Ingeniería de Modelos. Aplicación al alineamiento organizacional de los sistemas intensivos en software.

Model Engineering. Application to organizational alignment in software-intensive systems.

Francisco Ruiz

Universidad de Castilla-La Mancha (Spain)

Agenda

- Motivation
- The New Model Engineering
- Business Model Engineering
  - Seeing the Enterprise as a System
  - Kinds of Business Models
- Research Challenges
- Experiences
  - From the process to the service
  - Metamodeling to support the IT governance
- Conclusions

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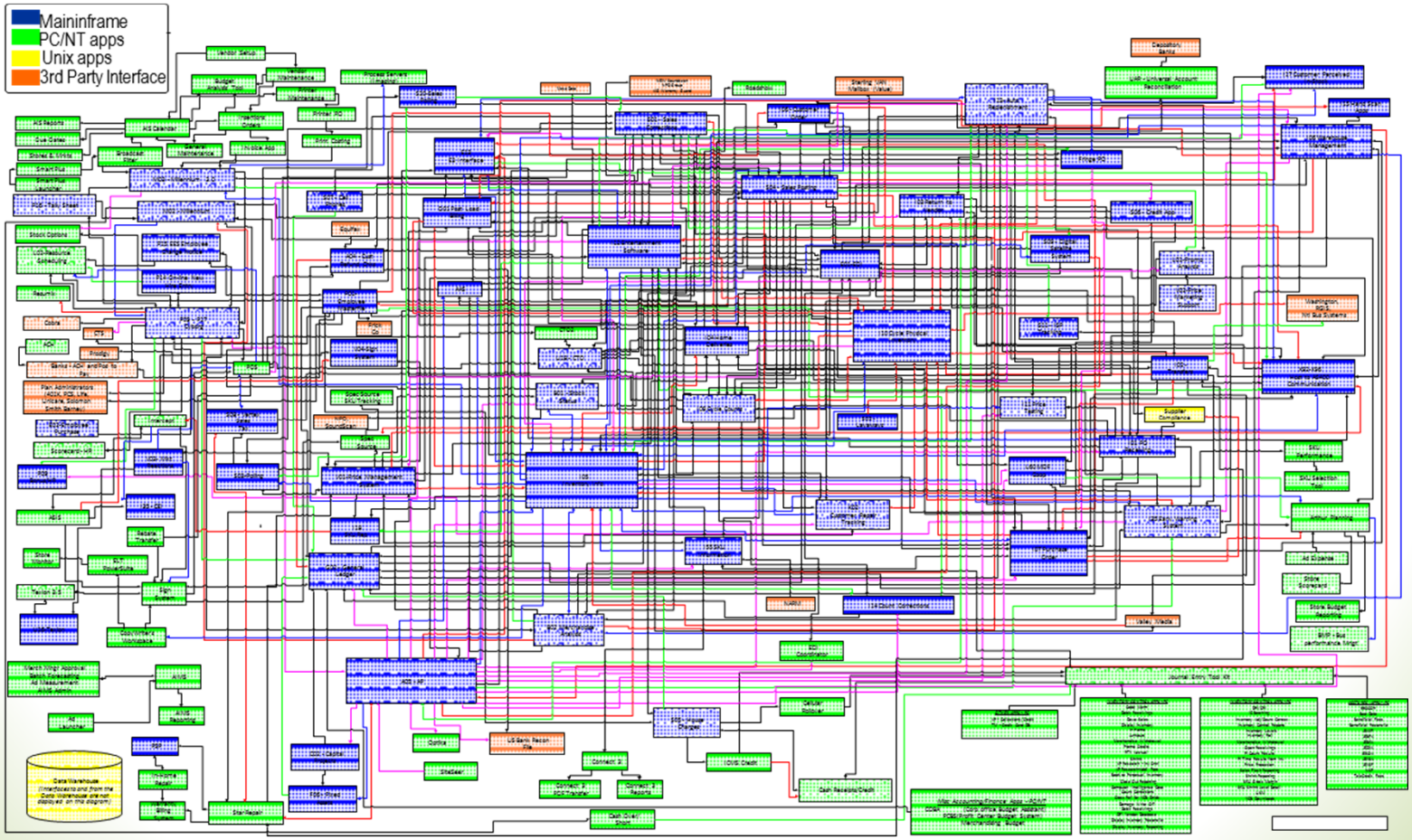
Motivation

- What are the main needs of organizations?
  - Efficiency (more with less)
  - Agility (time to X is shorter)
  - Flexibility (changing is the norm)

Motivation

- How IT departments can satisfy these needs?

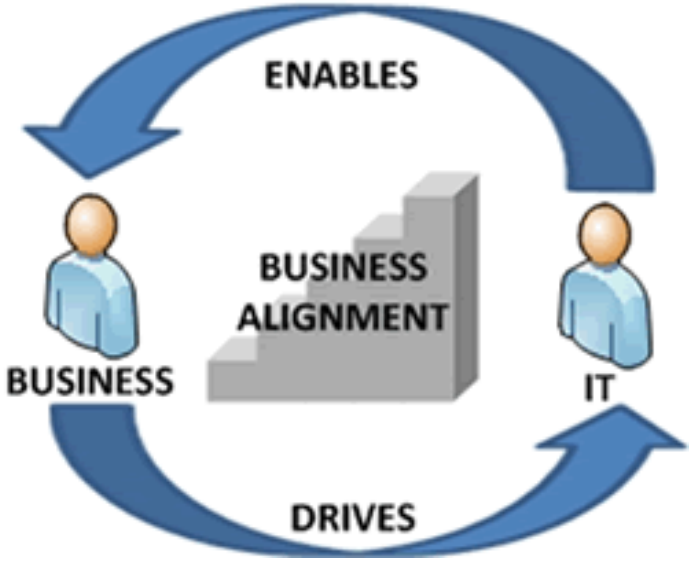
  Helping to manage the **complexity** (internal and external)



Motivation

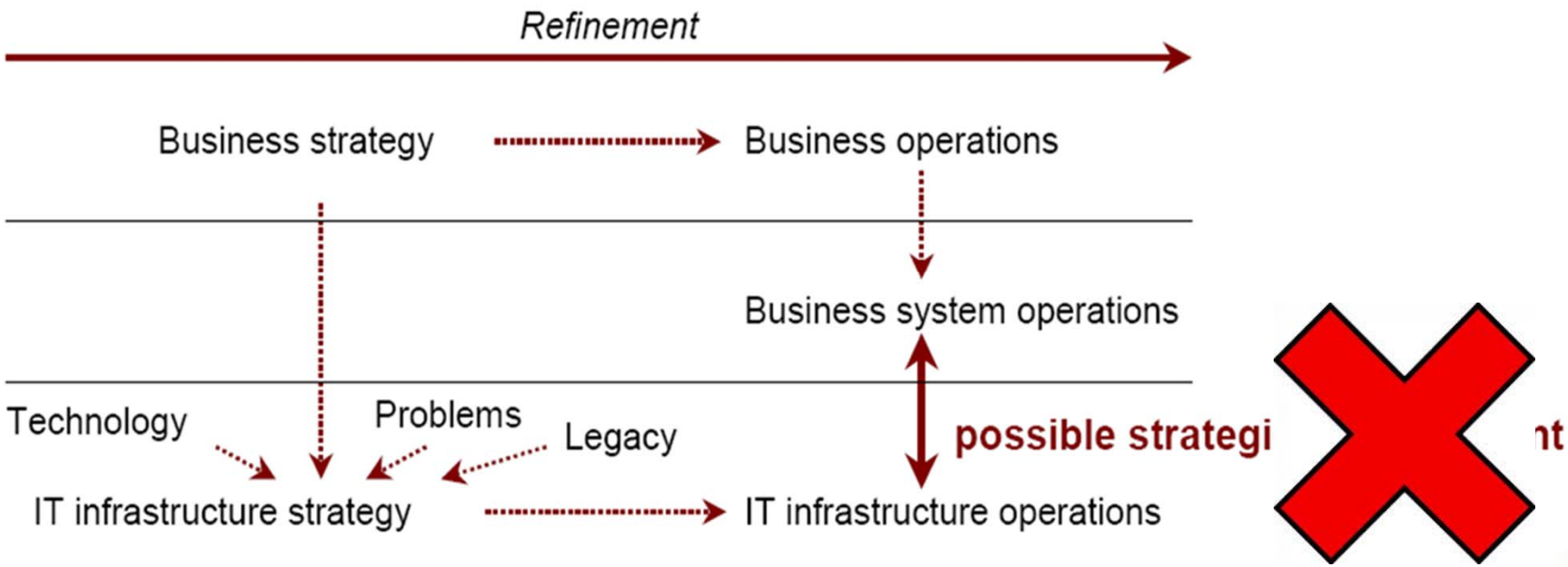
- How IT department can satisfy these needs?

  Correct **alignment** of IT systems with the organization



Motivation

- How IT department can satisfy these needs?

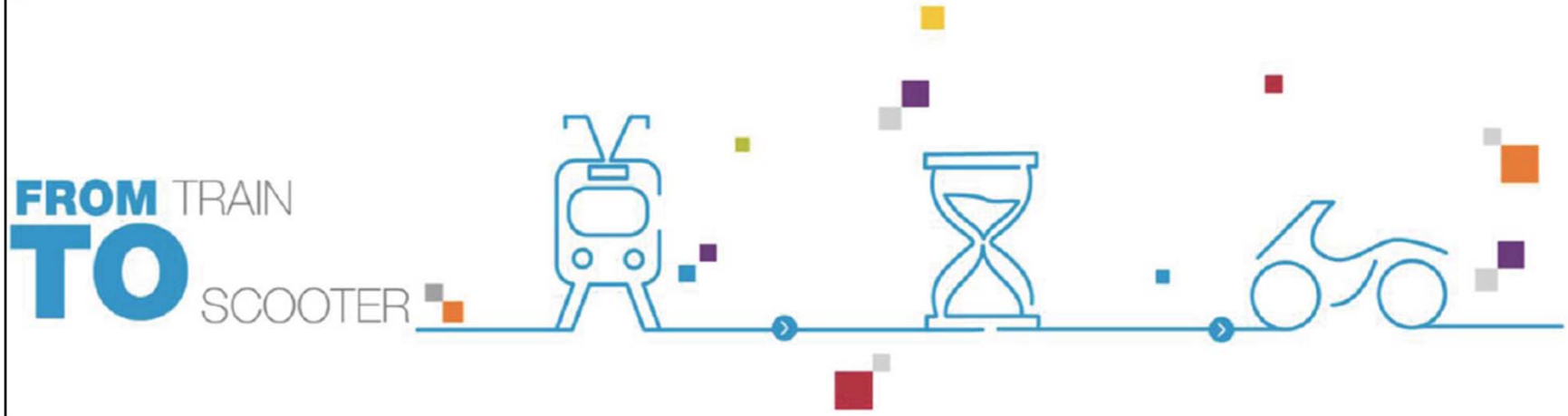


Misalignment between IT and business is the main cause of failures in IT projects and of the historic bad fame of the IT department.

Motivation

- How IT departments can satisfy these needs?

  More internal agility and flexibility

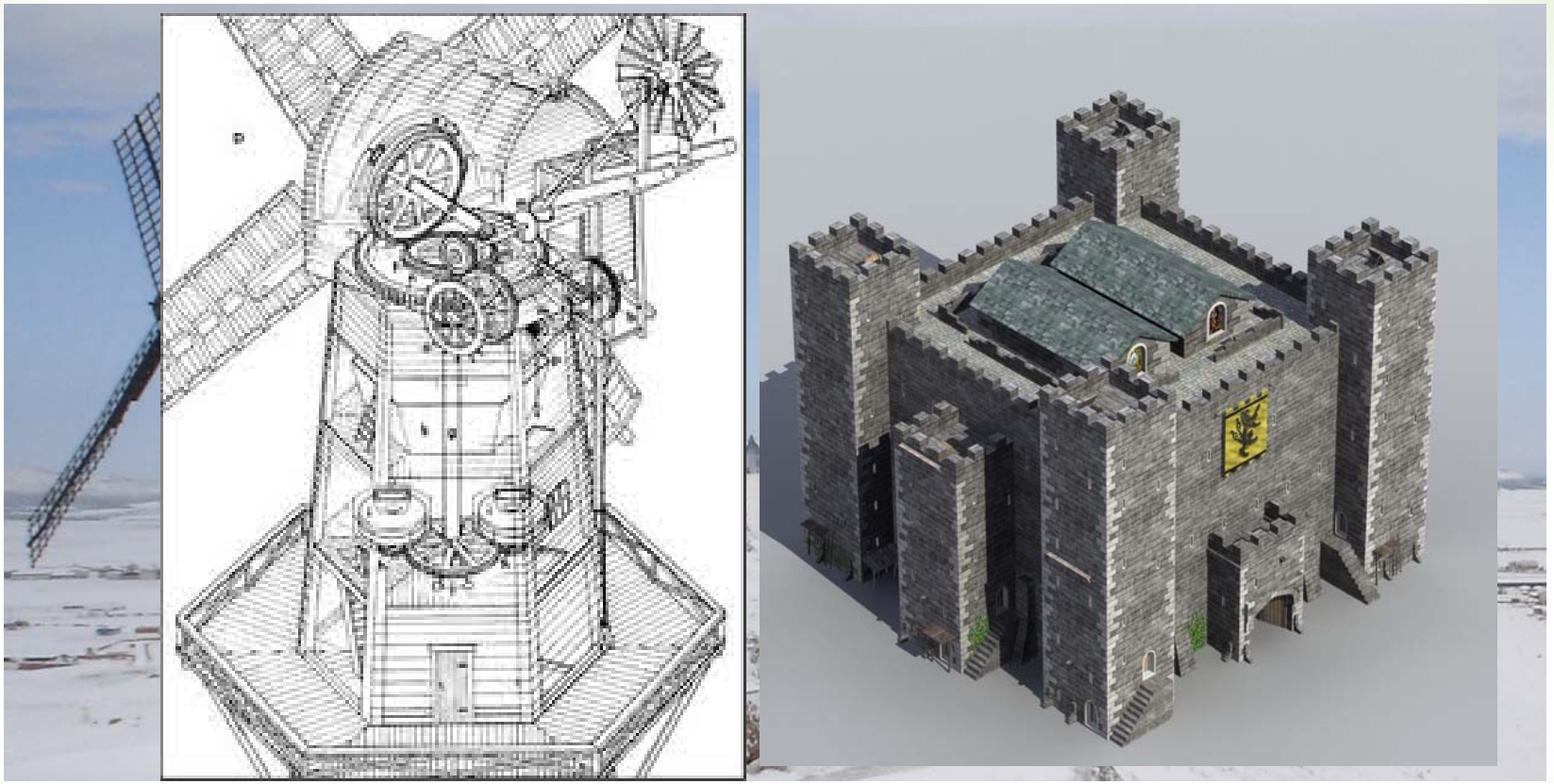


*The next generation of business IT solutions has a short time to market, is created and delivered in an agile way and is developed and owned in the nearest proximity of the business. These solutions are much like **Scooters and Cars**, where the current applications landscape typically is populated with **Trains and Buses**.*

Motivation

*When the complexity of the real world is excessive the human mind conceives **models** as mental tools.*

Motivation



Models are representations of the real world.

They can be abstract (SW artifacts) or material objects.

Motivation

- **Benefits** of using Models
  - To ensure **alignment** of IT plans/systems with business needs.
    - Better knowledge of the whole organization, including systems and technology.
  - To facilitate the **organizational transformation**.
    - First you know it, later change it.
  - To improve the **change management**.
    - Understanding the motivations and reasons of changes.
    - Foreseeing what should change and what and where will be the impacts.
  - To face the **complexity**.
    - Facilitating the knowledge and study of the whole organization.

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The New Model Engineering

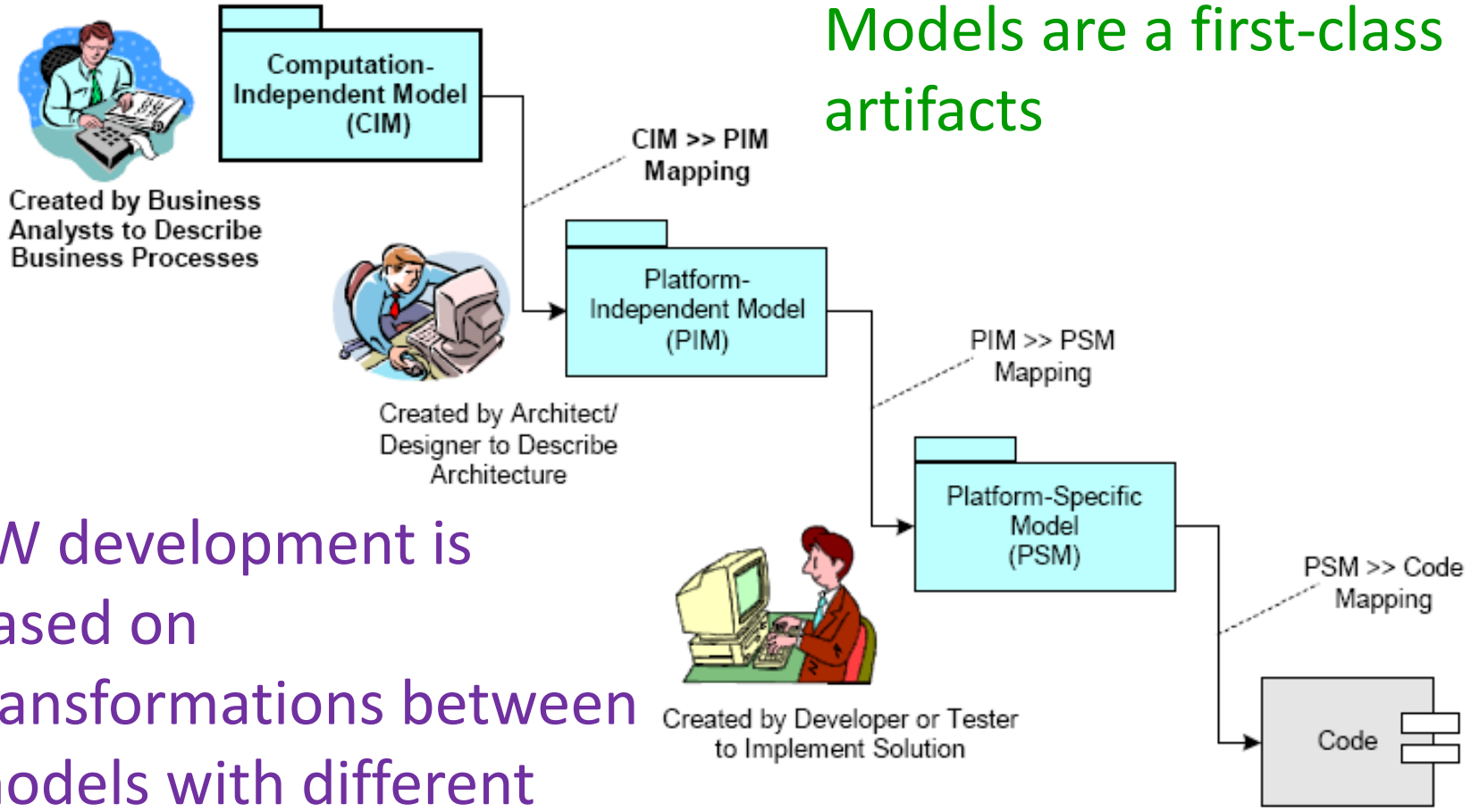
- Model (Driven) Engineering was devised to solve some issues in software development
- But it is useful to face more problems in more fields

Bézivin

Towards Cross-Disciplinary Practices: Software Modeling for Enterprise, Business and other Domain Engineering Fields.

