Architecture Frameworks

Dr. Rudolf Hauber

Bertil Muth

HOOD GmbH
Büro München
Keltenring 7
82041 Oberhaching

Tel: 0049 89 4512 53 0
www.HOOD-Group.com

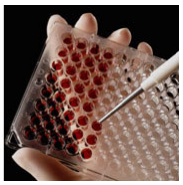
Übersicht

Our Business

The usage of **Requirements Management & Engineering (RM&E)** and continuous **process improvement** initiatives like **CMMI** or **SPICE** are an essential part for big and world wide organisations to develop complex products, services and systems.





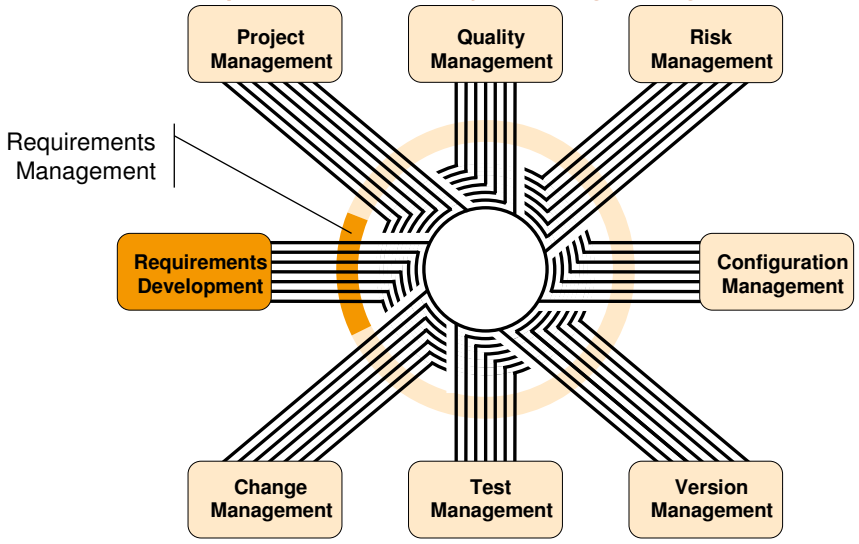


Our Customers

- **Automotive Manufacturer**
  - Adam Opel GmbH
  - Audi AG
  - BMW AG
  - Daimler AG
  - Volkswagen AG
- **Automotive Supplier**
  - Hella KGaA Hueck& Co
  - Robert Bosch GmbH
  - TRW
- **Logistic**
  - Deutsche Bahn AG
  - Schenker Logistics
  - Siemens Mobility
  - Thales Group
- **IT/ Software Development**
  - BMW AG
  - Volkswagen AG
  - Deutsche Nationalbibliothek
- **Aerospace Industry**
  - EADS
  - Astrium
  - Airbus
- **Medical Industry**
  - Drägerwerk AG & Co. KGaA
  - Siemens Healthcare
  - CareFusion (Viasys Healthcare)
- **Telecommunication**
  - Alcatel Lucent
  - NetCologne Gesellschaft für Telekommunikation mbH
  - O2 Germany GmbH & Co. OHG
- **Banking and Insurance**
  - AXA Konzern AG
  - BMW Bank GmbH
  - Interpolis

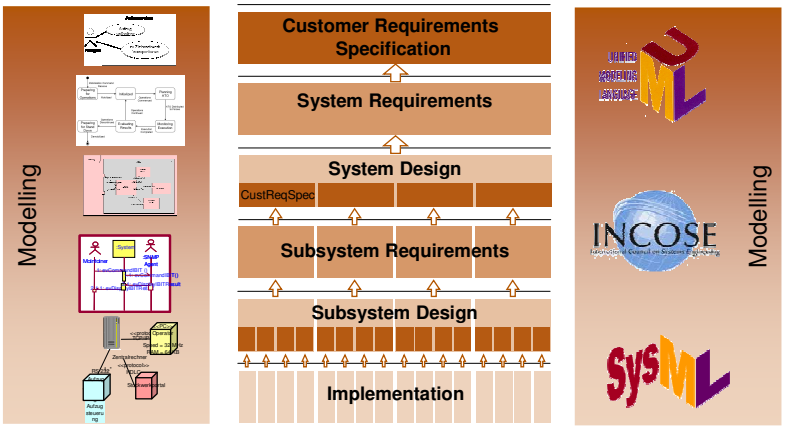
Our Expertise

Requirements Management is the interface between Requirements Development and all other Systems Engineering Processes



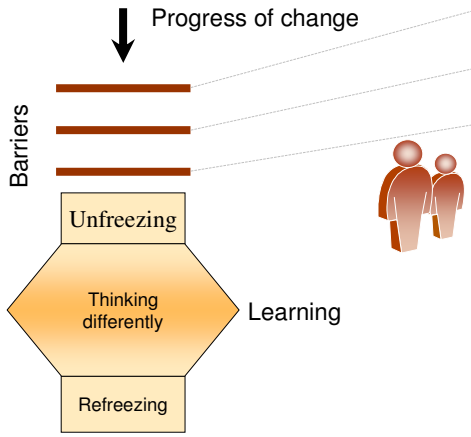
Model Based Systems Engineering Expertise (MBSE)

- Modelling is a central element in the HOOD Requirements Specification Process and in the derivation of requirements
- HOOD actively works on INCOSE “Model Based System Engineering vision 2020”



HOOD Guideline: Structure of Change

Process Improvement is not just a technical challenge.

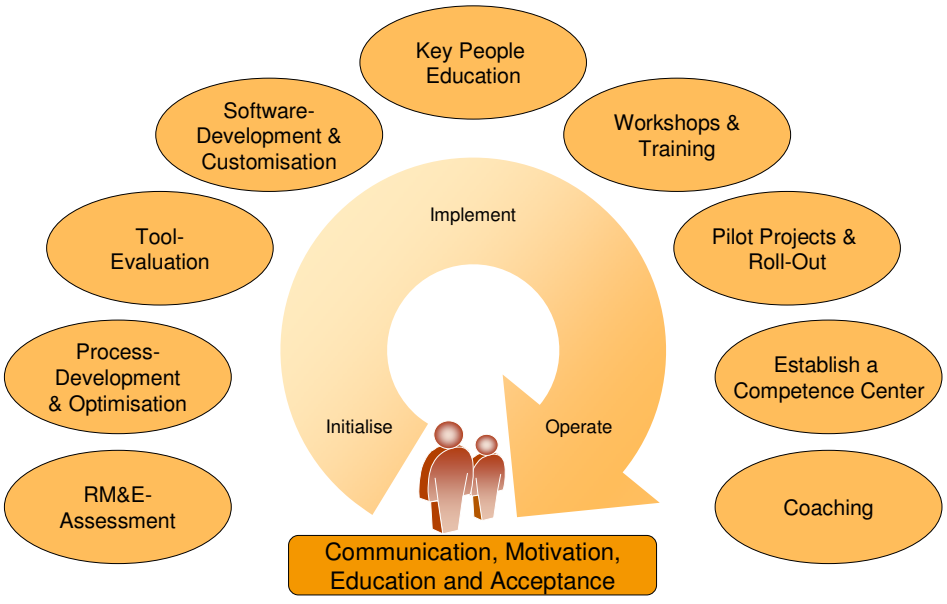


- Lack of discomfort/anxiety with present system
- Ignoring information that does not fit with the past
- Lack of psychological safety in the change, fear of loss of identity or integrity

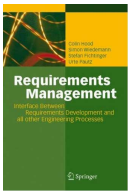
Recognising the barriers to change and helping people to overcome their anxiety, is necessary for successful change

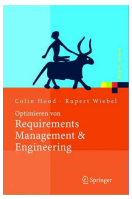
Source: Colin Hood 1997
Model of change based on work by Lewin 1947 and Schein 1961-1965

