Semantic Days 2009

Enterprise architecture frameworks with semantic models as a foundation for complex networked operations

TUTORIAL

Semantic Days 2009, May 18th-20th,Stavanger, Norway

18.05.2009

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Enterprise architecture frameworks with semantic models as a foundation for complex networked operations

- Enterprise architecture frameworks like Zachman, EIF (European Interoperability Framework) DODAF/MODAF/NAF (Defense Architectural Frameworks), TOGAF and others provide an important foundation for the understanding and planning of business models and system models for complex networked operations both in industry, eGovernment and crisis management/defense. This ensures both alignment between business and IT, and also provides a better foundation for system interoperability in networked systems. We will demonstrate the approach using ODM (Ontology Definition Metamodel) with OWL for semantic modelling, BMM (Business Motivation Model) and BPMN (Business Process Modeling Notation) and ARIS/EPC (Event Process Chains) with a transformation so system and service specification in SoaML (Service oriented architecture Modeling Language) with further realization in heterogeneous service oriented architectures (SOA) including web services, Cloud Computing/SaaS (Software as a Service), P2P/Grid and agents. We will show how semantic annotations from existing system specification to an ontology can support semantic interoperability. A basic understanding of business modelling or system specification is an advantage, but experiences in enterprise architectures, semantic models or any of the specific technologies that will be presented is not required

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Agenda

- **(I) Enterprise Architecture, TOGAF, UPDM (Arne, Ulf, Dima)**
  - Zachman, TOGAF, MODAF/DODAF/NAF, MDA, UPDM - Arne
  - Saarstahl SHAPE - Dima
  - European ATM/SESAR - Ulf
- **(II) INFORMATION and ONTOLOGY MODELING (UML/ER, ODM/OWL with examples/tools) Arne (Ulf, Dima)**
  - Conceptual Modeling, Information Modeling, Ontologies - Ulf and Arne
  - ODM with OWL for semantic modeling (WSMT) - Dima
- **(III) PROCESS MODELING (EPC/BPMN with examples/tools) (Dima)**
  - ARIS/EPC (Event-Driven Process Chains) Dima
  - BPMN (Business Process Modeling Notation) Dima
- **(IV) SERVICE MODELING and Interoperability (SoaML with examples) (Arne)**
  - SoaML (Servic oriented architecture Modeling Language) Arne
  - Semantic annotations, SAWSDL, from existing system specifications to an ontology can support semantic interoperability Arne

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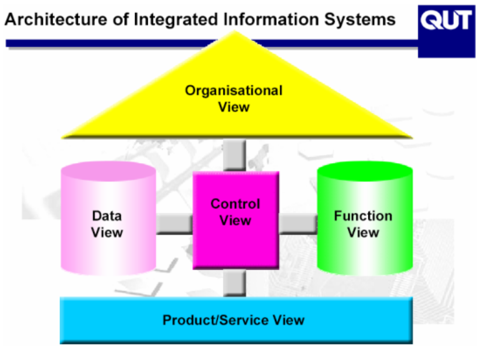
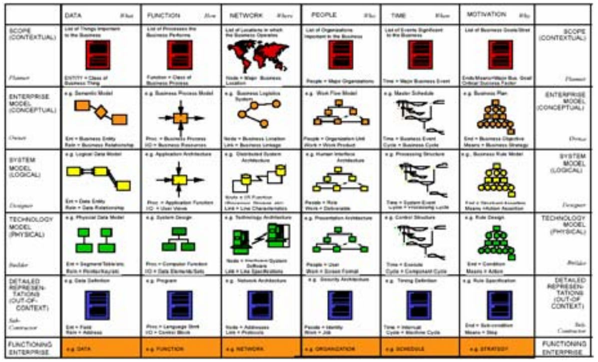
Relevant OMG and other modeling standards

- EA: Zahcman and TOGAF
- UPDM – (MODAF, DODAF, NAF), TOGAF
- UML 2.0 – updated for architecture modeling
- MDA – Model Driven Architecture
- BPMN – Business Process Modeling Notation
- BMM _ Business Motivation Model
- SysML – Systems Engineering Modeling Language
- ODM – Ontology Definition Metamodel
- OWL – Ontology Web Language
- SoaML – SOA Modeling Language
- SAWSDL – Semantic Annotation of WSDL/XML (W3C)
- See www.omg.org

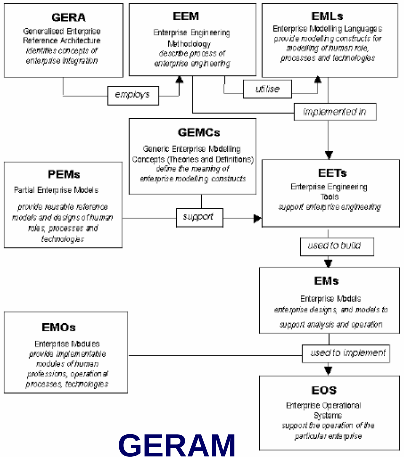
Representations of Architecture



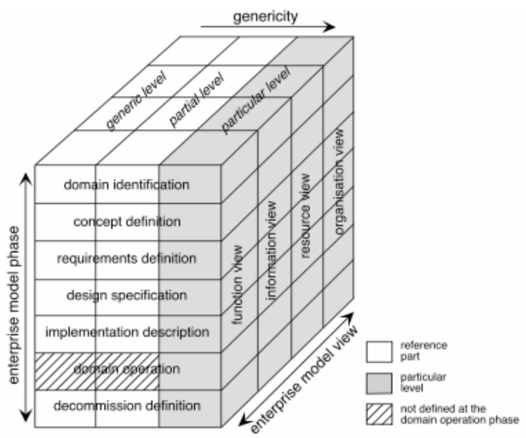
ARIS



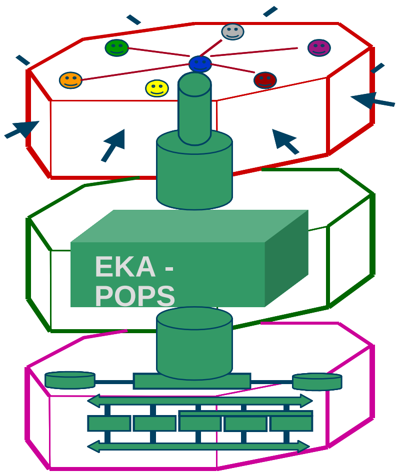
ZACHMAN



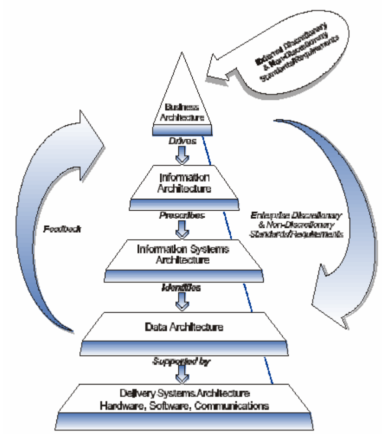
GERAM



EN/ISO 19439



Athena OEA



NIST

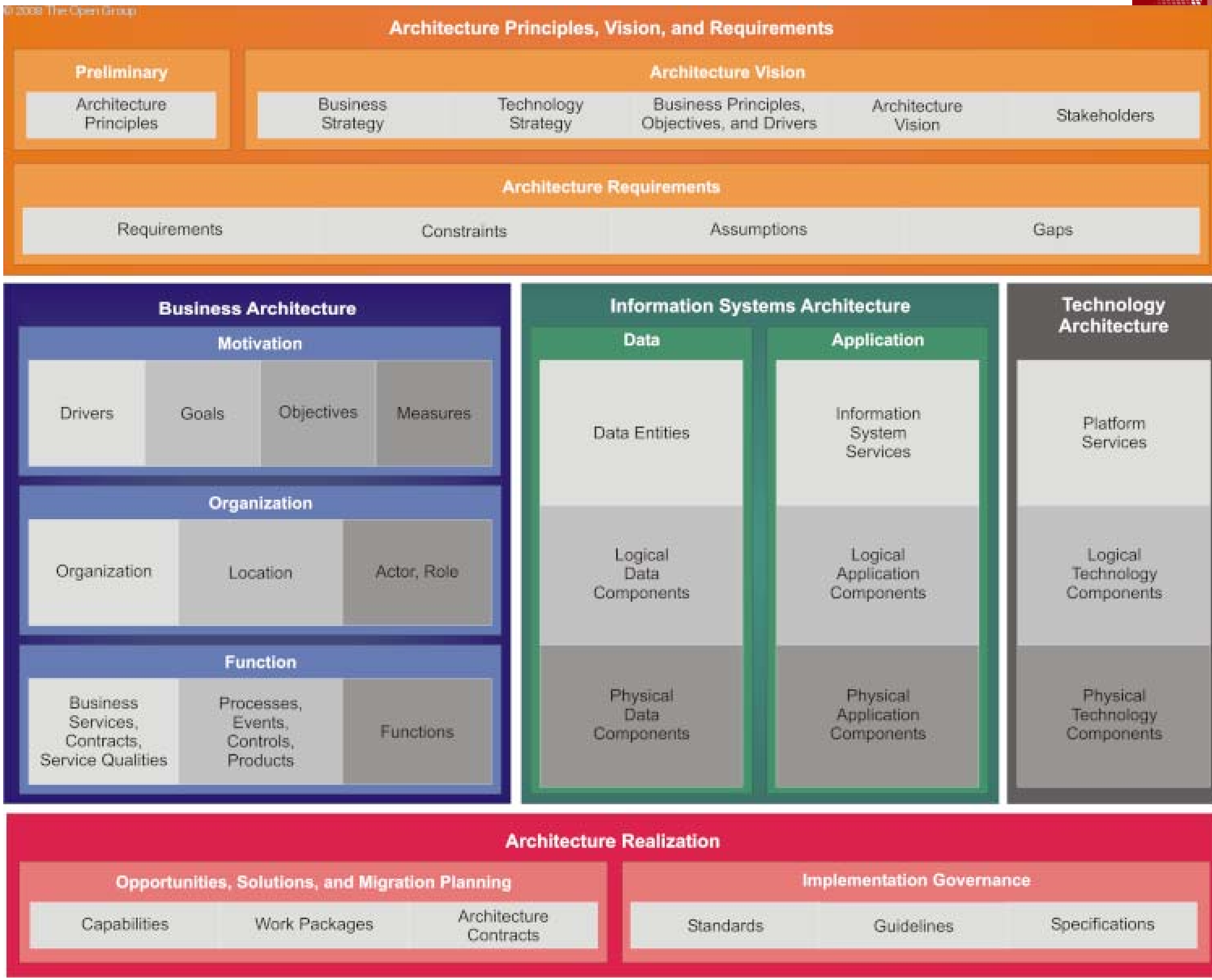
Selected standards and technologies

- Zachman, TOGAF, DODAF/MODAF/NAF, ARIS, EIF
- OWL, RDF, ODM, (UML, Topic Maps, ISO 15926, …)
- BPMN, EPC
- SysML and SoaML
- WS-*, SWS (OWL-S, WSMO), Agents, P2P, Grid, Cloud, SaaS
- SAWSDL

Zachman Framework – for Enterprise Architecture

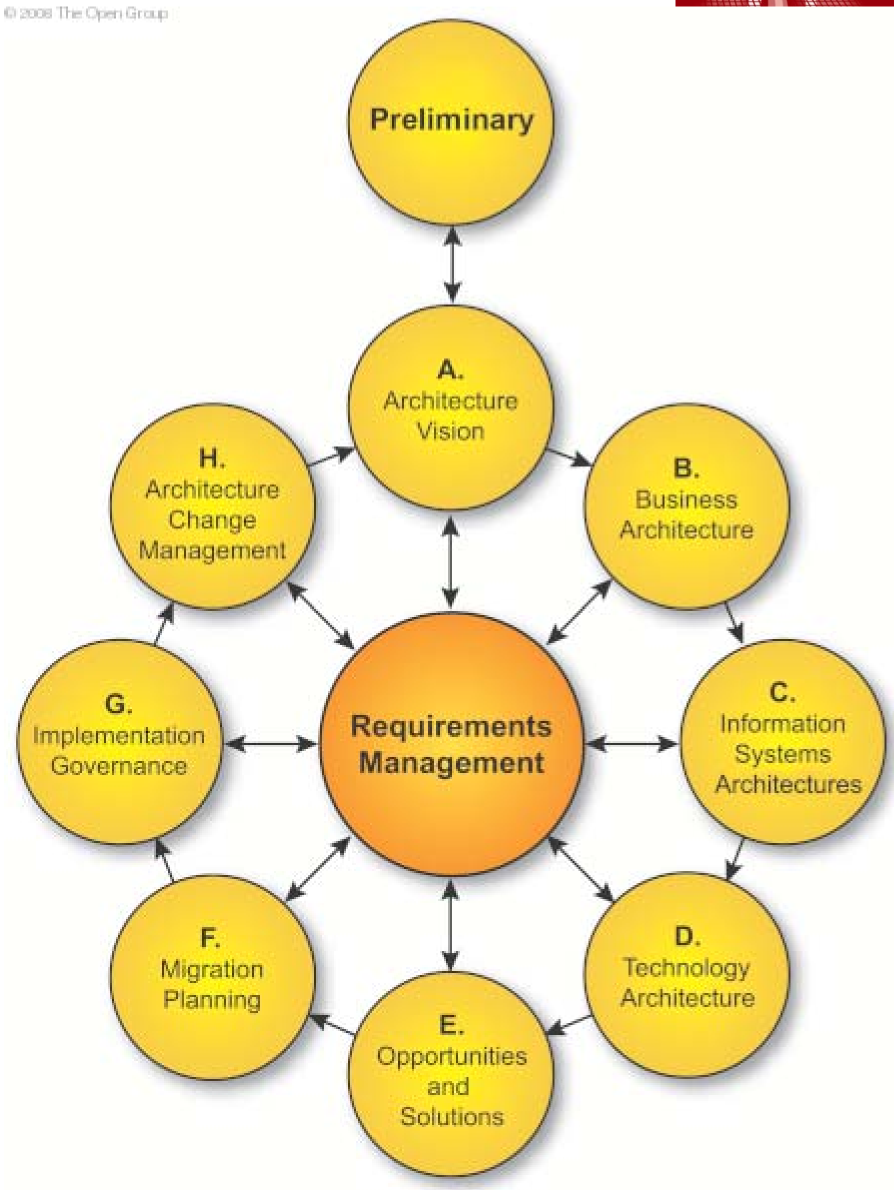
VA Enterprise Architecture	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*	Based on work by John A. Zachman
SCOPE (CONTEXTUAL) *Planner*	Things Important to the Business Entity = Class of Business Thing	Processes Performed Function = Class of Business Process	Business locations Node = Major Business Locations	Important Organizations People = Major Organizations	Events Significant to the Business Time = Major Business Event	Business Goals and Strategy Ends/Means = Major Business Goals	SCOPE (CONTEXTUAL) *Planner*
ENTERPRISE MODEL (CONCEPTUAL) *Owner*	Semantic Model Ent = Business Entity Rel = Business Relationship	Business Process Model Proc = Business Process I/O = Business Resources	Business Logistics System Node = Business Location Link = Business Linkage	Work Flow Model People = Organization Unit Work = Work Product	Master Schedule Time = Business Event Cycle = Business Cycle	Business Plan End = Business Objective Means = Business Strategy	ENTERPRISE MODEL (CONCEPTUAL) *Owner*
SYSTEM MODEL (LOGICAL) *Designer*	Logical Data Model Ent = Data Entity Rel = Data Relationship	Application Architecture Proc = Application Function I/O = User Views	Distributed System Architecture Node = IS Function Link = Line Characteristics	Human Interface Architecture People = Role Work = Deliverable	Processing Structure Time = System Event Cycle = Processing Cycle	Business Rule Model End = Structural Assertion Means = Action Assertion	SYSTEM MODEL (LOGICAL) *Designer*
TECHNOLOGY MODEL (PHYSICAL) *Builder*	Physical Data Model Ent = Segment/Table Rel = Pointer/Key	System Design Proc = Computer Function I/O = Data Elements/Sets	Technology Architecture Node = Hardware/Software Link = Line Specifications	Presentation Architecture People = User Work = Screen Format	Control Structure Time = Execute Cycle = Component Cycle	Rule Design End = Condition Means = Action	TECHNOLOGY MODEL (PHYSICAL) *Builder*
DETAILED REPRESENTATIONS (OUT-OF-CONTEXT) *Sub-Contractor*	Data Definition Ent = Field Rel = Address	Program Proc = Language Statement I/O = Control Block	Network Architecture Node = Addresses Link = Protocols	Security Architecture People = Identity Work = Job	Timing Definition Time = Interrupt Cycle = Machine Cycle	Rule Design End = Sub-Condition Means = Step	DETAILED REPRESENTATIONS (OUT-OF-CONTEXT) *Sub-Contractor*
FUNCTIONING ENTERPRISE	Data Ent = Rel =	Function Proc = I/O =	Network Node = Link =	Organization People = Work =	Schedule Time = Cycle =	Strategy End = Means =	FUNCTIONING ENTERPRISE
	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*	

