Enterprise Architecture Frameworks

Prof. Dr. Knut Hinkelmann

Chapter 3: Enterprise Architecture Frameworks

- Enterprise Architecture Frameworks
- Zachman Enterprise Ontology
- TOGAF
- ArchiMate
- Best Practice Architecture

Enterprise Architecture

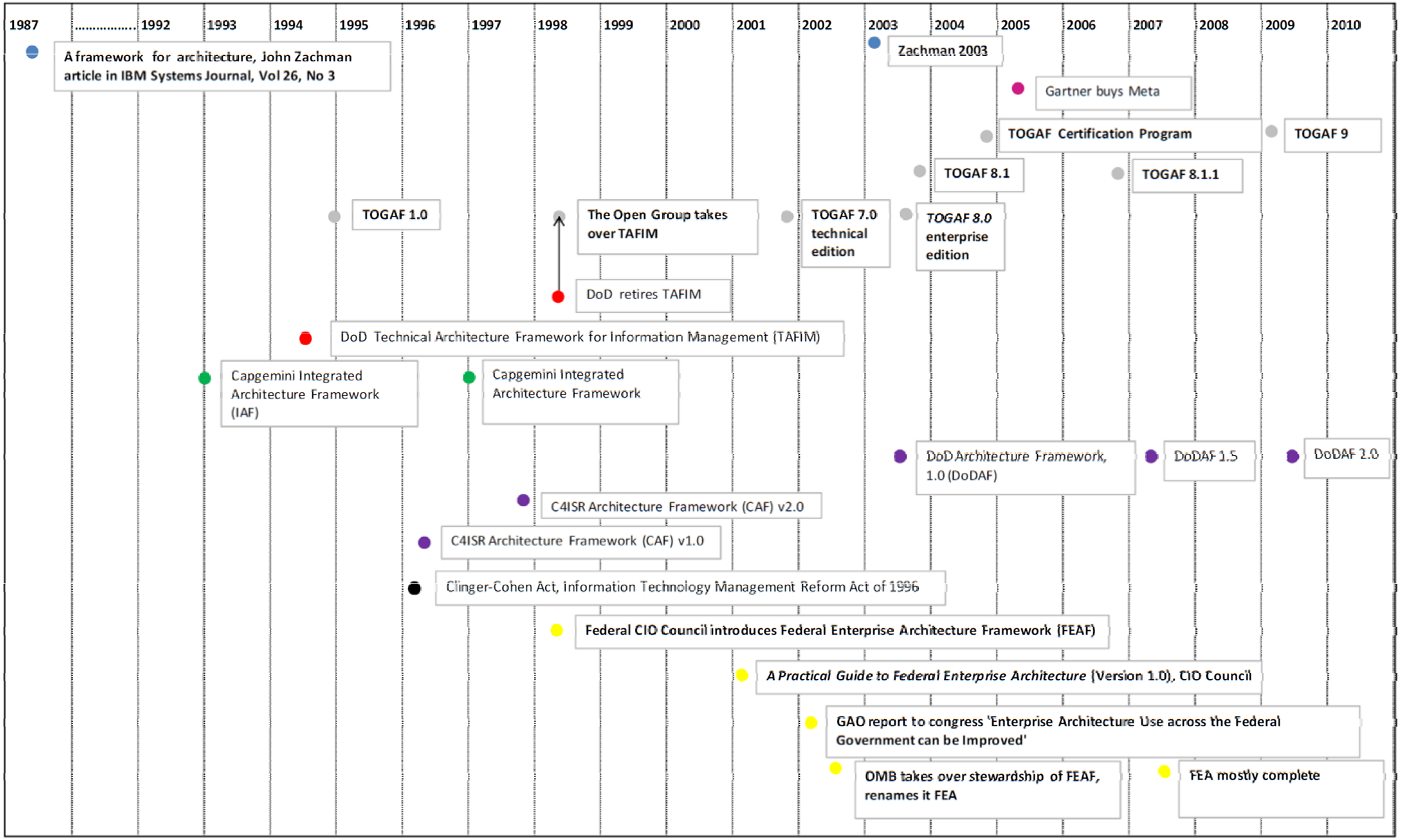
- **An Enterprise Architecture** is a coherent whole of principles, methods, and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure
- An Enterprise Architecture contains all *relevant*
  - Business 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.

Enterprise Architecture Frameworks

- There are a number of Enterprise Architecture Frameworks
- We can distinguish to main types of structures:
  - Matrix of aspects and perspectives, e.g.
    - ***Zachmann Enterprise Architecture Framework***
      - An enterprise Ontology
  - Three layer architecture with business, applications and technology
    - ***TOGAF - The Open Group Architecture Framework***
      - A methodology for Enterprise Architecture Development
    - ***ArchiMate***
      - A graphcial language for Enterprise Architecture Descritpion
    - ***Best Practice Enterprise Architecture***

Timeline of Enterprise Architecture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2010
A framework for architecture, John Zachman article in IBM Systems Journal, Vol 26, No 3
Zachman 2003
Gartner buys Meta
TOGAF Certification Program
TOGAF 9
TOGAF 8.1
TOGAF 8.1.1
TOGAF 1.0
The Open Group takes over TAFIM
TOGAF 7.0 technical edition
TOGAF 8.0 enterprise edition
DoD retires TAFIM
DoD Technical Architecture Framework for Information Management (TAFIM)
Capgemini Integrated Architecture Framework (IAF)
Capgemini Integrated Architecture Framework
DoD Architecture Framework, 1.0 (DoDAF)
DoDAF 1.5
DoDAF 2.0
C4ISR Architecture Framework (CAF) v2.0
C4ISR Architecture Framework (CAF) v1.0
Clinger-Cohen Act, Information Technology Management Reform Act of 1996
Federal CIO Council introduces Federal Enterprise Architecture Framework (FEAF)
A Practical Guide to Federal Enterprise Architecture (Version 1.0), CIO Council
GAO report to congress 'Enterprise Architecture Use across the Federal Government can be Improved'
OMB takes over stewardship of FEAF, renames it FEA
FEA mostly complete

(Bespoke Systems 2012)

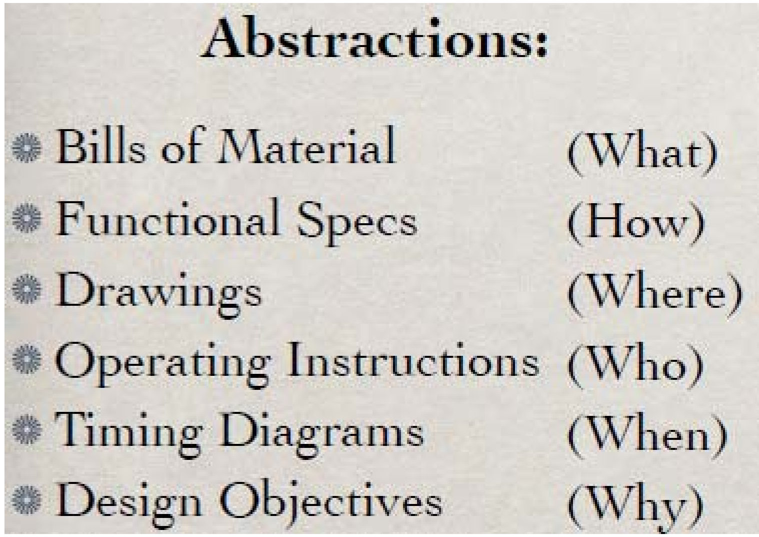
THE ZACHMAN FRAMEWORK

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
- It is still further developed by Zachman International (http://www.zachman.com)
- 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

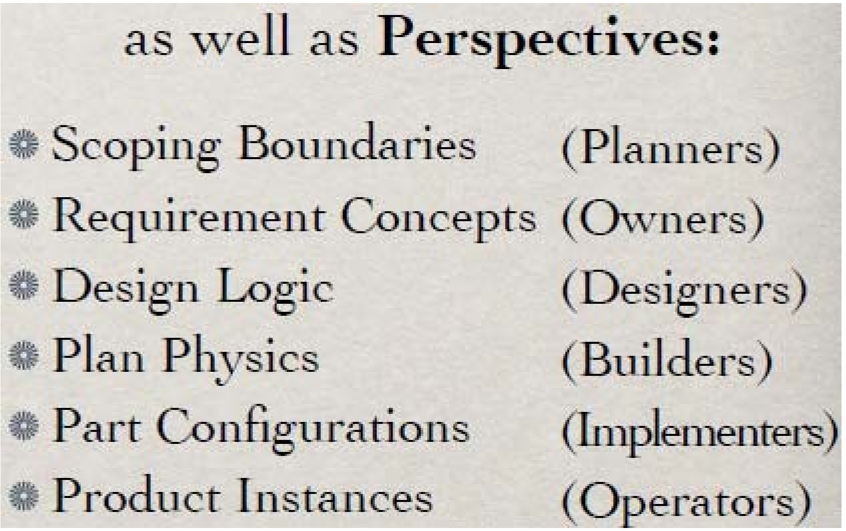
Rationale of the Zachman Architecture

- There is not a single descriptive representation for a complex object ... there is a SET of descriptive representations.
- Descriptive representations (of anything) typically include :



Abstractions:

❁ Bills of Material	(What)
❁ Functional Specs	(How)
❁ Drawings	(Where)
❁ Operating Instructions	(Who)
❁ Timing Diagrams	(When)
❁ Design Objectives	(Why)

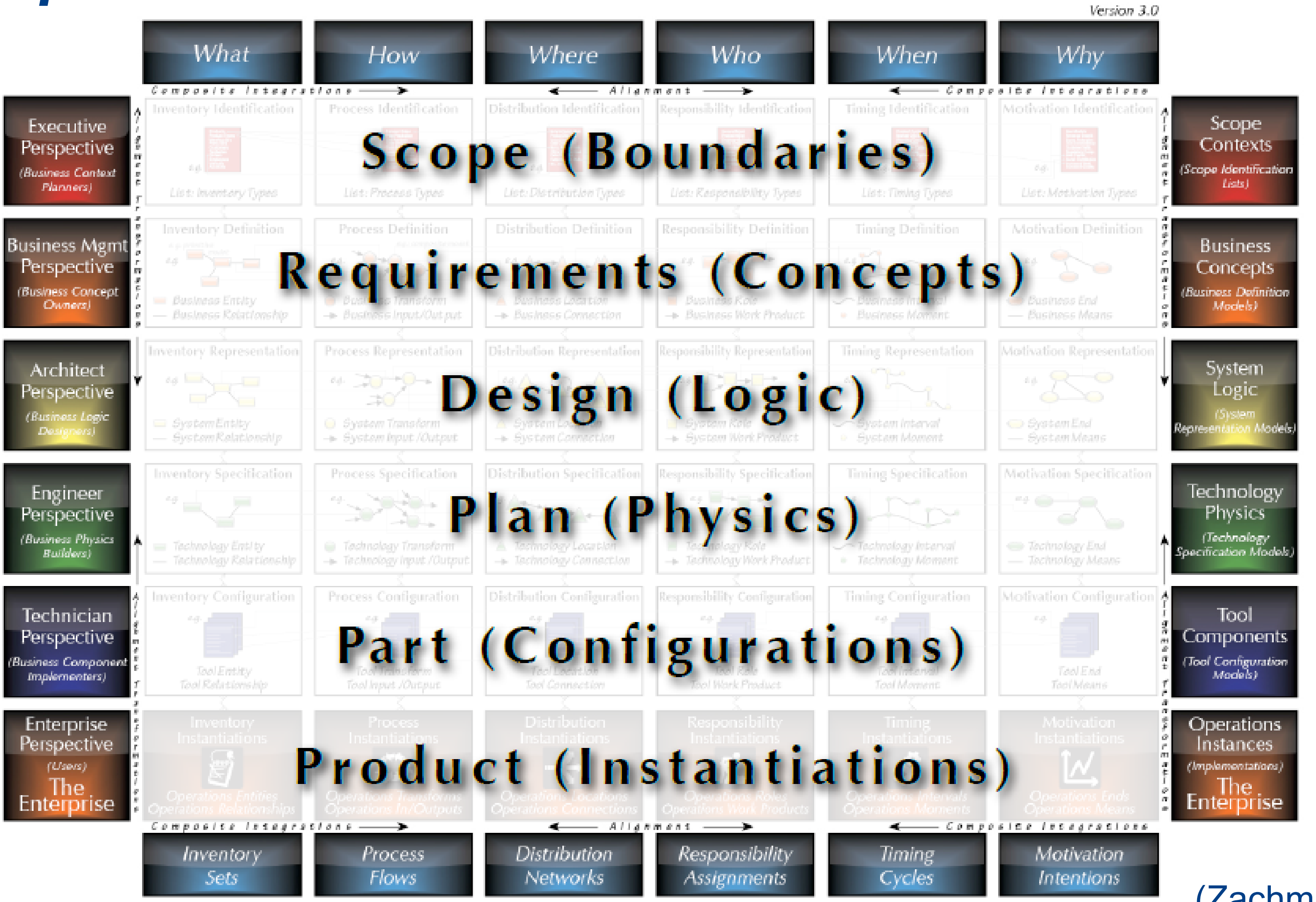


as well as **Perspectives:**

❁ Scoping Boundaries	(Planners)
❁ Requirement Concepts	(Owners)
❁ Design Logic	(Designers)
❁ Plan Physics	(Builders)
❁ Part Configurations	(Implementers)
❁ Product Instances	(Operators)

