Mercedes-Benz

TU/e Technische Universiteit Eindhoven University of Technology

Master graduation presentation

Applying and analyzing A3 Architecture Overviews in a complex and dynamic engineering environment

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Monday, October 14, 2019

Where innovation starts

Content

- Introduction
  - Company description
  - A3 Architecture Overviews
- Research methods
- Use case
  - Charging system
  - Current situation analysis
  - A3 Architecture Overviews created
- Results
- Conclusion

Daimler AG

> 2.000.000
Cars

> 30
Vehicle models

> 280.000
Employees worldwide

> €150 billion
Revenue

Technical complexity

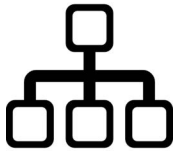
> 180
Systems

> 100
ECU's

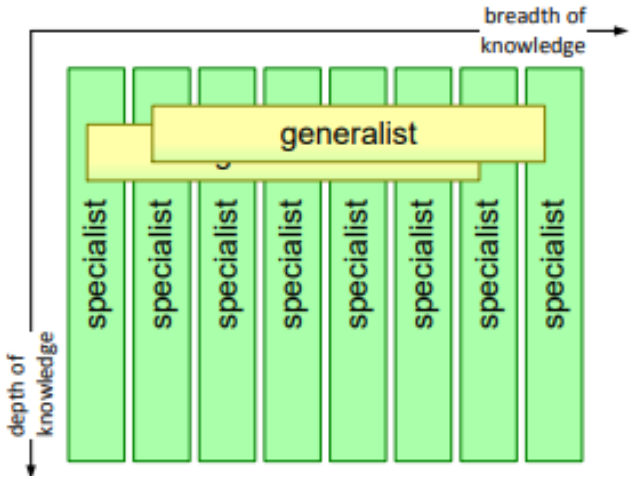
> 100 million
lines of software code

Source: https://www.daimler.com/documents/company/business-units/daimler-mbc-ataglance-2017.pdf

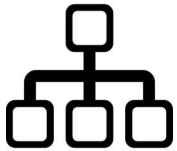
Partitioning



Specialists
&
Generalists



System architect



Designs the architecture of a (sub)system

Complex task

Communication with many stakeholders

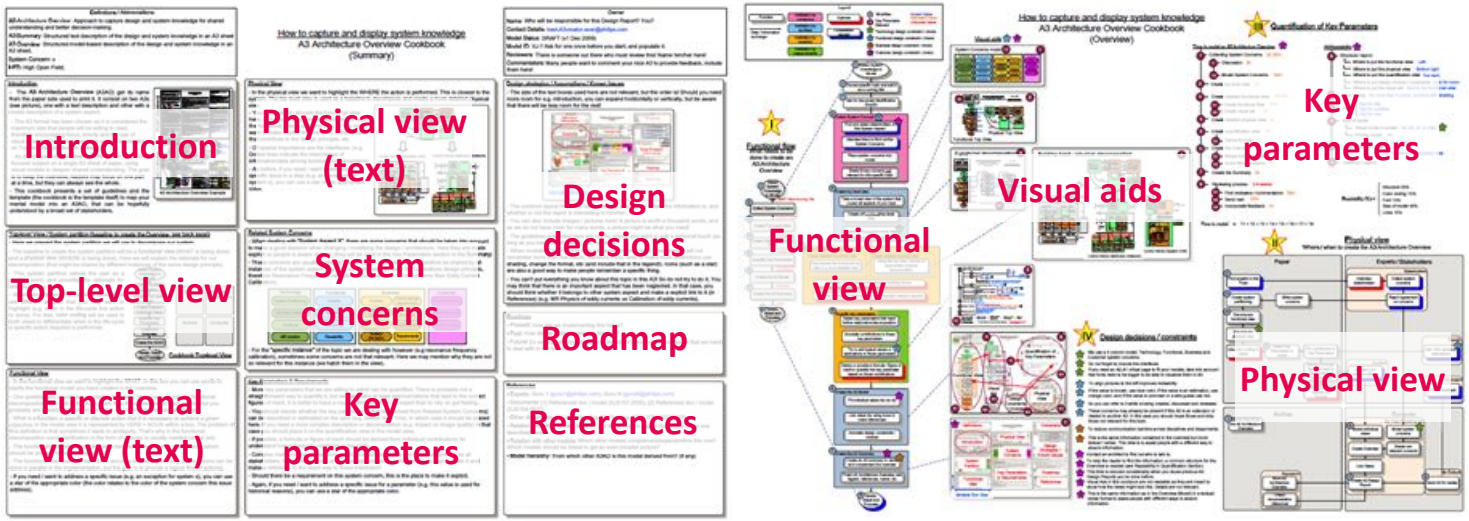
Source: https://www.daimler.com/documents/company/business-units/daimler-mbc-ataglance-2017.pdf