Open Group TOGAF 9.0

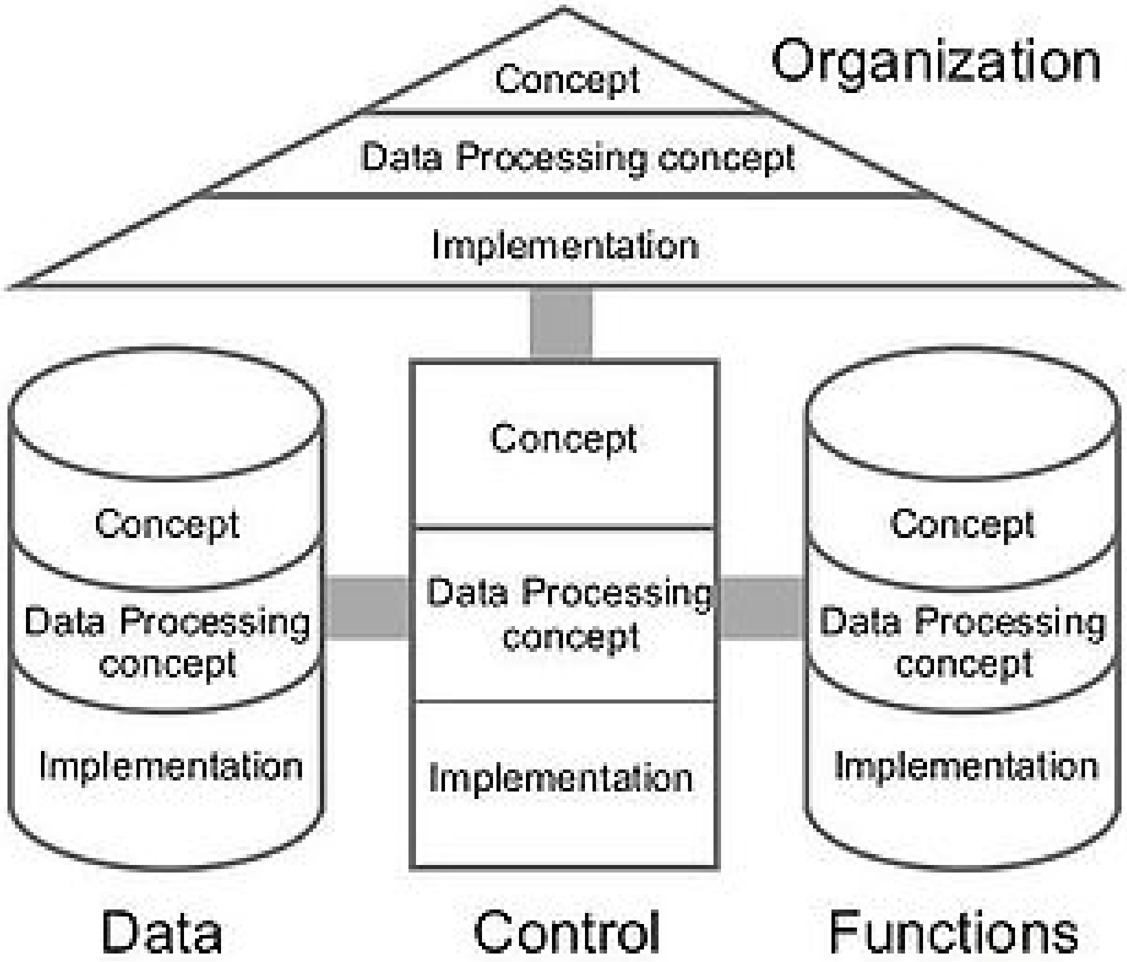


Open Group TOGAF ADM

Architecture Development Method

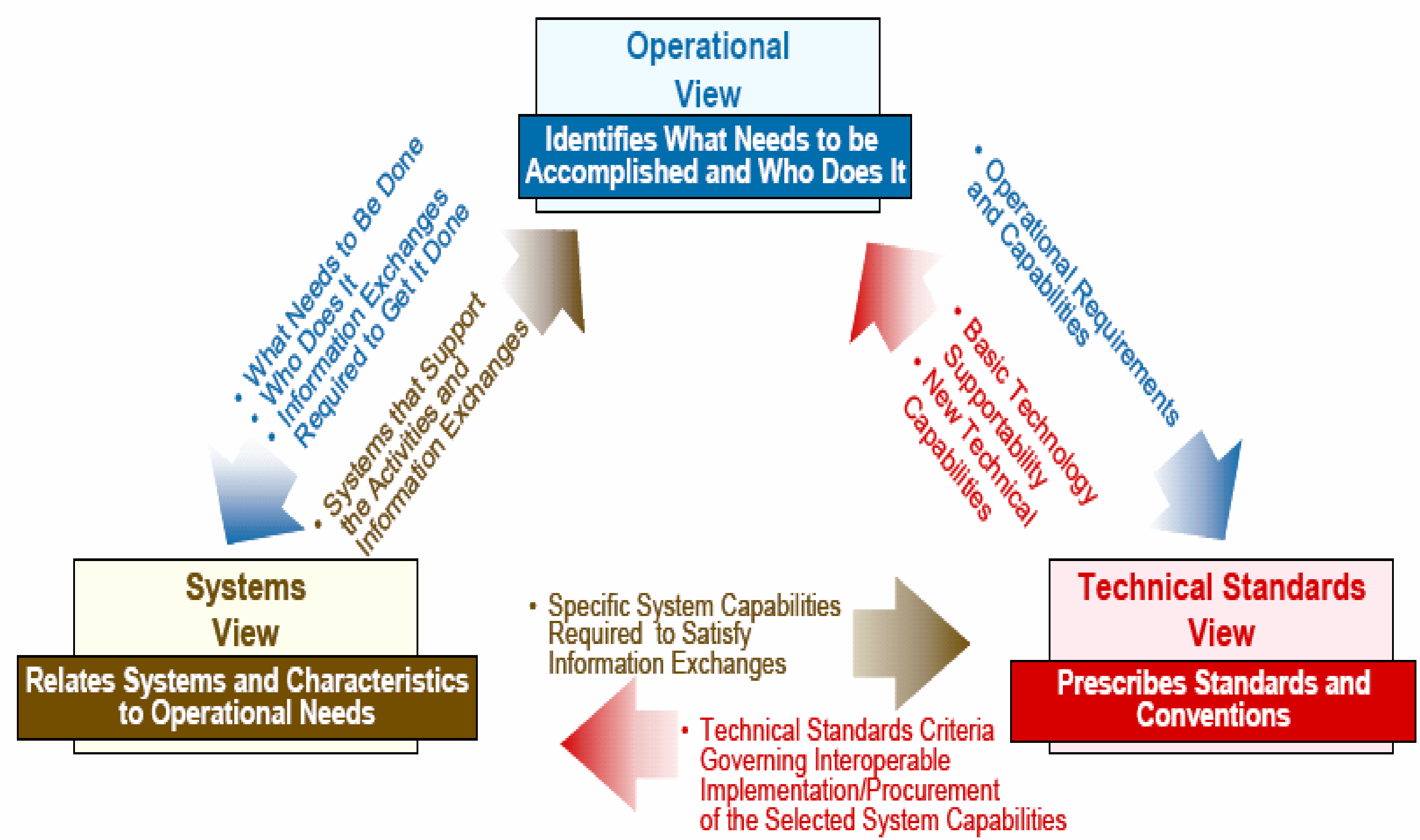


ARIS House

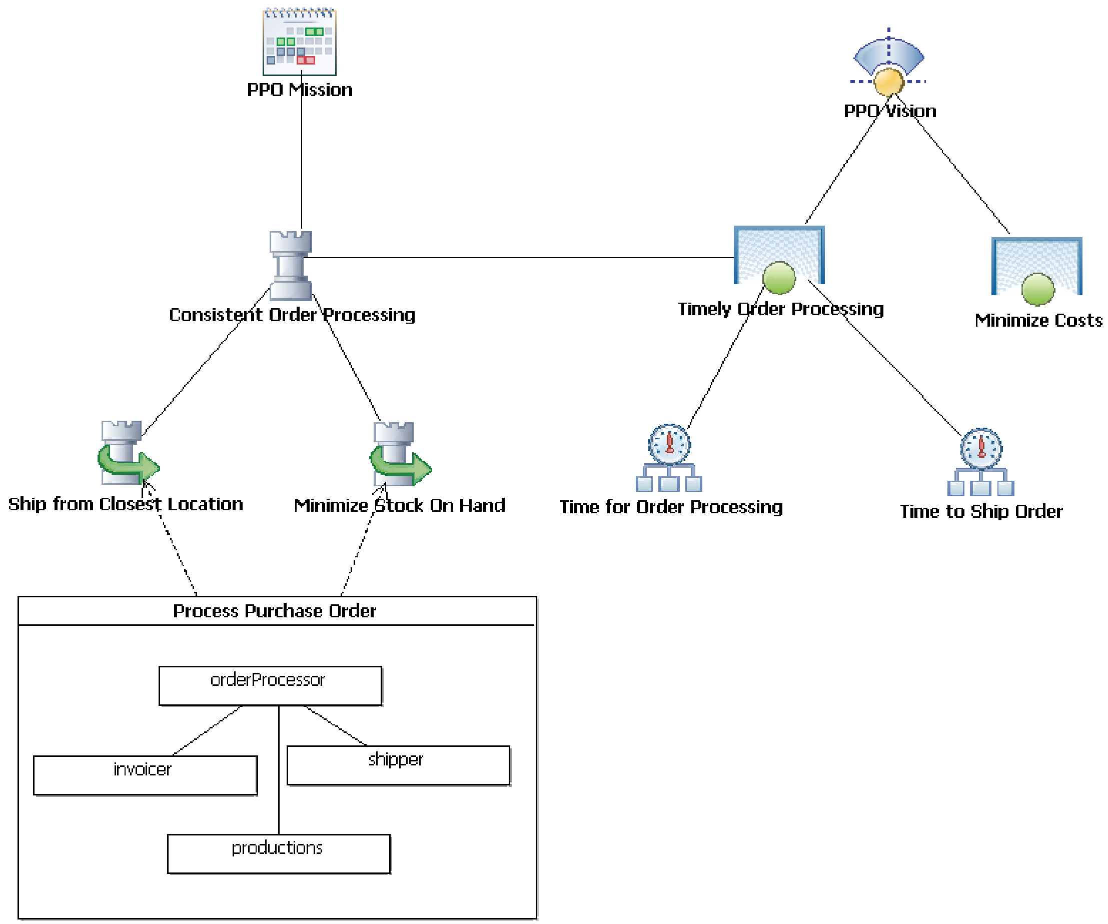


Organization
Concept
Data Processing concept
Implementation
Concept
Data Processing concept
Implementation
Concept
Data Processing concept
Implementation
Concept
Data Processing concept
Implementation
Data
Control
Functions

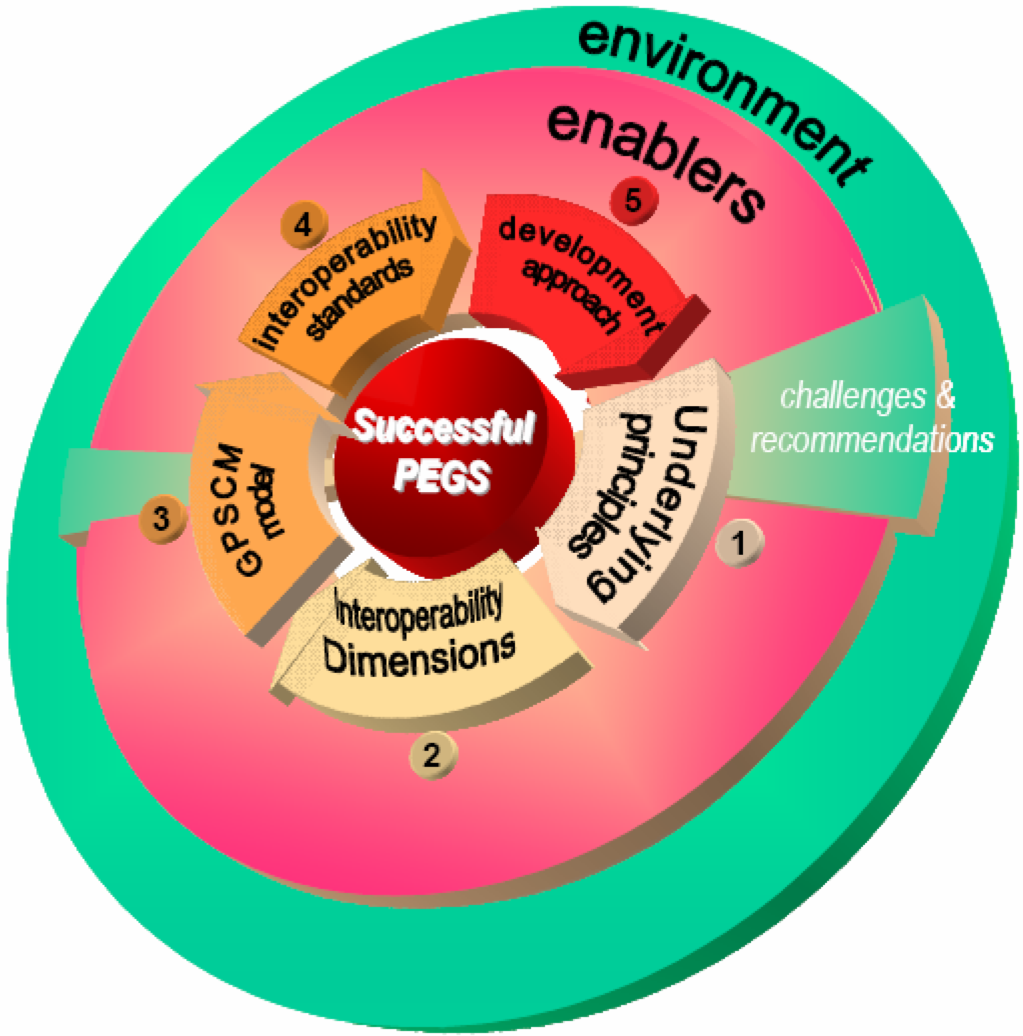
Three Views in C4ISR-AF, DODAF, MODAF, NAF, (UPDM)



Business Motivation Model (BMM) with MeansRealizations



EIF version 2.0 (2009)



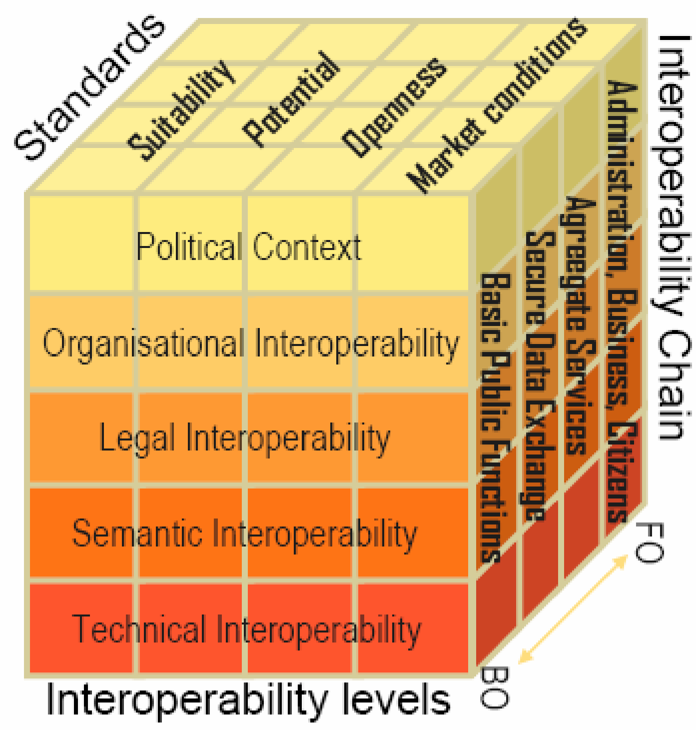
Definition: Interoperability

"Interoperability is the ability of disparate and diverse organisations[1] to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems."

