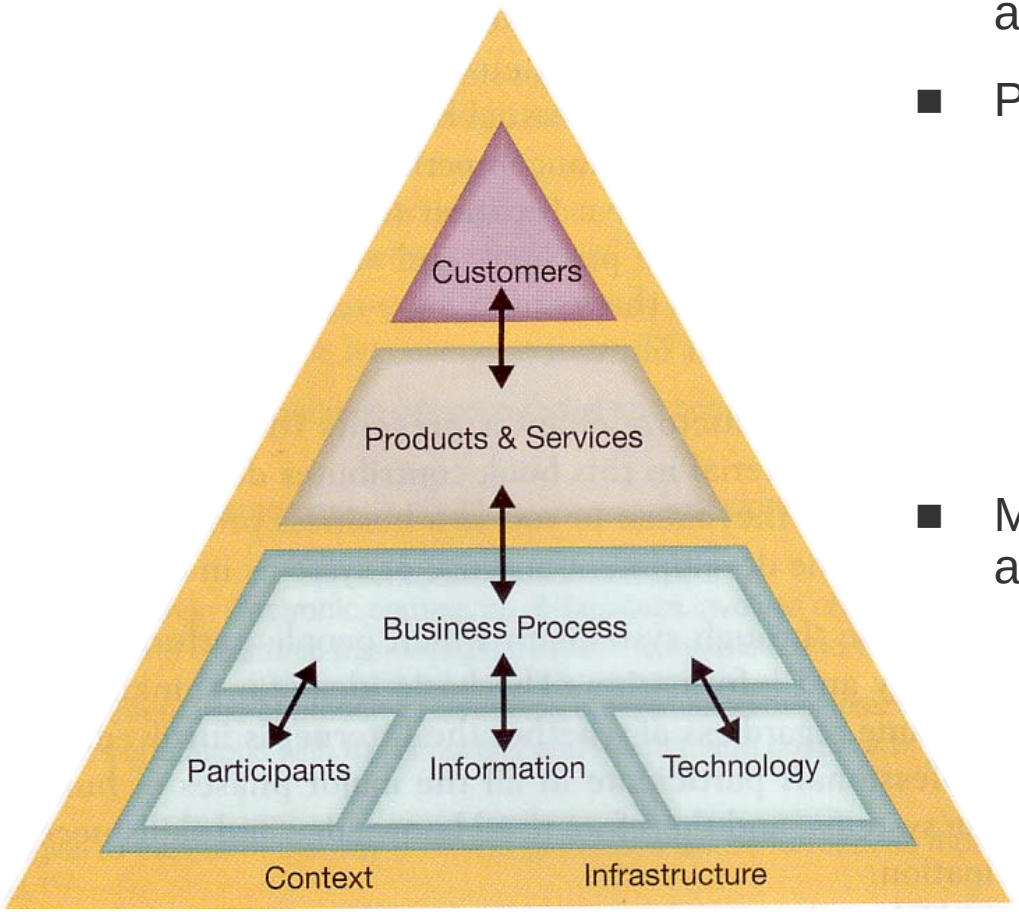
University of Applied Sciences Northwestern Switzerland
School of Business

Enterprise Architecture Frameworks

Prof. Dr. Knut Hinkelmann

Work-Centered Analysis



- Value added: Processes realise products and services for customers
- Processes …
  - … are executed by people and machines (participants)
  - … use, generate and communicate information
  - … use Information Technology
- Mutual dependencies between business and IT
  - adequate information and innovative technology enable processes for unique products and services
  - new business models call for processes with improved IT

Quelle: Alter, Steven: Information Systems – The Foundation of E-Business, 4. Auflage, Prentice Hall, New Jersey, 2002

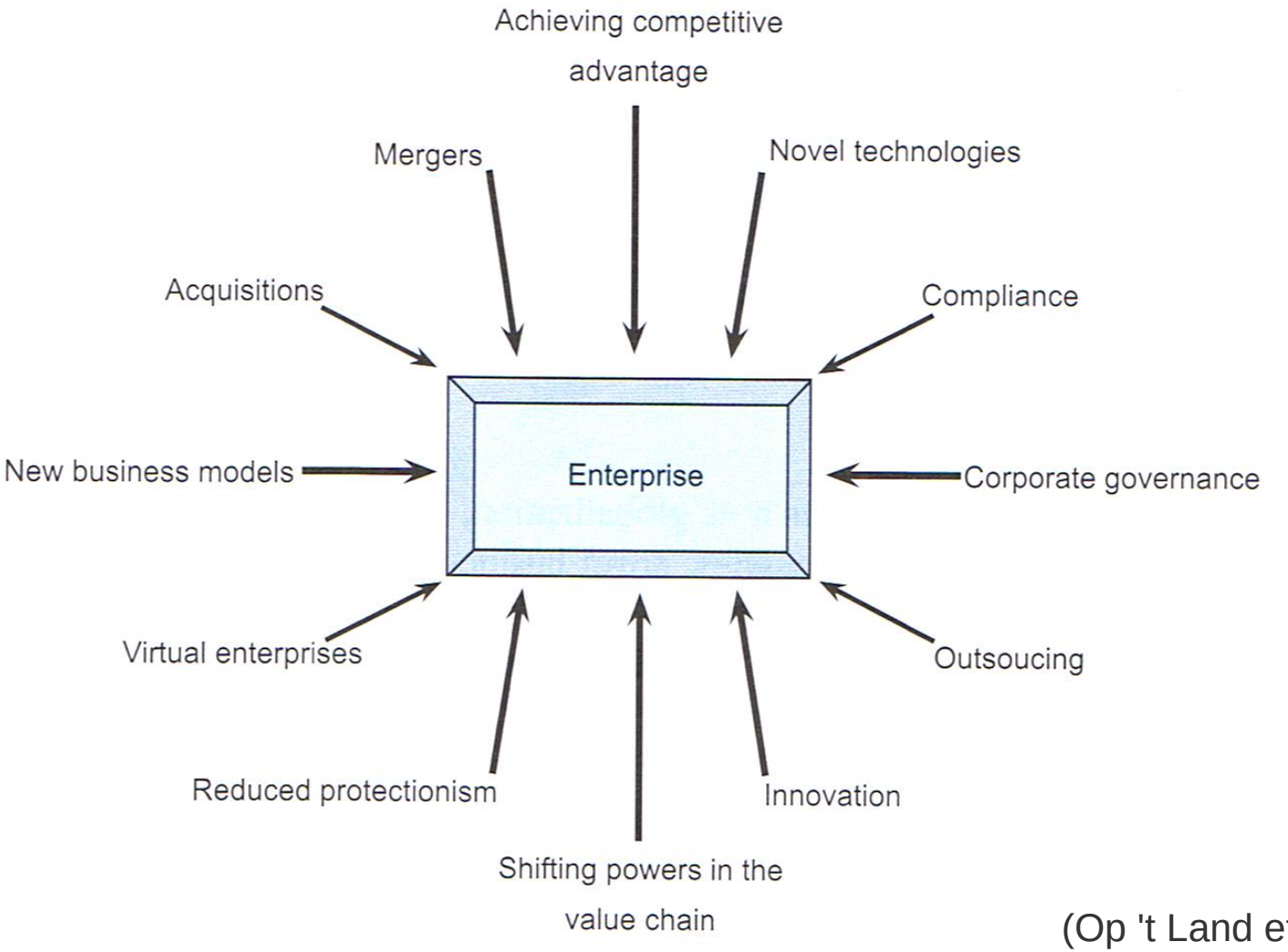
Problem: Alignment of Business and Information Technology (IT)

- Almost all processes have become IT reliant, if not fully automated
- The alignment of business and IT has to deal with problems like the following:
  - What happens to IT if the company has to react on market requirements?
  - What IT innovations are needed to remain competitive?
  - How do changes in the IT affect the Business?

