D4.2

Report on novel business models (Final)

SCOUT

Fraunhofer Institute for Structural Durability and System Reliability LBF

Darmstadt, August 22nd 2017

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Date: 2017, August 22nd

Document change record

Version	Date	Status	Author	Description
0.1	30/06/2017	Draft	Heiko Hahnenwald	Finalization of value proposition canvas
0.2	09/08/2017	Draft	Heiko Hahnenwald	Integration of stakeholder and societal implications
0.3	09/08/2017	Final	Heiko Hahnenwald	Final adjustments and bibliography
0.4	10/08/2017	Final	Heiko Hahnenwald	Final review
1.0	22/08/2017	Final	Carolin Zachäus	Final review & submission

Consortium

No	Participant organisation name	Short Name	Country
1	VDI/VDE Innovation + Technik GmbH	VDI/VDE-IT	DE
2	Renault SAS	RENAULT	FR
3	Centro Ricerche Fiat ScpA	CRF	IT
4	BMW Group	BMW	DE
5	Robert Bosch GmbH	BOSCH	DE
6	NXP Semiconductors Netherlands BV	NXP	NL
7	Telecom Italia S.p.A.	TIM	IT
8	NEC Europe Ltd.	NEC	UK
9	Rheinisch-Westfälische Technische Hochschule Aachen, Institute for Automotive Engineering	RWTH	DE
10	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V., Institute for Structural Durability and System Reliability FHG	FHG	DE
11	CLEPA aisbl – The European Association of Automotive Suppliers	CLEPA	BE
12	Asociación Española de Fabricantes de Equipos y Componentes para Automoción SERNAUTO	SERNAUTO	ES

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Executive Summary

In addition to the investigation of user expectations and possible use-cases as well as the analysis of technical and non-technical enablers, a desk research has been carried out on existing or proposed business models for connected and automated driving (CAD).

This deliverable takes into account “use cases” for CAD, user expectations and relevant stakeholders. In addition, other basic considerations as an outcome of the desk research on existing business models and predicted design parameters as business model elements have been included.

For definition of possible new business models on connected and automated a set of design parameters and corresponding possible realisations have been elaborated and defined. Therefore a morphological matrix with a set of 16 design parameters, including e.g. functions, connectivity options, communication partners, target customers, value proposition, value creation partners, etc. with more than 65 possible realisations has been elaborated.

With respect to the defined use cases, five suitable sets of parameter realisations have been derived out of the morphological matrix and have been described by means of product or service, customer segment, value creation partners and monetization.

These descriptions have been extended by a value proposition canvas analysis for further investigation of the product or service benefits, the unique selling points and the fulfillment of stakeholders e.g. user expectations and possible stakeholder restraints. Based on this, implications for stakeholders and general societal benefits or restrictions of the business models have been derived. These implications show most of all the need for strategic cooperation between all stakeholders to offer suitable CAD features and to gain full potential in increasing driving comfort and safety as well as traffic efficiency.

1 Introduction

It is broadly presumed that CAD will be changing the whole automotive ecosystem, starting with the transformation of traditional value chains and the market entrance of new players from “outside” the automotive sector like software or telecommunication companies going towards changes in user perspectives and therewith changes in mobility behaviour overall. The biggest challenge especially for OEMs and their suppliers will be the proposed shift from car ownership to mobility as a service; the same shift that e.g. the media went through with changing costumer behaviour from content ownership to on-demand streaming. Furthermore, the entry of new players with new value propositions will challenge the conventional stakeholders.[1]

The developments and trends in CAD will lead to much more fragmented value chains and enable multiple different stakeholders.

WP 4 of SCOUT aims to identify novel business models based on the potential of CAD. Such business models will support the large-scale deployment of automated and connected vehicles in Europe. The business models will recognize Europe’s unique selling proposition of services and technologies for CAD taking into account existing resources, activities and sales channels as well as user expectations.

2 Definitions and Approaches

2.1 Business Model

A business model describes the rationale of how an organization creates, delivers and captures value in an economic, social or cultural context. It’s the way a company wants to make money, taken into account target customers, how to reach, acquire and keep them and their problems or challenges to be solved. It also addresses the value that will be delivered to customers and stakeholders, possible technical realisations and how revenue will be generated.

In the following analysis the aspects of a business model described above will be represented by four basic elements:

- **Stakeholder benefit:**
  This element contains all possible users and beneficiaries as well as functionalities to cover user expectations and their value proposition
- **Technical properties:**
  This include different technical opportunities to realise functions and services of CAD
- **Value Chain:**
  Most of all within this element, stakeholders are described that will be part of the potential business model value chain
- **Profit model:**
  This element describes the way the connected and automated functionalities and services will be paid

These basic elements and their describing parameters will be further detailed in section 3.1.

2.2 Morphological Analysis (and their use for developing new business models)

The search for novel business models will be done through a so called morphological analysis. The morphological analysis was initially designed by Fritz Zwicky, a Swiss astrophysicist and aerospace scientist based at the California Institute of Technology (Caltech) as a modeling method for multi-

[1] McKinsey & Company „Competing for the connected customer“ – Perspective on the opportunities created by car connectivity and automation, **September** 2015

dimensional, non-quantifiable problems. It has been widely used for structuring and analyzing technological, organizational and social problems.[2]

The method breaks a problem down into its essential dimensions or sub-concepts which are permitted to assume a number of realisations. Thus every solution is considered as a bundle of attributes. New ideas are found by searching the matrix for new combination of attributes. While some of the combinations may already exist or other may not be appropriate or even possible, the morphological analysis often leads to prospective new ideas and innovative solutions. One prominent example is Morphology of Propulsive Power (Zwicky, 1962). The topic has been divided into six parameters with two to four realisations, which led to 576 theoretically possible modes of propulsion systems of which one is highlighted in Fig. 1. [3]

Parameter	Realiziation/ Attribute 1	Realiziation/ Attribute 2	Realiziation/ Attribute 3	Realiziation/ Attribute 4
Character of chemical reactions	Self-contained-carries all chemicals necessary for activation and operation	If air-propelled, carries only fuel and uses atmospheric oxygen.	If propelled through or over water, uses water as propellant reacting with an on-board-water-reactive chemical	If propelled through or over the earth may use earth as propellant reaction with an on-board erath reactive chemical
Mechanical charakater of propulsion system	No Motion	Translatory motion	Rotary motion	Oscillatory motion
Method of thrust augmentation	No thrust augmentation	Internal thrust augmentation	External thrust augmentation	
Physical state of propellants	Gaseous stat	Liquid stat	Solid state	
Operating mode of propulse power plant	Continous operation	Inermitted (pulsating) operation		
Reactively or Reaction Speed of the Propellans	Propellants are self-lighting	Artificial ingnition is necessary		

Figure 1: Morphology of Propulsion Power; Zwicky, 1962 - Parameters, possible realisations and one examplified combination, displayed by the blue line.

The morphological analysis does not provide any specific guidelines for combining parameters and tends to provide a large number of ideas.
The morphological analysis could be divided into the following steps:

1. The problem is decomposed into different parameters. Possible business model parameters could for examples be “target customers” or “profit model”.
2. All possible realisations of each assumed parameter will be identified. Possible realisations of target customers could be individuals, fleet operators. Potential profit model realisations could be pay per use, subscription fee, etc.
3. Setting up a matrix with the list of parameters and their possible conditions.
4. Finding suitable solutions by combining parameter realisations (e.g. target customers: fleet operators; profit model: subscription fee).

The creation of business models in this context will be done by consideration of the system elements respectively, the possible realisations of the business model design parameters by “thinking them

[2] Álvarez, Asunción; Ritchy, Tom: „Applications of General Morphological Analysis – From Engineering Design to Policy Analysis“. AMG Vol. 4 No. 1(2015), ISSN 2001-2241

[3] Álvarez, Asunción; Ritchy, Tom: „Applications of General Morphological Analysis – From Engineering Design to Policy Analysis“. AMG Vol. 4 No. 1(2015), ISSN 2001-2241

through". Depending on the amount of parameters and complexity it cannot be guaranteed that the derived set of combinations is consistent to itself. To eliminate combinations of parameter realisations that are impossible or reduce the set of formally possible configurations in step 4, a so called cross-consistency assessment is applicable. Within the scope of this assessment all of the parameter conditions in the morphological matrix are compared in pairs with one another. For each pair of conditions a judgement is made concerning whether (or to which extent) this pair can coexist.

Beside the initial design, the morphological analysis has been applied to several disciplines such as new product or service development because of their complex, multi-dimensional, uncertain and immeasurable character. Also the development of new business models can be considered as a multi-dimensional and complex problem in the way that it includes different dimensions like e.g. function, customers, value proposition or payment model with various possible realisations, which could be combined in consistent bundles. Figure 2 shows the morphological matrix for a virtual mobile business[4].

Parameter	Realiziation/ Attribute 1	Realiziation/ Attribute 2	Realiziation/ Attribute 3	Realiziation/ Attribute 4
Value Proposition	Private mobile virtual smart office solution	Public mobile virtual space	Physical state of propellants	
Customer	Private enterprise user	Public mobile virutal space user	Public mobile cloud app programmer	
Ressource	Mobile virutal smart office	Mobile cloud computing infrastructure		
Partner	Mobile cloud computing infrastructure maintenance partner	Public mobile virtual app developer	Public mobile virtual smart office solution developer	
Channel	Public channel	Private channel		
Revenue Model	Monthly fee	Freemium	App sales	Solution development fee

Figure 2: Example of the morphological matrix for a virtual mobile business

The morphological approach will be used within the SCOUT project to develop a set of new business models for CAD that will be validated in an in-depth assessment regarding their potential for implementation, benefit for the involved stakeholders as well as impact on the large-scale deployment of automated driving. In context of the search for new business models the elements mentioned in 2.1 will be represented by certain parameters and their possible realisations.

2.3 Value Proposition Canvas

The value proposition canvas, created by *Ostwalder, Pigneur, Bermarda and Smith* in correlation with the *Lean-Start-up Movement*, is a tool to further investigate the fit between customer needs and the products or services offered to them. This user centric approach focusses mainly on the value proposition of product or service within a business model and therefore could be used to adjust or reformulate a proposed value proposition to better fit customer needs by comparing these needs systematically with the benefits and advantages that a product or service will offer.

The Value Proposition Canvas in this context consists of two segments. The customer map (demand side) for which an offer creates a value and the corresponding value map (supply side) that is used to attract customers. In that context the customer map describes characteristics of the customer, their

[4] Im, Kwanyoung, Cho Hyundbo: "A systematic approach for developing a new business model using morphological analysis and integrated fuzzy approach, Expert Systems with Applickations 40 (2013), 4463 - 4477

jobs or tasks the customer wants to perform as well as the negative aspects they want to avoid as well as the positive aspects and benefits the customers want to gain from the product. The value map on the other hand describes how the proposed business model will challenge the customer expectations and the proposed value for the use has to be created.