The New Model Engineering

- Traditional ME – MDA (model driven architecture)



Models are a first-class artifacts

SW development is based on transformations between models with different abstraction level

The New Model Engineering

(Bezivin, CBI2014)

- Until now we have learned many things in ME:
  - Representation principle
    - Any model M represents a system S
  - Multiple view principle
    - A system S may be represented by several models
  - Conformance principle
    - Any model M conforms to its metamodel MM
  - 3-level conjeture
    - Any metamodel MM conforms to a common meta-metamodel MMM
  - Transformation principle
    - The most important operation applicable to models is a transformation
  - HOT principle
    - A transformation is a model
  - Weaving principle
    - Abstract declarative correspondences between models may be represented as models
  - Megamodel
    - A model which elements are models or metadata and relations between these models
  - Unification principle
    - All models specialize a common abstract model
  - Technical Space Framework
    - Any model has a given representation defined by its technical space

The New Model Engineering

(Bézivin, CBI2014)

The two engineering spaces

Problems lie here →

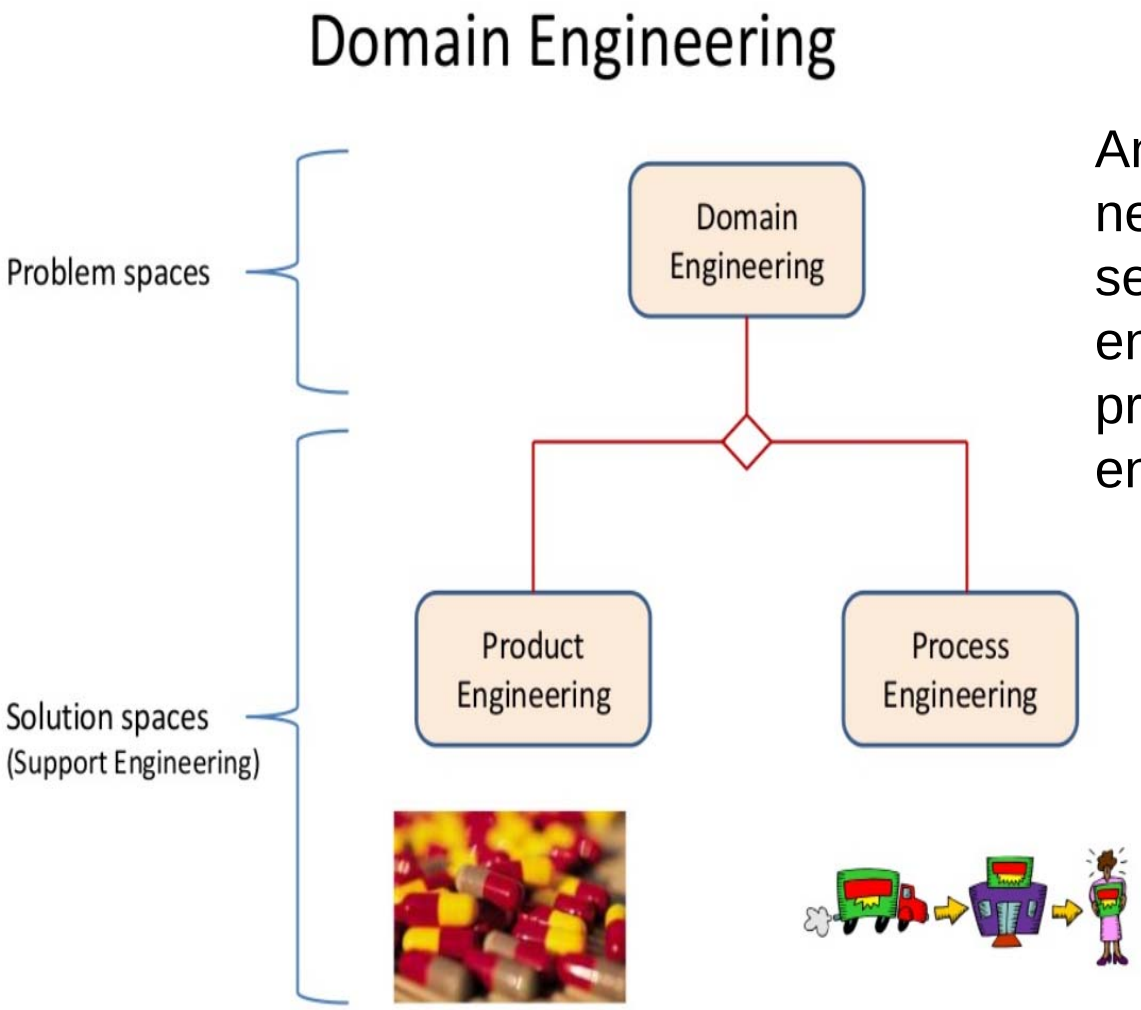
Domain Engineering

Tools to solve problems may be found here →

Support Engineering

The New Model Engineering

(Bézivin, CBI2014)



Any domain engineering needs the solutions of several support engineerings, including product and process engineering.

The New Model Engineering

(Bézivin, CBI2014)

- **DOMAIN**
  - Civil engineering
  - Electrical eng.
  - Chemical
  - Mechanical
  - Building
  - Biological
  - **Software eng.**
  - Automative eng.
  - **Enterprise engineering**
  - …
- **SUPPORT**
  - Process engineering
  - Product (line) eng.
  - Services
  - Data
  - Programs
  - Contraints / Rules
  - Systems
  - Requirements eng.
  - **Models engineering**
  - …

The New Model Engineering

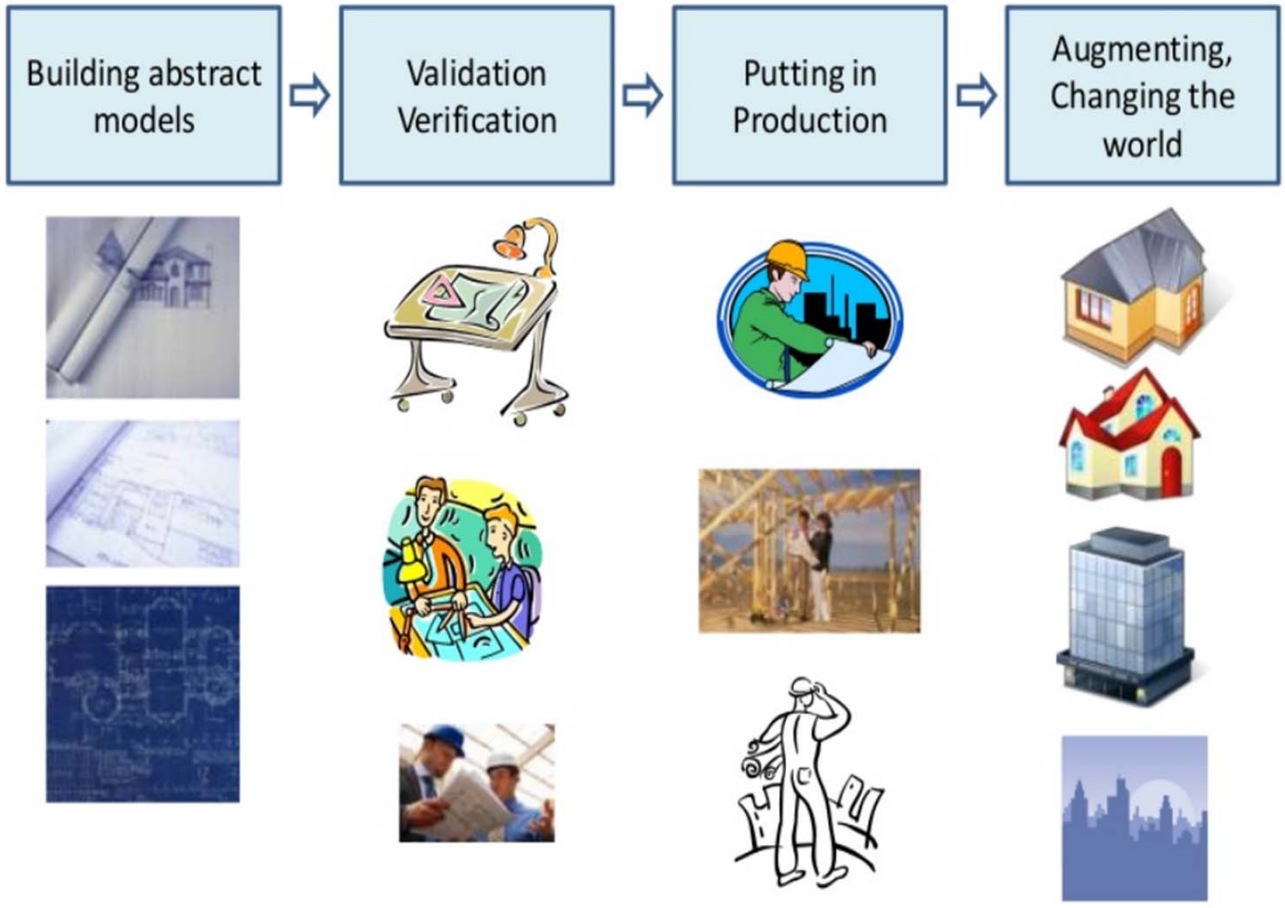
(Bézivin, CBI2014)

- Many features are common to all domain engineering fields
  - Based on support engineering
  - Products, Processes, Services, Rules, …
  - Including HR and team management
  - Human in the loop
  - Engineers in control
  - Need for a **strong model repository**
    - Scaling up to millions of parts
    - Cooperative concurrent access
    - Point of view mechanisms
    - Strong zooming mechanisms

The New Model Engineering

(Bézivin, CBI2014)

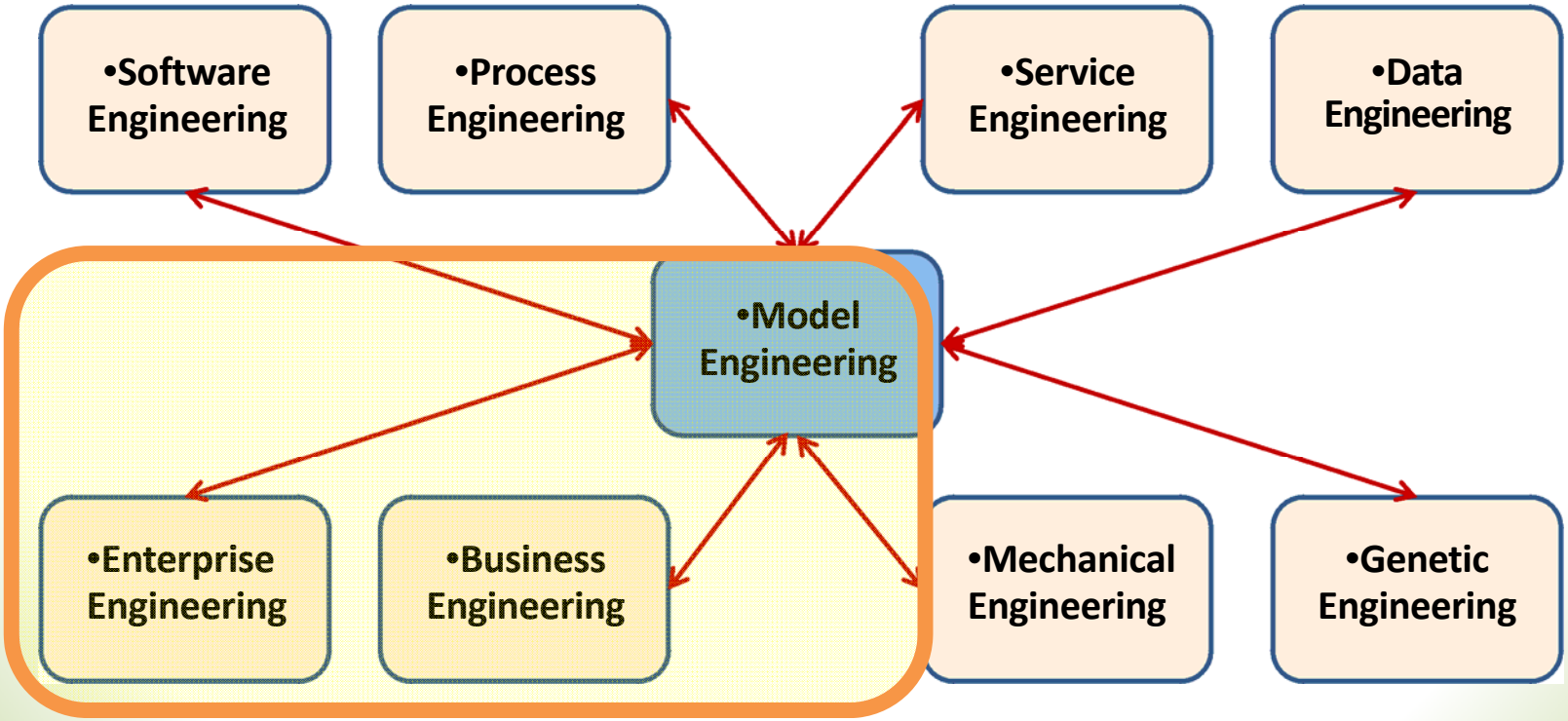
- Many features are common to all domain engineering fields
  - Chain (the process)



The New Model Engineering

(Bézivin, CBI2014)

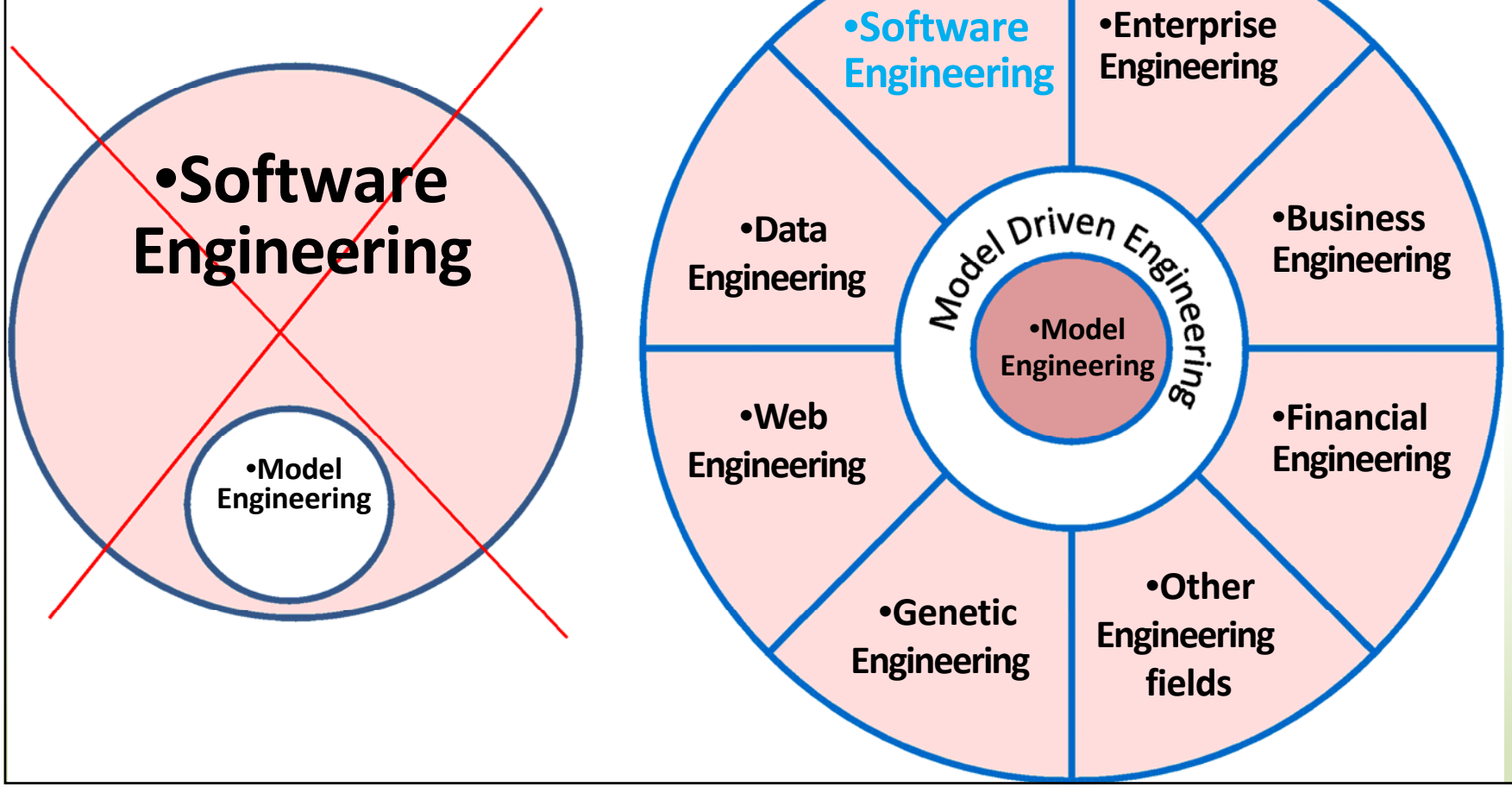
- **Model Engineering** is a support engineering potentially useful in most other domain and support engineering fields



The New Model Engineering

(Bézivin, CBI2014)

- The new Model Engineering is no more part of SW Engineering only



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  - **Seeing the Enterprise as a System**
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Business Model Engineering

- Business Model Engineering (BME) is the application of Model Engineering to the enterprise and business domains, with special focus into the **context** of the **information systems**.