Services - Overview



HOOD- Excellence in Requirements



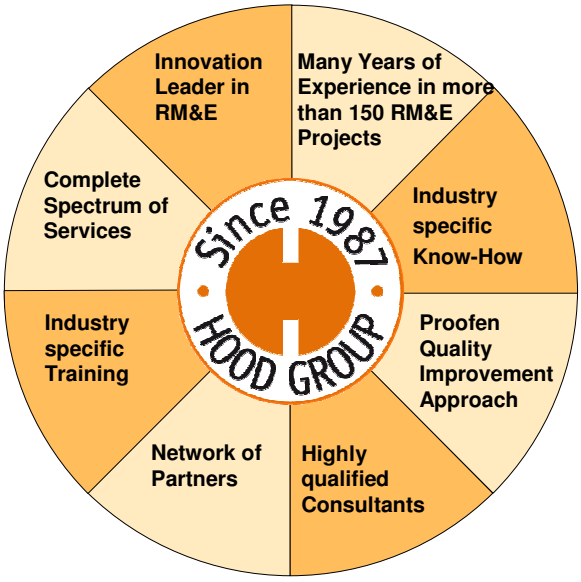


ReConf

SubConf

Hochschule Rosenheim
University of Applied Sciences

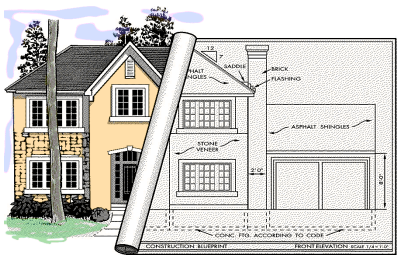
Your Advantage in Working with HOOD



Content

Motivation

- **System-Development and Maintenance is not easy!**
- Using models for problem area and solution area
  - reduces complexity
  - facilitates communication
  - eases re-use
- Modelling is an established engineering technique
- Modelling supports
  - Customers
  - Project management
  - Development
  - Quality assurance
  - Strategic Planning/Portfolio Management
  - IT-Maintenance
  - Other stakeholders



Architecture Modelling

Brand, *How Buildings Learn*

- ISO/IEC 42010: 2007 defines ‘‘architecture’’ as:
  ‘‘The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.’’
- Different views and stakeholders

Front

Interior decoration

Groundwork Statics

Logistics

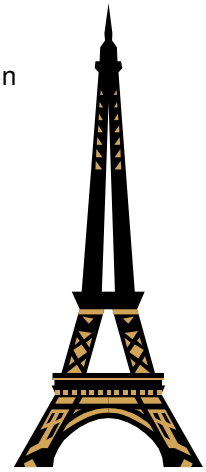
Spatial planning

Services
(gas, water, electricity)

Introduction into Architecture

What is an Architecture ?

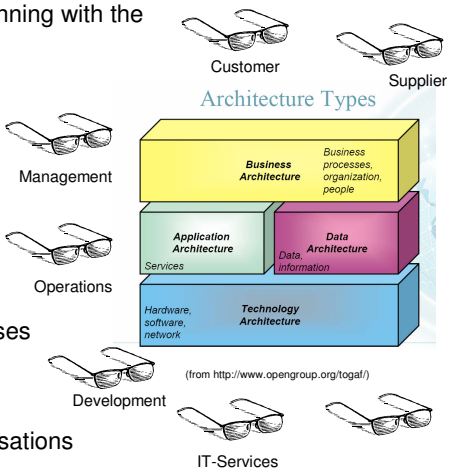
- Fundamental organisation of a system
  - embodied in its components
  - their relationships to each other and the environment
- Principles and patterns guiding system design and evolution
- can be captured in a formal description
- can cover many aspects, including
  - Capabilities
  - Operational Context
  - Operational Activities
  - System Interfaces
  - Provided Services
  - System Structure
  - System Behaviour
  - Used technique and standards
  - Performance
  - Evolution over time



Enterprise Architecture Introduction

What is an Enterprise Architecture ?

- Aligns higher level guidance and strategic planning with the
  - Organisation and infrastructure,
  - Governance,
  - Business processes,
  - Information systems
  - Supporting technology
- Role of an Enterprise Architecture is to provide decision support
  - in the context of the enterprise strategy
  - for the use of resources (including processes and procedures) in the enterprise.
- Used as analysis tools to
  - Develop new capabilities, structure organisations
  - Optimize processes and spending



Architecture Framework Introduction

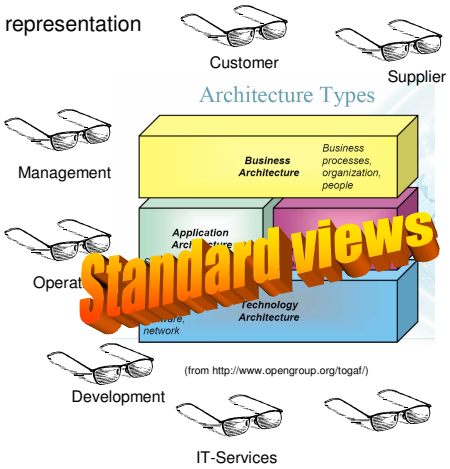
What is an Architecture Framework?

- foundational structure, or set of structures, which can be used for developing a broad range of different architectures.
- should describe a method
  - for designing a target state of the enterprise in terms of a set of building blocks
  - for showing how the building blocks fit together.
- should contain a set of tools and provide a common vocabulary.
- should also include a list of recommended standards and compliant products that can be used to implement the building blocks.

Architecture Framework Introduction

Architecture Framework objectives

- Form common language
  - Defines common language for architecture representation
    - Standardized views
    - Unified way of describing complex real world objects
  - Enables better communication between
    - Teams of architects
    - Architects and stakeholders
    - Purchaser and supplier
- Support decision making
  - Identifying capability needs
  - Relating needs to systems development and integration,
  - Attaining interoperability and supportability
  - Managing investments
- Support interoperability
- …by reducing complexity



Architecture Framework Introduction

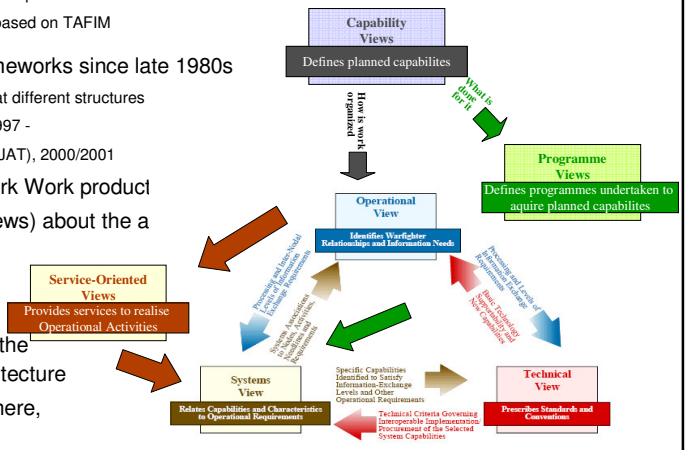
- Architecture Framework objectives
  - Support decision making for different decision types
    - Enterprise and Portfolio Management
    - Capability and Interoperability Readiness
    - Operational Planning
    - Acquisition Programme Management and System Development
    - Modelling and Simulation

Architecture Framework Introduction

- Architecture Framework objectives
  - Long Term Benefits
    - Reduction in cost overruns
    - Reduction in contract errors
    - Improved integration across platforms
    - Reduction in duplication of investment spend
    - Agile acquisition and reduced time to bring capability into service
    - More efficient use of common funded budgets.
    - Improved requirements specifications
    - New projects scoped more accurately meaning fewer adverse 'surprises' and cost increases during implementation
    - Reduced development risks/costs for projects and faster introduction, so that business benefits can be realized earlier
    - Improved validation and assurance of solutions
    - Improved portfolio and programme management

DoD/NATO Architecture Framework

- US federal IT recommendations and guidance (the Clinger-Cohen Act in 1996)
  - information technology architectures as means of integrating business processes and agency goals with IT
  - Model enterprise architectures as blueprints
  - Triggered development of C4ISR based on TAFIM
- DoDAF: First architecture frameworks since late 1980s
  - different terminology and somewhat different structures
  - C4ISR Architecture Framework, 1997 -
  - DoD Joint Technical Architecture (JAT), 2000/2001
- DoDAF Architecture Framework Work product
  - capture information (or views) about the a
  - provide an exhaustive set of blueprints for any DoD project
  - Describes the **content** of the the DoD "enterprise" architecture
    - Why, What, Who, Where, How, When



Architecture Frameworks Examples

- DoDAF/MoDAF/NAF – US DoD/UK MoD/NATO/UPDM Architectural Framework
- TOGAF – The Open Group Architectural Framework
- Zachman – IBM Architectural Framework

Same predecessor TAFIM

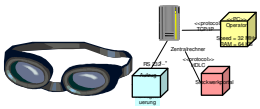
Differences

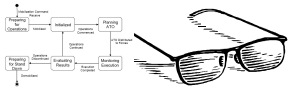
- Differences between these architectural frameworks vary according to heritage
- MoDAF is built from and heavily aligned to DoDAF (see history in earlier slides)
- NAF is built from DoDAF and MoDAF
- TOGAF was based originally on TAFIM (Technical Architecture Framework for Information Management), which was a precursor to both DoDAF and subsequently MoDAF
- Zachman Framework was published in 1987 at IBM