The different elements and core contents of the canvas approach is shown and described in Figure 3.

Elaboration of the value proposition canvas follows a certain sequence, starting with the customer profile map and within that with the customer job followed by the customer pains and frustrations and finalized by the description of the expected gains and outcomes of the offered product/service. Afterwards, the value map will be elaborated starting with the description of the products/services followed by the offered pain relievers and finalized by the corresponding benefits or gain creators.

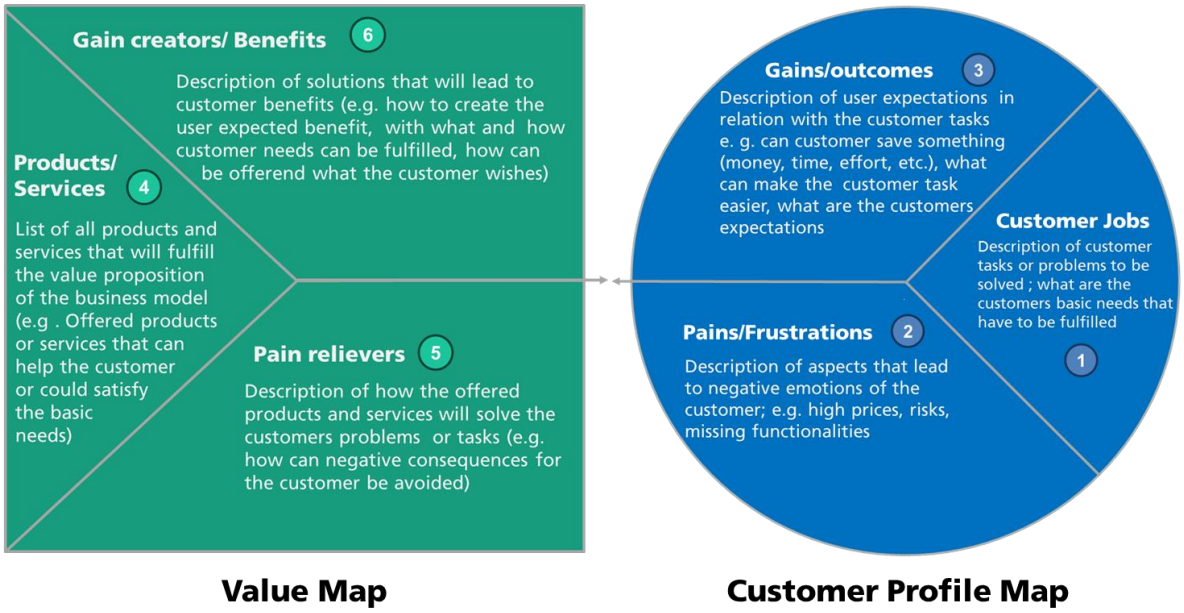


Figure 3: Value proposition canvas

3 Morphological analysis of business models for connected and automated driving

3.1 Definition and investigation of relevant business model parameters

Desk research has been carried out on existing or proposed business models for CAD. The objective of this analysis is to identify relevant business model parameters and possible realisations and on the other hand to identify reference models for the verification of the selection of business model opportunities from the morphological table.

As described in section 2 the first step in the proposed approach is to find a set of suitable parameters to describe a business model on CAD, taking into account all relevant aspects from proposed functionalities and technical parameters up to value proposition and payment models.

	Audi	BMW	GM	Mercedes	Peugeot	Renault	Toyota	VW
Service Name	Audi Connect	Connected Drive	Intellilink	Mercedes-Benz Connect/ Comand online	Connect	R-Link	Touch and go	Car Net
Value Proposition	Driving comfort, Time saving	Driving comfort	Driving comfort	Driving comfort, Time saving	Driving safety	Driving comfort, Time saving	Driving comfort	Driving comfort/, Time saving
Functions	• Vehicle telematics • Navigation • Infotainment • Diagnostics	• Vehicle telematics • Navigation • Infotainment	• Infotainment • Navigation	• Vehicle telematics • General navigation • Infotainment • Diagnostics • Driving assistance	• Vehicle telematics • Navigation • Infotainment • Diagnostics	• Navigation • Infotainment	• Navigation	• Vehicle Telematics • Other Telematics • General Navigation • Infotainment • Diagnostics
Functions in Detail	• Remote control of vehicle features • Breakdown service • Emergency call • Internet services • E-Mail function • Location based services • General navigation • Maintenance information diagnostics • App store	• Remote control of vehicle features • Breakdown Service • Emergency call • Internet services • E-Mail function • Location based services • General navigation • App store	• Internet services • General navigation • App store	• Remote control of vehicle features • Breakdown service • Emergency call • Internet services • E-Mail function • Location based services • General navigation • Traffic/journey times • Semi-automated driving • App store	• Breakdown service • Emergency call • Maintenance Information diagnostics • App store • General navigation	• Internet services • Email function • General navigation • Traffic/journey times • Location based services • App store	• General navigation • Traffic/journey times • App store	• Breakdown service • Emergency call • Driving profiles (vehicle tracking) • On demand real time content • General navigation • Travel/journey times • Travel & traffic assistance • Maintenance information • App store
Connectivity Option	Smartphone integration	Embedded, smartphone integration	Smartphone integration	Embedded, Smartphone integration	Embedded, smartphone integration	Embedded	Tethered	Embedded, Smartphone integration
Payment model	Special equipment Limited duration External mobile required	One-time payment	One-time payment of smartphone App	One-time-payment; Freemium (free use for 3 Years, subscription after)	Subscription fees	Freemium (free use for 12 months), Subscription fees	One-time payment	Freemium (free use for min. 12 months), Subscription fees

Table 1: Examples on existing business models on connected vehicles

According to the results from the literature research, the degree of automation in vehicles in public and individual transport, allows driver assistance features offered by the OEMs as comfort and safety features.[5] On the other hand car connectivity features are actually developing to a critical purchasing factor for customers; in this context studies claim that about 28 % of new car buyers even prioritize car connectivity features over features like engine power or fuel efficiency. Therefore, connectivity features in cars are growing in line with consumer expectations and are getting an important factor for vehicle manufacturers. An overview of already existing services regarding connectivity features of different OEMs is given in Table 1.

In particular with the investigations of business models for connected cars[6][7][8] and with the input of user expectations from WP2, an initial set of design parameters for the business model elements described in section 2.1 have been identified. These parameters and their possible realisations are described in detail in the following sections, ordered by business model elements (Table 2):

Business model element	Parameters addressing the business model element
Stakeholder benefit	User/beneficiary
Stakeholder benefit	Functions
Stakeholder benefit	Value Proposition
Technical Properties	Way of vehicle interaction
Technical Properties	Connectivity Options
Technical Properties	Location dependence
Technical Properties	Vehicle dependence
Technical Properties	Sensor dependence
Technical Properties	Hardware
Technical Properties	Communication Partner
Technical Properties	Automated driving area
Value chain	Value Adding Partner
Value chain	Drivers of value creation
Profit Model	Payment model
Profit Model	Rights of use
Profit Model	Delivery

Table 2: Parameters to describe business model elements

[5] Meyer, Gereon, Beiker Sven (Hrsg.) „Road Vehicle Automation“, Springer, 2014

[6] Vogt, Joerg-Oliver: “Geschäftsmodelle für das vernetzte Fahrzeug – Klassifikation, Angebot und Nutzen für das mobile Arbeiten, HNU Working Paper Nr. 30, 2014

[7] “Connected Cars: Business Model Innovation”, GSMA Connected Living Programme: mAutomotive, 2012

[8] McKinsey & Company „Competing for the connected customer“ – Perspective on the opportunities created by car connectivity and automation, September 2015

3.1.1 Business model element: Stakeholder benefit

Within this element a set of parameters is included that contains all potential users or beneficiaries, as well as the functionalities and the expected benefit corresponding to user expectations of connected and automated driving.

Users/beneficiaries
Principal users of connected and automated road vehicles are “drivers”. But also other passengers could be potential beneficiaries of connected or automated vehicle functionalities e.g. infotainment. Beside the vehicle occupants as immediate user of connected and automated vehicles also the vehicle manufacturer, fleet operators or other service providers e.g. workshops or maintenance companies as well as insurers are potential beneficiaries. CAD can also have potential effects on the improvement of traffic flow as well as emission and noise reduction. With this also the general public will experience benefits from CAD.

Functions
Connected and automated vehicles are offering a set of functionalities that ideally meet customer expectations. The possible realisations could be e.g. infotainment functions, navigations solutions and telematics.

Value Proposition
The value proposition of a product/service is the core element of buying decisions. The value proposition of CAD could be differentiated by driver centered aspects (safety, comfort, time saving, cost saving), company centered aspects such as information retrieval (location, vehicle conditions) or the optimisation of business processes.

The following table shows the parameters and realisations of the business model element stakeholder benefit:

Parameter	Realisations						
Functions	Vehicle telematics	Other telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information retrieval	Business process optimization	
Customer/ benificiary	Driver	Co-Driver	Passengers	OEM	Service provider	Fleet operators	General public

Table 3: Parameters and realisations of stakeholder benefits

3.1.2 Business model element: Technical properties

The combination of technical properties describes the different possibilities to realise services of CAD.

Vehicle interaction
This parameter represents the main design possibility regarding the possible automation of vehicles. The range of possible realisations of interaction last from driver information and driver assistance to Level 5 automation of road vehicles where drivers act like passengers and only need to insert the destination.

Connectivity option

The parameter considers the connectivity options as well as the way connectivity is realised. On the one hand, embedded means the connectivity hardware (modem, SIM) as well as applications and the user interface is built directly into the car. Tethered on the other hand means the connectivity will be brought in by the users' mobile device while the applications and the user interface will be realised by embedded hardware in the vehicle. Also the connectivity (modem and SIM) as well as the intelligence (applications) will be brought in the vehicle via the users' mobile device (e.g. smartphone).

Location dependence

This parameter represents the dependence of connected and automated services on the vehicle position. In this context services could be location based (e.g. information about gas stations, parking areas or hotels in direct vicinity of the vehicle) or location independent.

Parameter	Realisations						
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/ information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Dependent service	Independent service					
Sensor dependence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchange-able	External integration				
Communication Partner/Car to x	Car	Driver	Mobile device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				

Table 4: Technological parameters and realisations

Vehicle dependence

This parameter describes if offered services and functionalities are bound to a certain vehicle brand or even a specific car model or if a service will be offered vehicle independent. The first realisation offers vehicle manufacturers the opportunity to establish a unique selling point and to build market entry barriers. Open systems on the other hand offer the opportunity for partnerships as well as a faster deployment of services and broader user acceptance.