  - Enterprise Engineering
  - Business Engineering
  - Model driven business
  - Model driven organization

Spanish:
Ingeniería de Negocio

Seeing the Enterprise as a System

System Thinking

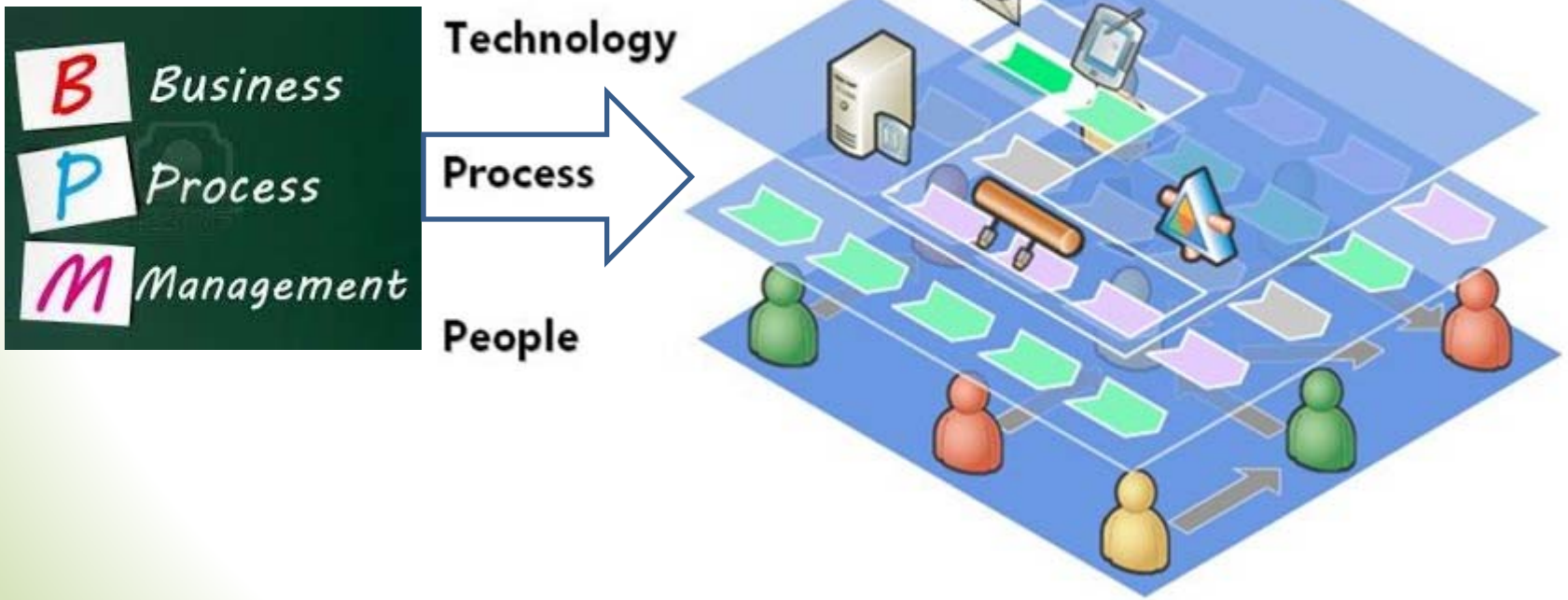
- **Engineering the Organization**
  - Seeing the organization as an open sociotechnical system.
  - People and Technology interact and complement.
  - Efficiency depends on the combined optimization of both parts.
  - Each part offers possibilities to the other part but it also implies constrains or demands.
  - It is open because inputs and outputs flow between the system and the environment.

Seeing the Enterprise as a System

Engineering the Organization

In real world the technology is not alone.

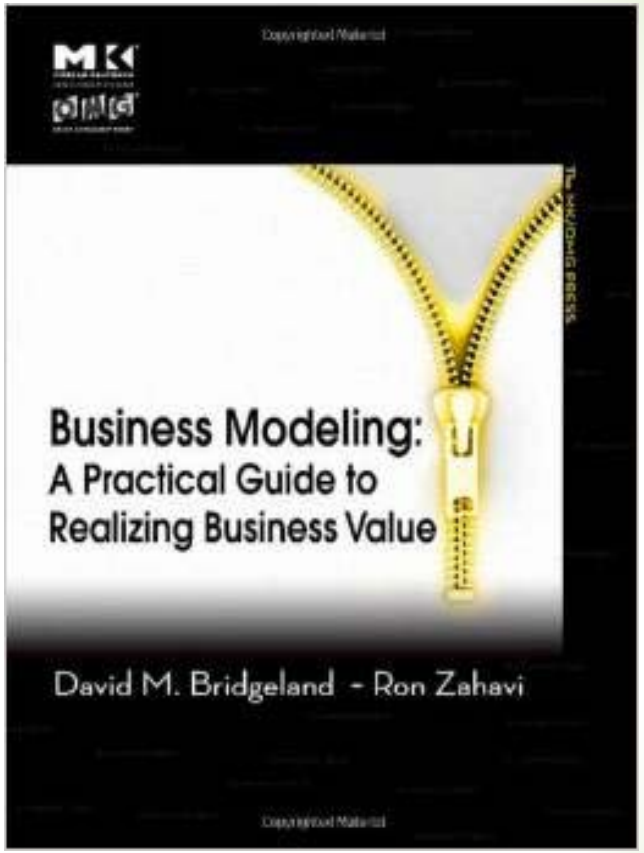
In real world the people is not alone.



Kinds of Business Models

- *A **business/enterprise model (BM)** is a simple representation of the complex reality of a business/enterprise.* (Bridgeland)

- *It is **a model** that describes the details of a business/enterprise: its goals, organization, processes, rules, systems, infrastructure, ...*

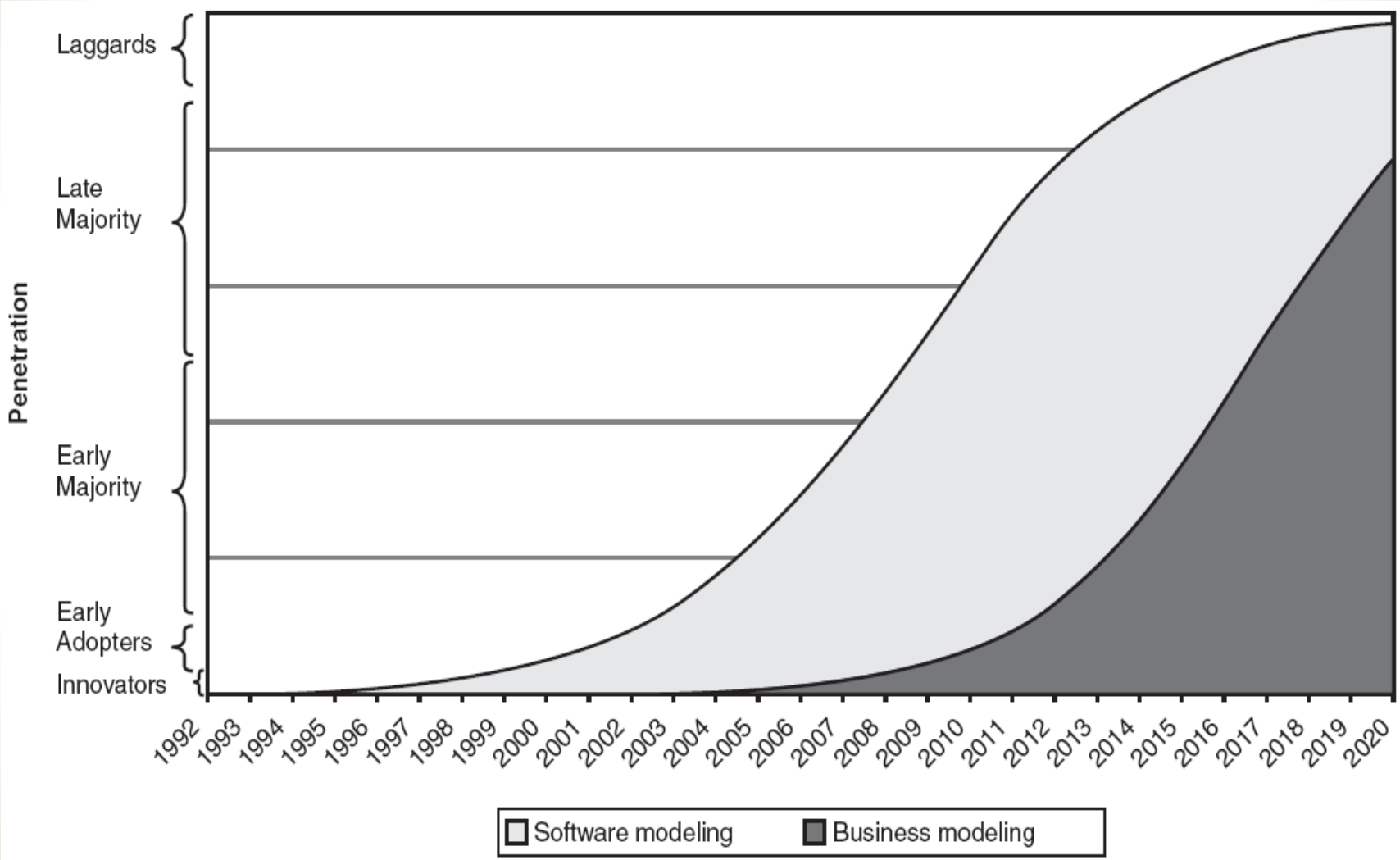


Kinds of Business Models

(Bridgeland, 2009)

- **Business Models** generate **value** supporting
  - Communication between people
  - Training and learning
  - Persuasion and ‘selling’
  - Analysis of a business situation
  - Compliance management
  - Development of software requirements
  - Direct execution in software engines
  - Knowledge management and reuse

Kinds of Business Models



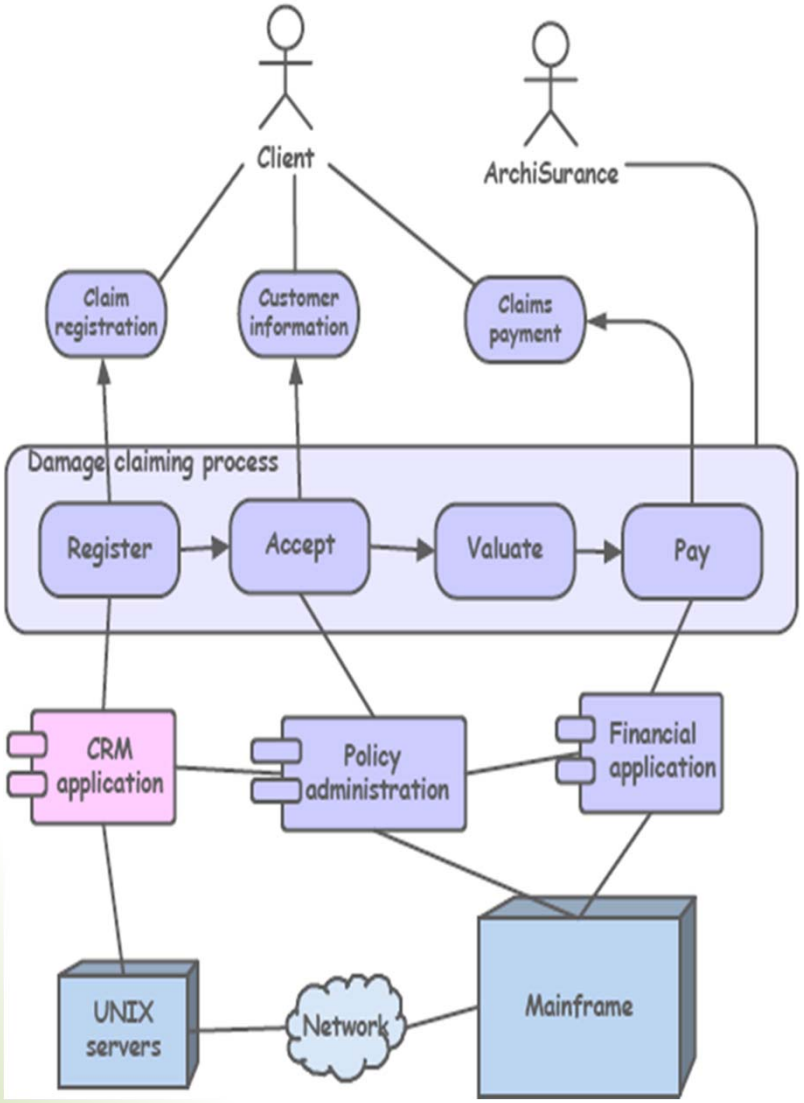
(Bridgeland, 2009)

Kinds of Business Models

- To each dimension of any organization corresponds one kind of Business Model
  - **Motivation**
    - Our goals and reasons
  - **Process**
    - Who, what and how the things are carried out.
  - **Rule**
    - The conditions that should be satisfied
  - **Organization Structure**
    - Structures/Units and its relationships
  - **Enterprise Architecture**
    - Integral vision of all the elements/concerns and its relationships
  - …

Kinds of Business Models

- Enterprise Architecture Models



¿System Architecture?
=> ISO 42010

Kinds of Business Models

- *Enterprise Architecture: a coherent whole of **principles, methods, and models** that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure ...(LANKHORST)*

EA= Inf. Technology + Strategy + Business

Kinds of Business Models

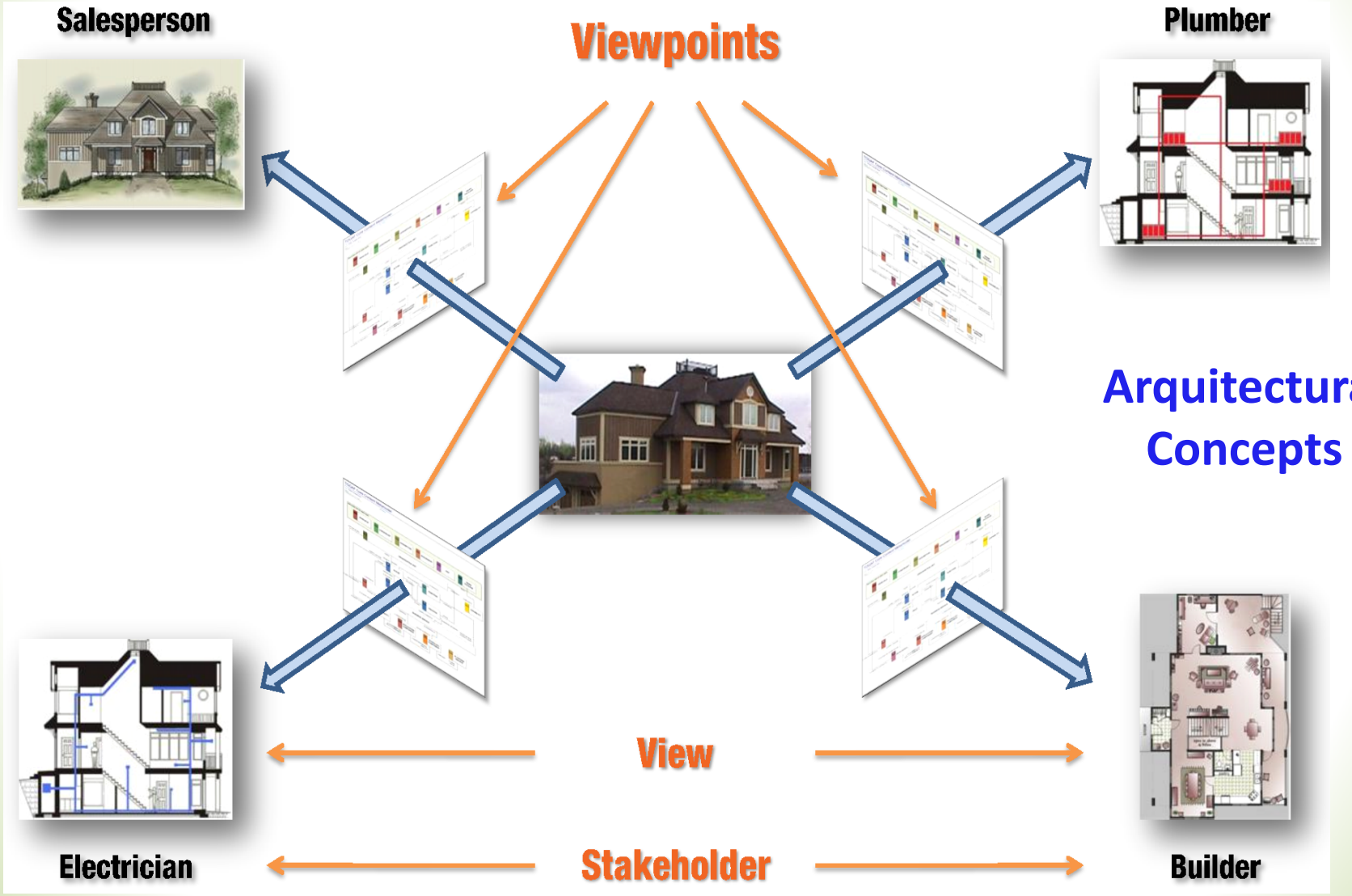
Architecture:

fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution.