In fact, interoperability is often confused with other, related concepts. It can be therefore a useful exercise to observe explicitly what interoperability is NOT:

- Interoperability is not ***Integration,*** which is a means of changing loosely coupled systems to make them into more tightly coupled systems.
- Interoperability is not ***Compatibility***, which is more about the interchangeability of tools in a particular context
- Interoperability is not ***Adaptability***, which is a means of changing a tool, adding additional capabilities as needed even on an ad-hoc basis, whereas interoperability refers to inherent capabilities

EIF - Dimensions of Interoperability



Interoperability levels

Political Context

Cooperating partners having compatible visions, and focusing on the same things.

Legal Interoperability

The appropriate synchronization of the legislation in the cooperating MS so that electronic data originating in any given MS is accorded to proper legal weight and recognition wherever it needs to be used in other MS.

Legislative Alignment

Organisational Interoperability

The processes by which different organisations such as different public administrations collaborate to achieve their mutually beneficial, mutually agreed eGovernment service-related goals.

Organisation and Process Alignment

Semantic Interoperability

Ensuring that the precise meaning of exchanged information (concept, organisation, sservices, etc) is preserved and well-understood

Semantic Alignment

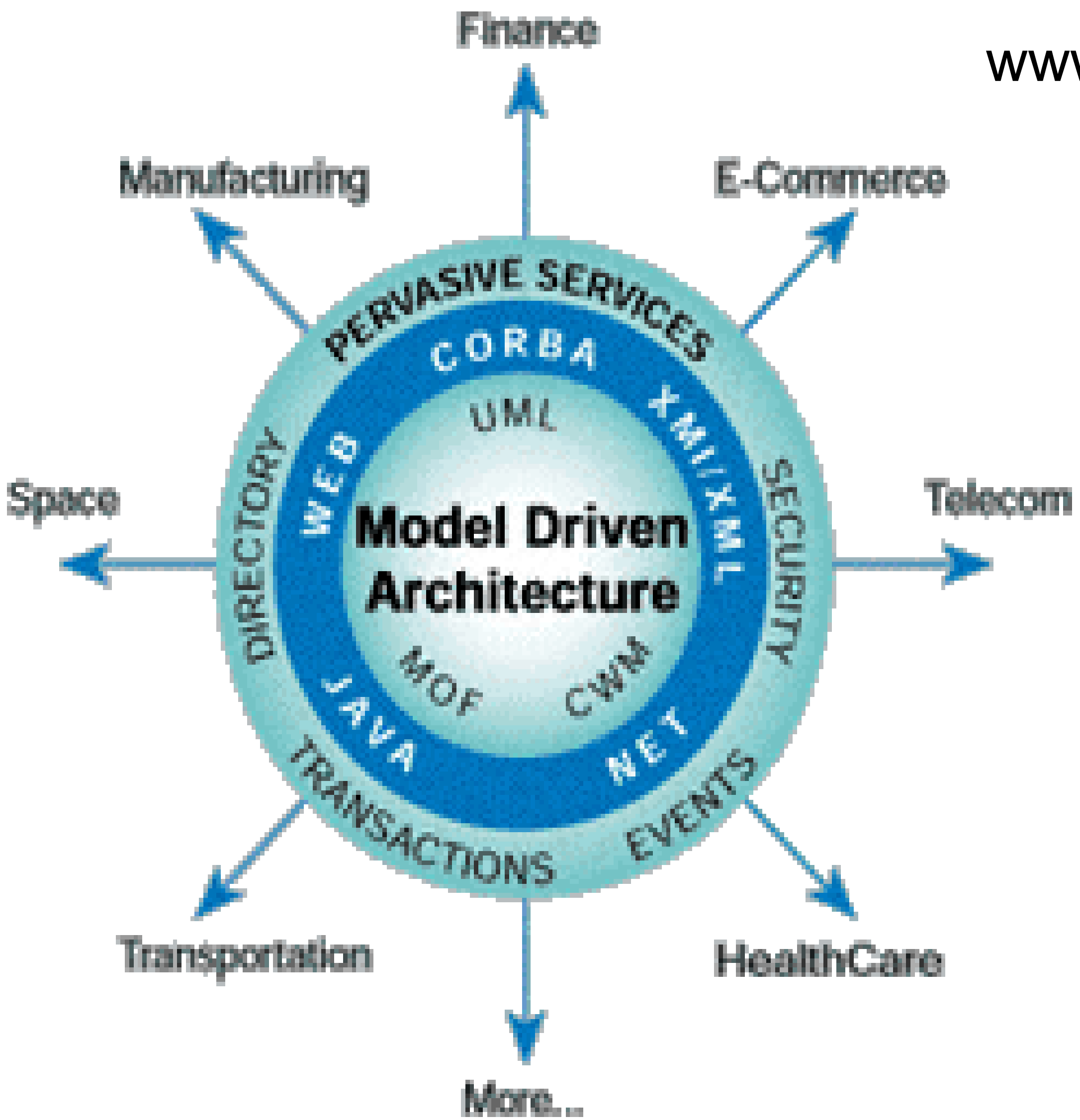
Technical Interoperability

The technical issues involved in linking computer systems and services (open interfaces, interconnection services, data integration, middleware, data presentation and exchange, accessibility and security services, …)

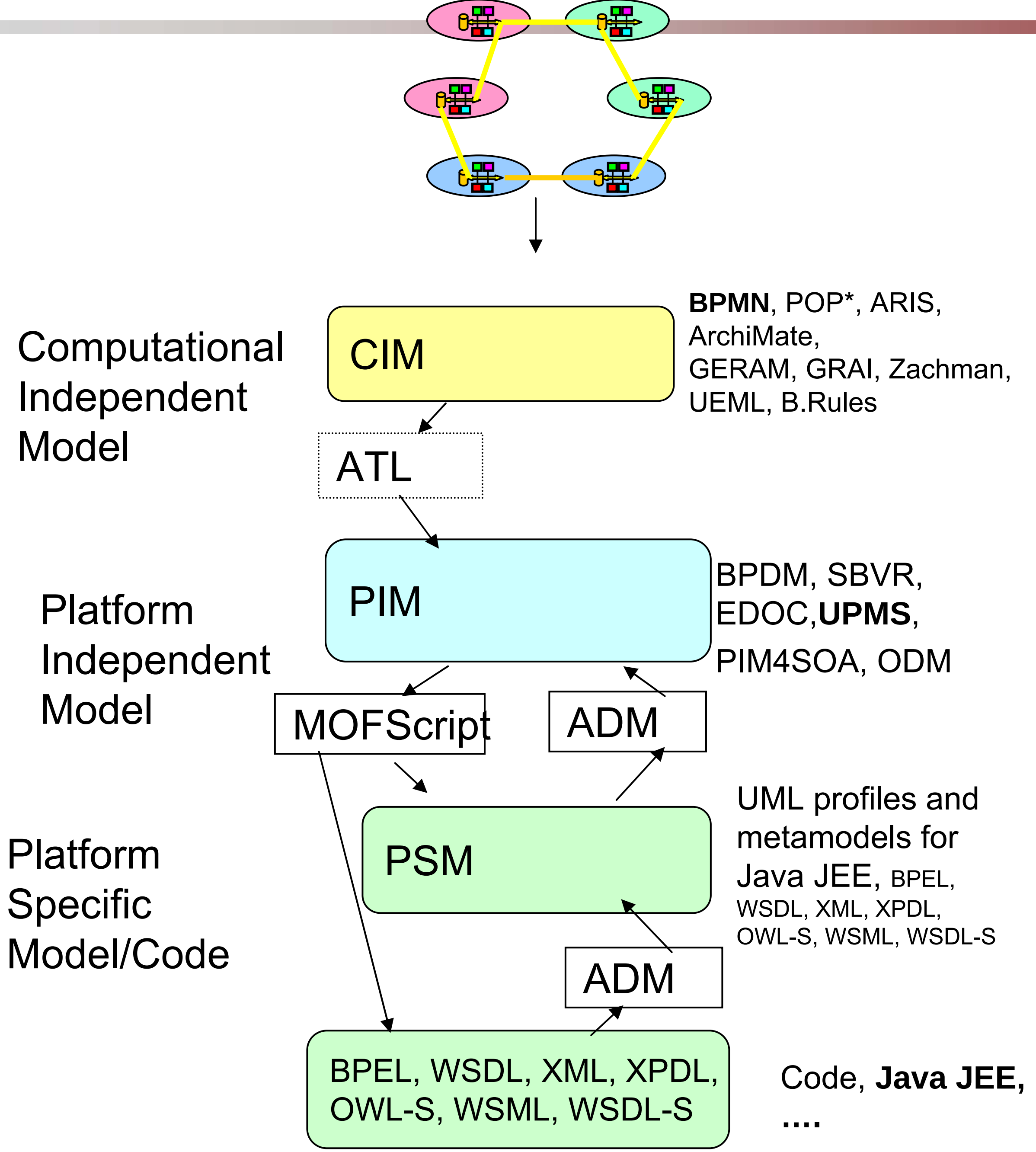
Syntax, Interaction & Transport

OMG Model-Driven Architecture (MDA)