(Zachman 2012)

Perspectives


Version 3.0
What
How
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Composite Integrations
Alignment
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Business Mgmt Perspective (Business Concept Owners)
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Timing Cycles
Motivation Intentions

Scope (Boundaries)

Requirements (Concepts)

Design (Logic)

Plan (Physics)

Part (Configurations)

Product (Instantiations)

(Zachman 2012)

Dimension 1 – Perspectives

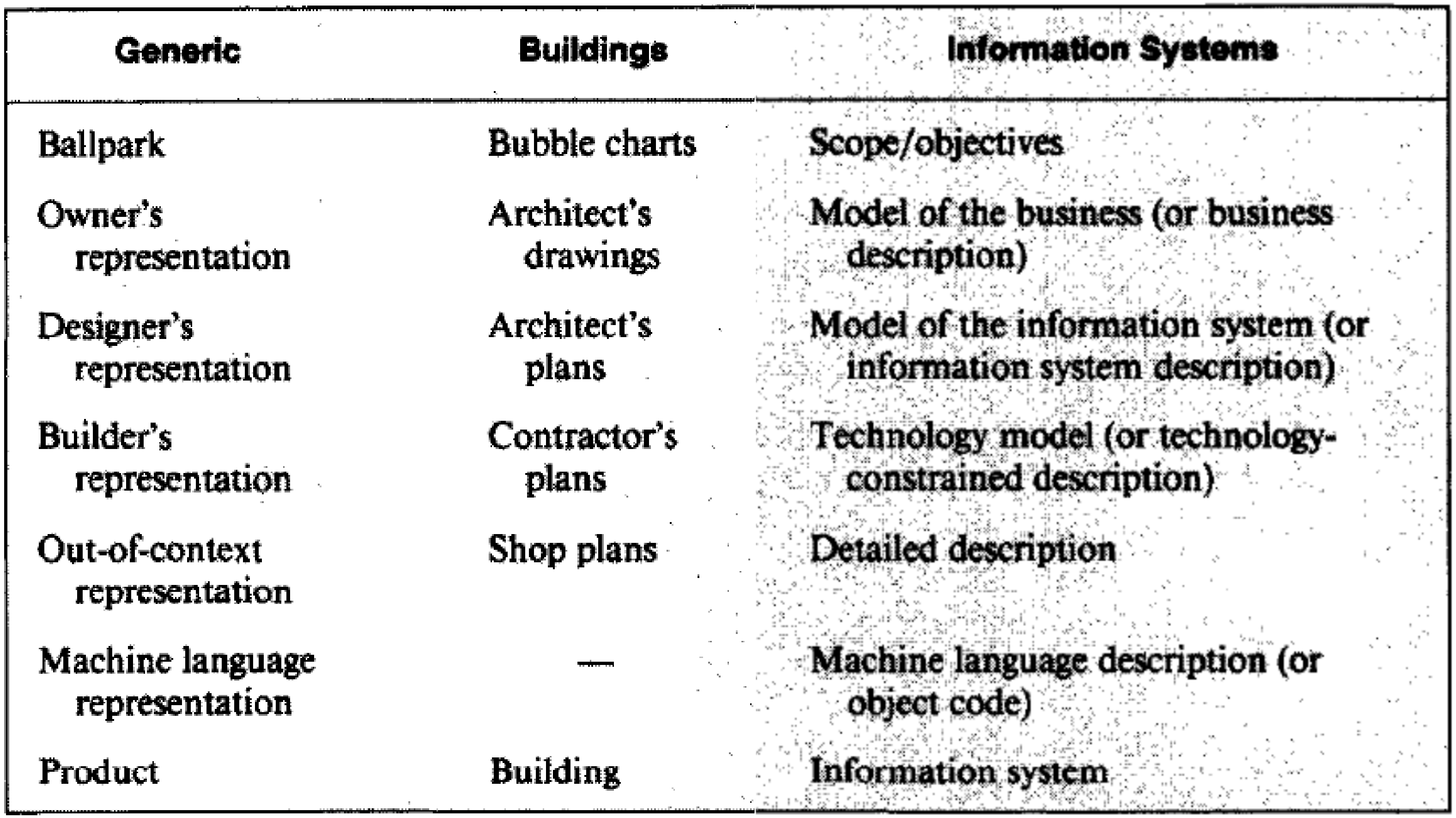
Zachman originally used the analogy of classical architecture

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)

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

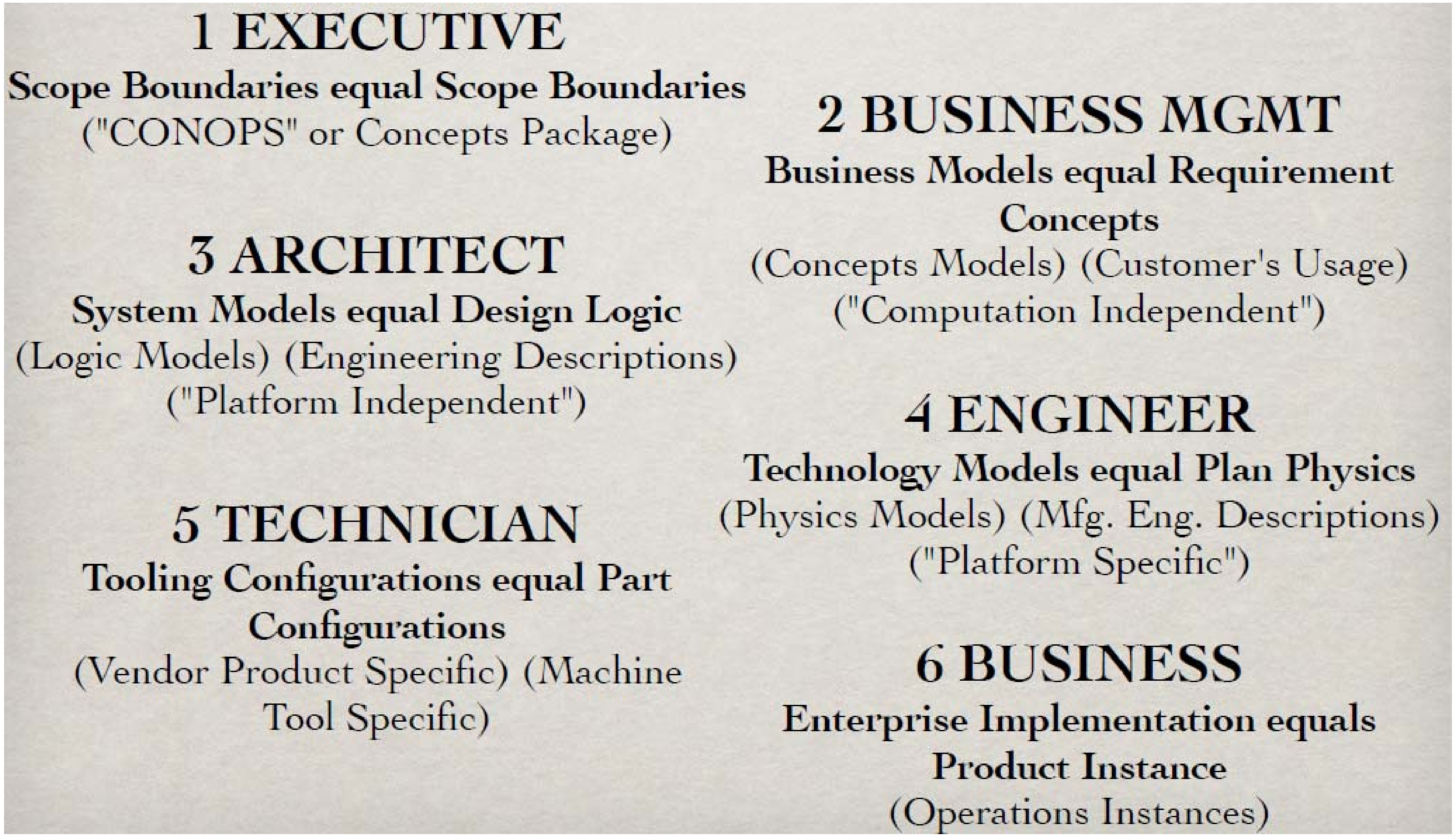


Generic	Buildings	Information Systems
Ballpark	Bubble charts	Scope/objectives
Owner's representation	Architect's drawings	Model of the business (or business description)
Designer's representation	Architect's plans	Model of the information system (or information system description)
Builder's representation	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)

Perspectives in Enterprise Architecture

The total set of descriptions would necessarily have to include **Perspectives**:



1 EXECUTIVE

Scope Boundaries equal Scope Boundaries
("CONOPS" or Concepts Package)

2 BUSINESS MGMT

Business Models equal Requirement Concepts
(Concepts Models) (Customer's Usage)
("Computation Independent")

3 ARCHITECT

System Models equal Design Logic
(Logic Models) (Engineering Descriptions)
("Platform Independent")

4 ENGINEER

Technology Models equal Plan Physics
(Physics Models) (Mfg. Eng. Descriptions)
("Platform Specific")

