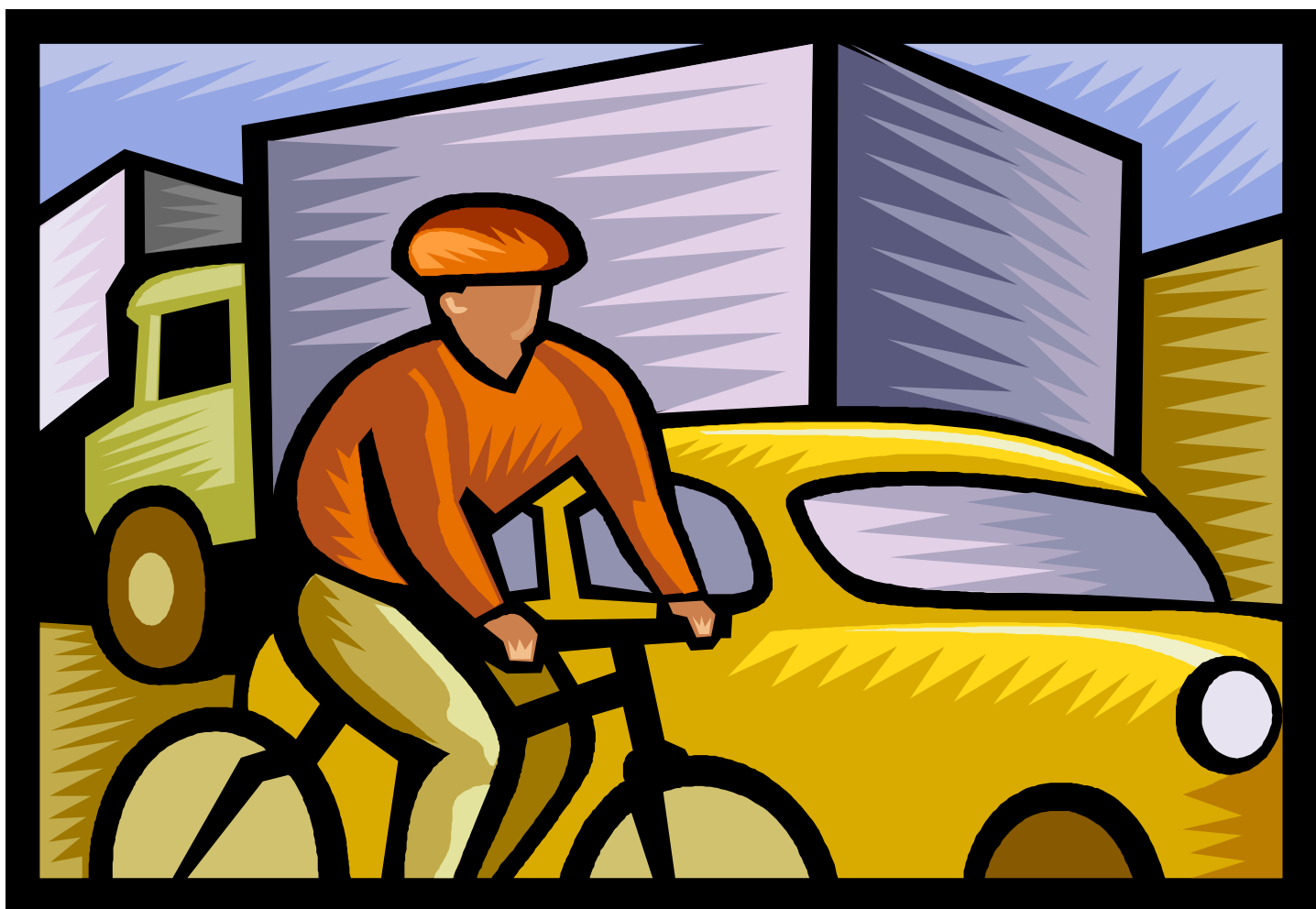


# BADA Business models state-of-the-art report

Vinnova-FFI

Version 1.0



**FFI** Fordonsstrategisk  
Forskning och  
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VINNOVA

Energimyndigheten

TRAFIKVERKET



SCANIA VOLVO

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## Glossary

Table 1 - Glossary

Term	Definition
ACEA	European Automobile Manufacturers Association
AD	Atonomous Driving
ADAS	Advanced Driver Assistance Systems
APN	Access Point Name – The gateway between GSM network and Internet.
ASFA	French Motorway companies association
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft" which is German for "Autobahn and high way financing stock corporation
CAGR	The Compound Annual Growth Rate (CAGR) is the mean annual growth rate of an investment over a specified period of time longer than one year.
CAN	Controller Area Network – Communication protocol commonly used in vehicles
Cybersecurity	The protection of information systems from theft or damage to the hardware, the software, and to the information on them, as well as from disruption or misdirection of the services they provide
ECU	Electronic Control Unit
FCD	Floating Car Data
FMS	Fleet Management Services
Head Unit	The control centre and user interface for an automobile's entertainment centre, which typically resides in the centre of the dashboard. It provides the main controls for the radios (any combination of AM, FM, XM, Sirius, HD Radio) as well as a CD/DVD player, GPS navigation, Bluetooth cell phone integration, hard disk storage for music and iPod connector. There may be auxiliary controls on the steering wheel.
IPR	Intellectual Property Rights
MNO	Mobile Network Operator
NSC	National Sales Company
NIST	National Institute of Standards and Technology is an organisation run by US trade department
OBD-II	On-board Diagnostics, version two. A vehicle's self-diagnostic and reporting system which uses a standardized digital communications port to provide real-time data and a standardized series of diagnostic trouble codes.
ODPI	Open Data Platform Initiative, ODPi will accelerate the delivery of Big Data solutions by driving interoperability
OEM	Original Equipment Manufacturer (often used for the Vehicle Manufacturers)
OTA	Over-the-Air

PSAP	Public-Safety Answering point
SIM	Subscriber Identity Module – unique identity for a unit in a mobile network
STA	Swedish Transport Administration (Trafikverket)
TMC	Traffic Management Centre
TCU	Telematics Control Unit
TSP	Telematics Service Provider
VMS	Variable Message Sign
Wi-Fi	The standard wireless local area network (WLAN) technology for connecting computers and electronic devices to each other and to the Internet. Every laptop, tablet and smartphone comes with Wi-Fi. Wi-Fi is an IEEE standard with the official designation of 802.11. In the early 2000s, 802.11b was the first popular version, followed by 11a, 11g and 11n. The latest is 11ac (see 802.11ac).

