Summary of Lecture 27.11.2019

http://englishskills.se

… Very condensed summary of the 27.11.2019 lecture

https://de.fotolia.com

Summary 27.11.2019

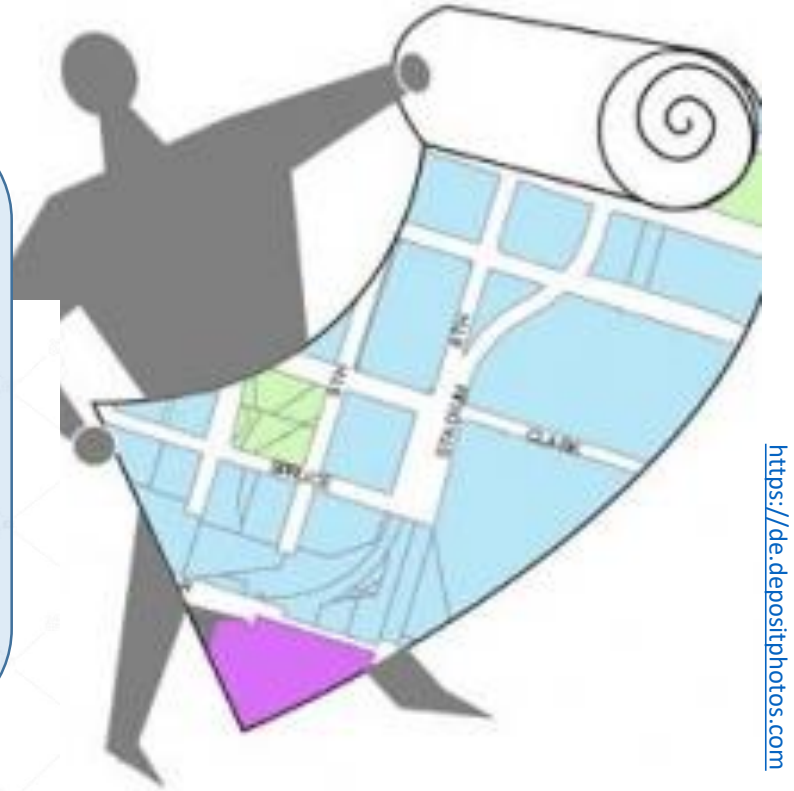
Architecture principles and patterns are the **knowledge-carriers** for future-proof software-systems

The **future-proof software-systems engineer** must know and understand the architecture principles and patterns. He must correctly apply them to his/her design

Summary 27.11.2019

Fundamental Architecture Principles for **Changeability**

- A1: Architecture Layer Isolation
- A2: Partitioning, Encapsulation and Coupling
- A3: Conceptual Integrity
- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Framev
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture
- A11: Formal Modeling
- A12: Complexity and Simplification



https://de.depositphotos.com

http://www.holyoke.org

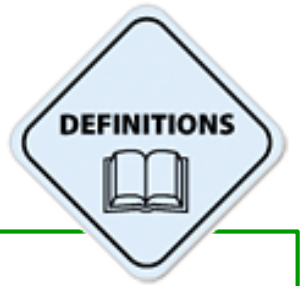
Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019

Redundancy in an IT-system is – in most cases – poison for the structure and for many quality properties of an IT-system

	Managed redundancy	**Un**managed redundancy
Known and wanted	**Yes** (if valid reason)	**NO!**
Unknown or **un**wanted	**?**	**NO!**

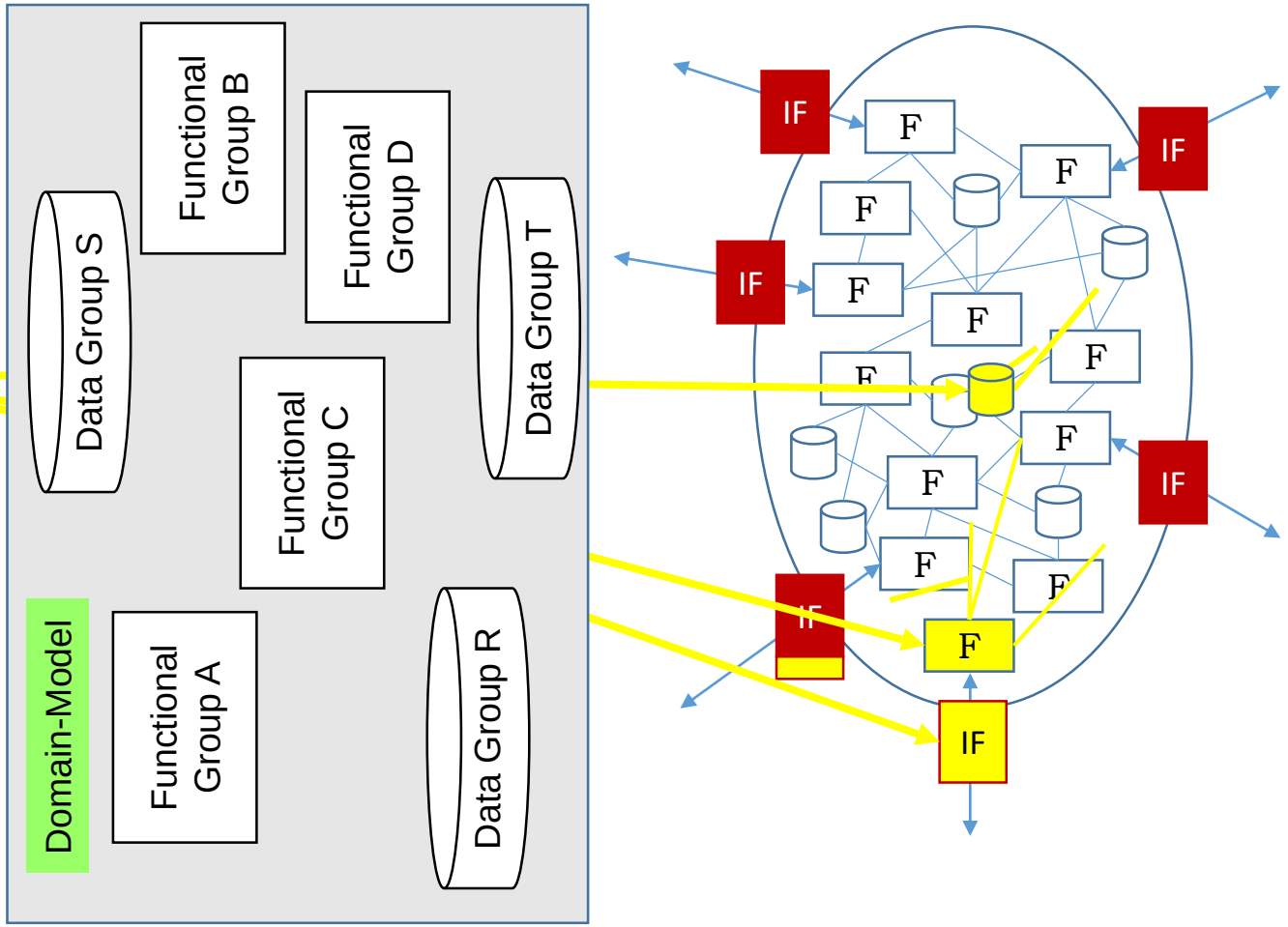


Managed redundancy definition:

- There is only exactly ***one source*** for the functionality and for the data (both during development time and during run-time)
- All redundant copies must be materially and time-wise ***synchronized*** (also partial copies)

Summary 27.11.2019

New Requirements

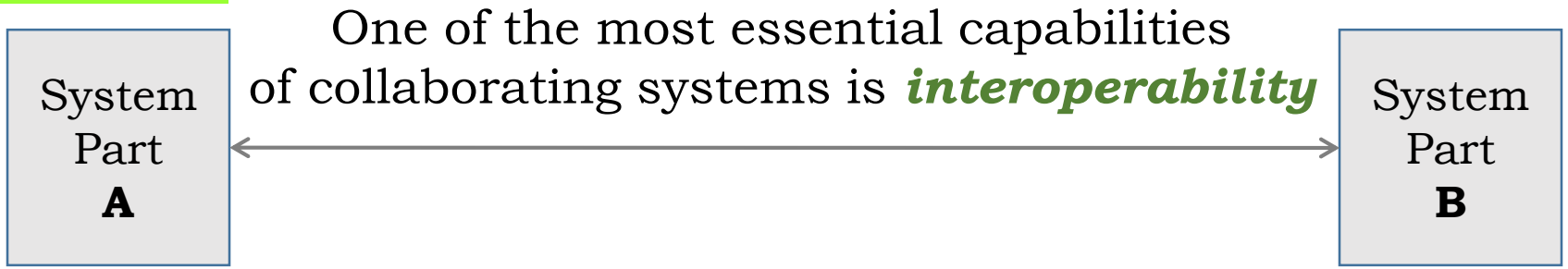


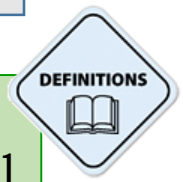
The domain model *unambiguously* assigns data and functionality to one and only one partition in the system

Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

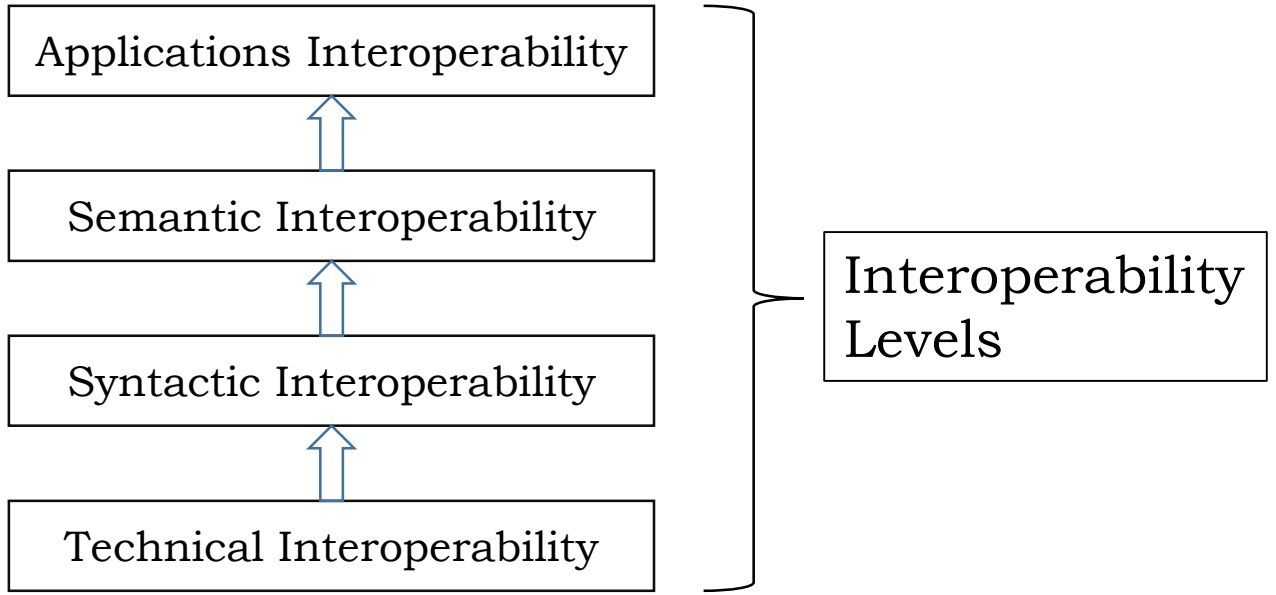
Summary 27.11.2019





Definition: **Interoperability** is the capability to exchange and make use of information and control

Interoperability must be assured on 4 levels:



Summary 27.11.2019

How can we assure interoperability?

System Part **A**

Interface

… by specifying interfaces

Interface

System Part **B**

… and formally describe their behaviour, properties, attributes etc. in **contracts**

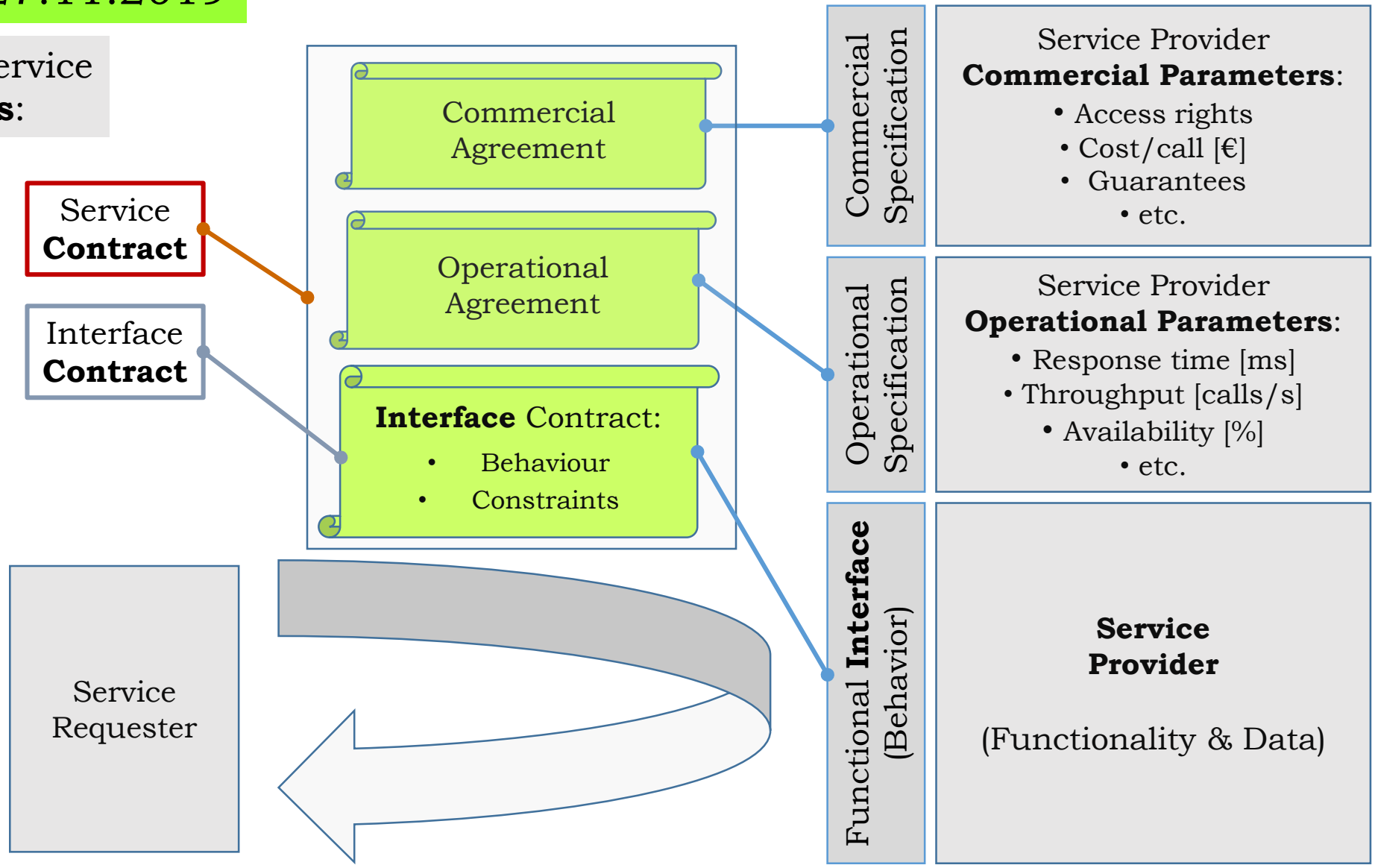
Interface Contract
Service Contract

- Technology alignment
- Syntax alignment
- Semantic alignment
- Model alignment

Interface Contract
Service Contract

Summary 27.11.2019

Interface & Service **Contracts**:



Summary 27.11.2019

Precondition:
1. ID not already active

addCustomerID

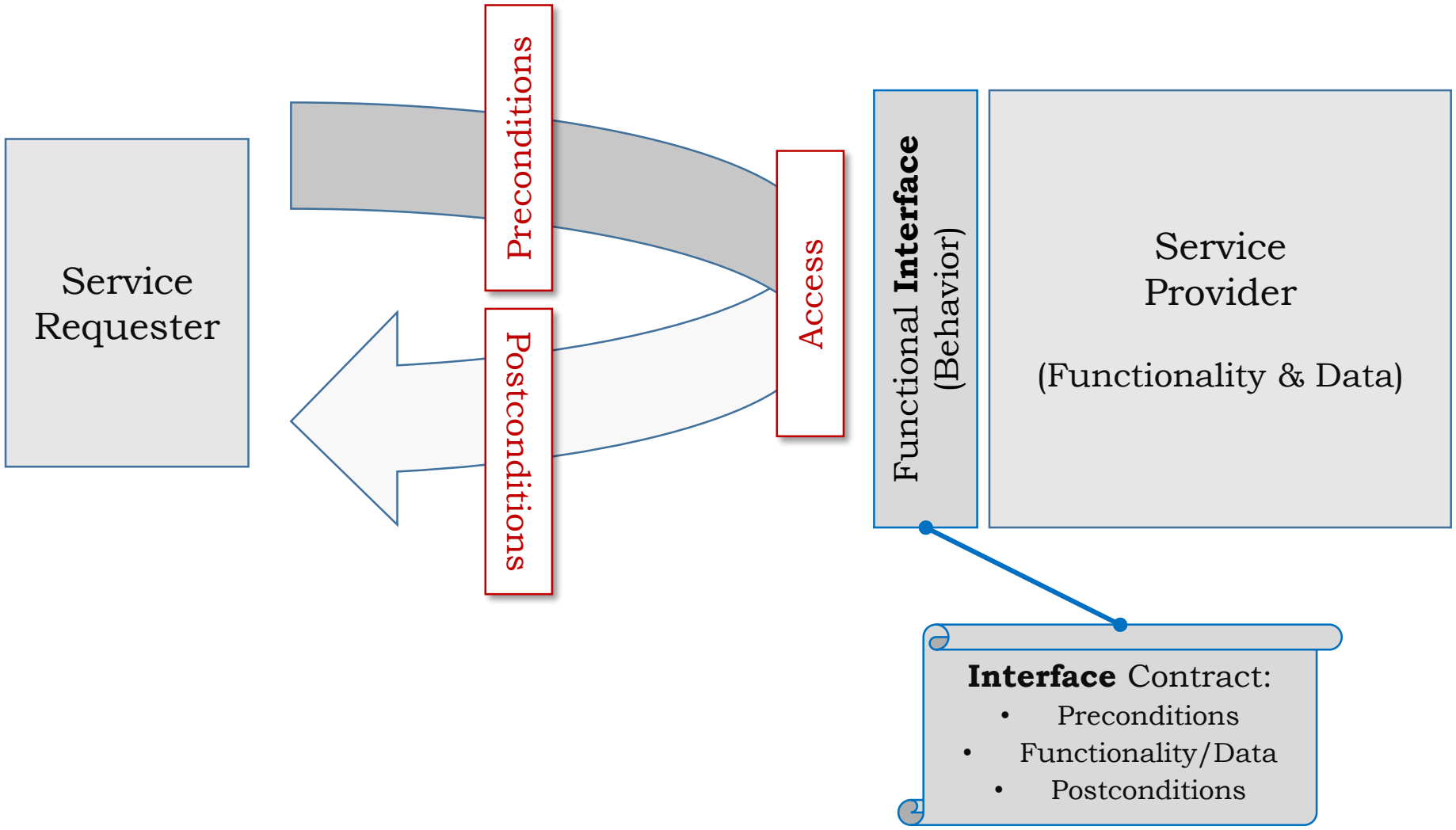
Postconditions:
1. ID now active
2. #ofCustomers + 1