Views, models and diagrams

- UML/SysML diagrams are views of a model of a real system
- Different types of diagrams show different aspects of the system
- Architecture frameworks guide the creation of models


Logical View


Location View

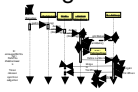

Behavior View


Timing View


Requirements View

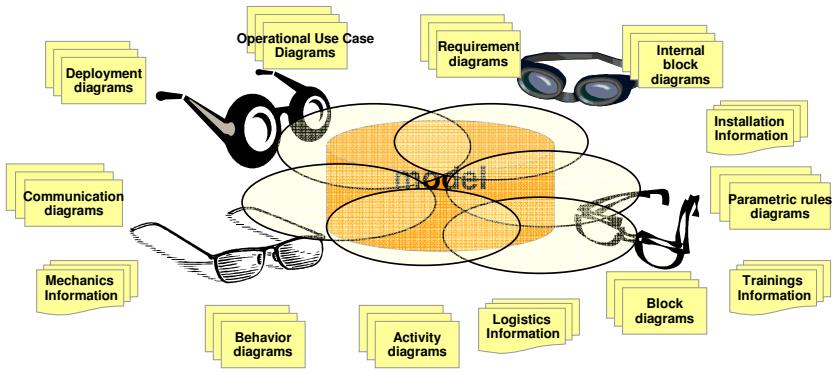

Operational View


Logistics View



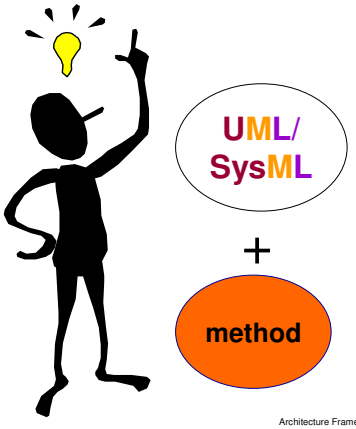
Views, models and diagrams

- Aspects complement and overlap one another
- Consistency of the model must be established
- Architecture framework provides support for consistency by clear rules
- UML/SysML supports consistency with notation built-in mechanisms



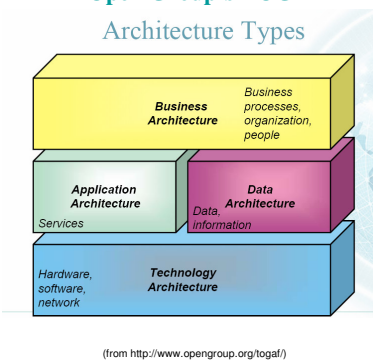
Unified Modelling Language

- UML/SysML includes:
  - notation (graphical)
  - concepts and semantics
  - guidelines
- Design Principles of UML/SysML:
  - mature notation on formal basis
  - extensible (stereotypes)
  - support for established well-tried concepts
    - i.e. state charts, message sequence charts,...
- not included:
  - method

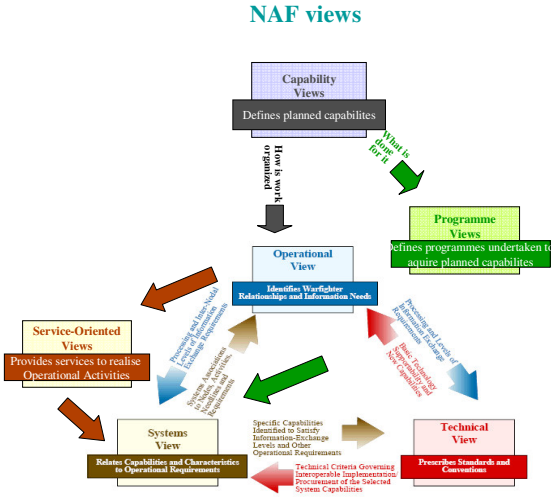


Content

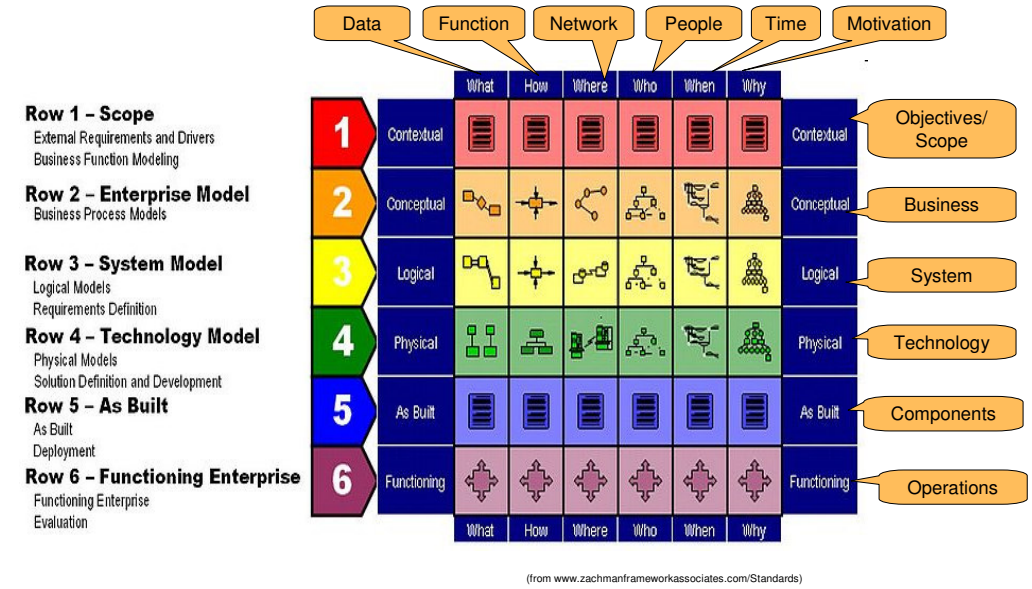
Architecture Types/View



(from http://www.opengroup.org/togaf/)



Zachmann Enterprise Framework



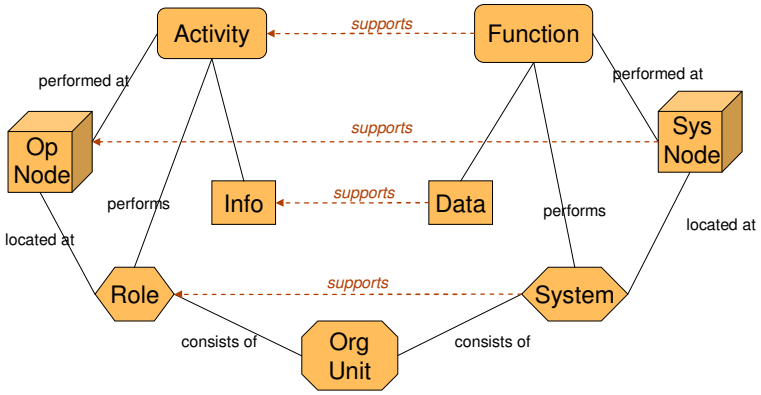
(from www.zachmanframeworkassociates.com/Standards)

Zachmann Enterprise Framework

- ***The Zachman Framework™***
  - **is a metamodel,** not a methodology or prescription
  - is the basis for Architecture
  - It does not imply how you do Architecture: top-down, bottom-up, left to right, right to left, where to start, etc.

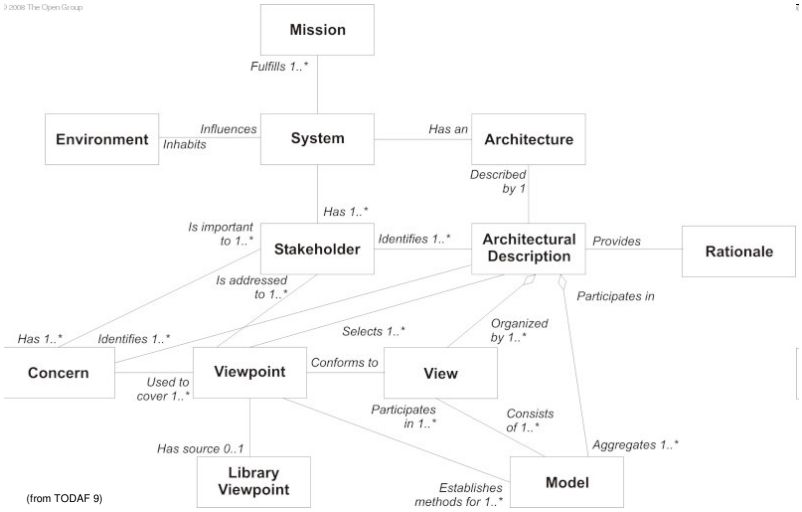
NAF Core Entities

- Relationship of the Core Architecture Artefacts
  - Operation Node • Activities • Roles
  - System Functions • System Nodes • Systems
  - Organizational Units • Roles • Systems