Sensor dependence

For current or future functions and services of connected and automated vehicles one important design possibility is the dependence on sensors. Possible realisations could be that the service or function depends on vehicle-integrated sensors, dependence of service on external sensors (e.g. sensors in infrastructure) or sensor independent services.

Hardware
Not only the connectivity options described above could be differentiated between embedded or integrated. Also other hardware concerning CAD could be built-in directly to the vehicle (e.g. control devices, sensors), exchangeable hardware (e.g. infotainment hardware) or integrated hardware (e.g. smartphone) which represents different realisation of this parameter.

Communication partner
This parameter describes the possible communication partner of the connected and automated vehicle. Possible realisations representing the different partners could be other cars, the driver, mobile devices, infrastructure, internet, home or enterprises.

Automated driving area
This parameter describes if the connected and automated vehicle operates on restricted (e. g. parking lots), semi-restricted (e. g. special lanes on motorways or bus-lanes) or unrestricted areas (connected and automated vehicles are fully integrated in road traffic).

The table 4 summarises the set of technical parameters and their possible realisations influencing new business model opportunities.

3.1.3 Business model element: Value chain

It is broadly presumed that CAD is changing existing value added structures in the mobility sector. Not only because of the market entrance of new players from outside the automotive sector, e.g. software or telecommunication companies, but also by changing means of mobility from a user perspective. Past key performance features influencing buying decisions will change drastically. Connectivity features will more and more gain importance over engine power. This will have a significant impact on future value chains and the composition of value-added partners involved.

Value adding partner
Based on the vehicle (and the OEMs), possible value-added partners are automotive suppliers, infotainment hardware and software suppliers as well as telecommunication providers. Key players could be big software companies or content providers. Additional other, yet not recognized, players could occur because of the growth of community e.g. based on traffic information.

Drivers of value creation
This parameter describes drivers for the establishment of possible new services. Drivers will be aligned with the value adding partners. Therefore one approach could be that OEMs develop and offer connected and automated vehicles with all other value adding partners being suppliers for components, systems, products and services. Another form of realisation could be platform strategies where value adding partners act more in a co-creation way together with some basic elements and links. A third possible development could be the establishment of networks, where similar to social networks information will be shared but regarding e.g. traffic conditions.

Parameter	Realisations						
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommu-nication-provider	Software provider	Infrastructure operator	Content provider
Drivers of value creation	OEM driven	(Software-) Platform	Community				

Table 5: Value adding partners and drivers of value creation

3.1.4 Business model element: Profit model

To answer the question how a service will gain money the profit model seems to be the most important part of a business model for providers. In this context it is also important to know if customers are willing to pay for a certain service on connectivity or automation of vehicles. Especially OEMs are faced with the challenge to sell connectivity features that could be also realised by smartphone integration and in that regard provide attractive solutions beyond the performance of smartphone interfaces.

Payment model
This parameter covers possible ways to gain revenue for products/services. The broad variety of solutions include the purchase via a one-time payment to the provider, subscription fees on different basis (e.g. per month, per year) or payment per use models (e.g. for a certain duration, a defined volume). Other realisations could be the so called Freemium model (with respect to multi-media offers) where a basic version of the product/service will be free for use but additional functionalities or contents have to be paid. With respect to the digital community a third party financing of services would also be possible. In this case an additional party will take over service costs to offer it for free to the users and will refinance the costs via advertising or the sale of the rights to use the gained data.

Delivery
This parameter covers the different “time” the service/product is available for the user. Possible realisations could be the simultaneous delivery of the automated or connected features with the purchase of a vehicle; they could be bought in terms of an after sales service in the case of physical installation (e.g. sensor black-boxes, etc.) or in case of soft- or firmware there is the possibility for updating (e.g. navigation maps).

Rights of use
It could be possible that the use of a certain product/service regarding CAD is bound to a vehicle and the rights of use will pass over to another user e.g. in cases of reselling the vehicle. The other possibility would be that the product/service is linked to the user that has paid for the service, especially in the context of smartphone integration or after sales upgrading.

Parameter	Realisations				
Payment model	One-time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing
Rights of use	Linked to vehicle	Linked to individual user			
Delivery	Vehicle purchase	After sales individual	After-sales update		

Table 6: Parameters and realisation of possible profit models

3.2 Morphological table

The different elements of business model creation of CAD and their design parameters as well as corresponding possible realisations described in 3.1 are combined in a morphological table (Table 7).

Parameter	Realisation 1	Realisation 2	Realisation 3	Realisation 4	Realisation 5	Realisation 6	Realisation 7
Customer/ beneficiary	Driver	Co-Driver	Passengers	OEM	Service provider	Fleet operator	General public
Functions	Vehicle telematics	Other telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information collection	Business process optimization	
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Vehicle dependent service	Vehicle independent service					
Sensor dependence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchangeable	External integration				
Communication Partner	Car	Driver	Mobile device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommunication provider	Software provider	Infrastructure operator	Content provider
Marketplace	OEM driven	Software-Platform	Community				
Payment model	One-time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing		
Rights of use	Bound to vehicle	Bound to single user					
Delivery	Vehicle purchase	After sales individual	After sales update				

Table 7: Morphological table on parameters and possible realisations of elements of business models on CAD

4 Use cases as a basis for novel business models of connected and automated driving

As can be seen in the morphological table there will be great amounts of possible parameter combinations and therefore great sets of possible business model opportunities. To better focus this variety, specific use cases will be defined representing a framework for the search of possible parameter combinations.

Based on the user expectations highlighted during the co-creation workshop in February, four use cases have been derived to be further investigated for a new business development. The use cases represent exemplary future implementations of CAD, take into account different types and modes of mobility.

Use case	Type of mobility	Based on results from co-creation workshop
Connected maintenance and safety	Passenger transport	Health sensing
Automated valet parking	Passenger transport	Field operational tests
Autonomous trucks on highways	Goods transport	Truck platooning, cross-border compatibility
The car as digital experience center	(Public) Passenger transport	Taking into account several aspects also of mobility as a service

Table 8: Definition of use cases for CAD

This list is not conclusive and there are a lot more business model opportunities related to different technologies or specific realisations. Furthermore, it is quite challenging to describe well defined business opportunities in a technology field as dynamic as CAD.

Taking all these dynamics and uncertainties into account, the defined use cases cover a broad range of different technology issues as well as cooperation aspects that will be addressed by the further development of CAD. Regarding the fact that the future cannot be foreseen, the use cases and their corresponding business opportunities give an initial impression of what could happen in the future but still leaving enough space for adjustment and additional approaches to be open and responsive for dynamic changes in technology as well as the market development.

5 Deriving new business models from the morphological table

For each of the different use cases now the morphological table has been scanned in a creative process to define suitable possible combinations of parameter realisations. From all these combinations one set of parameters was selected for each use case by consideration of the system elements and in the context of the use case.

Based on these combinations the identified business models will be further detailed and elaborated through the value proposition canvas method to emphasize the added value as well as possible restrictions. The process starting with the definition of business model design parameters described in section 3 is shown in Figure 4.

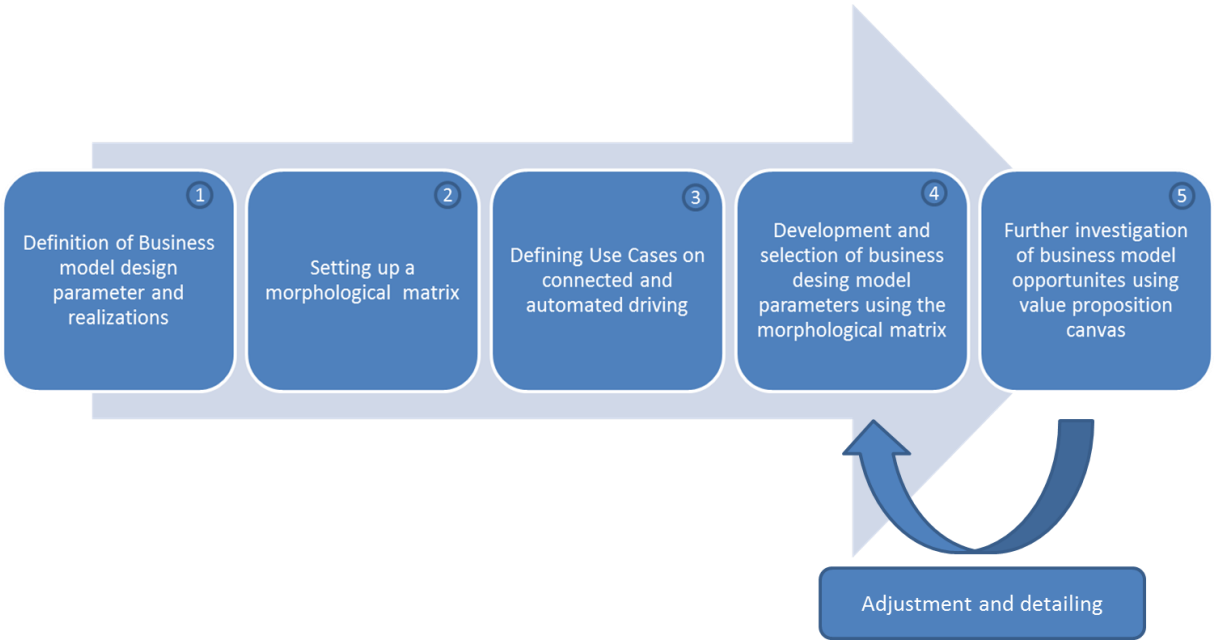


Figure 4: Steps of business model development using morphology

5.1 Business model development

For each use case, different combinations of parameter realisations in the morphological table have been investigated. Usually the starting point for the logic development of business models could be every parameter or every parameter realisation. Due to the relation to specific use cases the environment of the use case determines a fixed set of parameter realisations (mostly technical properties, or framework parameters). This also has a simplified consistency assessment described in section 2. Therefore, the set of parameter realisation pairs that have to be assessed have been significantly reduced.

During the combination process, which was mostly a creative and iterative process, some parameter realisations have been occurred in different combination sets within the same use case. Therefore, in contrast to the classical morphology these parameter realisations have been grouped together in one morphological matrix. Already existing ideas for new business models in the area of CAD[9] have also

[9] e.g. described in "Competing for the connected customer – perspectives on the opportunities created by car connectivity and automation, McKinsey & Company, September 2015

been taken into account in the selection process. In the end one set of parameter realisations has been chosen for each use case for the proposed business models. The morphological matrix for each set is shown in the corresponding business model descriptions.

Based on the specific use case the business model description will be performed along the following elements:

1. *General description (use case)*

The basic principles of the use cases are described which will be the basic framework for the business model development.

2. *Set of parameters of the morphological analysis*

This section shows the chosen business model design parameter realisations.