Alignment of Business and IT

- Desired state in which a
  - business organization is able to use information technology (IT) effectively to achieve business objectives
  - IT enables business models

Challenges confronting an Enterprise



(Op 't Land et al. 2009, p. 6)

Enterprises need to be agile in an increasingly dynamic Environment

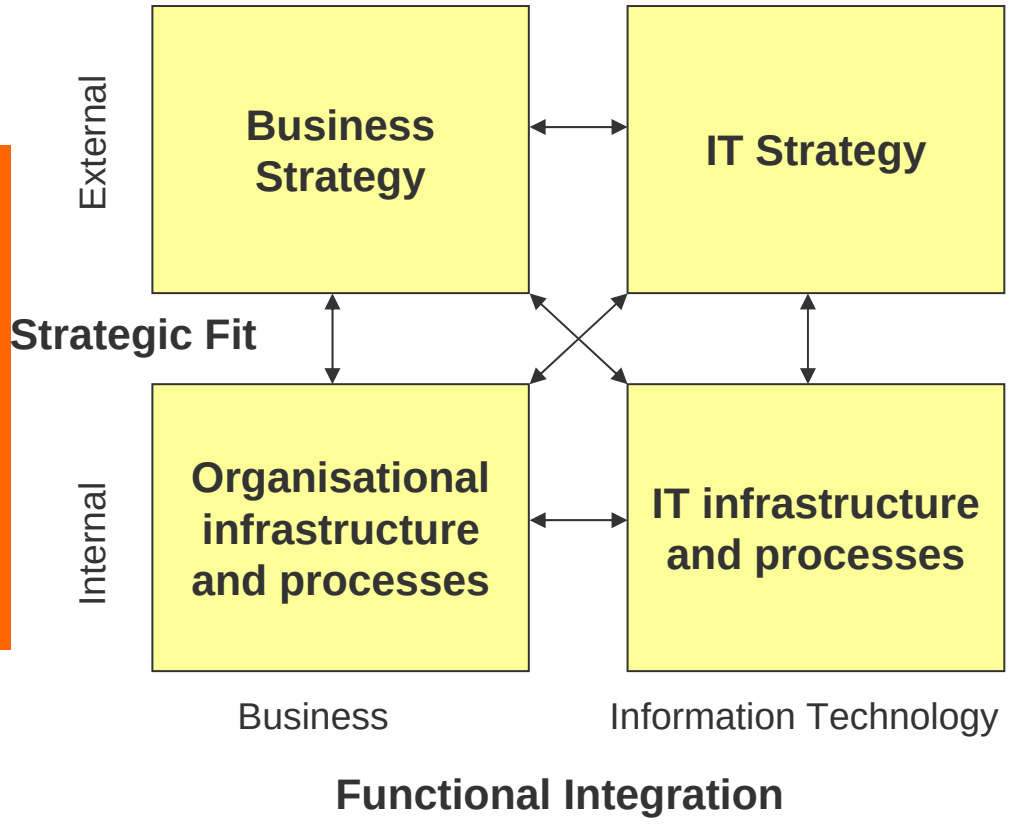
- Dynamic environment because auf mergers, acquisitions, innovations, novel technologies etc.
- To improve chances of survival, enterprises need to be agile
- Agility is the ability
  - to quickly adapt themselves to changes in their environment and
  - to seize opportunities as they avail themselves
- Agility has become a business requirement in many lines of business

Extended Virtual Enterprise

- Agile enterprises co-operate with large number of suppliers, partner, and sub-contractors, e.g.
  - components are manufactured outside
  - detailed design tasks may be subcontracted
  - after sales service may be provided by third party
  - a close cooperation with partners in a supply network
  - strategic relations with some suppliers
- When considering business processes of an enterprise, the scope must include all value-adding activities – internal and external

(Bernus et al. 2003, p. 10f)

Strategic Alignment Model of Henderson and Venkatraman (1993)



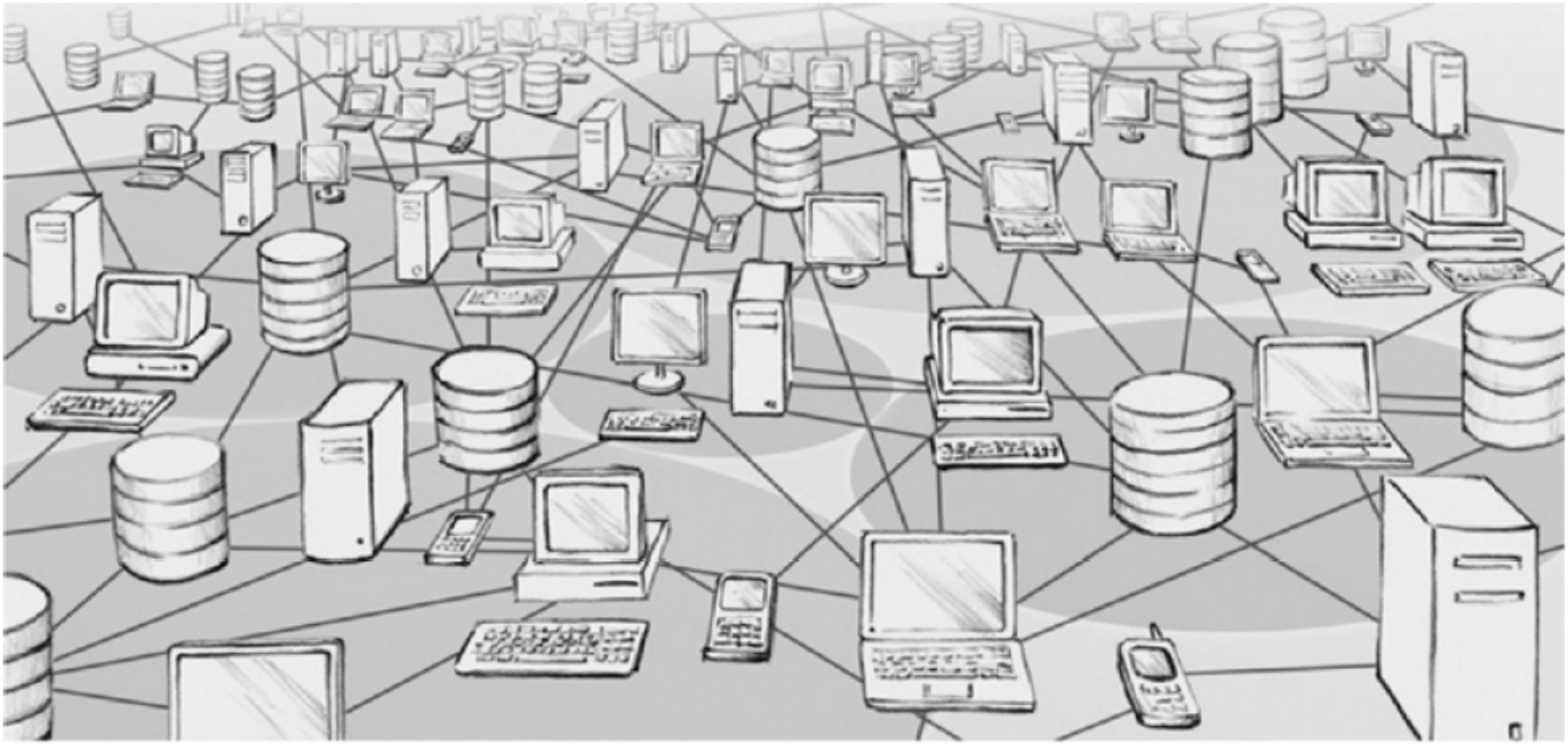
- The strategic alignment model distinguishes between aspects of
  - business strategy and organisational infrastructure
  - IT strategy and IT infrastructure
- Four dominant perspectives to tackle alignment between these aspects:
  - take the business strategy as the starting point and derive the IT infrastructure either
    - via IT strategy or
    - through organisational infrastructure
  - focus on IT as an enabler and start from IT strategy deriving organisational infrastructure
    - via business strategy or
    - based on IT infrastructure

from (Lankhorst et al. 2005)

In Practice, Enterprises see themselves hampered in their Ability to Change in Several Ways

- being uninformed about their own products, services, capabilities, internal structures
- traditionally organisations were designed with efficiency and effectiveness in mind rather than agility
- no common understanding and governance of key data resources
- a plethora of legacy applications and infrastructures
- duplicated functionality in terms of people and/or technology
- interwoven and unclear responsibilities
- organisational silos, self-contained business units who operate on their own, with no sharing of data
- silo applications, i.e. self-contained and isolated applciations, which only provide functionality to a specific business process
- old generation ERP systems embedded in the organisation‘s package based silos

Common Situation



Definitions

- **Architecture** is a fundamental organisation of a system embodied in its components, their relationships to each other, and to the environment, and the principle guiding ist design and evolution.
- **Enterprise**: any collection of organisations that has a common set of goals and/or a single bottom line
- **Enterprise Architecture**: a coherent whole of principles, methods, and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure
- **Informations Systems Architecture**: synonym for Enterprise Architecture

(Lankhorst et al. 2005, pp. 2f)

Enterprise Architecture

- An Enterprise Architecture contains all *relevant*
  - Business structures
  - IT structures
  - and their relationships
- Enterprise Architecture gives an overall view on the enterprise
  - merge distributed information from various organisational entities and projects into a whole
  - show the interconnectedness and dependencies between these information