Daimler's goal

"Method to support the system architect to effectively communicate architectural information"

A3 Architecture Overviews

- Key characteristics
  - Architectural information
  - Complex systems
  - Complementary views
  - A3 paper size (297x420 [mm])
- Goal
  - Improve communication & documentation of architectural knowledge
  - Create and maintain system overview
  - Triggers discussion



Source: *A3 Architecture Overview Cookbook, Daniel P. Borches*

Research goal

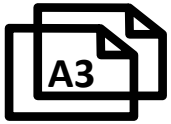
"To what extent can A3 Architecture Overviews aid the development process within a large, complex and dynamic engineering environment?"

"What are the impact factors that affect a successful implementation of A3 Architecture Overviews in this type of organization?"

Research method

Industry-as-laboratory

Representative use case



Multiple variations on cookbook

Feedback

Observations

Experiences

Surveys

HV CHARGING SYSTEM - CONTEXT

ABBREVIATIONS
GPM – Ground Pad Module
HV – High Voltage
LV – Low Voltage
Pre-con – Preconditioning
SOC – State of Charge
WPT – Wireless Power Transfer

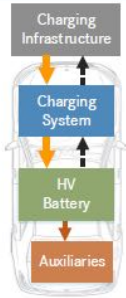
DOCUMENT INFORMATION
Author: Wilco Pesselse
Date: 01.12.2017
DocID: ChgSys_A3AO_L0_D1
Model status: DRAFT (v0.5)
Reviewers: M. Simons, A. Lepple, C. Reuter, G. Muller, T. Hofman

2 USE CASES

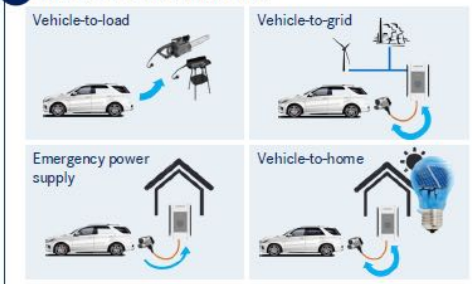
2.1 Charging the HV battery

2.2 Auxiliary energy supply

2.3 Reverse power transfer



2.3 REVERSE POWER TRANSFER



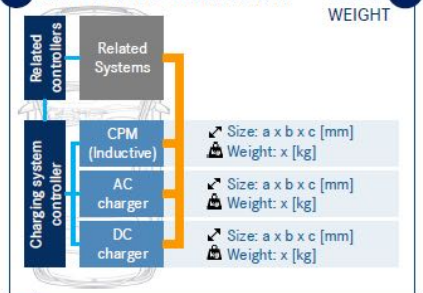
3 CHARGING MODES

Mode	Type	Grid	Max. Power	Cable
1*	AC	Home/ Industrial socket	x - y [kW]	
2	AC	Home/ Industrial socket	x - y [kW]	ICCB
3	AC	Wallbox/Charging Station	x - y [kW]	
4	DC	Wallbox/Charging Station	Up to x [kW]	
Wireless Power Transfer			x - y [kW]	

* Mode 1 is not used anymore due to safety reasons

4 MODULARITY & COMPATIBILITY

SIZE & WEIGHT 5



1 INTRODUCTION: Key architectural concerns of the charging system

The charging system provides electrical energy from an external source to the vehicle during vehicle standstill. This energy can be used to charge the HV battery 2.1 or to supply energy to other vehicle functions, e.g. low voltage network (12V) and preconditioning of the vehicle interior 2.2. Furthermore, the charging system supports reverse power transfer, meaning energy is transferred from the HV battery to the infrastructure, which has four different use cases 2.3.