## 1 Abstract

The automotive industry is facing a revolution, and today's standalone vehicle can potentially be replaced by an ecosystem of co-existing transport units. In this ecosystem, it is decisive to have the ability to control the system and manage data, not to focus on individual vehicles. At the same time all vehicles will act as multiple sensors in the road network, collecting huge amounts of data that can be combined with other types of data and used for a wide variety of purposes. The great challenge for society and the automotive industry is to benefit from these new possibilities and meet the trends of Big Data Analytics.

This state-of-the-art report starts with a brief history of the evolving market of Telematics and the Connected Car. The Connected Car Ecosystem is an enabler of large amounts of data and business development built on data and data analytics. There are multiple ways to view the Connected Car Ecosystem, the actors involved, services enabled, etc. and a few of them are shown in the report. The business related to the Connected Car Ecosystem is expected to grow quickly in the coming years and actors have to identify their role and take positions. Actors include Vehicle OEMs, Mobile Network Operators, Content Providers, On-board System Providers, Telematics Service Providers, Traffic Management Centres, Road Operators and new roles as Big Data Analyzers and Mobility Providers.

The integration platform is the heart of the ecosystem, but it is important to understand the level of integration necessary for enabling business opportunities. One can argue that Big Data Analytics has been around for a while, but the importance of analyzing big data both as large amounts of historical data and in real time, will definitely grow with the increasing amount of data collected from all kind of connected devices including vehicles. Services for mobility is one area that will benefit from connected vehicles and big data analytics. Crowdsourcing, Mobility-as-a-Service and the development of sharing economy are new areas that will influence the development of new business models.

Business models can be seen as the answer to the questions: Who is your customer; what does the customer value; and, how do you deliver value at an appropriate cost? At the end of the day, the goal for a commercial company is to earn enough money to generate a profit. A governmental organization, such as the Swedish Transport Administration, also has a business model, even though the goals are traffic safety, less environmental impact and improved traffic flow. Figures showing Revenue Flow with Value Propositions, Actors, Resources and Cost Structure are included in the report and these figures visualize money flow and data flow for some of the current business models.