5 TECHNICIAN

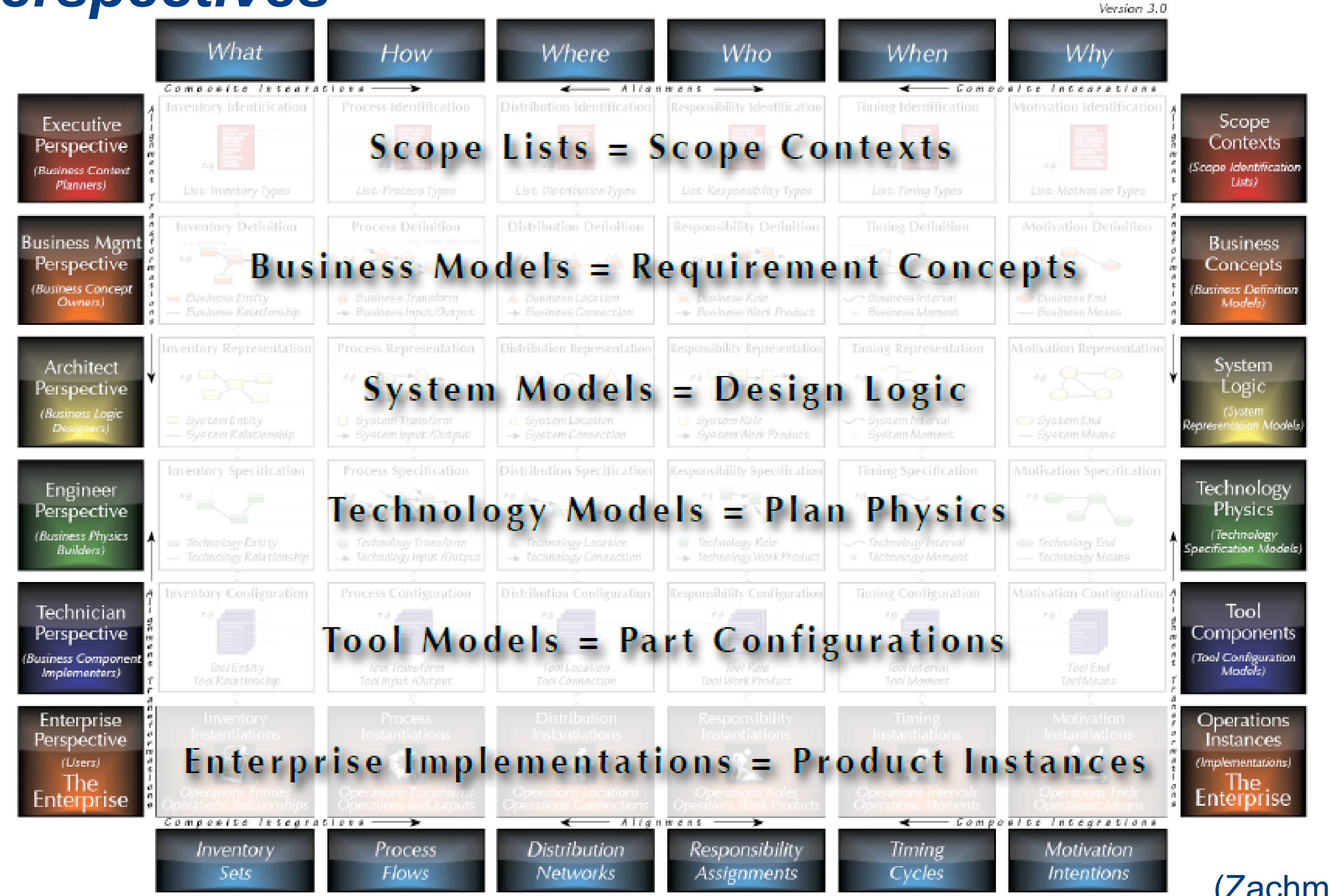
Tooling Configurations equal Part Configurations
(Vendor Product Specific) (Machine Tool Specific)

6 BUSINESS

Enterprise Implementation equals Product Instance
(Operations Instances)

(Zachman 2012)

Perspectives



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Timing Cycles
Motivation Intentions

Scope Lists = Scope Contexts

Business Models = Requirement Concepts

System Models = Design Logic

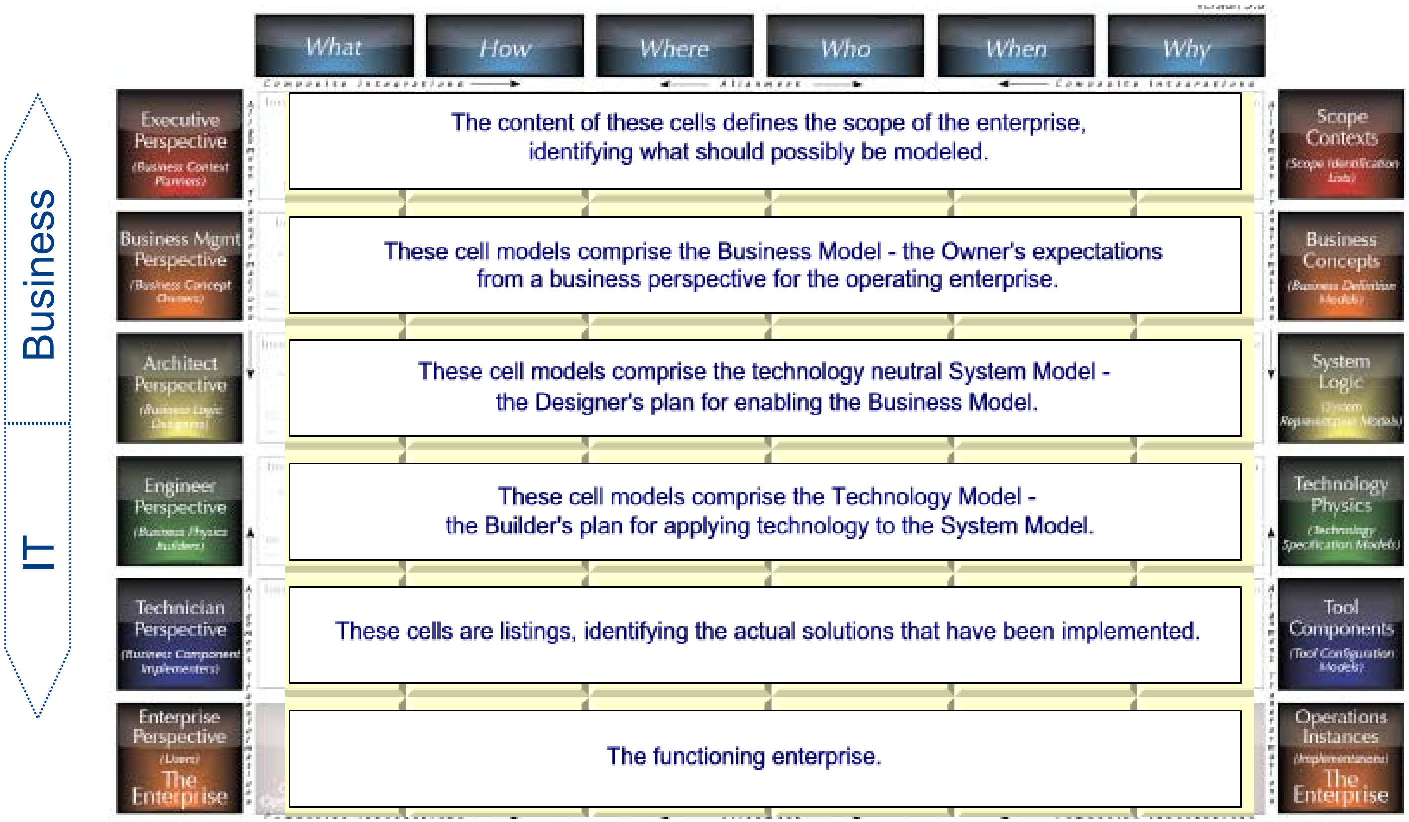
Technology Models = Plan Physics

Tool Models = Part Configurations

Enterprise Implementations = Product Instances

(Zachman 2012)

Perspectives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The content of these cells defines the scope of the enterprise, identifying what should possibly be modeled.

These cell models comprise the Business Model - the Owner's expectations from a business perspective for the operating enterprise.

These cell models comprise the technology neutral System Model - the Designer's plan for enabling the Business Model.

These cell models comprise the Technology Model - the Builder's plan for applying technology to the System Model.

These cells are listings, identifying the actual solutions that have been implemented.

The functioning enterprise.

Scope (Boundaries)

Requirements (Concepts)

Design (Logic)

Plan (Physics)

Part (Configurations)

Product (Instances)

- Each row is different in 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

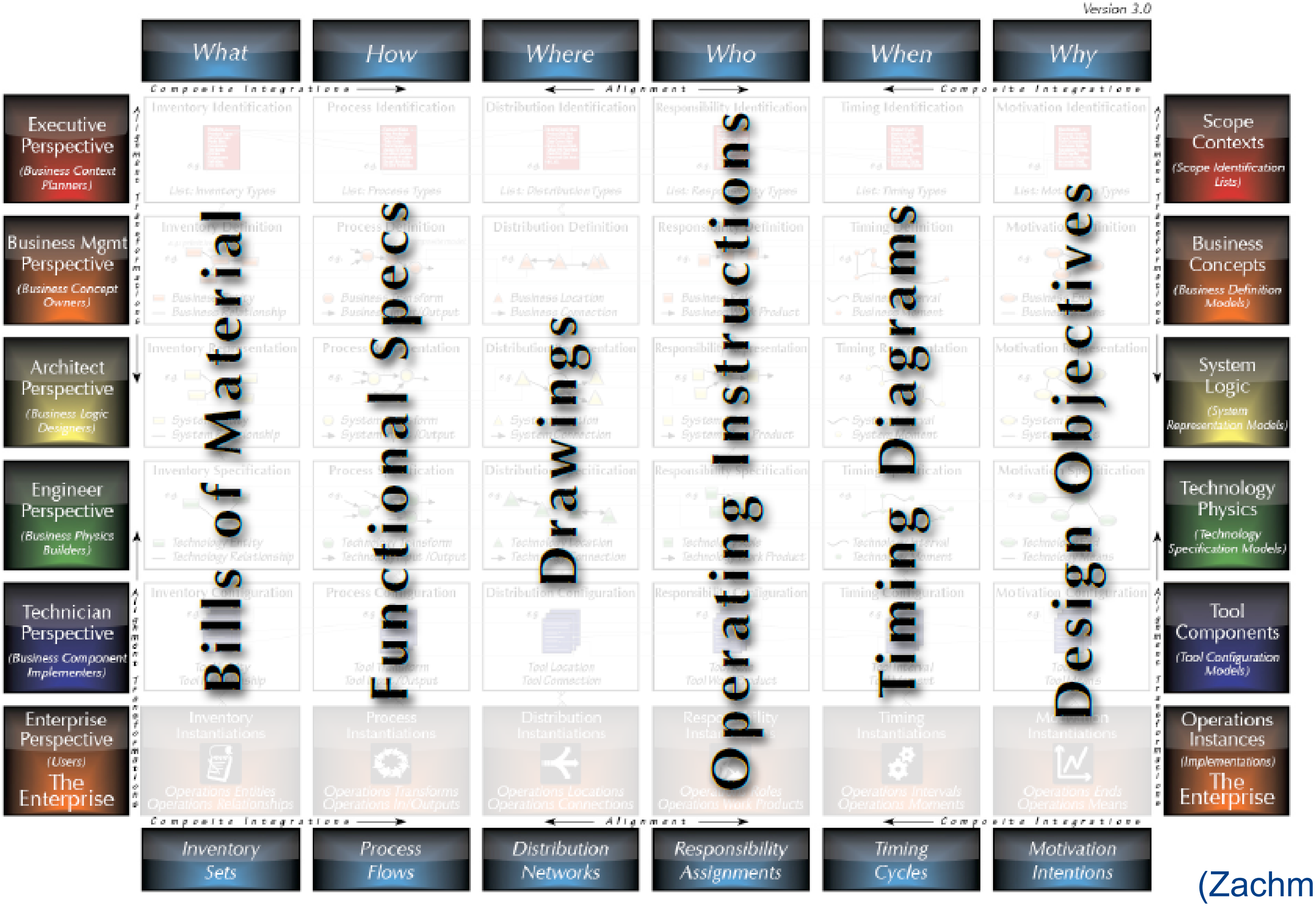
Dimension 2: Aspects of an Architecture

- 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)

