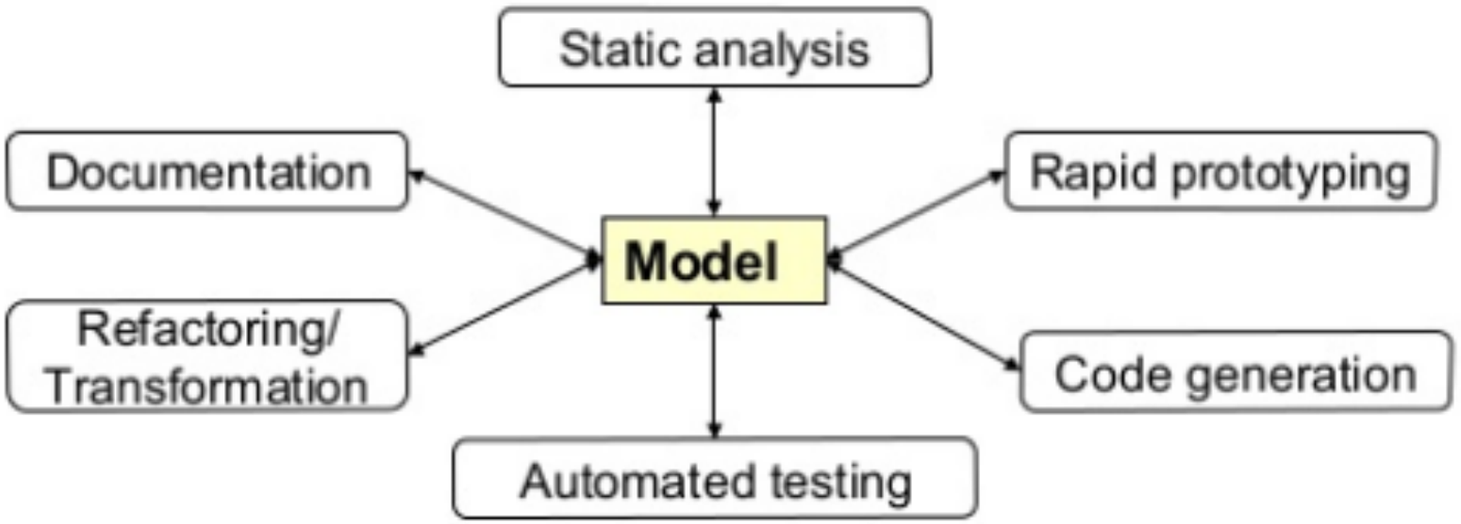
"Systems Engineering (SE) is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions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

SEBoK-2015


"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

Requirements Analysis

System-of-Interest (Level of Design)	OOSEM Black-Box Scenario	Corresponding OOSEM White-Box Scenario
Enterprise	Mission Scenario	System Scenario
System	System Scenario	Logical Scenario
Logical Subsystem (recursively)	Logical Scenario	Logical Scenario (recursively)

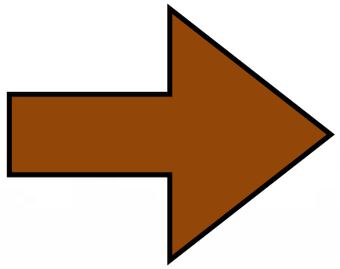


- Related terms
  - Model Driven Engineering (MDE),
  - Model Driven [Software] Development (MDD/MDSD),
  - Model Driven Architecture (MDA)
  - Model Integrated Computing (MIC)

A mudança de paradigma

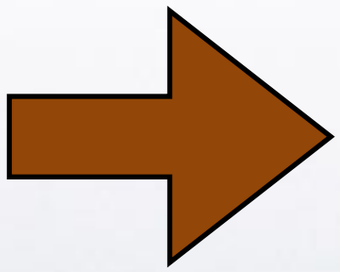
produto

sistema



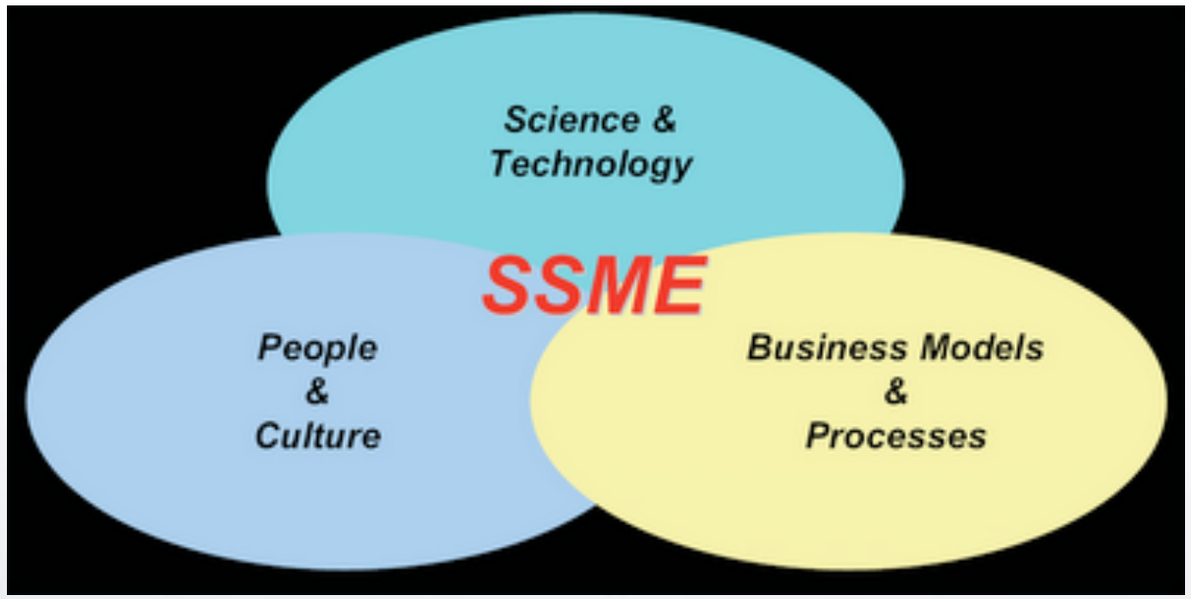
mesmo desenvolvimento orientado a produto