(structure with a vision)

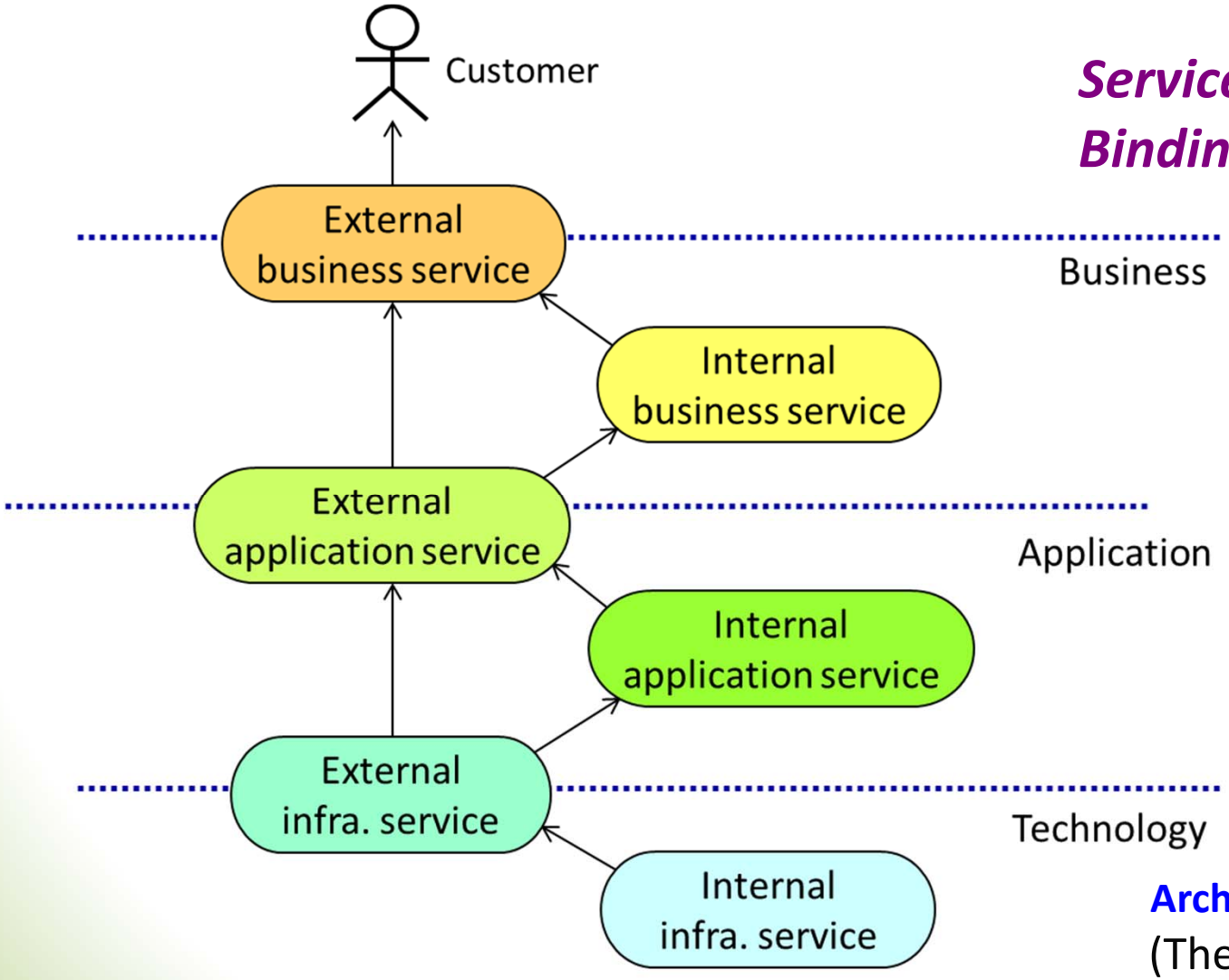
ISO/IEC/IEEE 42010

Kinds of Business Models



Kinds of Business Models

- Levels in Enterprise Architecture



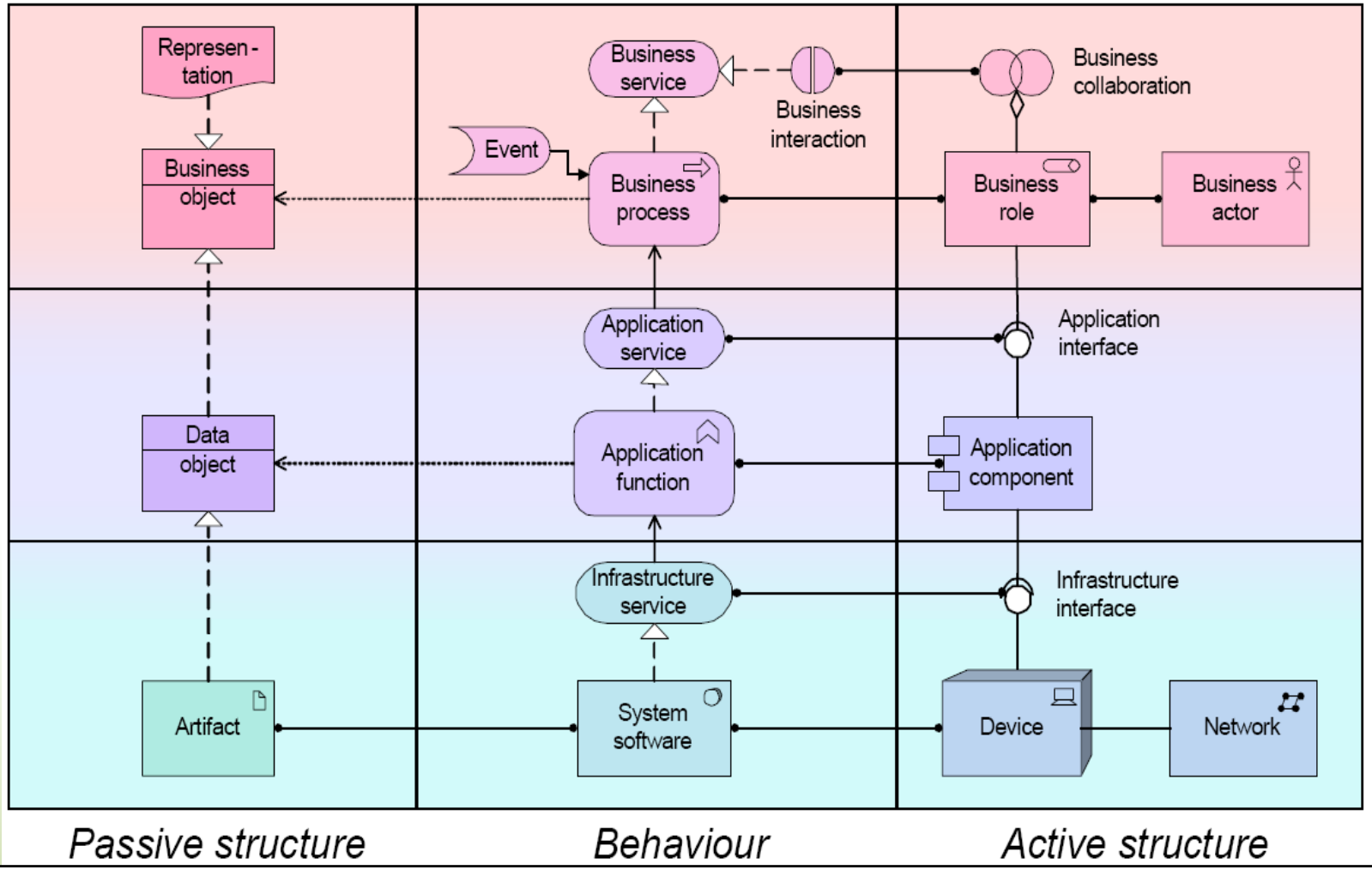
Services as Binding Concept

Archimate notation
(The Open Group)

Kinds of Business Models

Archimate notation
(The Open Group)

- In enterprise architecture each level-perspective pair has specific elements.

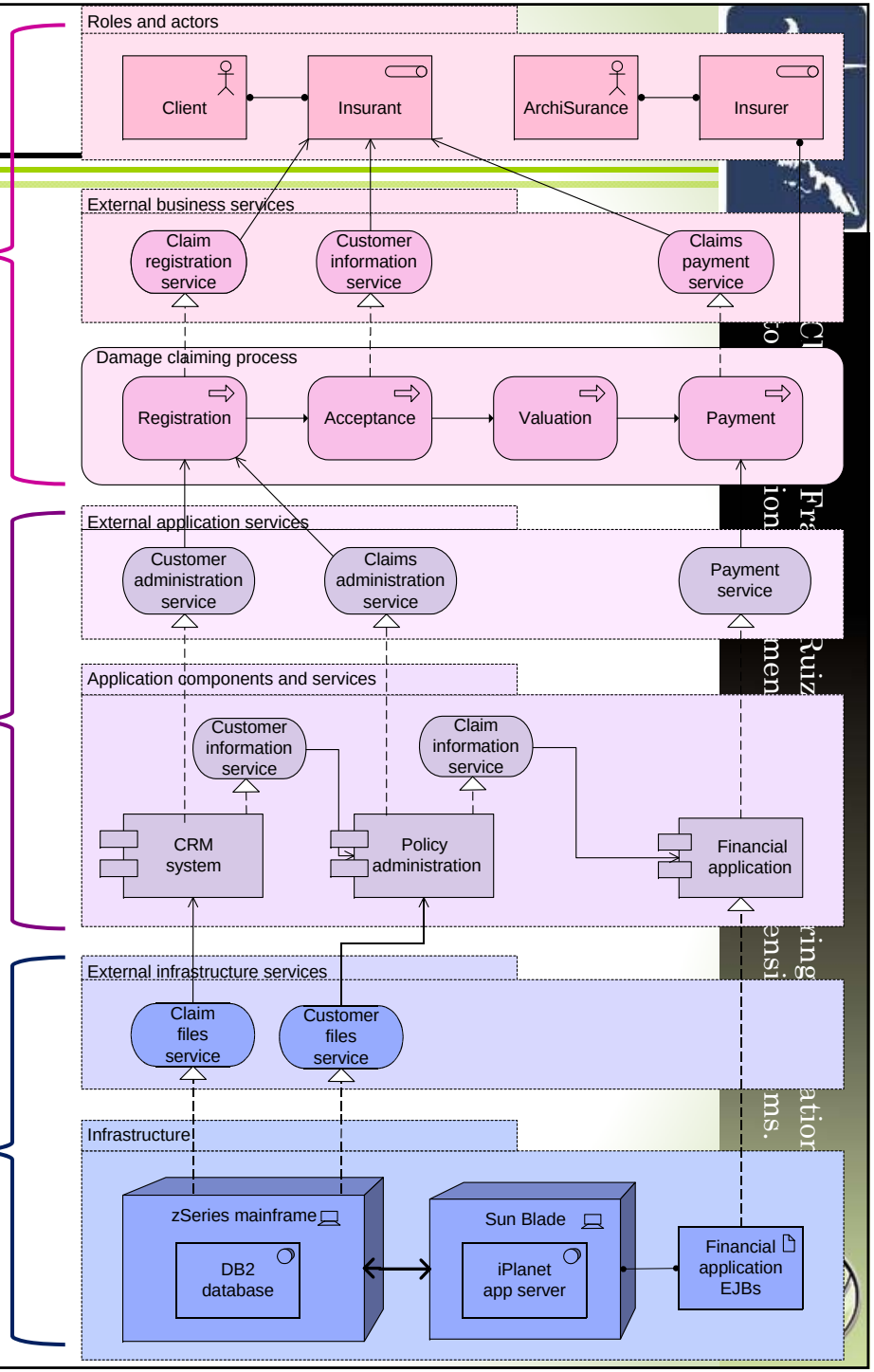


Kinds of Business Models

Enterprise Architecture

Layered View

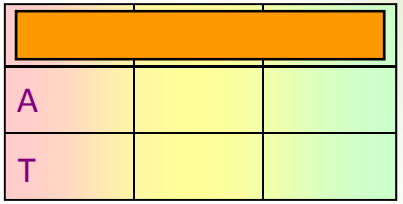
A global view with the several layers and aspects of an enterprise in a single diagram.