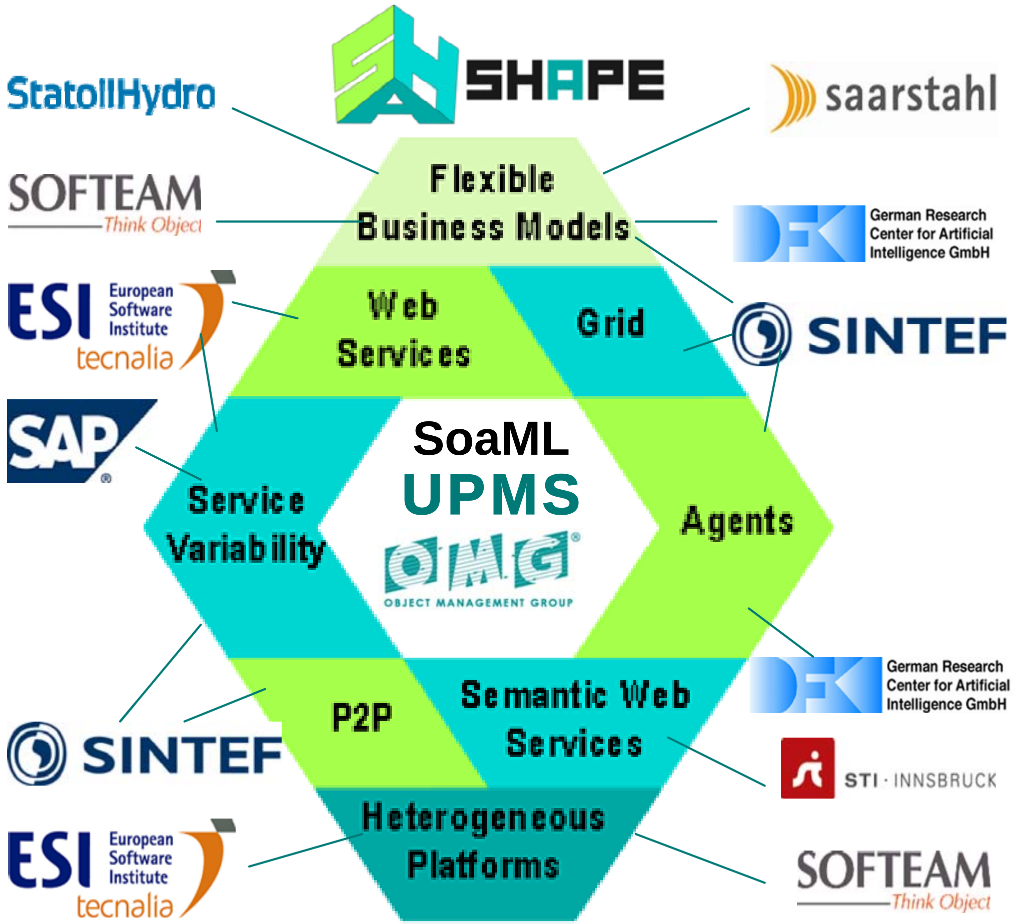
www.omg.org/mda



MDA CIM, PIM and PSM/Code



SHAPE project partners and roles



See www.shape-project.eu

SHAPE Reference Matrix

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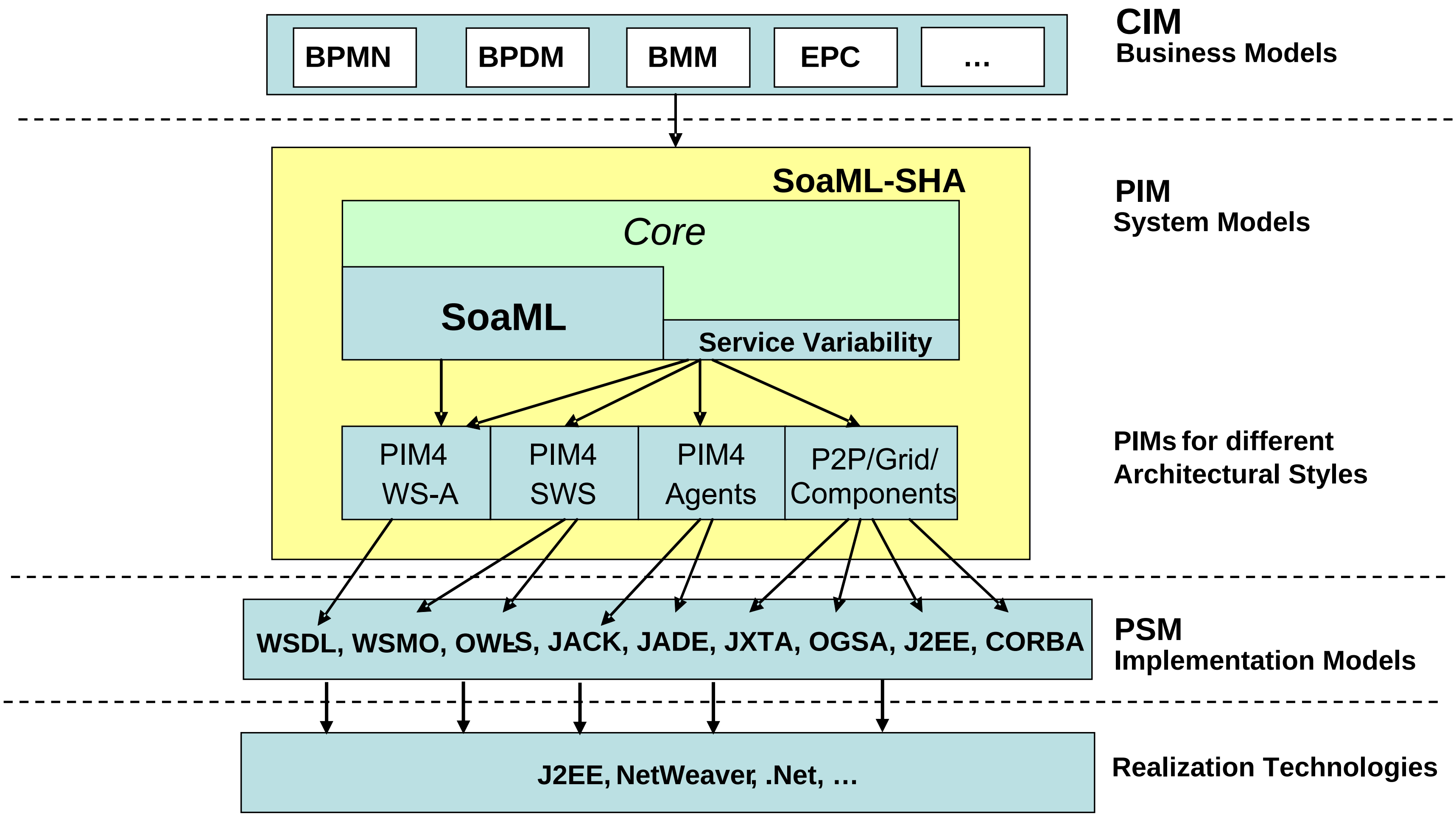
Aspect / Level		Information	Service	Process	Rules	Events	Organization	Goals	NFA
CIM	MM	Ontologies - ODM	(BPMN2) (SoaML)	BPMN EPC	SBVR	EPC BPMN (EMP)	OSM	BMM	OMG MM for performance / security / quality
	Tool	Objecteering, WSMT	Objecteering	CIMFlex	CIMFlex	CIMFlex	CIMFlex, Objecteering	CIMFlex, Objecteering	Objecteering, WSMT
	Meth	OE Methodologies, GERAM,ARIS, EUP, COMET-S, ESIM, SCM, SM, ISE, ESOA	GERAM,ARIS, EUP COMET-S, OGSOA, ESIM, SM, SCM, SMART, SOMA, ISE, ESOA	GERAM,ARIS, EUP, COMET-S, OGSOA, ESIM, SAE,SCM, SM, SMART, SOAD, SOMA, ISE, ESOA	GERAM, EUP, ESIM, SM, SOMA, ISE, ESOA, Cyc	GERAM, EUP	GERAM,ARIS, EUP, ESIM, SAE, SM, SMART, SOMA, ISE, ESOA	GERAM,ARIS, EUP, COMET-S, ESIM, SM, SMART, SOMA, ISE, ESOA	GERAM, ESIM, SCM, SM, SOMA, ISE, ESOA
CIM2PIM	Tool								
	Meth	COMET-S	COMET-S	COMET-S					
PIM	MM	UML Class diagram ODM, IMM	SoaML	UML Behaviour (BPMN)	(BPR)	EMP	SoaML Participant, UML Deploym. Element	(Agent Goals), (WSMO Goals)	OMG MM for performance, security, quality
	Tool	WSMT	Objecteering, PIM4Agents,WSMT	Objecteering	WSMT	CIMFlex	Objecteering	PIM4Agents, WSMT	Objecteering, WSMT
	Meth	COMET-S, OASIS, ESIM, SCM, SM, SMART, SOMA, ISE, ESOA	COMET-S, OASIS, OGSOA, ESIM, SAE, SCM, SOAD, SMART, SOMA, ISE, ESOA	OASIS, OGSOA, ESIM, SAE, SCM, SMART, SOAD, SOMA, ISE, ESOA	SMART, ISE, ESOA	OASIS	SMART, ESOA	SMART	OASIS, ESIM, SCM, SMART, SOMA, ISE, ESOA
PIM2PSM	Tool	[automated model transformation]	[automated model transformation]	[automated model transformation]	[automated model transformation]	[automated model transformation]	[automated model transformation]	[automated model transformation]	[automated model transformation]
	Meth	COMET-S	ESOA, COMET-S		ESOA	ESIM, ESOA	ESIM	ESIM	ESIM
PSM	WS	XML	WSDL	BPEL	RTF	-	-	-	WS*-standards
	Agent	Jack: Data Jade: Classes	-	Jack: Plans Jade: Behaviors	Jack: Plans Jade: -	Jack: Events Jade: Messages	Jack: Team Jade: Agent/Organ.	Jack: Goals Jade: -	- -
	SWS	OWL WSML	OWL-S WSMO	OWL-S WSMO	SWRL WSML	-	-	WSMO Goals	WSMO NFP
	P2P	-	JXTA	JXTA	-	(JXTA)	-	-	-
	Grid	Grid Resource Ontologies	OGSA (Open Grid Service Architect.)	OGSA	-	-	OGSA (Virtual Organizat. Management)	JSDL (Job Submission Description Lang.)	Grid Security Infrastructure (GSI)

Adopted to SoaML

CIM-PIM-PSM



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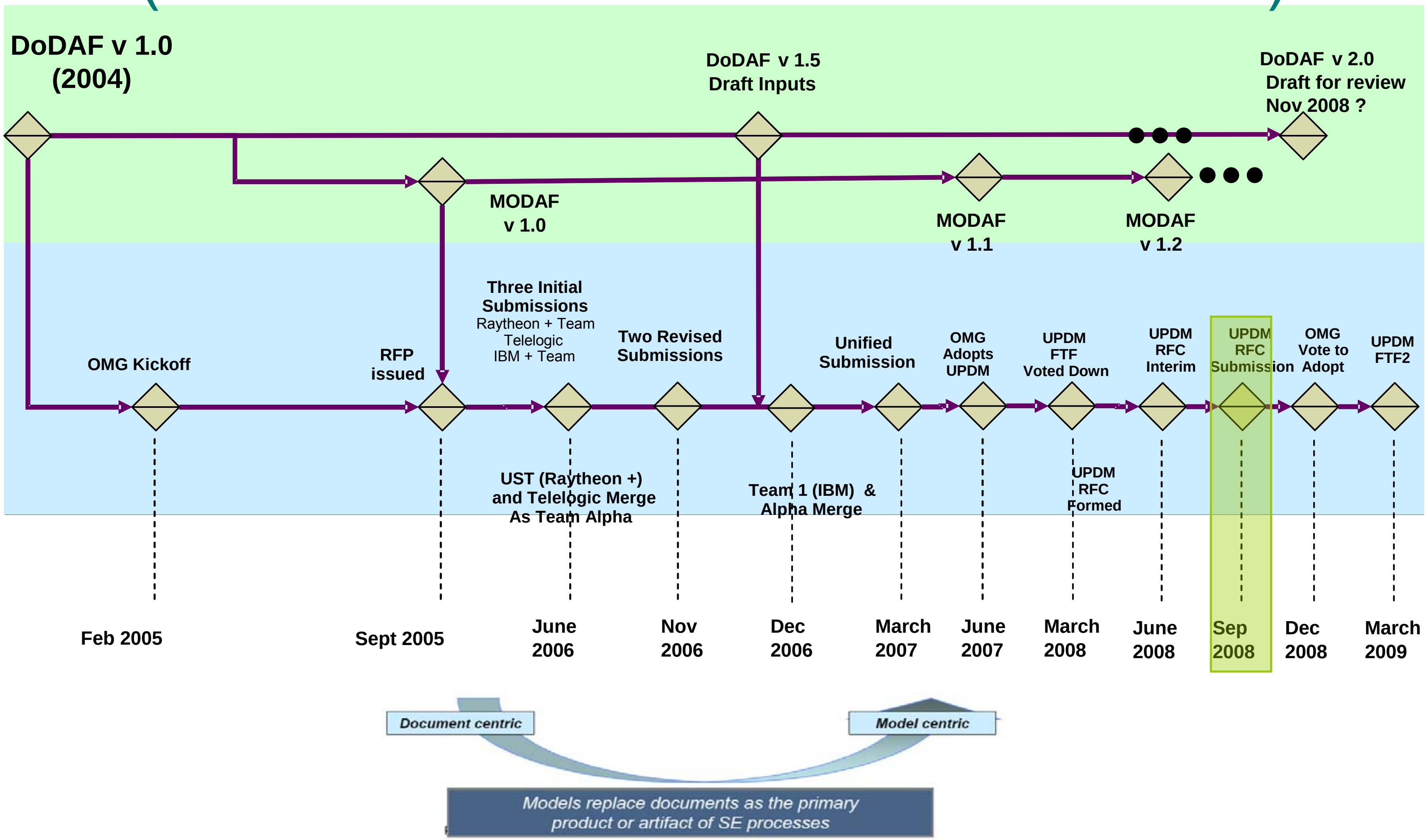
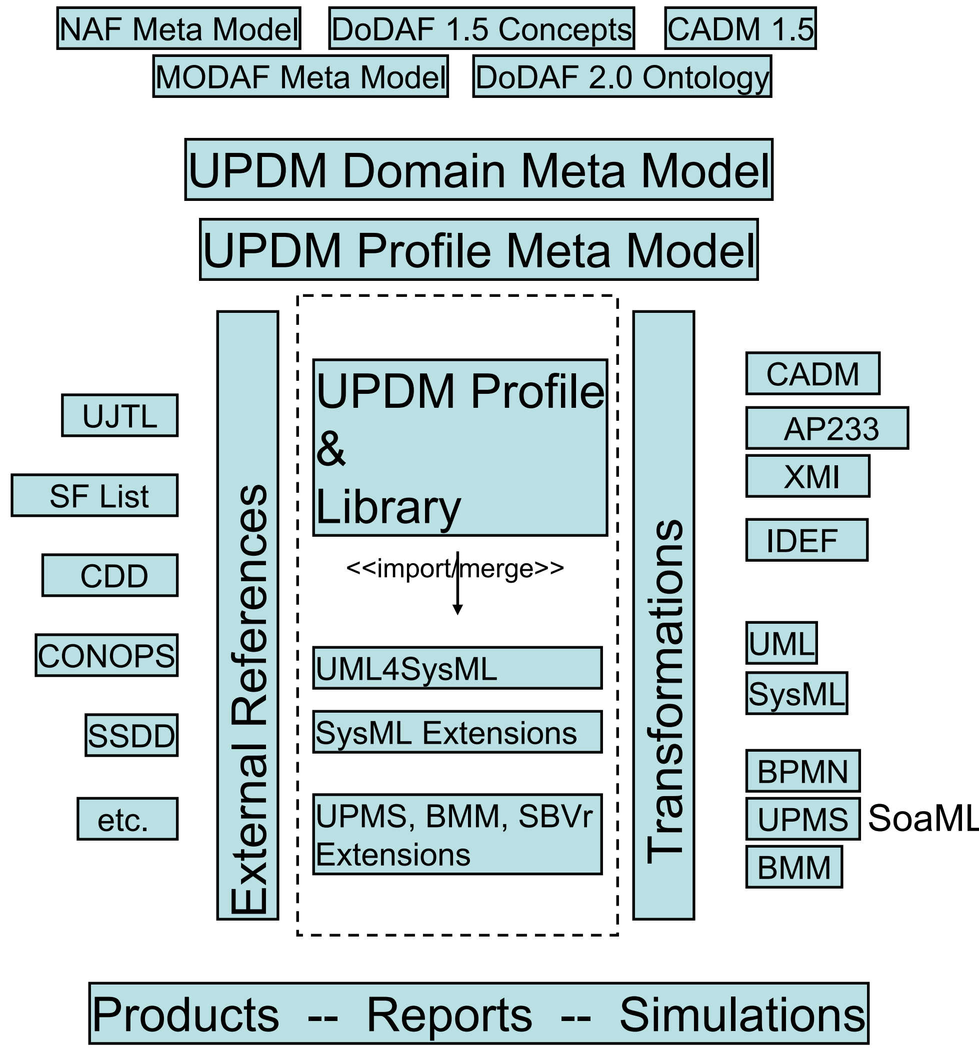
UPDM History (UML Profile for DODAF and MODAF)



UPDM: Context – Introduction

UPDM: Context – Introduction

- Context
  - Stakeholders
    - US DoD
    - UK MOD
    - NATO
    - Canada/Australia
    - OMG, INCOSE
  - OMG
    - XMI, UML, SysML
    - BPMN
    - UPMS, BMM
  - End Users
    - Aerospace
    - Commercial
  - Tool Vendors
    - Software
    - Systems
    - Enterprise