produto & systema



opção por um desenvolvimento orientado a modelos

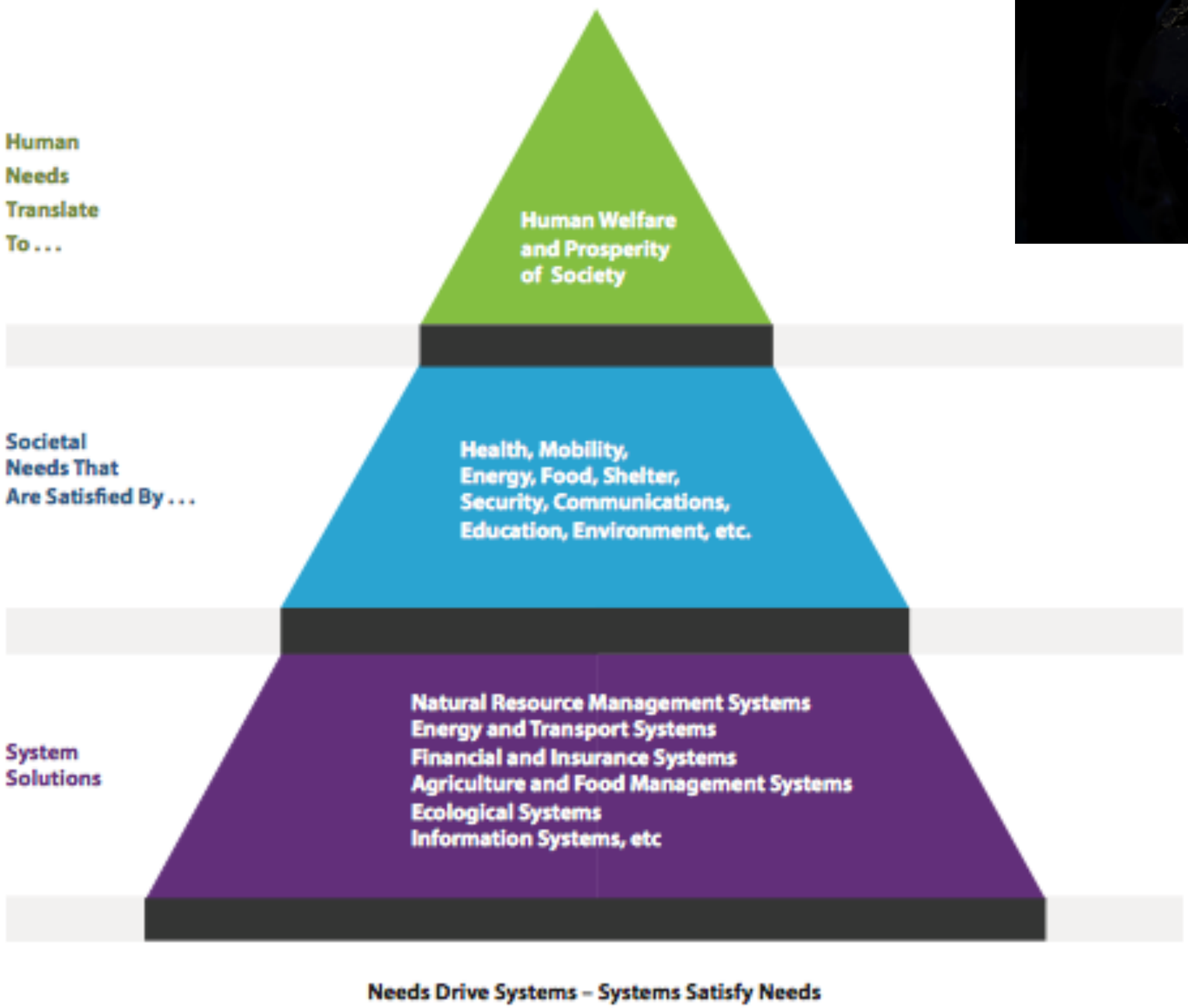
Service Science, Management and Engineering