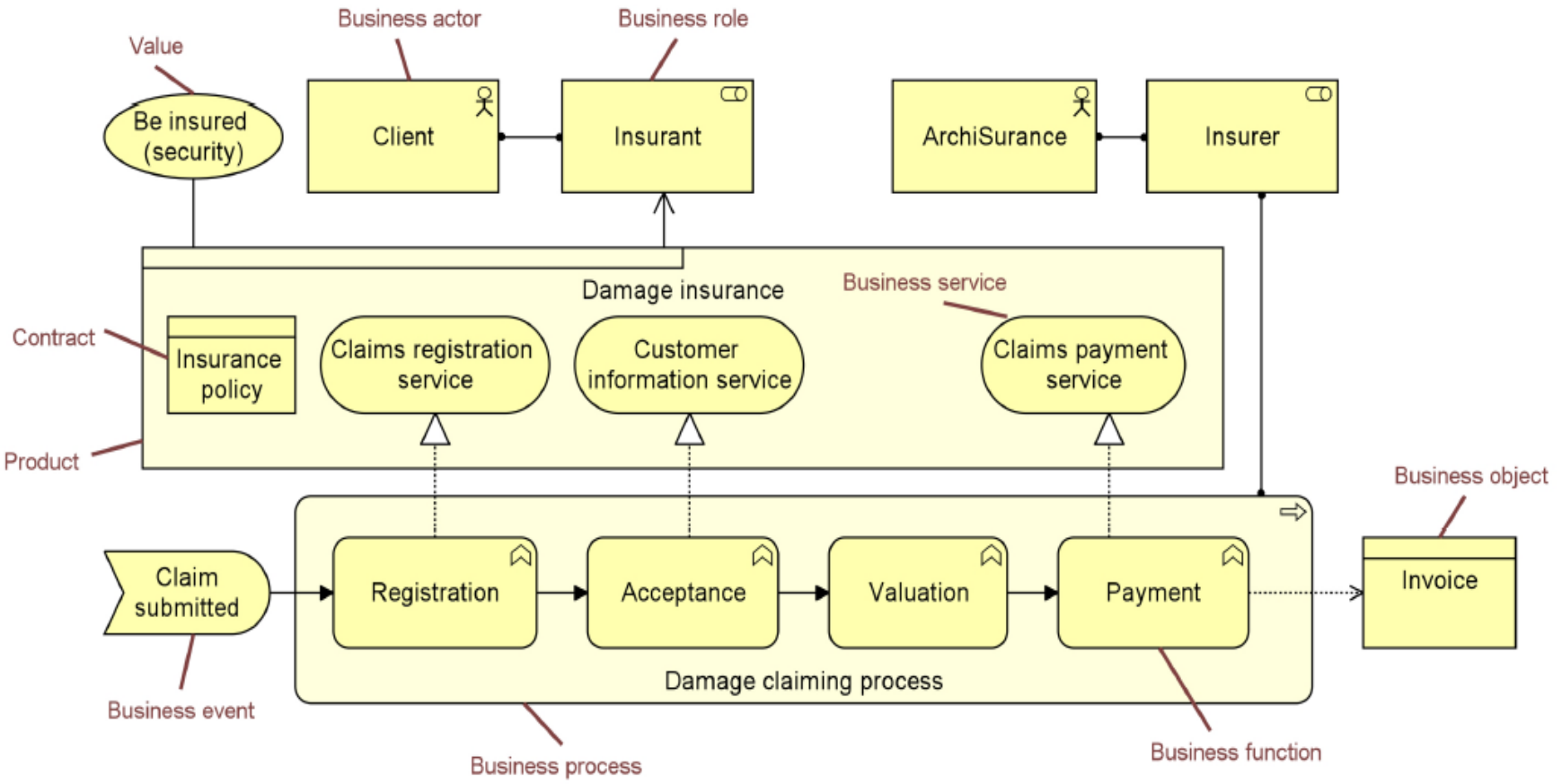


Kinds of Business Models

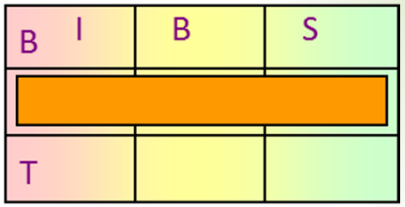
Enterprise Architecture

Sample of view of the business layer



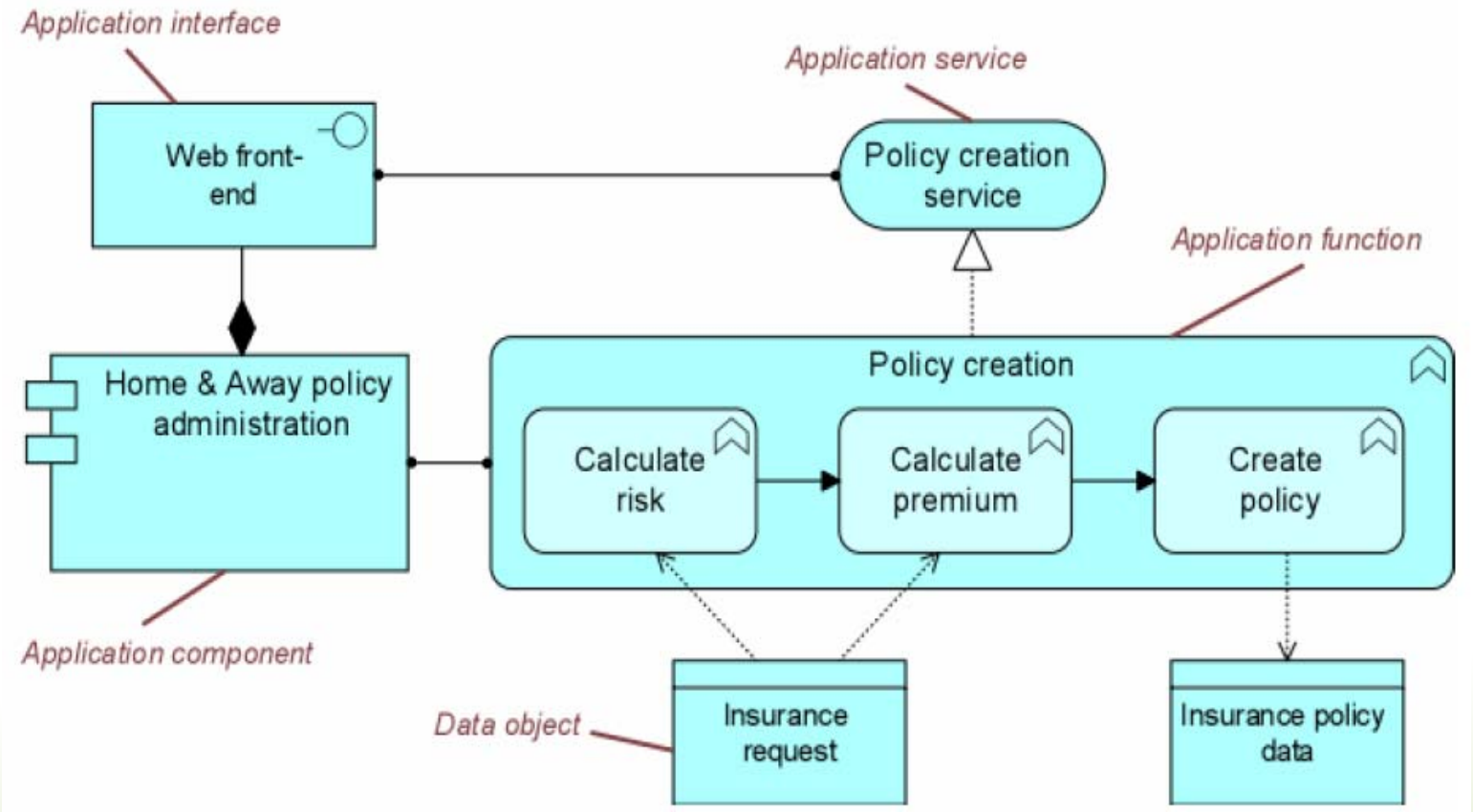


Kinds of Business Models



Enterprise Architecture

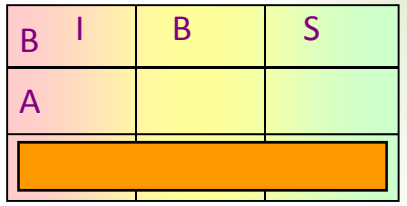
View of the systems/applications layer

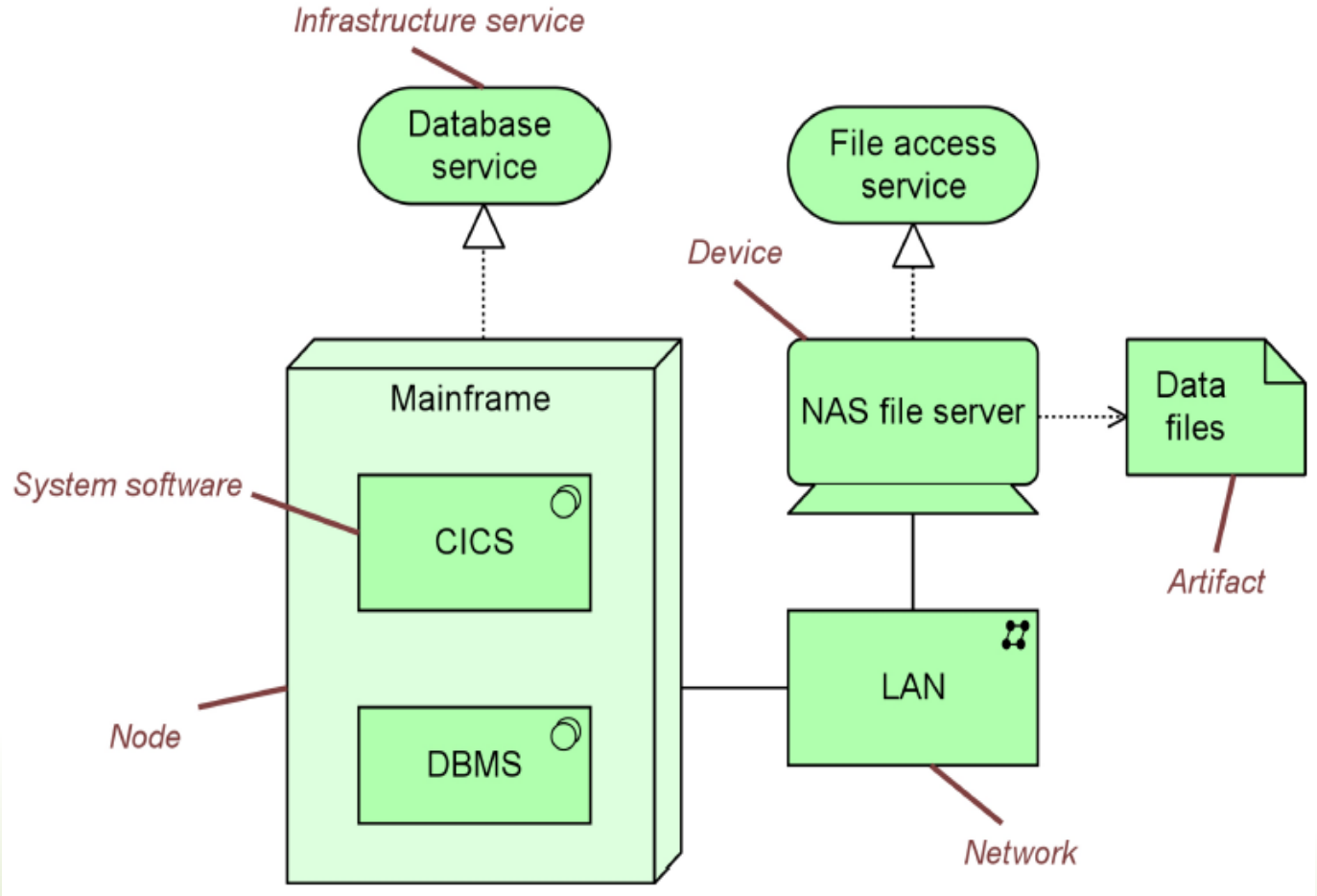


Kinds of Business Models

Enterprise Architecture

View of the infrastructure/technology layer





Kinds of Business Models

- We have technology
  - standards

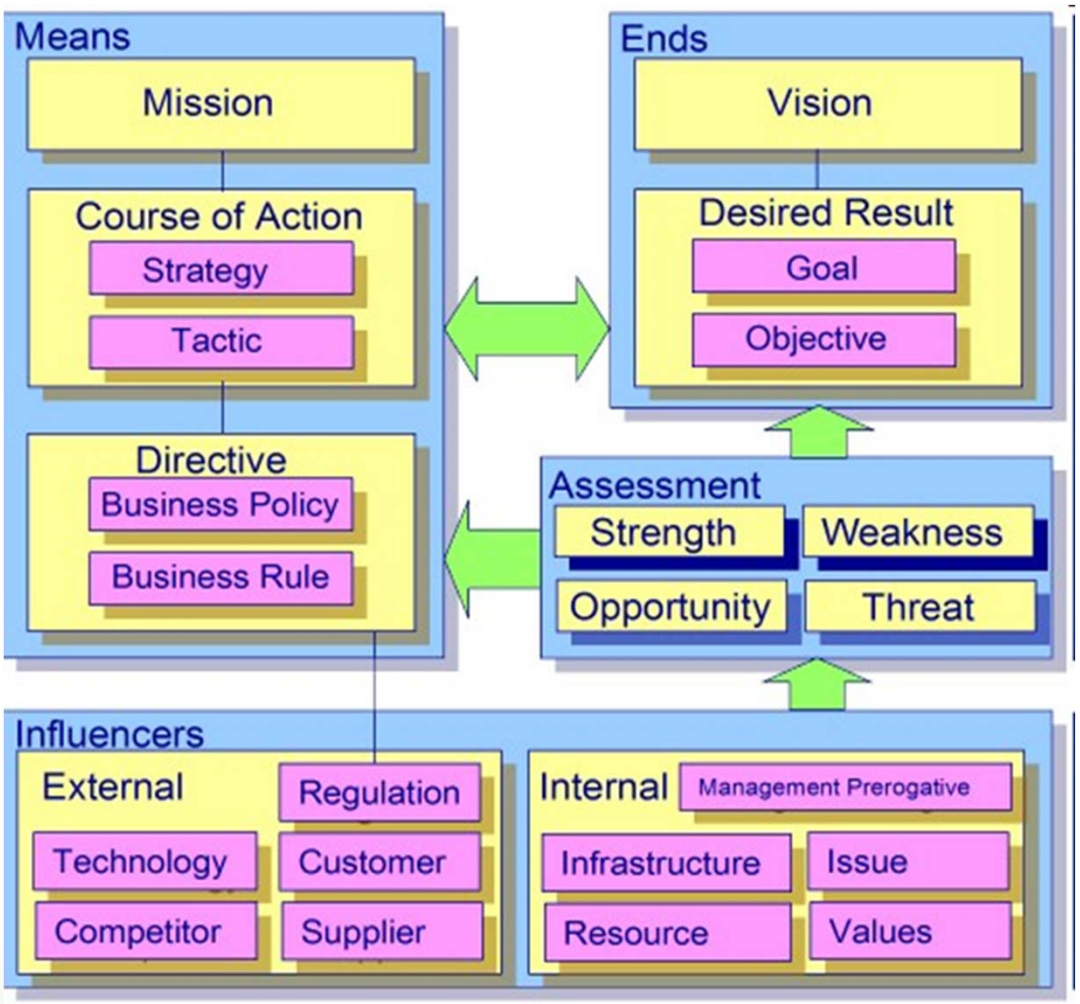
BUSINESS MODELING SPECIFICATIONS

OBJECT MANAGEMENT GROUP

SPECIFICATION	acronym	topical area / domain
Business Motivation Model	BMM	business process design
Business Process Definition Metamodel	BPDM	business process design
Business Process Maturity Model	BPMM	business process design
Business Process Model and Notation	BPMN	business process design
Case Management Model and Notation	CMMN	business modeling
Date-Time Vocabulary	DTV	business process design
Decision Model and Notation	DMN	bmi
Production Rule Representation	PRR	business process design
Semantics of Business Vocabulary and Business Rules	SBVR	business process semantics
Value Delivery Modeling Language	VDML	bmi
Workflow Management Facility	WfMF	cross-domain

Kinds of Business Models

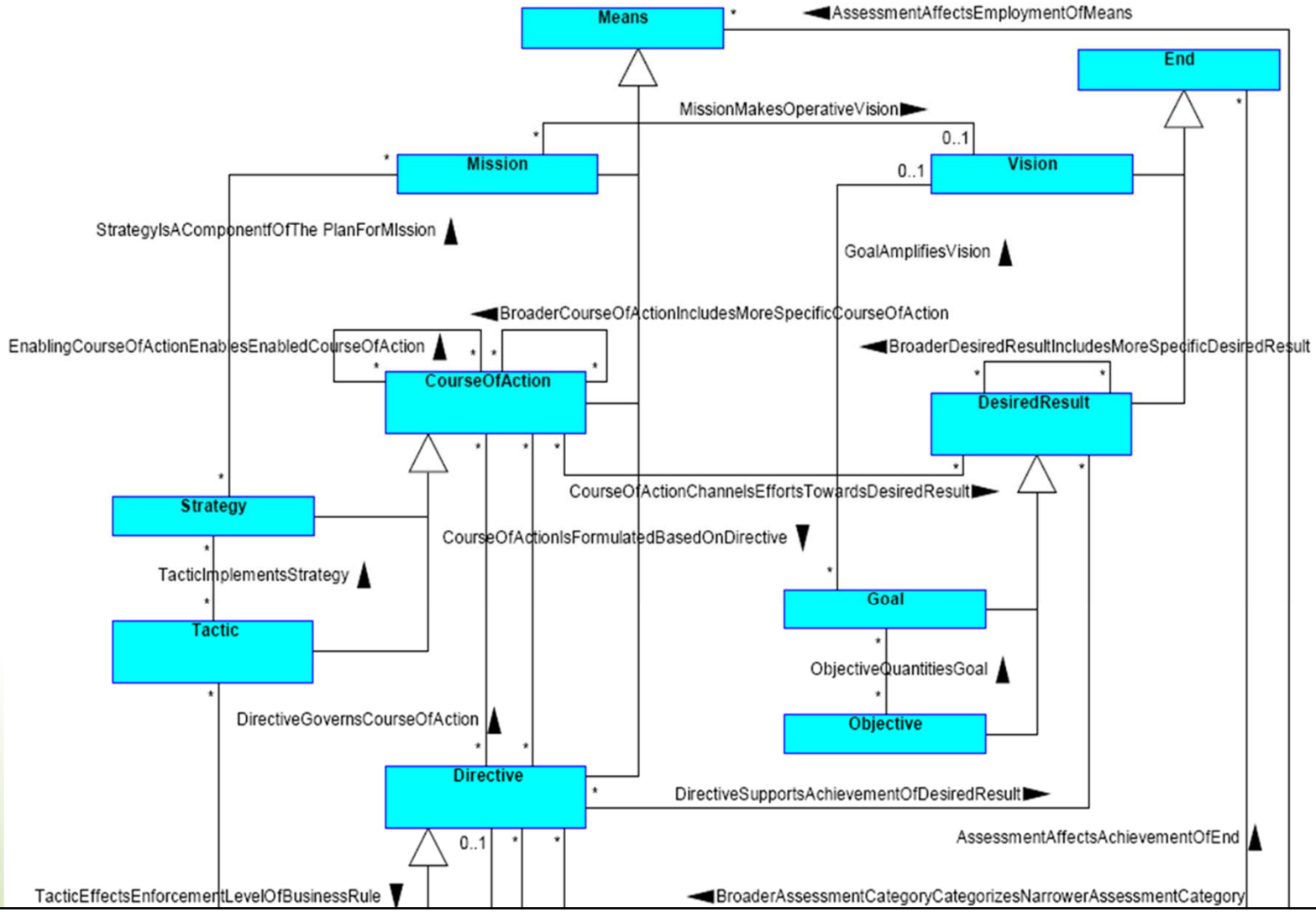
- Sample of standard: BMM



OMG Business Motivation Model

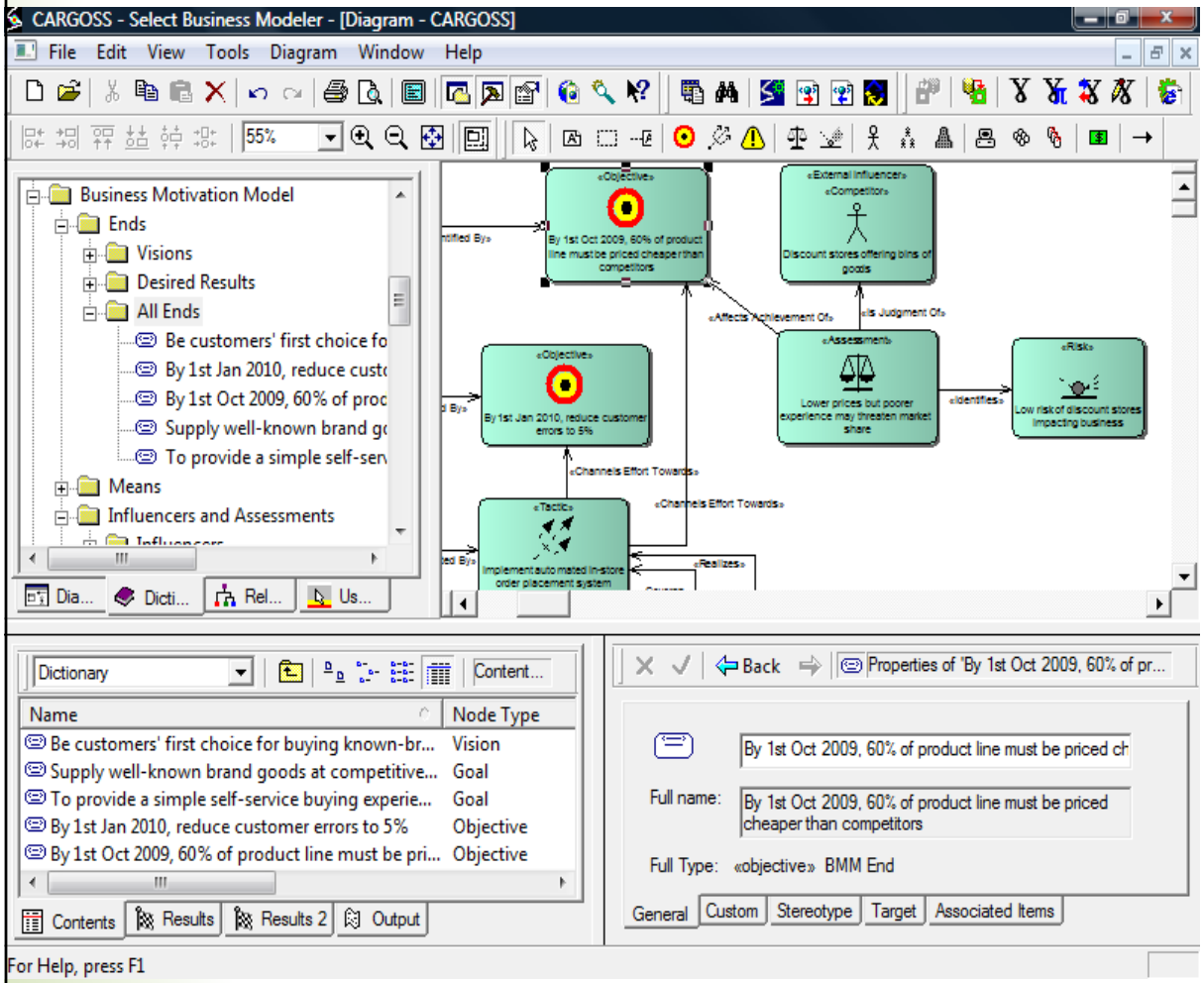
Kinds of Business Models

- BMM Metamodel (part)