Charging can be done conductive (AC or DC), inductive (WPT) or by a combination of these (parallel) and can be done at home or at a public charging station 3. Since not al vehicles are equipped with all charging options, a modular design is required, while all different options have to be both hardware and software compatible with all related systems 4. Each charging mode requires a physical component, which increases the weight of the vehicle and must fit in the vehicle 5. One of the most important concerns are the safety and security of the user and system, they must be protected at all time 6. Efficiency 7, charging mode, user settings 8 and total power available from the grid in each country 9 influence the charging time. Furthermore, the vehicle being active other than during driving affects the robustness requirements significantly 10. Communication with the user is done in-vehicle (User Interface) and/or using a smartphone app through the Daimler operated vehicle back-end 8.

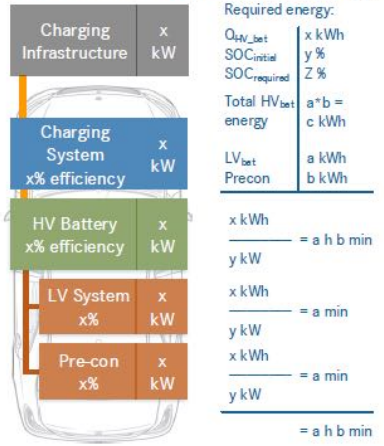





6 SAFETY / CYBER SECURITY

7 EFFICIENCY

Case scenario: 11kW AC conductive charging



10 ROBUSTNESS

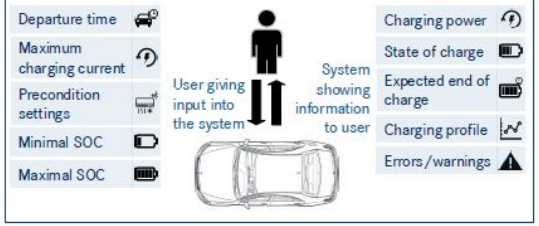
Total operating time charging (avg. x kW)	n [hours]
Total time preconditioning	n [hours]
Vehicle usage time	n [hours]
Total system awake time	n [hours]
Maximum charging cycles	n [cycles]

9 PLUG STANDARDS

	USA	EU	CHN	JPN
AC	Type 1	Type 2	GB-T AC	Type 1
DC	Combo 1	Combo 2	GB-T DC	CHAdeMO
Com.	PLC	PLC	CAN	CAN

CC Connection Check
CS Connection Status
CP Control Pilot
PP Proximity Pin
PE Protective Earth
Lx AC Phase x