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 WORLD IN
MOTION

INCOSE


Human
Needs
Translate
To . . .
Human Welfare
and Prosperity
of Society
Societal
Needs That
Are Satisfied By . . .
Health, Mobility,
Energy, Food, Shelter,
Security, Communications,
Education, Environment, etc.
System
Solutions
Natural Resource Management Systems
Energy and Transport Systems
Financial and Insurance Systems
Agriculture and Food Management Systems
Ecological Systems
Information Systems, etc
Needs Drive Systems – Systems Satisfy Needs

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"Additive Manufacturing Technologies: 3... | www.tempastic.org/papers/CMU-CS-04... | www.omgsysml.org/Pearce House ISO... | Wayne Waymore - Pesquisa Google | Vitech Corporation

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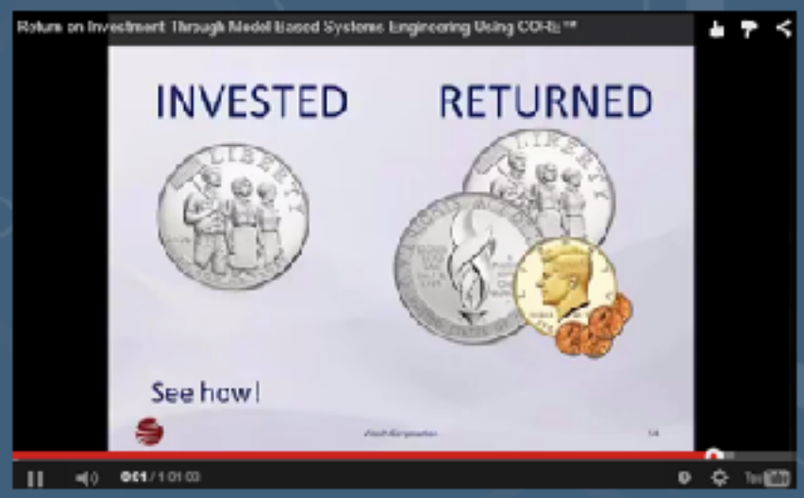
CORE and GENESYS
With Zane Scott



CORE™

A comprehensive integrated model-based systems engineering environment with rich capabilities for the engineer and continuous project insight.

Learn More!

GENESYS

An integrated, open model-based systems engineering environment that's both scalable and extensible, delivering the power of MBSE to the enterprise.

Learn More!

Solutions for Model-Based Systems Engineering

Introducing the subject

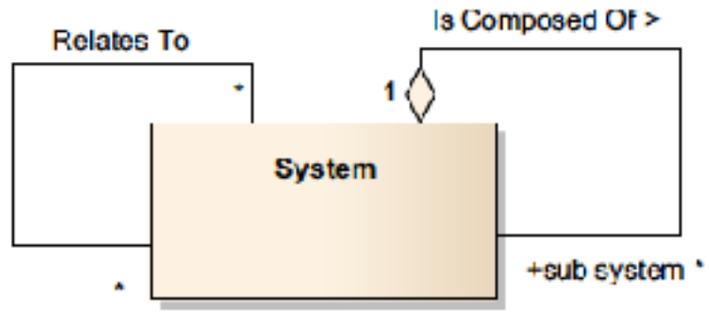


Fig. 1. The System definition.

- System

  In the context of MDE, we define "system as a generic concept for designating a software application, software platform or any other software artifact".

- Model

  A model is an abstraction of a system under study (SUS, also known as the "Universe of Discourse" or just "system"), which may already exist or is intended to exist in the future.

- Model

(1) model is a set of statements about the system under study;

(2) model is an abstraction of a (real or language-based) system allowing predictions or inferences to be made;

(3) model is a reduced representation of some system that highlights the properties of interest from a given viewpoint; and

(4) model is a simplification of a system built with an intended goal in mind so a model should be able to answer questions in place of the original system.

Direct criteria for a good model

Stachowiak, Herbert (1973) (in german (DE)). *Allgemeine Modelltheorie [General Model Theory]*. Springer. ISBN 3-211-81106-0.

