

Enterprise Architecture – Dealing with Complexity and Change



Business

Strategy

Organizational

Infrastructure

and Processes

IT Strategy

I/S Infrastructure

and Processes

Many organisations lack transparency due to the number and frequency of their organisational changes and have problems to answer these questions.

- What information does the business process need and how can it be stored?

What applications and infrastructure technologies do we require to run new or

- Which business units and users will be affected by the migration of an application?
- On the operational level questions can be:

redesigned business processes?

- How can we successfully integrate new firms after an acquisition?
- problems like the following:

What IT innovations are needed to react on market requirements?

- On strategic level the alignment of business and IT has to deal with
- Change can affect the alignment of business and IT on both strategic and operational level



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Architecture: Dealing with Complexity and Change





- If the object you want to create or change is simple, and it is not likely to change, then you can do it directly.
- On the other hand, if the object is complex, you can't see it in its entirety at one time and it is likely to change considerably over time, you need a description or model.
- This description is what we call an "Architecture".

(John Zachmann, 2012)





Is this an Architecture?

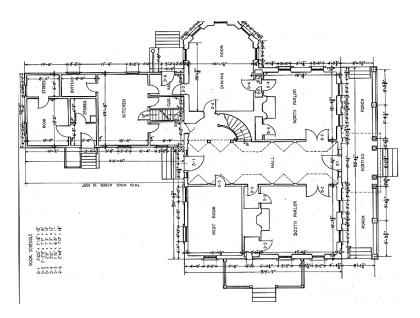




Enterprise Architecture Frameworks



Is this an Architecture?







Architecture – What is it?

"*Architecture*" names that which is fundamental about a system; the set of essential properties of a system which determine its form, function, value, cost, and risk. That which is **fundamental** to a system takes several forms:

- its elements: the constituents that make up the system;
- the relationships: both internal and external to the system; and
- the principles of its design and evolution

ISO/IEC/IEEE 42010 - http://www.iso-architecture.org/ieee-1471/cm





Enterprise Architecture: Overall View on the Enterprise

An Enterprise Architecture contains all relevant

- **Business structures** (e.g. organisation structure, business processes)
- **IT structures** (e.g. information systems, infrastructure)
- and their relationships



Architecture and Architecture Description

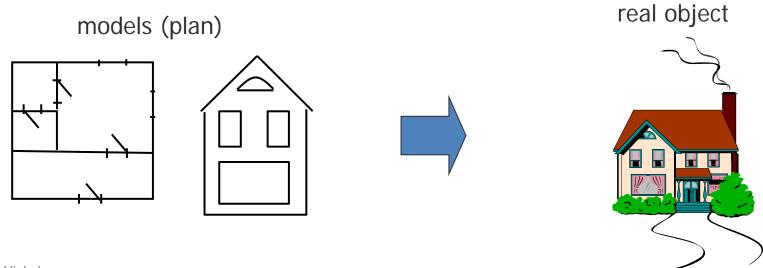
- An architecture is a conception of a system i.e., it is in the human mind. An architecture may exist without ever being written down.
- An architecture description (AD) is an artifact that expresses an Architecture to share with others.
 - An AD is what is written down as a concrete work product. It could be a document, a repository or a collection of artifacts used to define and document an architecture
 - Architects and other system stakeholders use Architecture Descriptions to understand, analyze and compare Architectures, and often as "blueprints" for planning and construction.

http://www.iso-architecture.org/ieee-1471/cm/



Archtecture Description and Architecture Models

- An Architecture Description consists of one or several Architecture Models
- A Model is a reproduction of a *relevant* part of reality which contains the essential aspects to be investigated.

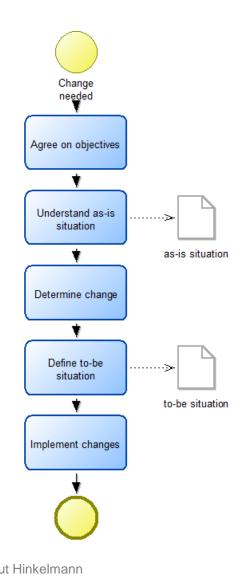


Enterprise Architecture (Description) – What is it?

- An "Architecture" (for anything) would be the total set of descriptive representations (models) relevant for describing a complex object such that it can be created and that constitute a baseline for changing the object after it has been instantiated.
- Therefore "Enterprise Architecture" would be the total set of models relevant for describing an Enterprise, that is, the descriptive representations required
 - to create a (coherent, optimal) Enterprise and
 - to serve as a baseline for changing the Enterprise once it is Adapted from Zachman (2012)



Typical (Change) Projects

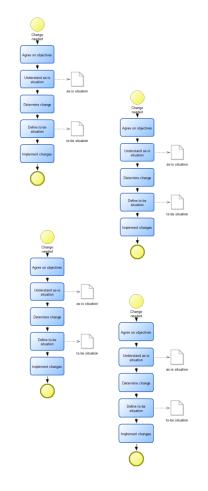


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- Typically organisations go through several stages in a change project:
 - recognizing the need to change
 - agreeing on the objectives of the change and a vision that describes a better future
 - understanding what the organisation is changing from (as-is model)
 - determine what needs to change
 - designing the new way of working and its support and management (→ to be model)
 - testing and implementing changes



Architecture Descriptions in an Enterprise



Typically ...