TOGAF Core Entities

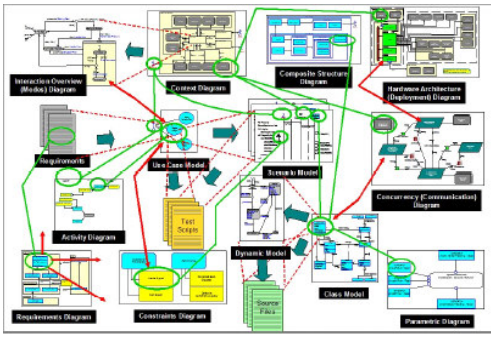
- Relationship of the Core Architecture Artefacts

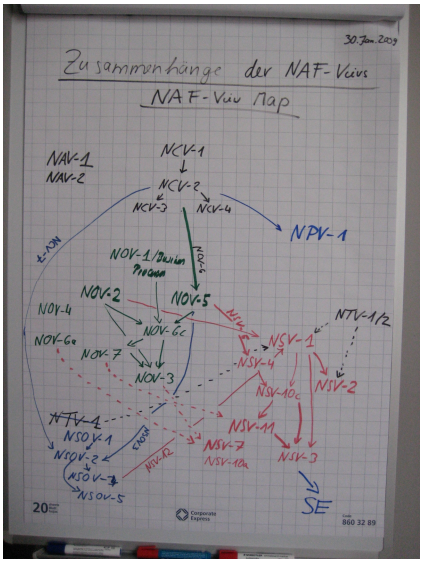


(from TODAF 9)

NAF Views Interdependency

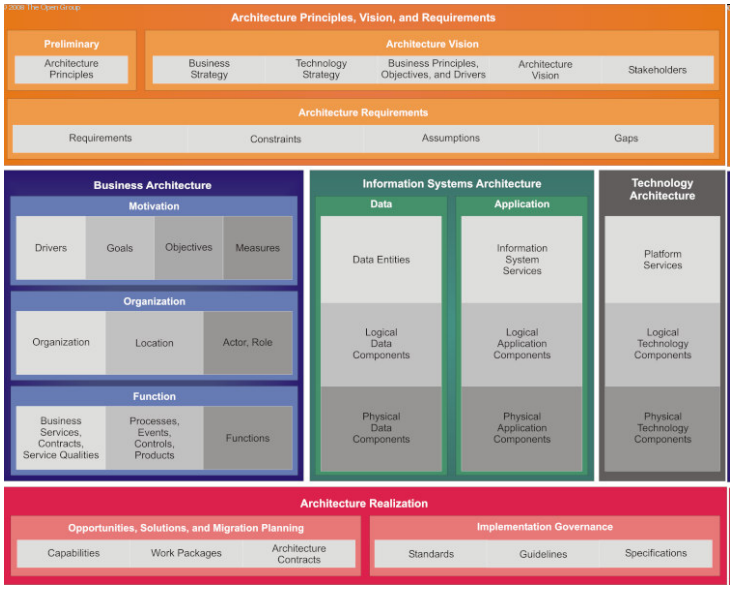
- How everything fits together





Content

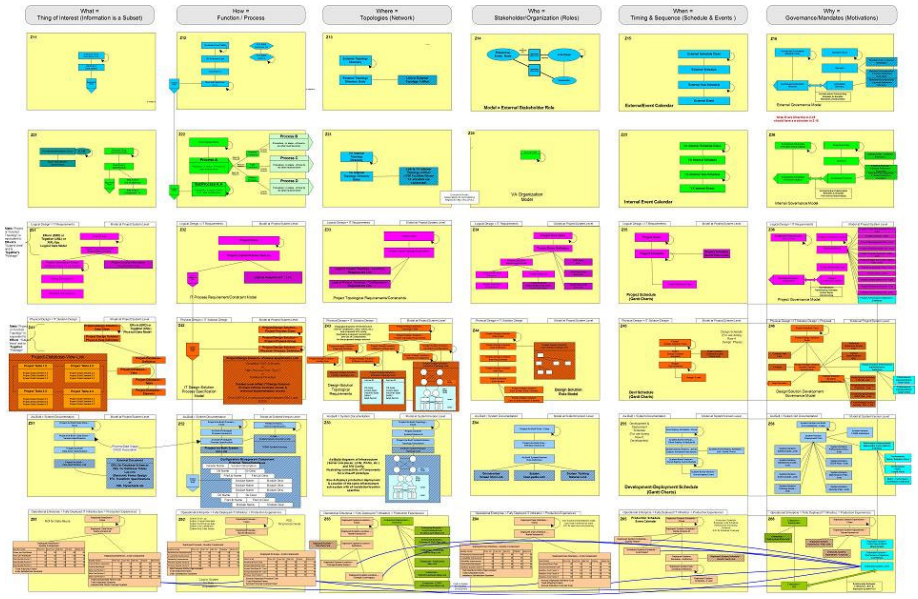
TOGAF content overview



Zachmann Enterprise Framework

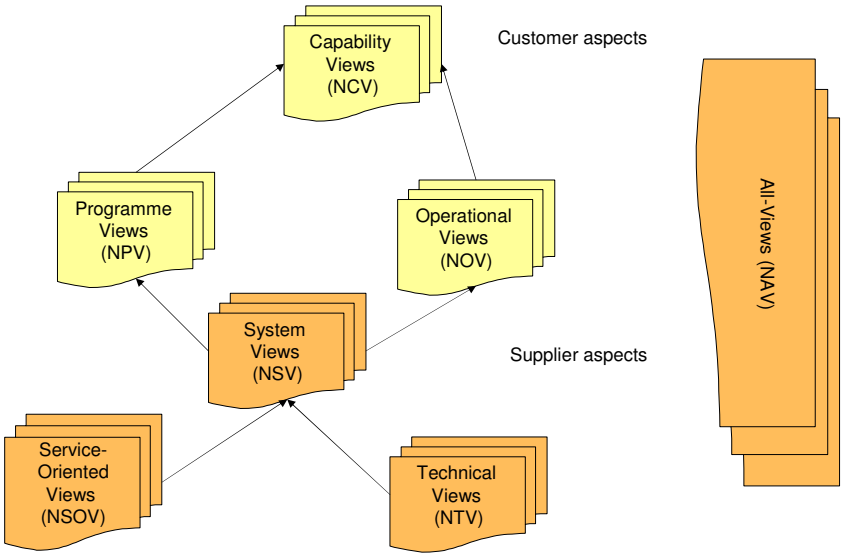
	What	How	Where	Who	When	Why
Business	Business Entity	Business Transform	Business Location	Business Role	Business Cycle	Business End
	Business Relation	Business Input	Business Connection	Business Work	Business Moment	Business Means
System	System Entity	System Transform	System Location	System Role	System Cycle	System End
	System Relationship	System Input	System Connection	System Work	System Moment	System Means
Technology	Technology Entity	Technology Transform	Technology Location	Technology Role	Technology Cycle	Technology End
	Technology Relationship	Technology Input	Technology Connection	Technology Work	Technology Moment	Technology Means
Component	Component Entity	Component Transform	Component Location	Component Role	Component Cycle	Component End
	Component Relationship	Component Input	Component Connection	Component Work	Component Moment	Component Means
Operations	Operations Entity	Operations Transform	Operations Location	Operations Role	Operations Cycle	Operations End
	Operations Relation	Operations Input	Operations Connection	Operations Work	Operations Moment	Operations Means

Zachmann Enterprise Framework



(from http://en.wikipedia.org/wiki/Zachman_Framework)

