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CPS, IoT and Industry 4.0 for the Smart Enterprise:

What are the implications for enterprise and process modeling?

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Overview

- Motivation:
Why discuss Internet-of-Things, Cyber-Physical Systems, Industry 4.0
in the context of Enterprise and Process Modelling?
- Implications for Enterprise and Process Modeling – 4 Cases
 - IoT in Smart Garden (Husqvarna)
 - CPS in Logistics (DataChassi)
 - Digitization in Utility Industry (Stadtwerke Rostock)
 - Additive Manufacturing
- Conclusions

Smart Enterprises

Business definitions:

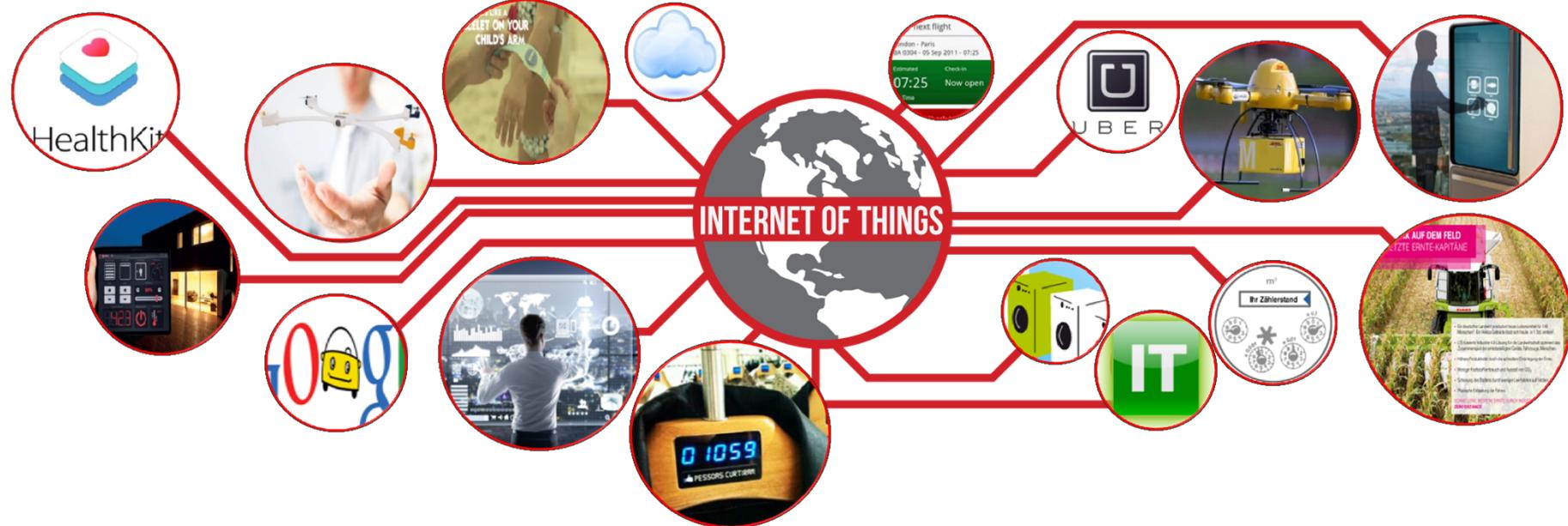
- Smart enterprise is a new breed of computing companies focusing on enabling knowledge workers to process and analyze massive amounts of heterogeneous data and to collaborate and monitor things
Joe Lonsdale, Entrepreneur, Silicon Valley
- Smart enterprises: Successful implementation of semantic technologies in enterprises
Georg Günther, Salzburg Research
- Smart enterprises, i.e. companies making use of technology, such as IoT, big data and machine learning, will thrive on the cost of traditional enterprises
Topplab AB, Malmö

Scientific definitions

- Smart enterprises „comprise the real-time understanding, reasoning, planning and management of all aspects of the enterprise [manufacturing] process and is facilitated by the pervasive use of advanced sensor-based data analytics, modeling, and simulation.“
Jim Davis et al.: Smart manufacturing, manufacturing intelligence and demand-dynamic performance, 2012
- Sensing, Smart and Sustainable Enterprise: “enterprises must build true smart systems (including human and technological systems) to react rapidly and flexibly to the changing environment. [...] Smart decisions are required that take a large amount of information into account. Sensing systems are required to be able to handle, organise and analyse all data/ information sources in order to feed the smart systems part.”
G. Weichhardt et al. (2016) Challenges and current developments for Sensing, Smart and Sustainable Enterprise Systems

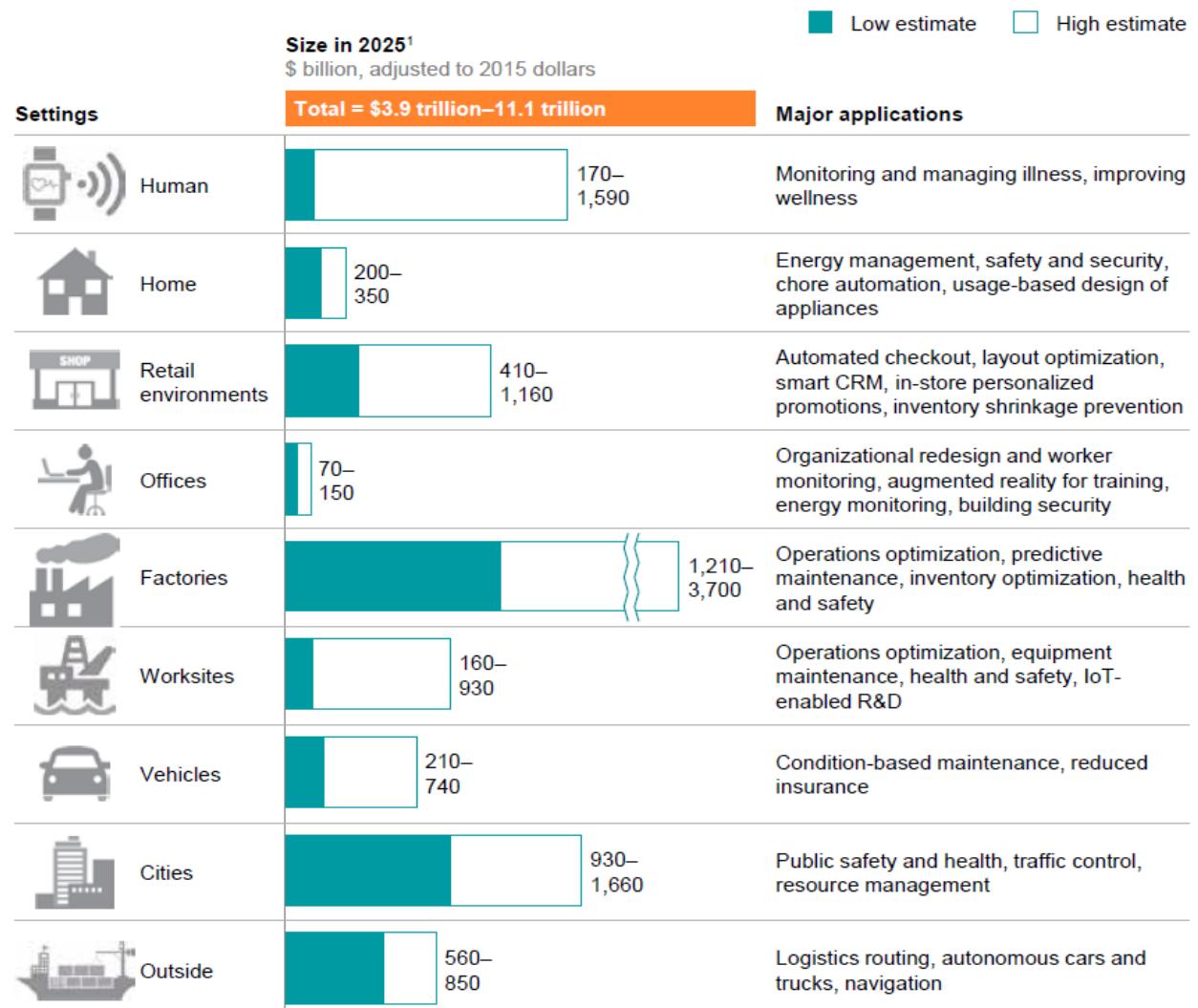
Internet of Things (IoT)