- ... there are a large number of projects
 - running concurrently or
 - building on the result of previous projects
- ... projects have an extensive documentation of their (intended) result
- ... each project manages its own documentation which is not available for other projects
- ... there is a lack of coordination between projects



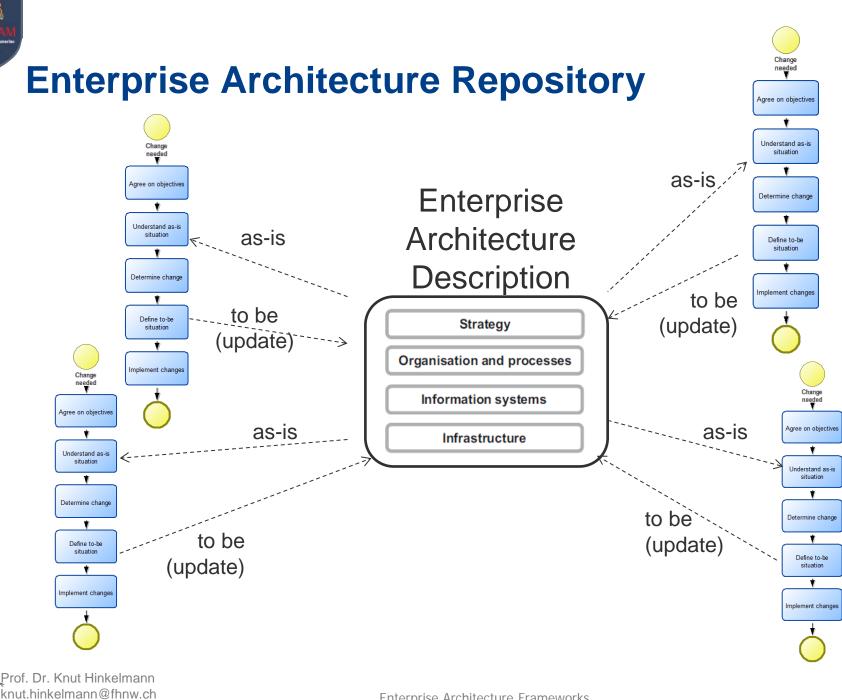


- Complexity: If you can't describe it, you can't create it (whatever "it" is).
- Change: If you don't retain the descriptive representations after you create them (or if you never created them in the first place) and you need to change the resultant implementation, you have only three options:
 - Change the instance and see what happens. (High risk!)
 - Recreate ("reverse engineer") the architectural representations from the existing ("as is") implementation. (Typical for many projects - Takes time and costs money!)
 - Scrap the whole thing and start over again.

Better: Retain description of your enterprise architecture

(John Zachmann, 2012)





Enterprise Architecture Frameworks



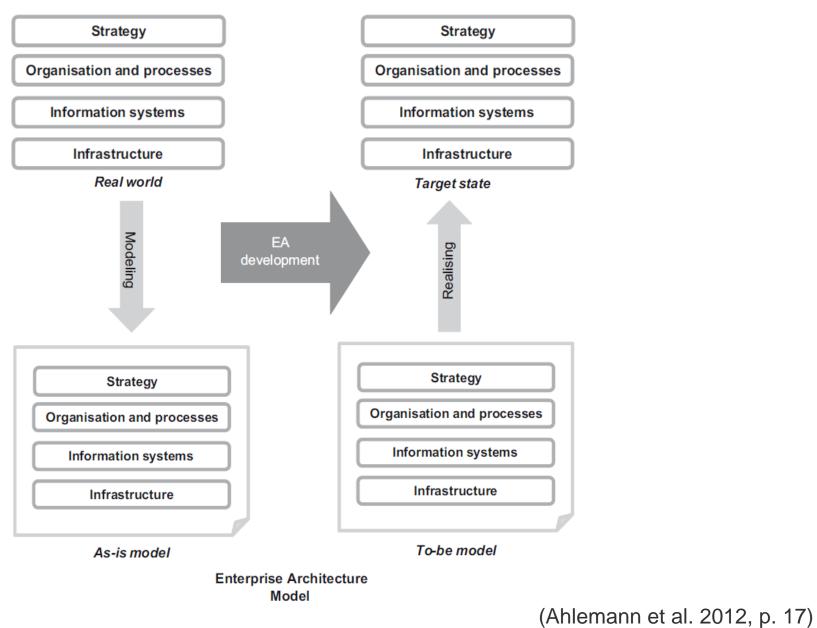
Use of Enterprise Architecture: Managing Change and Decision Making

- Change the architecture before you change the object!
- The Enterprise Architecture is managed as a program that facilitates
 - systematic organization change
 - continuously aligns technology investments and projects with organisation mission needs.
- Enterprise Architecture is updated continuously to reflect changes
- It is a primary tool for baseline control of
 - complex, interdependent enterprise decisions and
 - communication of these decisions to organization stakeholders.