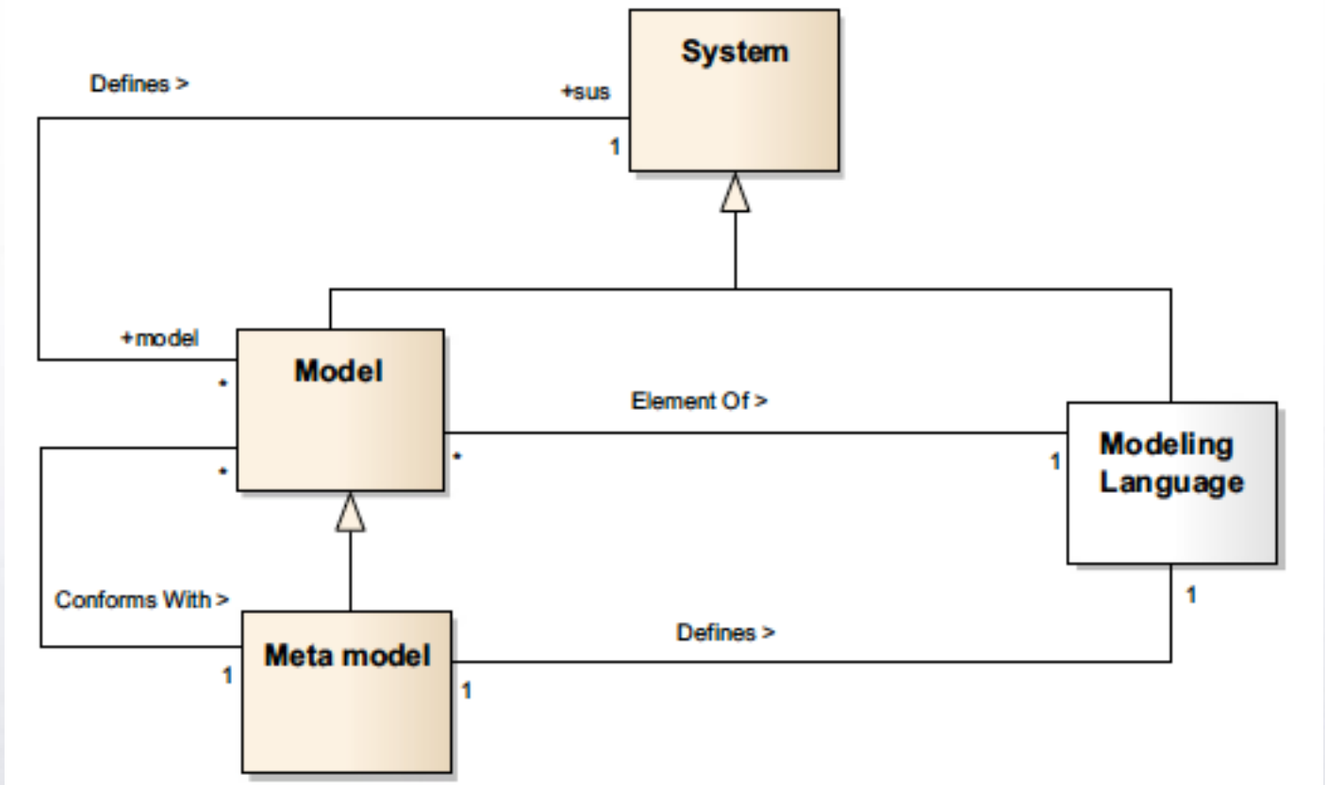
Modeling Theory

(1) Identification criteria: It must be possible to identify the object or original phenomenon (of the system) that is represented or mapped in the model;
(2) Reduction criteria: The model must be a simplified version of the original, so not all aspects of the original must be depicted in the model; and
(3) Pragmatism criteria: The model has to be useful; namely it should be able to replace the original for certain purposes.