8 EASE OF USE: MULTIMODAL USER INTERFACE



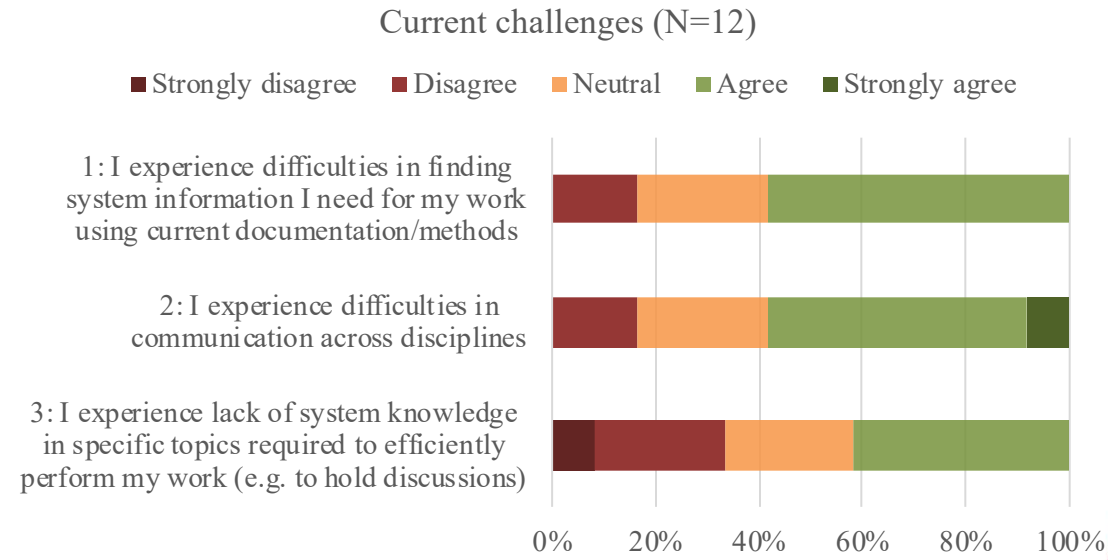
Current situation analysis

Observations & experiences

Lack of system documentation

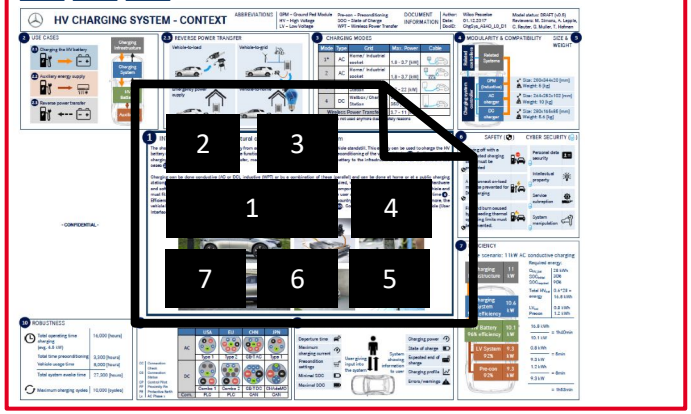
Communication issues

Lack of system knowledge/overview



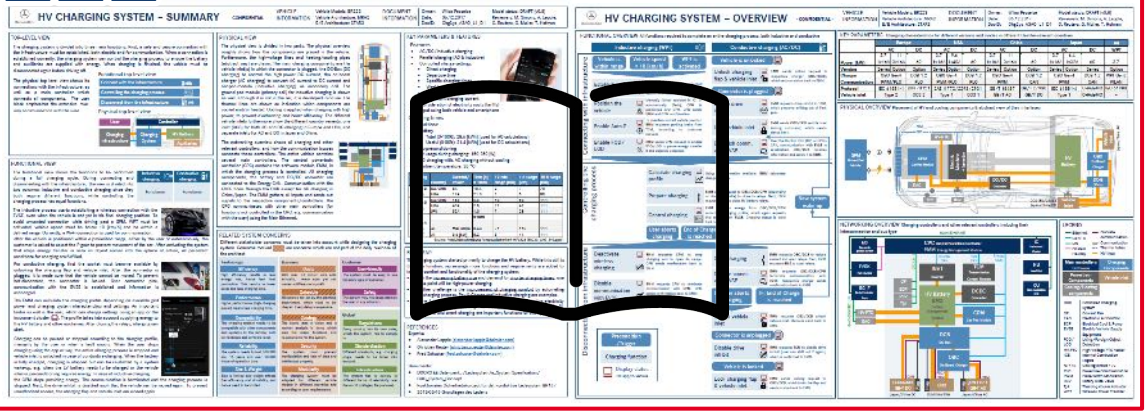
L0D1: Context