Public Authorities do have an important role also in the future, but it will be more and more important to cooperate with other actors in the whole ecosystem to be able to provide traffic management, traffic information and other information to the travellers. This is specifically true when it comes to the collection and processing of large amounts of data necessary for efficient traffic management.

## FFI – Big Automotive Data Analytics

Last but not least, laws and regulations set the basis for business based on connected vehicles and big data analytics. Integrity and privacy are fundamentals that all actors have to relate to.

## 2 Introduction

### 2.1 Prerequisites and background

The automotive industry is facing a revolution, and today's standalone vehicle can potentially be replaced by an ecosystem of co-existing transport units. In this ecosystem, it is decisive to have the ability to control the system and manage data, not to focus on individual vehicles. At the same time all vehicles will act as multiple sensors in the road network, collecting huge amounts of data that can be combined with other types of data and used for a wide variety of purposes. The great challenge for society and the automotive industry is to benefit from these new possibilities and meet the trends of Big Data Analytics.

### 2.2 Overall goal and purpose with big data analytics in the transport sector

At the end of the day the goal for the vehicle OEMs are higher revenue and higher profit margins, while the overall goal for public authorities as Swedish Transport Administration are fewer vehicle-related deaths and injuries, lower harmful emissions and improved traffic flow.

### 2.3 The aim of work package BADA Business models

Each of the partners in the BADA project, including Swedish Transport Administration, has its own business model which is representative of the business area it represents (i.e. automobile OEMs for Volvo Cars, truck/bus OEMs for Volvo Technology and Scania, national road administrations for Swedish Transport Administration). At present, none of the project team members is in a business directly related to Big Data. There is, however, the possibility that as a result of this project work, one or more members of the team will realize there is a business which it can enter that is based on Big Data. Whether this is an implicit or explicit goal of participation is up to each of the members, but it is not the goal of this work package to identify business opportunities. It is to identify how Big Data can reinforce the current business models, or perhaps lead to modifications in the current business models, that will result in better performance on the important indicators of success. In the case of the vehicle OEMs, success results in higher revenue and higher profit margins. In the case of Swedish Transport Administration, success results in fewer vehicle-related deaths and injuries, lower harmful emissions and improved traffic flow.

### 2.4 Scope and delimitations

For the automotive industry Big Data Analytics can be used in a number of different areas. Computer Sciences Corporation has identified the following areas: Conceptual Design, Drawing Board, Procurement, Manufacturing, Marketing, Finance, Performance, Service and Aftermarket. Most of these areas are out of scope for BADA as the focus in BADA is business models for exchange and use of data and Big Data Analytics within road transport and traffic, i.e. when the car has left the factory. Our focus is therefore part of the three areas Performance, Service and aftermarket listed above.

Out of scope is also:

- Transportation on rail, on sea and in air
- The use of data in public transport
- The use of data for optimization of freight

Data from all kinds of sources can be of interest when optimizing road transport and traffic. All roles, actors and business models that currently are involved in businesses around this, are of interest in this study. This means that data from a broad spectrum of sources are of interest, e.g. vehicle sensors, mobile phones and networks, road side equipment, social media, etc.

Big Data can be used directly in real time in support safe, smooth and environmental friendly traffic, which is the focus in this report. Another way of using Big Data with the same goals is by analysing historical data to find trends, dependencies, optimizing the infrastructure, etc. This second way of using Big Data with the same goals was covered in the pre-study and will be more covered in the next phase of the project.

## 2.5 BADA Use Cases

BADA Use Cases are:

- Traffic Safety
- Vehicle- and environmental data for analysing purposes
- Data sharing between clouds
- The vehicles as information seekers
- Optimization of transports

The Use Cases define the scope for BADA and it is necessary to have all use cases in mind when describing roles and actors in the Connected Car Ecosystem and possible business models related to the Ecosystem.

## 3 A brief history of the evolving market of Telematics and the Connected Car

### 3.1 Introduction

Push-the-button safety, security and convenience services represent the early, first stage of the connected car with data passing both from and to the vehicle. As a primary customer offering, and a presumptive supplementary cash generator, these services did not prove to be successful for any of the companies involved in their delivery, including OEMs and device manufacturers, network operators, service and content providers or telematics service providers, like WirelessCar, who deliver connectivity, customer management and service integration.