NATO Architecture Framework Views - Overview



NAF – Capability View

Developing the Capability View

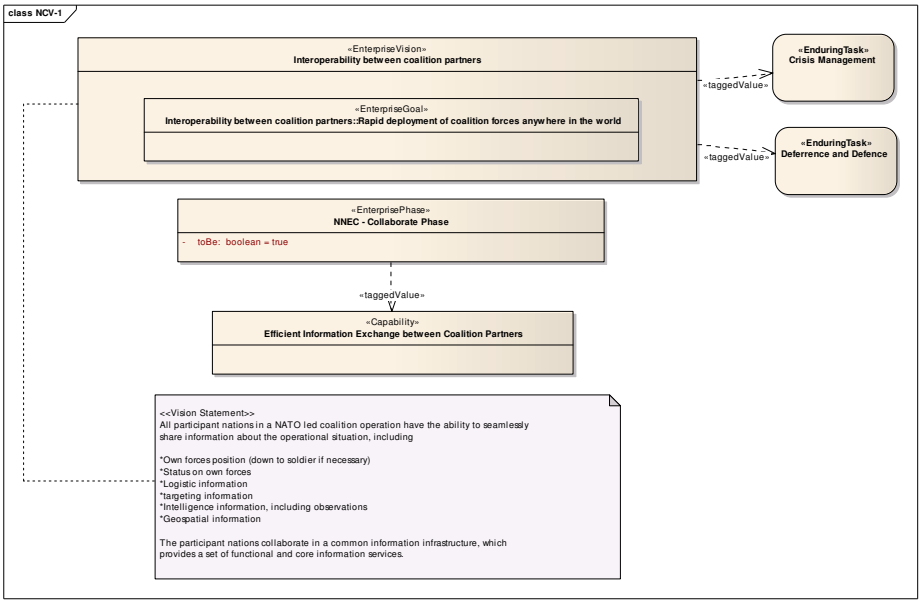
Architecture View	#	Architecture Product	
Capability View (Vision)	NCV-1	Capability Vision	
Capability View (Taxonomy)	NCV-2	Capability Taxonomy	
Capability View (Phasing)	NCV-3	Capability Phasing	
Capability View (Dependencies)	NCV-4	Capability Dependencies	
Capability View (Deployment)	NCV-5	Capability to Organisational Deployment Mapping	
Capability View (Activities)	NCV-6	Capability to Operational Activities Mapping	
Capability View (Services)	NCV-7	Capability to Services Mapping	

NAF Capability View (NCV)

NCV-1, Capability Vision

- High-level concept: high-level operational goals and strategy in military capability terms
- Information provides guidance on future capabilities
- Information allows acquisition specialists to identify future needs
- Textual document or UML/SysML diagram(s)

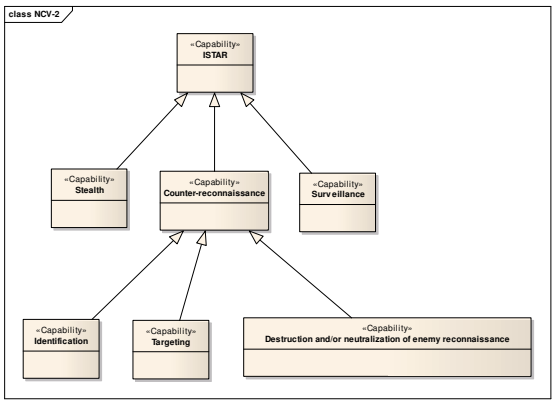
NAF – NCV-1 View



NAF Capability View (NCV)

NCV-2, Capability Taxonomy

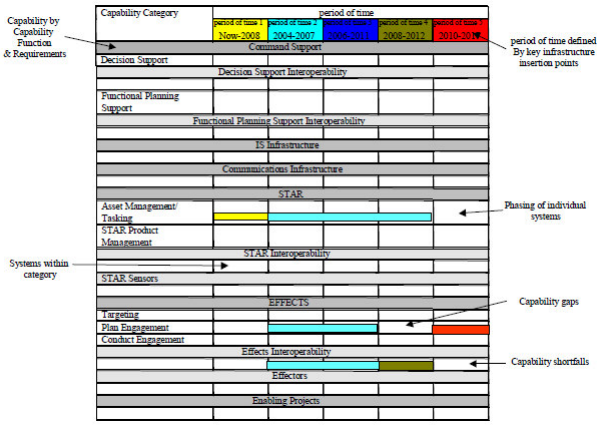
- Comprehensive list of the capabilities that need to be delivered during a particular timeframe
- Each capability is, where necessary, subdivided into sub-capabilities and/or functions
- Used to support the Capability Audit process
- Format selected must be able to support the representation of a structured/hierarchal list



NAF Capability View (NCV)

NCV-3, Capability Phasing

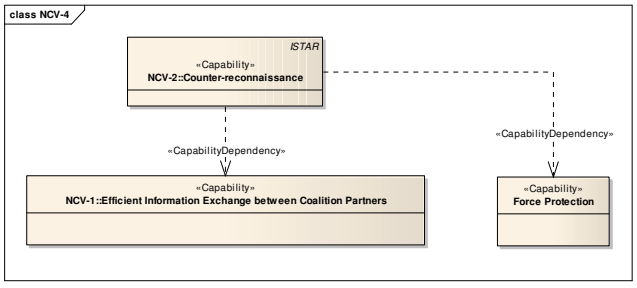
- Structured list of required capability functions (derived from the Capability Taxonomy (NCV-2) subview) as rows
- Cells show the system that delivers the capability within that time period
- Timescale/ timeframe as columns



NAF Capability View (NCV)

NCV-4, Capability Dependencies

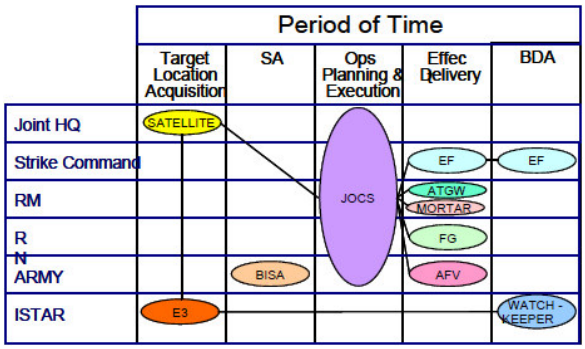
- Cluster: logical grouping of capabilities
- The elements are not intended to represent individual systems or items of equipment
- Graphical description
  - Functional dependency diagram



NAF Capability View (NCV)

NCV-5, Capability to Organisational Deployment Mapping

- Matrix with the appropriate organisational structure (such as described in NOV-4) represented by one axis, and the capabilities (as defined in NCV-2) by the other axis
- Graphical objects representing NATO and National systems are placed in the relevant positions relative to these axes



NAF Capability View (NCV)

NCV-6, Capability to Operational Activities Mapping

- Matrix showing operational activities on one axis and capabilities (optionally including military functions) on the other
- Shows „gaps“ or „white spots“ (activities do not, or only partially support military functions)
- Shows „ redundancy „ (military functions are supported by more than one operational activity)

	ISTAR	Decision Support	Effects-Planning	Effects-Engagement
Prepare estimate		x		
Plan collection	x			
Manage Intel collection	x			
Assess Intel	x			
Maintain Recognised Picture	x	x		
Deconflict Battlespace			x	
Conduct Fires				x
Battle Damage Assessment	x			

NAF - Operational Views

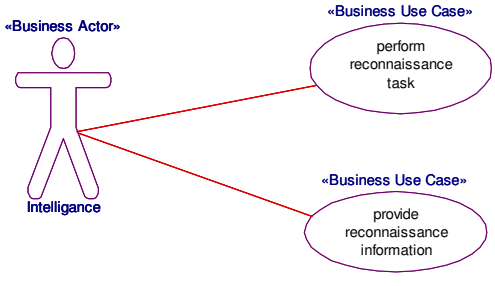
Developing the Operational View Products

Operational	NOV-1	High-level Operational Concept Graphic	Essential	High-level graphical description of operational concept (high-level organizations, missions, geographic configuration, connectivity, etc.)
Operational	NOV-2	Operational Node Connectivity Description	Essential	Operational nodes, activities performed at each node, connectivities & information flow between nodes
Operational	NOV-3	Operational Information Exchange Matrix	Essential	Information exchanged between nodes and the relevant attributes of that exchange such as media, quality, quantity, and the level of interoperability required.
Operational	NOV-4	Command Relationships Chart	Supporting	Command, control, coordination relationships among organizations
Operational	NOV-5	Activity Model	Supporting	Activities, relationships among activities, I/Os, constraints (e.g., policy, guidance), and mechanisms that perform those activities. In addition to showing mechanisms, overlays can show other pertinent information.
Operational	NOV-6a	Operational Rules Model	Supporting	Showing mechanisms, overlays can show other pertinent information. One of the three products used to describe operational activity sequence and timing that identifies the business rules that constrain the operation
Operational	NOV-6b	Operational State Transition Description	Supporting	One of the three products used to describe operational activity sequence and timing that identifies responses of a business process to events
Operational	NOV-6c	Operational Event/Trace Description	Supporting	One of the three products used to describe operational activity sequence and timing that traces the actions in a scenario or critical sequence of events
Operational	NOV-7	Logical Data Model	Supporting	Documentation of the data requirements and structural business process rules of the Operational View.