3. *Business Model description*

The set of business model design parameter realisation will be grouped and described along the following structure, which mainly represents the most important aspects of business models that should be further investigated:

- *3.1. Product/service/value proposition (including most of the technical property parameters)*
- *3.2. Customer segment (corresponding mainly to the parameter users/beneficiaries)*
- *3.3. Value creation partners (corresponding to the value chain parameters)*
- *3.4. Monetization (representing parameters like payment model, rights of use, etc.)*

5.1.1 Business model for connected maintenance and safety

1. General description (use case)

In this use case especially the connectivity aspect is taken into account. Despite the fact that autonomous driving vehicles are proposed to increase driving safety by the fact that autonomous driving operations reduce or eliminate elements of human error, which causes most of today's accidents, the collection and forwarding of data allows real time reactions. This may result in driving recommendations for the driver or the "driving robot", reduction in energy consumption and traffic optimization, remote or predictive maintenance.

2. Set of parameters of the morphological analysis

The following table shows the resulting morphological matrix and the selected set of parameters representing elements of a potential business model.

Parameter	Realization 1	Realization 2	Realization 3	Realization 4	Realization 5	Realization 6	Realization 7
Customer/benificiary	Driver	Co-Driver	Passengers	OEM	Service Provider	Fleet Operators	General public
Functions	Vehicle Telematics	Other Telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information collection	Business process optimization	
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Vehicle dependent service	Vehicle independent service					
Sensore depence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchangeable	External integration				
Communication Partner	Car	Driver	Mobile Device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommunication-provider	Software provider	Infrastructure operator	Others
Marketplace	OEM driven	Software-Platform	Community				
Payment model	One time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing		
Rights of use	Bound to vehicle	Bound to single user					
Delivery	Vehicle purchase	After sales individual	After sales update				

3. Business model description

3.1. Product/service/value proposition

The business model consists mainly of three elements for a connected and automated vehicle. As already in implementation the emergency call is one core offer. In case of emergency situations (e.g. accidents or other serious health issues) the vehicle alerts automatically the emergency service and forwards core location data as well as available actual health data based on in-car sensors and/or stored patient data to a central emergency agency and if possible try to establish a phone connection. In case of an emergency situation actual health data and or patient data will be forwarded and shared

with the emergency service. It is also possible to manually trigger the emergency car by the driver.[10] A so called breakdown service is operating in a similar way: In case of a breakdown the nearest garage and or breakdown service is automatically informed about the technical defect and if a fixation is possible or not. As shown in Table 1 this type of application is already implemented in vehicles nowadays, but their use is limited to premium class cars. Beside this, with the increase in sensor data, data processing, communication standardisation and data security on one hand and increasing willingness from the user to collect and exchange data on the other hand, the quality of services could be significantly increased.

In contrast predictive maintenance and predictive driving information are provided to prevent breakdowns. Therefore, car sensors and vehicle to vehicle communication is used to exchange information about vehicle, road and weather conditions or provides traffic warnings to give driving recommendations.

Beside this the drivers do not only increase safety aspects but could also save money by following driving recommendations. This means they can save repair and downtime costs by driving more economically as well as insurance costs by using a so called pay as you drive (PAYD) vehicle insurance. Hereby the insurance costs are dependent upon the type of vehicle used and are measured against time, distance, place and especially driving behavior.

3.2. Customer segment

While the end user benefit from the increase in security and safety, also fleet operators like car sharing providers or logistics providers take advantage from security and safety features. Also insurance companies can benefit from the change in mobility behavior by providing sustainable business models.

3.3. Value creation partners

Providing relevant information and the links to other service providers, car manufacturers do not only have to cooperate with their suppliers but also with other stakeholders as garages, emergency services, etc. to define standards for the exchange of data. A main role in the value chain is given to the telecommunication providers by suppling robust and secure hardware and data processing.

3.4. Monetization

Whether or not it is about private car ownership or mobility on demand vehicle use the end user is paying for the safety and security issues. OEMs will offer certain functionalities the driver pays for directly with the vehicle purchase or in terms of a subscription base fee for using the services over time. A mobility service provider like a car sharing company offers a usage fee for vehicle features or it can be included in the user charge in general. On the other hand the car manufacturer (and/or mobility service provider) is paying for the telecommunication services and the necessary technical car equipment as well as the cooperation with garages or breakdown service providers. Furthermore, insurance companies could benefit from the decrease of effort in claim settlement and in providing more user-based insurance models such as PAYD especially for car sharing operators.

[10] The emergency call (eCall) has been initiated by the e-Safety initiative of the European Commission and is already planned to be implemented mandatory in new cars from march 31th 2018.

5.1.2 Business Model for automated valet parking

1. General description (use case)

This use case seems to be a short term realisable basic scenario for automated driving.[11] The driver leaves the connected and automated vehicle at a certain drop-off-point at a public or private parking lot. After dropping the car off it will fully autonomous drive to its final parking position. It is not important if the car is privately owned or owned by a car sharing or mobility service provider. Sensors within the car and the restricted or semi-restricted parking area allow the fully automated driving at low velocity to reach and leave the final parking position. The integrated navigation system or respectively a special mobile phone app shows the free parking possibilities near the travel destination. Also the payment will be done via mobile phone. To take over the car again the driver gets to the pick-up point, identifies himself to the system via mobile phone (and/or car key) and get picked up by the car.

2. Set of parameters of the morphological analysis

The following table shows the resulting morphological matrix and the selected set of parameter representing elements of this potential business model.

Parameter	Realization 1	Realization 2	Realization 3	Realization 4	Realization 5	Realization 6	Realization 7
Customer/benificiary	Driver	Co-Driver	Passengers	OEM	Service Provider	Fleet Operators	General public
Functions	Vehicle Telematics	Other Telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information collection	Business process optimization	
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Vehicle dependent service	Vehicle independent service					
Sensore depence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchangeable	External integration				
Communication Partner	Car	Driver	Mobile Device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommunication-provider	Software provider	Infrastructure operator	Content provider
Marketplace	OEM driven	Software-Platform	Community				
Payment model	One time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing		
Rights of use	Bound to vehicle	Bound to single user					
Delivery	Vehicle purchase	After sales individual	After sales update				

[11] Actually a pilot project is running by Daimler and Bosch on automated valet parking in the at the Mercedes-Benz Museum in Stuttgart. In the project cars can be hailed and sent to a parking space with a command from a smartphone supported by infrastructure technology within the garage.

3. Business model description

3.1. Product/service/value proposition

Automated valet parking supports well-organized and safe parking in large parking areas. The connection of location based services (possible parking areas based on navigation destination), payment services and automated driving exonerates the drivers from search traffic. The most important value propositions regarding the drivers willingness to pay for that type of service are comfort and especially time saving.

3.2. Customer segment

Beside the drivers comfort the parking area providers also benefit from an automated parking system. Due to an optimised pathfinding and the missing need for open-door space for dropping-off the driver and other passengers less parking space is needed for the individual car. This means overall more parking lots could be provided at a certain area.

3.3. Value creation partners

For the parking system it is not relevant if the car is private owned or owned by a mobility service provider (e.g. car sharing) as long as the car is offering Level 4 autonomous driving functions and connection features that will be provided by the OEM and respectively their suppliers. Also the parking area provider needs to implement certain sensor and connectivity infrastructure to share data also with software and app providers such as navigation map providers to offer location based information on free parking areas. As linking element, telecommunication providers supply a stable and safe communication infrastructure.

3.4. Monetization

As it is today, the end-user (the driver) is paying for the parking service in different ways. The obvious way of charging is the parking fee itself. This does not differ from current business models. Maybe the driver also has to pay a subscription fee for the location based service offering parking space information around its travel destination. This could be included in the infotainment service package of the vehicle or could be purchased separately as mobile service. According possible costs for smartphone apps may occur e.g. for payment services or identification services. The parking area provider will be responsible for the infrastructure investment at the parking ground and the connectivity hardware to provide parking space information to third party content providers whom will pay for this information or directly pay for being listed in navigation systems embedded in the car or via smartphone app depending on the market position of the service provider.

5.1.3 Business model for automated truck platooning on motorways

1. General description (use case)

Automated truck platooning systems provide lateral and longitudinal control at highway speeds. Once on the motorway the platoon consisting of several trucks that are aligned on closely, following the other mutually communicating. All relevant information (braking, accelerating, steering, etc.) is sent via vehicle to vehicle communication from the first truck to the rear trucks until it reaches the end of the platoon. Within this use case the automated system takes full control of the vehicle and the driver can safely turn his attention away from the driving task. However, the driver has to be prepared to intervene within limited time, when called upon the vehicle.

2. Set of parameters of the morphological analysis

The following table shows the resulting morphological matrix and the selected set of parameters representing elements of potential business models.

Parameter	Realization 1	Realization 2	Realization 3	Realization 4	Realization 5	Realization 6	Realization 7
Customer/benificiary	Driver	Co-Driver	Passengers	OEM	Service Provider	Fleet Operators	General public
Functions	Vehicle Telematics	Other Telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information collection	Business process optimization	
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Vehicle dependent service	Vehicle independent service					
Sensore depence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchangeable	External integration				
Communication Partner	Car	Driver	Mobile Device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommunication-provider	Software provider	Infrastructure operator	Others
Marketplace	OEM driven	Software-Platform	Community				
Payment model	One time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing		
Rights of use	Bound to vehicle	Bound to single user					
Delivery	Vehicle purchase	After sales individual	After sales update				

3. Business model description

3.1. Product/service/value proposition

Truck platooning will significantly improve traffic safety. Furthermore, platooned driving at a constant speed will lead to lower fuel consumption and less CO_2 emissions, which in turn results in significant savings as well as better environmental conditions. Additionally, constant distance between trucks and the constant speed reduces traffic jams and accidents and therefore helps to increase the overall traffic efficiency on motorways. This in turn leads to less congestion. This solution also means a relief for the driver, which might decrease the necessary rest time. Less congestion and longer travel times at least lead to higher transport efficiency and therefore decreasing costs.

3.2. Customer segment

This use case is aiming especially on hauliers/transport companies and the truck driver as direct beneficiaries. Furthermore the whole traffic system and with this all road users will take advantage of automated truck platooning. According to the passenger car sharing companies special truck as a service providers may occur and therefore the business model of truck OEMs might change in the way that they offer “kilometers instead of vehicles”.

3.3. Value creation partners

The main value creation partners in this use case are the truck manufacturer themselves. But to provide a robust system, all OEMs have to work together with the suppliers and telecommunication providers to define and implement reliable general communication and data exchange standards to provide robust and reliable vehicle to vehicle and vehicle to infrastructure communication. To ensure the use of the potential traffic efficiency increase and also to ensure cross-border compatibility, infrastructure operators (as well as traffic management and other national authorities) need to be taken into account to develop suitable solutions.