- Initially: tagging „things“ (RFID)
- Now: „things“ are smart and interact
- „things“ bring services
- New business models
- Changed value creation
- New kinds of services



Impact of IoT

Potential economic impact of IoT in 2025, including consumer surplus, is \$3.9 trillion to \$11.1 trillion

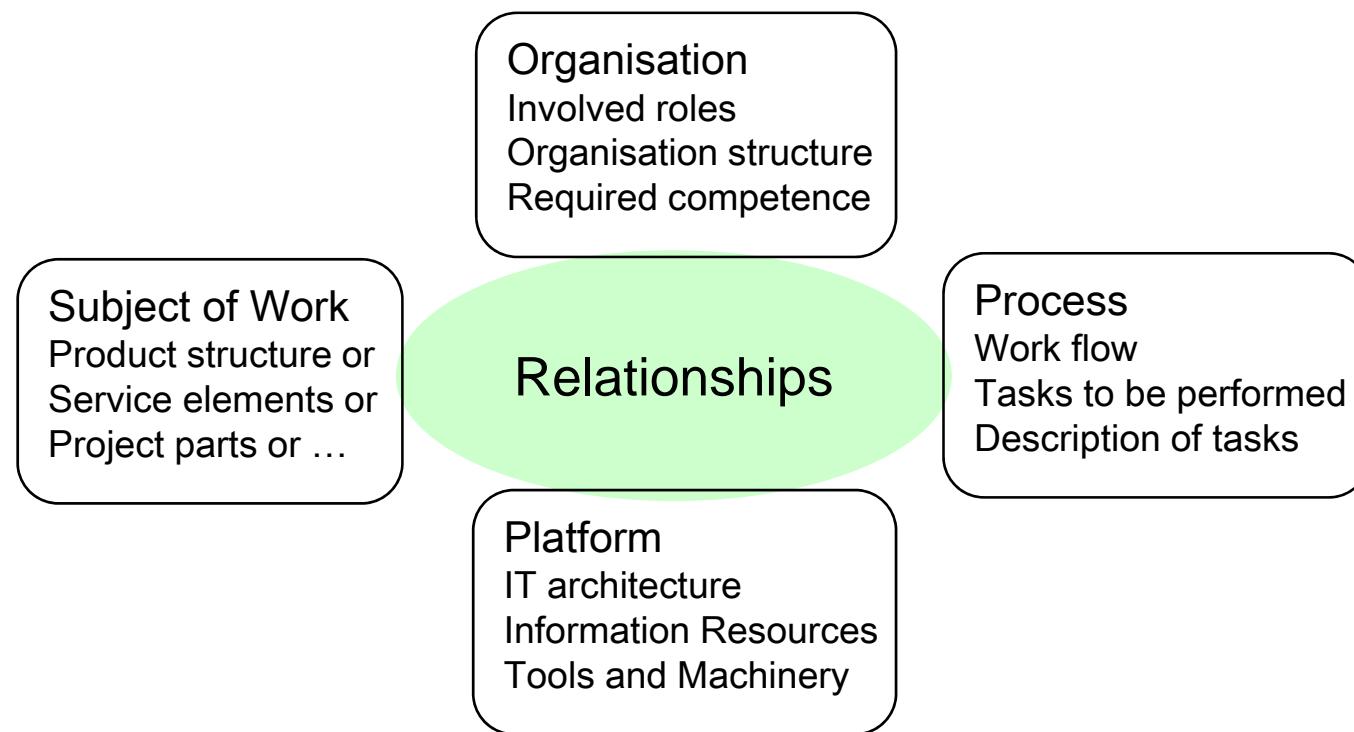


1 Includes sized applications only.
NOTE: Numbers may not sum due to rounding.

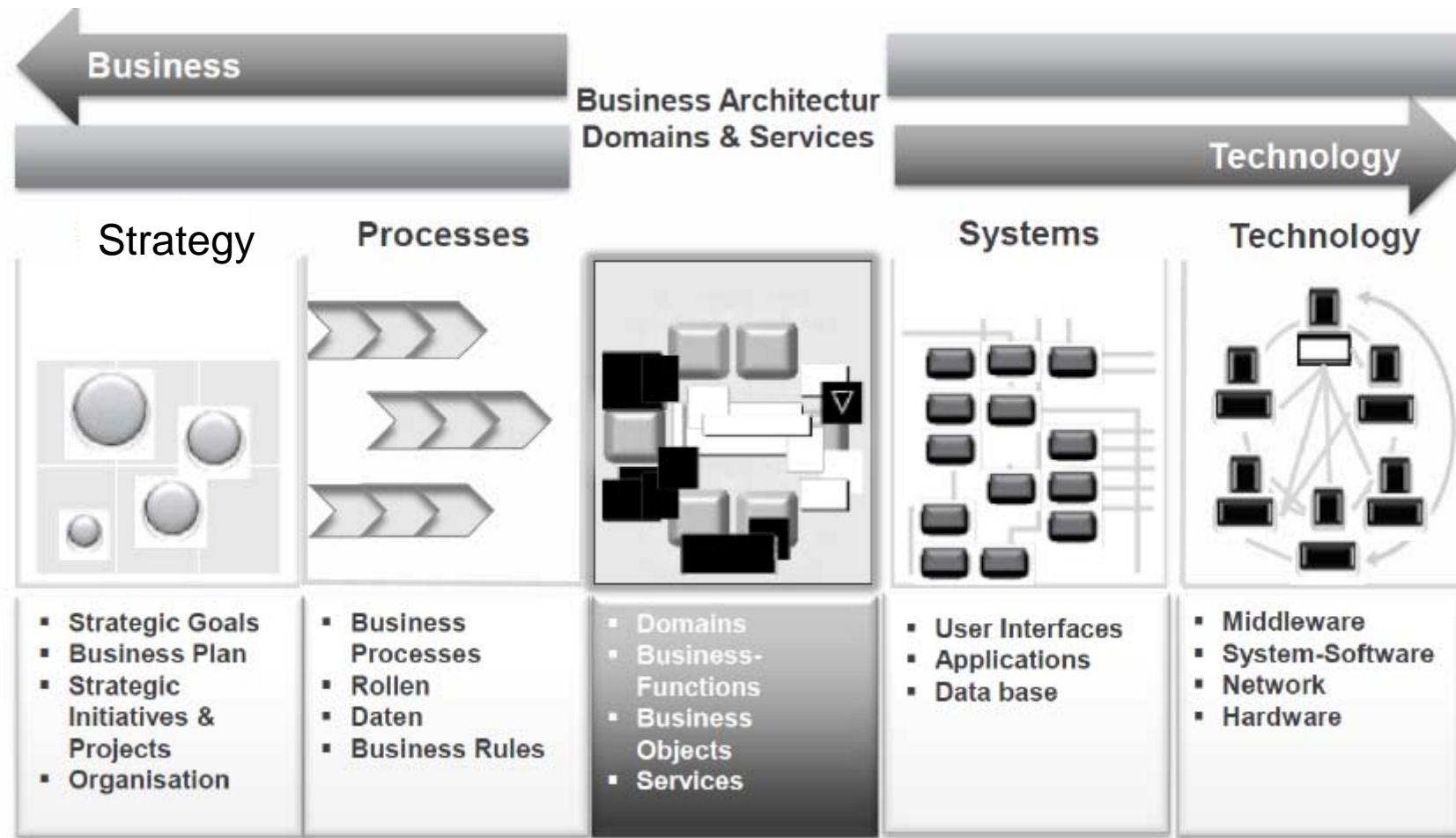
SOURCE: McKinsey Global Institute analysis