Abstractions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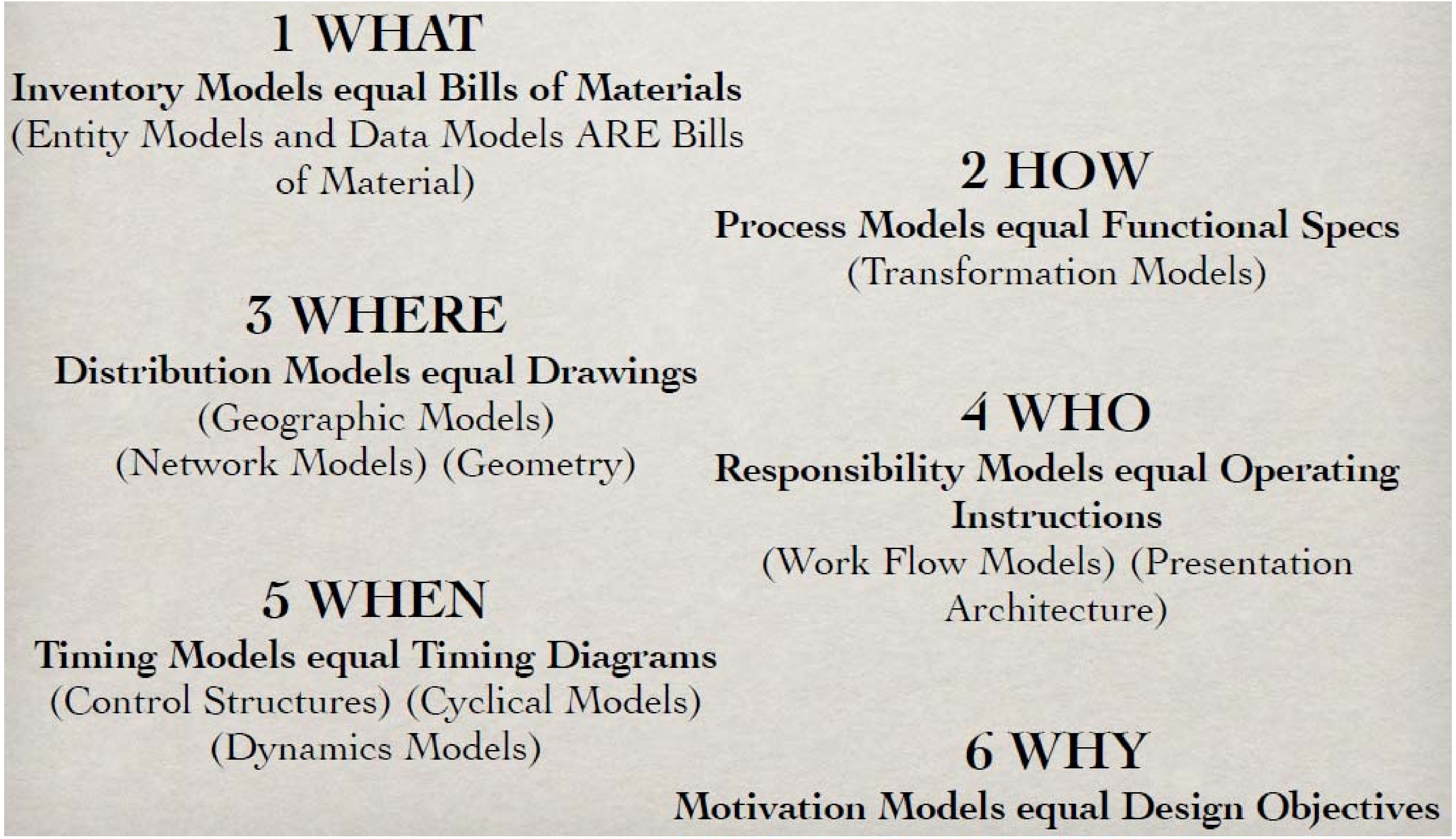
Operations Transforms Operations In/Outputs
Operations Locations Operations Connections
Operations Roles Operations Work Products
Operations Intervals Operations Moments
Operations Ends Operations Means
Inventory Sets
Process Flows
Distribution Networks
Responsibility Assignments
Timing Cycles
Motivation Intentions
Bills of Material
Functional Specs
Drawings
Operating Instructions
Timing Diagrams
Design Objectives

(Zachman 2012)

Abstractions in Enterprise Architecture

The total set of descriptions would necessarily have to include **Abstractions**:



1 WHAT

Inventory Models equal Bills of Materials

(Entity Models and Data Models ARE Bills of Material)

2 HOW

Process Models equal Functional Specs

(Transformation Models)

3 WHERE

Distribution Models equal Drawings

(Geographic Models)
(Network Models) (Geometry)

4 WHO

Responsibility Models equal Operating Instructions

(Work Flow Models) (Presentation Architecture)

5 WHEN

Timing Models equal Timing Diagrams

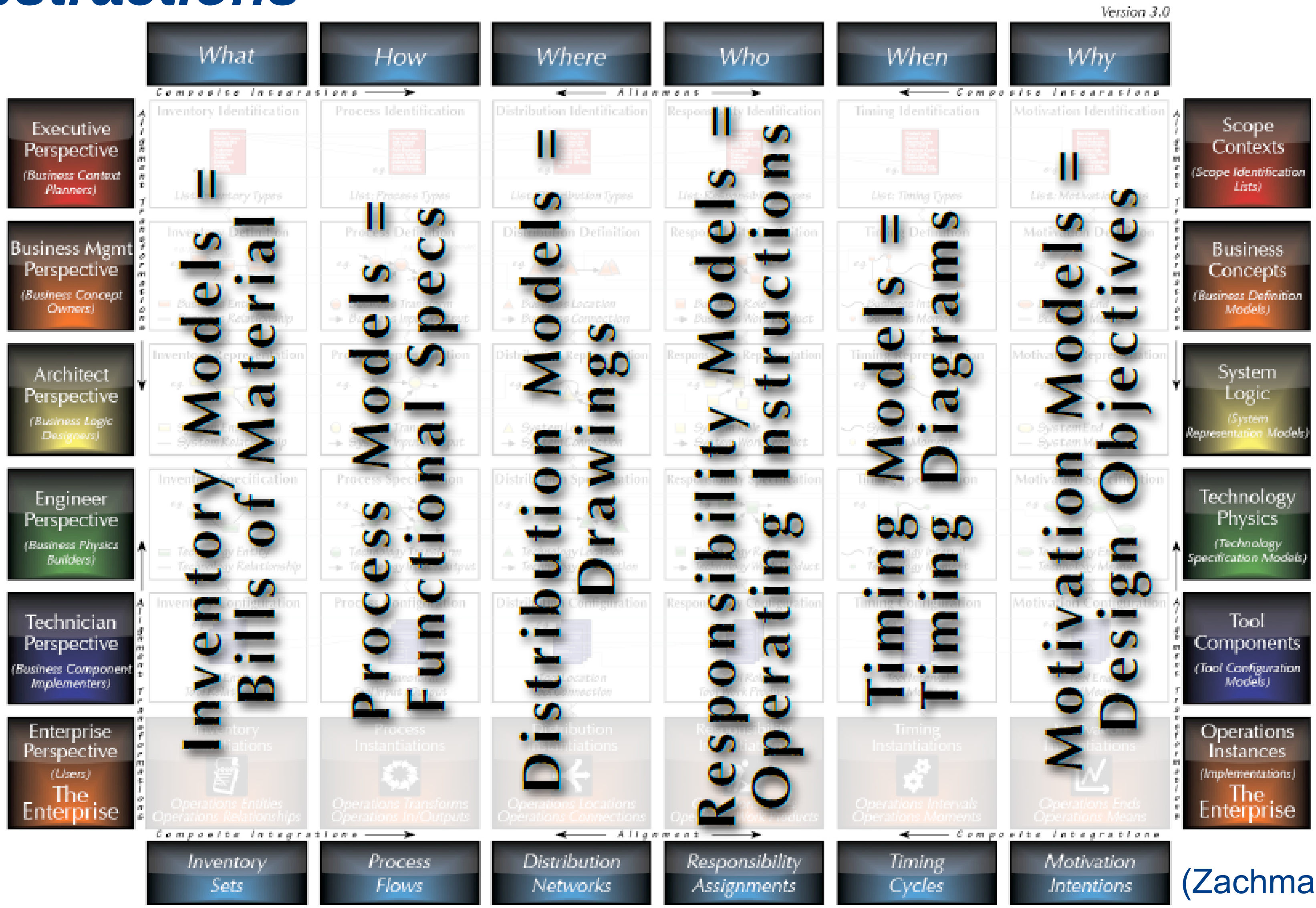
(Control Structures) (Cyclical Models)
(Dynamics Models)

6 WHY

Motivation Models equal Design Objectives

(Zachman 2012)

Abstractions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Inventory Models = Bills of Material

Process Models = Functional Specs

Distribution Models = Drawings

Responsibility Models = Operating Instructions

Timing Models = Timing Diagrams

Motivation Models = Design Objectives

(Zachman 2012)