3.4. Monetization

According to the passenger car orientated use cases the forwarder such as the truck fleet operator will pay for the technical service by purchasing the vehicle. Also according to the passenger car segment third party providers may offer “truck-sharing” and so the forwarder only pays a usage fee. With respect to traffic management the traffic data collected by the trucks could be sold to the traffic management authorities to offer a more load dependent public traffic control via dynamic gantries which again avoid economic and ecologic losses and damages because of less congestions. Beside this the cost reductions due to lower fuel consumption and emission as well as better usage of road capacity are significant advantages to implement automated truck platooning solutions.

5.1.4 Business model for “The car as digital experience center”

1. General description (use case)

Studies have shown that on average 1.2 billion people spend 50 minutes driving by car per day.[12] Furthermore, commuters waste a lot of time in traffic jams. Commuters in the 25 cities with the highest congestion in Europe loose about 47 hours a year being stuck in traffic[13]. Most autonomous vehicles offer the opportunity to use travelling time for different activities. The multimedia equipment of the future connected and automated car allows using the car as a moving virtual office while driving. The driver could also use travelling time as free time for activities such as surfing in the internet, watching videos/TV as well as using social media platforms. The only interaction between driver and car will be the exchange of the destination he or she wants to go and the “start” command.

2. Set of parameters of the morphological analysis

The following table shows the resulting morphological matrix and the selected set of parameters representing elements of a potential business model.

Parameter	Realization 1	Realization 2	Realization 3	Realization 4	Realization 5	Realization 6	Realization 7
Customer/benificiary	Driver	Co-Driver	Passengers	OEM	Service Provider	Fleet Operators	General public
Functions	Vehicle Telematics	Other Telematics	Navigation	Infotainment	Diagnostics	Driving assistance	
Value Proposition	Driving safety	Driving comfort	Time saving	Cost saving	Information collection	Business process optimization	
Way of vehicle interaction	Driver interaction (driver information; Level 0/1)	Direct vehicle interaction (Level 2)	Direct vehicle interaction (Level 3)	Direct vehicle interaction (Level 4)	Direct vehicle interaction (Level 5)	Independent service/information	
Connectivity Options	Embedded	Tethered	Smartphone integration				
Location dependence	Location based	Location independent					
Vehicle dependence	Vehicle dependent service	Vehicle independent service					
Sensore depence	Vehicle internal sensors	External sensors	Sensor independent				
Hardware	Embedded	Exchangeable	External integration				
Communication Partner	Car	Driver	Mobile Device	Infrastructure	Internet	Home	Enterprise
Automated driving area	Restricted	Semi-restricted	Unrestricted				
Value Adding Partner	OEM	Infotainment supplier	Automotive supplier	Telecommunication-provider	Software provider	Infrastructure operator	Content provider
Marketplace	OEM driven	Software-Platform	Community				
Payment model	One time payment	Subscription fees/flat rate	Pay per use (volume, duration)	Freemium	Third-party financing		
Rights of use	Bound to vehicle	Bound to single user					
Delivery	Vehicle purchase	After sales individual	After sales update				

[12] McKinsey & Company „Car data: paving the way to value-creating mobility“ – Perspective on a new automotive business model, March 2016

[13] Inrix 2016 Traffic Scorecard, Inrix Research, February 2017

3. Business model description

3.1. Product/service/value proposition

As described above the car is dramatically changing its functionality from a transport vehicle to a moving office or living room with the full range of infotainment functionalities from internet services, video and music streaming and e-mail applications to augmented reality points of interest and location based services, where points of interest (such as supermarkets, other retailers, cinemas, museums etc. based on user preferences) will be highlighted during the trip for a spontaneous stop or can be chosen as travel destination. This also effects navigation not only in the way that the car “knows where to go” but also in the way that the car “knows the best way to get there” e.g. regarding time of day, disposable time, road and weather conditions as well as traffic situations or points of interest that should be visited in a certain time scope.

3.2. Customer segment

The group of people that will be most affected by the offer of an “infotainment car” are the car drivers themselves. For them all the named functionalities will offer a real benefit. All other car users will also be affected by that and will be pleased by the realisation of connectivity that will be offered by a lot of OEMs. By adding the automation functionality the driver can also benefit from all the infotainment technology.

3.3. Value creation partners

For this use case to become reality value adding partners from a broad range of disciplines have to work together: Primarily OEMs and automotive suppliers as well as infotainment suppliers to provide the suitable multimedia infrastructure. Telecommunication companies for development and provision of the adequate data exchange systems as well as the communication infrastructure. Software providers are mandatory to develop a multi device mobile operating system and also to develop necessary software applications. Furthermore, providers that will deliver attractive content for the driver and other car occupants have to be involved. All the partners need to work together in a strategic and collaborative way to define and establish standards which are mandatory to deploy CAD and to reach scale effects. Accordingly infrastructure operators also need to be involved to support the build-up of a V2X infrastructure as well as to be a partner in information exchange e.g. of traffic data.

3.4. Monetization

As many-facetted and complex the value creation is as complex are the possibilities of monetization of this vision. To build up and provide the described vision of a car strategic alliances of all the named stakeholders needed. None of them could provide a complex solution without the other. In contrast to other perspectives such as mobility as a service in this case the car still is the center aspect of the business model and therefore the OEM is the major stakeholder to the end-user. The end-user then is paying for all the described features. Some of them will be paid with the car purchase (multimedia interiors, sensors, etc.). Others, especially the content will be paid by different models depending on who is responsible for it. It would be possible that basic internet services, e-mail function or app stores will be provided by a yearly subscription. Other services such as video on demand will be paid per use by defined partners or could be part of the private offline subscription. Navigation services also could be provided as basic with no extra charge or with dynamic features the user will be pay by subscription. Different other combinations like freemium (basic features for free and fee based extended features) could be possible. This depends not only on the content but also on the provider involved and the willingness of the users to pay for the service. Therefore, it has to be further investigated by the implementing partners which payment model will be suitable for which service and which target customer. It can also be presumed that initial payment models will be adjusted or changed completely during time.

5.2 Elaboration of the business models relating to each use case

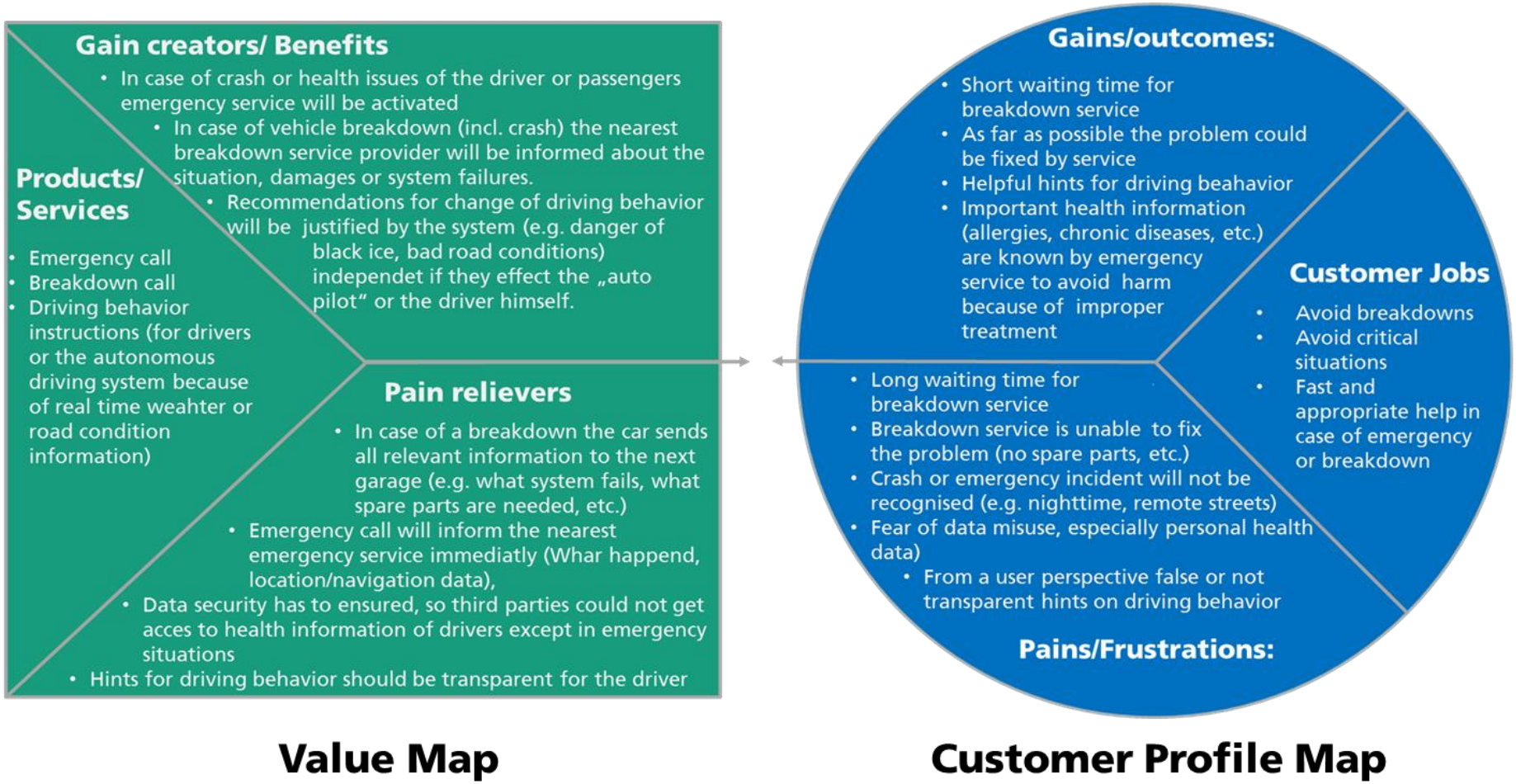
The clustered combinations of business model parameters described in chapter 5.1 will be further detailed by investigation of added values (value proposition defined for each business model), fitting with stakeholder expectations and possibilities to overcome stakeholder restraints. This was done with the method of the value proposition canvas as described in section 2.3. For the product/service and respectively the value proposition of each use case the canvas method is used to investigate the fit between the proposed offers of the business model with the user perspective.

Based on the described product/service and functionalities of each use case, the expectations, gains and restraints of the defined target customers will be described in detail. The value proposition canvas customer profile map is based on information from existing studies and within some creative sessions and own estimations derived from the business model description while the value map is based on the chosen business model parameters and realisation from the morphological analysis.

Afterwards the value proposition will be adjusted (if necessary) to meet the customer expectations and described in detail. Generally, the conclusion of the canvas discussion leads to two types of results. First of all, a more detailed description of the service within the business model is generated and secondly a defined set of requirements for each stakeholder involved in the value creation will be demonstrated.

The results of the value proposition canvas analysis on the business models are shown in the following sections for each of the defined use cases.