- Versions: 5 / Sessions: 7



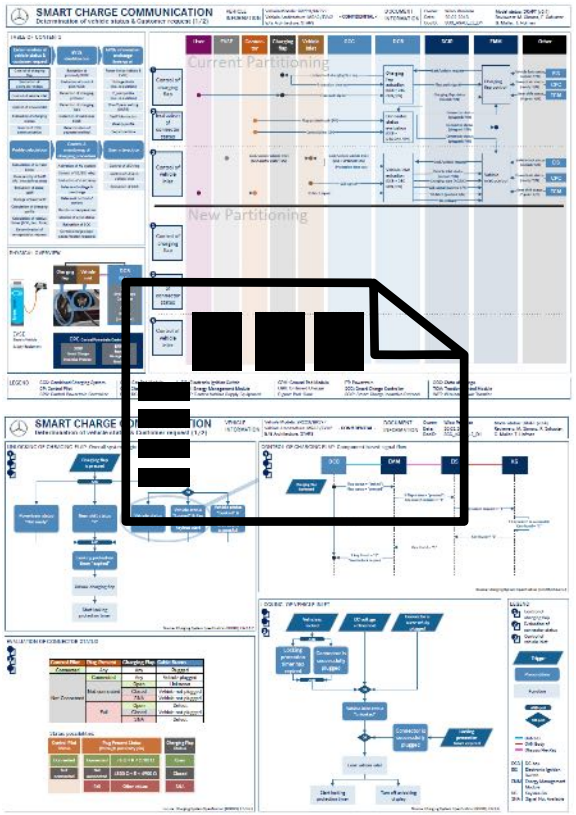
L1D1: Technical overview

- Versions: 8 / Sessions: 12



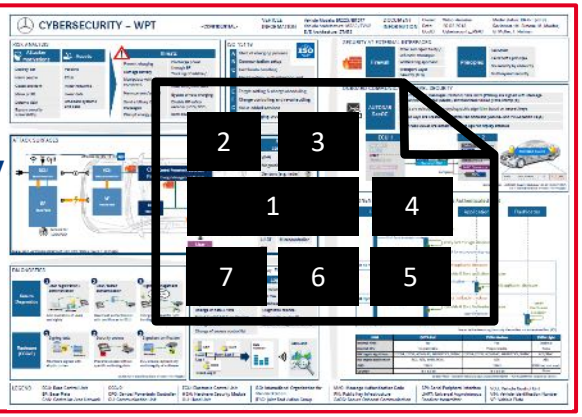
L2D1: SCC (Smart Charge Communication)

- Versions: 4
- Sessions: 5



L2D2: Cybersecurity on inductive charging

- Versions: 3
- Sessions: 4



L2D3: User Interfaces (UI)