Compared to navigation systems, which eventually delivered real profits to vehicle OEMs, system developers and map data suppliers, the early telematics systems and services were a disappointment. This is because the telematics offerings were not perceived by prospective customers as more compelling than other options, such as navigation systems, and the value proposition (i.e. what telematics systems were replacing with a better alternative) was not clearly explained in the OEMs' marketing campaigns or at the point of sale. This was also the case when navigation systems were introduced in 1995. Dealers made higher margins on sun roofs and other options, and they knew they would have fewer complaints from customers after the sale. It was only when customers began to demand navigation systems—when they understood the value proposition better than the dealers—and when the systems became more dependable and the databases covered larger areas, that the dealers began to promote them. Neither the dealers nor the customers—nor the OEMs for that matter—were able to clearly state the value proposition for telematics during the first ten years of their existence, and why the customers should pay for the systems or the fees for their use.

### 3.2 The Start of the Connected Car

Part of the reason for this was the way early telematics systems were initially conceived and then promoted inside the car companies. Telematics systems were engineering-driven, not market driven. As opposed to navigation systems, in which marketing and product development departments played key roles in their conception and introduction in the mid-1990's, telematics boxes with positioning and communications technology were seen by some engineering departments as security system enhancements. Instead of a simple car alarm, telematics systems would be able to relay the exact position of the vehicle at the time of a break-in, and security services would be able to follow the car if it was stolen. This was the case with Volvo Cars, where the Security Systems department financed the initial efforts to build prototypes and develop the service provision network.

Ford with its RESCU system, General Motors with its OnStar system and Mercedes-Benz with its TeleAID system were more concerned with sending out a distress signal from the vehicle in case of an accident or a car-jacking. Other OEMs, like BMW,

viewed the addition of a telecommunications device to their navigation system, which already had positioning capabilities, as a logical extension and the means to add new customer convenience services. Safety and security were secondary for BMW.



*First Volvo On Call system. (Source Volvo Cars)*

In order to enhance the value proposition, initiatives started in the US and Europe to provide integrated, hands-free telephones, either to prepare for possible legislation restricting mobile phone use in vehicles, or to capture revenue as a virtual private network operator as OnStar did. Volvo Cars combined its hands-free telephone with the telematics box into a single offering, and the Volvo On Call telematics option was offered as an add-on to the telephone.

The idea of requiring a separate business unit to develop and manage services was an afterthought in most cases. GM was an exception from the outset to this division of responsibility. GM created OnStar as a separate subsidiary to provide telematics services to all of its brands. Some believe that OnStar was created in order to offer a brand-neutral service, while others believe that it was intentionally separated from the brands for liability reasons. That is, if OnStar was sued, the brand names would not be tarnished. GM started to offer OnStar to Cadillac customers in 1996, and has since made OnStar a standard offering in most of its brands' models, with the hands-free telephone, emergency and breakdown assistance components standard parts of the service. GM provides the OnStar equipment as a standard factory fit (i.e. free) in the majority of its brands' models, and the standard services are free for the first year. The telephone works with pre-paid telephone minutes, so the customer can either use it or ignore it. Premium services, like route planning and traffic information, or personal assistance services, can be added by the customer to the service offering at any time.

The other part of the problem for telematics systems is that they were the subject of oversimplification of the technical difficulties, and overselling by the financial markets. First, the overselling issue. External forces (i.e. non-automotive) took over the telematics concept in the late stages of the dot.com era. Telematics was projected by financial analysts to be the next big expansion area for the IT and telecommunications industries. It was also promoted as being the next large money-maker for the automotive OEMs, like the financial services business they had entered a few decades earlier and which by the late 1990s accounted for a large percentage of their profits. Telematics, it was said, would generate double-digit growth for an industry that had grown accustomed to single-digits or less. Ford Motor Company, under its former CEO Jacques Nasser, was the principal promoter of automotive companies re-engineering themselves into information technology companies. Telematics, he claimed, was Ford's future.

Unfortunately, Ford and several other OEMs underestimated the cost of creating the necessary infrastructure to support the full range of mobile services they were

promising. The communications technology lacked the bandwidth. In the pre-smartphone era, there were very few applications that could run effectively in a vehicle environment. It was simply too early.