Enterprise Architecture





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member of



Enterprise Architecture Frameworks

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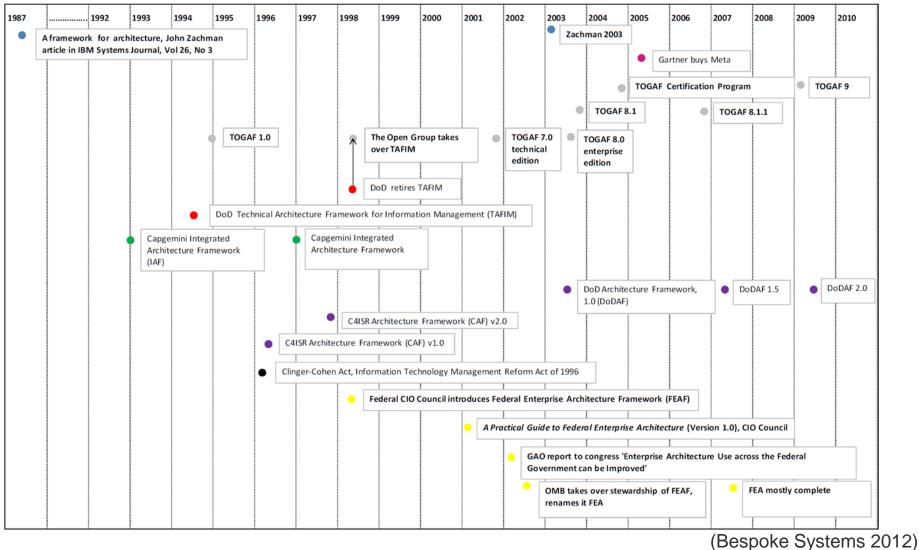
Architecture Framework

- An Architecture Framework establishes a common practice for creating, interpreting, analyzing and using architecture descriptions
- It is a logical structure for classifying and organising the descriptive representations of a system



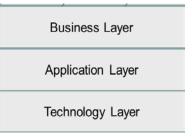


Timeline of Enterprise Architecture Frameworks



Enterprise Architecture Frameworks

- We can distinguish two main types of structures for Enterprise Architecture Frameworks:
 - Three layer architecture with business, applications and technology, e.g.
 - TOGAF The Open Group Architecture Framework
 - A methodology for architecture development
 - ArchiMate A modeling language for EA
 - Best Practice Enterprise Architecture
 - *Matrix* of aspects and perspectives, e.g.
 - Zachmann Enterprise Architecture Framework
 - An enterprise ontology









The Zachman Framework



Enterprise Architecture Frameworks



- Regarded the origin of enterprise architecture frameworks (originally called "Framework for Information Systems Architecture")
- First version published in 1987 by John Zachman
- It is still further developed by Zachman International (http://www.zachman.com)
- Often referenced as a standard approach for expressing the basic elements of enterprise architecture

Zachman, J.A., 1987. A framework for information systems architecture. IBM Systems Journal, 26(3).





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:
 - Perspectives
 - Abstractions



Abstractions

(Zachman 2012)





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)





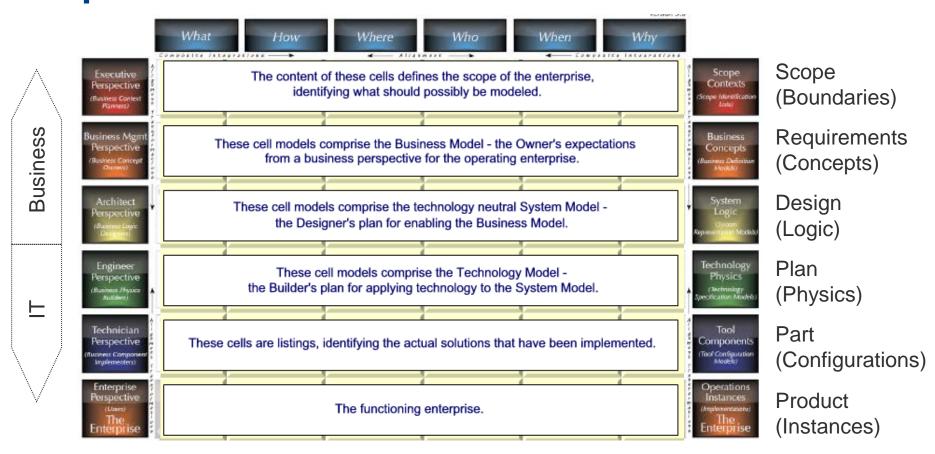
Dimension 1: Architectural Representations with analogies in Building and Information Systems

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









- 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

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- There exist different types of descriptions oriented to different aspects
- Zachman associates each aspect with a question word
 - WHAT inventory models
 - HOW functional/process models
 - WHERE location/distribution models
 - WHO organisation models
 - WHEN timing models
 - WHY motivation models

(Zachman 1987)





Abstractions for Manufacturing



(Zachman 2012)