The Zachman Framework for Enterprise Architecture – Enterprise Ontology

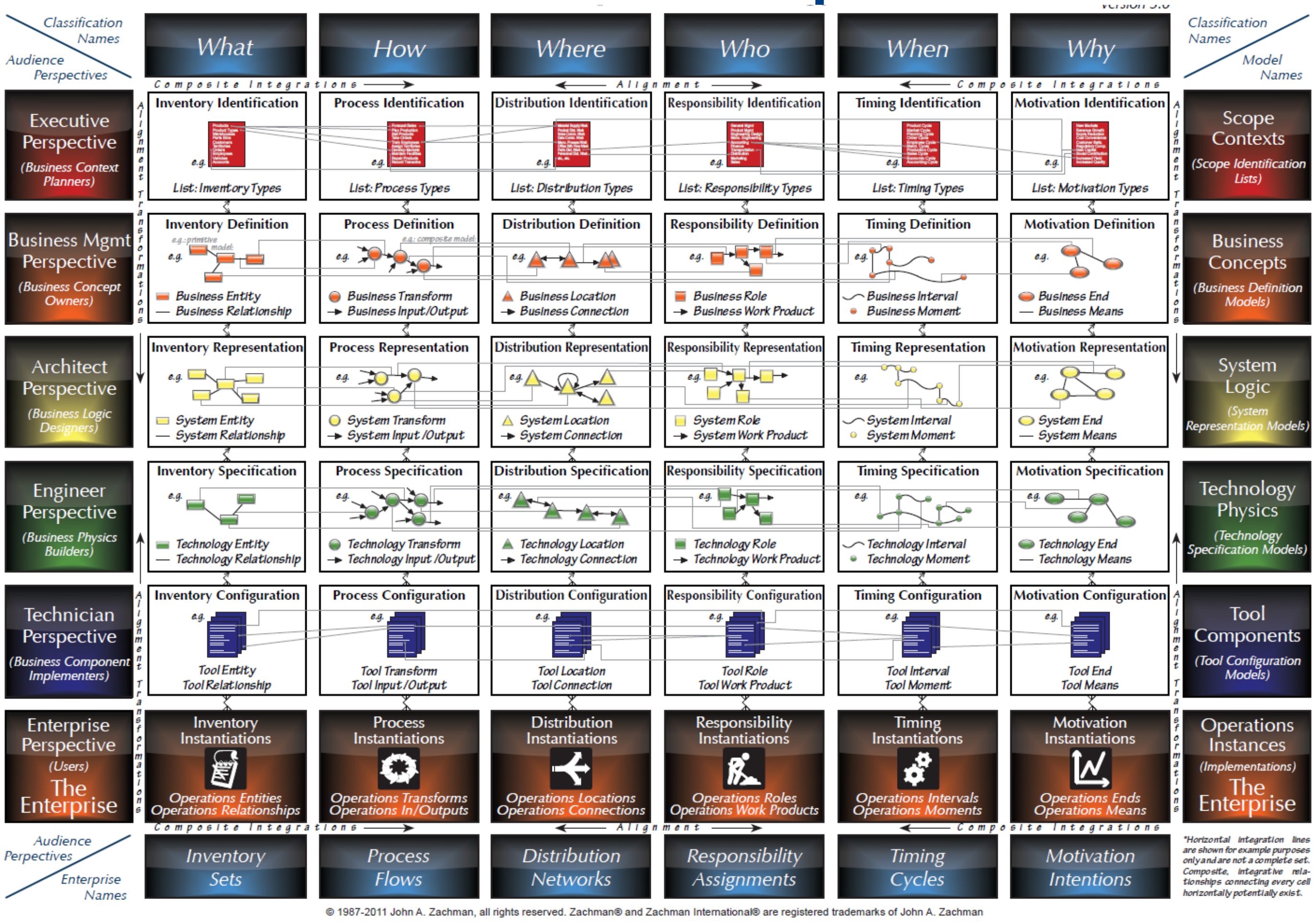
Each cell contains models

Abstractions/Aspects

Perspectives

Business

Information Technology



Classification Names / Audience Perspectives	What	How	Where	Who	When	Why	Classification Names / Model Names
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Business Mgmt Perspective (Business Concept Owners)	Inventory Definition e.g. e.g.: primitive model: Business Entity Business Relationship	Process Definition e.g. e.g.: composite model: Business Transform Business Input/Output	Distribution Definition e.g. Business Location Business Connection	Responsibility Definition e.g. Business Role Business Work Product	Timing Definition e.g. Business Interval Business Moment	Motivation Definition e.g. Business End Business Means	Business Concepts (Business Definition Models)
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Composite Integrations
Alignment
Composite Integrations
Alignment Transformations
Alignment Transformations
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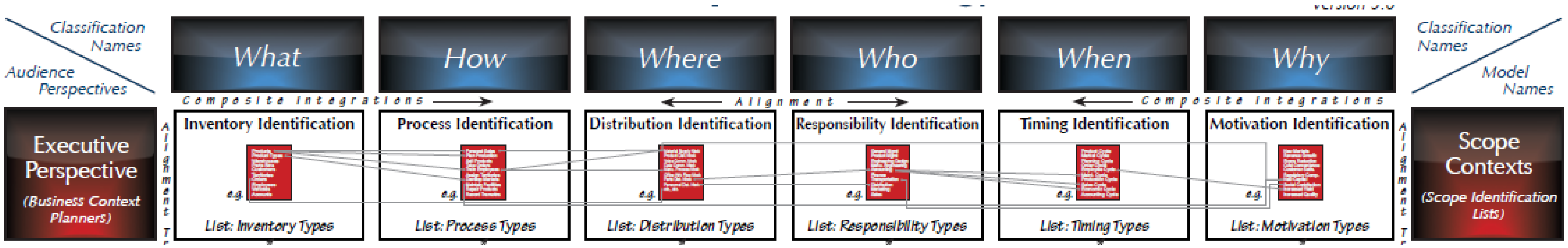
Alignment Transformations

Southwest Airlines

- For the Southwest Airlines…

…what information can you find to describe the enterprise architecture according to the Zachman Framework

…from the enterprise perspective (scope contexts)



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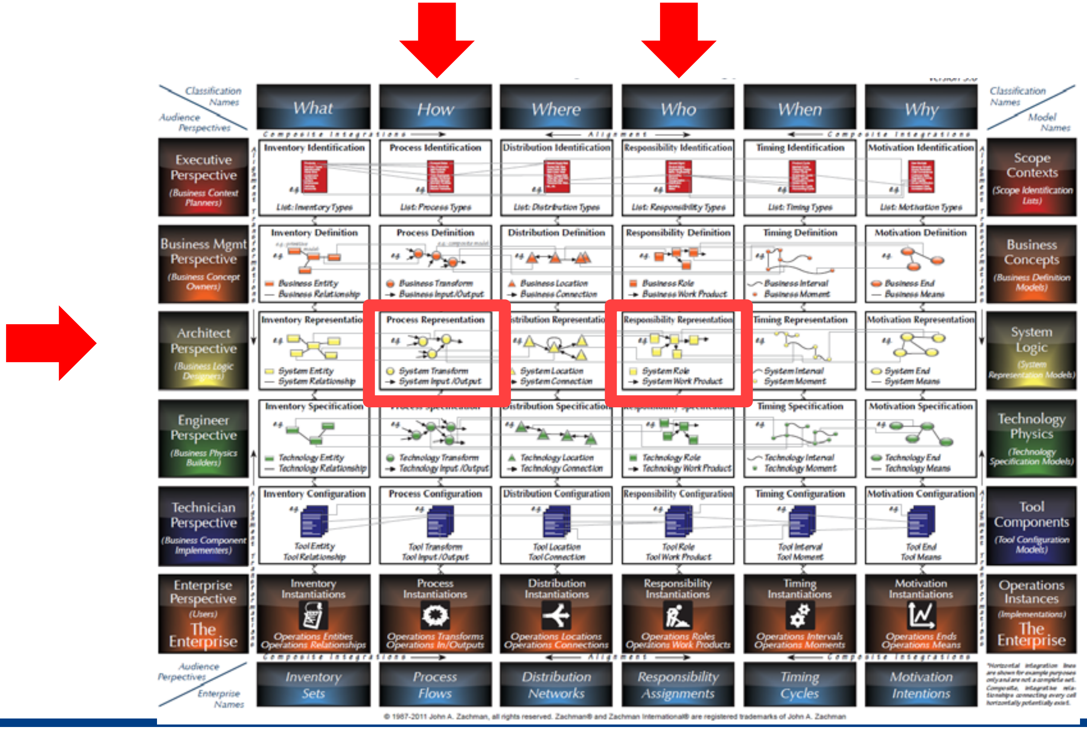
View and Viewpoints in Zachman Framework

- In the Zachman Framework, viewspoints are classified by perspectives and aspects, i.e. a choice of columns and rows
  - ♦ Example: the "how" and "who" from the "Architects Perspective"
- A view is a set of models of the cells for the corresponding viewpoint (incl. the relationships between the models)



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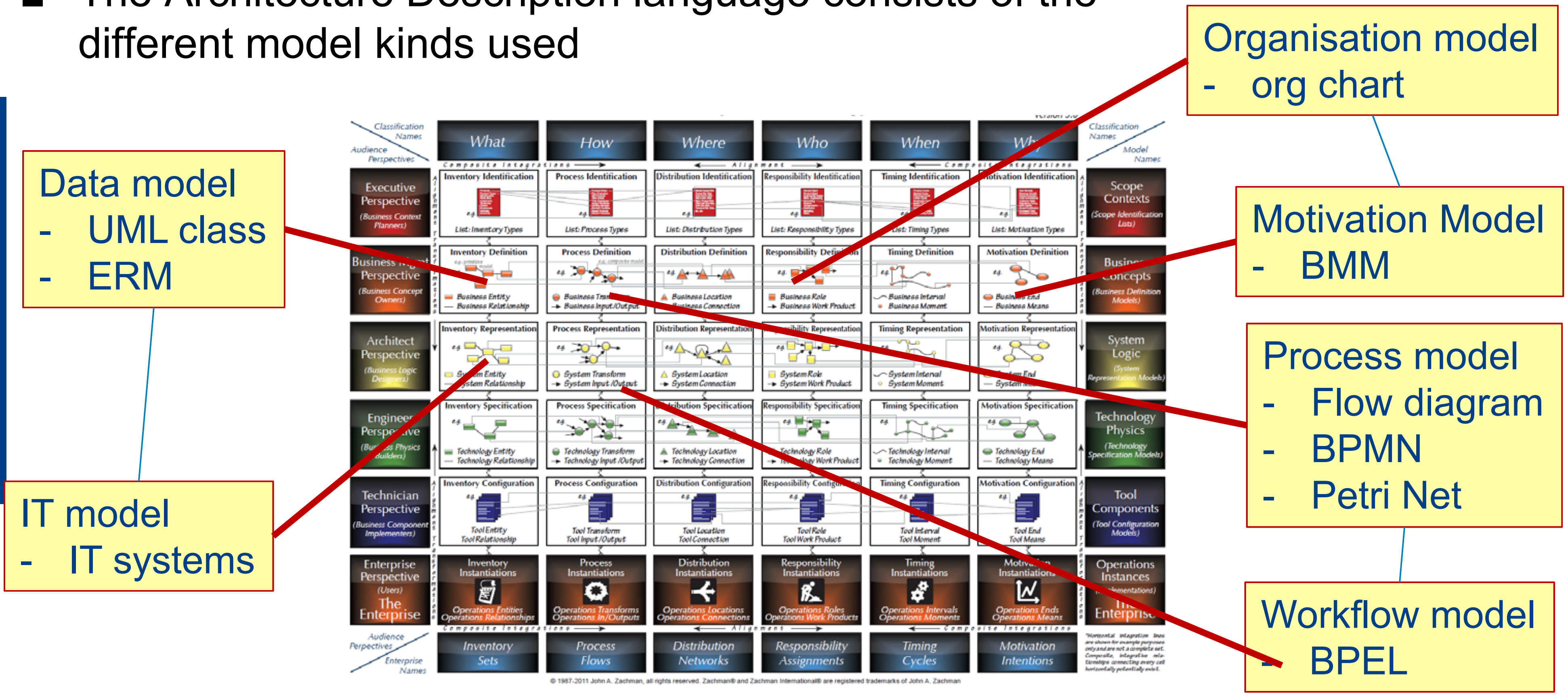
Model Types in Zachmann

- There are different model kinds for each viewpoint (one model kind per cell)
- There can be different modeling languages to represent a kind of model
- The Architecture Description language consists of the different model kinds used



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Organisation model
- org chart

Motivation Model
- BMM

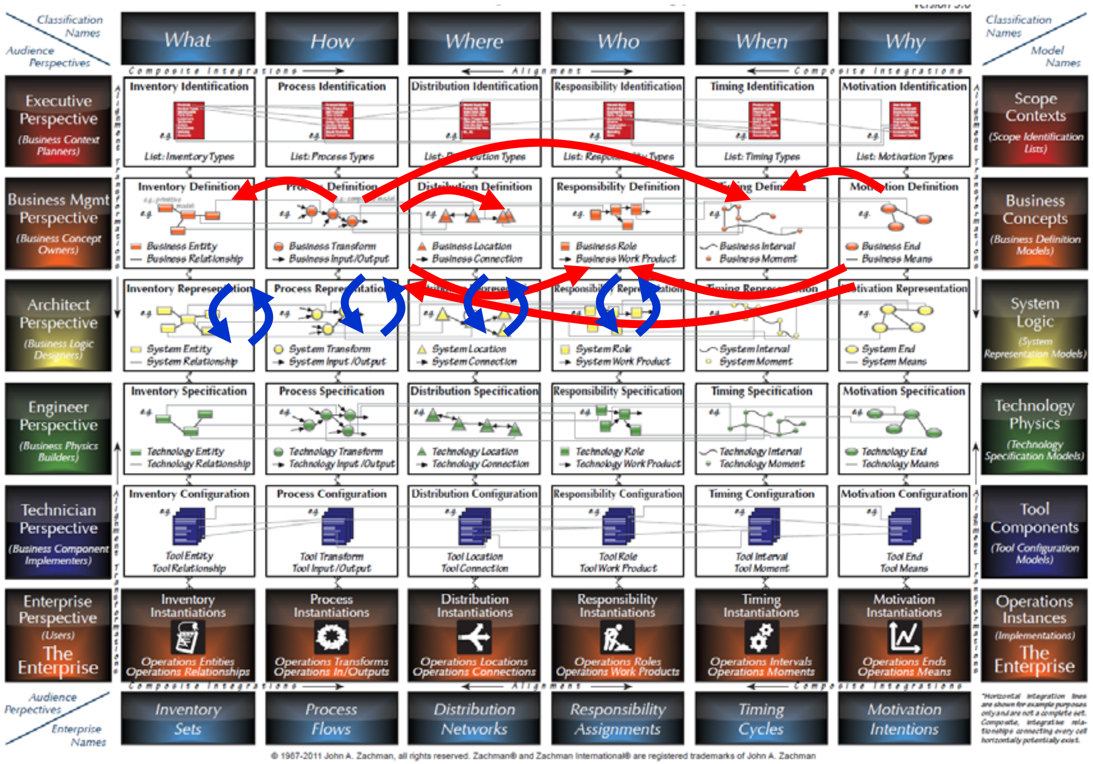
Process model
- Flow diagram
- BPMN
- Petri Net