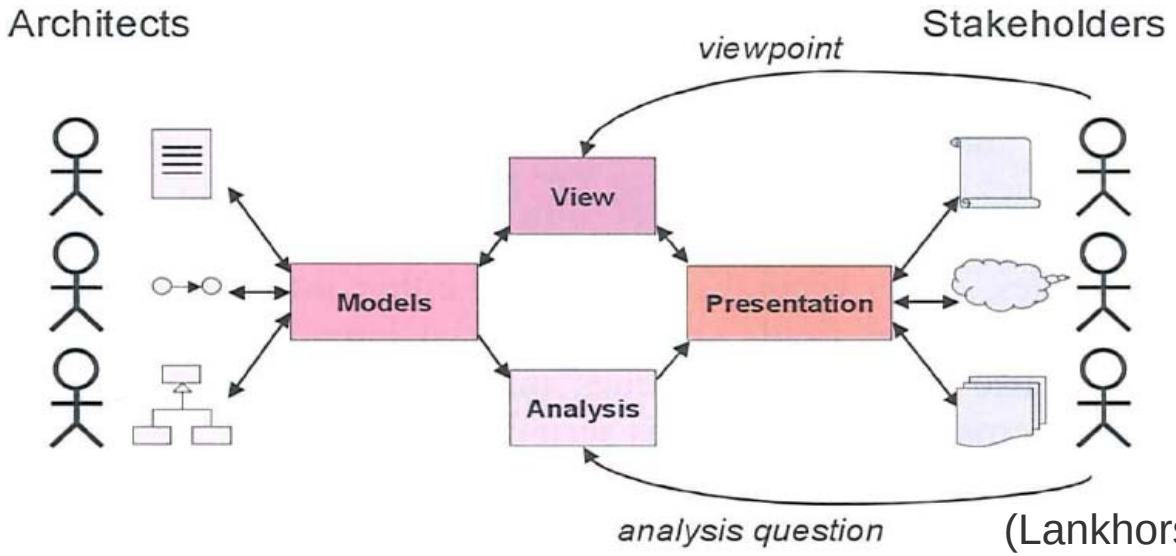
➢ Show which information systems contribute to which business processes.

Objective of Enterprise Architecture

- Ensuring alignment of business strategy and IT investments
- Describing the interaction between business and information technology
- Making dependencies and implications of changes in business and IT transparent
- Supports communication between different stakeholders by approrpiate models

Communicating about Architecture

- Different types of stakeholders have their own viewpoints on the architecture
- Architectures are subject to change; methods to analyse the effects of changes are necessary
- An integrated set of methods for specification, analysis and communication of architectures is needed that fulfils the needs of different types of stakeholders



(Lankhorst et al. 2005, p. 4)

Business Process Perspective

- From the business process perspective, enterprise architecture achieves enterprise integration through
  - capturing and describing processes, strategies, organisation structures, information and material flow, resources etc.
  - concentration on how to perform core business processes in an organisation
  - considering the information and material flow in the entire process
- In this sense, business process management (BPM) and business process re-engineering (BPR) rely on enterprise architecture
- Tools for BPM and BPR are part of the toolset of enterprise architecture

(Bernus et al. 2003, p. 9f)

Enterprise Architecture Frameworks

- Zachman Framework
  - Origin and basis for many other apporach
- The Open Group Architecture Framework (TOGAF)
  - TOGAF is based on the „Technical Architecture Framework for Information Management“ (TAFIM) of the US Department of Defense (DoD)
- US Federal Enterprise Architecture Framework (FEAF)
  - Structure for enterprise architectures of US Administrations
  - supports the development of standardized processes
- Department of Defense Architecture Framework (DoDAF)
  - used for enterprise architectures in the US military sector
  - especially suited for large systems with complex integration and communition tasks
- Extended Enterprise Architecture Framework (E2AF)
  - based on existing frameworks like FEAF and TOGAF

Vgl. (Hanschke 2009)

Zachman Framework

- The Zachman framework is regarded the origin of enterprise architecture frameworks (although originally called "Framework for Information Systems Architecture")
- John A. Zachman published the first version in 1987, which he extended in 1992 together with John F. Sowa
- The Framework is often referenced as a standard approach for expressing the basic elements of enterprise architecture
- The framework is a logical structure for classifying and organising the descriptive representations of an enterprise that are significant to
  - the management of the enterprise
  - the development of the enterprise's systems

(Lankhorst et al. 2005, p. 24)

Dimension 1 – Perspectives

Zachman uses the analogy of classical architecture

For the different stakeholders different aspects of a building are relevant - models of the building from different perspectives

Bubble charts: conceptual representation delivered by the architect

Architect's drawing: transcription of the owner's perceptual requirements – *owner's perspective*

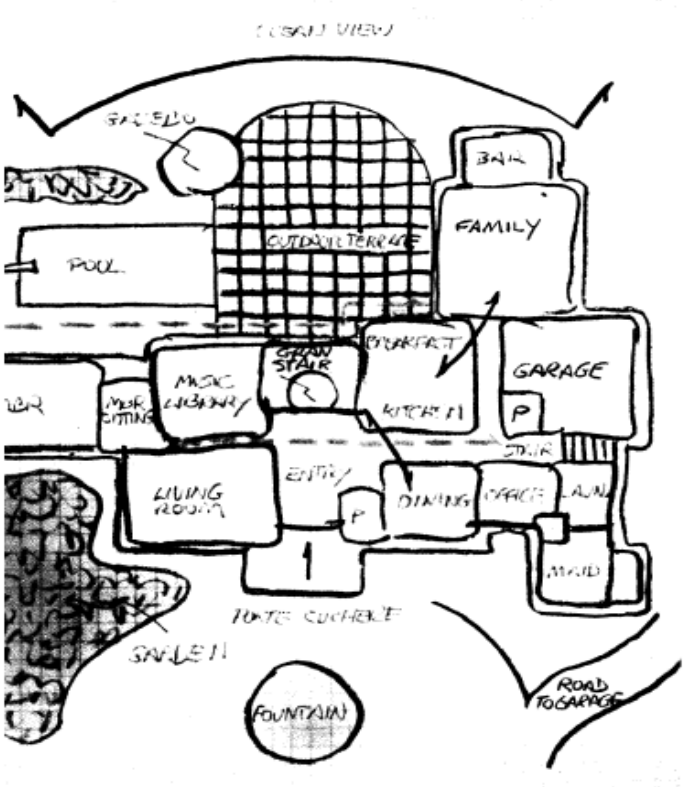
Architect's plans: translation of the owner's requirements into a product – *designer's perspective*

Contractor's plans: phases of operation, architect's plans contrained by nature and technology – *builder's perspective*

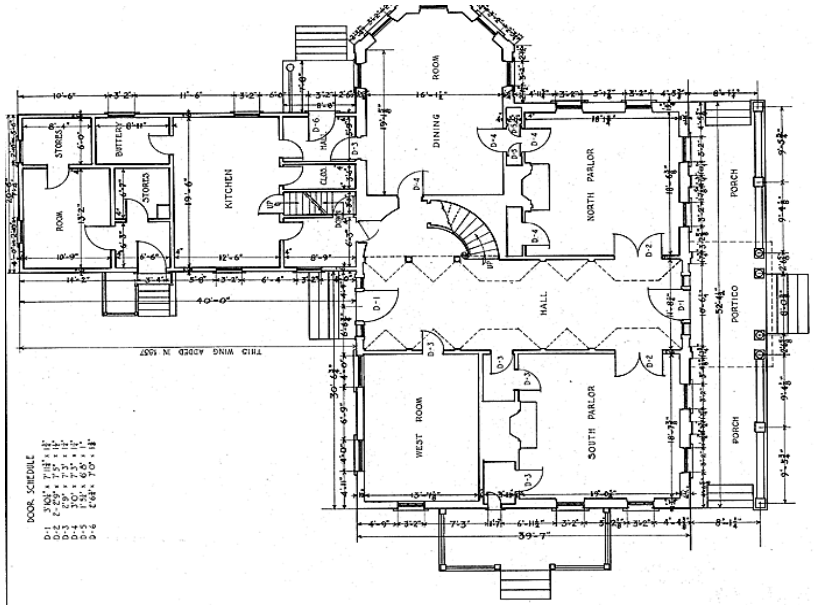
Shop plans: parts/sections/components of building details (out-of-context specification) – *subcontractor's perspective*

The building: physical building itself

(Zachman 1987)