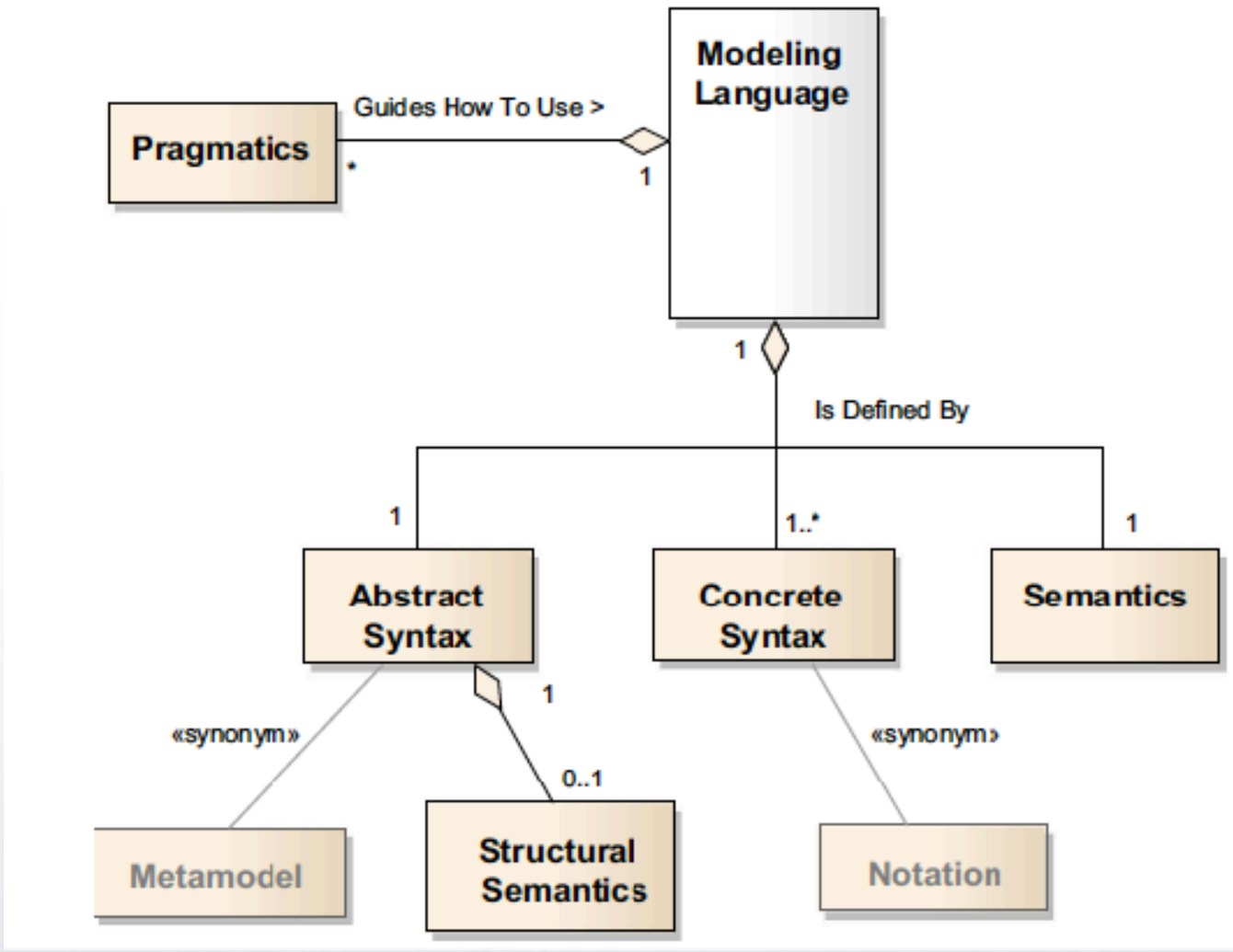
Language, model and meta-model

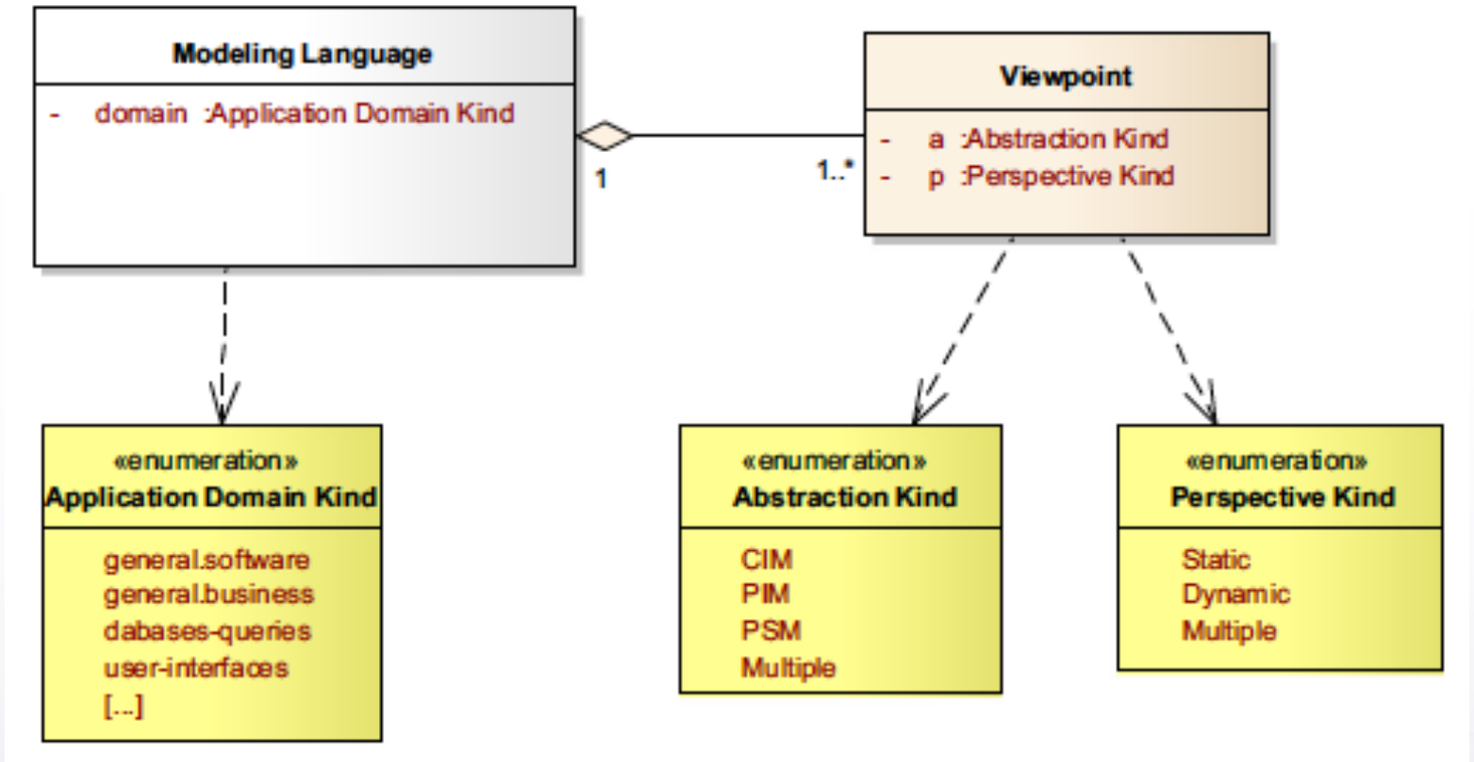
- System

  "a metamodel is a model that defines the structure of a modeling language".