Kinds of Business Models

BMM Tools



Visual Paradigm for UML (enterprise architecture)

IBM Rational System Architect

Select Business Modeler

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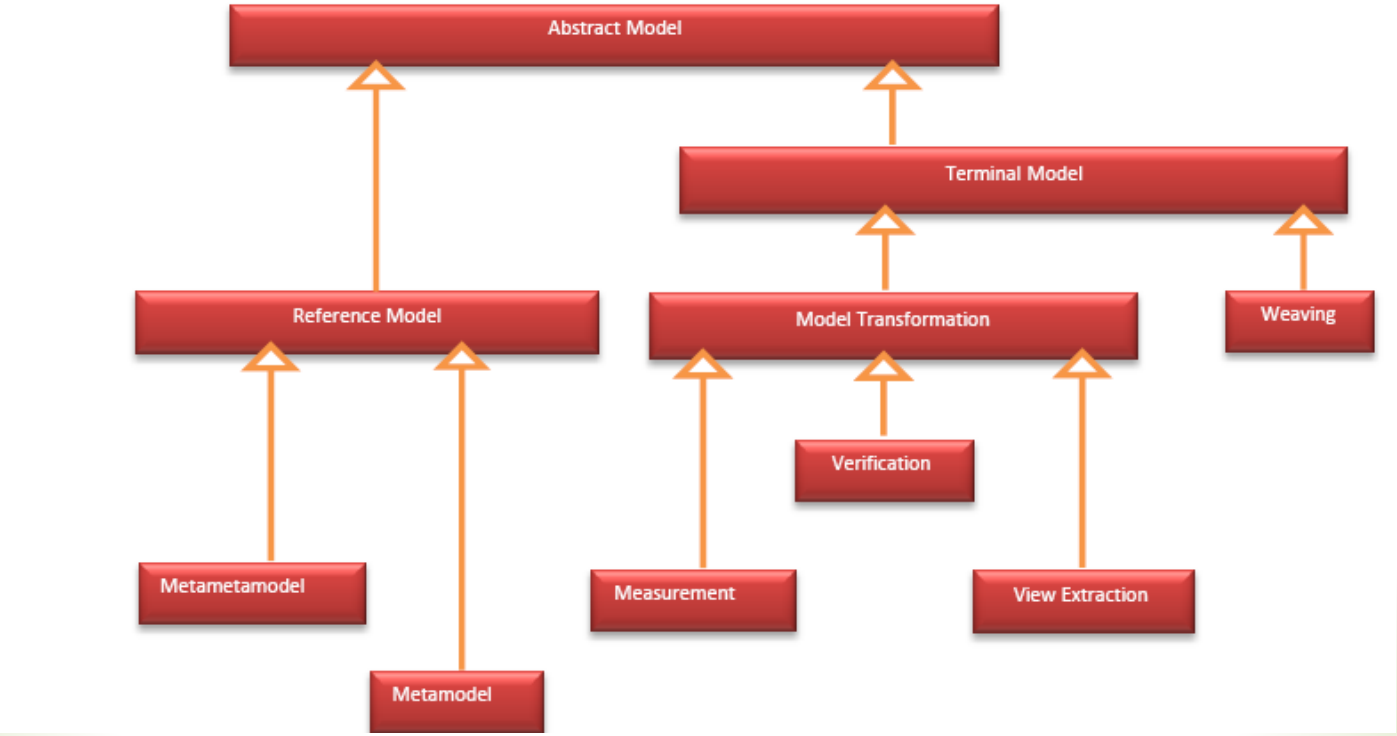
Research Challenges

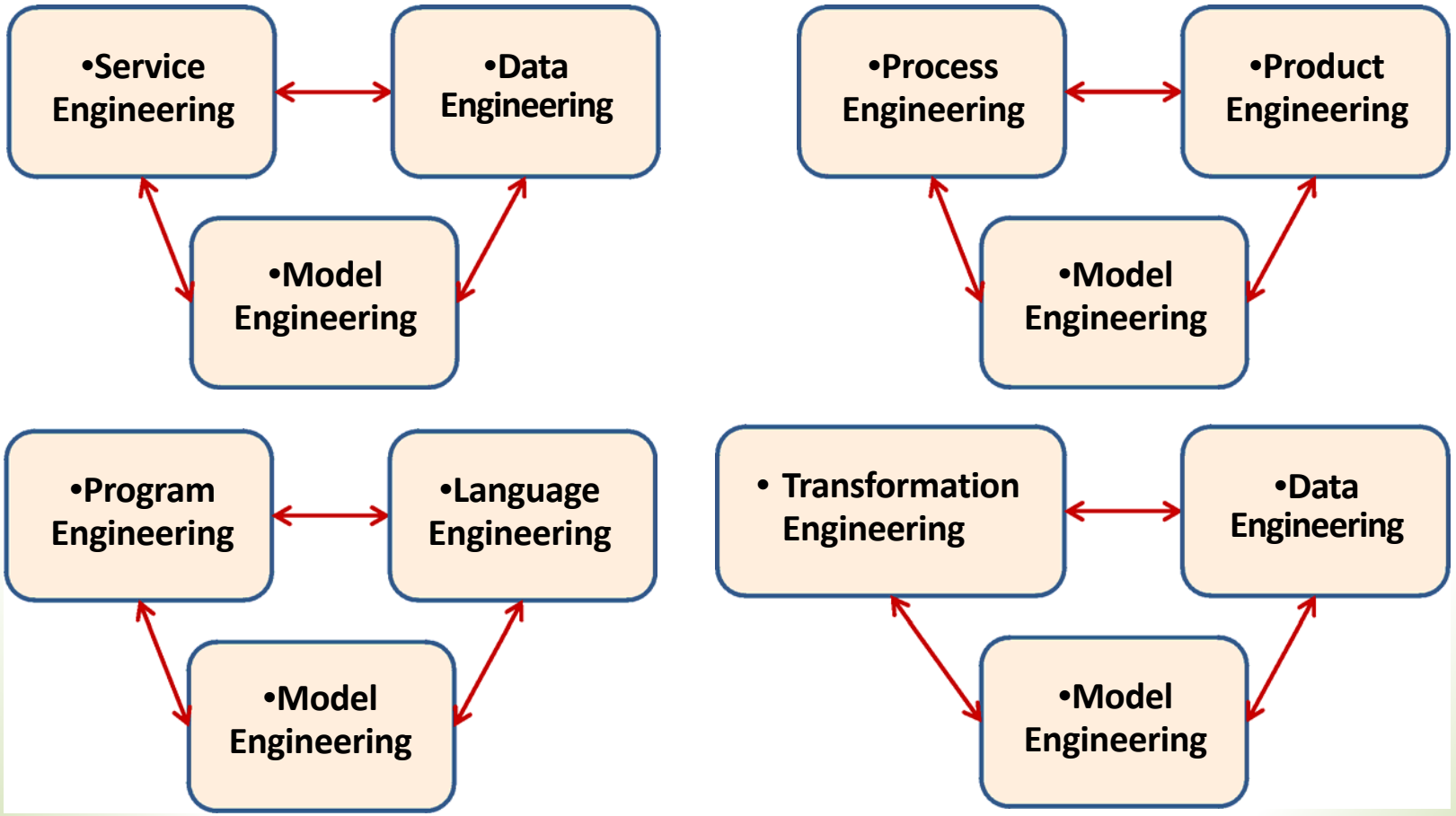
- Research on **Model Engineering** (ME) and its applications is problem oriented (practical research) but a formalization is necessary many times.
- ME is a *typed polymorphic calculus on labelled graphs*

$$Mt\ [MMt] : Ma\ [MMa] \rightarrow Mb\ [MMb]$$



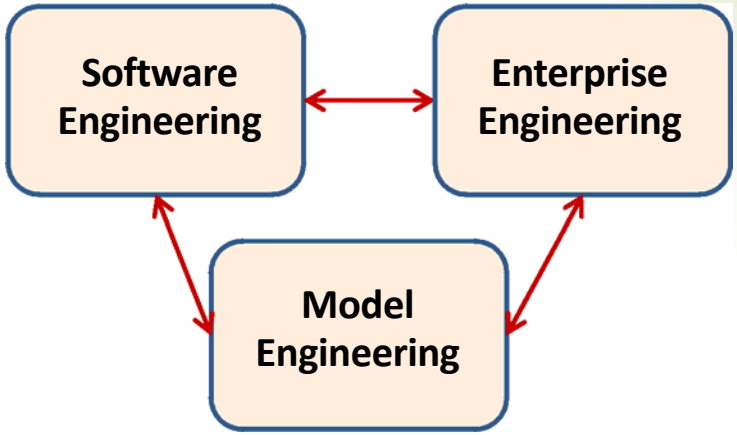
Research Challenges

- Many possible useful collaborations between Model Engineering and other support/ domain eng. can be explored



Research Challenges

- Synergy between ME, enterprise engineering and SW engineering is a hot research topic.



- Int. Workshop on TowArds the Model DrIveN Organization (AMINO)
  - Goals, Domains, and Enterprise Architecture in the MDO.
  - Multimodel-Driven SW Engineering for Evolving Enterprise Systems.
  - Meta-model Patterns for Expressing Relationships Between Organization Model Concepts and SW Implementation Concepts.
  - Enterprise Models as Drivers for IT Security Management at Runtime.

Research Challenges

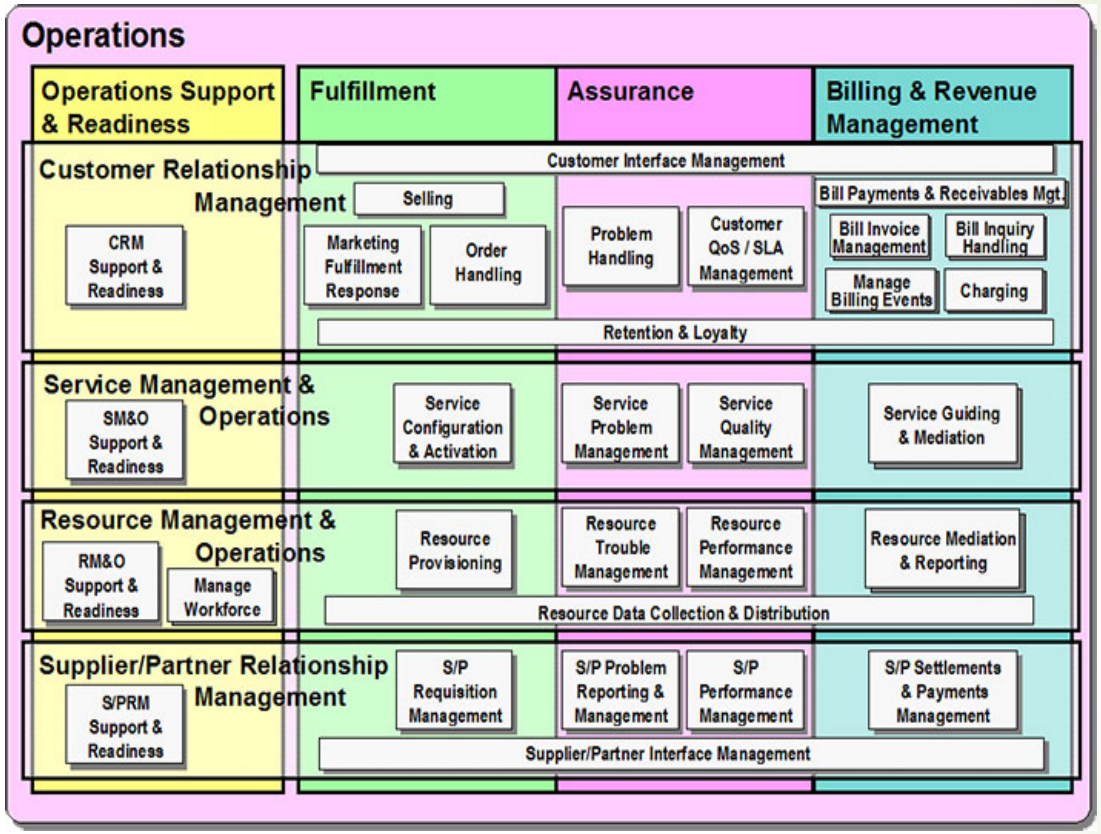
- **AMINO** (towArds the Model drIveN Organization)
- Motivation:
  - Enterprise Systems (ES) are pivotal to a company's competitiveness.
  - Current ES technologies, approaches, and architectures do not adequately address the growing demands for inter-organizational collaboration, flexibility and advanced decision support in organizations.
  - MDO is an organization in which models are the primary means for interacting with and evolving the systems that drive the organization.
  - Realizing the MDO vision will require research that cross-cuts many areas, including research on enterprise architectures, business processes, workflow modeling, system requirements and design modeling, metamodeling, and models@runtime.

Research Challenges

- There are a lot of open research issues in Business Model Engineering (BME):
  - **Integration**
    - Heterogeneous repositories of (meta)models
    - Megamodels. Models of models
    - Mapping and traceability
  - **Analysis**
    - Simulation
    - Verification and Validation
  - **Evolution**
    - Very complex transformations
  - **Reuse**
    - Patterns (process catalogs)
  - **Execution / enactment**

Research Challenges

- Reuse in BME
  - More Engineer
  - Less Gardener



Standard catalog of business (sub)processes

Components and patterns in a very high abstraction level with implications to the IT services or systems

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Experiences

- Our trayectory until BME
  - 1997-2000: SW maintenance
  - 2000-2004: SW process modeling [*generalization*]
  - 2004-2012: business process modeling [*translation*]
    - Quality of models
    - Measurement
    - Improvement
  - 2009-2012: integration of model-driven (MDE), service-oriented (SOC) and business process management (BPM) [*amplification*]
  - 2013-2014: BME applied to IT governance in SW factories [*zoom out*]

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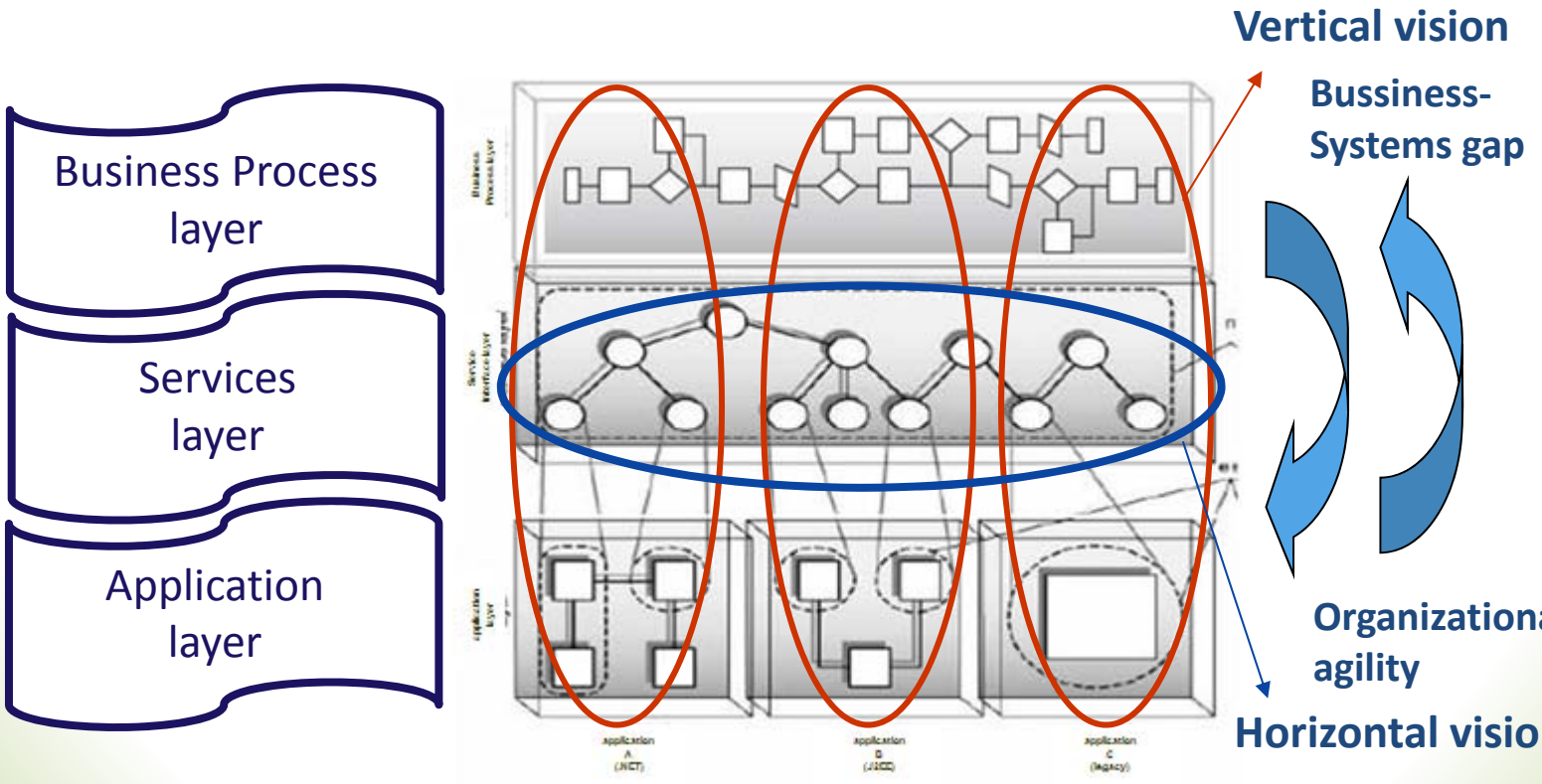
From the process to the service