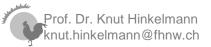


The Zachman Framework for Enterprise Architecture Each cell Enterprise Ontology contains

version 3.0 Classification Classification Names Names What How Where Who When Whv Model Audience Perspectives Names omposite intear ite Intearation Inventory Identification **Process Identification** Distribution Identification Responsibility Identification Timing Identification Motivation Identification **Business** Scope Executive Contexts Perspective 6.0. (Scope Identificatio (Business Context List: Inventory Types List: Process Types List: Distribution Types List: Responsibility Types List: Timing Types List: Motivation Types Perspectives Inventory Definition **Process Definition** Distribution Definition Responsibility Definition **Timing Definition** Motivation Definition **Business Mgmt** Business eg. 🎾 🔎 🖕 eg 📻 + 🗮 + 📕 + °9. 🛕 🖌 6.g. 6.g. Perspective Concepts (Business Concep Business Definitio Business Entity 📕 Business Role ∕ Business Interval 📄 Business End 👄 Business Transforn 🔺 Business Location Business Relationship - Business Input/Output - Business Connection Business Work Product Business Moment – Business Means Distribution Representation Responsibility Representatio Motivation Representation nventory Representation Process Representation Timing Representation System Architect e.a 三 -----eg. 🔭 🖓 🛶 <u>eg.</u> □ * **_** • - • • e.g 🔨 6.q. 6.q. Perspective Logic 6 \geq 10 nformation **echnology** System Entity 🔘 System Transform 🛆 System Location System Role System Interval System End System Relationship System Input /Output System Connection System Work Product System Moment System Means Inventory Specification **Process Specification** Distribution Specification esponsibility Specificatio Timing Specification Motivation Specification Engineer Technology e.g. 📕 📲 🕨 6.4 🖳 7.2 Physics Perspective ľ 1 ¥= 0 (Technology (Business Physics Builders) Technology Entity Technology Transform A Technology Location Technology Role Technology Interval Technology End Technology Relationshi Technology Input /Output - Technology Connection Technology Work Produce Technology Moment · Technoloay Means wentory Configuration **Process Configuration** Distribution Configuratio ponsibility Configuration **Timing Configuration Motivation Configuration** Technician Tool -Components Perspective (Tool Configuration Models) Business Compone Tool Entity Tool Transform Tool Location Tool Role Tool Interval Tool End Implementers) Tool Relationshi Tool Input /Output Tool Connection Tool Work Product Tool Moment Tool Means Distribution Timing Instantiations Responsibility Instantiations Motivation Enterprise Inventory Instantiation Process Operations Instantiation Instantiations Instantiation Perspective Instances å Î ÷ N R. (Users) 63 (Implementations The The Enterprise Enterprise posite Inter te integration Audience *Horizontal integration line are shown for example purposes Responsibility Perpectives Inventory Process Distribution Timing Motivation only and are not a complete set Composite, integrative rela-tionships connecting every cell horizontally potentially exist. Flows Enterprise Sets Networks Cycles Intentions Assignments

Abstractions/Aspects

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Names

Enterprise Architecture Frameworks

models



The Zachman Framework is not a Methodology

ONTOLOGY

The Zachman Framework[™] schema technically is an ontology a theory of the existence of a structured set of essential components of an object (the object being an Enterprise, a department, a value chain, a "sliver," a solution, a project, an airplane, a building, a bathtub or whatever or whatever).

> A Framework is a STRUCTURE. (A Structure DEFINES something.)

METHODOLOGY

A Methodology is a PROCESS. (A Process TRANSFORMS something.)

> A Structure IS NOT A Process A Process IS NOT a Structure.

> > © 1990-2011 John A. Zachman, Zachman International®



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ONTOLOGY VS METHODOLOGY

An Ontology is the classification of the total set of "Primitive" (elemental) components that exist and that are relevant to the existence of an object.
A Methodology produces "Composite" (compound) implementations of the Primitives.



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ONTOLOGY The Zachman Framework for Enterprise Architecture The Enterprise Ontology Cassification **Classification** Name Name What Where When Audience Model angentin lange - Issagrablas Distribution Identification Responsibility Identification Medication Identification investory identification Process Identification Resing Identification Scope Contexts Decutive . Perspective ., 85 List Detriverier Types Lies: Investory Types List. Process Types Uvi: Responsibility Types Elec Texty Open List. Methodics Types Investory Definition Process Definition Distribution Definition espansibility Deflaition **Timing Definition** Mativation Definition -4 79-9-30------4 % no 10 the she will Concept Perspective Basiness Franky Basiness Relationship Jackess Resolves Jackess Input/Output Authors interest Business Connection Distance Kale Sustance Nork Product - Business letanal Business Vorunt Destress End Dastress Neard centory Representatio voces Representatio tribution Representation enablity Representation Taming Representation iolication Representation System Ascilution "20 4 8 " 20-9-"" - B-20 System Entity System Relationship System Ransform SystemLocation SystemConnection System Role System West Pred - System Internel Gestem Manager SystemEnd SystemMeans This is NOT mentory Specification Prices Specification istribution Specification pocalbility Specification Timing Specification Mathation Spec Engineer Perspective 12 12: FP A & A & -----a Process. 4 Scholig Zekty Scholig Rinte Textnology Transform Textnology Upper Output Solitering Location Solitering Connection Entering Are Technology Hiernal Technology Morand - Interving Part writery Corrigeration hoove Configuration Visbilisation Configuration oublin Conferration ming Courl gutufi Motivation Conti Technician Tool ** Perspective Componenta Ted Castgoute Replacementers SetEstig-East Name Some Tool in part Albeigant Tavilaciation ToolConnection Kool Rale Tool Hark Proving Red lot wind Tool Monumit TailEad Sudding Process Distribution Timin Operations Instances + đ O r. 8 2 Distribution Repectives, Inventory. Process Antional Schurchtparpare region at en autripet anti-Cimposta, reagint a con-tendiça antening hary off Cycles Datepula Networks Assimments 2011 John J. Sarbrian, all rights taxanant Ziedmanill and Da "Primitives" are Timeless.