Bubble Chart



Architect‘s Plan

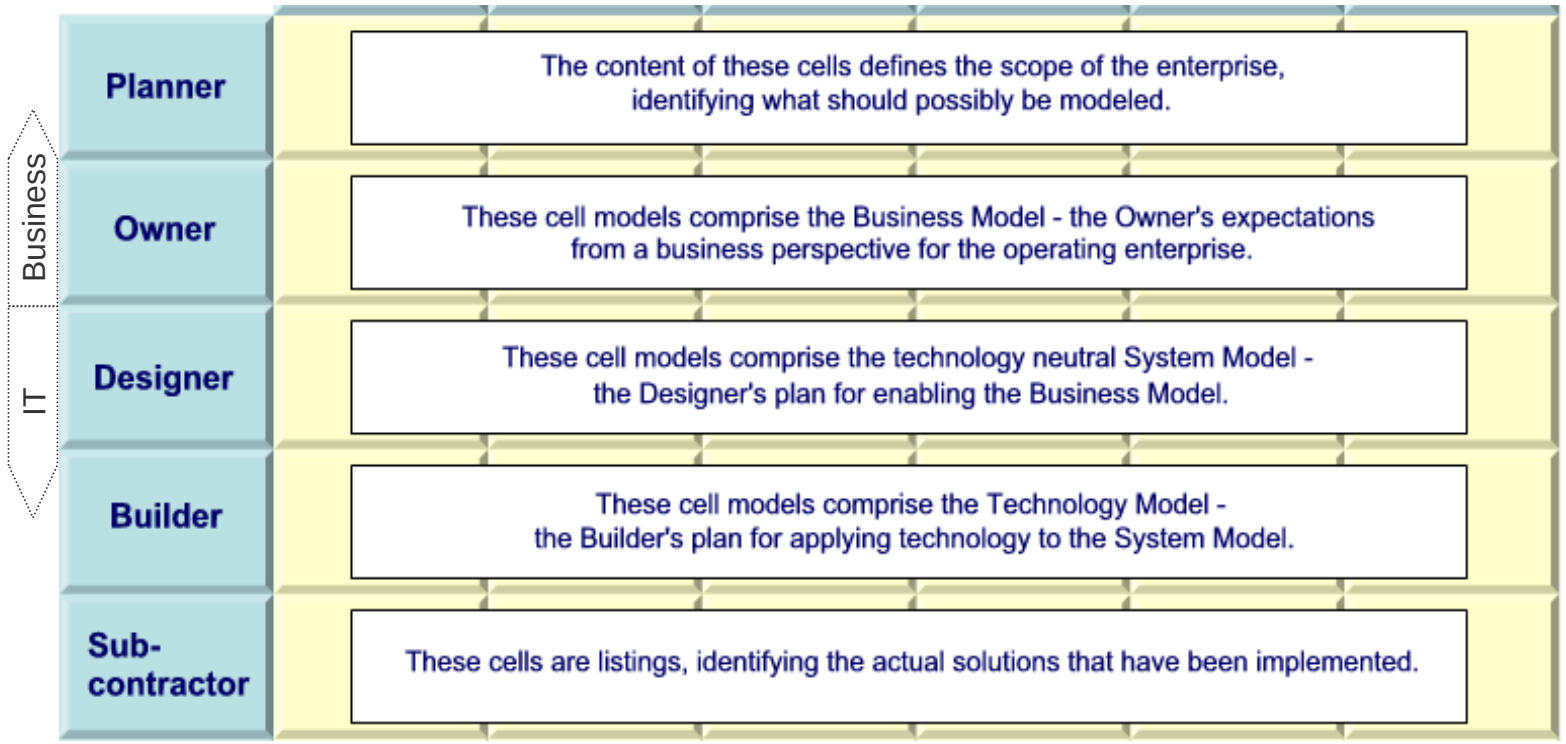
(Zachman 1987)

Dimension 1: Architectural Representations with analogs in Building and Information Systems

Generic	Buildings	Information Systems
Ballpark	Bubble charts	Scope/objectives
Owner's representation	Architect's drawings	Model of the business (or business description)
Designer's representation	Architect's plans	Model of the information system (or information system description)
Builder's representation	Contractor's plans	Technology model (or technology-constrained description)
Out-of-context representation	Shop plans	Detailed description
Machine language representation	—	Machine language description (or object code)
Product	Building	Information system

(Zachman 1987)

Dimension 1 - Perspectives



- Each representation is different nature, in content, in semantics from the others – representing different perspectives
- Representations do not correspond to different levels of details – level of detail is an independent variable, varying within one representation

Dimension 2: Aspects of an Architecture

- There exist different types of descriptions oriented to different aspects
- Zachman associates each aspect with question word

WHAT	material description
HOW	functional description
WHERE	location description
WHO	organisational description
WHEN	temporal description
WHY	motivational description

(Zachman 1987)

Combination of the two ideas

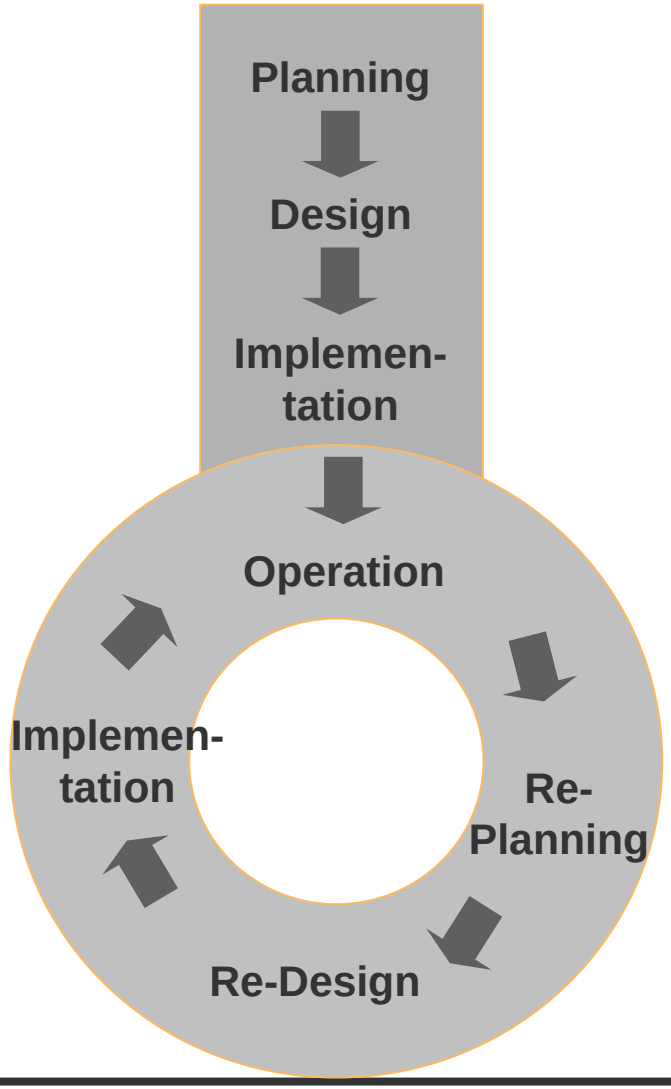
For each different type of description there are different perspectives:

	What	How	Where	Who	When	Why
Planner	The content of these cells defines the scope of the enterprise, identifying what should possibly be modeled.					
Owner	These cell models comprise the Business Model - the Owner's expectations from a business perspective for the operating enterprise.					
Designer	These cell models comprise the technology neutral System Model - the Designer's plan for enabling the Business Model.					
Builder	These cell models comprise the Technology Model - the Builder's plan for applying technology to the System Model.					
Sub-contractor	These cells are listings, identifying the actual solutions that have been implemented.					
Functioning Enterprise	The functioning enterprise.					

Zachman Framework – each cell contains models

	What (Data)	How (Function)	Where (Locations)	Who (People)	When (Time)	Why (Motivation)
Scope {contextual} Planner	List of things important to the business	List of processes that the business performs	List of locations in which the business operatses	List of organizations important to the business	List of events/ cycles important to the business	List of business goals/strategies
Enterprise Model {conceptual} Business Owner	e.g. Semantic Model	e.g. Business Process Model	e.g. Business Logistics System	e.g. Workflow Model	e.g. Master Schedule	e.g. Business Plan
System Model {logical} Designer	e.g. Logical Data Model	e.g. Application Architecture	e.g. Distributed System Architecture	e.g. Human Interface Architecture	e.g. Process Structure	e.g. Business Rule Model
Technology Model {physical} Implementer	e.g. Physical Data Model	e.g. System Design	e.g. Technology Architecture	e.g. Presentation Architecture	e.g. Control Structure	e.g. Rule Design
Detailed Representation {out-of-context} Subcontractor	e.g. Data Definition	e.g. Program	e.g. Network Architecture	e.g. Security Architecture	e.g. Timing Definition	e.g. Rule Definition
Functioning System	e.g. Data	e.g. Function	e.g. Network	e.g. Organization	e.g. Schedule	e.g. Strategy

New Development vs Re-organisation



- Use of the models
  - Designing a new systems (analogy: building a new house)
  - Reorganisation of the enterprise (analogy: reconstructing a building)
- Reorganisation of the enterprise is more frequent than reconstruction of a building
  - Agility!
- Enterprise Architecure is a living thing