In the post-dot.com environment, the telematics industry began searching for applications that could unite the OEM's engineering and marketing organisations. It started to promote applications that focused on the benefits of the communications systems in the vehicles, such as remote diagnostics and customer relationship management (CRM). But even these types of applications, as useful as they are, were not enough to support telematics as a standard fit in all cars.

On the technical oversimplification issue, the OEMs' engineering departments lacked the broad range of experience needed to integrate a telephone module in a vehicle environment, and the telecommunications industry had little or no appreciation for or understanding of the automotive business. It took over a decade of trial and error for both of these groups to have sufficient know-how to work together and deliver working solutions.

### 3.3 The Future of the Connected Car

In spite of all difficulties, the concept of telematics and the connected car survived. What occurred with telematics, roughly from mid-1995 when GM, Ford and BMW introduced the first systems, up until approximately 2010, was only a prelude to what was to come. All of the actors in the supply chain (i.e. all those who were still in the business and were determined to remain in it) had learned what it really takes to build a communications device into a vehicle, to make it work in all circumstances and under all conditions, and to manage the complete life cycle process for the combination of a telecommunications device installed in a vehicle and the owner/driver of that vehicle.

From 2010 until today, many car OEMs refined their connected car infrastructures in order to broaden the service offerings for their customers and to increase the benefits that they can derive for their businesses from the vehicle data. BMW moved through a series of steps in which it first separated its diagnostics data stream from its telematics and infotainment flow. Then, with the assistance of WirelessCar and SEI, an IT consultancy, BMW separated the vehicle communications component, called the dispatcher, from the back-end servers, dropped its long-time TSP, ATX, and moved all of the back-end operations to WirelessCar. Finally, it moved the back-end servers in-house so that today, it has in-sourced all of its connected car operations except for its eCall, bCall and iCall operator services.

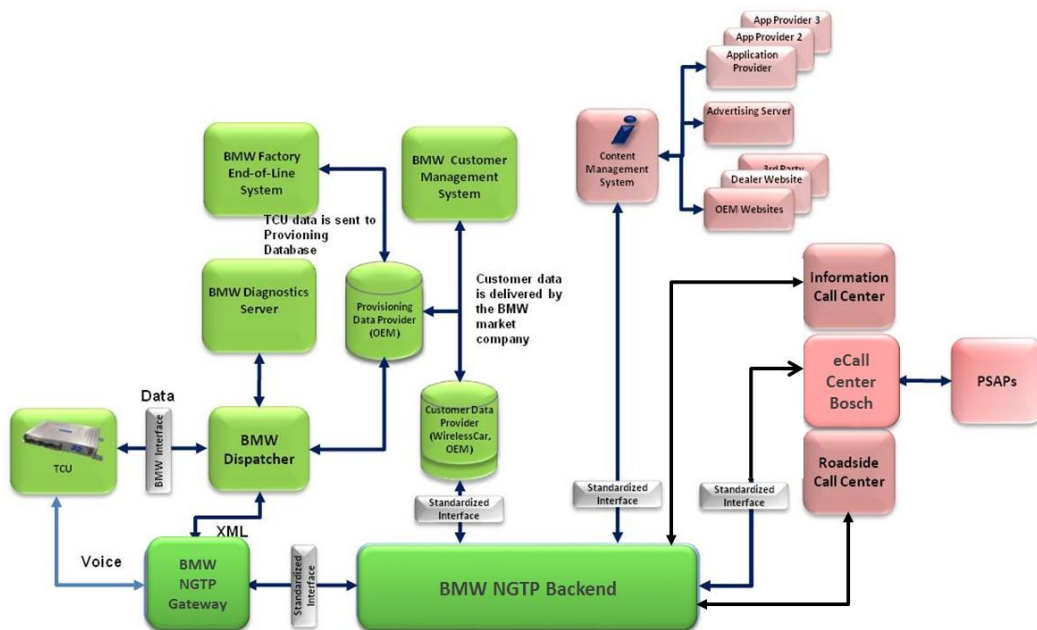


Figure 1 – BMW Telematics configuration (Source M.L. Sena Consulting AB)