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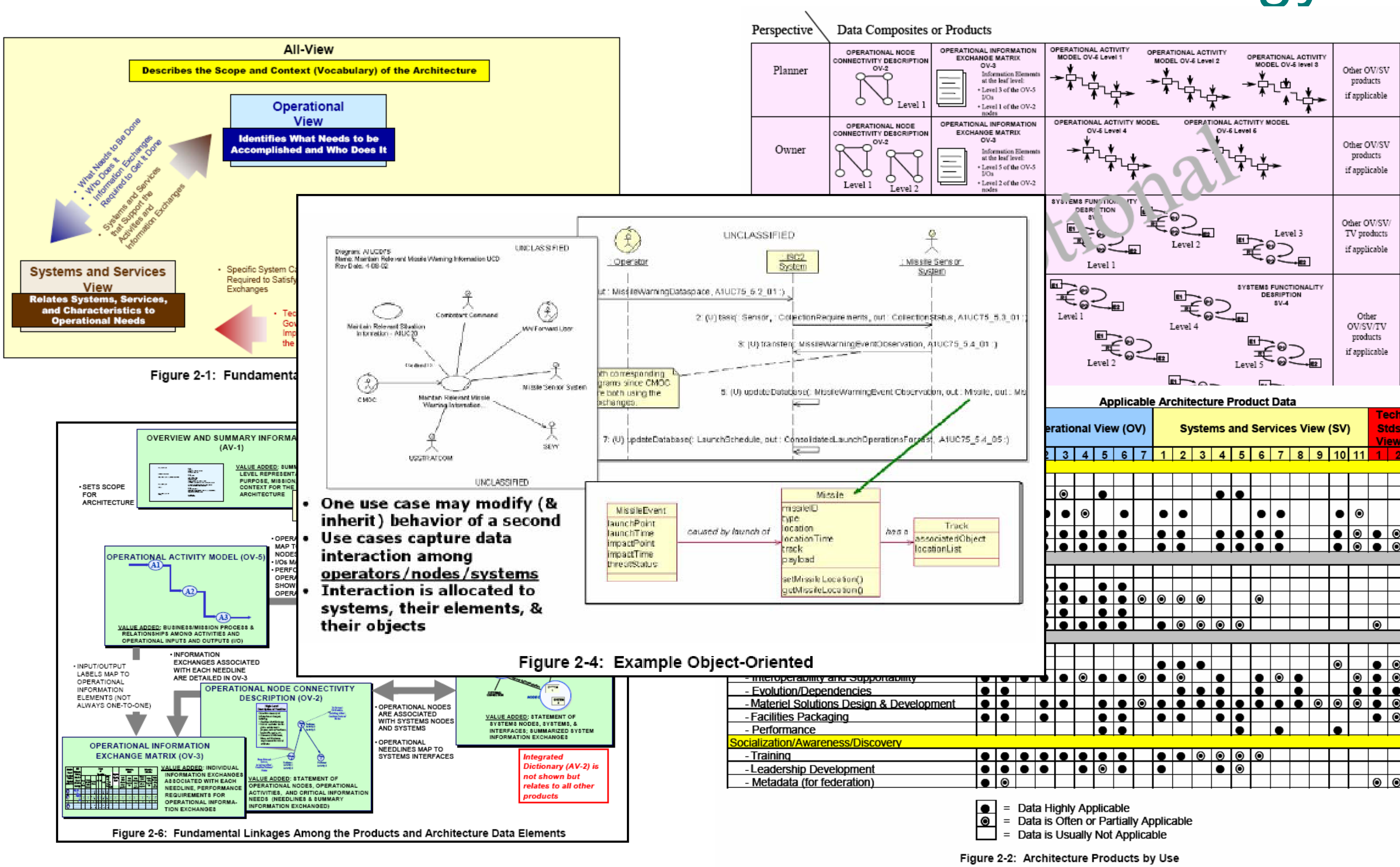
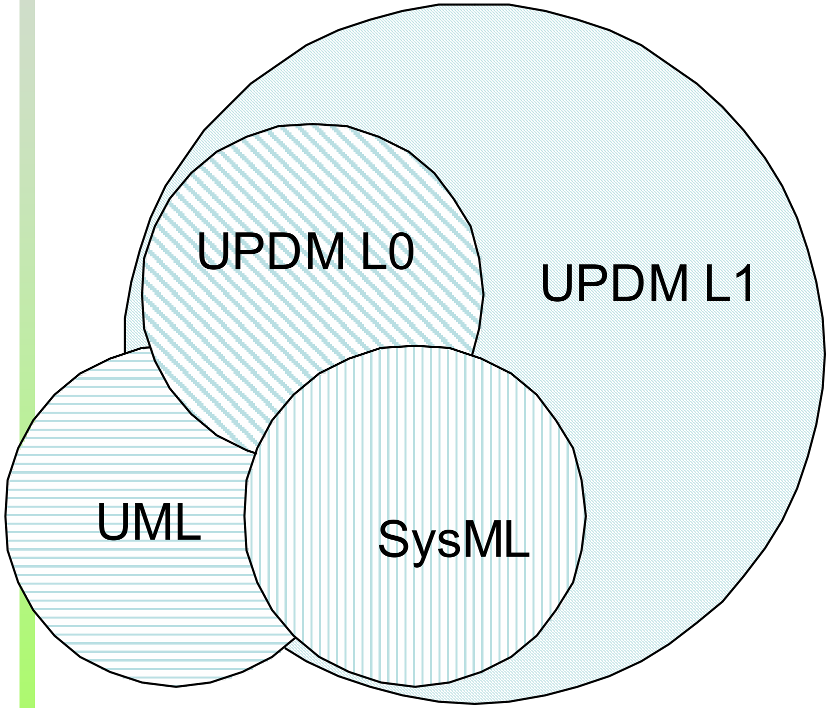
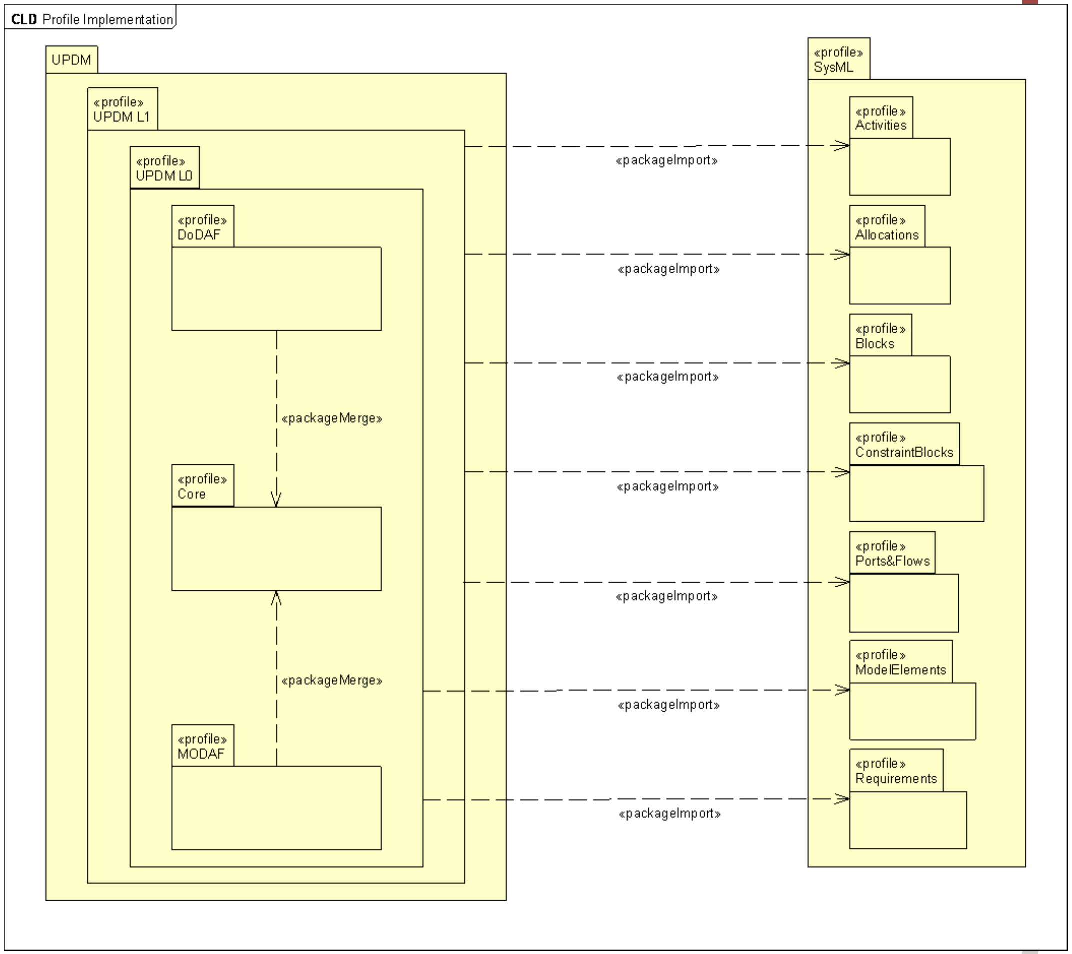
Context – DoDAF 1.0 / 1.5 ….2.0 Ontology