Precondition:
1. ID active

addCustomerName

Postcondition:
1. Name registered

Interface Contracts:



Summary 27.11.2019

We have now understood:

- Technical interoperability
- Syntactical interoperability
- Semantic interoperability
- Applications interoperability

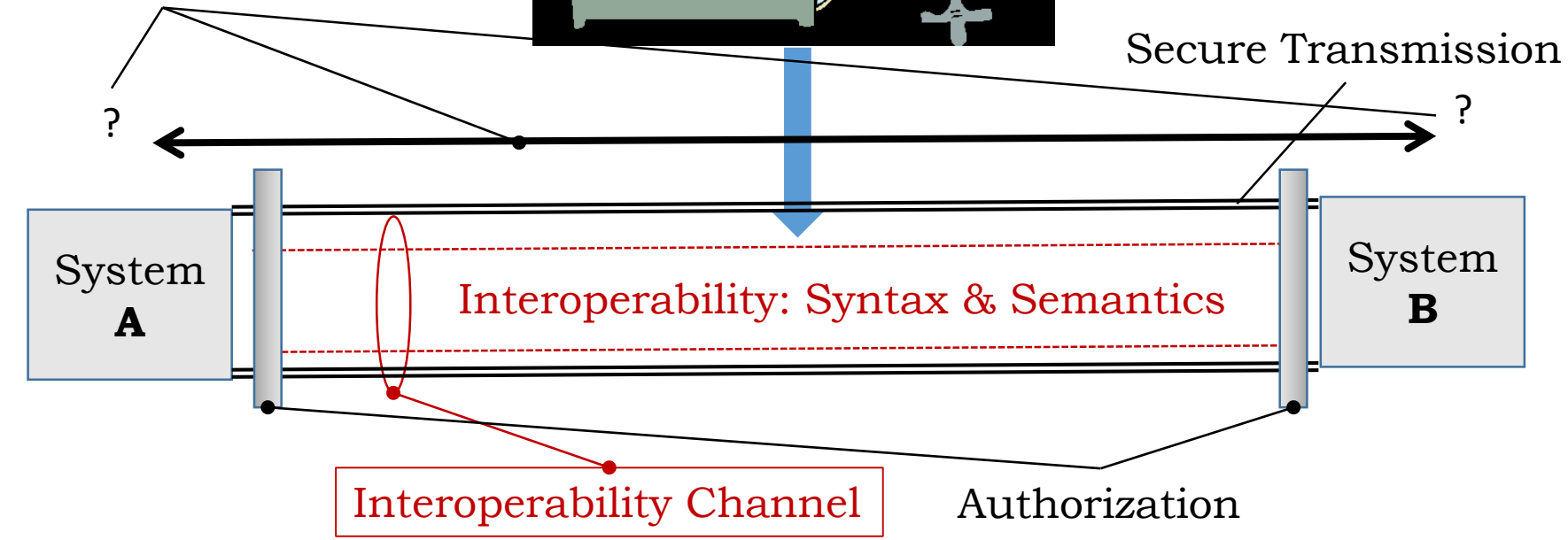
√

What happened to the **quality properties?**

- Security?
- Safety?
- Integrity?
- …

⇒ **Additional concerns**

Example: Secure Interoperability



Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019

A disturbing **dilemma**:

A2

Partitioning

- Assign functionality & data to the **single** correct partition

A4

Redundancy

- No (unmanaged) **redundancy**

What do we do if we need the *same* functionality or data in several partitions?

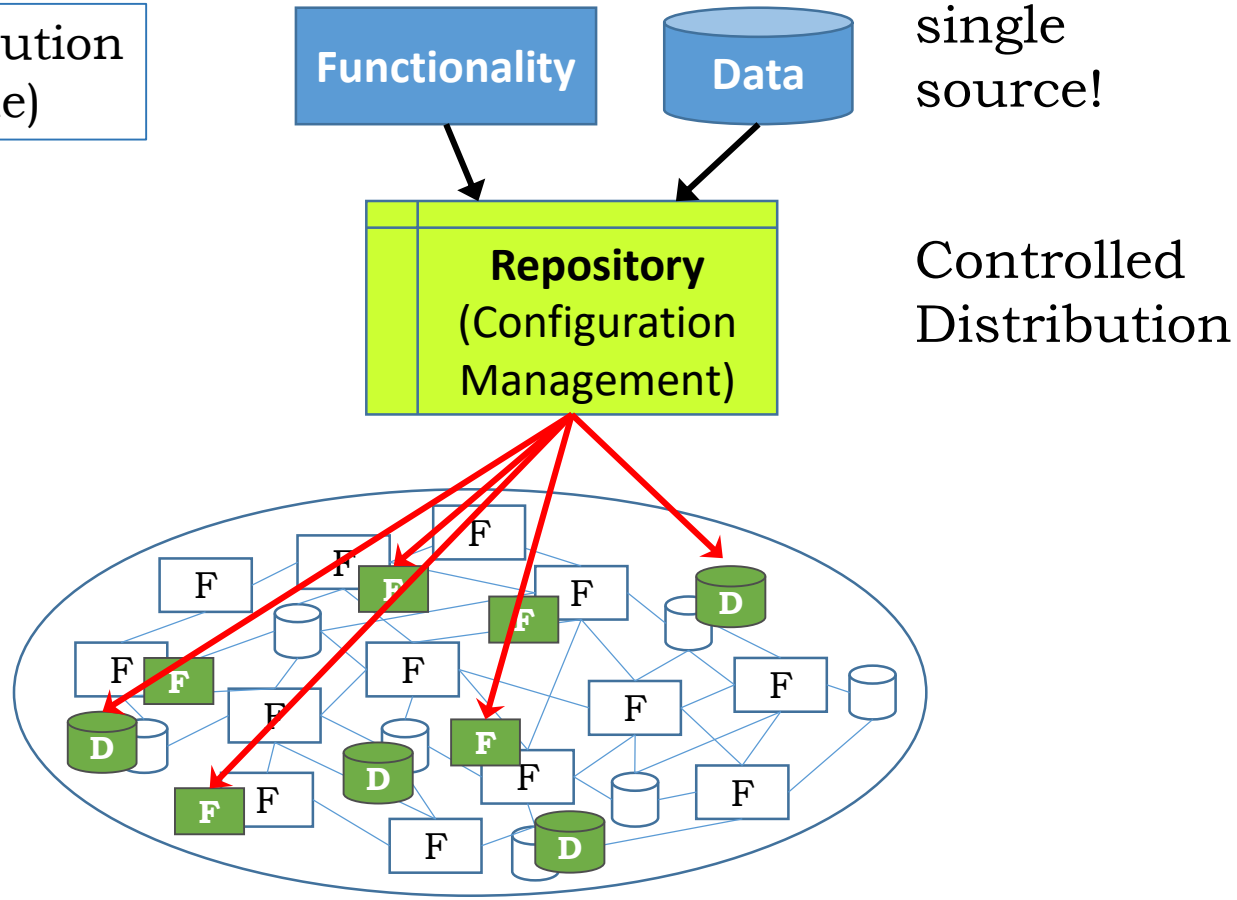
Summary 27.11.2019

How can we deal with common functionality and data?

Identify, control and manage it!

Managed Distribution
(At *Build* Time)

It is exactly known at all times which *common functionality* is located where in the system

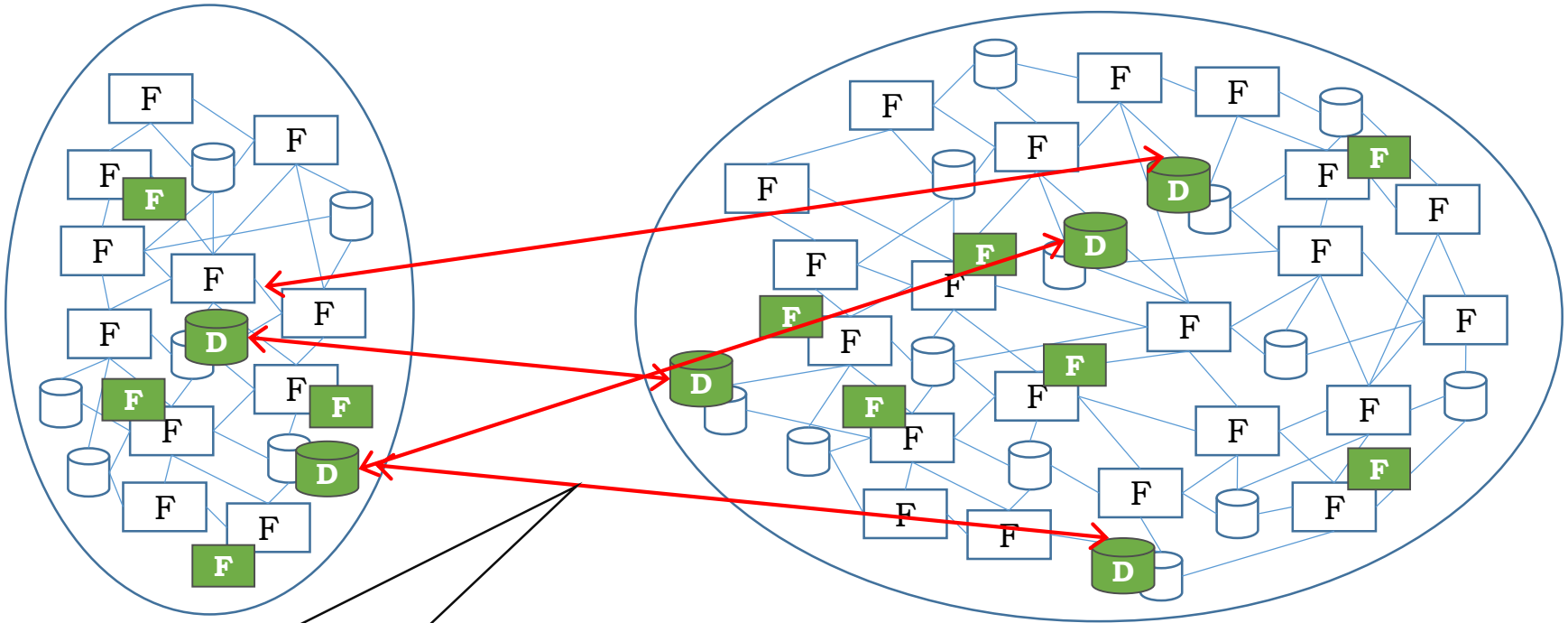


single source!