Mercedes-Benz, like BMW, dropped ATX and built a new telematics platform with Verizon Telematics (originally Hughes Telematics) and a new Internet connectivity platform with Siemens IT. Volvo Cars expanded its Volvo On Call platform to cover four continents (Europe, North America, South America and Asia) and added an Internet platform, called Sensus Cloud Services, which is able to deliver Infotainment applications specially adapted by Volvo to its head unit, and to obtain data from the vehicle. The path for this communication is either through the customer’s smartphone or through a personal SIM-card installed in a SIM-card holder that uses the Volvo On Call telematics unit modem. Audi, VW, Jaguar Land Rover, Hyundai, Toyota, Nissan, Subaru, Chrysler and Tesla have all built similar infrastructures that are now capable of moving large amounts of data from and to their vehicles, and to do it on a global basis.

### VOC global datacenter setup

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 Contact: Michael Dalvald

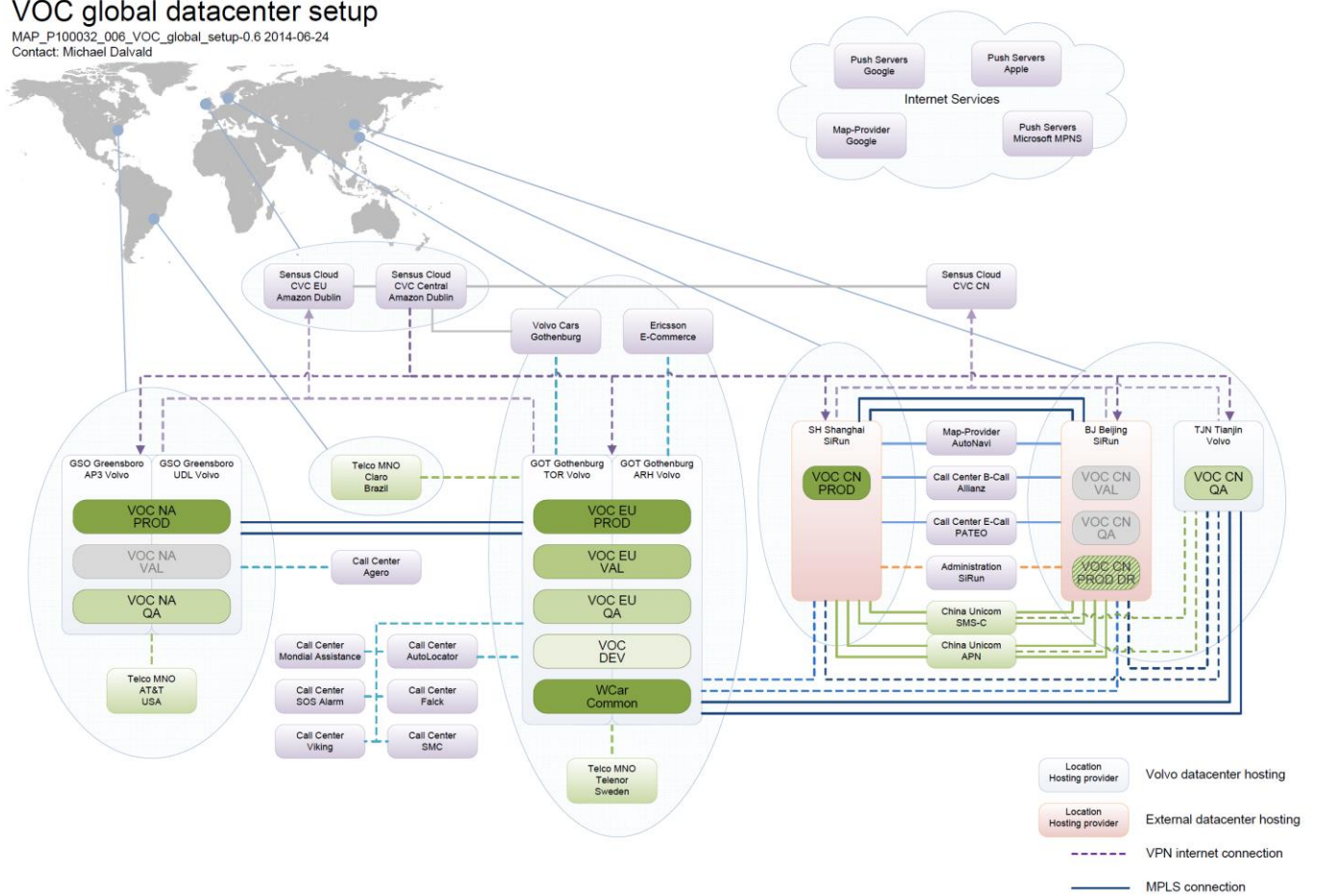


Figure 2 – Volvo On Call Global architecture (Source Volvo Cars)