Process Modeling and Enterprise Modeling



Enterprise Architecture Management

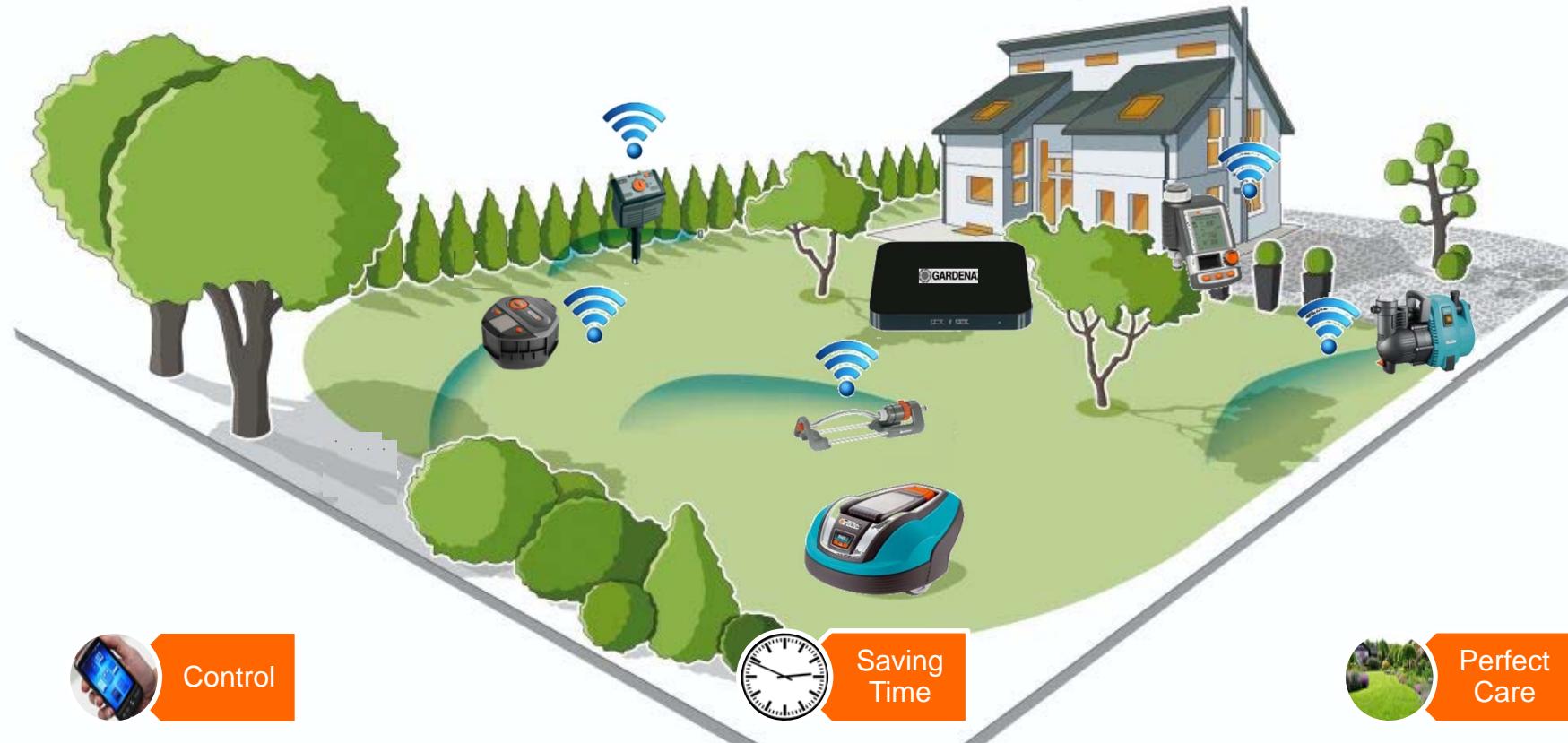


Impact of IoT: The Husqvarna Case

Smart Garden System

System structure...

All products are connected to the hub and the user can simply interact with all devices thru apps.



Courtesy of and (c) by Husqvarna AB, Sweden

Challenge: Product-IT and Enterprise-IT integration

Product-IT

Physical World / Systems and Infrastructure



Product-IT:

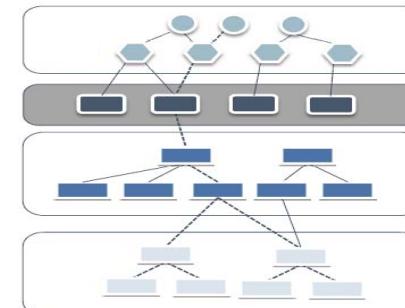
- „embedded“ in the product
- traditionally constructed separately from enterprise IT (due to reliability requirements, different lifecycle, different funding strategy, etc.)
- Connections to enterprise IT often specific „point-to-point“ solutions

Cyber-Physical Systems
or
„Internet of Things“

CPS and IoT require interaction in real time, closer integration of product IT and enterprise IT and changes in EA