5.2.1 Value Proposition Canvas on business models for "Connected maintenance and safety"



Value Map **Customer Profile Map**

5.2.2 Business model for "Connected maintenance and safety" – Stakeholder implications

Table 9 shows a short assumption of the business model elements based on the description in section 5.1.1. In comparison with the value proposition canvas for each value creation, partner/stakeholder implications (requirements and opportunities) have been derived. Beside the business aspects, connected and automated vehicles also have general societal implications that may support or hinder the implementation of these features.

Value creation partner	Service/Product	Target customer	Customer benefit	Monetization
Car manufacturers	Connected automated vehicle • Emergency call • Breakdown call • Predictive maintenance • Driving recommendations	End user	Increasing perceptions of security Cost and time saving regarding maintenance Driving dependent insurance fees	Car purchase Regular fee
Automotive suppliers	Sensors and sensor data processing hardware	Car Manufacturer	Basis for car manufacturers to connected and automated vehicles	Selling components Corporate development
Telecommunication providers	Telecommunication infrastructure Secure data transmission service	Car manufacturer End User	Basis for service provision respectively service availability	Flat rate/subscription fee
Garages/workshops	Enhanced maintenance	End user	Service enhancement, more targeted repair	Service subscription/After sales service of OEM
Breakdown services	Targeted repair service in case of car breakdown	End user	Fast situation dependent help in breakdown situation	Pay per use/Subscription fee
Emergency services	Targeted help in case of emergency	End user	Fast situation dependent help	Free use for drivers

Table 9: Overview of business model elements for "connected maintenance and safety"

5.2.2.1 Implications on end-users (car-owners/drivers)

For car owners and drivers all described benefits could have significant impacts that could gain a certain demand for automated and connected features around maintenance and safety and therefore users would be willing to pay for this service. The type and amount that users are willing to pay could not be identified during this analysis.

5.2.2.2 Implications for car manufacturers/OEMS, garages and breakdown service providers

To provide breakdown and maintenance services as mentioned in the business model a close corporation between the stakeholders is needed. To gain competitive advantage OEMs extend their networks of authorized workshops to enhance the regional service coverage. In contrast it does not seem suitable for each OEM to provide own breakdown service companies. Connected car features should be standardised to enable brand-independent information exchange with existing breakdown services.

5.2.2.3 Implications for car manufacturers/OEMS, automotive suppliers, telecommunication providers

While automotive suppliers (especially Tier1 and Tier2) will be in charge to provide components and systems to realise connected and automated vehicle features close cooperation with OEMs is need. Together with telecommunication providers standards for data modelling and transmission need to be developed to achieve the requested stable and reliable services. Furthermore, investments in (mobile)

communication infrastructure should be harmonised between all stakeholders to ensure reliable ubiquitous communication and service availability as well as data collection and data transmission security. The security aspect will be an especially crucial element to achieve customer's confidence. As an additional business opportunity, the vehicle hardware could gain information for driving recommendations. Furthermore, the information collected in case of a breakdown or emergency could be used to provide and commercialise enhanced traffic management data respectively telematics services by stakeholders. Again cooperation between the stakeholders is needed to increase service efficiency.

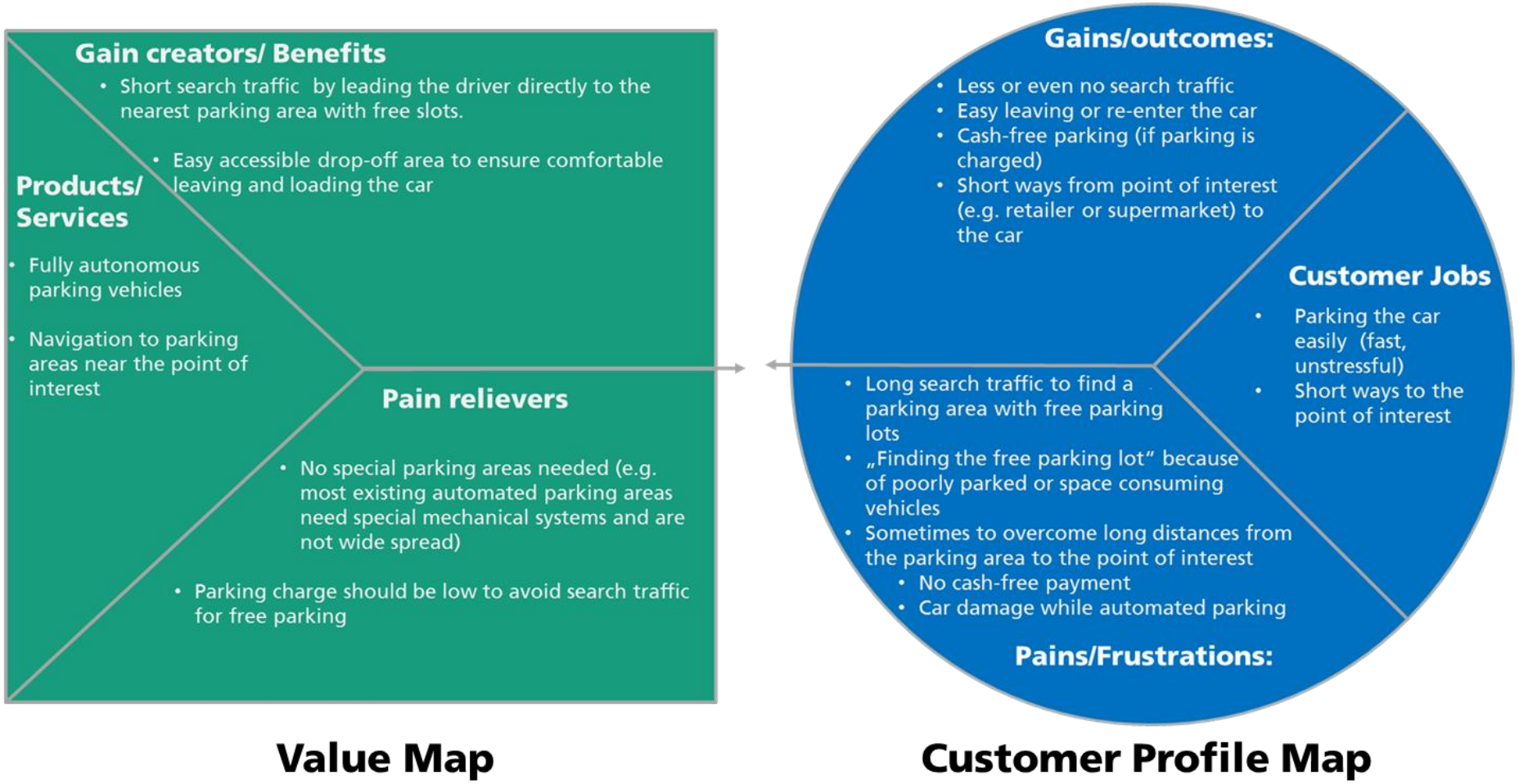
5.2.2.4 Implications for car manufacturers/OEMS, telecommunication providers emergency services

Although the emergency call service is quite defined already cooperation between OEM, telecommunication providers and national and transnational emergency services is needed. To gain full advantage of the technology, the emergency call service (as well as the breakdown service) should be available not only on a regional or national level but also on a European level. In this regard, European standards on data modelling, transmission and security should be developed. Furthermore, to gain a wide regional coverage a broad basis of emergency services needs to be involved in the system.

5.2.2.5 Implications on society

Closely related to the end-user advantages regarding the increase of individual driver safety due to the avoidance of critical situations the social impact of connected maintenance and safety features in vehicles complement to general improvements. Predictive maintenance and condition specific driving recommendations may lead to reduction of sudden breakdowns because of technical failures or the avoidance of critical driving situations. This will lead to less congestion (e.g. fewer accidents) and therefore will increase traffic efficiency. Furthermore, the emergency call system is proposed to reduce the number of people being killed or being seriously injured by car accidents significantly.

5.2.3 Value Proposition Canvas on business models for "Automated valet parking"



5.2.3.1 Business model for "Automated valet parking" – Stakeholder implications

The assumption of the business model elements based on the description in section 5.1.2 is given in Table 10. The comparison with the value proposition canvas will lead to specific implications (requirements and opportunities) for each value creation partner/stakeholder respectively the relations between them. Beside the stakeholder specific implications, societal implications of the implementation of the use case will be described

Value creation partner	Service/Product	Target customer	Customer benefit	Monetization
car manufacturers/OEM	Connected automated vehicle (at least level 4)	End user (driver)	Relaxed and time saving parking close to point of interest	Car purchase/-car sharing fee
Automotive suppliers	Hardware components and systems to realise connected and automated vehicles	OEM Parking area providers	Provision of connect automated vehicles	Cooperative development/purchase
Parking area provider	Automated valet parking	End users (driver)	Well organized and safe parking	Pay per use for parking (maybe a little higher than actual fees as long as the service is new)
Application/Software providers/Content providers (Navigation map providers)	Location based service on parking information	End users (driver)	Exoneration from search traffic, close connection to point of interest	Subscription fee - App integration in navigation map (car internal or on mobile device)/ Stand-alone mobile service
Telecommunication providers	Providing safe and stable mobile communication infrastructure	OEM/Automotive suppliers End user (driver)	Ubiquitous availability of location based parking information	Subscription fee or pay per use

Table 10: Overview of business model elements for "automated valet parking"

5.2.3.2 Implications on End-Users (Car-owners/Drivers)

In contrast to the use case "Connected maintenance and safety" within this use case the benefits for car owners and drivers are related to comfort aspects. While the willingness to pay for automated valet parking itself will not be doubted, it must be questioned if such a service will be attractive enough to gain automated vehicle demand if the automated features lead to significant increase in vehicle prices.

5.2.3.3 Implications for car manufacturers/OEMS and automotive suppliers

To make this service available fully automated vehicles are recommended (at least Automation Level 4), driving at low speed in a certain restricted area. To support this automation level infrastructure technology within the parking area is needed. Furthermore, interfaces to mobile devices such as mobile Apps are needed to support payment on one hand and to offer automated valet parking control to the user on the other hand. If automated driving features are linked with infrastructure technology it is important for OEMs and system suppliers to cooperate close together to avoid proprietary solutions. While such stand-alone automated valet parking solutions within restricted parking areas will be the first step to gain broad acceptance by end-users, standardisation is needed to offer brand-independent interoperability.

5.2.3.4 Implications for car manufacturers/OEMS and App-/Software providers (inkl. Navigation map providers)

Automated parking features need to be triggered within the parking area. Therefore software applications on mobile devices are an adequate solution. While OEMs are not experts in App-development cooperation with software/App developers are needed and secure interfaces between mobile devices and the vehicle control are important. Especially the security aspect is crucial to ensure that no misuse or manipulation occurs and to gain user acceptance.