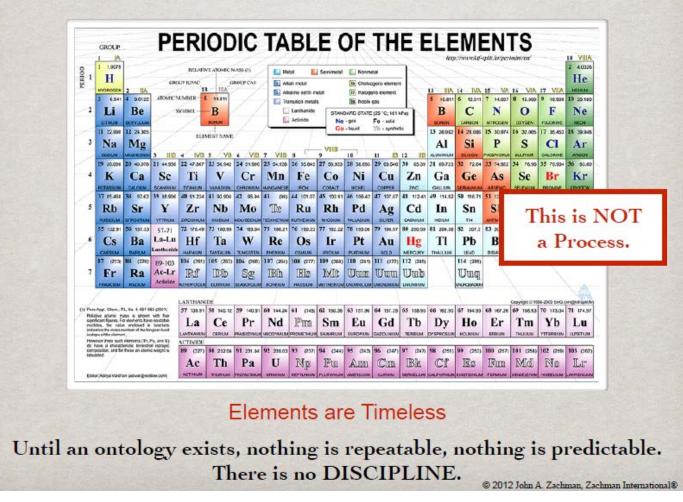


Enterprise Architecture Frameworks

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ONTOLOGY



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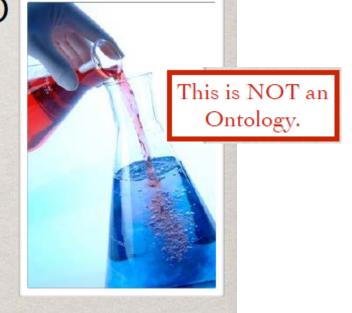
PROCESS

(METHODOLOGY)

Add Bleach to an Alkali and it is transformed into Saltwater.

HCI + NaOH - NaCI + H₂O COMPOUNDS

Salt NaCl Aspirin C9H8O4 Vicodin C18H21NO3 Naproxen C14H14O3 Ibuprophen C13H18O2 Viagra C22H30N6O4S Sulphuric Acid H2SO4 Water H2O etc., etc., etc.

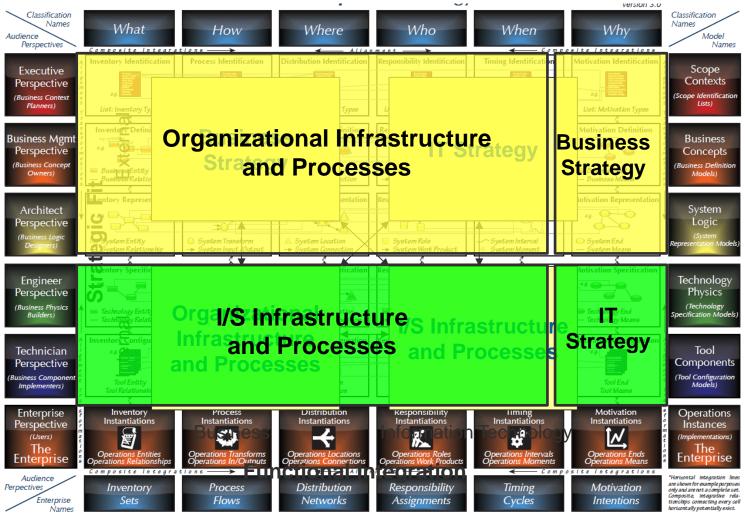




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Strategic Alignment Model and Zachman Framework



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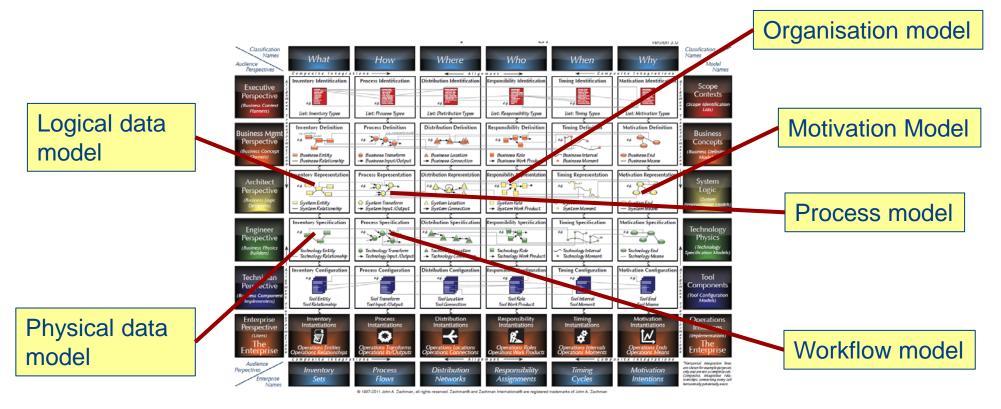
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Enterprise Architecture Frameworks