Enterprise-IT

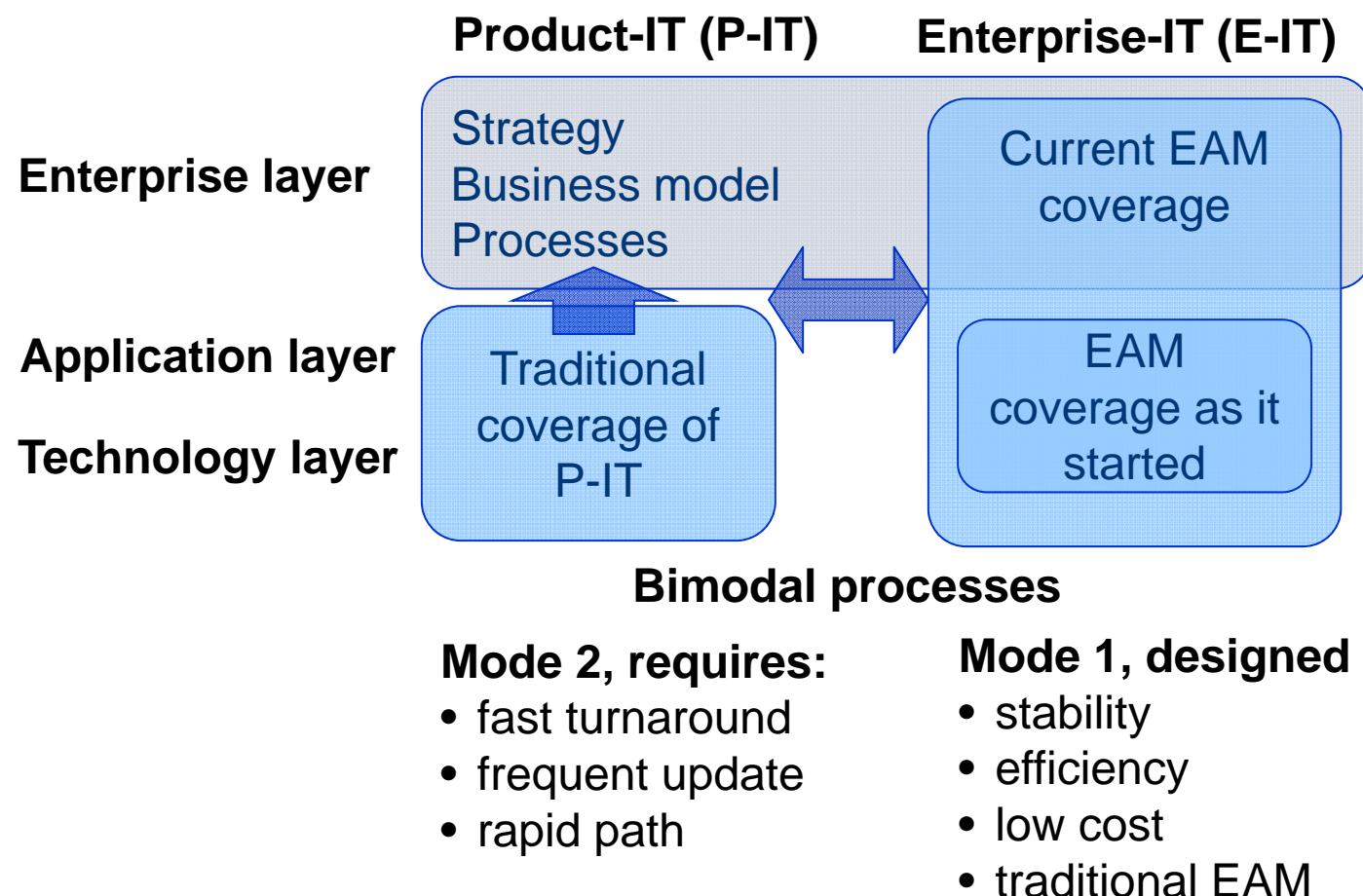
IT-World / Enterprise Computing



Enterprise IT:

- Support for value creation and support processes and functions
- Usually structured into different layers
- Currently main focus of EAM
- Product-IT usually „out-of-scope“ for enterprise IT

Product driven EAM



Implications of IoT for Enterprise and Process Modeling

- IoT is becoming part of product IT
- We have to integrate Product IT into Enterprise Architecture Models
 - The process, roles and principles for synchronizing Product-IT and Enterprise IT need to be redefined
- Different „paces“ in Product-IT and Enterprise-IT development will lead to different granularities and update cycles in enterprise models
- Highly dynamic situation in the field
 - What has to be part of the model, what should be excluded?
 - Potentially incomplete and quickly changing models