Controlled Distribution

Summary 27.11.2019

Managed Synchronization
(At *Run* Time)



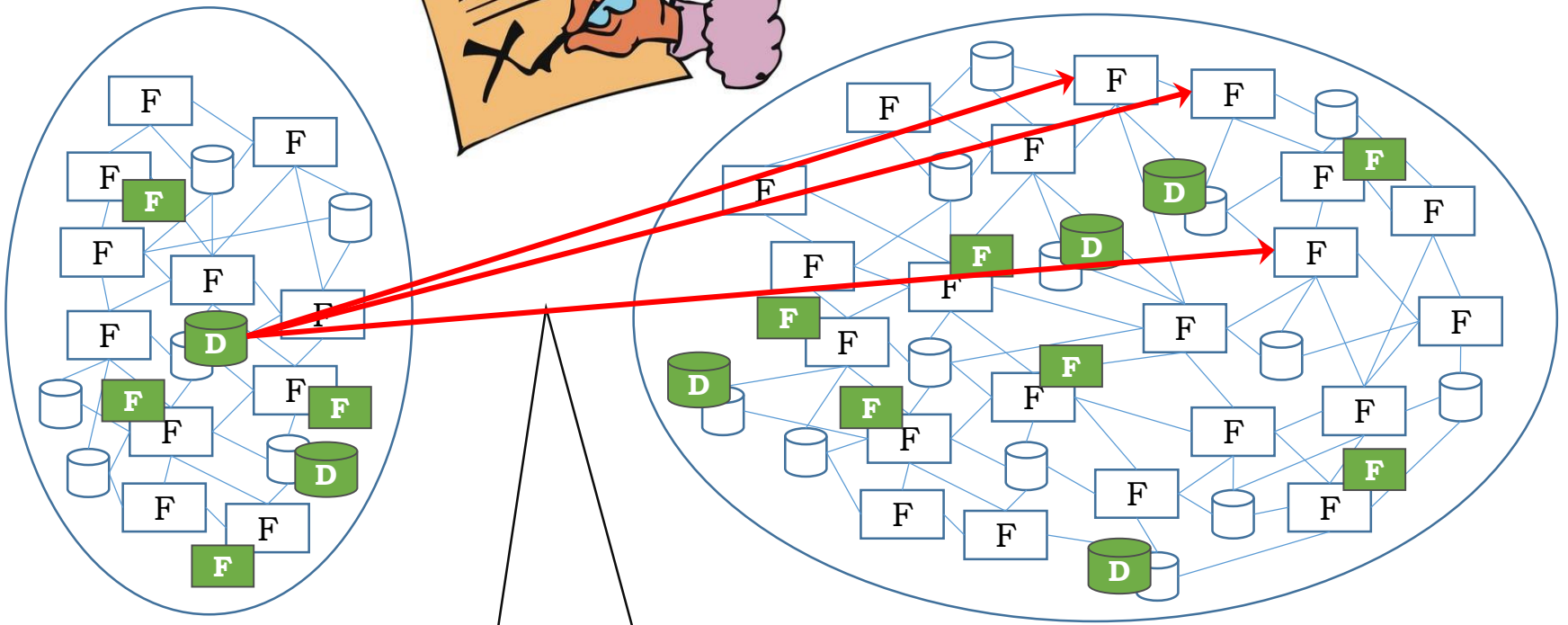
All data is correctly and timely synchronized (= ***Managed redundancy***)

Real-time synchronization
- Content
- Update rate

Summary 27.11.2019

How can we deal with common functionality and data?

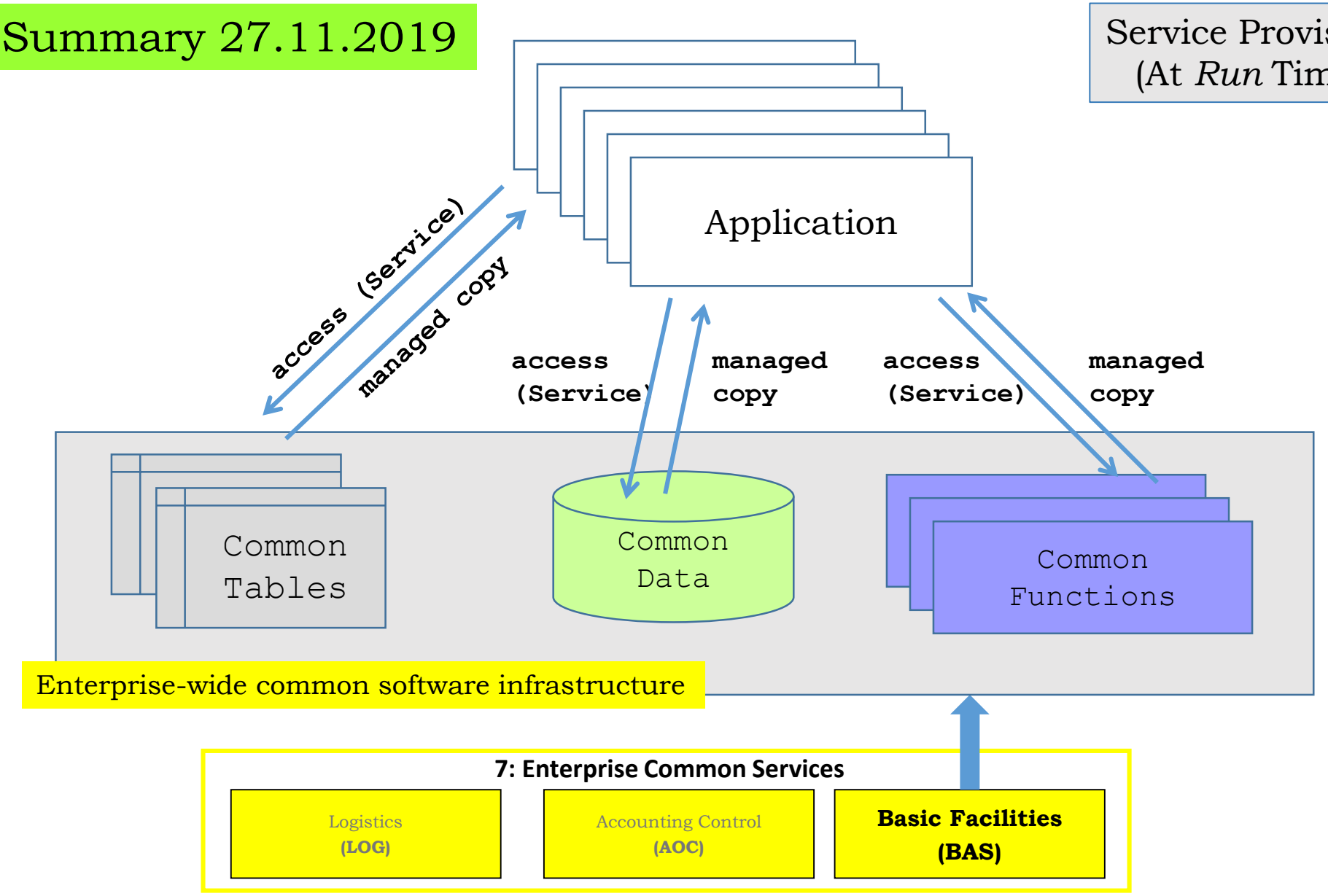
Service Provision
(At *Run* Time)



Provide Access Services

Common functionality and data are provided via ***services***

Summary 27.11.2019



Common functionality and data are provided via a ***enterprise-wide software infrastructure***

Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019 Architecture Knowledge: **Architecture Principles**

Highly valuable **software/system architecture knowledge** in proven & easily accessible form

Reference Architecture:

A reference architecture provides a template solution for an architecture for a particular application domain

- *such as financial systems, automotive, aerospace etc.*

Architecture Framework:

An architecture framework establishes a common practice for creating, interpreting, analyzing and using architecture descriptions within a particular application domain

[ISO/IEC/IEEE 42010]

Architecture Pattern:

An architectural pattern is a concept that solves and delineates some essential cohesive elements of a software architecture

http://en.wikipedia.org/wiki/Architectural_pattern

Summary 27.11.2019

Reference Architecture

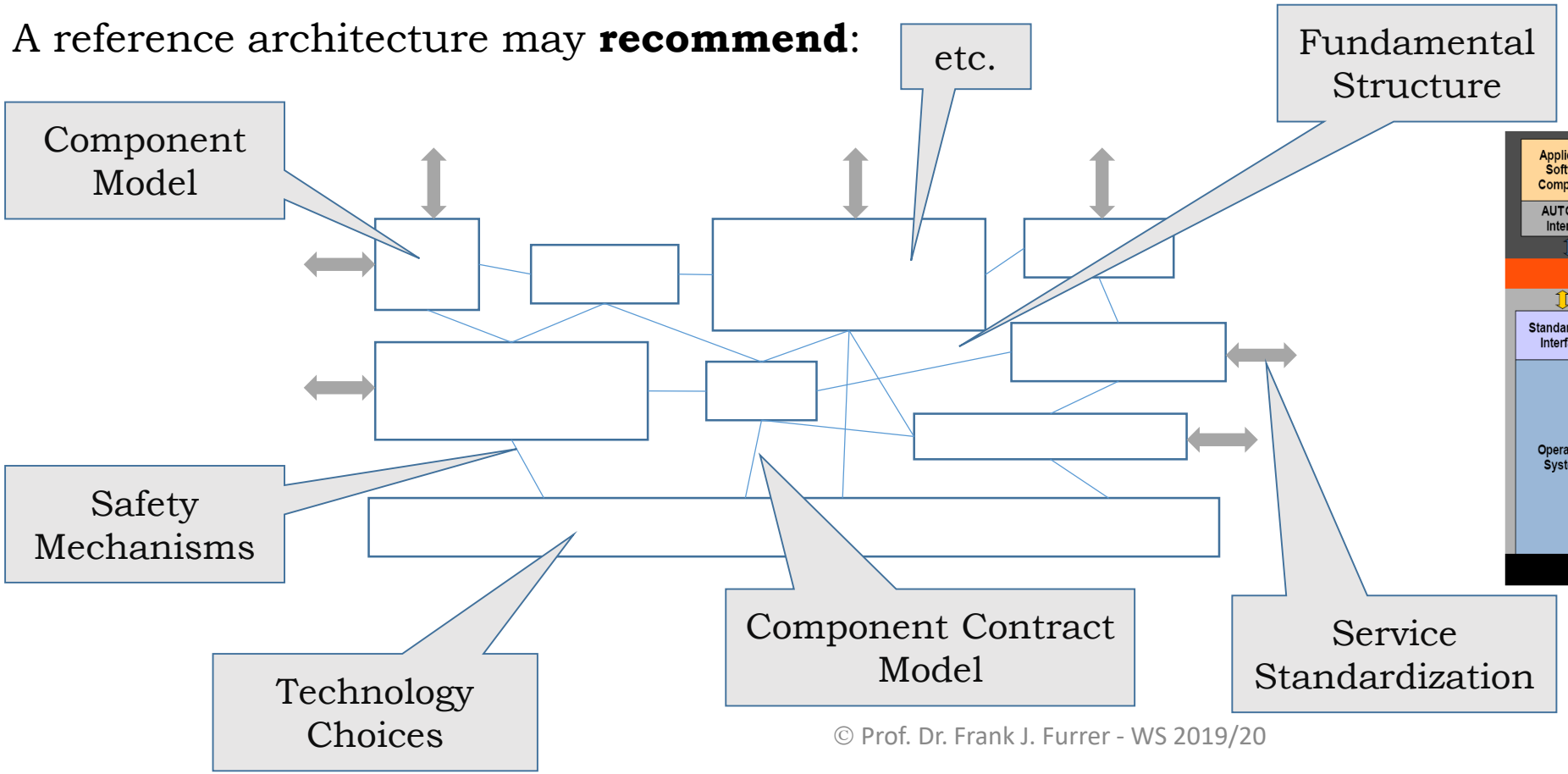
DEFINITIONS

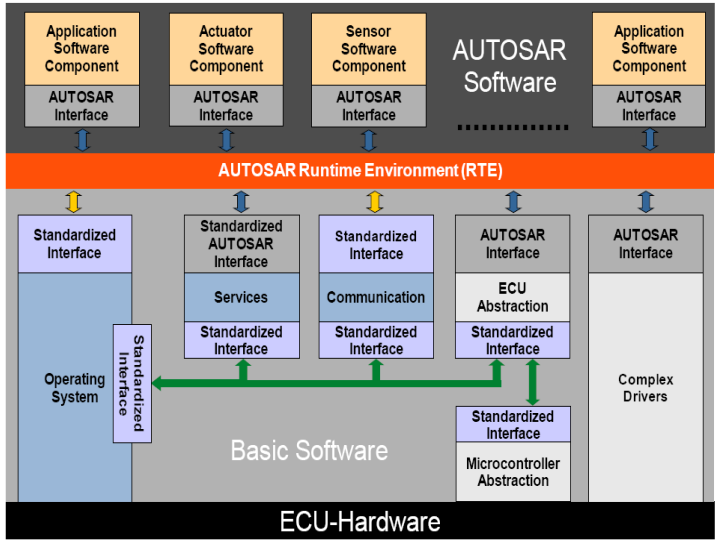
Reference Architecture:

A reference architecture provides a template solution for a *generic architecture* for a particular application domain

- such as financial systems, automotive, aerospace etc.

A reference architecture may **recommend**:





http://www.autosar.org/download/naenrsandnresentations/AUTOSAR_Brochure_EN.pdf

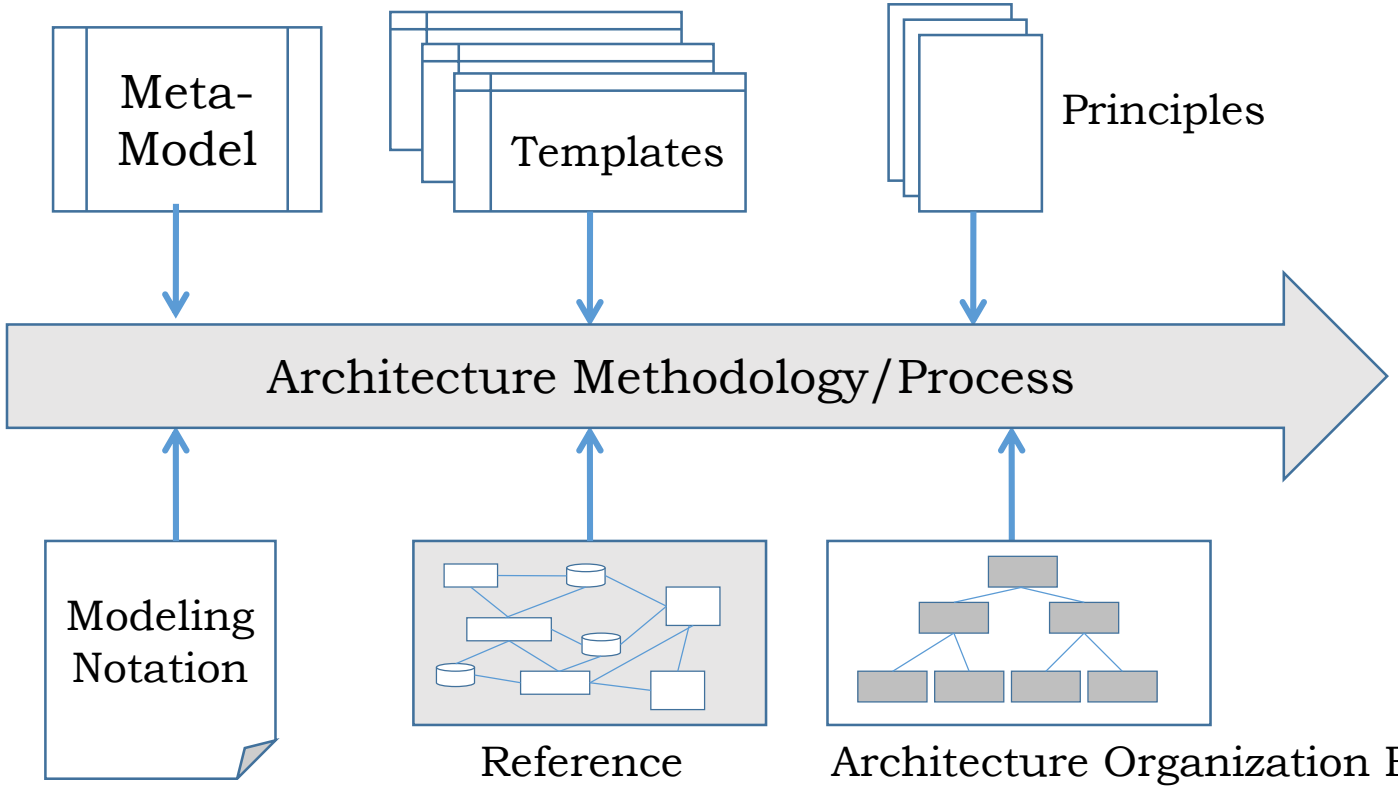
Summary 27.11.2019

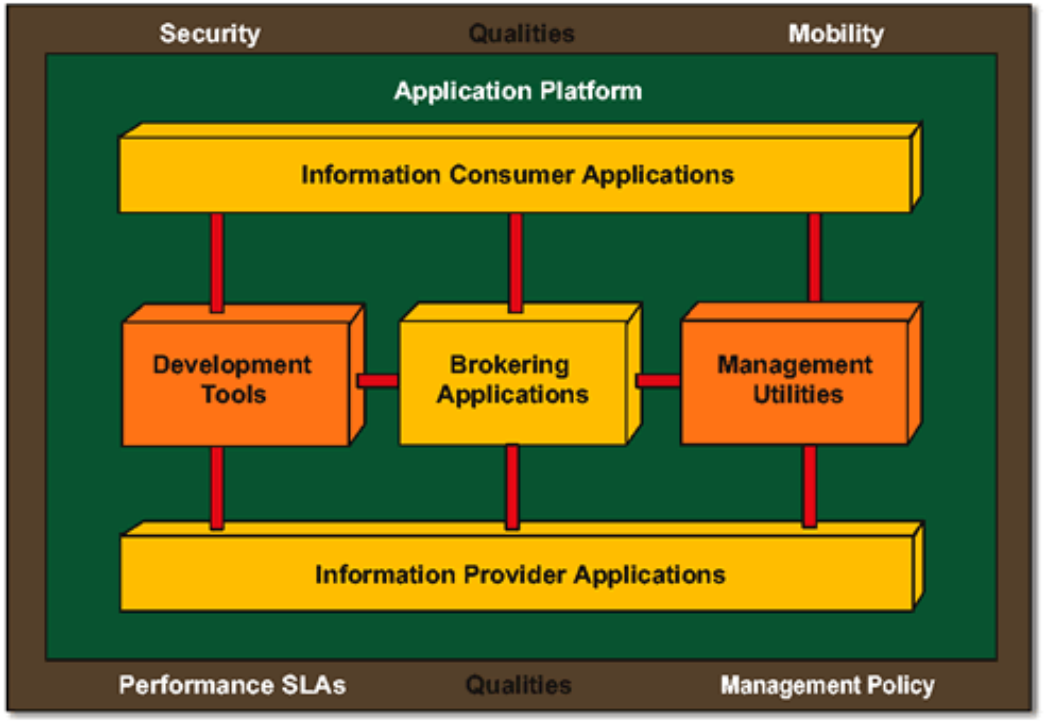
Architecture Frameworks

Architecture Framework:

An architecture framework establishes a common practice for creating, interpreting, analyzing and using architecture descriptions within a particular application domain

[ISO/IEC/IEEE 42010]





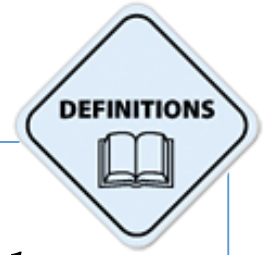
http://pubs.opengroup.org/architecture/togaf8-doc/arch/chap22.html

The **O**pen **G**roup **A**rchitecture **F**ramework]
http://www.togaf.org/

Summary 27.11.2019

Patterns

Structure!

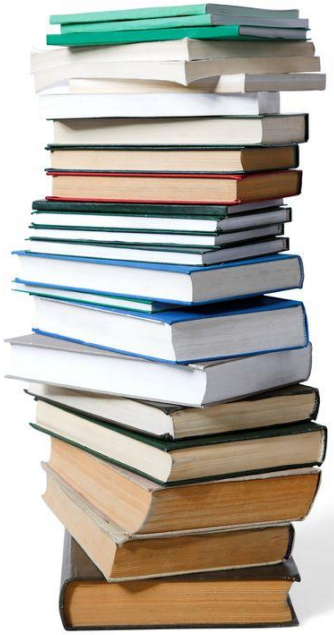


Architecture Pattern:

An architectural pattern is a concept that solves and delineates *some essential cohesive elements of a software architecture*

http://en.wikipedia.org/wiki/Architectural_pattern

Patterns are recorded **architecture and design wisdom** in „canonical“ form. Patterns help you build on the collective experience of skilled architects and software engineers (Buschmann et. al. ISBN 0-471-95869-7)



www.123rf.com

Patterns are not final, directly applicable solutions! Patterns are **intellectual building blocks** which must be intelligently integrated into your work

Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019

Reuse in Software-Systems Engineering

http://www.lybecker.com

Reuse:

Utilization of Software-Artefacts in another Context or Application

Successful reuse can be done with:

- Requirements
- Specifications
- Reference architectures
- Patterns
- Code (Functionality)
- Data (Information)
- Algorithms
- Configurations
- Documentation
- Models
- ….

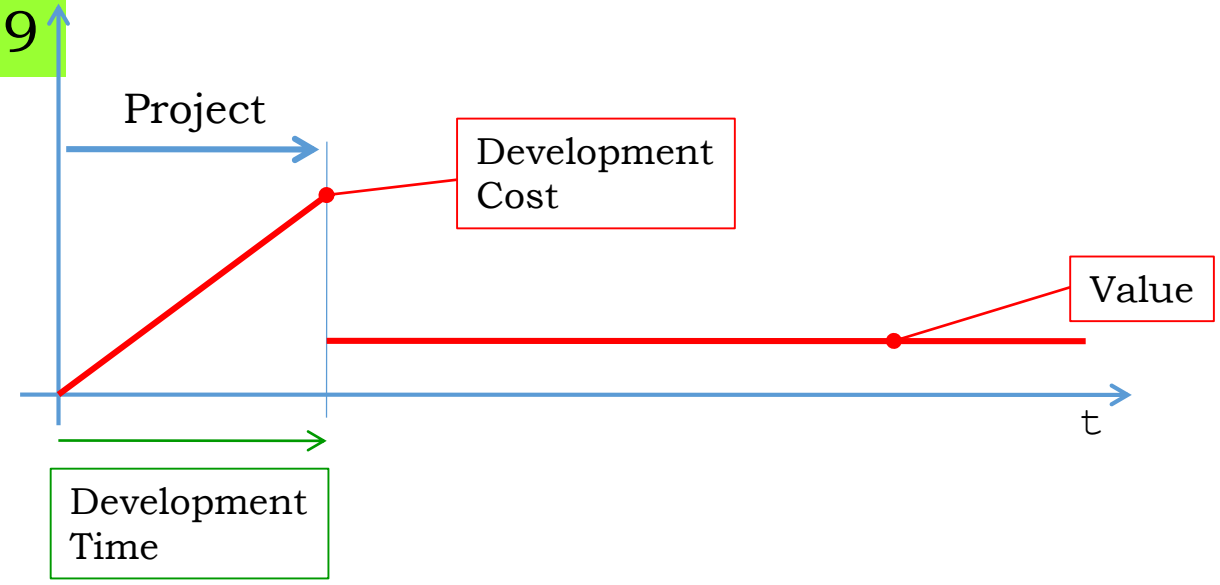
Successful Reuse requires:

- a company-wide *reuse strategy*
- a strong *reuse organization*
- a *dedicated, committed* management
- Adequate development & evolution *processes*