NAF – NOV-1 View

NOV-1 High-level Business process diagram

- Explore Business events and processes behind the Operational Concept

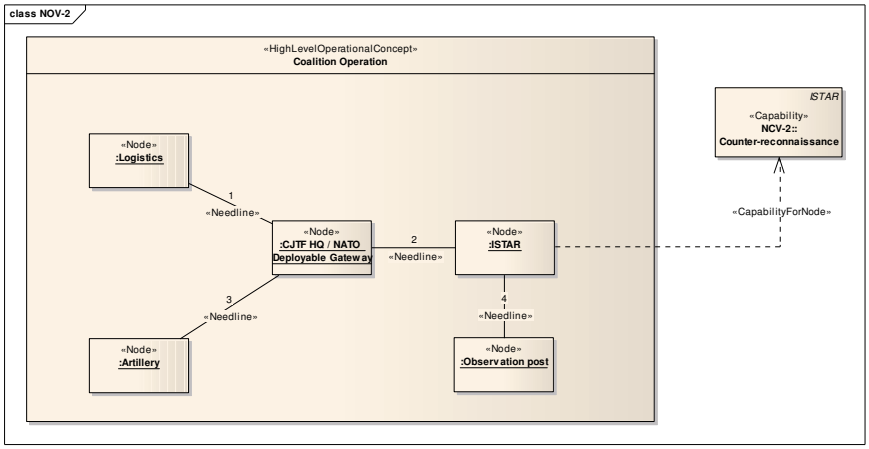


(from ww.OHB-systems.de)

NAF – NOV-2 View

NOV-2 Operational Node Connectivity Description

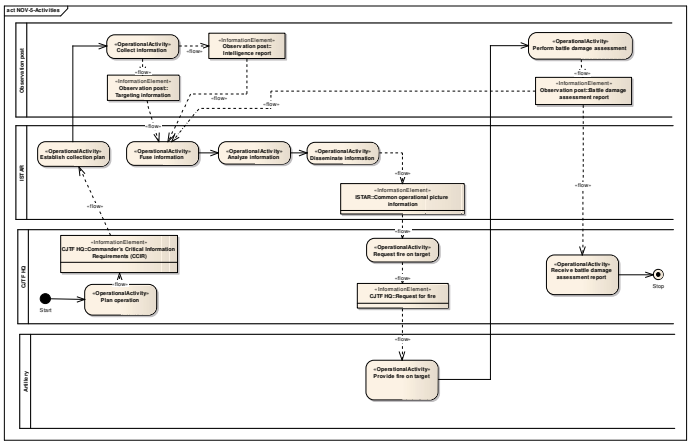
- Operational Nodes and Needlines



NAF – NOV-5 View

NOV-5 Activity Model

- Clarifies
  - Roles,
  - Responsibilities
  - Order of execution
- With respect to accomplishing key mission objectives in the context of the operational enterprise
- Create activities for each major step of flow or scenario, indicating logical choices or decision points.



NAF – System Views

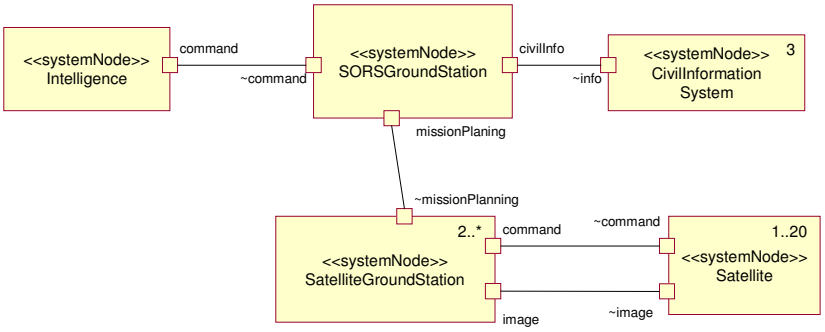
Developing the System View Products

Level	*View ID*	*View Content*
Systems	NSV-1	System Interface Description
Systems	NSV-2	Systems Communications Description
Systems	NSV-4	Systems Functionality Description
Systems	NSV-5	Operational Activity to System Function Traceability
Systems	NSV-7	System Performance Parameters
Systems	NSV-8	System Evolution Description
Systems	NSV-9	System Technology Forecast
Systems	NSV-10a	Systems Rules Model
Systems	NSV-10b	Systems State Transition Description
Systems	NSV-10c	Systems Event/Trace Description
Systems	NSV-11	System Data Model
Systems	NSV-12	Service Provision

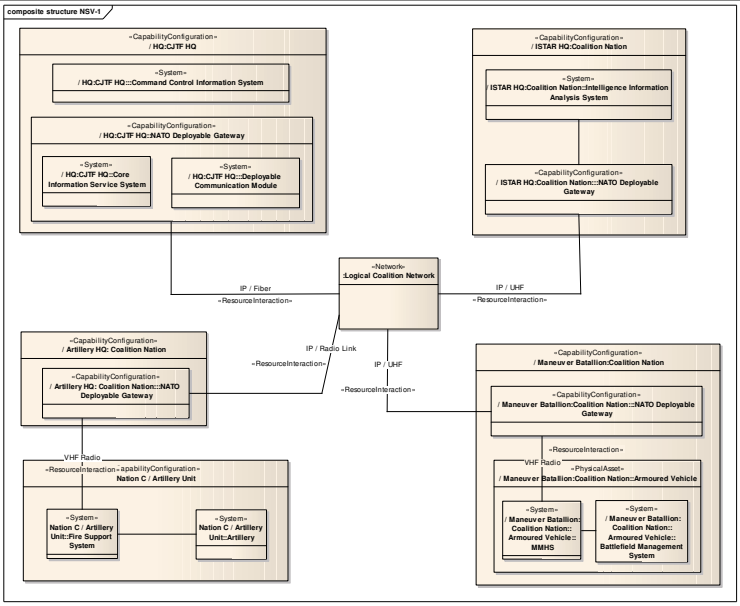
NAF – NSV-1 View

NSV-1 System Interface Description

- Depicts systems, system nodes, and the logical interfaces within and between them
- Foundation for internal architecture
- Provides elements for linkage between the Operational and System Views



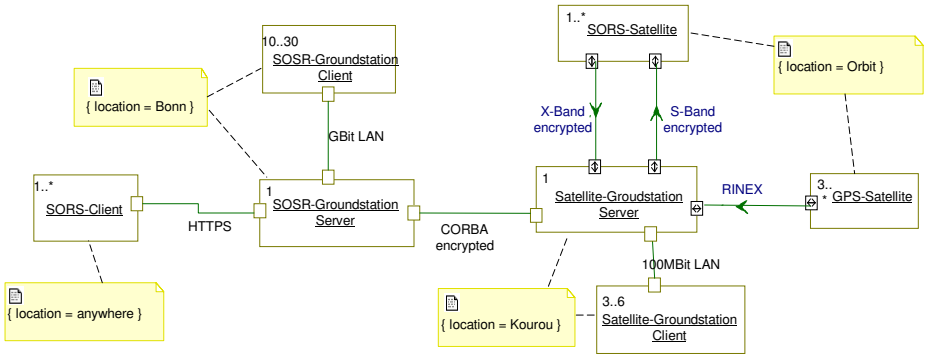
NAF – NSV-1 View



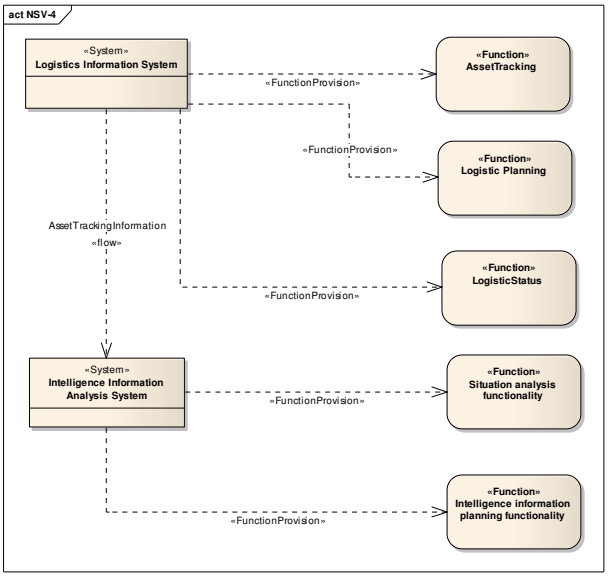
NAF – NSV-2 View

NSV-2 Systems Communications Description

- Reflect physical nodes (localities) and their communications infrastructure



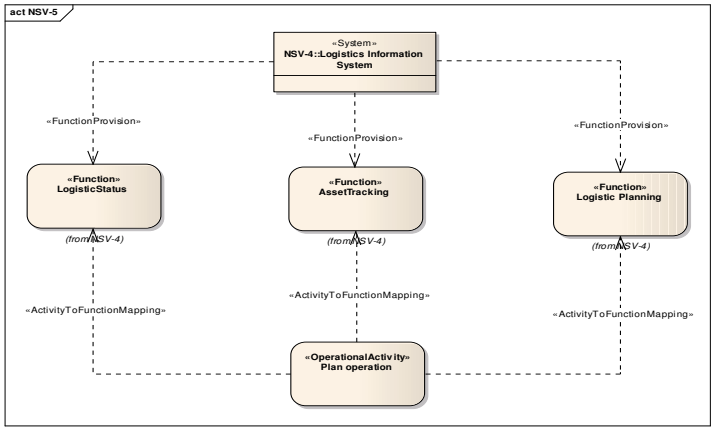
NAF – NSV-4 View



NAF – NSV-5 View

NSV-5 Operational Activity to System Function Traceability Matrix

- Provides traceability between operational activities and the system functionality (operations) that realize the required behaviour