Workflow model
- BPEL

Data model
- UML class
- ERM

IT model
- IT systems

Relations between Models and Model Elements



Version 3.0

Classification Names / Audience Perspectives	What	How	Where	Who	When	Why	Classification Names / Model Names
Executive Perspective (Business Context Planners)	Inventory Identification e.g. List: Inventory Types	Process Identification e.g. List: Process Types	Distribution Identification e.g. List: Distribution Types	Responsibility Identification e.g. List: Responsibility Types	Timing Identification e.g. List: Timing Types	Motivation Identification e.g. List: Motivation Types	Scope Contexts (Scope Identification Lists)
Business Mgmt Perspective (Business Concept Owners)	Inventory Definition e.g. primitive model Business Entity Business Relationship	Process Definition e.g. composite model Business Transform Business Input/Output	Distribution Definition e.g. Business Location Business Connection	Responsibility Definition e.g. Business Role Business Work Product	Timing Definition e.g. Business Interval Business Moment	Motivation Definition e.g. Business End Business Means	Business Concepts (Business Definition Models)
Architect Perspective (Business Logic Designers)	Inventory Representation e.g. System Entity System Relationship	Process Representation e.g. System Transform System Input /Output	Distribution Representation e.g. System Location System Connection	Responsibility Representation e.g. System Role System Work Product	Timing Representation e.g. System Interval System Moment	Motivation Representation e.g. System End System Means	System Logic (System Representation Models)
Engineer Perspective (Business Physics Builders)	Inventory Specification e.g. Technology Entity Technology Relationship	Process Specification e.g. Technology Transform Technology Input /Output	Distribution Specification e.g. Technology Location Technology Connection	Responsibility Specification e.g. Technology Role Technology Work Product	Timing Specification e.g. Technology Interval Technology Moment	Motivation Specification e.g. Technology End Technology Means	Technology Physics (Technology Specification Models)
Technician Perspective (Business Component Implementers)	Inventory Configuration e.g. Tool Entity Tool Relationship	Process Configuration e.g. Tool Transform Tool Input /Output	Distribution Configuration e.g. Tool Location Tool Connection	Responsibility Configuration e.g. Tool Role Tool Work Product	Timing Configuration e.g. Tool Interval Tool Moment	Motivation Configuration e.g. Tool End Tool Means	Tool Components (Tool Configuration Models)
Enterprise Perspective (Users) The Enterprise	Inventory Instantiations Operations Entities Operations Relationships	Process Instantiations Operations Transforms Operations In/Outputs	Distribution Instantiations Operations Locations Operations Connections	Responsibility Instantiations Operations Roles Operations Work Products	Timing Instantiations Operations Intervals Operations Moments	Motivation Instantiations Operations Ends Operations Means	Operations Instances (Implementations) The Enterprise
Audience Perspectives / Enterprise Names	Inventory Sets	Process Flows	Distribution Networks	Responsibility Assignments	Timing Cycles	Motivation Intentions	"Horizontal integration lines are shown for example purposes only and are not a complete set. Composite, integrative relationships connecting every cell horizontally potentially exist.

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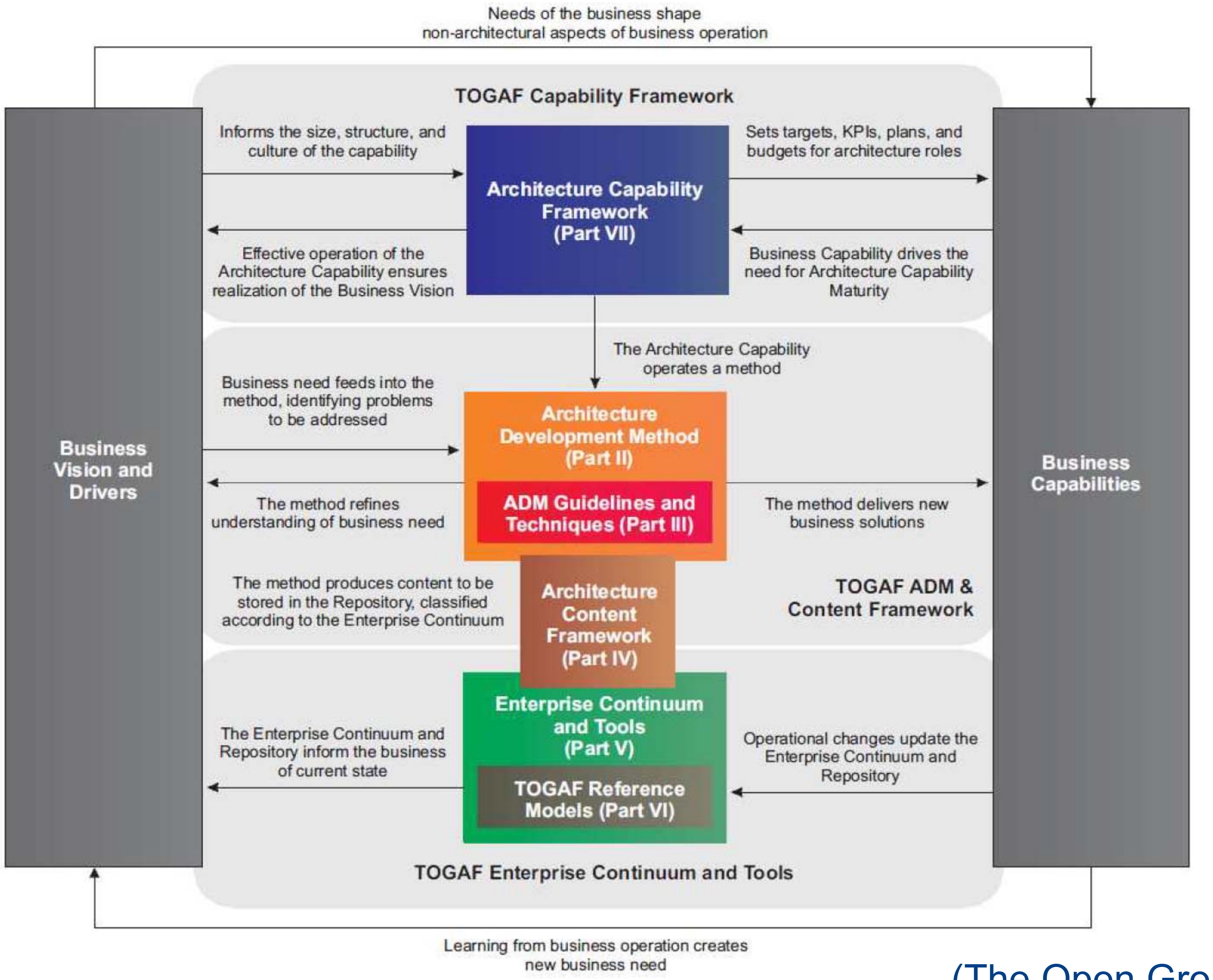
- There are relations between (elements of) the models
- Horizontal Relations: In same perspective, e.g.
  - Data used in a process
  - Application implementing a process activitiy
- Vertical relations: Between different perspectives
  - Implementation of an application
  - Database model for an entity relationship model

TOGAF – THE OPEN GROUP ARCHITECTURE FRAMEWORK

TOGAF – The Open Group Architecture Framework

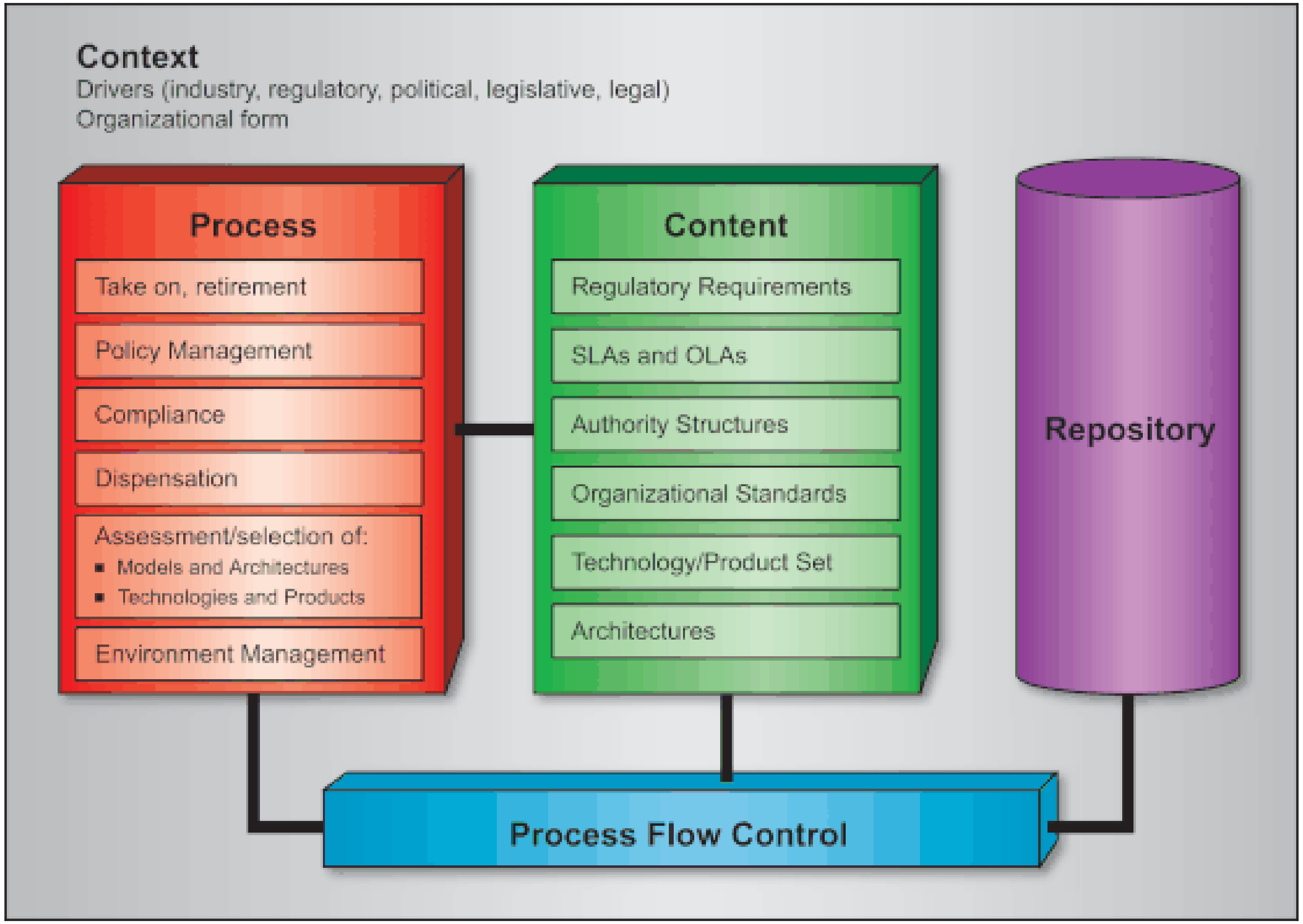
- Developed and continuously evolved since the mid-90’s by The Open Group’s Architecture Forum
- While Zachman is more an ontology, TOGAF is a methodology
- At the heart of the framework is the Architecture Development Method (ADM)
- http://www.opengroup.org/togaf/

Structure of the TOGAF Document


Needs of the business shape non-architectural aspects of business operation
TOGAF Capability Framework
Informs the size, structure, and culture of the capability
Architecture Capability Framework (Part VII)
Sets targets, KPIs, plans, and budgets for architecture roles
Effective operation of the Architecture Capability ensures realization of the Business Vision
Business Capability drives the need for Architecture Capability Maturity
The Architecture Capability operates a method
Business need feeds into the method, identifying problems to be addressed
Business Vision and Drivers
Architecture Development Method (Part II)
ADM Guidelines and Techniques (Part III)
Business Capabilities
The method refines understanding of business need
The method delivers new business solutions
The method produces content to be stored in the Repository, classified according to the Enterprise Continuum
Architecture Content Framework (Part IV)
TOGAF ADM & Content Framework
Enterprise Continuum and Tools (Part V)
The Enterprise Continuum and Repository inform the business of current state
TOGAF Reference Models (Part VI)
Operational changes update the Enterprise Continuum and Repository
TOGAF Enterprise Continuum and Tools
Learning from business operation creates new business need