http://www.clipartbest.com

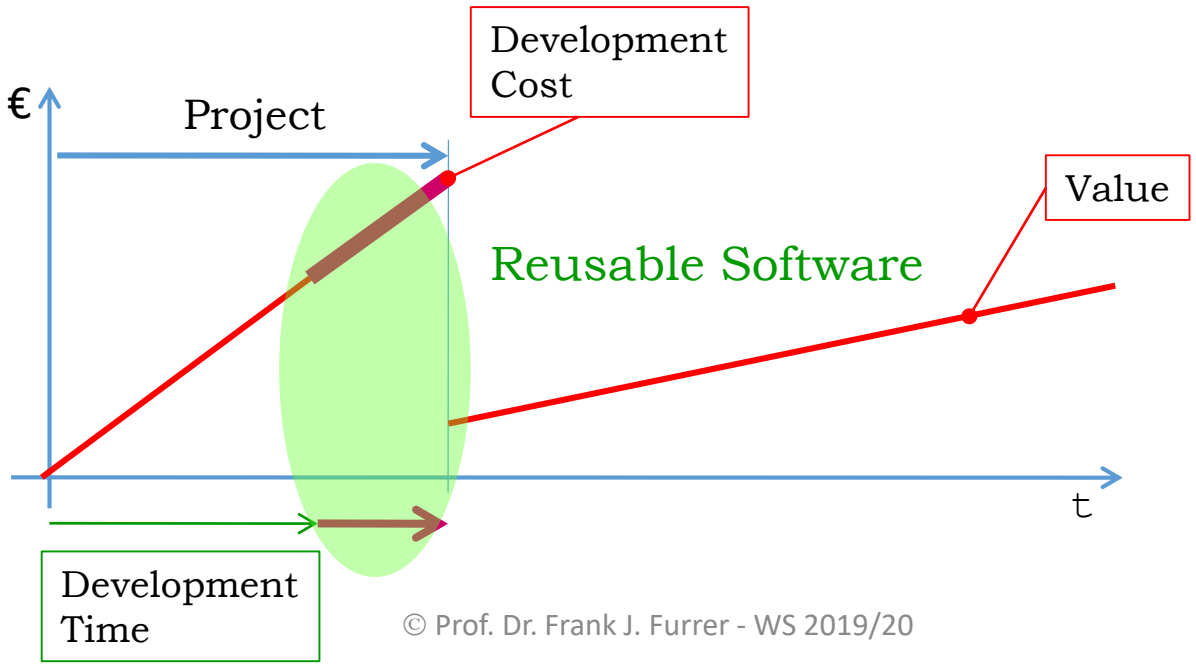
Summary 27.11.2019

one-time use



***Business Case* of Reuse**

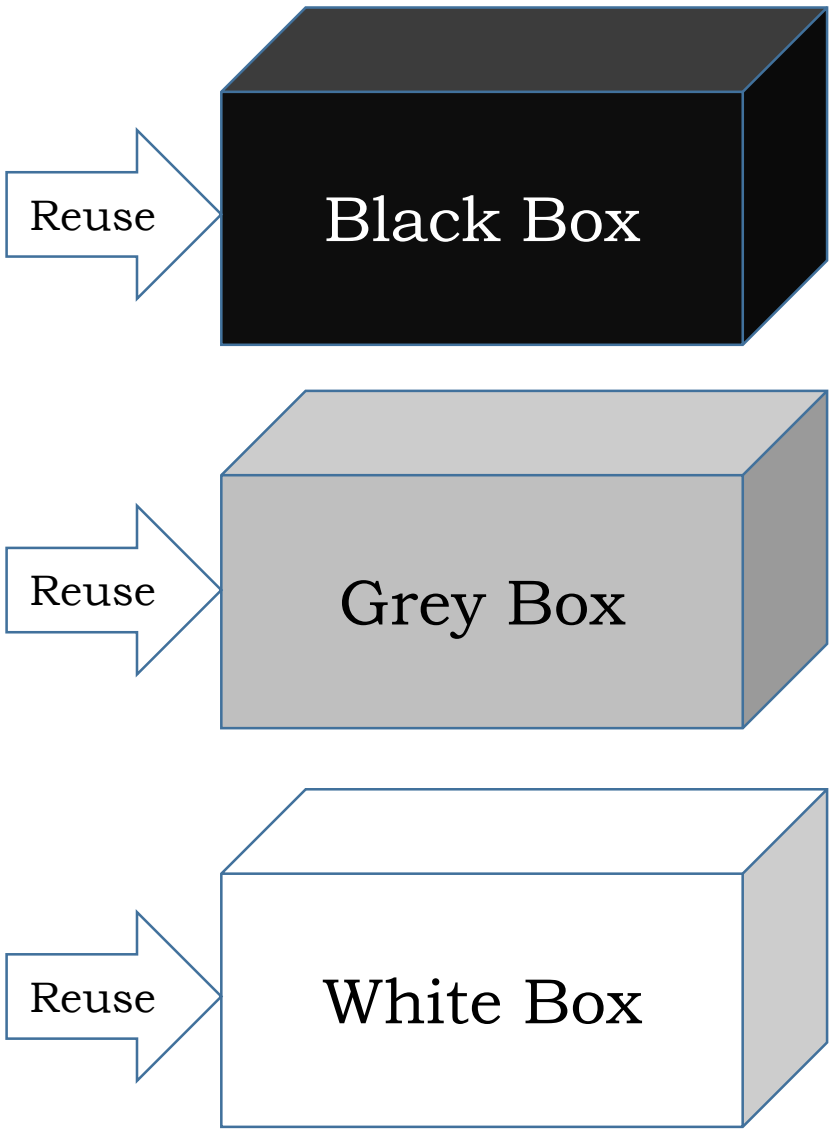
Reuse (n-time use)



Reusable software requires **considerable more effort** in planning, design, development and implementation

Summary 27.11.2019

Types of Reuse



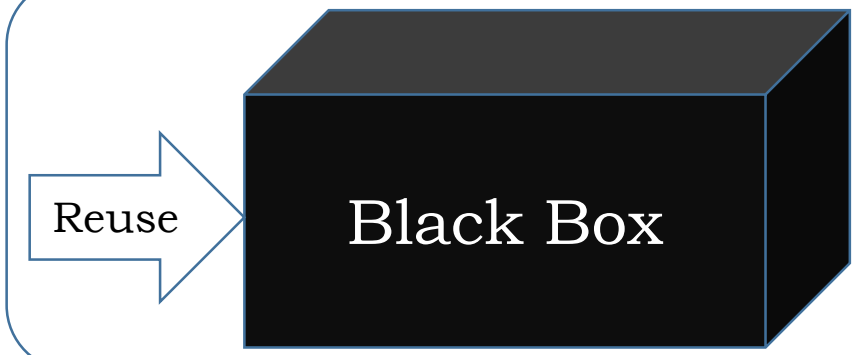
Unmodified (1:1) reuse

Limited modified reuse
(Specific changes ≤ 25 %)

Significantly modified
(Specific changes ≥ 25 %)

Important for functionality (**code**) and information (**data**)

Summary 27.11.2019

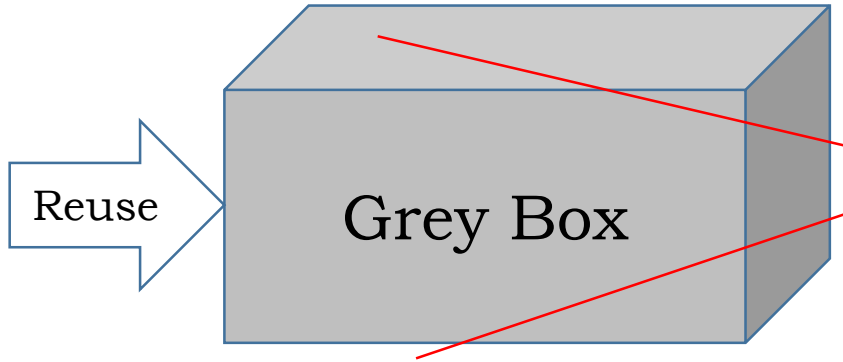


Unmodified (1:1) reuse

Parametrization

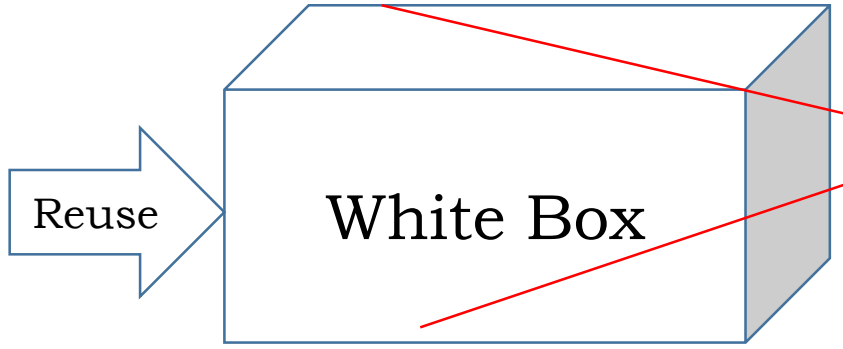
Business Rules

True, value-generating Reuse



Limited modified reuse
(Specific changes ≤ 25 %)

Not reuse ⇒ unmanaged redundancy



Significantly modified
(Specific changes ≥ 25 %)

Not reuse ⇒ unmanaged redundancy

http://sr.photos2.fotosearch.com

Summary 27.11.2019

- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019

Interoperability Requirements

System A		System B
Applications Interoperability		Applications Interoperability
Semantic Interoperability		Semantic Interoperability
Syntactic Interoperability		Syntactic Interoperability
Technical Interoperability		Technical Interoperability

Industry Standards

Agreed Rules

ISO International Organization for Standardization
www.iso.org

IETF
www.ietf.org

OMG OBJECT MANAGEMENT GROUP
www.omg.org

International Standards Organizations

CREDIT SUISSE
CS Business Object Model V1.1/2009

Company Standards

Summary 27.11.2019

- What is the impact of standards ?
- Why are standards important ?

Impact:

- Forcing uniform, interoperable solutions in the industry
- Providing proven, widely accepted and mature solutions
- Enabling exchangeable products (mostly)
- Facilitates reuse
- Foundation for validation & certification

Importance:

- Provides long term stability with managed change
- Forces vendors to comply to interoperable solutions
- Advances industries as a whole
- Provides confidence in technical solutions (e.g. safety or security)

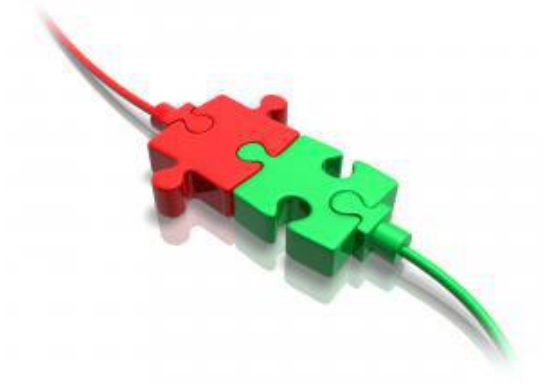
Negative: Standards-setting process is quite slow (Wide consensus required)

Summary 27.11.2019

ISO International Organization for Standardization

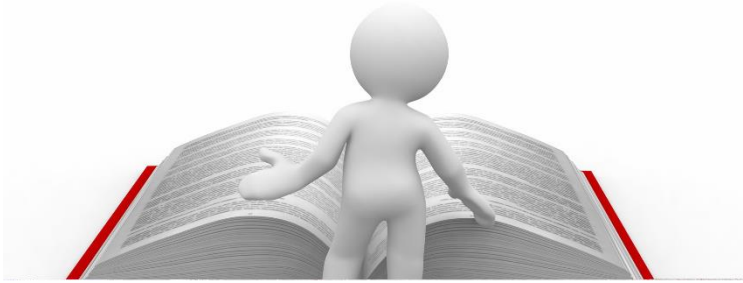
Industry-Standard

Technical Impact:
- Interoperability
- Communications
- Technology
- …



Certification:
- Safety
- Security
- Interfaces
- …

Knowledge:
- Processes
- Domain-Knowledge
- Cooperation
- …



Summary 27.11.2019

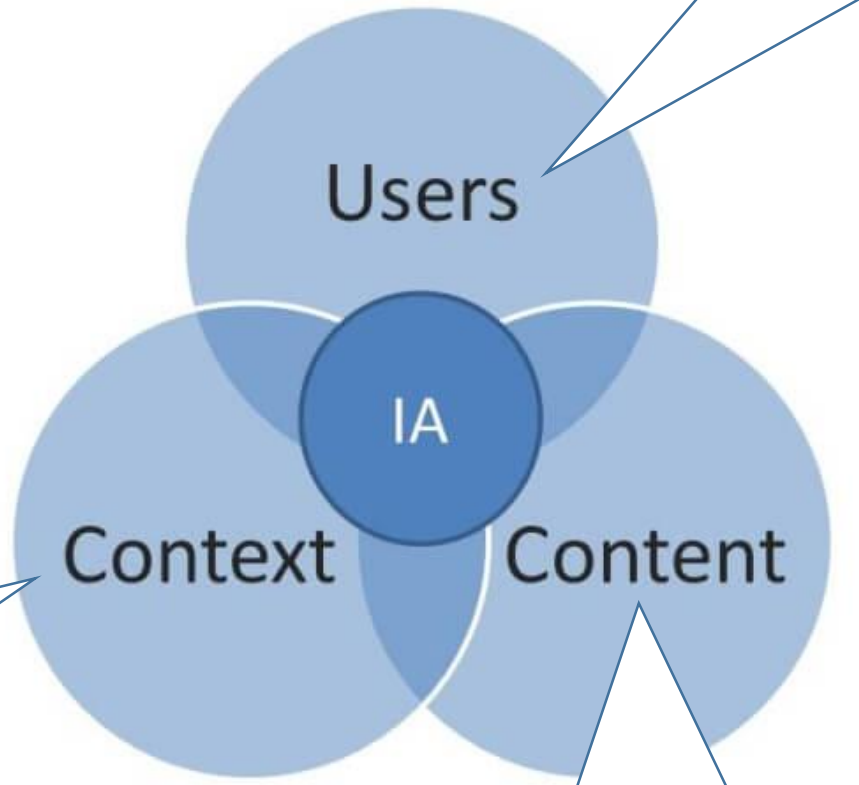
- A4: Redundancy
- A5: Interoperability
- A6: Common Functions
- A7: Reference Architectures, Frameworks and Patterns
- A8: Reuse and Parametrization
- A9: Industry Standards
- A10: Information Architecture