Impact of CPS: The DataChassi Case

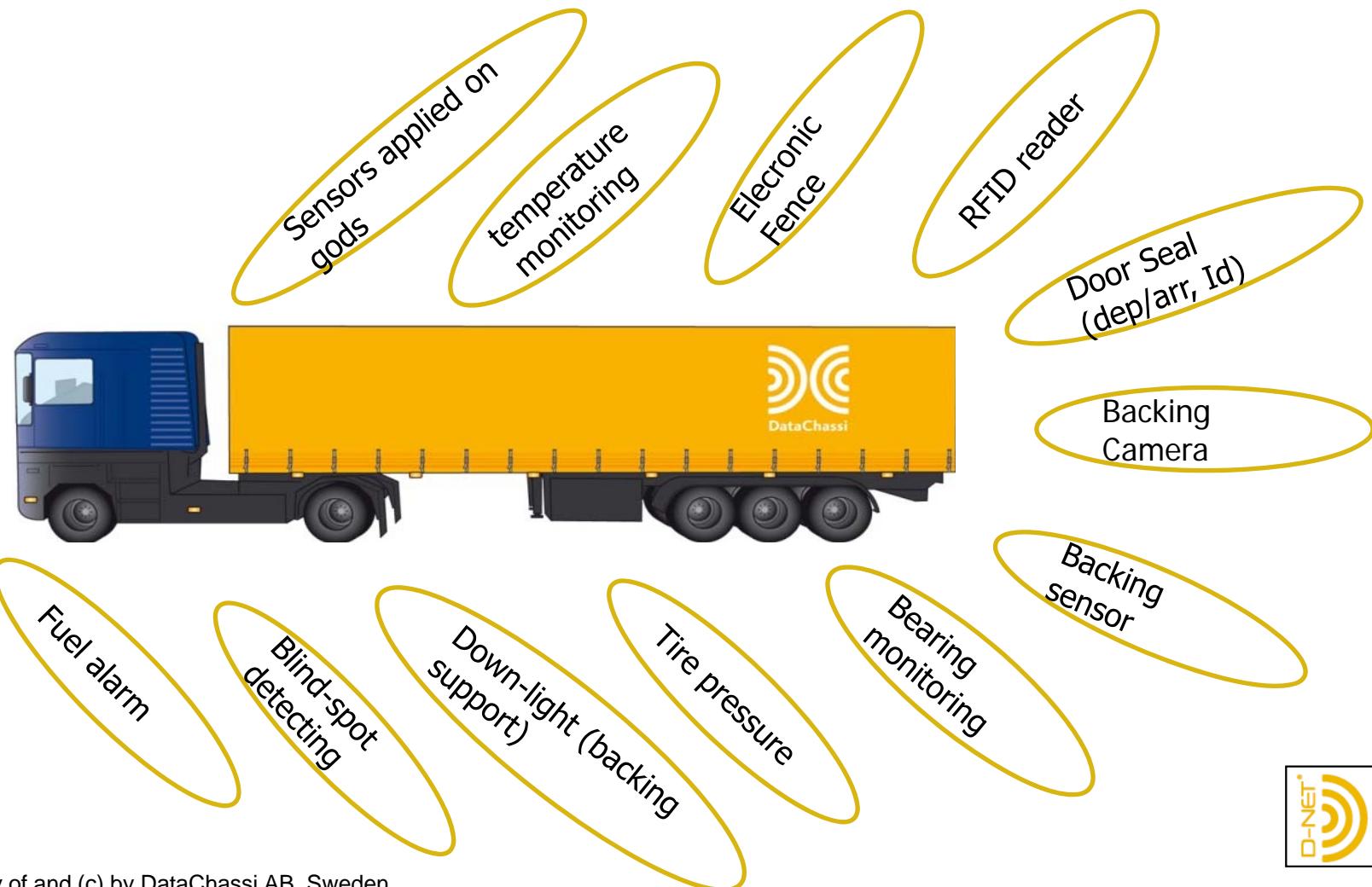
Industrial Case from Transportation



Courtesy of and (c) by DataChassi AB, Sweden



Intelligent Information Logistics Services



Courtesy of and (c) by DataChassi AB, Sweden



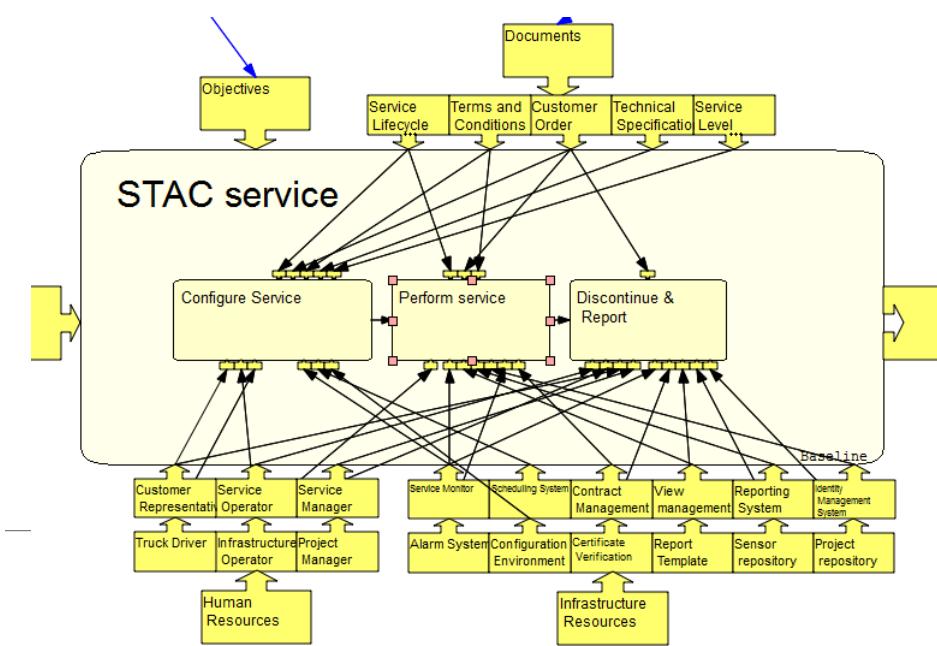
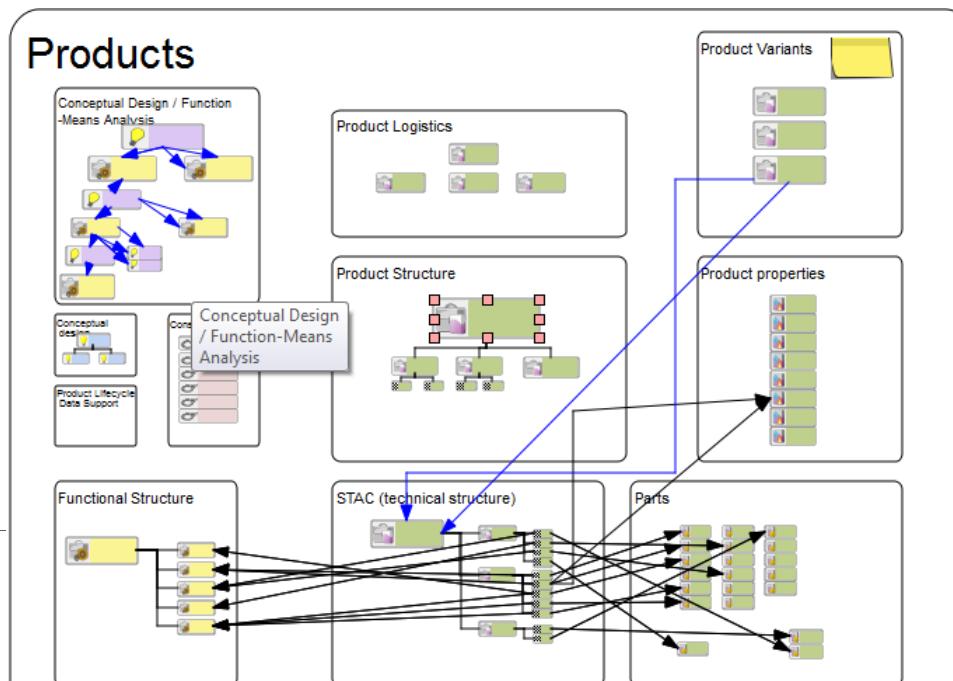
CPS development process

- a. Business objectives Enterprise Modelling
- b. Business model Enterprise Modelling
- c. CPS integration into the enterprise Enterprise Modelling
- d. Specification of CPS
 - d.1 architecture of the technical solution
 - d.2 services for operating the CPS Enterprise Modelling
- e. Support of operations Enterprise Modelling
- f. Monitoring, maintenance
- g. CPS revision

Example for use of Enterprise Modelling

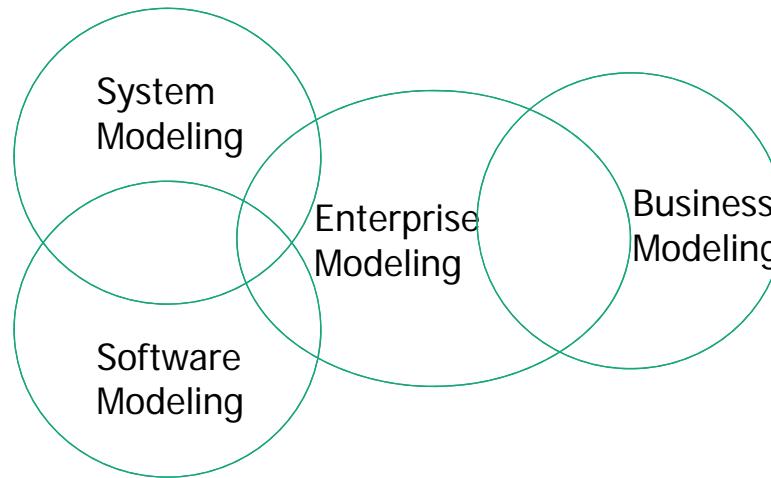
c. CPS integration into the enterprise

- Development of an enterprise model
 - Processes: product-in-use and back-office
 - Organisation: roles involved
 - Product: general service product structure
 - System: technology required



Implications of CPS for Enterprise and Process Modeling

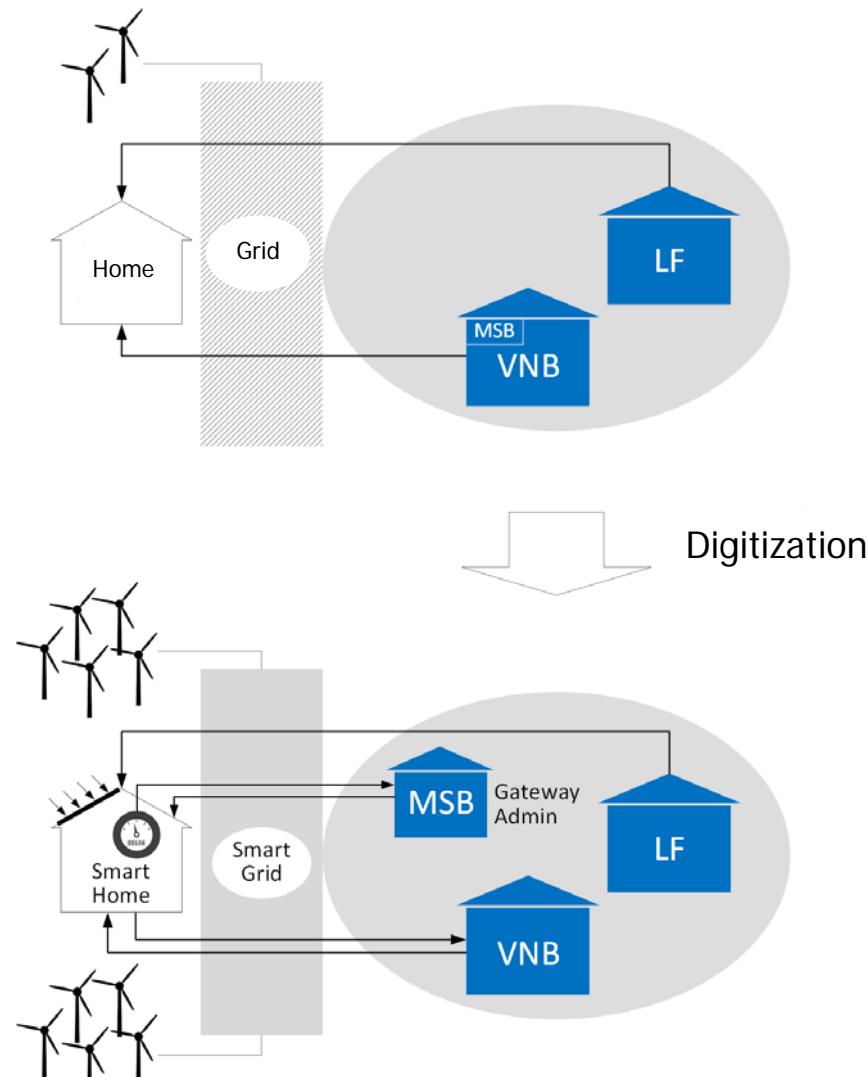
- Enterprise Architecture is changed on several layers by CPS introduction
- Enterprise Models can serve as „glue“ between other model types