- Versions: 3
- Sessions: 3

Results – Specific A3AOs

Observations & experiences

Provides overview

Easy to use and understand

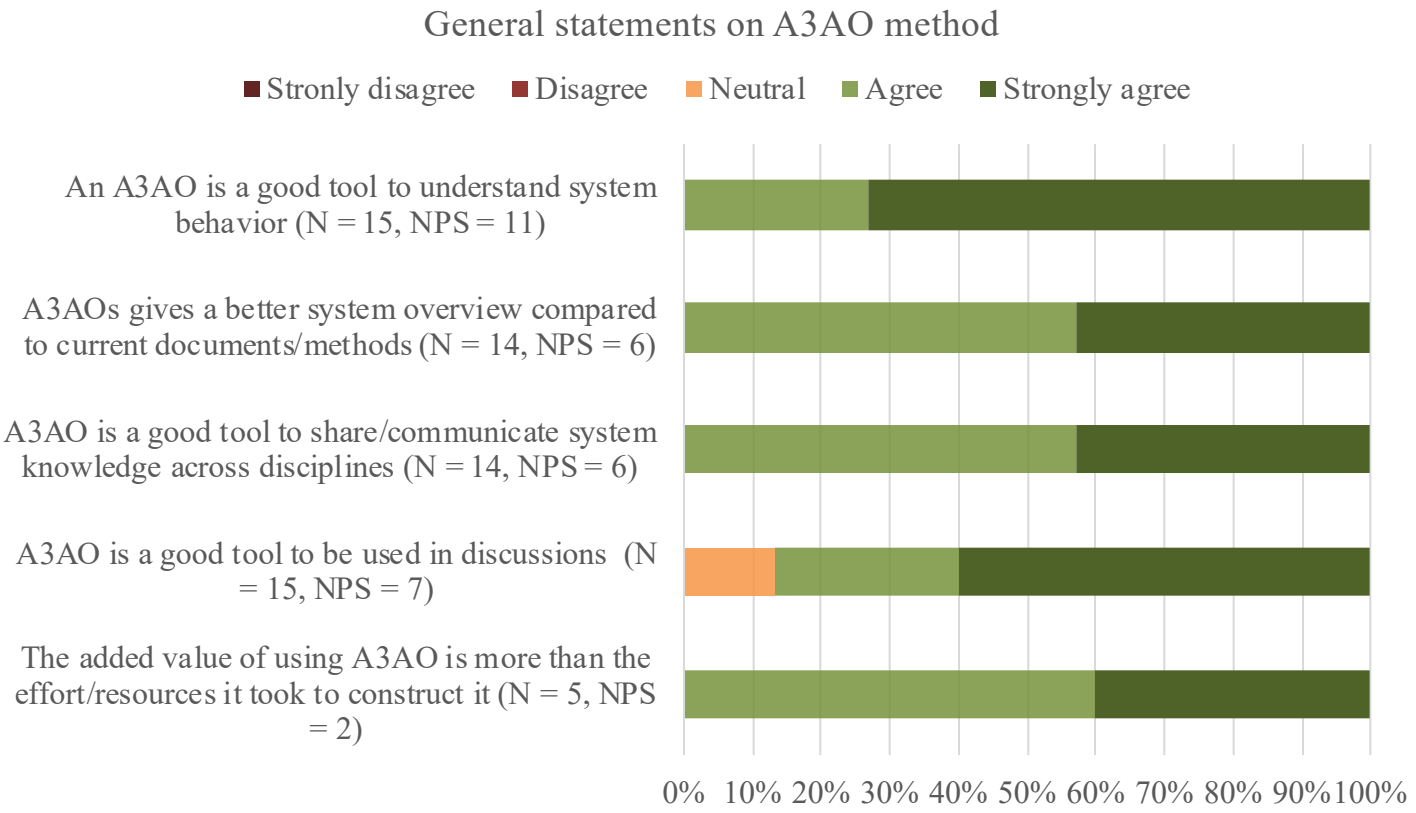
Navigational aids for self-study

Implementation time

Creation of formats

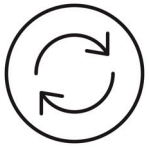
Statement **(# respondents to specific statement)**	**L0D1** **(8)**	**L1D1** **(8)**	**L2D1** **(3)**	**L2D2** **(3)**	**L2D3** **(1)**
1: The A3AO gives a **good overview of the topic** addressed	3	4	2	1	0
2: The A3AO gives a **better system overview compared to current documents/methods**	3	3	0	0	1
3: The A3AO is **easy to understand**	1	1	1	-1	0
4: The A3AO is **easy to navigate**	3	2	1	-1	1

Results – General A3AO method



Effort to create

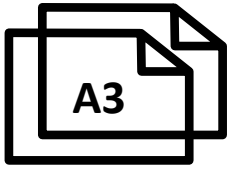
Effort to update



Consistency of data

Impact factors

- Main impact factors



Structure

Integration in current design processes

- Other impact factors

Goal

Level of detail

Navigational aids

Consistency

Implementation time

Finalizing A3AO

Summary

- Developed 2 additional templates
- A3 Architecture Overviews
  - Provides good system overview
  - Stimulates communication
  - Documents architectural information
- Concerns
  - Effort to create
  - Effort to update
  - Consistency of the data
- Impact factors
  - Predefined structure
  - Integration in current processes

Discussion & Future Research

- Case study vs. General conclusions
- Number of survey respondents
- Feedback from more active usage
- Quantitative results

Thank you

- Graduation committee
- Colleagues at Daimler

- Family & Friends

Questions