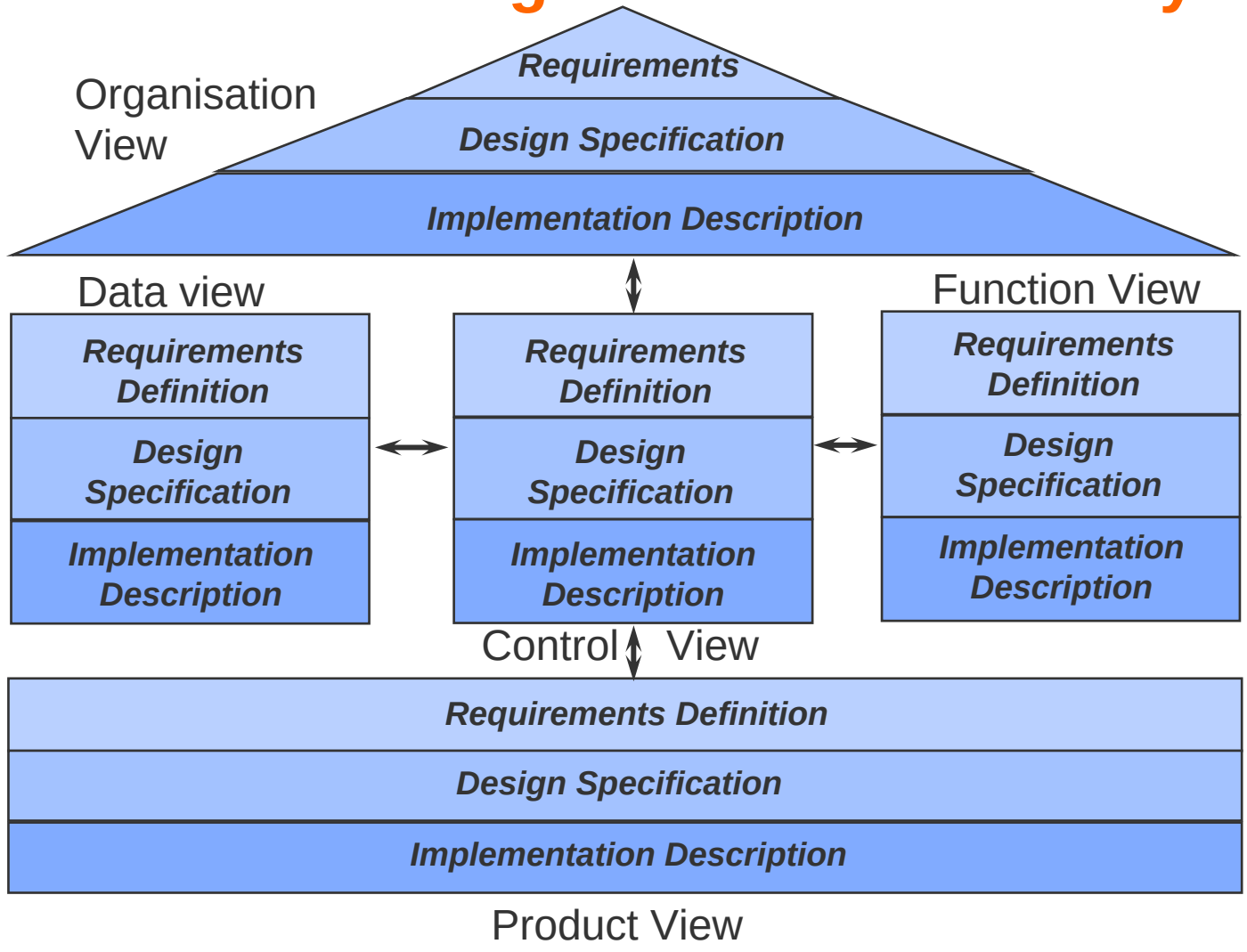
Agility means Re-organisation

- Business and IT alignment can start
  - top-down: Business defines requirements for IT
  - bottom-up: IT as enabler for new business, e.g. e-business
- But: change in the enterprise is always a mixture
- Satisfying business requirements is usually a compromise
  - There are *already systems available* that cannot be replaced (reasons can be costs or other dependencies)
  - Standards set by IT strategy avoid unmanagable varieties and ensure reliability
  - Centralisation reduces costs at the expense of specialisation

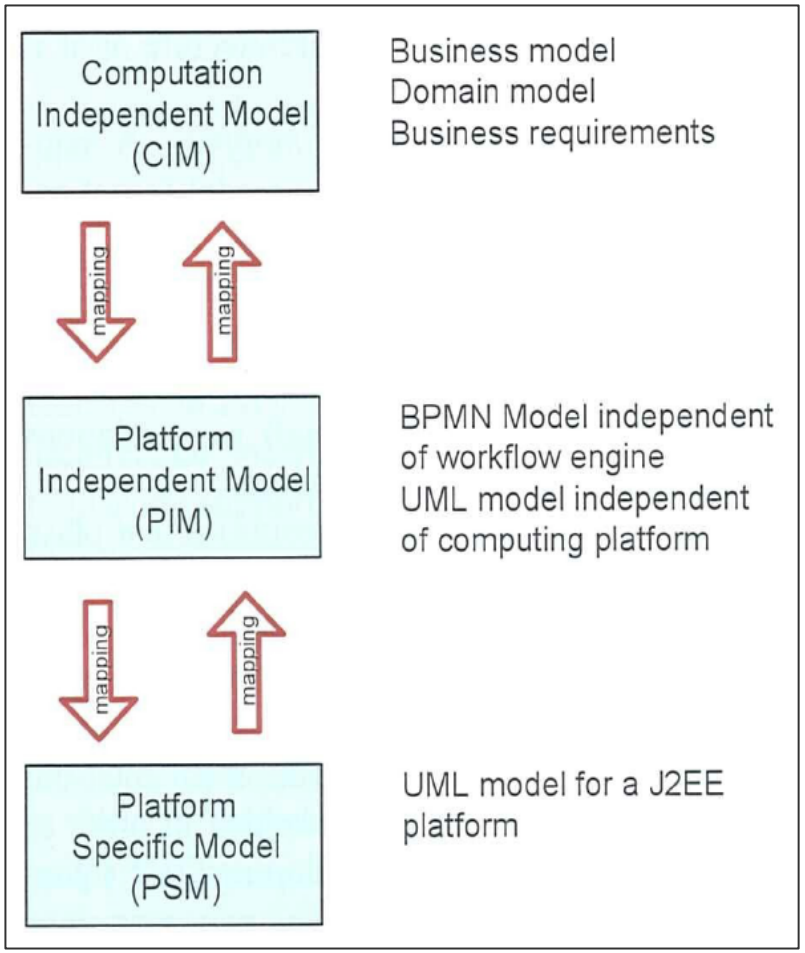
Alternative Frameworks

- Die distinction between perspectives and aspects can be found in various other frameworks, e.g.
  - MDA - Model-driven Architecture
  - ARIS – Architecture of integrated Information Systems
  - BPMS - Business Process Management Systems
  - Best Practice Enterprise Architecture
  - PlugIT Modelling Framework
  - TOGAF - The Open Group Architecture Framework
- They vary in the number and concrete definition of perspectives and aspects

ARIS – Architecture for integrated Information Systems



OMG's Model-Driven Architecture MDA



MDA comprises three levels of abstraction with mappings between them

CIM Computation-Independent Model

- modelling the requirements for the system describing the situation in which the system will be used
- hiding much or all information about the use of IT systems

PIM Platform-Independent Model

- describing operations of the system while hiding details for a particular platform
- describing those parts of the system specification that do not change from one platform to another

PSM Platform-Specific Model

- Combines specifications of PIM with details about a particular type of platform