- Enterprise models as design time and runtime artefact?
- Business Model can be and should be captured in an enterprise model

Impact of Digitization: The Utility Sector Case

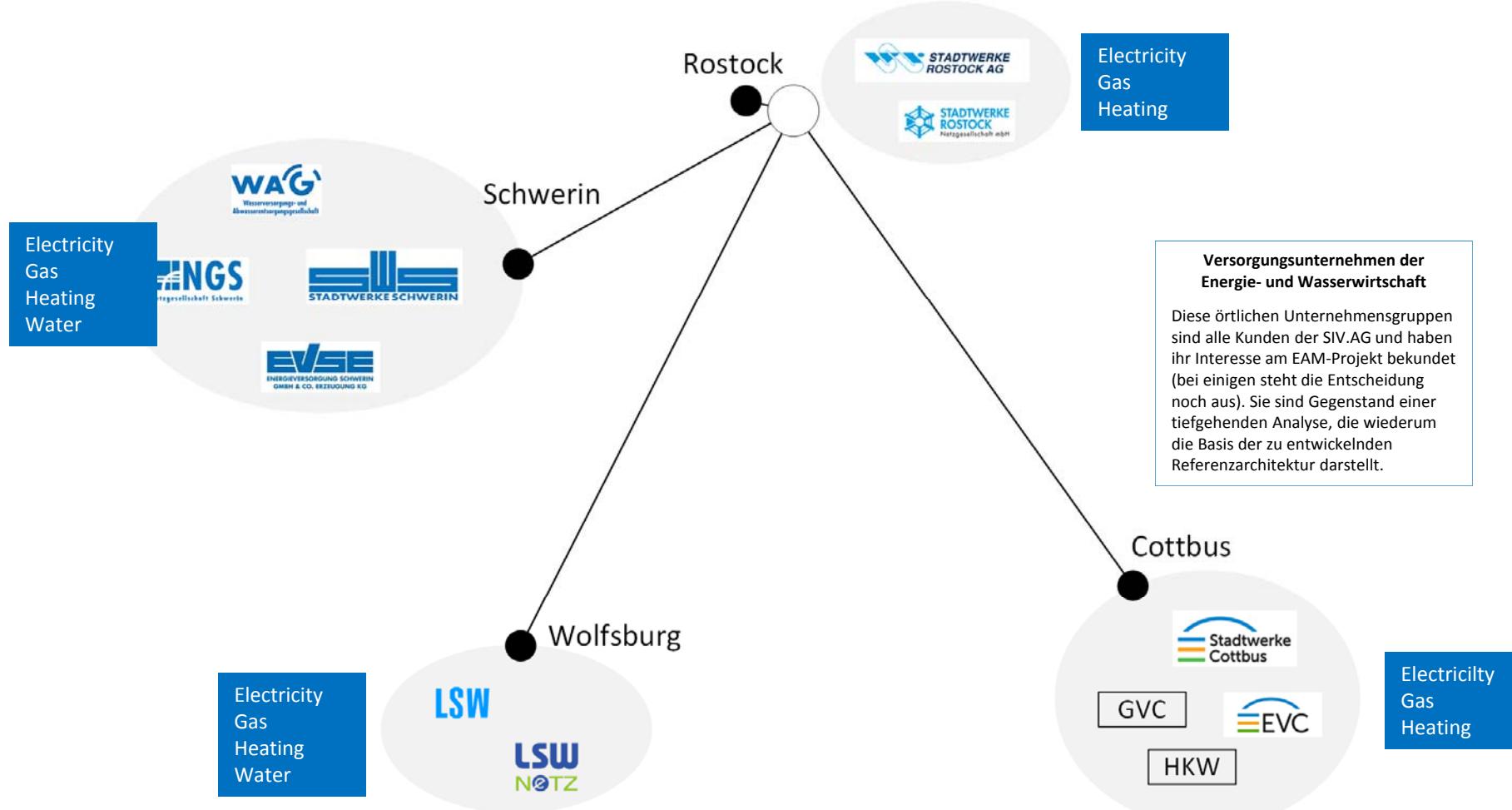
Developments in the Utility Sector



LF: Energi Supplier
VNB: Grid Operator
MSB: Metering Service Operator

Courtesy of and (c) by SIV.AG, Germany and ECLORA project

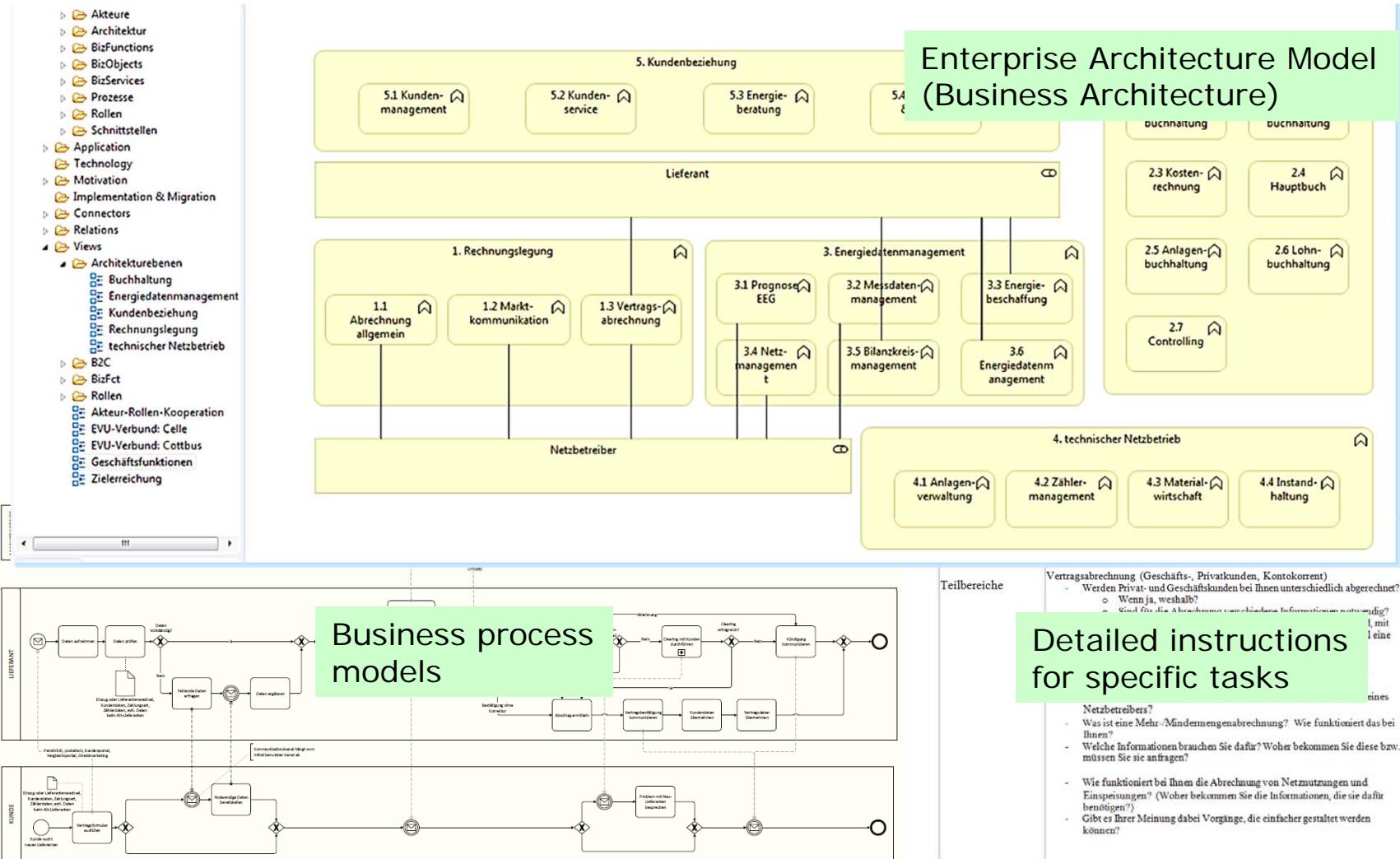
Development of a Reference Architecture



Courtesy of and (c) by SIV.AG, Germany and ECLORA project

Reference Architecture

Business Architecture + Business Process Integration

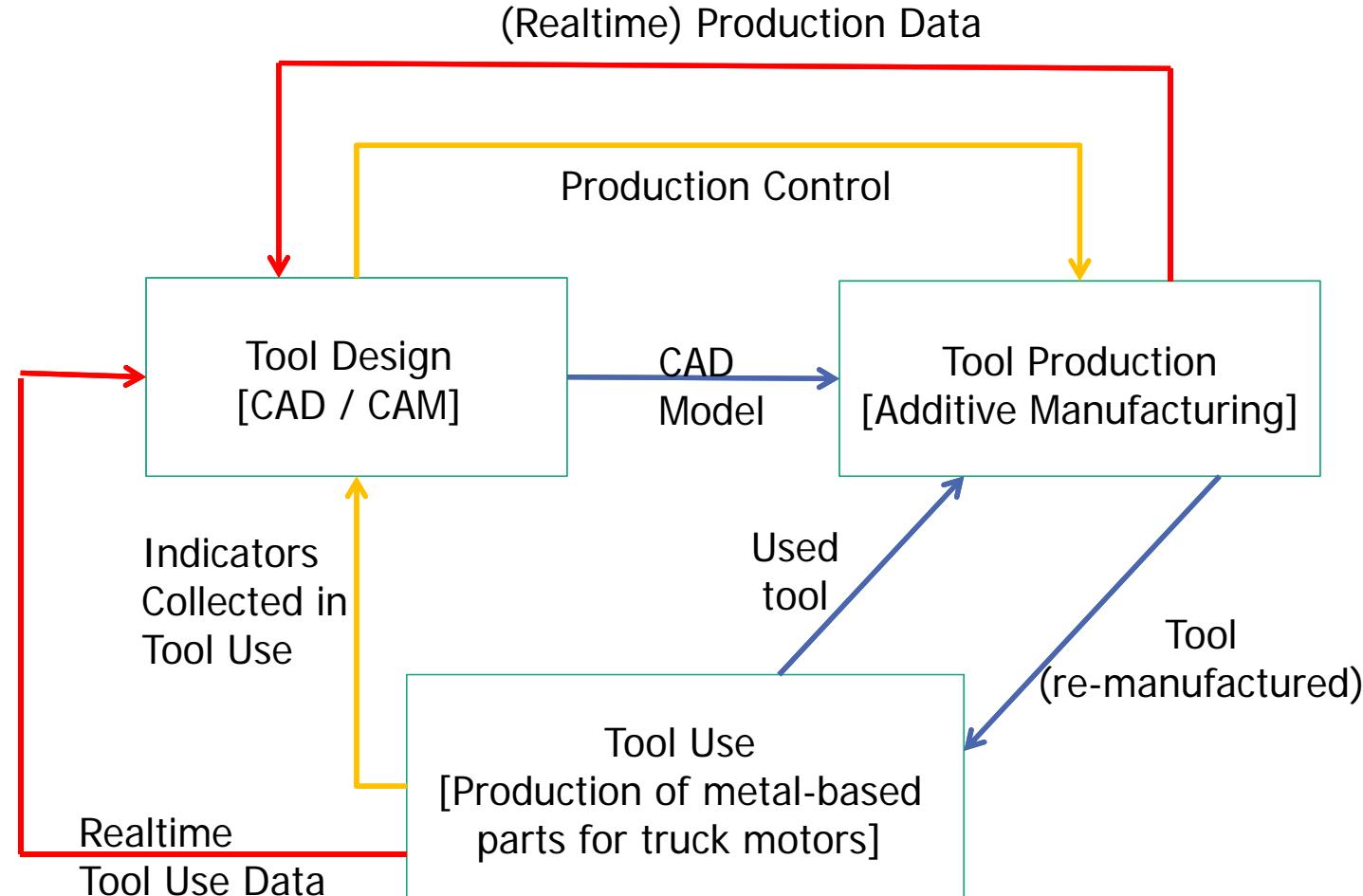