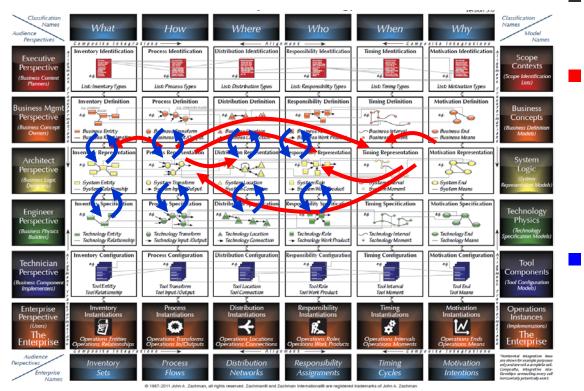
Models and the Zachman Framework

- Concepts for modelling are related to cells.
- Models are composites, they can roughly be assigned to cells, if they are composed of elements (concepts) of this cell.
- The elements of models can (roughly) be assigned to cells, but often cover





Relations between Models and Model Elements

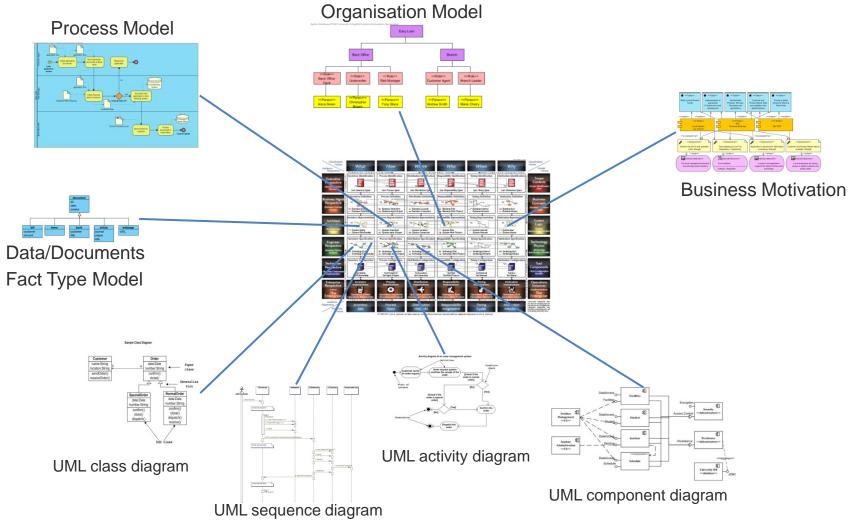


- There are relations between (elements of) the models
 - Horizontal Relations: In same perspective, e.g.
 - Data used in a process
 - Application implementing a process activitiy
 - Vertical relations: Between different perspectives
 - Implementation of an application
 - Database model for an entity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





Enterprise Architecture Modeling – Examples of Models Kinds



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Enterprise Architecture Frameworks



TOGAF – The Open Group Architecture Framework





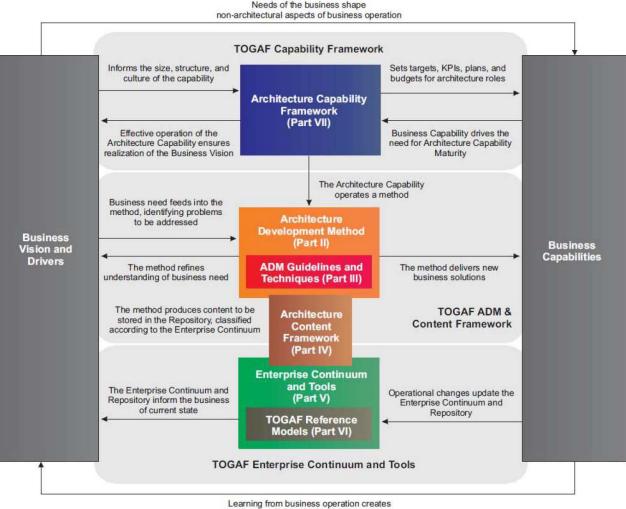
TOGAF – The Open Group Architecture Framework

- Developed and continuously evolved since the mid-90's by The Open Group's Architecture Forum
- At the heart of the framework are the
 - Architecture Development Method (ADM) and
 - The Ccontent Framework
- http://www.opengroup.org/togaf/





Structure of the TOGAF Document



new business need



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(The Open Group 2009, p. 4)