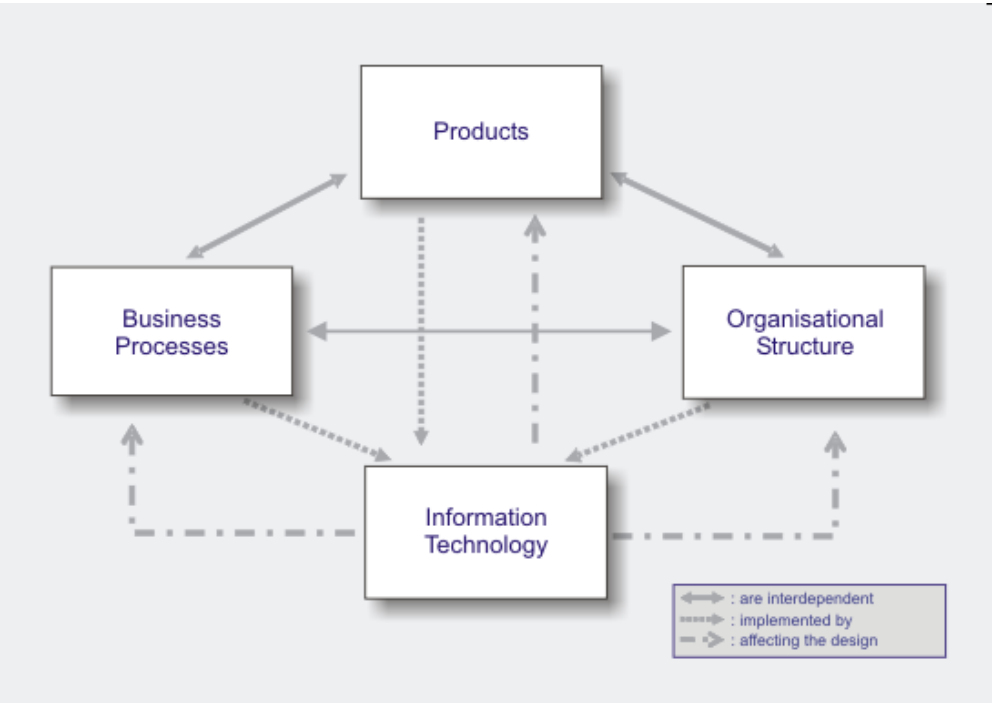
The levels correspond to perspectives

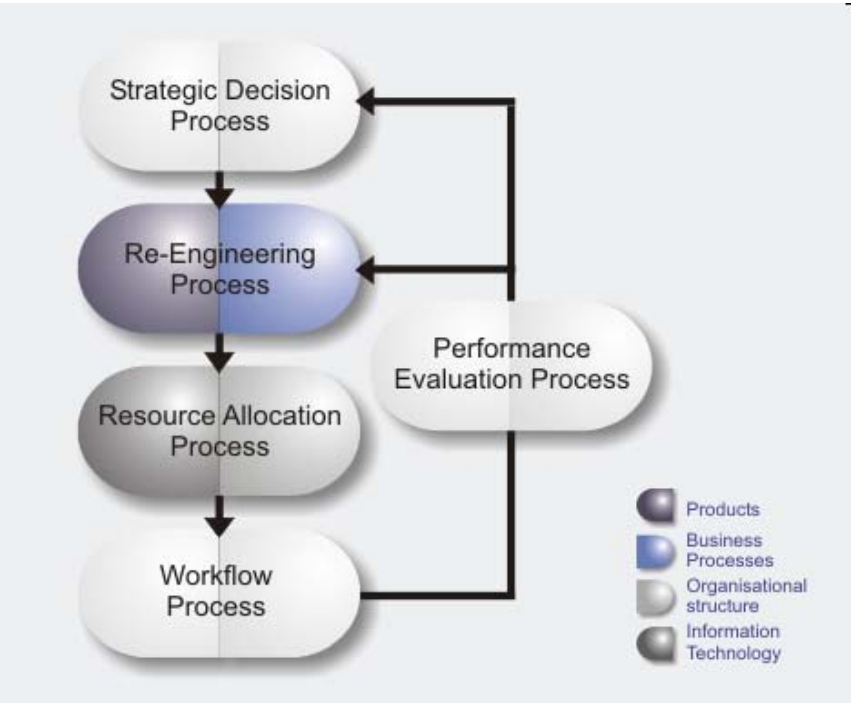
OMG's Model-Driven Architecture

- MDA is provided by Object Management Group OMG
- Aims to provide an open, vendor-neutral approach to interoperability
- Builds upon OMG's modelling standards
  - Unified Modelling Language UML
  - Meta Object Facility MOF
- MDA wants to raise the level of abstraction at which software solutions are specified
  - generate code from models and views
  - Example: specify software in UML instead of programming it in Java
- Recenty, OMG has extended the focus of MDA to cover business aspects of a company, e.g.
  - Business process modelling notation BPMN
  - Business motivation model BMM
  - Semantics for Business Vocabulary and Rules SBVR

(Lankhorst et al. 2005, p. 25f)

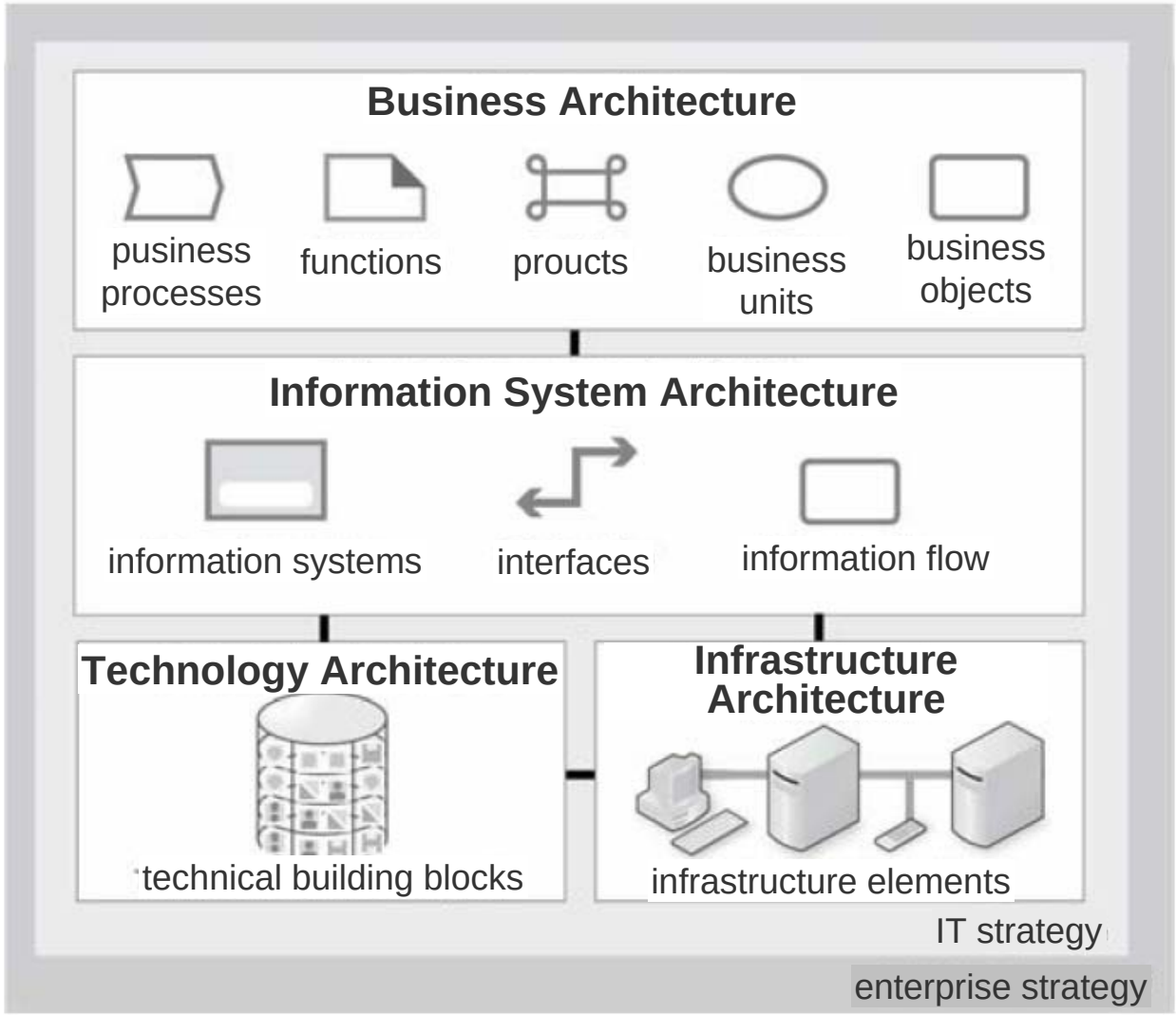
Aspects und Perspectives fo the BPMS Paradigm (Business Process Management Systems)