Going down to the concrete project




Modeling Language
- domain :Application Domain Kind
1
1..*
Viewpoint
- a :Abstraction Kind
- p :Perspective Kind
«enumeration»
Application Domain Kind
general.software
general.business
dabases-queries
user-interfaces
[...]
«enumeration»
Abstraction Kind
CIM
PIM
PSM
Multiple
«enumeration»
Perspective Kind
Static
Dynamic
Multiple

Classifying the modeling language

There are two kinds of modeling languages

(1) General Purpose Languages

(2) Domain Specific Languages

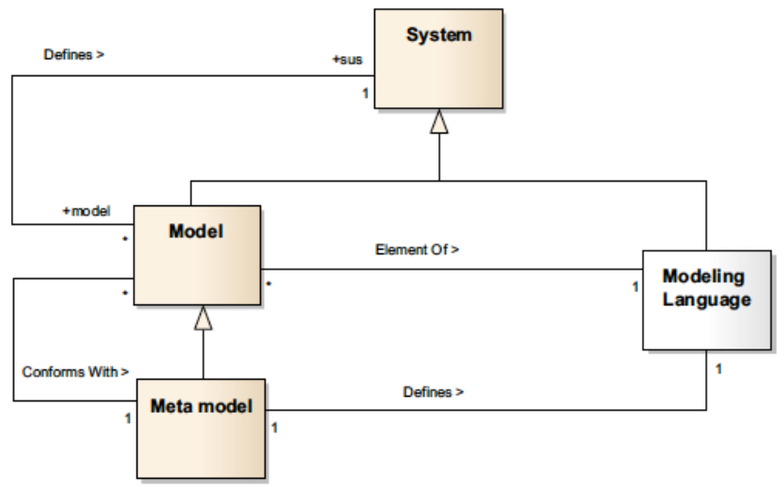
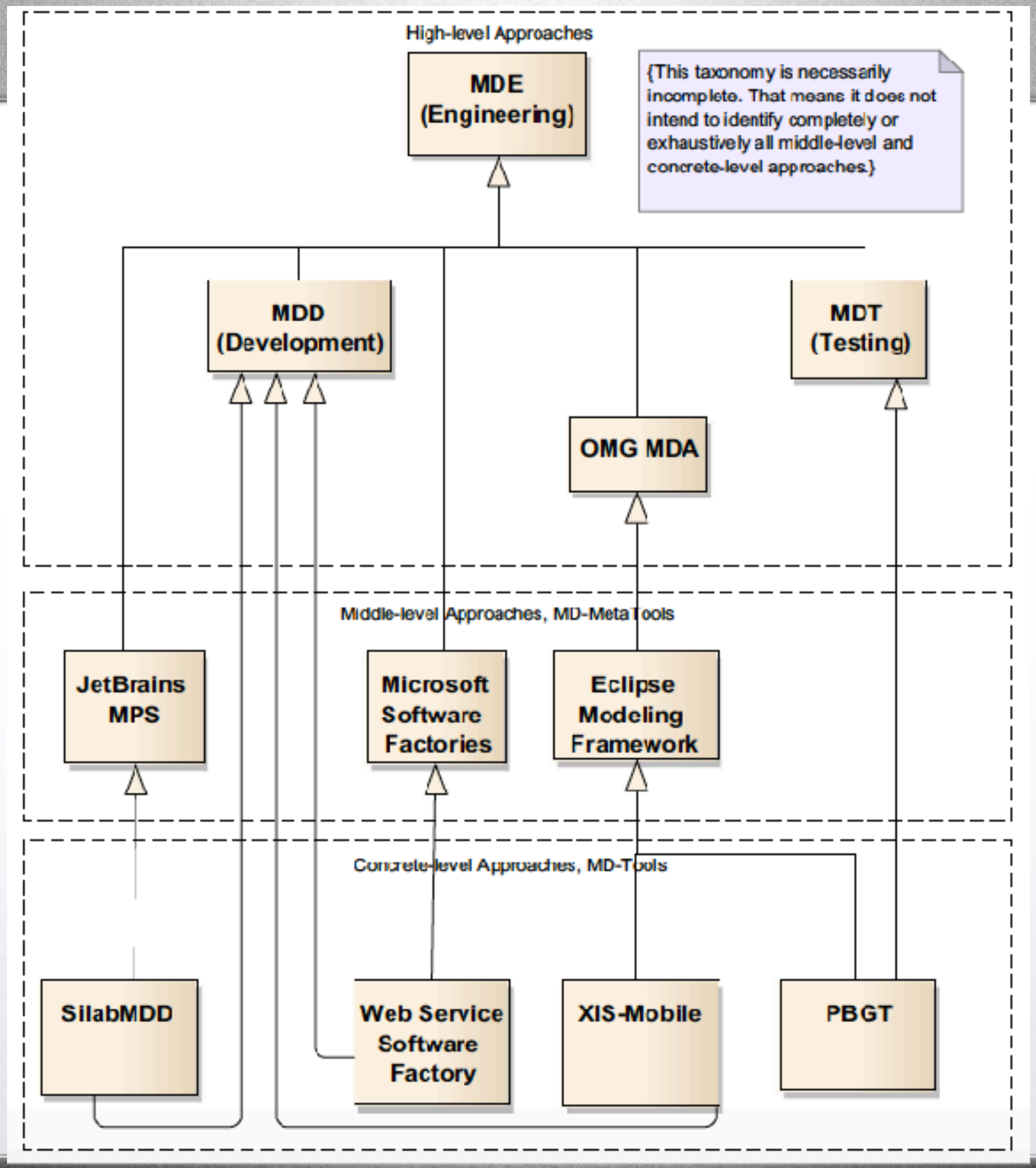