Beside the automated driving aspect, the information aspect is of same importance to develop the full performance potential. The integration of location based parking information (e.g. free parking space near point of interest) in navigation maps will enhance the automated parking service to another level and offer full customer benefits.

5.2.3.5 Implications for parking area providers (and navigation map providers)

Beside the car users also parking area providers gain significant benefits of automated valet parking. The biggest advantage is the reduction of space needed for parking. Automated parking offers the opportunity that cars could park closer together, allowing for as much as a 20 % increase in the number of vehicles that can be accommodated in the same space. Additionally, the precise automated guidance eliminates the risk of damage to infrastructure due to careless driving. On the other hand investments are needed by the parking area provider to retrofit existing parking areas by integration of infrastructure sensors and communication technology. Therefore, the cooperation with car manufacturers and their suppliers as well as software developers (e. g. payment and management systems) is needed.

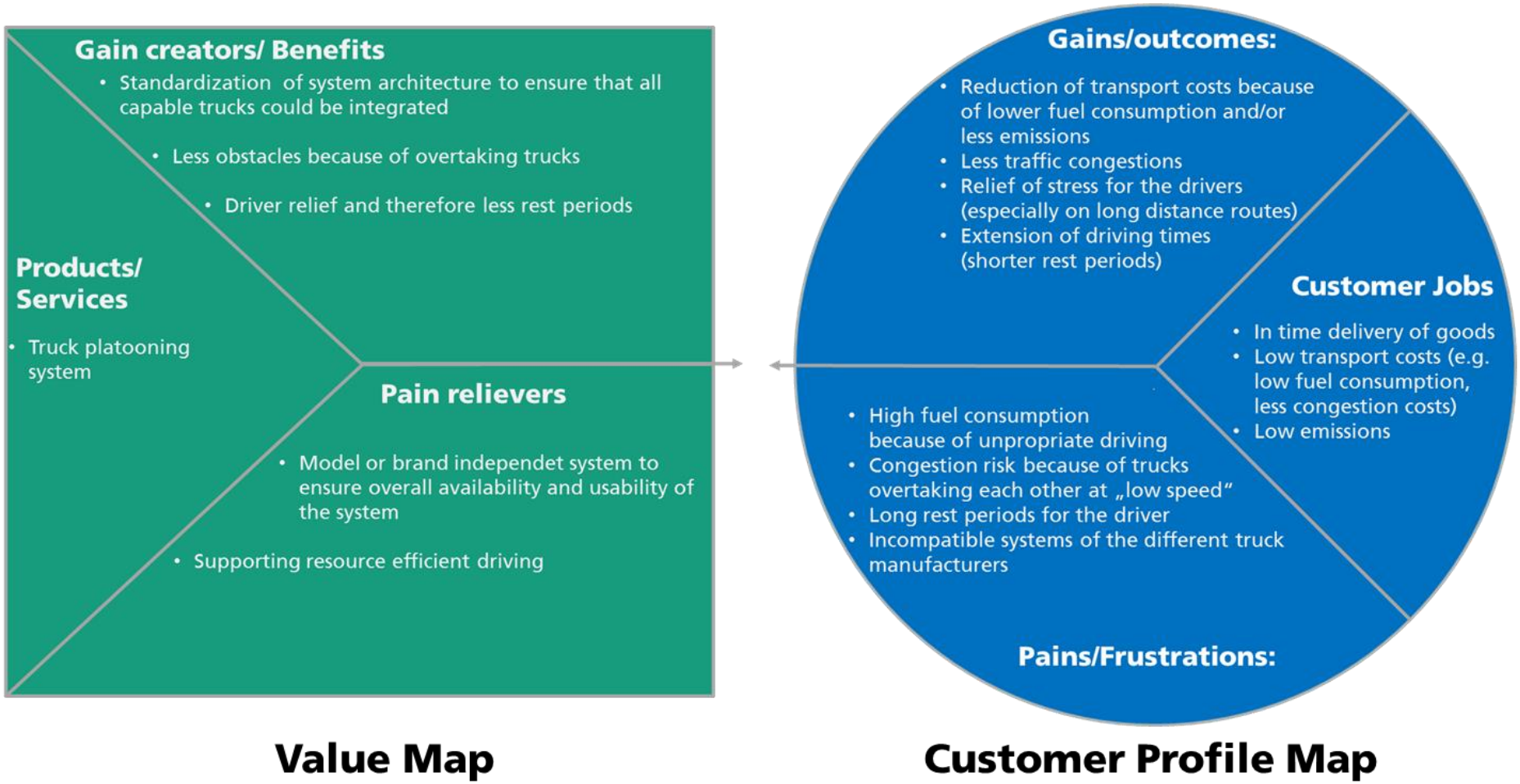
Furthermore, strategic cooperation with navigation solution providers are needed to integrate parking area providers in navigation maps to offer location based information of free parking opportunities. This enhanced navigation information could be offered directly by big parking area operators (via App connected with navigation map) or will be integrated in the navigation solution. The stand-alone App offers the opportunity to gain attention (if it is a free offer) for certain parking area operators and will gain revenue not only for parking but also for the provision of the App.

5.2.3.6 Implications on society

Beside the economic benefits for the stakeholders mentioned above the realisation of automated valet parking has some significant implications also regarding traffic efficiency and land use in general. The reduction of parking space for existing parking areas will raise their efficiency and according to that will reduce the demand on land capacity for new parking areas in and around cities.

Furthermore, the location based navigation to parking areas will increase traffic efficiency in cities and metropolitan areas by reducing search traffic for parking.

5.2.4 Value Proposition Canvas on business models for "Automated truck platooning on motorways"



Value Map **Customer Profile Map**

5.2.4.1 Business model for "Automated truck platooning on motorways" – Stakeholder implications

The assumption of the business model elements shown in Table 11 is based on the description in section 5.1.3 enhanced with aspects from the value proposition analysis. The advanced description assumes the implications (requirements and opportunities) for each value creation partner/stakeholder as well as the relations between them derived from the value proposition canvas. Beside the stakeholder specific implications, societal implications of the implementation of the use case will be described.

Value creation partner	Service/Product	Target customer	Customer benefit	Monetization
Truck manufacturers/OEM	Automated vehicles on automation level 3 or higher	Hauliers	Reduction of fuel and emission consumption (cost saving) Reducing of driver rest periods (increase in transport efficiency)	Truck purchase (Usage fee in case of "transport as a service")
Automotive suppliers	Provision of components and systems for realisation of connected and automated trucks	OEM	Provision of connect automated vehicles	Cooperative development/purchase
ICT providers	Providing safe and stable mobile communication between vehicles and road infrastructure	OEM Hauliers Infrastructure operators	Supporting robust truck platooning services by vehicle to x – communication	Cooperative development Subscription fee/ pay per use
Content providers (Navigation)	Real time routing based on traffic information	Truck drivers (hauliers) Passenger car drivers	Route optimization based on real time traffic information	Subscription fee /pay per use for enhanced traffic information
Infrastructure operators/	Traffic information	Drivers (trucks and passenger cars) Navigation solution providers Infrastructure operators themselves	Increasing traffic efficiency	Selling traffic information Owner-occupation of traffic information for traffic management

Table 11: Overview of business model elements for „Automated truck platooning on motorways"

5.2.4.2 Implications on hauliers

In contrast to the other business model analysis, the effects on end-users such as the hauliers within this use case could actually be determined as quite high. It is presumed that the reduction of fuel and emission consumption will lead to cost reductions up to 10 to 15 %[14]. Of same or even more importance could be the impact on extended driving time and with that the reduction of rest periods for truck drivers. The increase in transportation speed and efficiency will be interesting business opportunities for hauliers. Beside this the gentle operation of trucks also would lead to longer vehicle lifetime and the reduction of maintenance cost. Increasing prices for vehicles with connected and automated features therefore will be tolerated to a certain point.

5.2.4.3 Implications for truck manufacturers/OEMS and automotive suppliers

To reduce driver rest periods, automated driving features of level 4 are needed, while all other aspects may be realised in less pronounced way with automation level 3. Additionally, to gain full system advantage for truck manufacturers and their suppliers it is mandatory to cooperate regarding the development of truck platooning systems. Although there is the possibility to realise brand specific solutions to realise all aspects of customer benefits truck platooning systems need to be company and

[14] Automated Driving Roadmap; ERTRAC Working Group „Connectivity and Automated Driving"; Version .5.0; July 2015

brand independent to increase the availability and usability of the system. Therefore standards e.g. hardware interface and data models have to be developed. Furthermore, close cooperation with ICT-providers as well as infrastructure operators such as traffic management authorities should be involved in the standardisation process. From the European perspective standardisation is also needed to ensure cross-border availability for automated truck platooning.

5.2.4.4 Implications for ICT providers and content providers

As mentioned in section 5.2.4.3 standardisation is one main issue to ensure brand and model independent truck platooning features as well as cross-border service availability. While the vehicle to vehicle communication within the platoon could be realised via nearfield communication technologies communication between vehicles and infrastructure may refer to mobile communication channels. Because of vehicle infrastructure communication as well as maybe vehicle to vehicle communication telecommunication providers could have the opportunity to use the platoon traffic data and merge them with other sources to provide enhanced telematics and navigation information. That could be used by public traffic management authorities as well as third party navigation content providers. Furthermore, the telecommunication company itself could act as market player for traffic information.