TOGAF Architectures

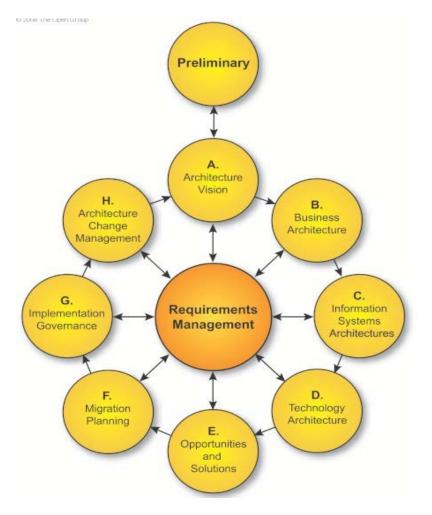
The TOGAF enterprise architecture model is organised in four partial sub-architectures:

- Business Architecture
 - Strategies, governance, organisation and business processes of the enterprise
- ♦ Information Systems Architecture consists of
 - 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, infrastructure



Technology Architecture

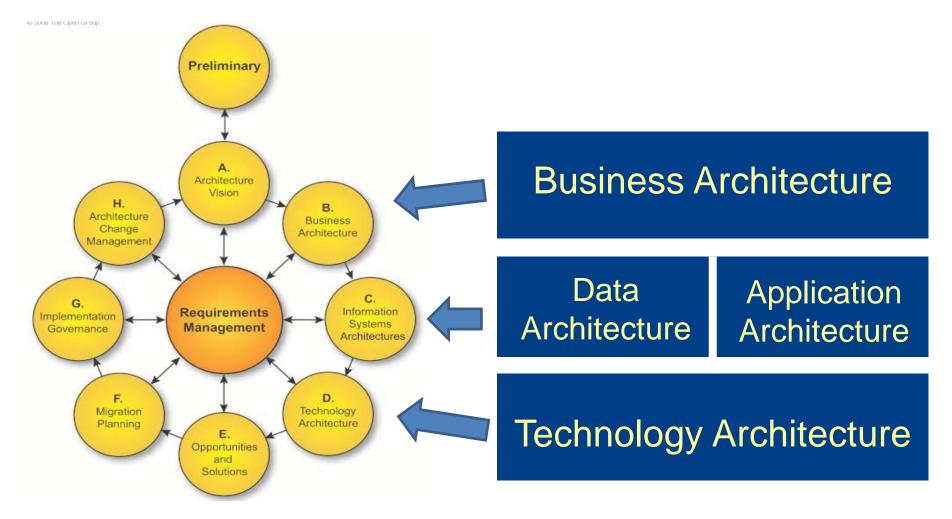
TOGAF Architecture Development Method (ADM)



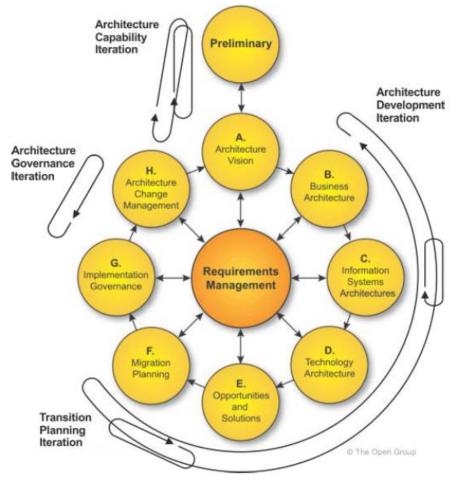
- TOGAF addresses the whole enterprise architecture lifecycle
- The TOGAF Architecture Development Method (ADM) is a generic method for developing an enterprise architecture
- The goals, approaches, required input, activities and deliverables are documented for each phase separately
- The ADM method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

(The Open Group 2009)





TOGAF Architecture Development Method (ADM)



 Although originally represented as a sequential method, chapter 19.2 of TOGAF describes also iteration cycles

(The Open Group 2011)

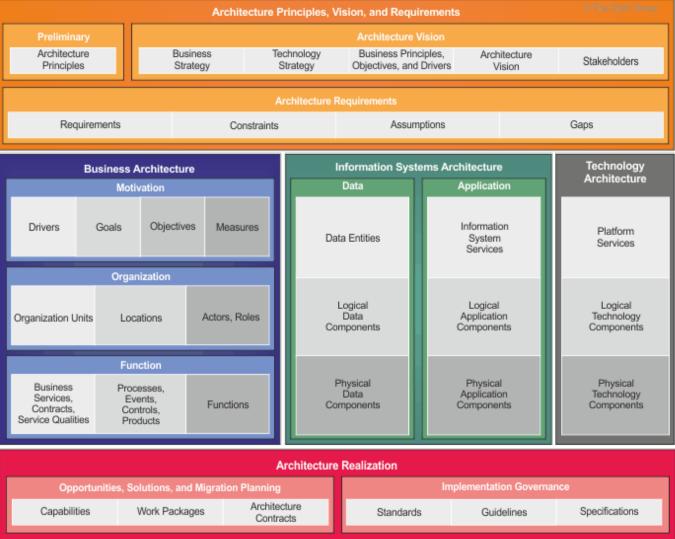


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TOGAF Content Metamodel

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http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap33.html Prof. Dr. Knut Hinkelmann

(The Open Group 2011)