Table 1
Classification of modeling languages: UML2, BPMN, XIS-Mobile and DSL3S.

Modeling Language				
Name	**Application Domain**	**Viewpoint**	**Abstraction**	**Perspective**
UML (Unified Modeling Language)	General/Software	Class Diagram	Multiple	Static
		Object Diagram	Multiple	Static
		Sequence Diagram	Multiple	Dynamic
		Use Case Diagram	PIM	Dynamic
		State Machine Diagram	Multiple	Dynamic
		Component Diagram	PSM	Static
		–	–	–
BPMN (Business Process Modeling Notation)	General/Business Processes	Process Diagram	CIM	Dynamic
		Collaboration Diagram	CIM	Dynamic
		Choreography Diagram	CIM	Dynamic
		Conversation Diagram	CIM	Dynamic
XIS-Mobile (DSL for Mobile Apps)	Specific/Mobile Apps	Domain View	PIM	Static
		BusinessEntities View	PIM	Static
		Architectural View	PIM	Static
		UseCases View	PIM	Dynamic
		NavigationSpace View	PIM	Static
		InteractionSpace View	PIM	Static
DSL3S (DSL for Spatial Simulation Scenarios)	Specific/Spatial Apps	Simulation View	PIM	Static
		Scenario View	PIM	Static
		Animat View	PIM	Static
		Animat Interactions View	PIM	Static


High-level Approaches
MDE (Engineering)
{This taxonomy is necessarily incomplete. That means it does not intend to identify completely or exhaustively all middle-level and concrete-level approaches.}
MDD (Development)
MDT (Testing)
OMG MDA
Middle-level Approaches, MD-MetaTools
JetBrains MPS
Microsoft Software Factories
Eclipse Modeling Framework
Concrete-level Approaches, MD-Tools
SilabMDD
Web Service Software Factory
XIS-Mobile
PBGT