Summary 27.11.2019

Information Architecture

„Data models are perhaps the most important part of developing software, because they have such a profound effect: Not only on how the software is written, but also on *how we think about the problem* that we are solving"

Martin Kleppmann, 2017



Humans, machines, robots, artificial intelligence, …

Static, dynamic, stable, unstable, uncertain, …

Business, people, autonomic, safety-critical, …

Big data, real-time, confidential, fuzzy, experimental, long-lived, …

http://www.antlr-interactive.com

Summary 27.11.2019

... a little bit of **history**:

Year: 1472

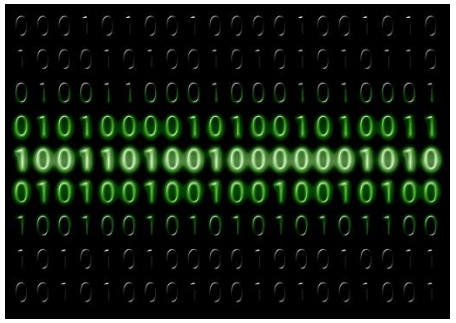
Dematerialization

Distribution

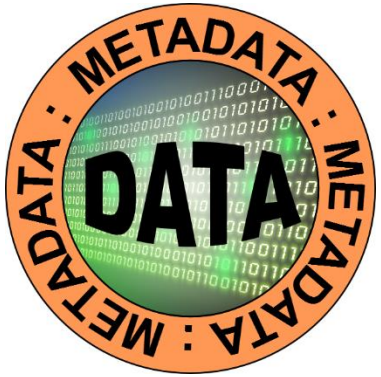
Copies

Rich metadata

Big data



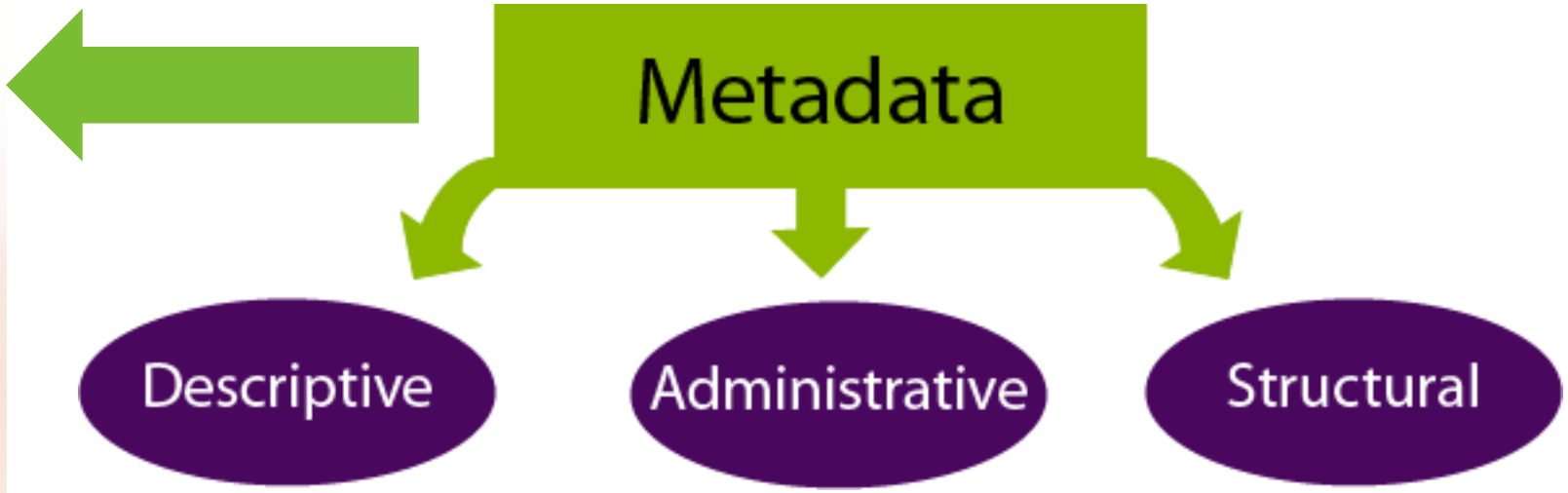
DIGITAL COPY



http://www.zeller.de

Summary 27.11.2019

http://blogs.teradata.com



- Characterization
- Tags
- Keywords
- Description
- Relations

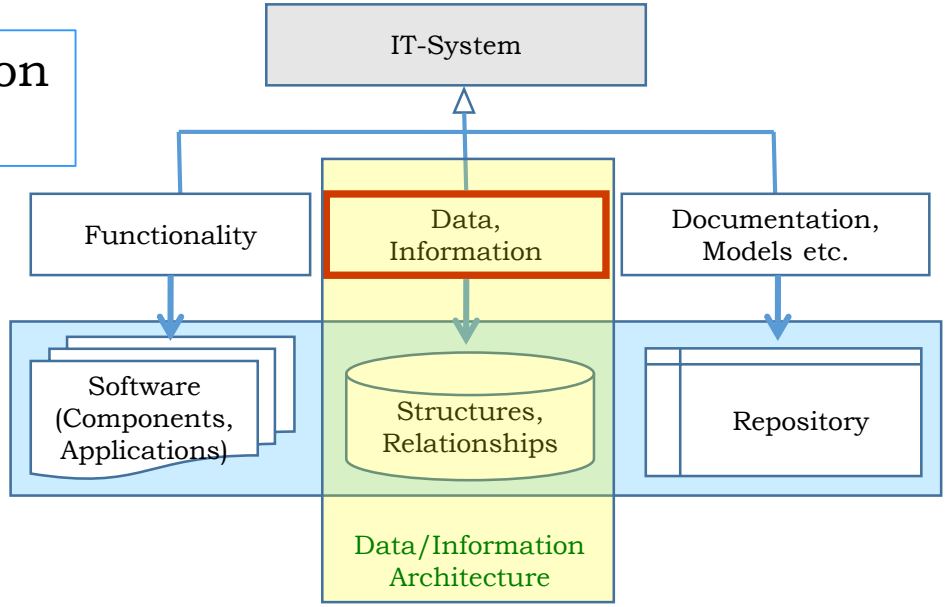
- Storage
- Access
- Rights (IPR)
- Delivery
- Rendering

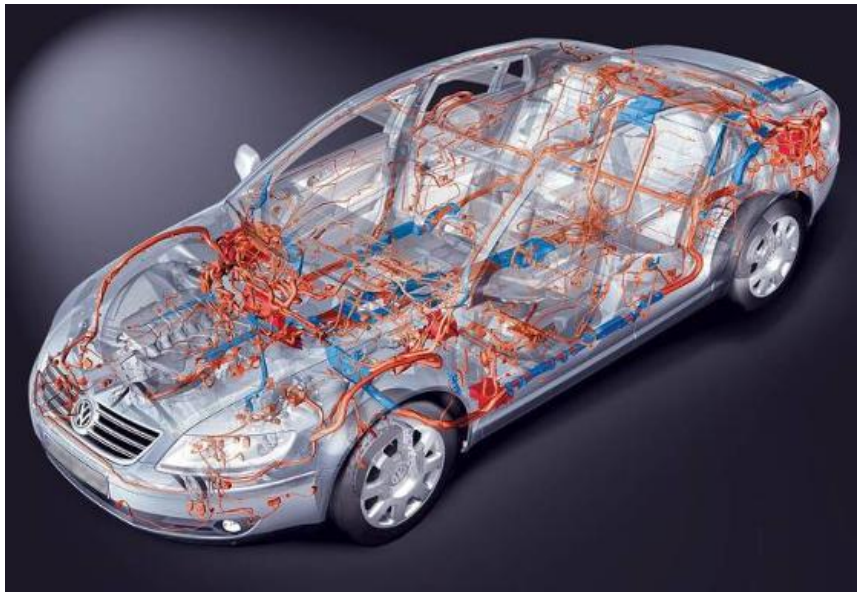
- Data structure
- Hierarchies
- Composition
- Ordering
- Coherence

Summary 27.11.2019

http://www.ormutual.com

Enterprise data/information architecture





http://www.ove.uk.com

Vehicle data/information Architecture
[Embedded Systems]

http://www.cdxetextbook.com/brakes

Time

Data items have ***timing*** *relationships* between them

… sometimes very demanding and stringent!

Inconsistency:

Data may be corrupted or inconsistent and needs «cleaning»

Summary 27.11.2019

... Continue with Part 3B