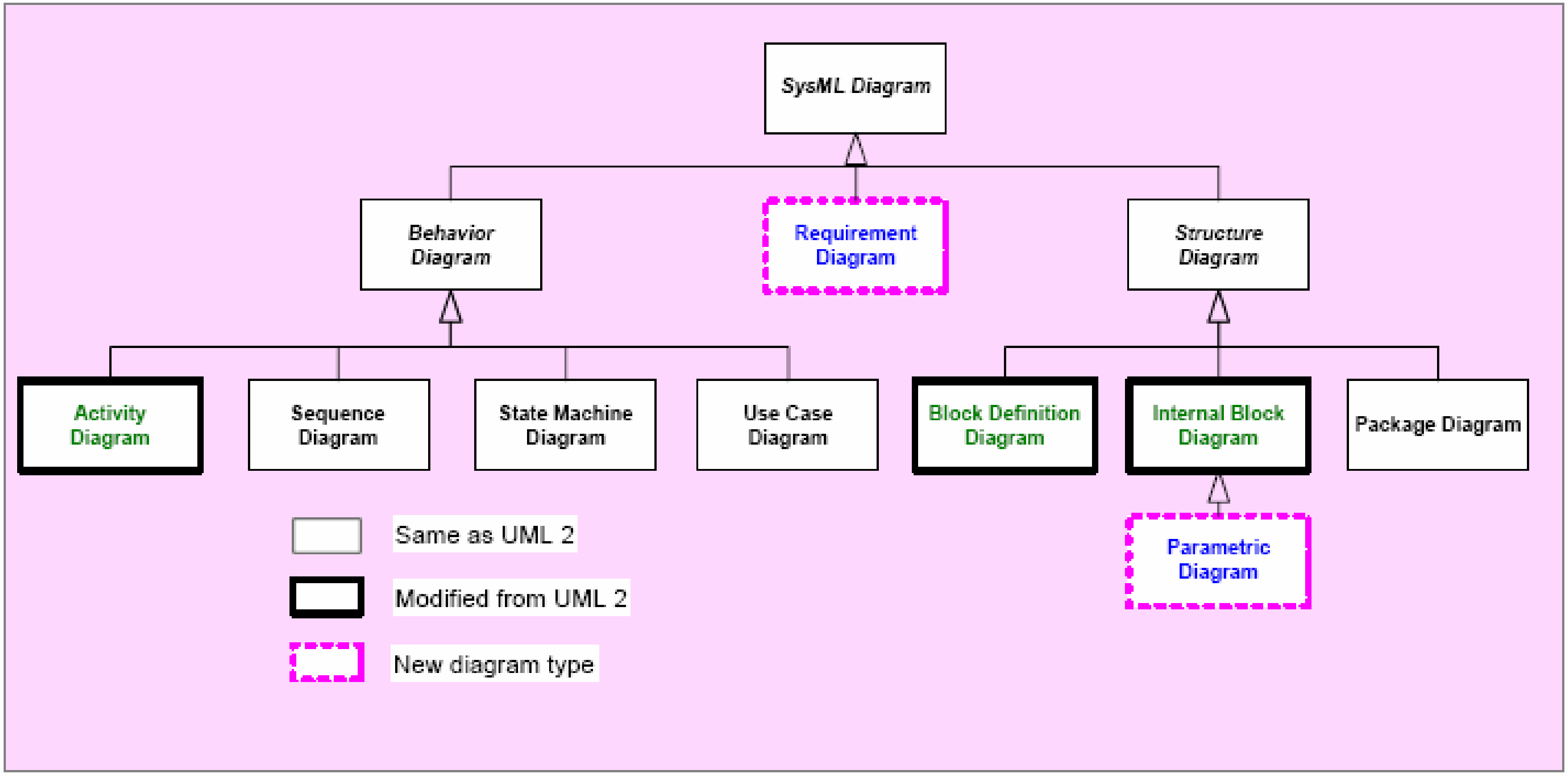


How: UPDM Compliance Levels

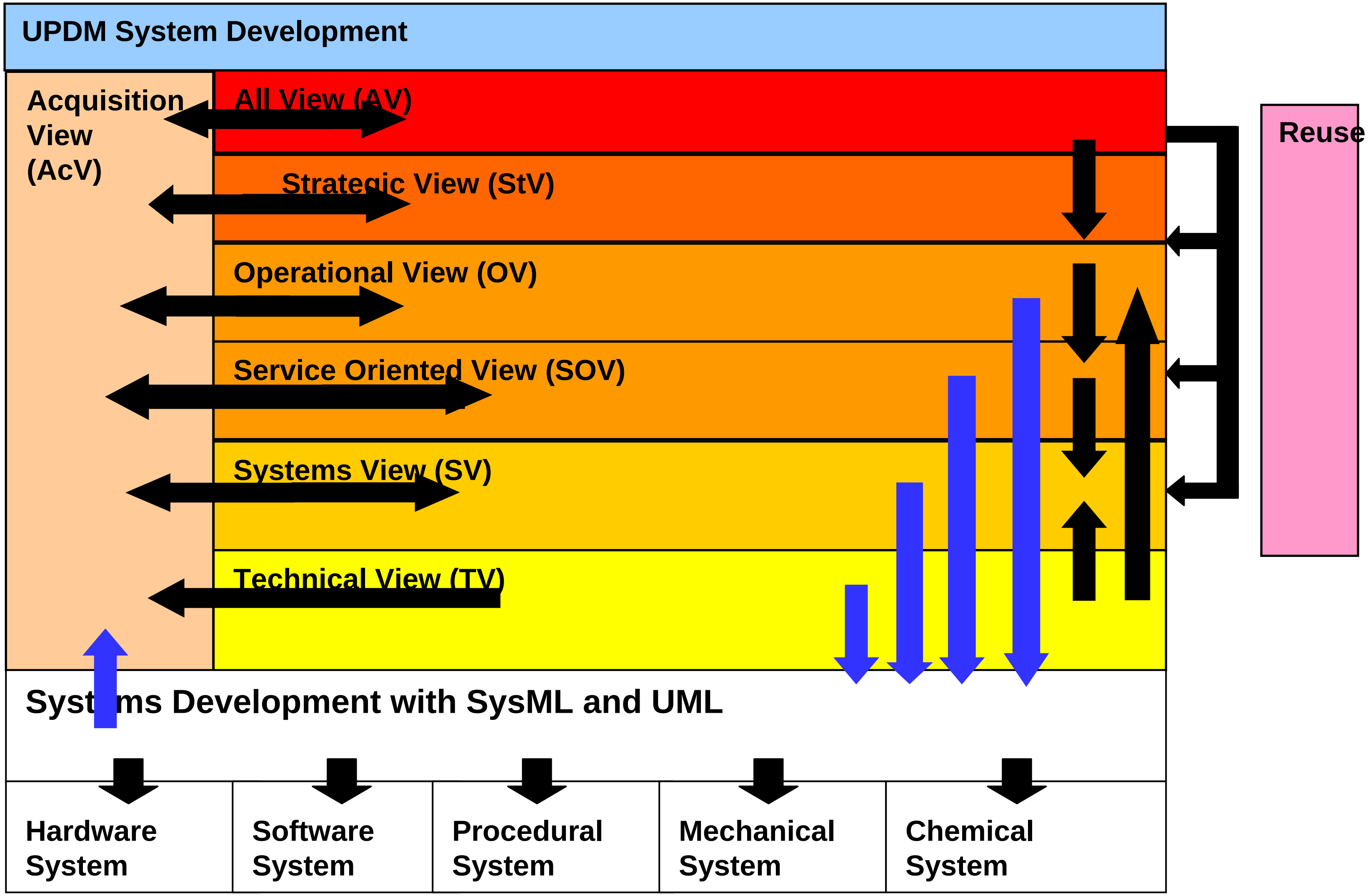




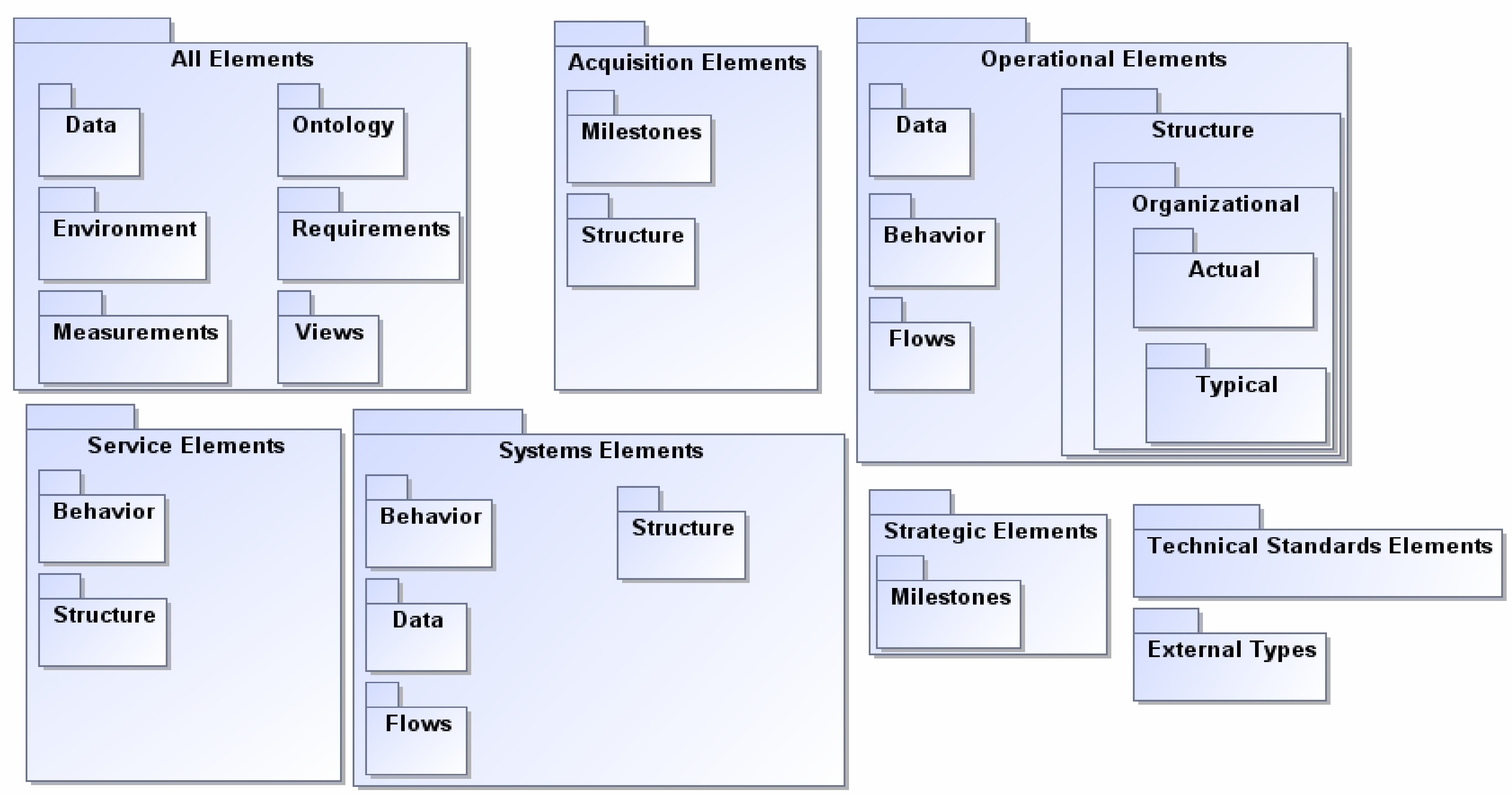
SysML diagrams



How: Information Flow into SysML and UML



UPDM RFC - Domain Meta Model



- Package structure organizes stereotypes by viewpoint
- Multiple viewpoints manage model complexity

EA Tool support

- EPC – ARIS
- UPDM – MagicDraw, Enterprise Architect
- Troux
- BPMN: 50+ tools
- SHAPE project: CIMFlex, Objecteering

Enterprise architecture frameworks with semantic models as a foundation for complex networked operations

Enterprise Architecture:
Problem areas
Saarstahl, Statoil, Eurocontrol Use Cases

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Example – StatoilHydro

- Ongoing activity in the SHAPE project
- Ref. Presentation by Einar Landre on Wednesday

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Agenda

- Saarstahl Example
  - Problem Domain
  - Use Case “Coordination between rolling mills and steel works”
  - Modeling Example

Problem Domain

- Saarstahl – German steel manufacturing company with global presence on the steel production market.
- Saarstahl – recognized for a high level of competence in the field of steel production and further processing.
- Saarstahl – one of the most important manufacturers of long products (i.e. bars or rods) in the world.
- Saarstahl – important preliminary products for the automotive, construction, the aerospace industry, general mechanical and power industry engineering, and other steel processing branches.

Steel Production

- Steel production – first phase of most Supply Chains in different areas
- Steel manufacturing companies are strongly affected by bull whip effect:
  - Irregular nature of incoming orders
  - Frequently changing customer requirements on accepted orders
- Therefore → it is important to improve operational efficiency
- Needed: flexible planning and scheduling systems handling considerable amounts of data

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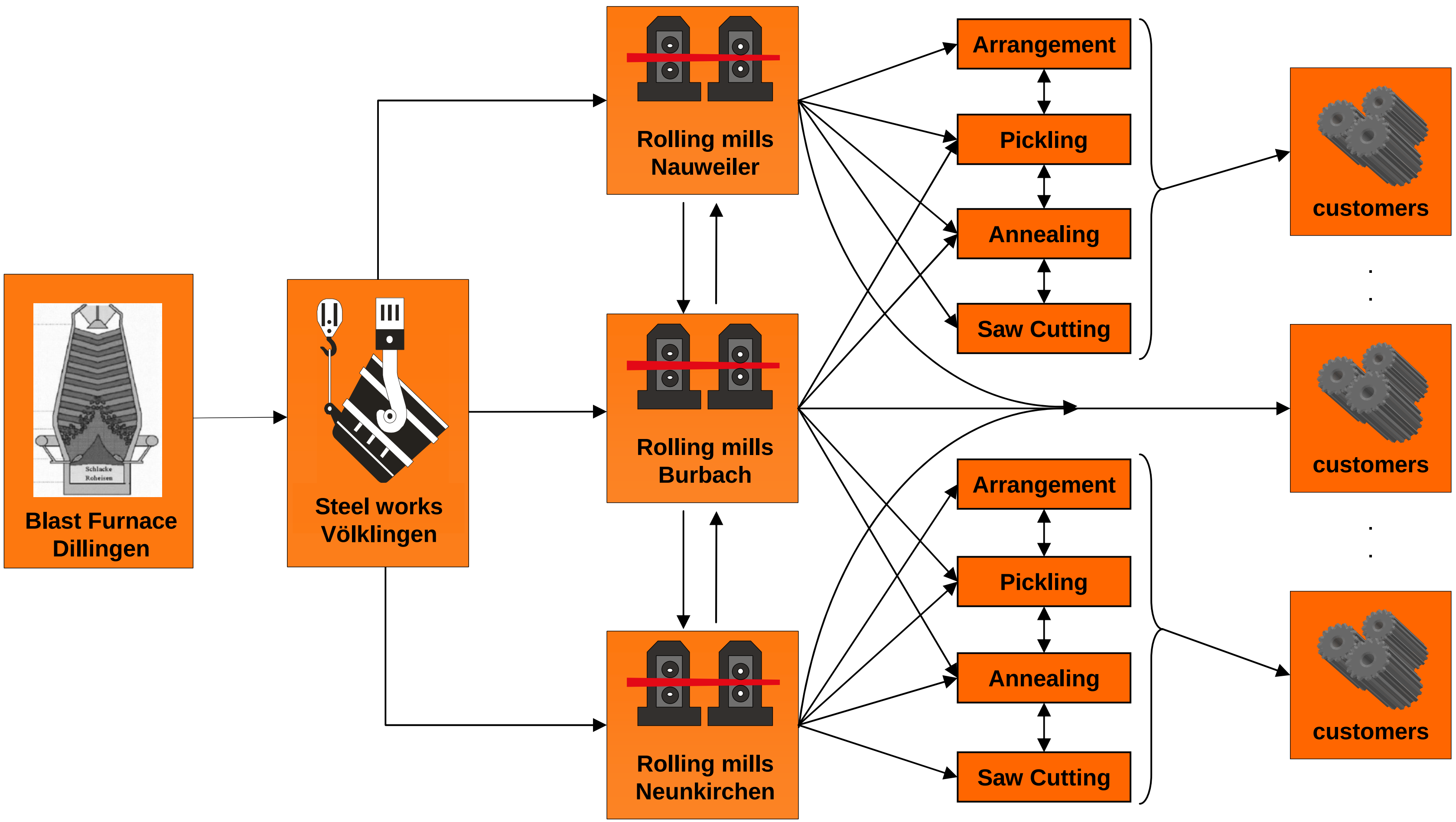
Planning Efforts

- Existing systems:
  - Commonly centralized decision making approaches
  - Mostly data driven
  - Often not modeling the business processes conveniently
- Saarstahl made great efforts to deal with the planning and scheduling problems along its production chain:
  - Steel production is a disassembling, continuous process and resulting in a vast number of different products
  - Time restrictions are more important than in other production chains, since certain processes cannot be interrupted
  - For instance, hot metal leaving the blast furnace factory must be transformed and casted into steel billets within a certain time

Supply Chain of Saarstahl



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Agenda

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Use Cases Overview

- Coordination between Rolling Mills and Steelworks
- Capacity planning of Annealing Furnaces
- Creation and Optimization of Heats and Sequences
- Cross-plant order coordination from steel works' point of view

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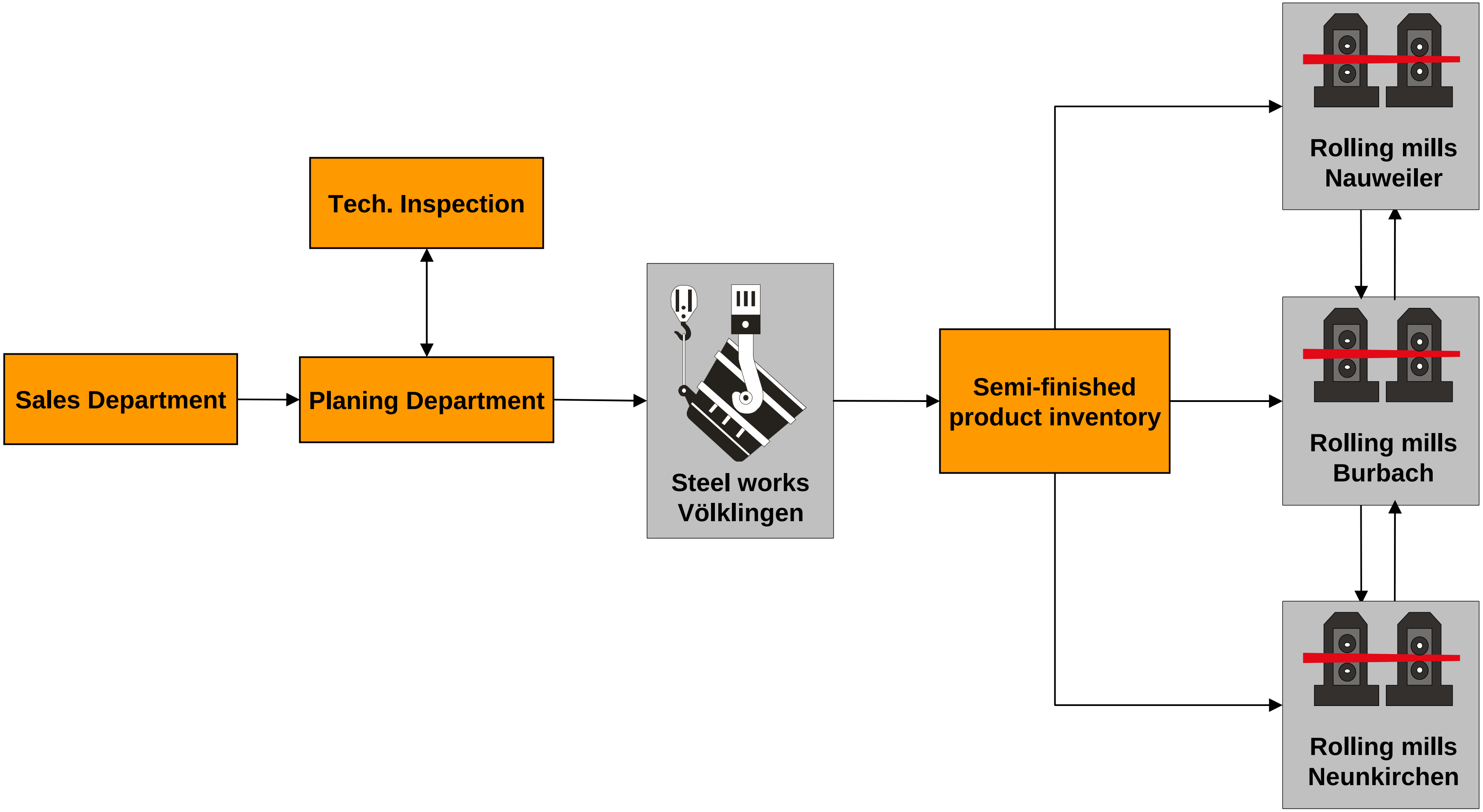
Coordination Use Case



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Saarstahl Pilot Case

- Specification of business models and requirements:
  - Formalize business models (CIM-level) using EPCs (event-driven process chains) or BPMN (business process modeling notation).
  - Ensure the business models will contain information wrt. involved organizational units, provided functionalities, and exchanged data and resources.
- Model transformations from CIM to the SoaML/ShaML.
- Model transformations from the SoaML/ShaML to Semantic Web Services, agents, P2P and Grid systems.

Use Case Challenges

- How to simplify the choreography of the 4 rolling mills and the steelmaking plant?
- Which kind of service interaction patterns should be used (e.g. multiagent systems)?
- How to formulate business requirements on the CIM-level that can then be easily translated into a running system?