(The Open Group 2009, p. 4)

TOGAF Architecture Governance Framework



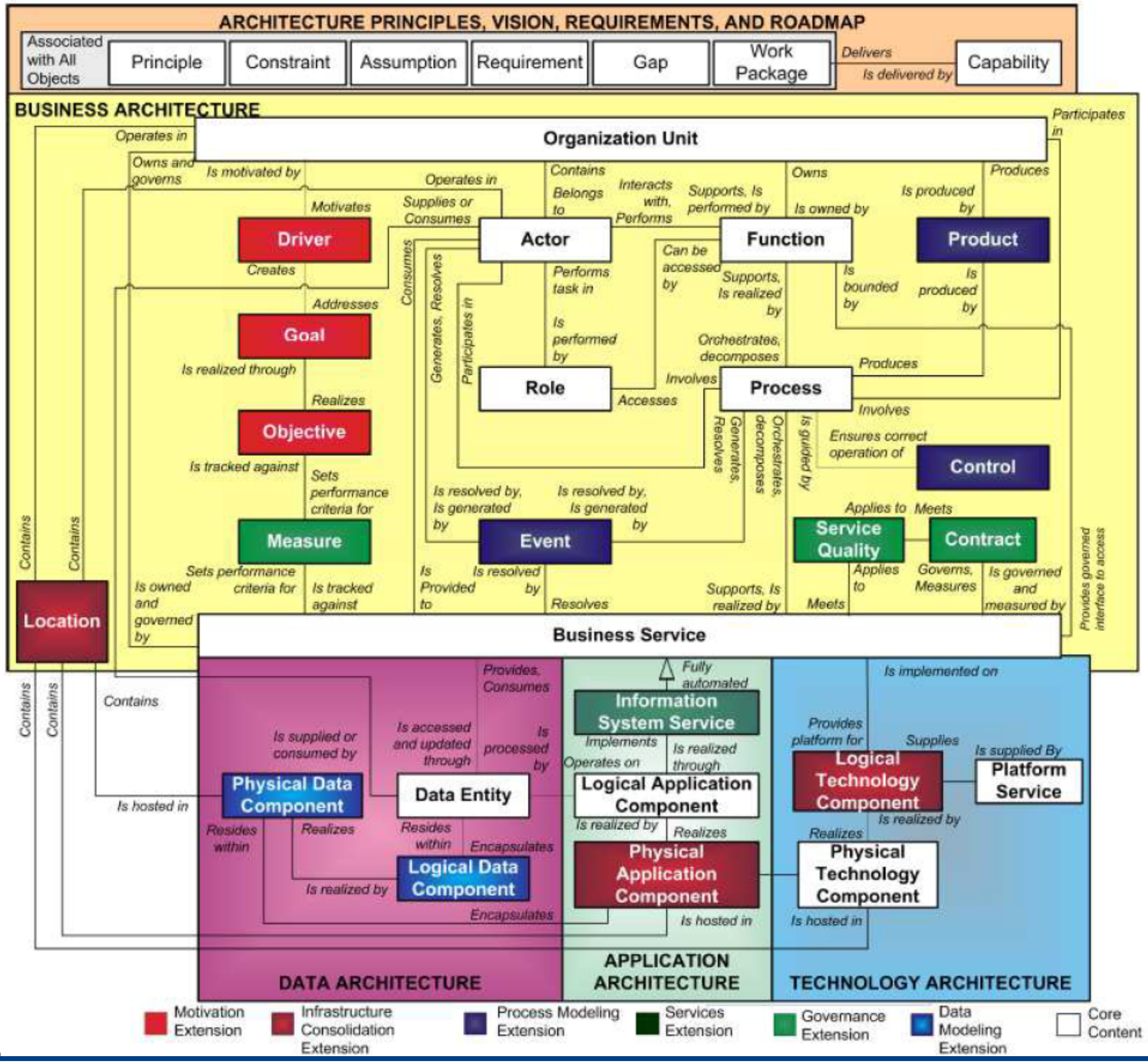
Context
Drivers (industry, regulatory, political, legislative, legal)
Organizational form

TOGAF (Sub-)Architecture Views

- The model of an enterprise architecture described in TOGAF is organised in four partial sub-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**

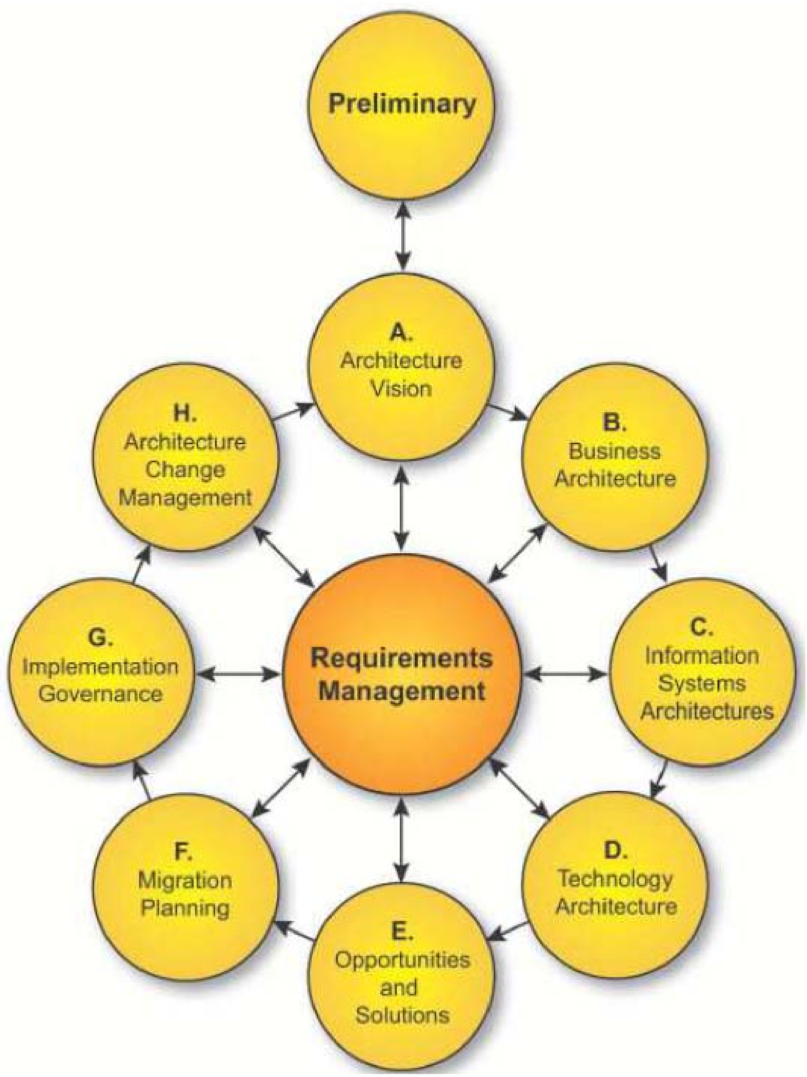
TOGAF: Architecture Content



The architecture content framework "provides a structural model for architectural content" and may also be substituted with other frameworks, such as the Zachman Framework (The Open Group, 2009, p. 361).

(The Open Group 2009, p. 379)

TOGAF Architecture Development Method (ADM)

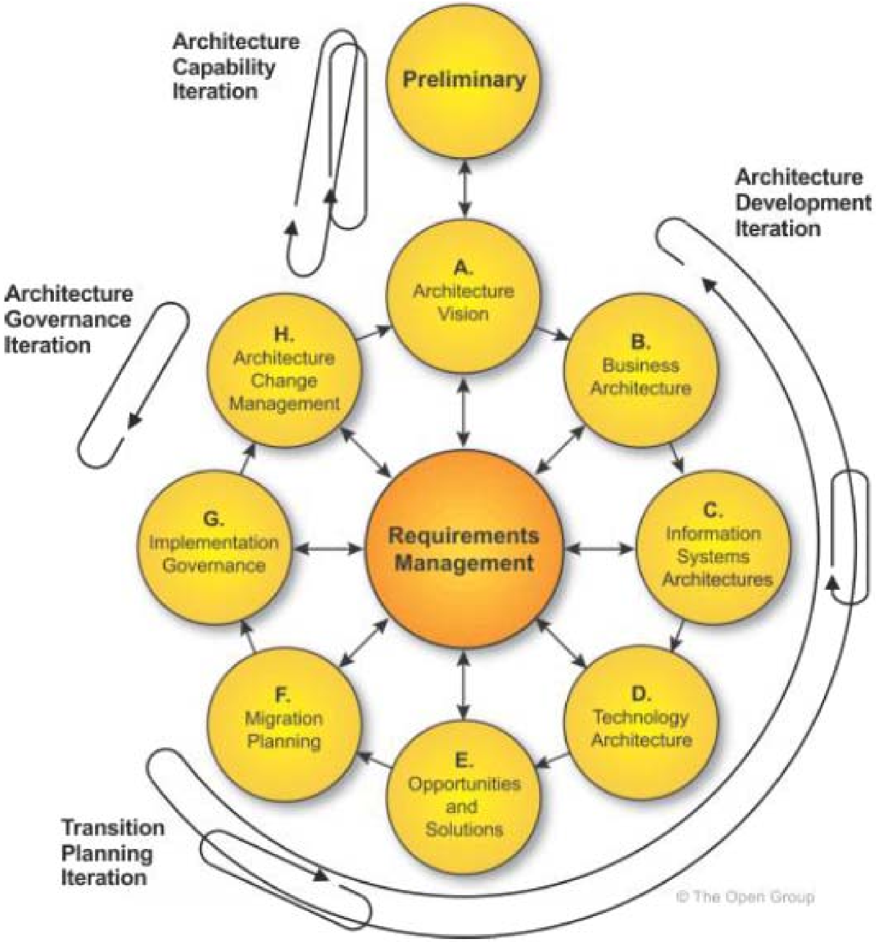


Preliminary
A. Architecture Vision
B. Business Architecture
C. Information Systems Architectures
D. Technology Architecture
E. Opportunities and Solutions
F. Migration Planning
G. Implementation Governance
H. Architecture Change Management
Requirements Management

- TOGAF addresses the whole enterprise architecture lifecycle
- The TOGAF Architecture Development Method (ADM) is a generic method for developing an enterprise architecture
- The goals, approaches, required input, activities and deliverables are documented for each phase separately
- The ADM method is enriched by specific ADM guidelines and techniques.