NAF – Service-Oriented Views

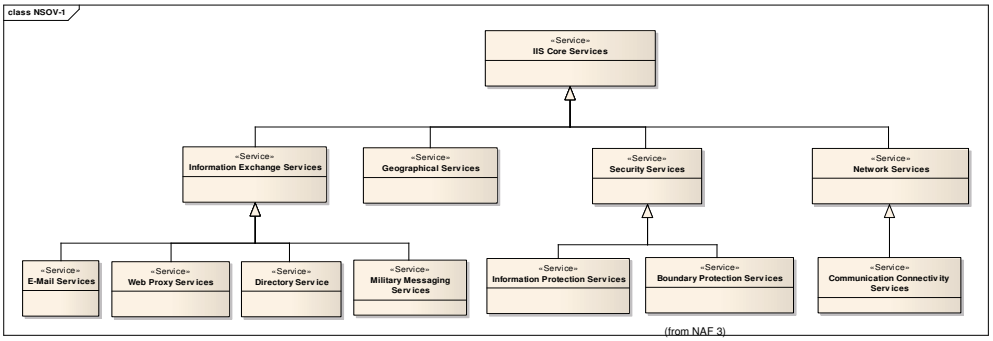
Developing the Service-Oriented Views

Architecture View	#	Architecture Product	General Nature
SO-View (Taxonomy)	NSOV-1	Service Taxonomy	Organise knowledge according to the service perspective
SO-View (Definitions)	NSOV-2	Service Definitions	Define services supporting operational activities
SO-View (Activities)	NSOV-3	Services to Operational Activities Mapping	Provide traceability by illustrating which services support which operational activities
SO-View (Orchestration)	NSOV-4	Service Orchestration	Identify and describe how services are used to support operational processes.
SO-View (Behaviour)	NSOV-5	Service Behaviour	Specify the function and behaviour of individual services

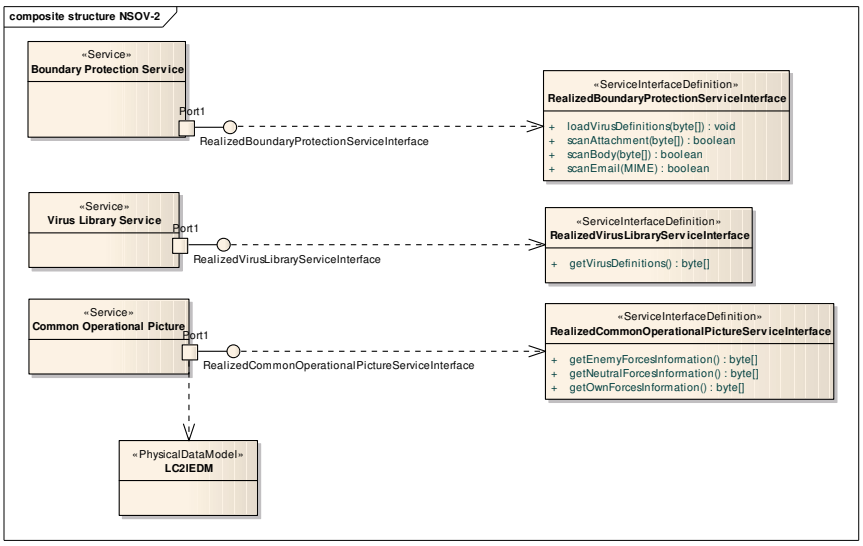
NAF Service-Oriented Views (NSOV)

NSOV-1, Service Taxonomy

- Represents Domain Knowledge in terms of services
- Represented by a:
  - Hierarchy, Tree
  - Network, loose set of groups



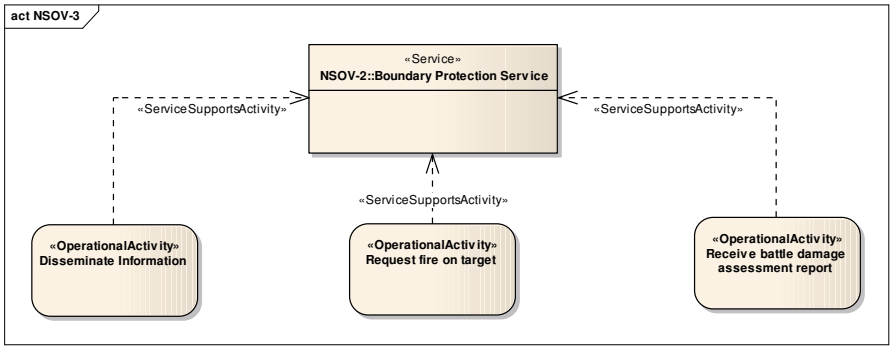
NAF NSOV-2



NAF Service-Oriented Views (NSOV)

NSOV-3, Services to Operational Activities Mapping

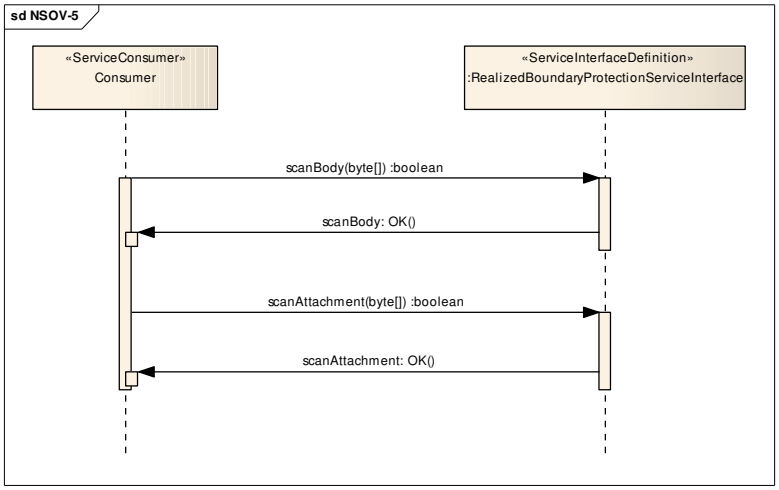
- The NSOV-3 subview shows which operational activities are supported by which services through the use of a
  - mapping matrix
  - graphically



NAF Service-Oriented Views (NSOV)

NSOV-5, Service Behaviour

- Shows the sequencing and timing of interactions between individual services



(from NAF 3)

NAF – Technical Views

Developing the Technical View Products

Technical	NTV-1	Technical Standards Profile	Essential	Extraction of standards that apply to the given architecture
Technical	NTV-2	Standards Technology Forecast	Supporting	Description of emerging standards that are expected to apply to the given architecture, within an appropriate set of timeframes
Technical	NTV-3	Standard Configurations	?	Capture and explicitly describe configurations that are of value to the ongoing or to future architecture projects