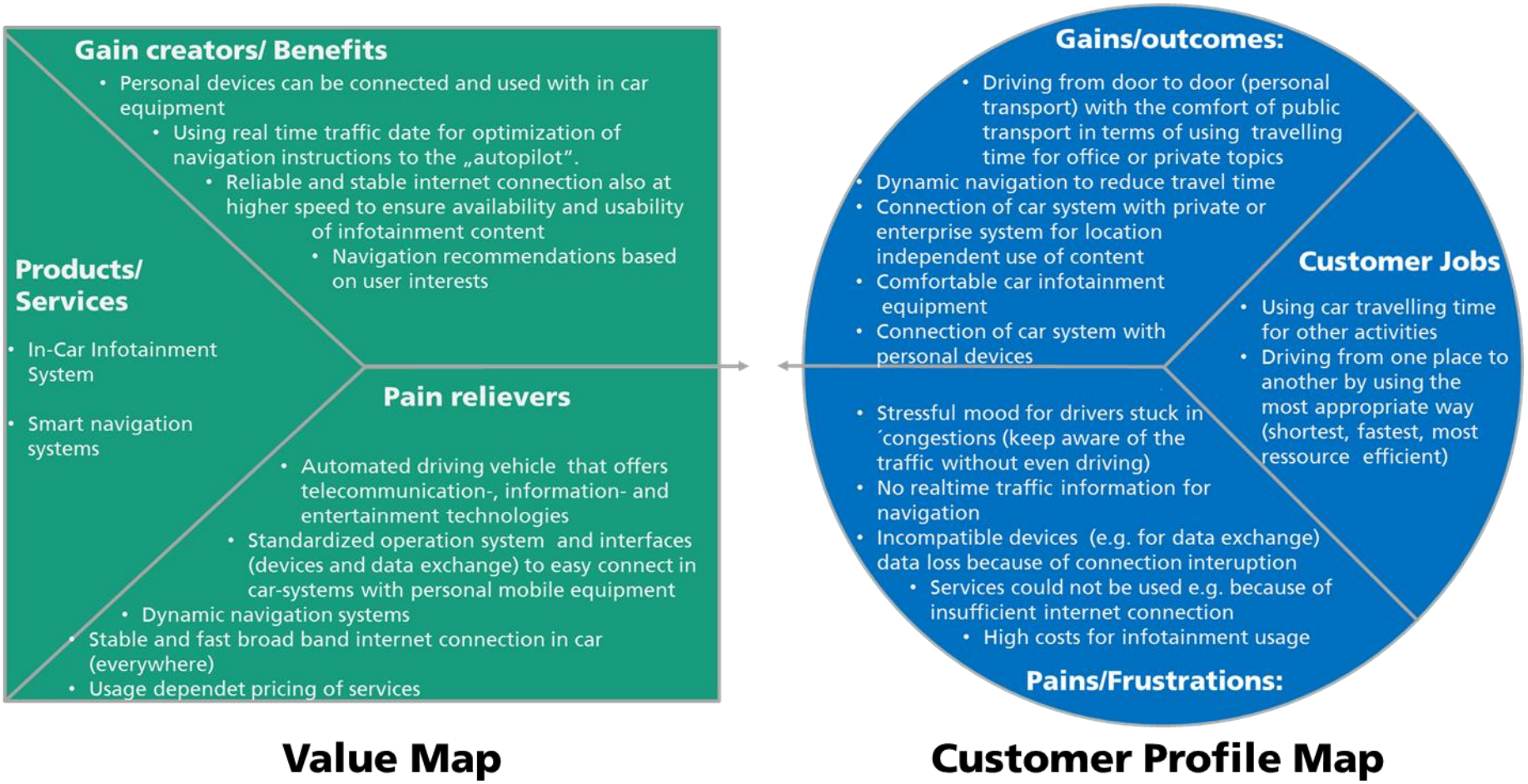
5.2.4.5 Implications for infrastructure operators

Similar to hauliers that will gain a direct financial benefit, road infrastructure operators will have a strong interest in the implementation of automated truck platooning solution. With continuously increasing road transport of freight as well as passenger cars and limited financial resources for investment in network expansion the road infrastructure is more and more reaching its capacity limits. Automated truck platooning offers the opportunity of a more efficient usage of road capacity and the improvement of traffic flows without any investments in cost and time intensive road construction.

5.2.4.6 Implications on society

Linked directly to the benefits of hauliers and infrastructure operators, the implementation of automated truck platooning addresses all three important characteristics of future road transport: clean, safe and efficient. Lower fuel consumption because of e.g. driving at constant speed with less braking and acceleration maneuvers could reduce CO2 emissions by up to 10 %. Furthermore, with truck platooning, accidents due to human error could be decreased (real low reaction time, no lack of concentration). Furthermore, due to the predictive driving behaviour of trucks within the platoon the safety of other road users will be improved by minimizing the risks of accidents because of impropriate driving behaviour. Additionally, the same factors as mentioned in section 5.2.4.5 such as reducing emissions and increasing safety will lead to an increase in efficiency in road capacity, less congestions and the improvement of traffic flow.

5.2.5 Value Proposition Canvas on business models for “The car as digital experience center”



Value Map **Customer Profile Map**

5.2.5.1 Business model for "The car as digital experience center"– Stakeholder implications

The assumption of the business model elements shown in Table 12 is based on the description in section 5.1.4 enhanced with aspects from the value proposition analysis. The further description assumes the implications (requirements and opportunities) for each target customer and value creation partner/stakeholder respectively the relations between them derived from the value proposition canvas. Beside the stakeholder specific implications, societal implications of the implementation of the use case will be described

Value creation partner	Service/Product	Target customer	Customer benefit	Monetization
Truck manufacturers/OEM	Fully connected and automated vehicle	Car owner, driver	Door to door mobility while using driving time for other activities; moving office or home	Car purchase
Automotive suppliers	Provision of components and systems	OEM	Provision of connect automated vehicles	Cooperative development/purchase
Telecommunication suppliers	Providing secure and stable mobile communication infrastructure with high bandwidth	OEM/Automotive suppliers End user (Driver)	Ubiquitous availability of content (streaming, location based services, etc.)	Subscription fee or pay per use
Infotainment suppliers	Systems and components for infotainment presentation	OEM Car owner/driver and passengers	Provision of multimedia infotainment equipment	Cooperative development/purchase (OEM) After Sales service/upgrade (Car owner)
Content providers	Streaming services,; navigation maps and services (location and situation based information)	OEM Car owner/driver	Provision of user based content	Subscription fee (internet services) Pay per use (streaming) Freemium (navigation)
Software provider	Provision of multi device mobile operating system, specific software applications	OEM Infotainment suppliers Car owner, driver	Interoperability of services and devices	Cooperative development/purchase (OEM)
Infrastructure operators	Supporting the provision of vehicle to infrastructure communication components	OEM	Supporting ubiquitous connectivity and vehicle automation by provision of communication components (e.g. sensors, transmitters)	?

Table 12: Overview of business model elements for "The car as digital experience center"

5.2.5.2 Implications on car owners/drivers

For drivers in general this vision of CAD will lead to a door to door flexible mobility with the comfort feature of public transport to use traveling time for office or private topics and beyond. So the connectivity of the car system (also via mobile devices) with private or office systems offer location independent use of content while driving. Furthermore, navigation and routing could be optimized depending on the user preferences with respect to e.g. time, traffic situation, road and weather conditions, as well as points of interest along the way.

5.2.5.3 Implications for OEMS and automotive suppliers

Within the center of this vision is the vehicle and therefore the OEMs and their suppliers to provide a fully connected and automated vehicle (level 5) offering the whole range of telecommunication-, information and entertainment technologies, as well as in-car systems. Some of those features are already beyond the competence zone of car manufacturers. This means more and more cooperation as well as coopetition with other stakeholders from different sectors are needed to provide broad knowledge regarding the technical solutions. Within this business model connectivity and automation will be a competitive factor for the car manufacturers. Nevertheless they need to work directly together or via suppliers to define standards in fields of operating systems as well as communication and data processing. One big challenge for car manufactures will be the pricing of connected and automated features. Although there is and will be an increase in willingness to pay especially for connected but also for automated driving features this will be a crucial point for dissemination of connected and automated vehicles. To gain a significant amount of vehicles in use and therefore the societal benefit like increasing road safety and traffic flow as well as more efficient traffic management the prices for vehicles with connected and automated features should not increase considerably.

5.2.5.4 Implications for telecommunication suppliers (and infrastructure operators)

To provide all mentioned features such as V2I communication, streaming and location based services while travelling a secure, reliable and stable wireless internet connection is needed that has to be provided by telecommunication suppliers to moderate prices. However, telecommunication companies do not only want to provide the communication “line” but also try to provide paid content to users. Due to the adequate monitoring of data such as the traveling destination and the location data of the vehicle, there telematics information e.g. real time navigation information can be combined with other products of the telecommunication suppliers. This will gain revenue forwarding this information to navigation content providers or public traffic management authorities. Furthermore, the telco suppliers are one of the main players to realise standardisation concerning communication protocols, data transmission, data security and the further development of high speed mobile connections. Cooperation with infrastructure operators is also needed to integrate and update V2I systems and components into existing infrastructure elements (e.g. traffic lights, environmental sensors).

5.2.5.5 Implications for infotainment, content and software suppliers

Standardisation and interoperability are main issues that infotainment and content suppliers have to deal with. Therefore, especially navigation data and routing based on real time traffic situation information will be a significant benefit for users. Information such as travel destination, truck platooning information as well as the amount of connected vehicles that are in use in combination with traffic prediction simulation solutions, the traffic forecast can be improved and can be offered to optimise routing information. One possible business extension could be to charge the user for certain enhancements of e.g. the navigation service, such as real time navigation.

5.2.5.6 Implications on society

As mentioned before CAD is proposed to increase traffic safety, traffic efficiency as well as traffic flow and reduce emissions. Furthermore, a flexible of door to door mobility which is available at all times is combined with the opportunity to use travel time for other activities. As long as car ownership preferences are not changing in society, public transport will be put under high pressure because it will lose one of its main advantages towards travelling by car.

On the other hand if (as it tends to be in different countries and especially younger people in metropolitan areas) car ownership will lose its preferences the situation will be totally different. However this will then affect the OEMs in a significant manner: The described vision of a highly comfortable vehicle used for transport as well as for working and as a private environment will not be

enforceable because the willingness to pay for such cars on the end-user side will be quite low. If infotainment and mobile content providers bound their services to users and not to a certain device connected infotainment features of cars could be still attractive for them. It will then be more interesting to have interfaces between the own mobile device and the car for a more comfortable use. If all infotainment and navigation features in this way will be bound in the future to the user or respectively their mobile device the connected and automated car will become only the interface to use this while traveling. With this car mobility will transform to mobility as a service similar to today's car sharing just with some additional features like "robot chauffeurs" driving the car to the customer.

This could lead to an increase in the amount of passenger cars on the roads, with which the advantages and benefits of CAD could be countervailed.

6 Conclusion

The implementation of CAD will lead to a significant change in the mobility landscape especially in the vehicle manufacturing industry. As digitalization does in other industry sectors technologies established value chains will break up or will be enhanced by new services. In this context new business models for value creation in the automotive ecosystem need to be developed.

On the other hand there's no clear view of how automated and connected road transport will look like in the future. Technical progress will influence a lot of different realisations of a broad range of parameters that will form business model opportunities, some of them might not be seen yet.

The described approach was to first focus on defined use cases, representing exemplary future implementations of CAD to help clustering business model opportunities. However, the business models need to be detailed further and specified in practice.

Beside this, one main outcome of the business model analysis is the fact that in all use cases different stakeholders with specific competencies are part of the value creation process. This shows the relevance of the formation of strategic alliances of relevant stakeholders to provide the necessary technology basis for CAD. Within this the roles of the partners depend on the technological topic and the main competencies of the different stakeholders.

However, CAD is not only about vehicle and infrastructure technology. Especially the overall vision of mobility as a service will not only affect the car manufacturing industry. It will also rearrange the system of urban public transport and could initially have effects on increasing vehicle traffic which require also the collaboration with public and national traffic management and infrastructure operators. All stakeholders need to work together to utilise the advantages of CAD to increase road transport efficiency.

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