### 3.4 What comes next?

Advanced driver assistance systems (ADAS) and automated assisted driving are already being delivered to customers. Autonomous driving is now in the testing stage—although one car company, Tesla Motors, has jumped the gun and will pay the price for its impetuosity<sup>1</sup>. These systems are primarily intended to improve the overall safety and performance of vehicles for the driver, the vehicle’s occupants, the vehicle in relation to other vehicles on the road, and pedestrians. Volvo Cars is among the leaders in developing autonomous driving capability, and on-road testing will begin in the Göteborg area in 2017 in cooperation with the City of Göteborg and Swedish Transport Administration.

There are extremely ambitious goals being set in Europe and North America to reduce the number of annual vehicle-related deaths from their currently high levels. EU had around 31 000 deaths in 2010 and 25 000 deaths in 2014. The goal is to half the 2010 figure by the year 2020. The US has slightly higher numbers, but the same goal to half

<sup>1</sup> Tesla Motors, in mid-October, 2015, allowed owners of the Tesla Model S to download over-the-air beta software that provides limited self-driving functionality. The new software allows the driver to take his or her hands off the wheel while the car stays in its lane, stops and starts when it senses nearby cars. It does not stop at red lights, and it has difficulty staying in its lane at intersections, where there are no lane markers. Several Model S drivers posted videos showing the car almost driving off the road.

the 2010-numbers by the year 2020. Other initiatives are Swedish Transport Authority’s Vision Zero to have zero fatalities as a goal and the goal from Volvo Cars that no one should die in a Volvo by the year 2020.

Passive methods, such as seat belts and air bags, and better vehicle design to improve their crashworthiness, have resulted in a levelling off in relative terms of serious and fatal injuries, but they have reached their limits of effectiveness. Active methods, such as braking and steering assistance, curve warning, obstruction warning, intelligent speed adaptation/advice, lane-keeping advice/assistance, and many other applications are seen as the only way, short of severely limiting vehicle usage—which is also under serious discussion—to reach the death and injury reduction goals.

Some ADAS functions can be performed with vision and movement systems, but many of them will rely on a combination of sensors and a digital map database that will allow predictive modelling of the road and its surroundings. These databases must be more accurate and up-to-date, and contain more detailed information than the databases used in the current on-board navigation systems. This will require new methods of collecting road-related data and new methods for transferring this data in real time to and from all vehicles. These methods will be based on communications devices in the vehicle capable of both transmitting and receiving location-based data.