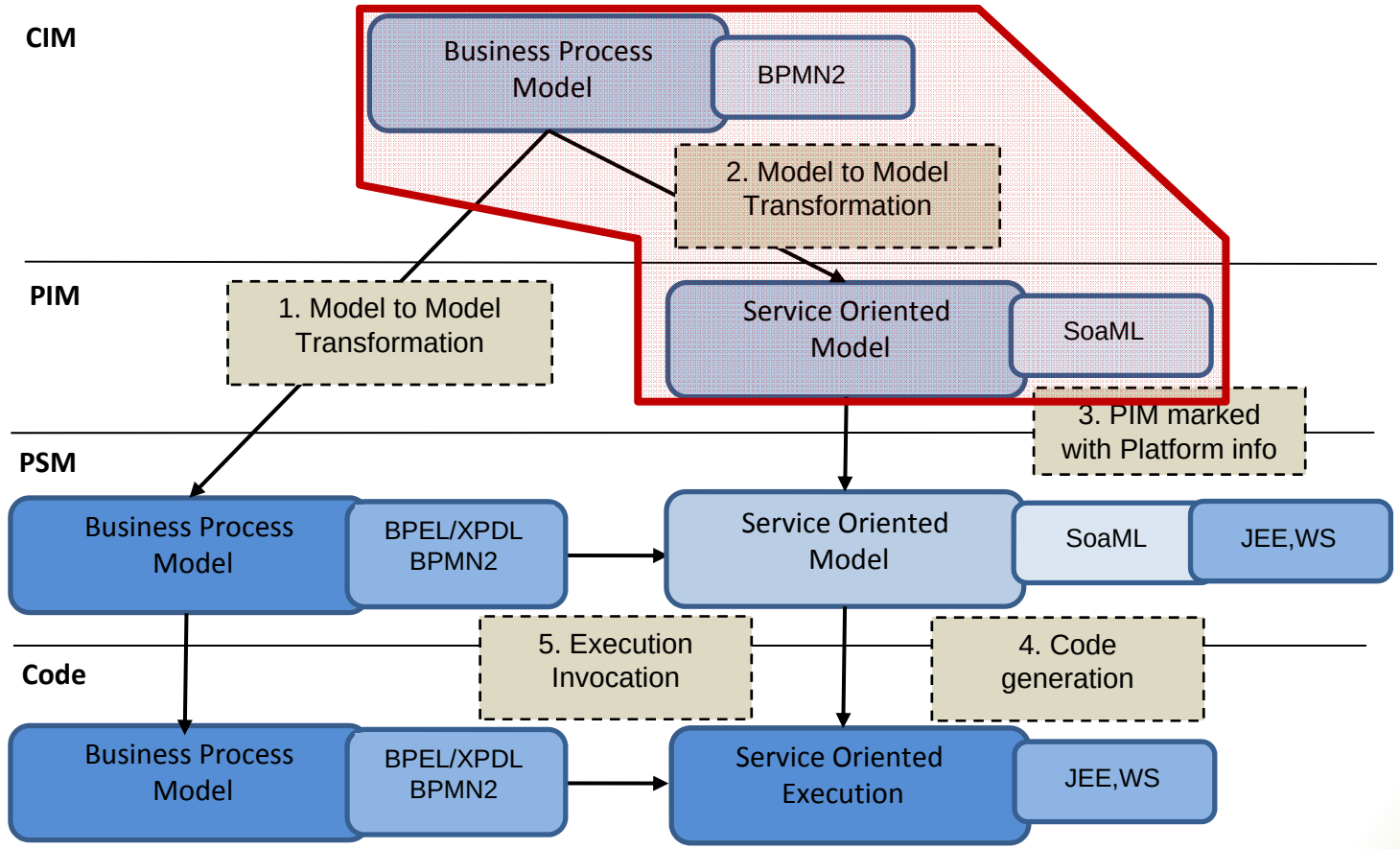
- Research goal: automatic transformations from business process (BP) models to IT services models.
- Practical problem: break the business-systems gap separating BP definition from its technical implementation → realization with services



Part of the Andrea Delgado PhD thesis

From the process to the service

- Our MDA approach for BPs implemented by services



BPMN2 model to SoaML model transformation

From the process to the service

- Correspondences defined between BPMN2 and SoaML metamodels
  - Based on BP and services modeling sub-ontologies

BPMN 2.0		SoaML beta2	
Element	**Icon**	**Element**	**Icon**
Definitions	(complete model)	Model	<Model>
Process		Participant	<Class>
ServiceTask (provider) +MessageFlow (sourceRef = Task , targetRef = ServiceTask) +Task (consumer)		MessageType	<Class>
		Interface	<Interface>
		Operation	<Operation>
		Parameter In/Out	<Parameter>
		ServiceContract Provider Consumer	<Collaboration> <Property> provider <Property> consumer

BPMN 2.0		SoaML beta2	
Element	**Icon**	**Element**	**Icon**
Collaboration		Services Architecture	<Collaboration>
Collaboration Participant		Participant Part	<Property>
MessageFlow (sourceRef = Task , targetRef = ServiceTask)		CollaborationUse Dependency consumer provider	<Collaboration Use> <Dependency>
ServiceTask (provider)		Service (of Participant)	<Port>
Task (consumer)		Request (of Participant)	<Port>

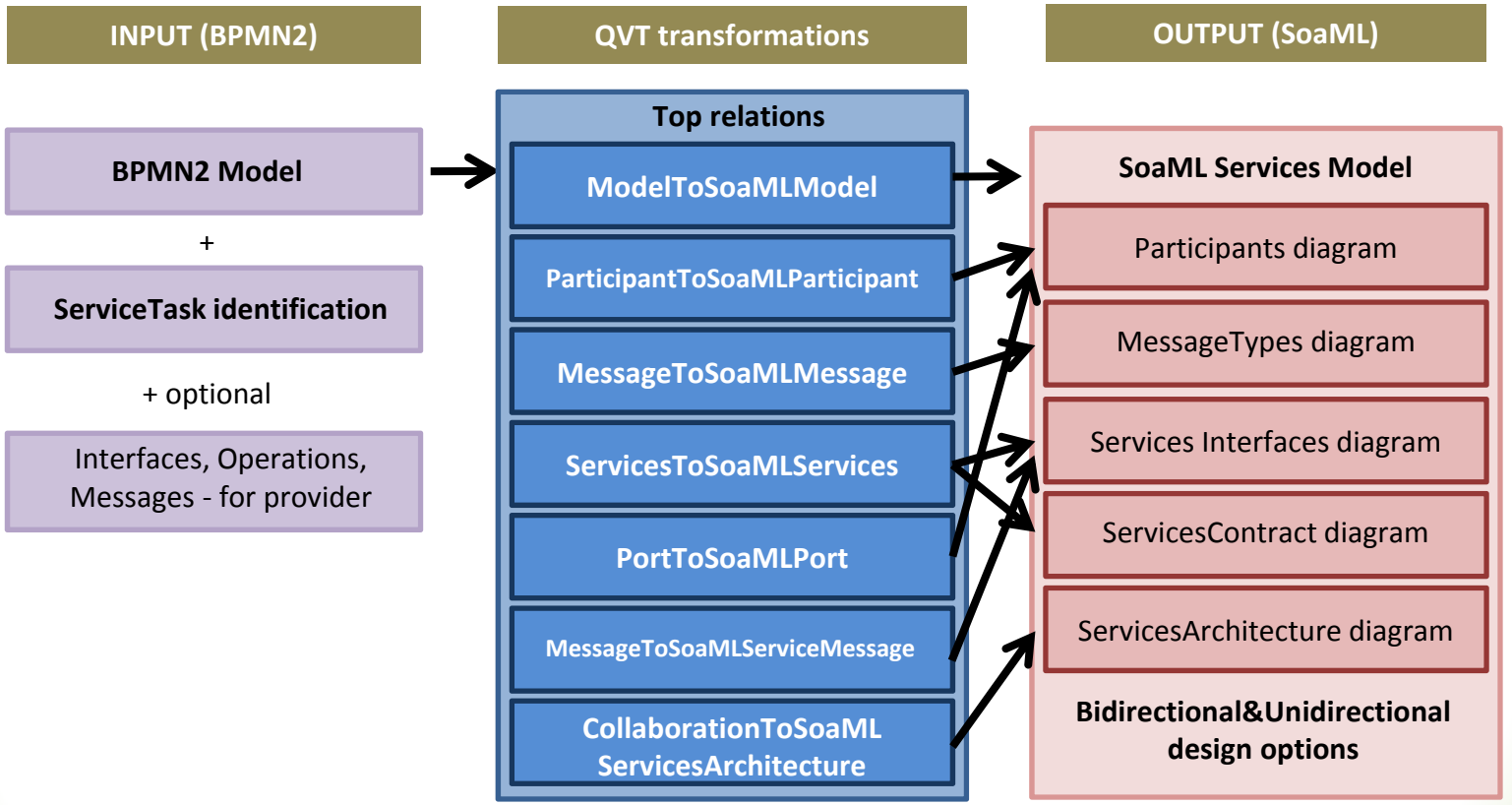
When Interfaces, Operations, Parameters and Messages are present in the BPMN2 model

MessageFlow (sourceRef = Task , targetRef = ServiceTask)		ServiceContract Provider Consumer	<Collaboration> <Property> provider <Property> consumer
Message		MessageType	<Class>

Interface	Interface	Interface	<Interface>
Operation	Operation	Operation	<Operation>
MessageRef In/Out		Parameter In/Out	<Parameter>

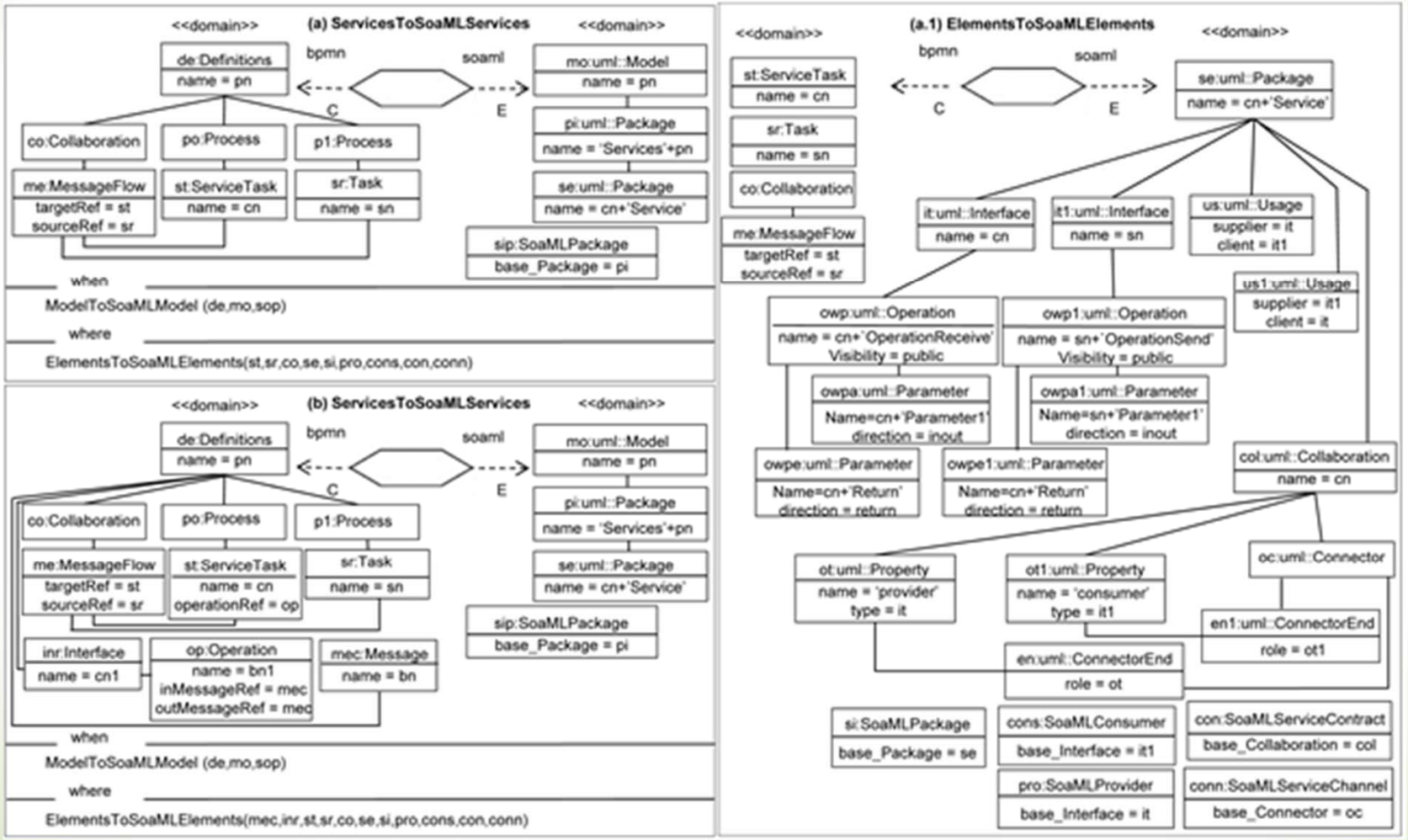
From the process to the service

- Relations defined for each QVT transformation



From the process to the service

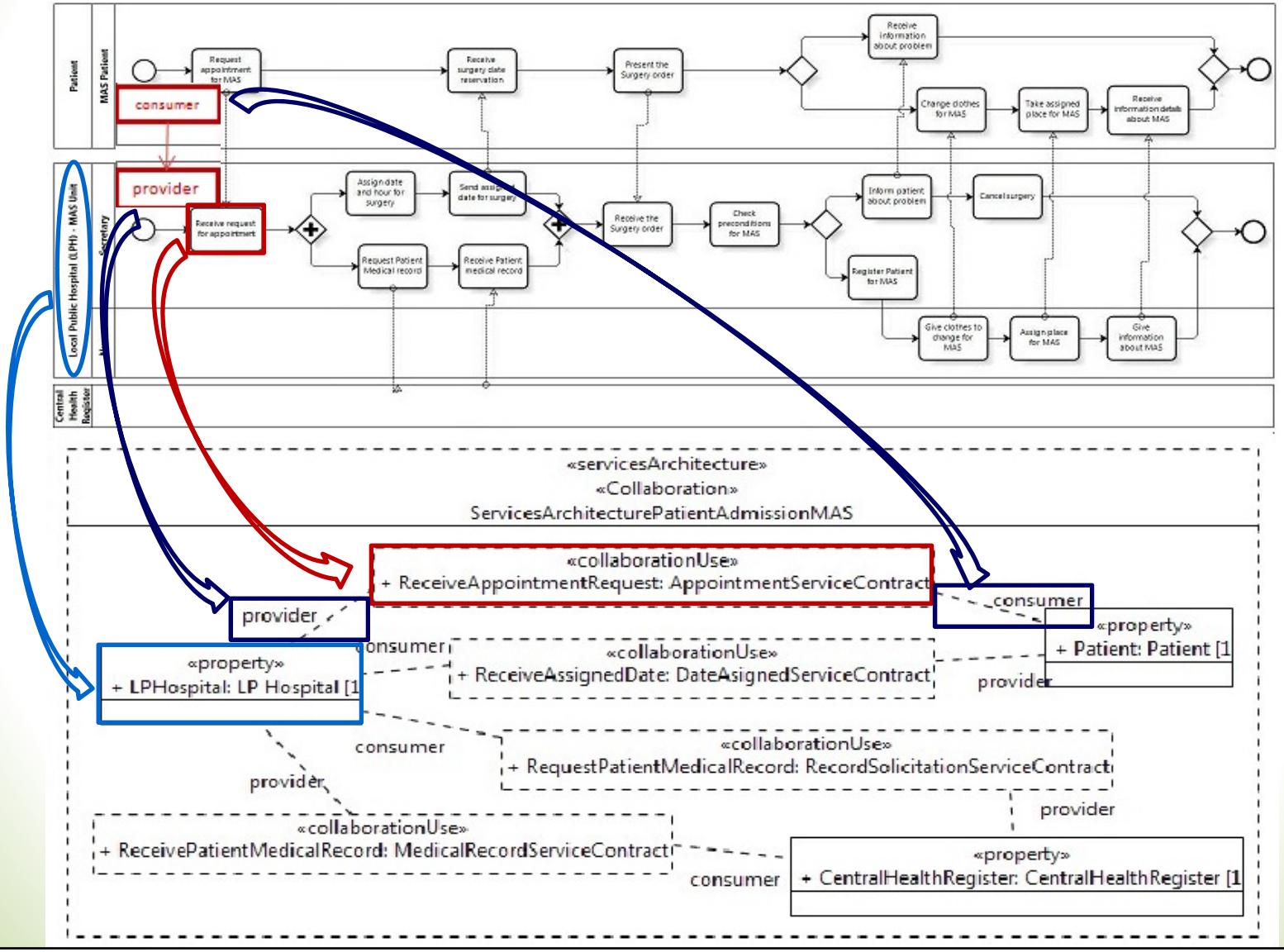
- Sample of QVT relations



QVT top relations for services generation (a) from ServiceTask with associated relation (a.1) and (b) with Interface, Operation and Message for the service provider