(The Open Group 2009)

TOGAF Architecture Development Method (ADM)


Architecture Capability Iteration
Preliminary
Architecture Development Iteration
Architecture Governance Iteration
A. Architecture Vision
H. Architecture Change Management
B. Business Architecture
G. Implementation Governance
Requirements Management
C. Information Systems Architectures
F. Migration Planning
D. Technology Architecture
E. Opportunities and Solutions
Transition Planning Iteration
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- Although originally represented as a sequential method, in chapter 19.2 of TOGAF describes also iteration cycles

(The Open Group 2011)

Further Components of TOGAF

TOGAF has additional components:

- **Architecture Content Framework**: a detailed model for deliverable types in the development and evoluation of an EA
- **Enterprise Continuum**: a collection of reference descriptions in the form of graphic models and text documents
- **Architecture Repository**: storage of various types fo architecture deliverables: Architecture Metamodel, Architecture Capability, Architecture Landscape, Standards Information Base (SIB), Reference Library, Governance Log
- **Resource Base**: templates or supplementary notes

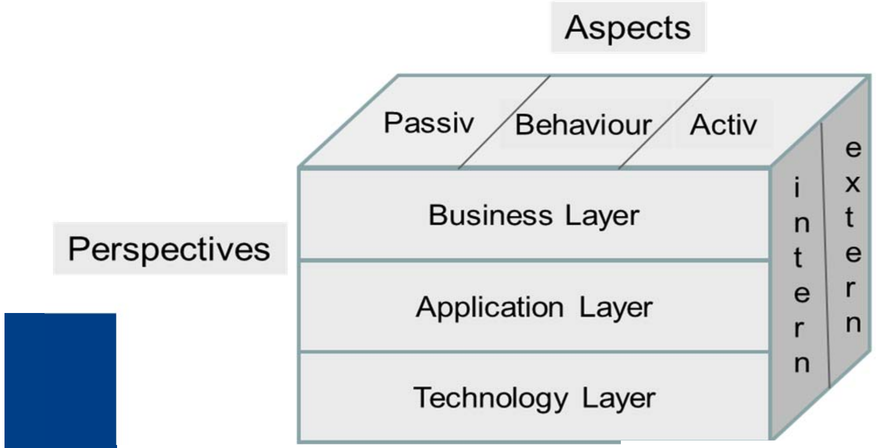
from (Hanschke, 2010)

ARCHIMATE

ArchiMate

- Developed 2005 and evolved by members of The ArchiMate Forum
- Current version: ArchiMate 2.0, from 2005
- Management framework for the overall architecture
- Defines a terminology to describe core architecture elements and their relations («a high level modelling language»)
- http://pubs.opengroup.org/architecture/archimate2-doc/

ArchiMate Generic Metamodel



Aspects

Passiv

Behaviour

Activ

Perspectives

Business Layer

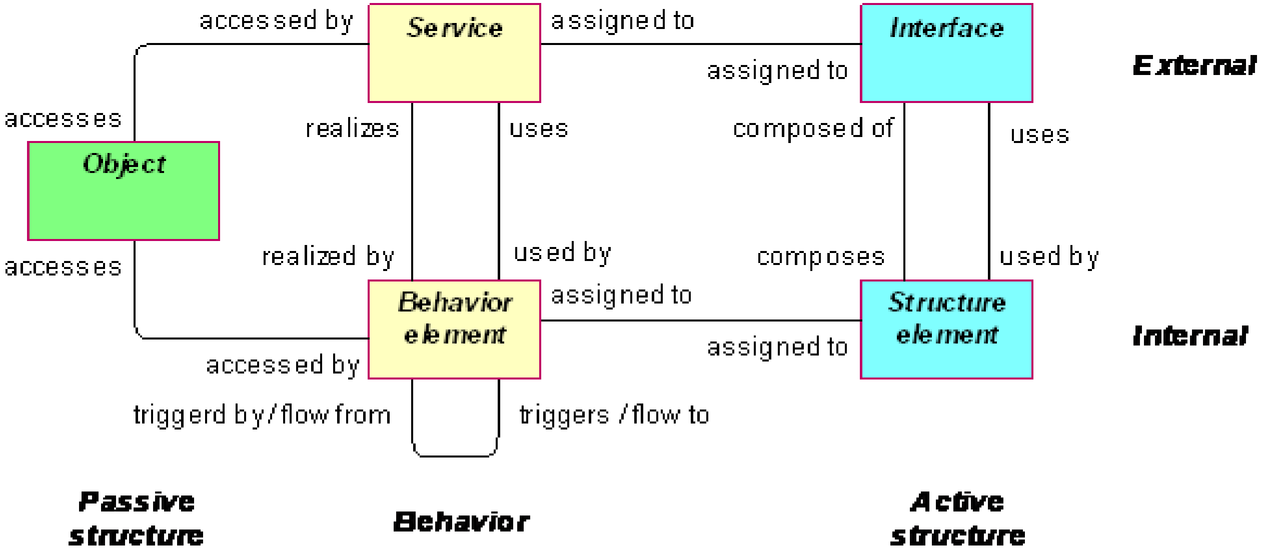
Application Layer

Technology Layer

intern

extern

Core Concepts



accessed by

Service

assigned to

Interface

assigned to

External

accesses

realizes

uses

composed of

uses

Object

realized by

used by

composes

used by

accesses

Behavior element

assigned to

Structure element

accessed by

assigned to

Internal

triggerd by/flow from

triggers / flow to

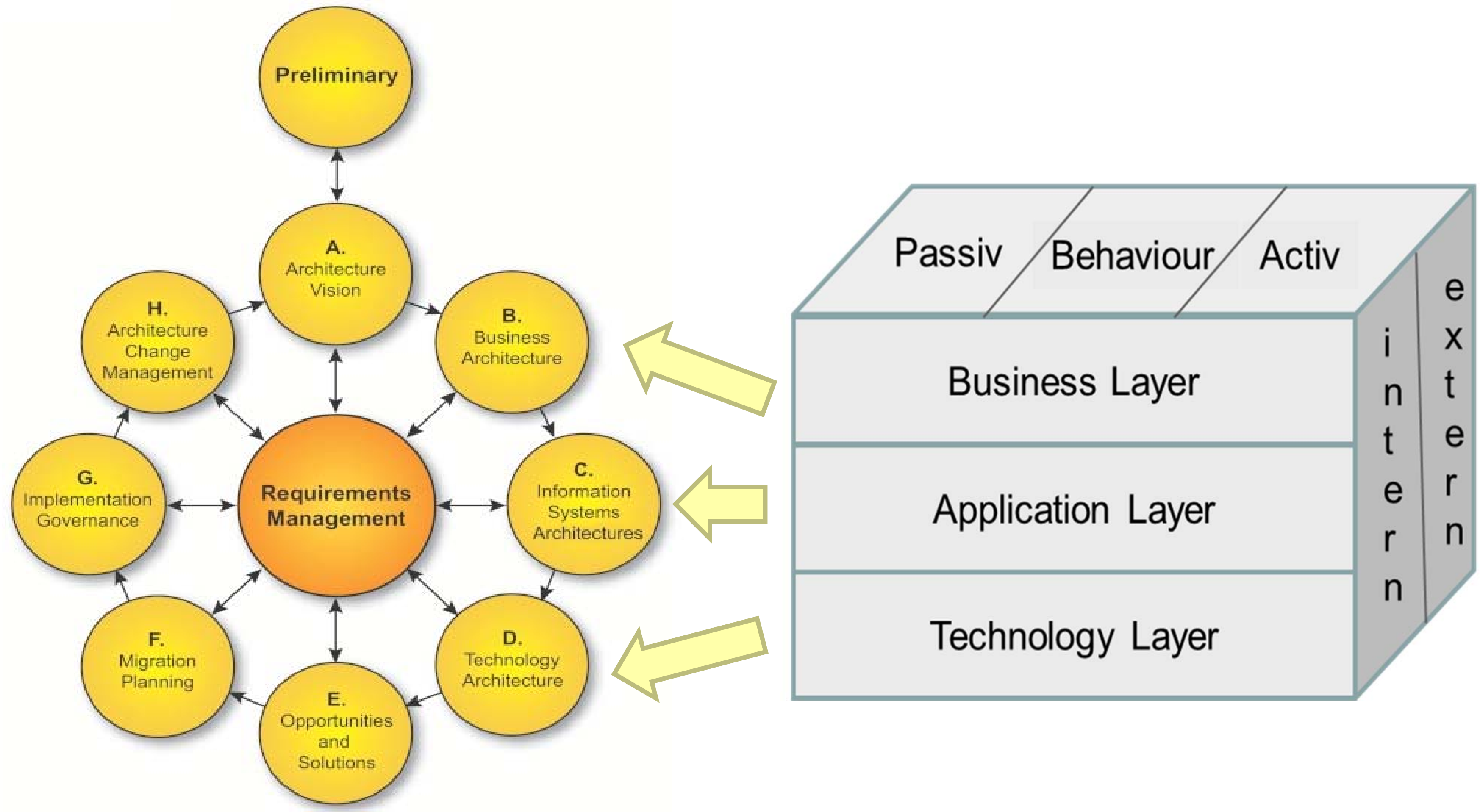
Passive structure

Behavior

Active structure

http://www.opengroup.org/archimate/doc/ts_archimate/

TOGAF and ArchiMate



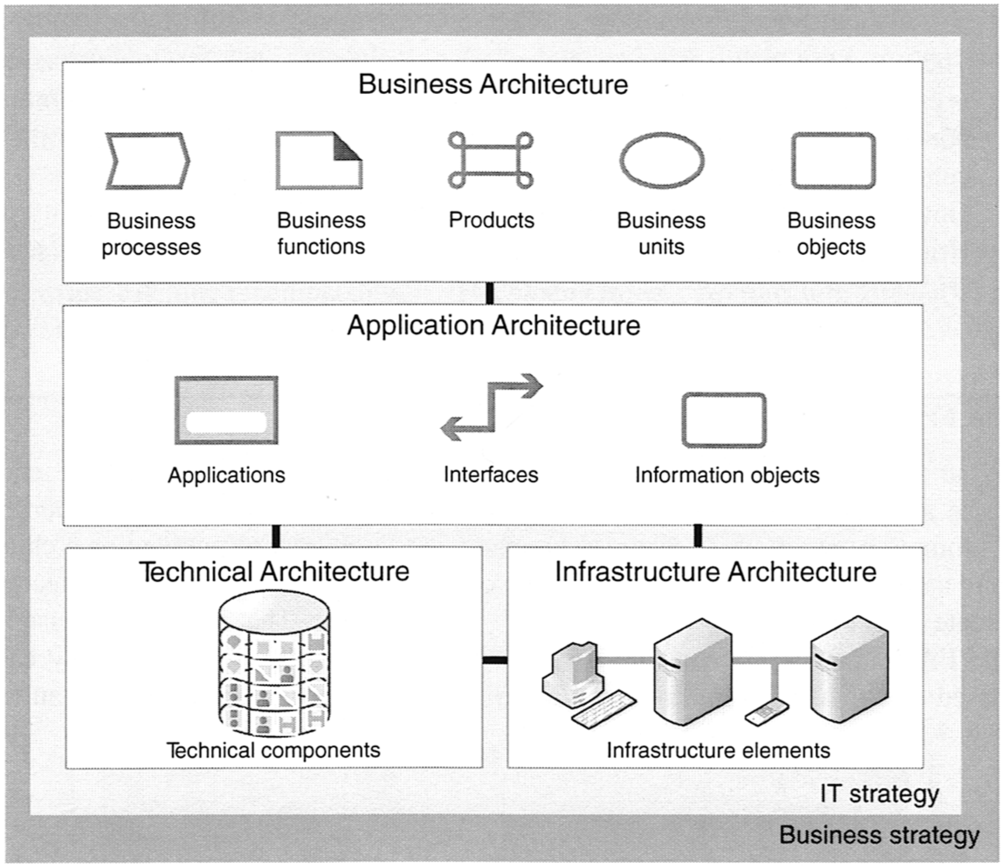
Using ArchiMate with an Architecture Method (e.g. TOGAF)

- TOGAF’s ADM process refers to artifacts and deliverables; those artifacts could be represented in ‘ArchiMate-Style’
- TOGAF is concerned with the application portfolio rather than application design. ArchiMate provides a language (kind of UML representation) for application design
- ArchiMate is probably best used at the level of system or solution architecture, whereas TOGAF is used at the level of cross-organisational strategic enterprise architecture
- The most important disparity between TOGAF and ArchiMate is that ArchiMate deals with the relationships between architectural layers, whereas TOGAF’s views are confined to a single architectural layer

Source: Berrisford, G., & Lankhorst, M. (2009). Using ArchiMate with an Architecture Method A conversation. Via Nova Architectur.
Lankhorst, M., & Drunen, H. V. (2007). Enterprise Architecture Development and Modelling. Via Nova Architectura.

BEST PRACTICE ENTERPRISE ARCHITECTURE

Best Practice Enterprise Architecture



- The Bast Practice Architecture from Inge Hanschke (2010) is another example of a three-layer enterprise architecture framework.
- In contrast to TOGAF
  - it is quite simple
  - it differentiates between the technical architecture and the infrastructure architecture
  - it does not have a separate data or information architecture

from (Hanschke, 2010)

Partial Architectures of the Best Practice Architecture

- **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