Implications of Digitization for Enterprise and Process Modeling

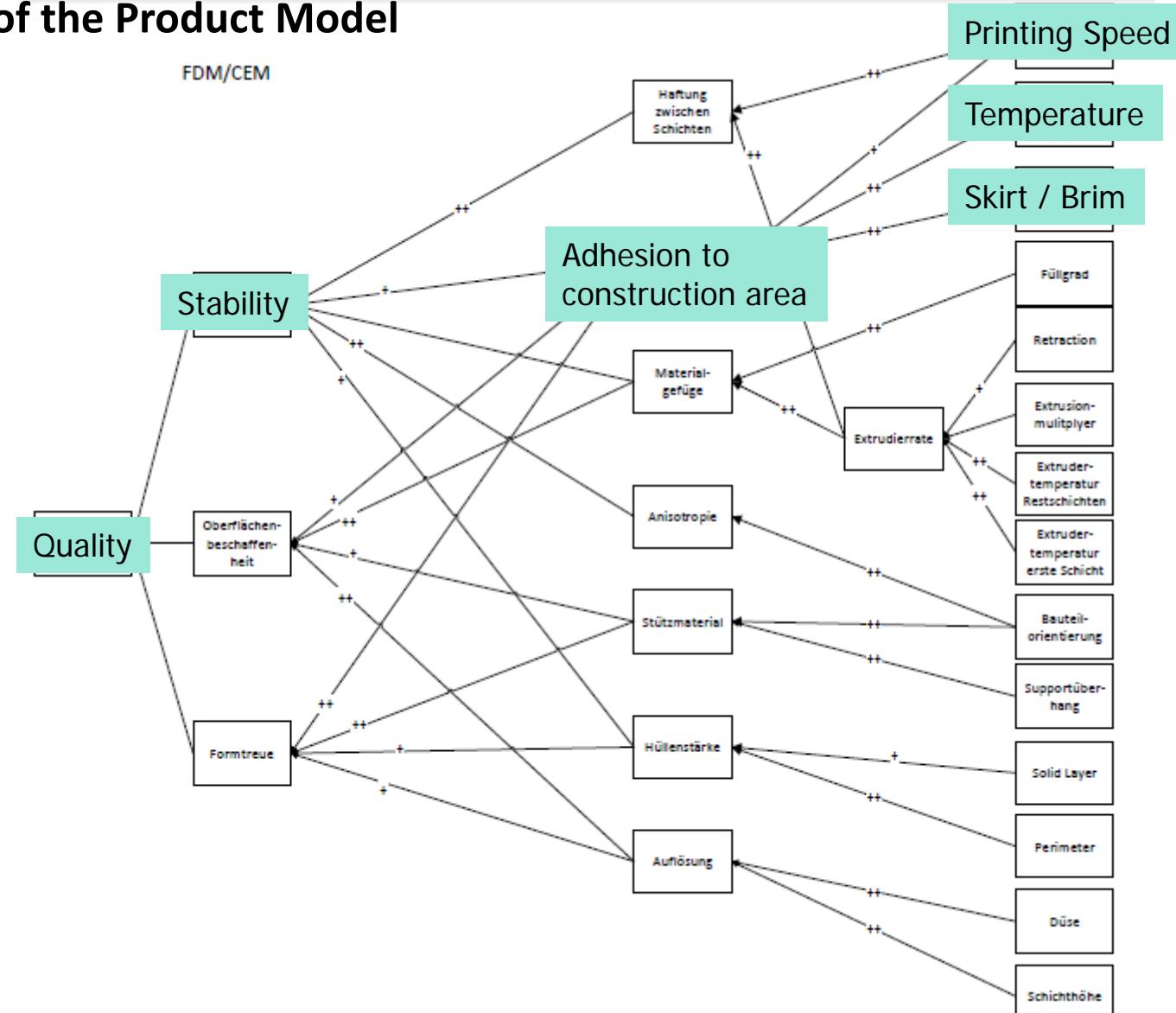
- Model the customer-side of services
- Integration of EAM , PM and EM
 - Combine architecture view (higher abstraction level) with operational view (lower abstraction level)
 - Enterprise Model captures the value creation, Enterprise Architecture Model the context of this value creation

Additive Manufacturing: A Smart Enterprise Case

Processes and Information Flows



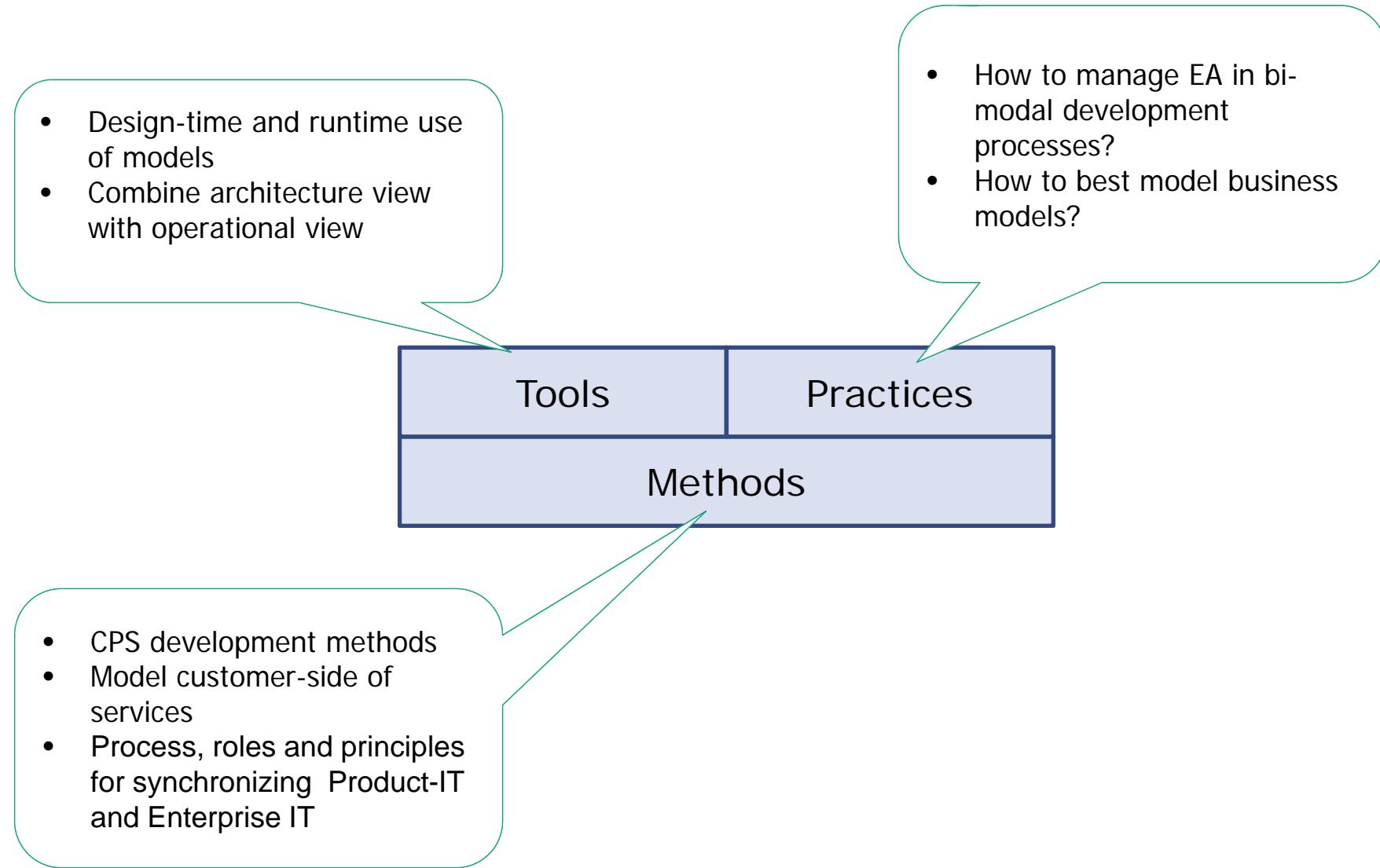
Excerpt of the Product Model



Implications for Enterprise and Process Modeling

- Model the product and service structure
 - Understand dependencies between process and product/service
 - Identify usage contexts of products/services and influences on processes
- Integration of design-time and run-time
 - Design depends on real-time context, and context is affected by design

Summary: Implications for Enterprise (Architecture) Modeling



Conclusions

IoT, CPS and digitization will not just pass or go away. These trends are affecting enterprises and thus also affecting Enterprise and Process Modeling

Implications

- Let us share experiences on IoT, CPS and Digitization projects or cases!
- Let us find ways to better support agility in enterprises
- Let us take the lead in modelling support for IoT, CPS, etc.

Thank you for your attention!

Time for questions!