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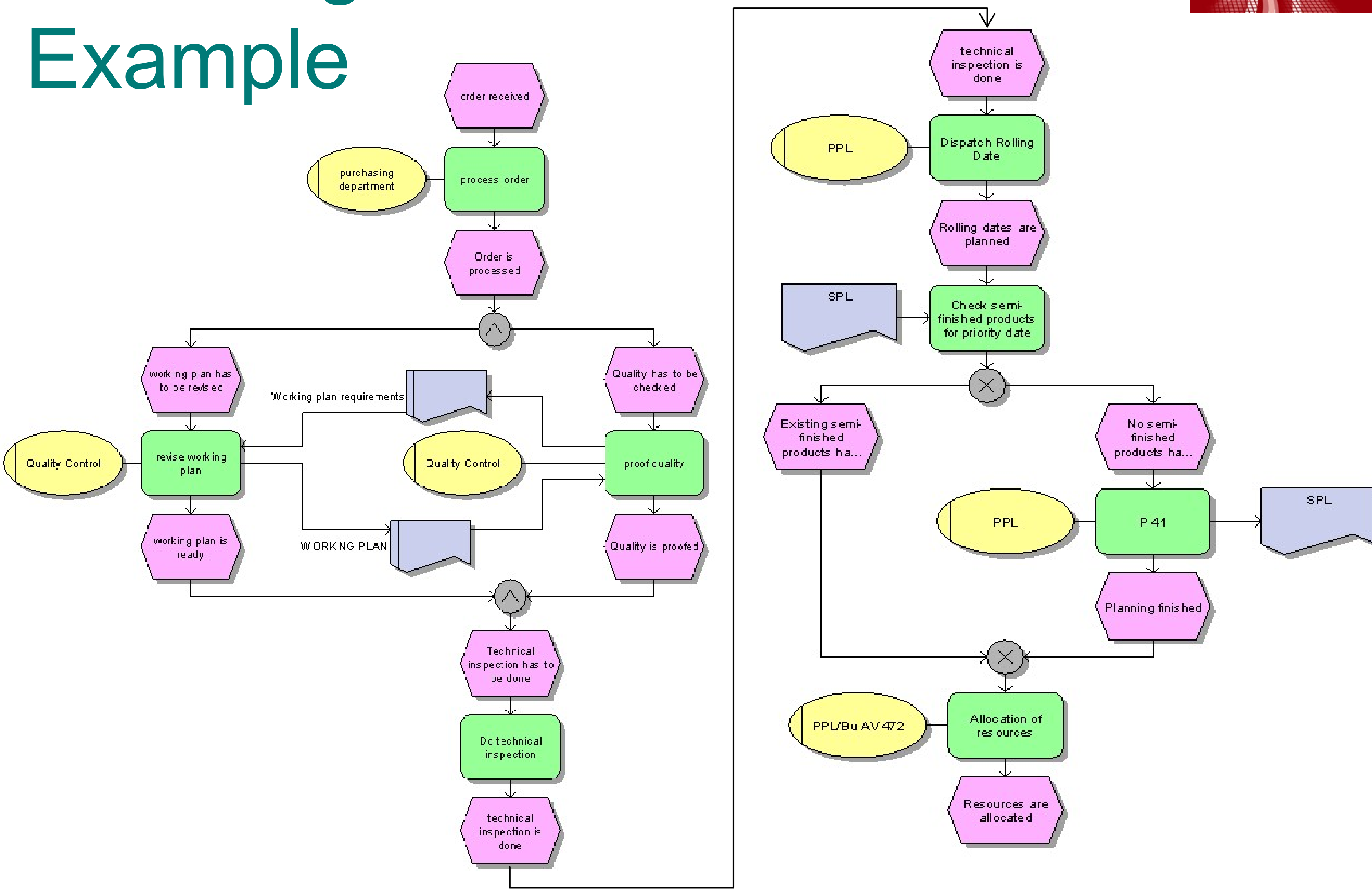
Modeling Example



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European Air Traffic Management

Ulf Larsson

LFV

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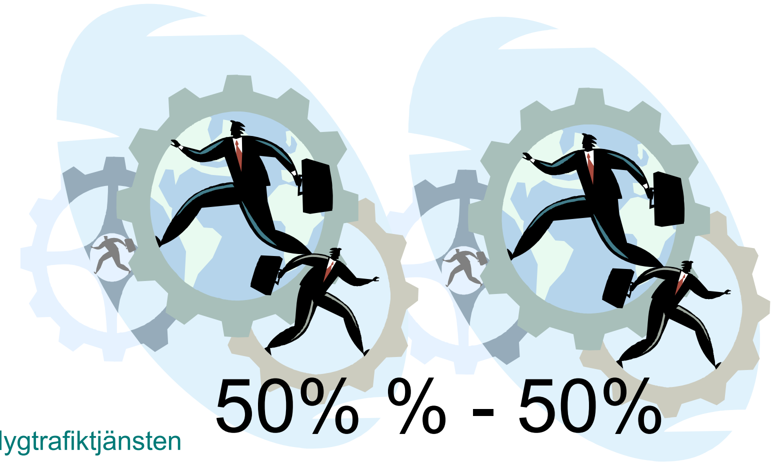
Single European Sky ATM Research, SESAR

- Why started European Commission SESAR?

Reduction of Cost, automation and rationalisation of ATM!

- Budget 22 billion Euros (2 billion used within the DP-phase –2006 to 2008)
- A new approach SESAR addresses the entire ATM? airports, ANSPs, Air Space Users (airlines), MIL, others
- A common joint development - SESAR Joint Undertaking (SJU)
  - 2009 till 2013 IP1
  - 2013 till 2017 IP2
  - 2017 till 2020 IP3

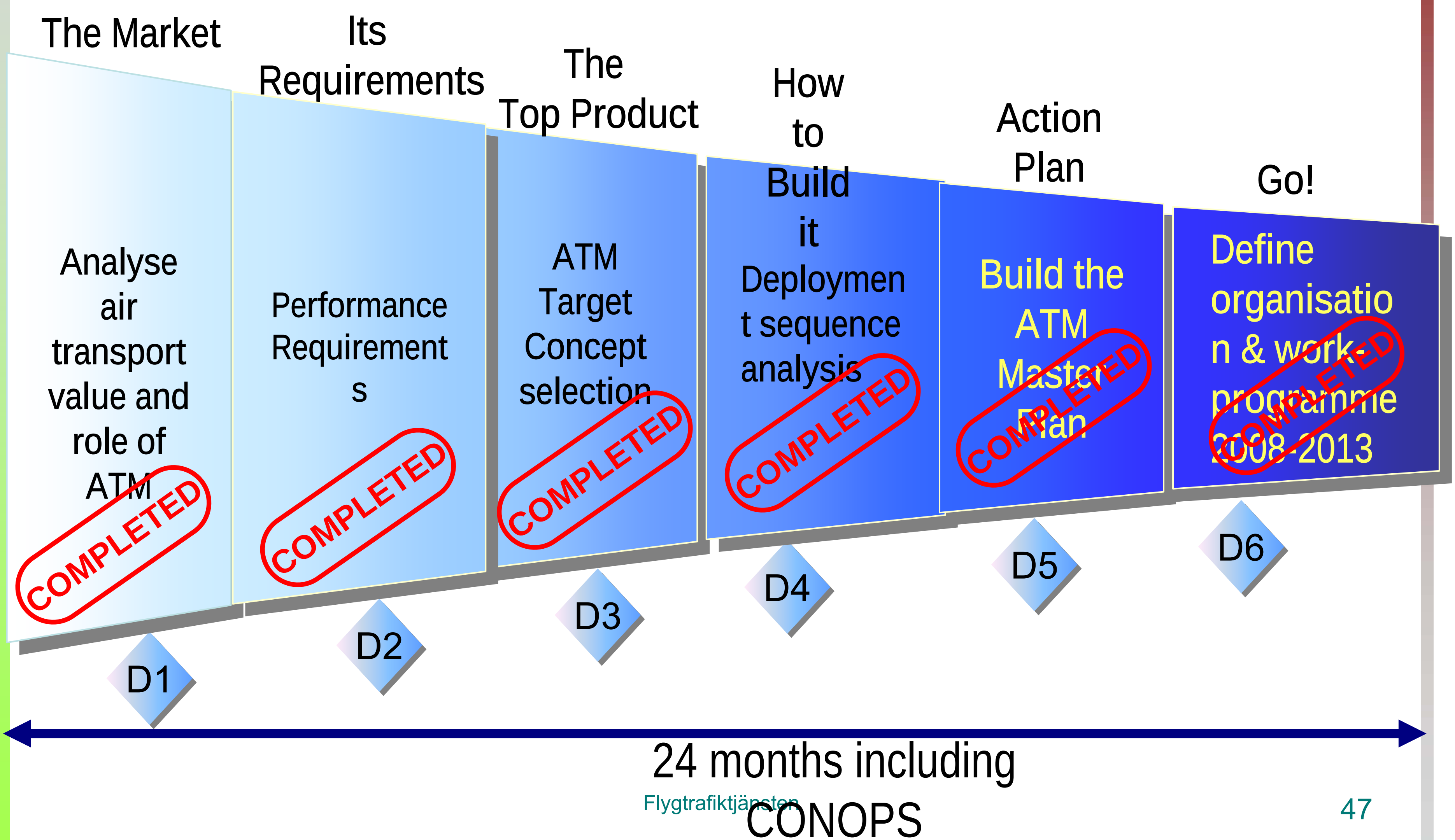


50% % - 50%

Participants in SESAR?

Lufthansa
Amsterdam Airport Schiphol
EADS
sofréavia votre guide expert en aviation civile
DLR
Air Traffic Alliance
THALES
KLM Royal Dutch Airlines
ATC EUC
Rockwell Collins
dgac DSNA
AIRBUS
Honeywell
DFS Deutsche Flugsicherung
Munich Airport International
AEA Association of European Airlines
AIR FRANCE
Fraport
SELEX Sistemi Integrati
INECO
ECA
BAA
era
DASSAULT AVIATION
ACPA GERMANY
Aena
IBERIA
BOEING
EUROCONTROL
AÉROPORTS DE PARIS
Luchtverkeersleiding Nederland Air Traffic Control the Netherlands
IATA
Civil Aviation Authority
ENAV S.p.A. ITALIAN COMPANY FOR AIR NAVIGATION SERVICES
BAE SYSTEMS
EBAA
austro CONTROL
Indra
Isdefe Ingeniería de Sistemas
IFATCA
NATS
ELFAA
IFATSEA
NAV NAV Portugal, E.P.E.
Sicta
EURAMID Conference
NLR
LFV

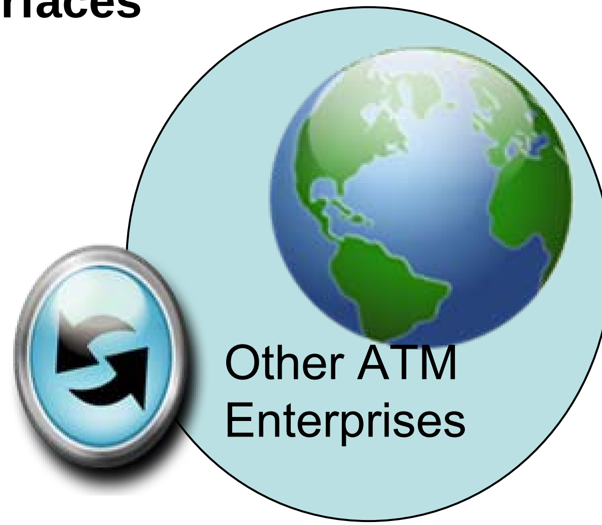
SESAR Definition Phase (start 2006 end March 2008)



SWIM Infrastructure …

Information Management addresses both Air-Ground and Ground-Ground Data and ATM Service Exchange

Information Management is supported by a set of architectural elements (the SWIM infrastructure) underpinned by a communication Network – opposed to closely coupled interfaces



Objectives and activities

Capacity: 3 fold increase (represents 73% on 2004 traffic for 2020)

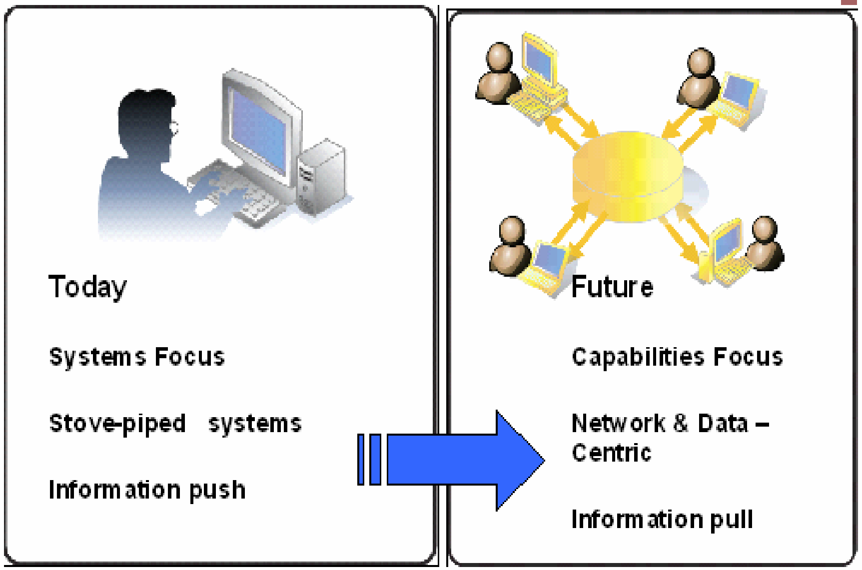
Safety : Increase by a factor of 10 (ensure no negative safety impact on 2020 traffic)

Environment : 10% reduction by flights (applicable 2020)

Cost : 50% reduction (applicable to 2020)

Main Gaps!

- Missing the Enterprise level of Architecture
  - Formal Business Process models
  - Formal Information Models
  - Formal Operational Goals
  - Formal Service Model
  - Framework
- The Development is not driven from Business Perspective
- Missing Service Oriented mindset, too much focus on Systems



The future ATM architecture – its focus!

Semantic Days 2009

It is about BPM and Service and less about systems and functions!

Systems will be system-objects in a larger ATM architecture, and within LFV an architecture office is required!

Flygtrafiktjänsten

Transition ..a cooperative effort forward!

Previous vision

Platform-centric,
service embedded,
large conflict,
well established C2

Revolution

Evolution

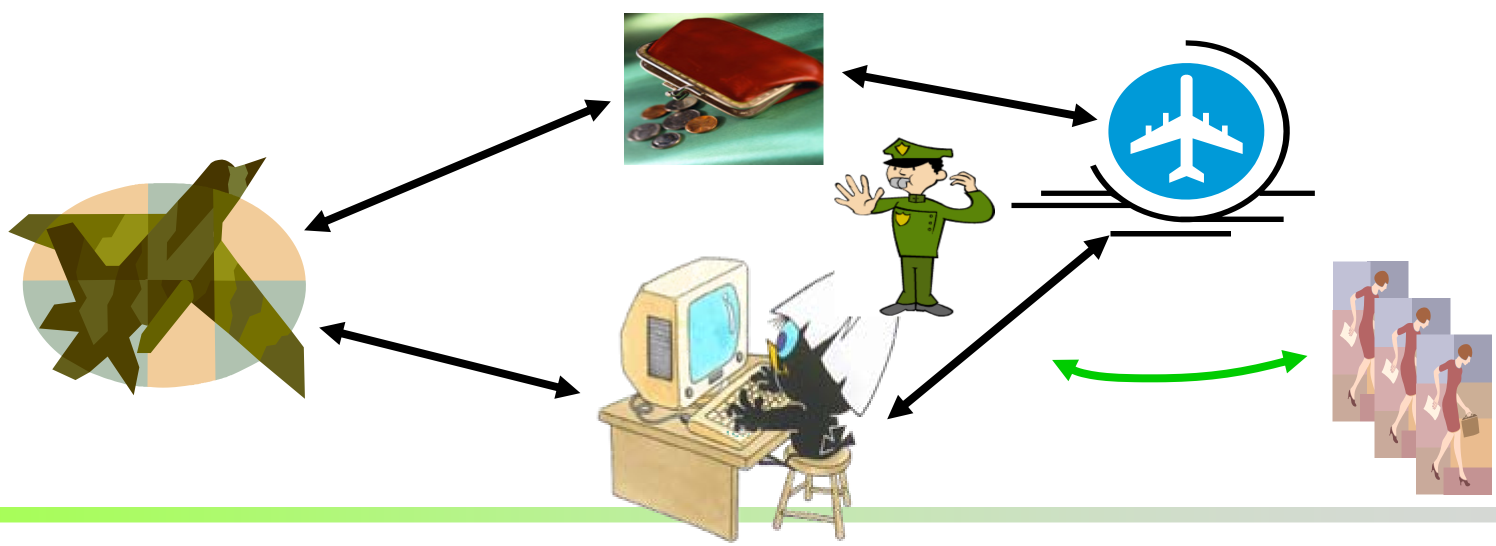
New vision

Network-centric,
interoperable,
joint, integrated,
flexible

Future structure

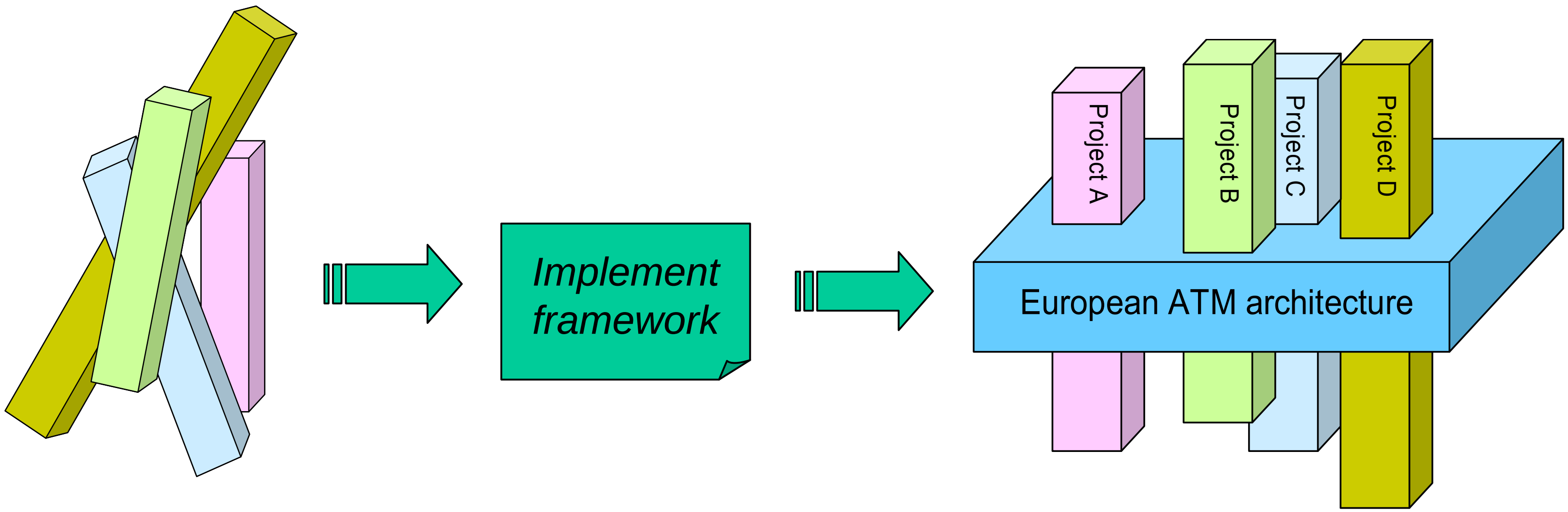
What is the goal/objectives more than reducing the costs?