http://www.boc-eu.com

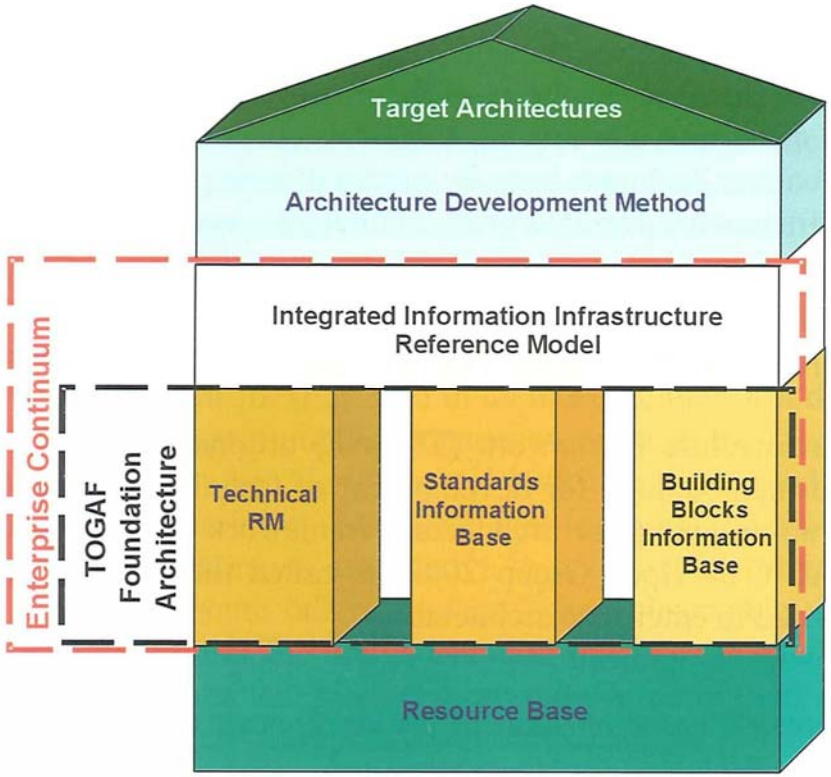
Best Practice Enterprise Architecture



Teilarchitekturen der Best Practice Architektur

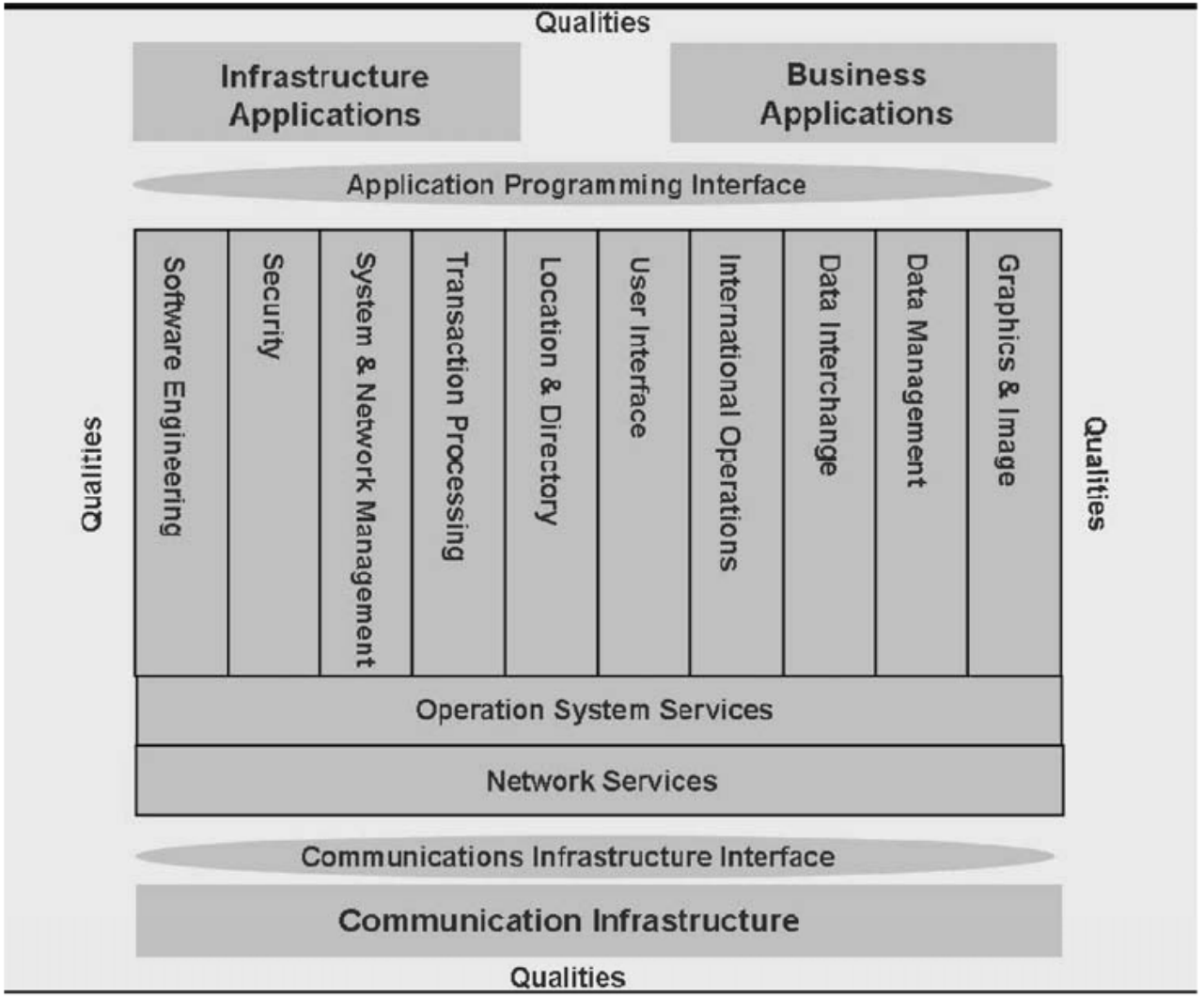
- **Business Architecture**
  - Describing main entities that determine the business: business processes, functions, products, business units and business objects.
- **Application Architecture**
  - documentation of the information systems landscape, i.e. information systems, their data und interfaces und the information flow
  - bridge between business architecture and the architectures of technology and infrastructure
- **Technology Architecture**
  - determination of enterprise-specific technical standards for information systems, interfaces and infrastructure
- **Infrastructure Architecture**
  - Entities of the infrastructure, on which the information systems are running

TOGAF - The Open Group Architecture Framework



- Building Blocks and method to develop enterprise architectures
- Architecture Development Method (ADM)
  - generic method for the development of an enterprise architecture
  - Objectives, approaches, needed input, acitivities and results for each pahse of the life cycle
- Enterprise Continuum
  - reference description in form of graphical models and text documents
  - Foundation Architecture
    - Building Blocks: Services and functions an architecture has to support:
    - Technical Reference Modell (TRM): defines the regulation framework
    - Standard Information Base (SIB): technical building blocks standardized for the enterprise
  - Integrated Information Infrastructure Reference Model
    - Description of reference architecture for the integration of Information systems
- Resource Base
  - templates, case studies etc

TOGAF Technical Reference Model

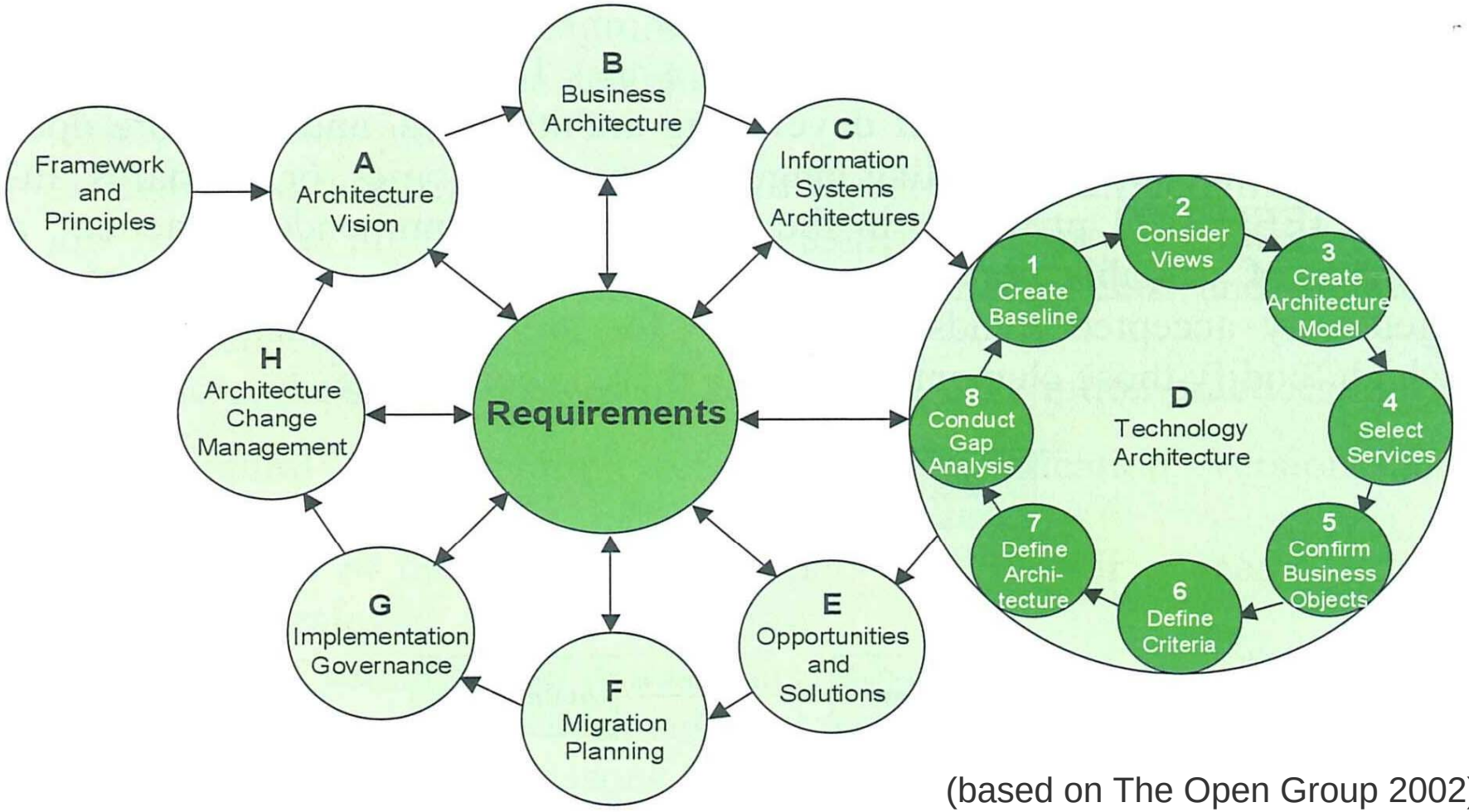


TOGAF Architecture Views

- The model of an enterprise architecture described in TOGAF distinguishes four partial architectures:
  - **Business Architecture**
    - Strategies, governance, organisation and business processes of the enterprise
  - **Data Architecture**
    - data and their releations as well as principles for the organisation and the management of resources
  - **Application Architecture**
    - information systems and their relations to business processes
  - **Technology Architecture**
    - currenct technical realisation and future enterprise-specific standards like operating system, middleware and infrastructure