www.jetbrains.com/mps/

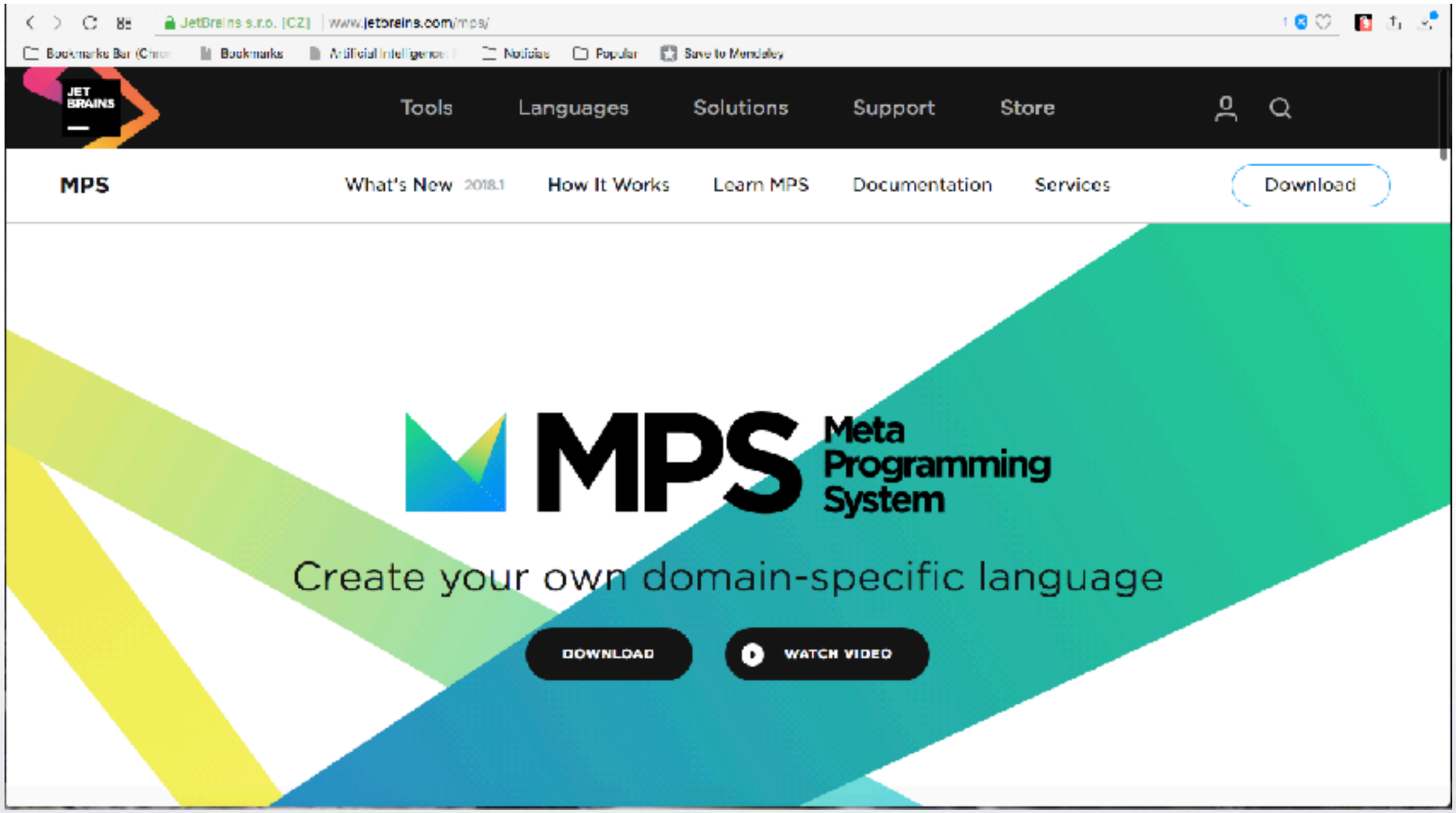


Table 2
Classification of model-driven approaches: from abstract to concrete approaches.

Model-Driven Approaches	Abstraction Level	Software Eng. Disciplines	Models		Transformations		Meta modeling languages	Domain	Tool Support
			Levels	Language	Types	Languages			
MDE	High	Any	ND	ND	ND	ND	ND	Any	ND
MDD		Requirements, Analysis and design, Implementation	ND	ND	ND	ND	ND	Any	ND
MBT		Testing	ND	ND	ND	ND	ND	Any	ND
OMG MDA		Analysis and design, Implementation	CIM, PIM, PSM	UML, UML Profiles	M2M, M2T	QVT	MOF, EMOF, Ecore, UML	Any	Several, e.g., Eclipse Modeling Framework, Enterprise Architect MDG
EMF (Eclipse Modeling Framework)	Medium	Any	Any	UML, UML Profiles	M2M, M2T	Several	Ecore, EMOF	Any	Eclipse and Eclipse Modeling Framework
Microsoft Software Factories		Any	Any	DSLs	ND	.NET languages	UML	Any	Microsoft Visual Studio - Visualization & Modeling SDK
JetBrains MPS		Any	Any	Textual DSLs	M2M, M2T	Java	MPS's Base Language	Any	JetBrains IntelliJ IDEA and MPS
Web Service Software Factory	Concrete	Design, Implementarion	PSM	DSL	M2T	.NET languages	UML	Web Services	Microsoft Visual Studio
XIS-Mobile		Analysis and design, Implementation	PIM	XIS-Mobile (UML Profile)	M2M, M2T	C#, Acceleo	UML	Mobile Apps	Sparx EA, Eclipse Modeling Framework, Accelo
SillaMDD		Requirements, Analysis and design, Implementation	CIM	SilabReq (Textual DSL)	M2T	Java	MPS's Base Language	Requirements of Business Apps	JetBrains IntelliJ IDEA and MPS
PBGT (Pattern Based GUI Testing)		Testing	PIM	PARADIGM	M2T	Java	Ecore	Software Testing	Eclipse Modeling Framework, Selenium

MDE is a relatively new engineering approach with some expectations and challenges to be addressed in the next years.

A variety of tools that embody the main ideas of MDE have been developed and improved over this last decade. Some of them correspond to tools developed in an academic environment, as is the case of experiments carried out under GME, ProjectIT, VMTS, MetaSketch, or AtomPM. Other tools are commercial, such as the case of Microsoft Visual Studio Visualization and Modeling SDK, Sparx Enterprise Architect, Metacase Meta Edit+, or ObeDesigner. Beyond these, it is worth to highlight some tools and technologies currently developed around the Eclipse Modeling Project and the JetBrains MPS.

A little more about DSLs

Domain specific languages are not very popular nowadays. However, they are not a new issue and was created to fit specific domains and to specific purposes in Computer Science. Later on it was seeing as an important feature in Engineering and inserted in Engineering Design. It remains a theoretical approach up to recent days when was restated in the viewpoint of new Engineering Design approaches, specifically MDE.

Where is the novelty?

DSL	Application domain
BNF	Syntax specification
Excel macro language	Spreadsheets
HTML	Hypertext web pages
LaTeX	Typesetting
Make	Software building
SQL	Database queries
VHDL	Hardware design

Obrigado

Reinaldo