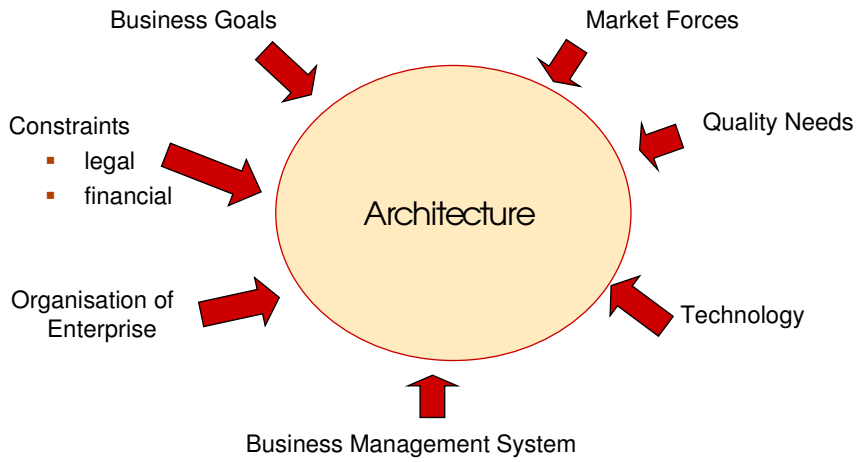
NAF – Programme Views

Developing the Programme Views

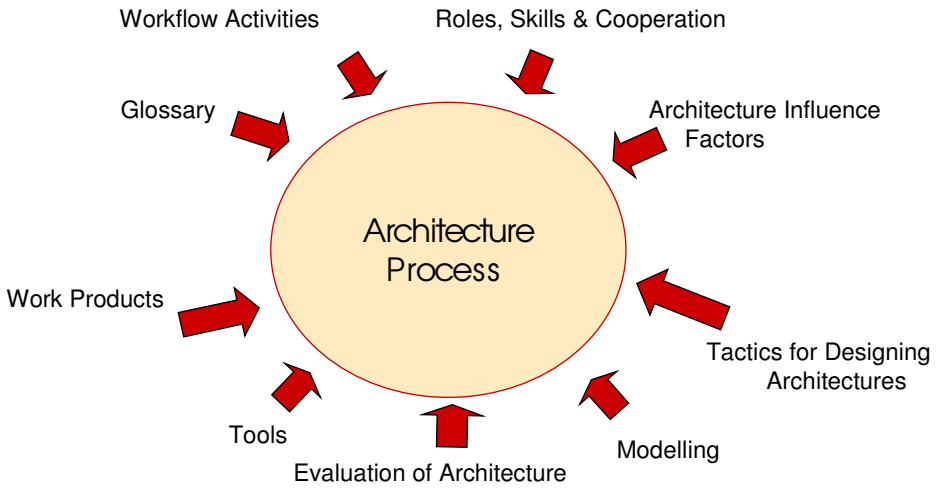
Architecture View	#	Architecture Product	Essential or Supporting	General Nature
Programme Portfolio Relationships	NPV-1	Programme Portfolio Relationships	?	Details relationships among projects within programmes
NPV-2, Programme to Capability Mapping	NPV-2	Programme to Capability Mapping	?	Depicts relationships between capabilities and programmes

Content

Forces that influence Architecture



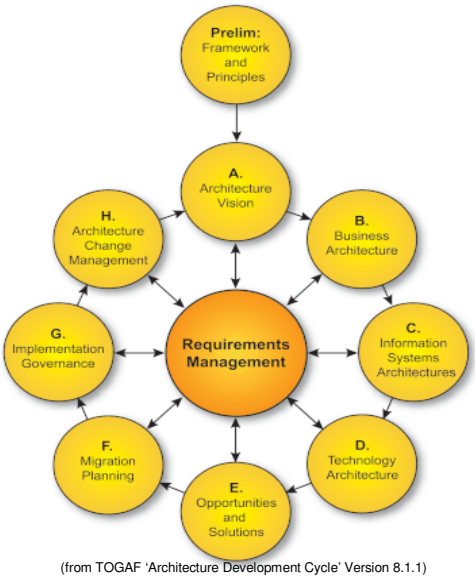
Building Blocks of an Architecture Process



Other Architecture Frameworks – TOGAF

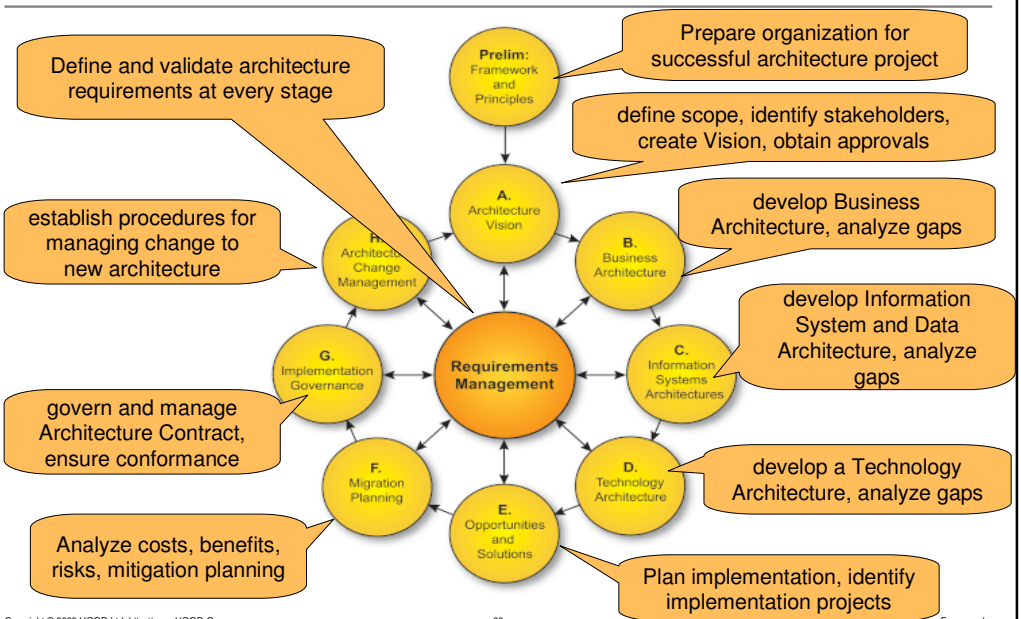
TOGAF Architecture Development Lifecycle

- The TOGAF Architecture Development Method (ADM) is subdivided into nine discrete phases
- Each phase contains documents a series of process steps, inputs and outputs



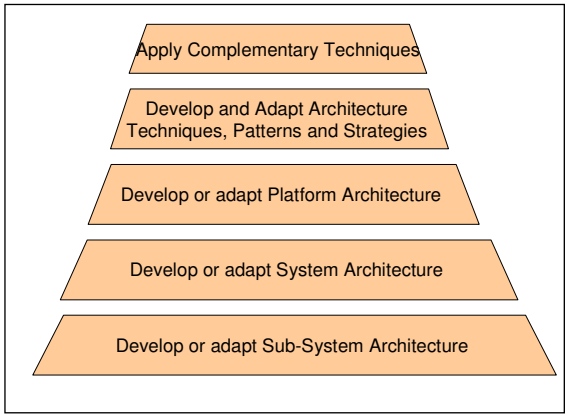
(from TOGAF 'Architecture Development Cycle' Version 8.1.1)

TOGAF Process



Architect Skill Descriptions

- Describing the skills required from an architect helps project leaders to assign persons to roles
- Level based descriptions simplify defining
  a) the skills needed to fulfill a purpose
  b) how to aquire the skills



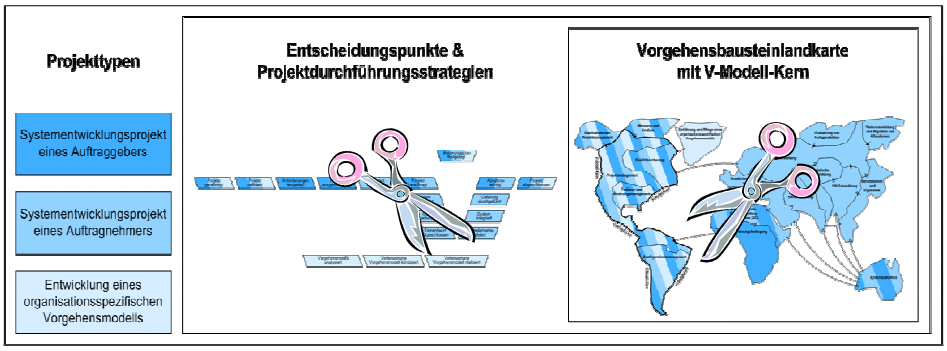
Content

Architecture Framework Tailoring

- Why tailoring?
- E.g. NAF encompasses more than 40 (!) views when taken to its fullest...
- However, different projects have different needs:
  - Scope: narrow or wide
  - Stakeholders: few or many
  - Technology: commodity or bleeding edge
  - Context: stand-alone or fully integrated

Comparison: Project types and Tailoring in V-Modell XT

- Selection of project type
- Selection of applicable practice building blocks
- Very similar to V-Model tailoring:



Content

Discussion

Thanks for your attention!

Questions & Discussion

Please contact me: Rudolf.Hauber@HOOD-Group.com

+49 173 394 1162