- It is about building seamless and interoperable distributed information systems within ATM;
  - Reuse of information and components (soft-ware components),
  - Share on-line operational information e.g. concerning flights and information that may affect a flight etcetera
  - In a flexible way make new demand/requirements possible (opposed to system flexibility)
  - The development requires new methods, tools, architecture (description) frameworks and formal description languages



Concept Description

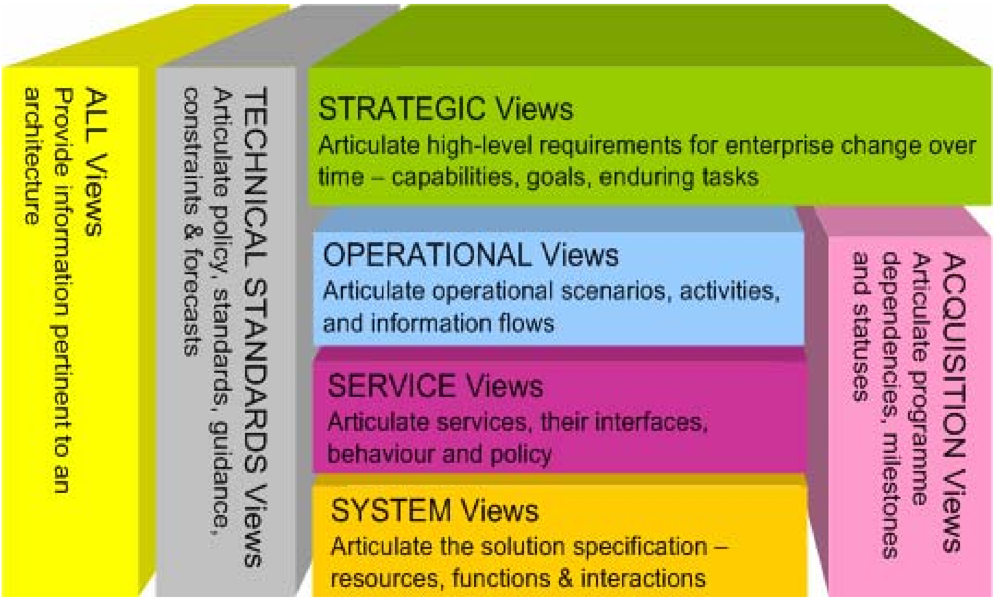
Enterprise Architecture Framework



Fragmentation
- Existing systems
- Development projects
- Interoperability
- Operational usage

Alignment
- Commonality
- Consistency
- Coherence
- Interchange
- Standardisation
- Increased cost/benefit

Concept Description
Enterprise Architecture Framework

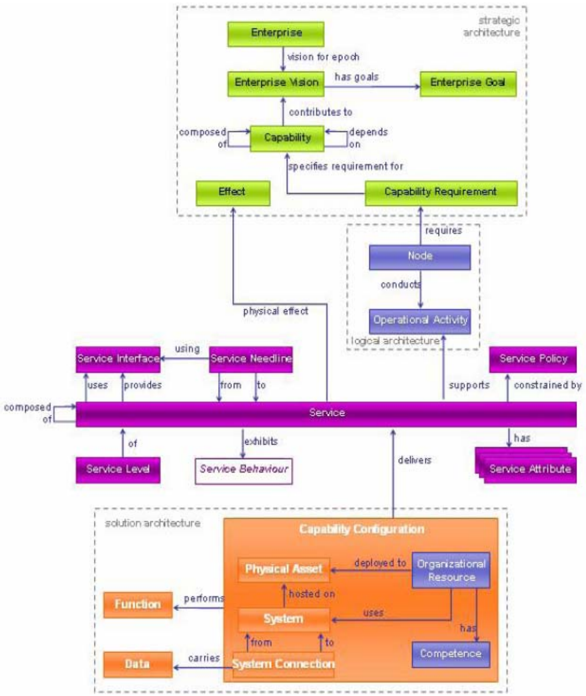


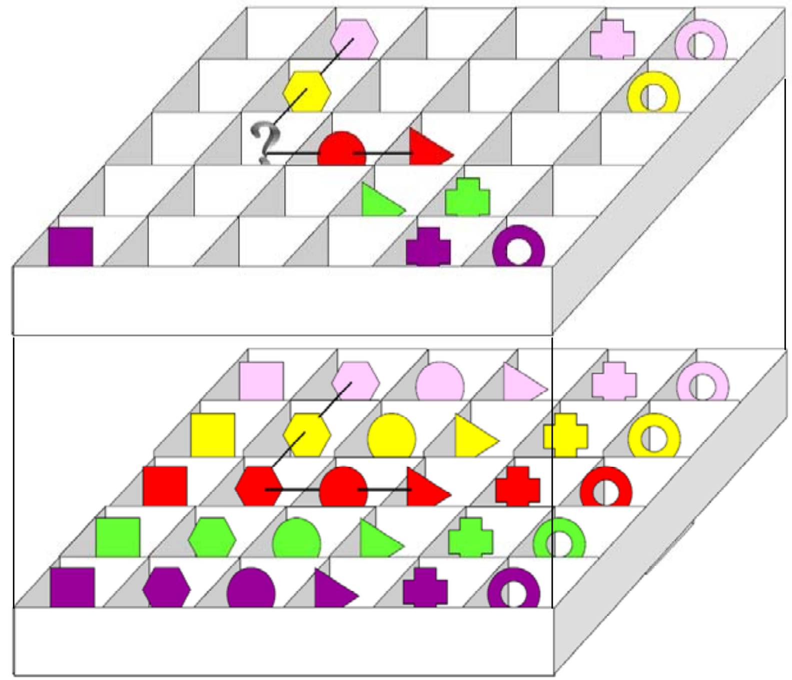
MoDAF 1.2 and NAF (NATO Architectural Framework)

- Each View represents a specific Perspective of the Architecture
- Each View contains subviews

Concept Description

Enterprise Architecture Framework





A framework Meta-model describes the content and relationships between views

The expected relationship and content can be used to check completeness

Enterprise Architecture

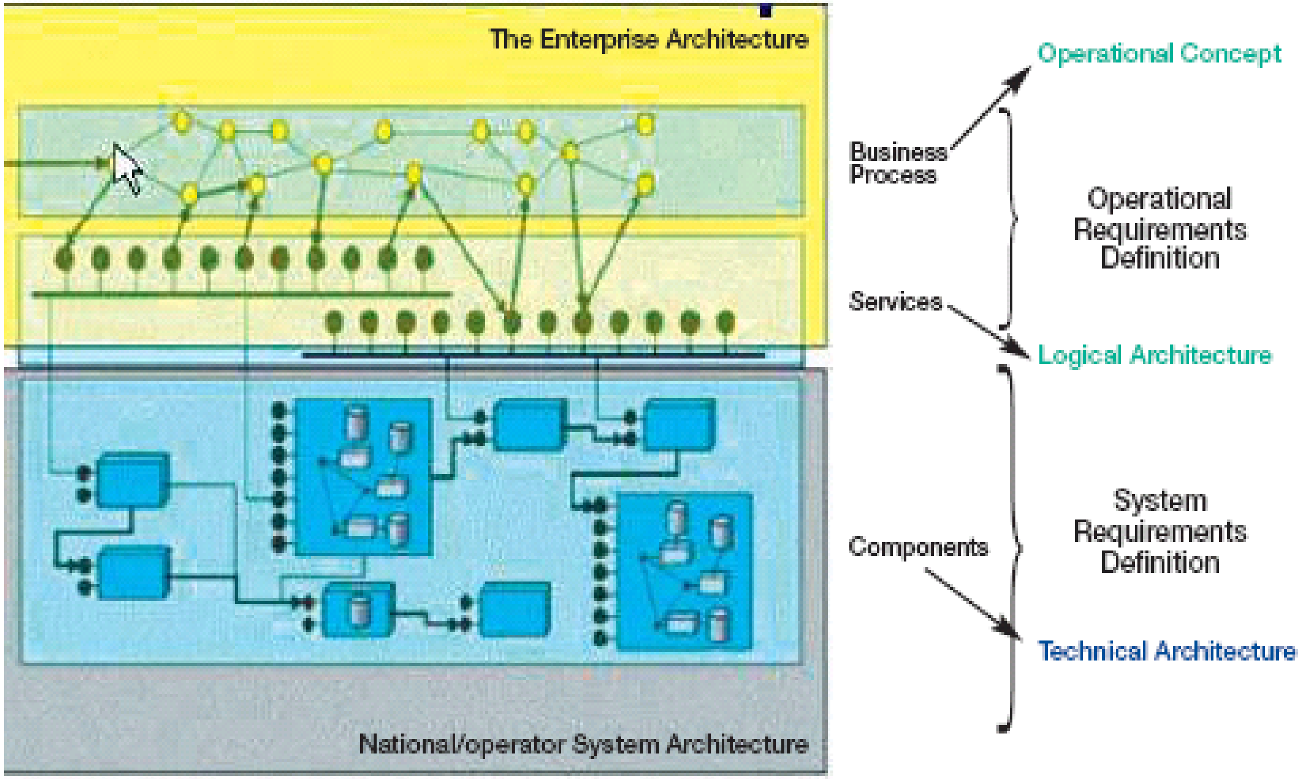


Figure 22: Boundary between operational requirements and implementation

What is on-going concerning architecture frameworks?

A global standardisation activity UPDM!

The outcome of SESAR DP !

- SESAR DP documented;
  - Performance Based Approach, 11 KPAs are described to guide decision makers in order to reach the Vision (Cost / Effectiveness, Capacity, Interoperability etc.)
    - EAEA perspectives
    - SOA vs Service-Orientation (SoS, FoS)
    - Enterprise Architecture Framework
    - MDA (Modelling Driven Architecture)
    - NetCentric (”Intranet of ATM”)
    - The development should follow a ”top-down approach”

ATM Europe has started changing the suit and it is a comprehensive paradigm shift which affect all levels within ATM (”requires a change in mind set”).

Logical Architecture 2020

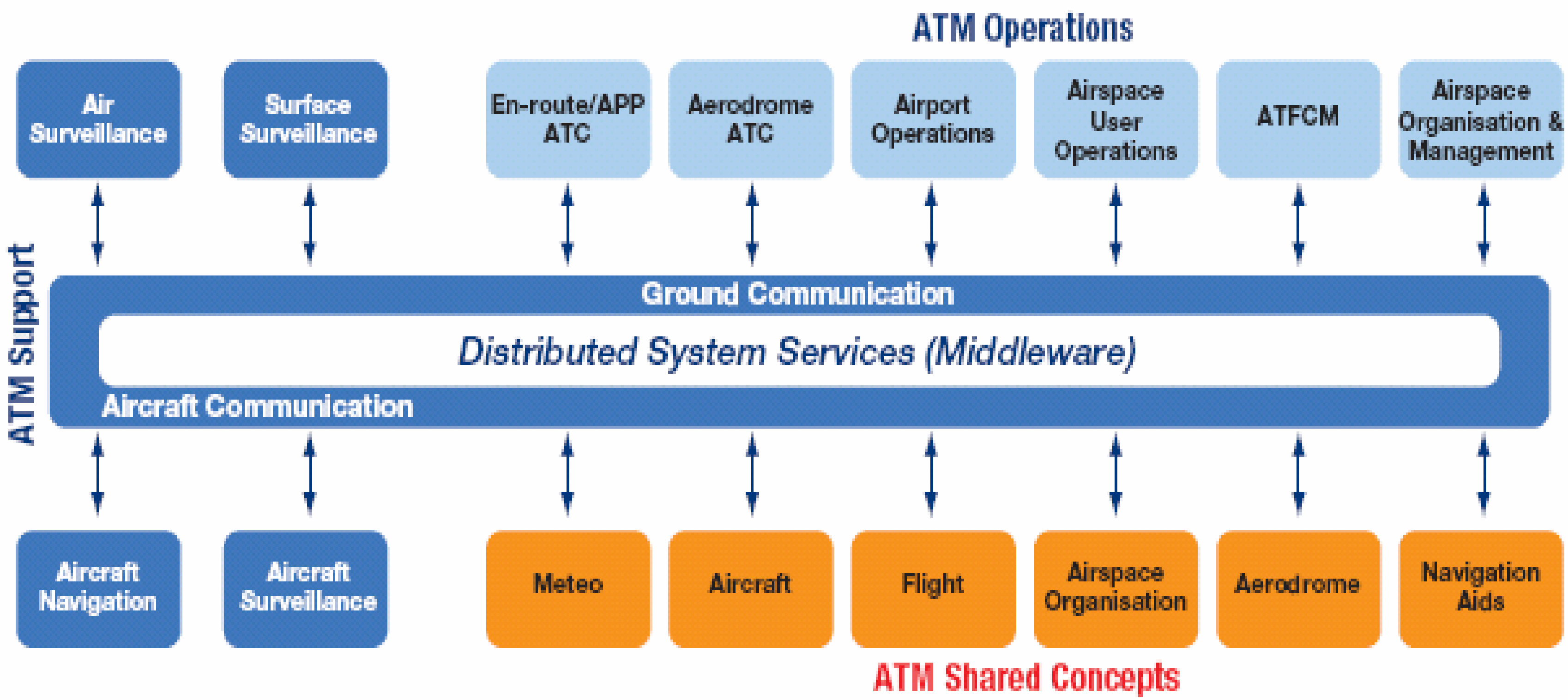


Figure 11: High level European ATM System 2020 logical architecture

Key Performance Areas (ICAO, SESAR)