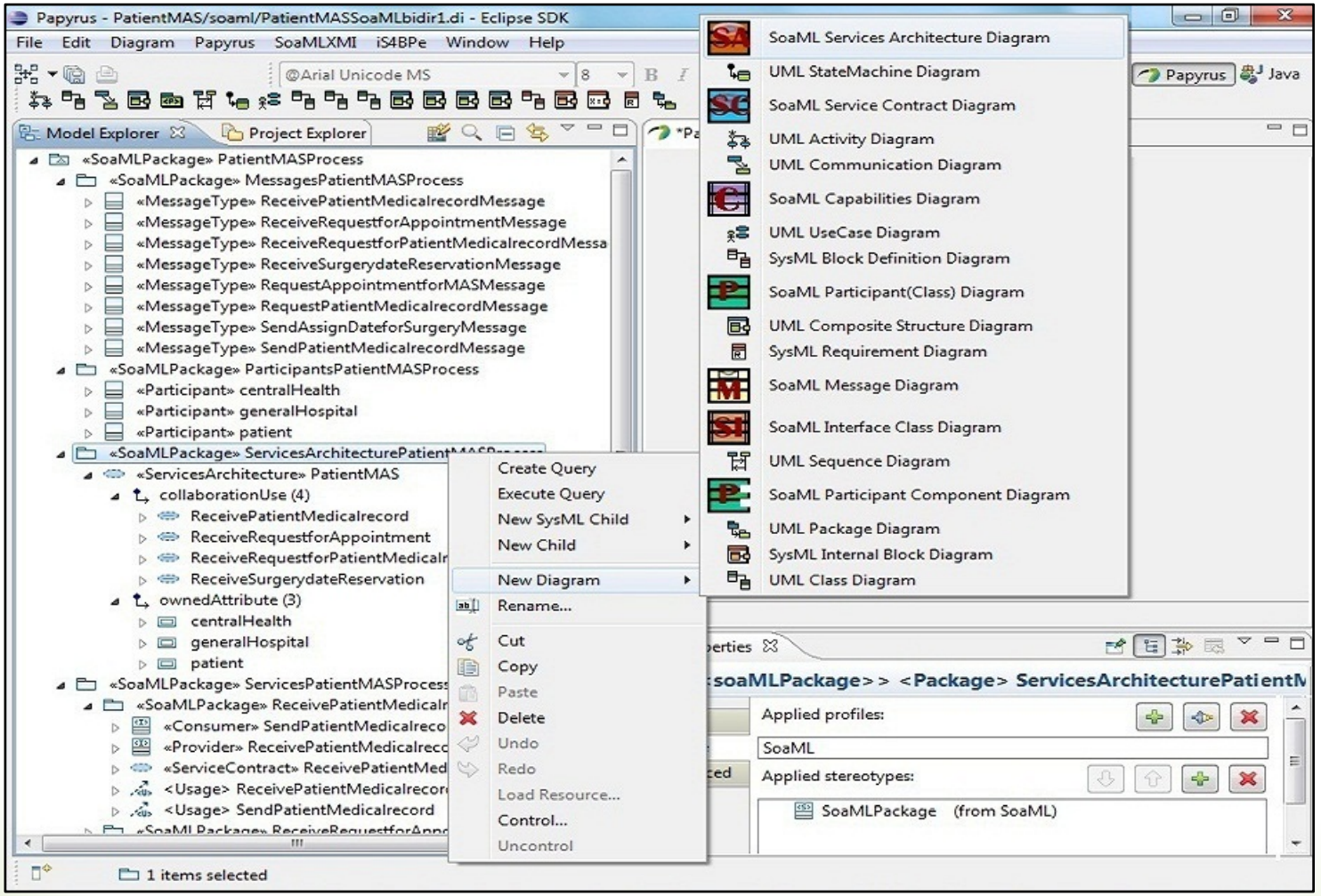
From the process to the service

- Example of services generation: **ServicesArchitecture**



From the process to the service

- New SW tools are necessary



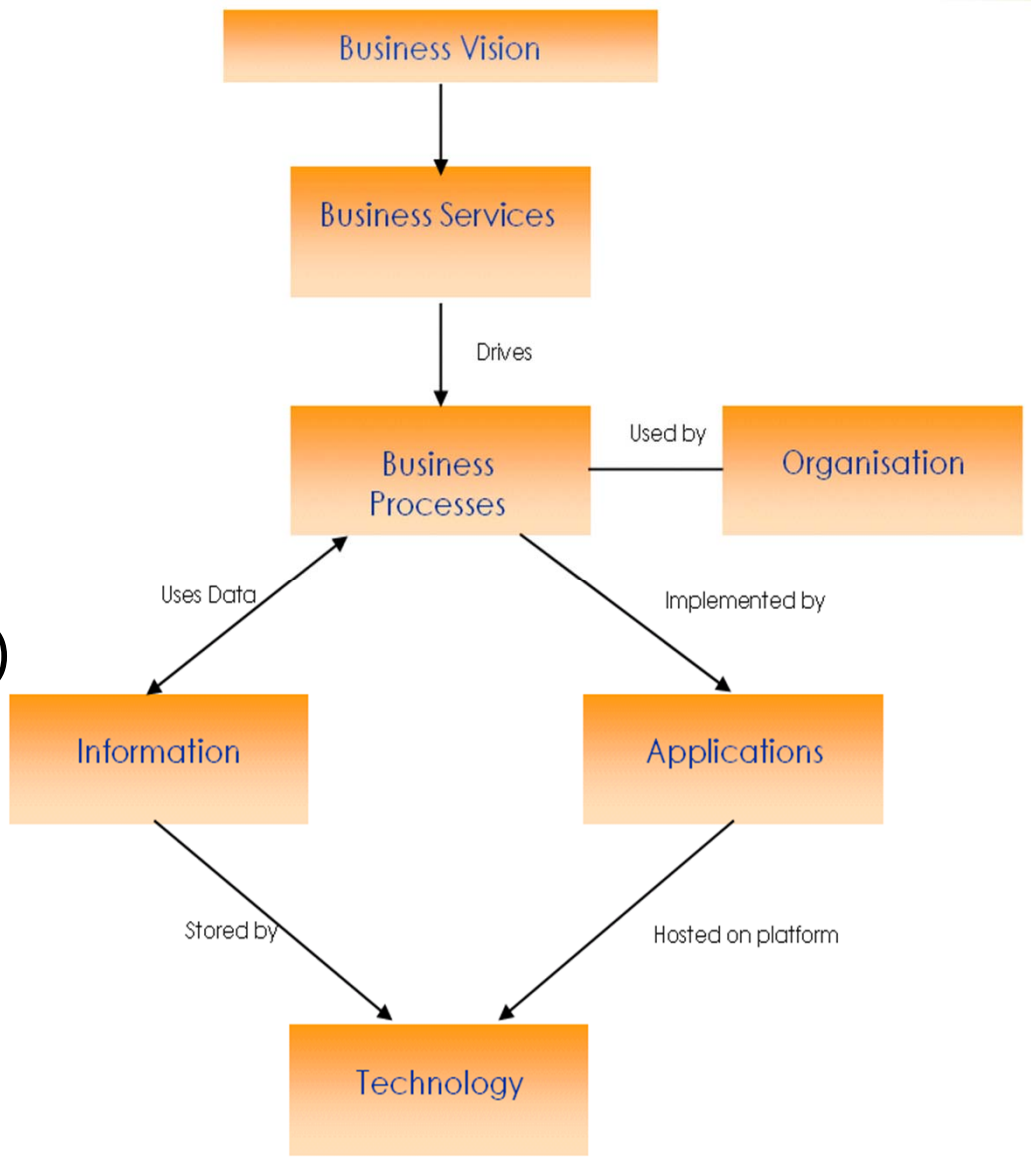
screenshoot of the Eclipse plug-in to create SoaML models and import/export it in XMI

Metamodeling to support the IT governance

- A new project with ambitious goals
  - To devise a framework for the IT governance of Software Factories (SWF), both in a directive /managerial level and in a technological level.
  - To facilitate the integrated management of the two mentioned levels by mean of implementing the bidirectional traceability between business elements and engineering elements.
    - For instance, between corporative politics (business rules) and best practices and methods followed in software projects.
    - For instance, between legal protection of the personal data (non functional business requirements) and information security practices.

Metamodeling to support the IT governance

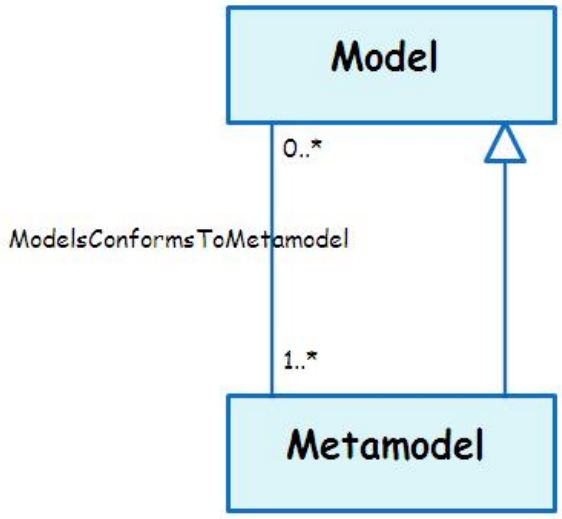
- Full bidirectional traceability between all kinds of models and elements is needed
- Enterprise Architecture models are the solution (part)



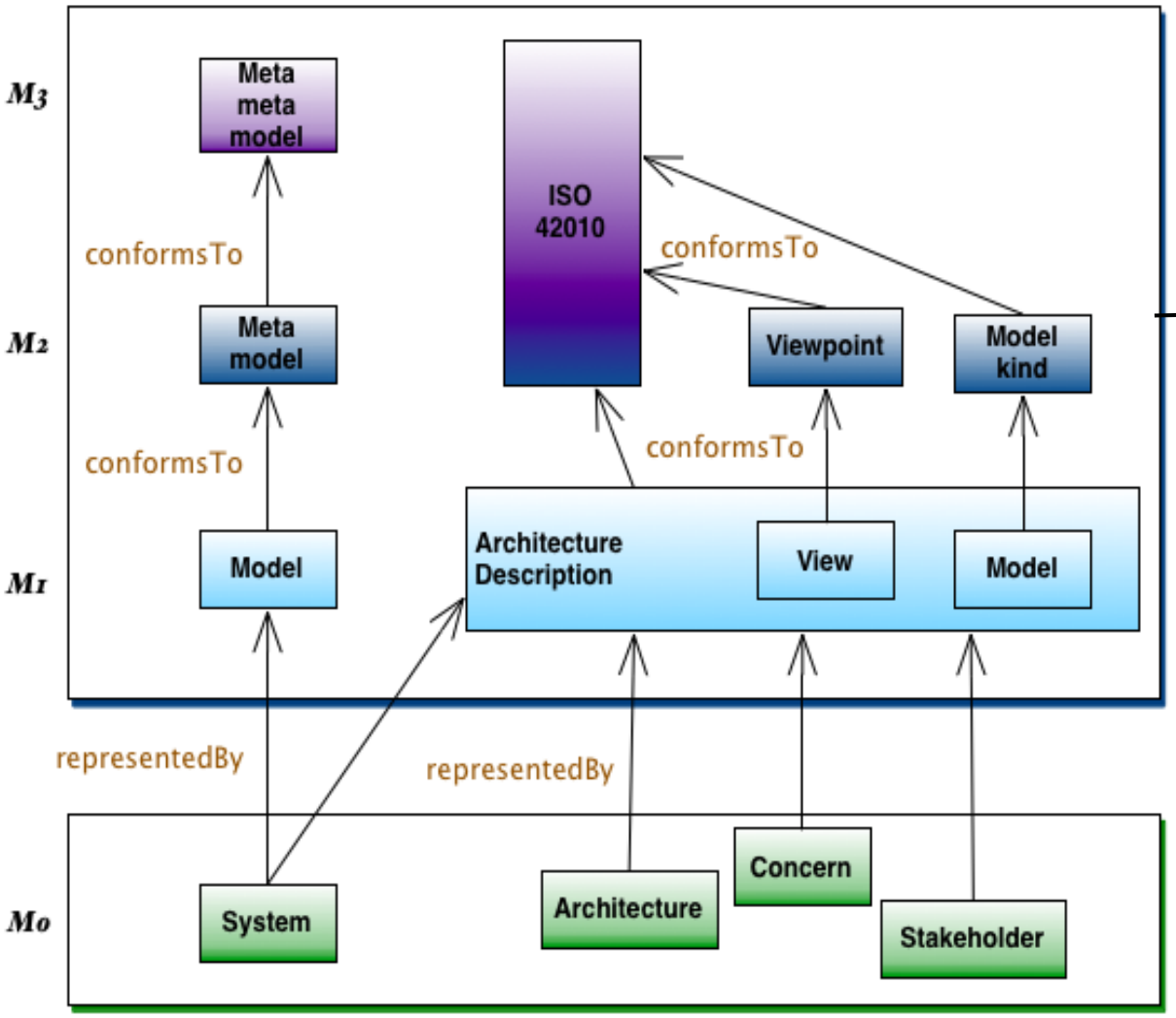
Metamodeling to support the IT governance

- The knowledge base will be an heterogeneous repository of business models, megamodels (models of models), and metamodels.

- Metamodeling is the mechanism of integration
  - **Vertical** (traceability between business and engineering elements)
  - **Horizontal** (mapping between different domains or dimensions).



Metamodeling to support the IT governance

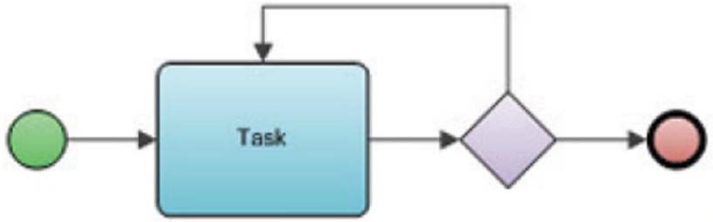


ARCHITECTURE IS KEY

Architectural concepts (ISO 42010) aligned with the three levels of MOF-MDA (Meta-Object Facility)

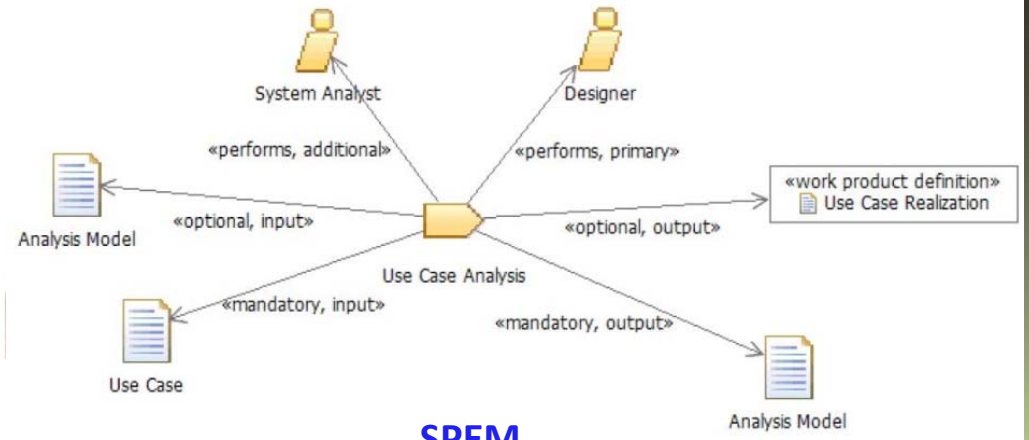
Metamodeling to support the IT governance

- Concrete Objective: The Process
  - Looking at the SW development process from two different but complementary viewpoints: business and SW engineering.
- Three kinds of models must be integrated:
  - Business process (**BPMN**)
  - SW Engineering process (**SPEM**)
  - Enterprise architecture (**Archimate**)
    - Viewpoints with the organizational context of the process.



BPMN

Viewpoint of the business stakeholder



SPEM

Viewpoint of the SW Engineer

Agenda

- Motivation
- The New Model Engineering
- Business Model Engineering
  - Seeing the Enterprise as a System
  - Kinds of Business Models
- Research Challenges
- Experiences
  - From the process to the service
  - Metamodeling to support the IT governance
- **Conclusions**

Conclusions

- Model Engineering can be applied to a lot of fields, opening new challenges for Informatics and Computing researchers.
- Business Model Engineering is the application of Model Engineering to business and enterprise domains.
  - It is focused on the organizational context of information systems.
  - A better alignment between IT systems and business is a main goal.
  - A multidisciplinary perspective is necessary.
  - Companies are very interested (of all sectors).
  - Necessary skills are traditional in IT but not in Business Administration.

Alarcos Research Group

EDICIÓN 40 CLEI 2014
15 al 19 de setiembre
Montevideo, Uruguay

Ingeniería de Modelos.
Aplicación al alineamiento organizacional de los sistemas intensivos en software.

Model Engineering.
Application to organizational alignment in software-intensive systems.

Gracias *Obrigado* *Thank you*

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