Enterprise Architecture Frameworks



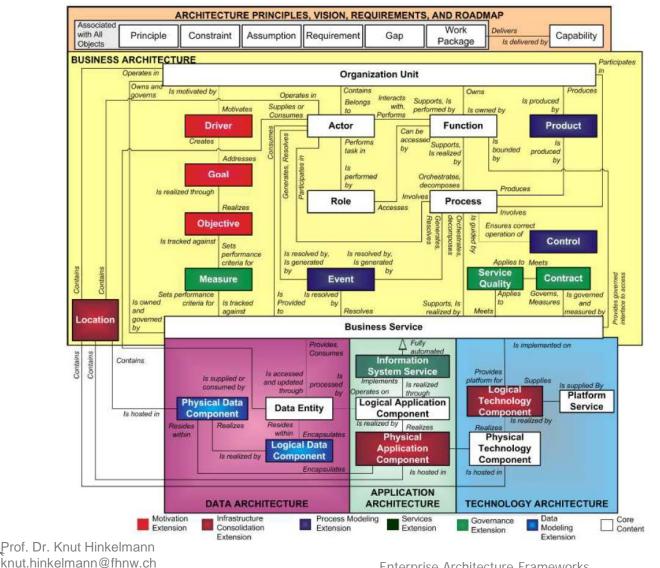
- The content metamodel provides a definition of all the types of building blocks that may exist within an architecture.
- The content metamodel
 - identifies all of these building block (i.e., application, data entity, technology, actor, and business service),
 - shows the relationships that are possible between them, e.g.
 - actors consume business services
 - data entities are held within applications
 - technologies implement applications
 - applications support buiness users or actors
 - identifies artifacts that can be used to represent them.

http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap33.html

(The Open Group 2011, Part IV)

TOGAF: Architecture Content

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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)



- The content framework is intended to allow TOGAF to be used as a stand-alone framework for architecture.
- However, some enterprises may opt to use an external framework (such as the Zachman Framework or ArchiMate) in conjunction with TOGAF.
- In these cases, the content framework provides a useful reference and starting point for TOGAF content to be mapped to other frameworks

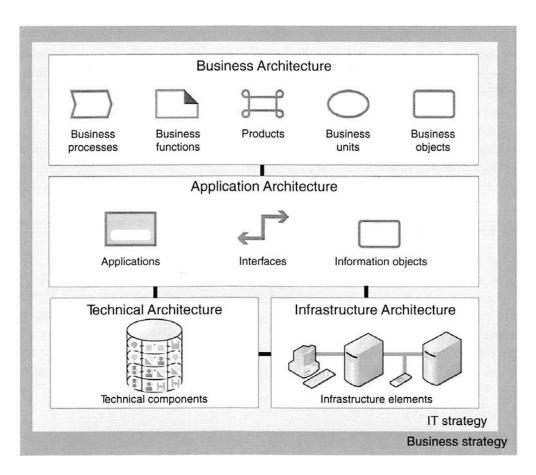




Best Practice Enterprise Architecture







- The Bast Practice Architecture from Inge Hanschke (2010) is another example of a threelayer 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

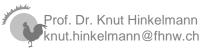
- documentation of the information systems landscape, i.e. information systems, their data und interfaces und the information flow
- bridge between business architecture and the architectures of technology and infrastructure

Technology Architecture

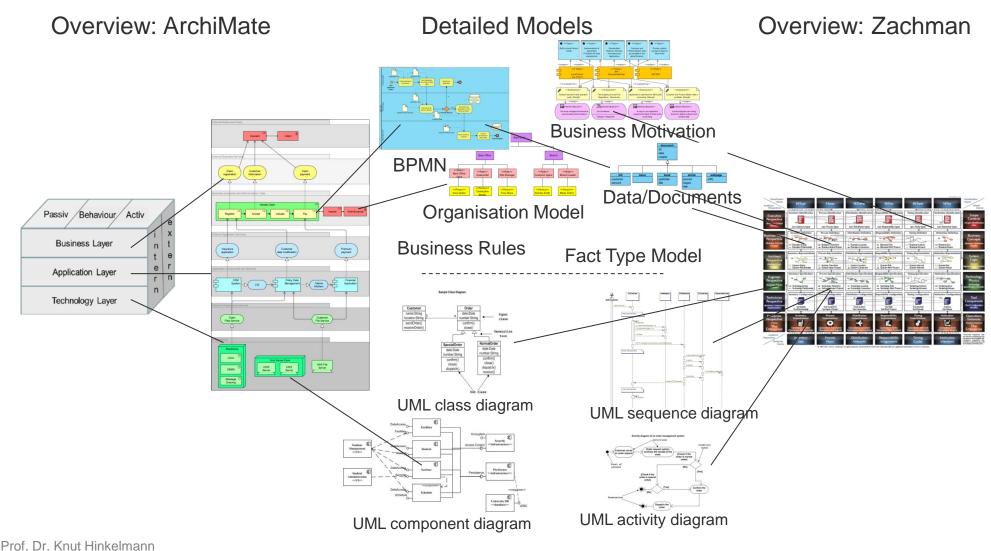
 determination of enterprise-specific technical standards for information systems, interfaces and infrastructure

Infrastructure Architecture

• Entities of the infrastructure, on which the information systems are running



Enterprise Architecture Modeling



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Enterprise Architecture Frameworks