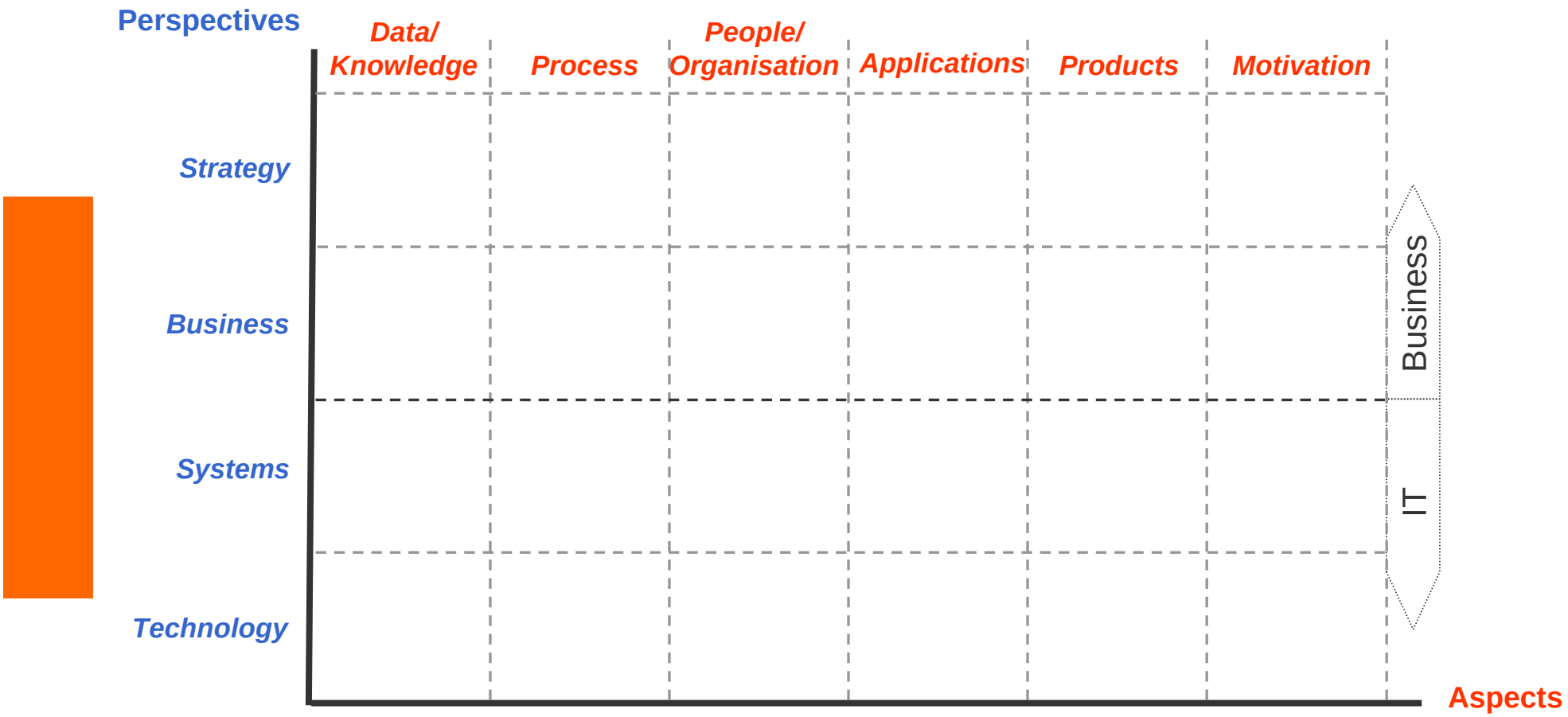
Data Architecture and Application Architecture together are the **Information System Architecture**

TOGAF Architecture Development Cycle



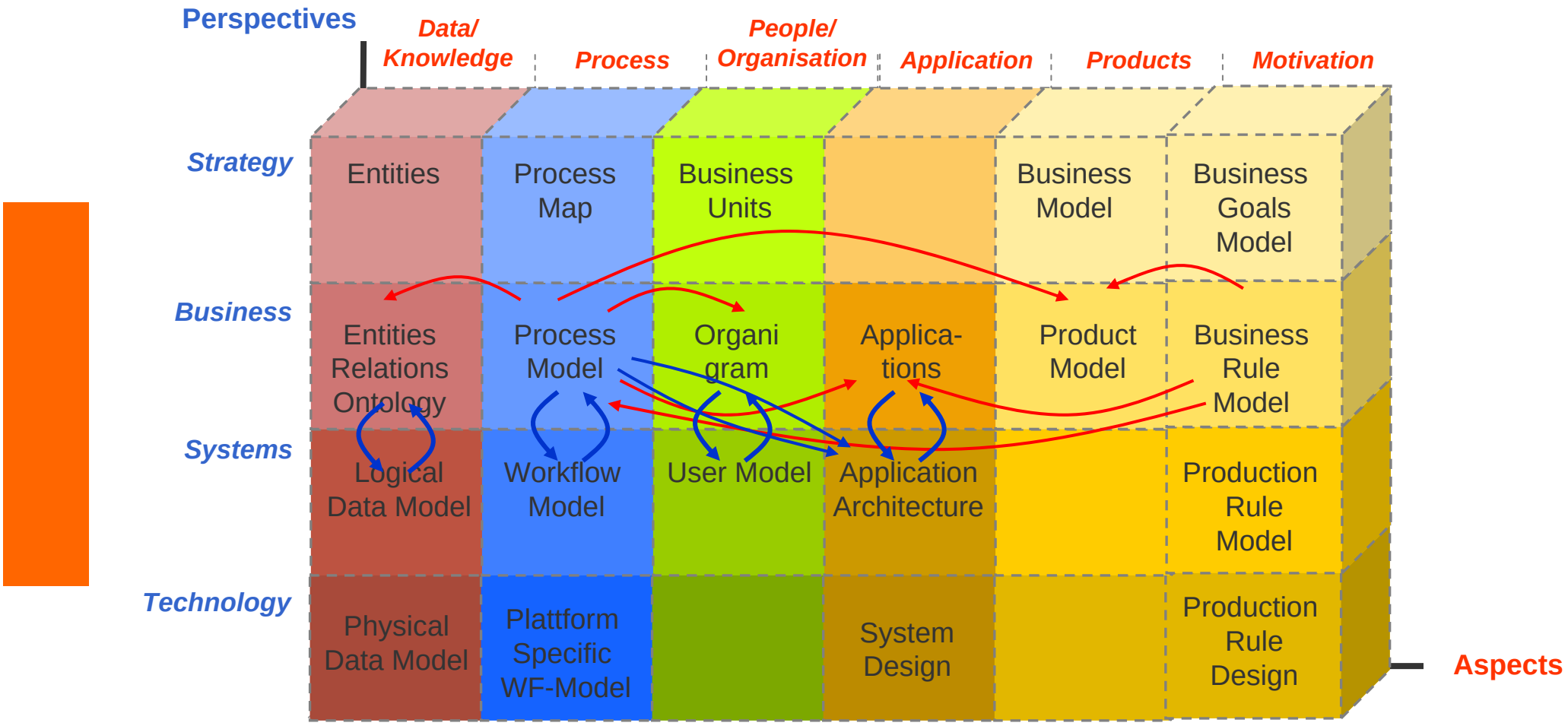
(based on The Open Group 2002)

Perpectives and Aspects in the Project plugIT



plugIT is a project funded by the EU http://plug-it-project.eu/

Relations between Models and Model Elements



Relations between Models and Model Elements

- THe models of the Framework are not isolated
- There are relations between (elements of) the models
- Horizontal Relations: In same perspective, e.g.
  - Data used in a process
  - Application implementing a process activitiy
- Vertical relations: Between different perspectives
  - Implementation of an application
  - Database model for an entity relationship model

Architecture Languages

- The unambiguous specification and description of components and especially their relationships in an architecture requires a coherent architecture modelling language – or modelling languages
- Requirements for modelling languages
  - enable integrated modelling of architectural domains
  - should be understandable by both people from IT and people with a business background
  - allow transition from "as is" to "to be": provide analysis methhods for quantitative and qualitative impact of changes
- There are no languages specifically designed for describing enterprise architectures. However, there are languages for subdomains
  - Business Process Modelling
  - Software Modelling

Architecture Languages

- Software Modelling
  - For software modelling, UML is the dominant language
- Business Modelling
  - For business process modelling there are a multitude of languages, e.g.
    - Business Process Management Notation BPMN
    - Event-driven Process Chains EPC
    - Flow Diagrams
    - Petri Nets
    - IDEF

    and a lot of vendor-specific variants
  - For other aspects there are emerging languages and standards, e.g. Business rules, Business motivation,

Perspectives, Aspects, and Frameworks