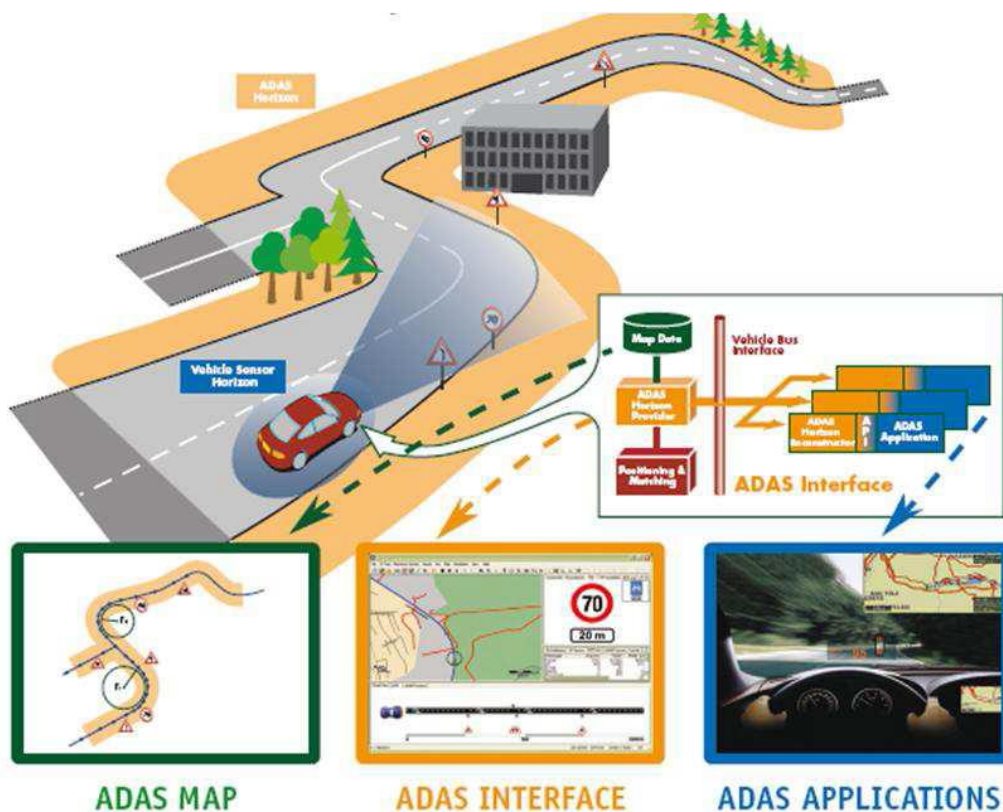


Figure 3: The ADAS Horizon Concept (Source: ADASIS Forum)

## 4 The Connected Car Value Chain and Ecosystem

The concept “The Connected Car Ecosystem” has been used for a while and it is more widely spread than talking about The Connected Vehicle Ecosystem, but when using “car” in the text below it could most of the time be exchanged for “vehicle”.

### 4.1 Beyond the Value Chain

A Value Chain is a sequential set of primary and support activities that an enterprise performs to turn inputs into value-added outputs for its external customer. The idea is to add value at each stage and end up with a margin.<sup>2</sup>



Figure 4: The Michael Porter Value Chain

The value chain has been adapted to the service delivery flow for connected car services. This linear view shows each of the supplier groups contributing to an offering delivered to the end user by an OEM.

### The Traditional Linear View of the Connected Car Value Chain:

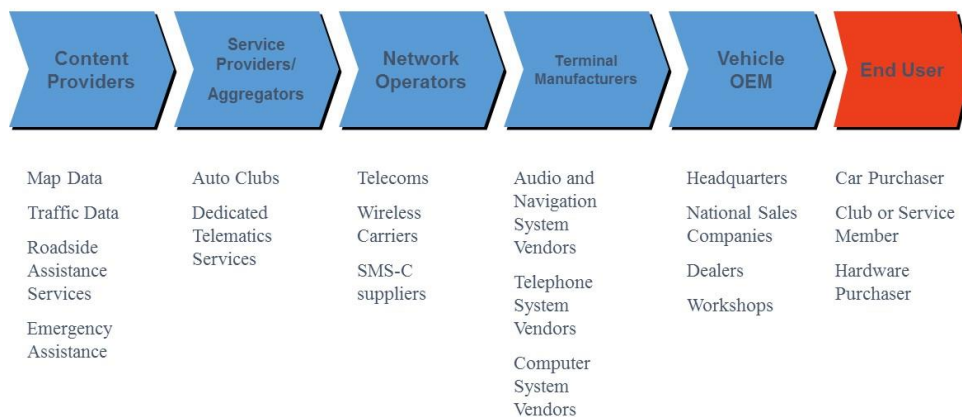


Figure 5: Linear View of the Connected Car Value Chain (Source M.L. Sena Consulting AB)

<sup>2</sup> The value chain was described and popularized by Michael Porter in his 1985 best-seller, **Competitive Advantage: Creating and Sustaining Superior Performance**, New York, NY The Free Press

One difficulty with using the linear view of the value chain as a model for connected car services is that any one of the input providers can have the end user client relationship. For example, map content provider TomTom delivers hardware with embedded communications to end users. Another difficulty is that each of the participants will both add value and take out margin, rather than progressively adding value up to the time of delivery, as is the case with a single company’s value chain.

The three principal inputs for connected cars are:

- The in-vehicle device with associated software
- The mobile network based on the subscriber identity module (SIM) or equivalent in the device
- The services and content delivered to the end user.

Each of these components can be mixed and matched according to various business models to create interdependent architectures. In between the three major components are the links that make possible the service delivery to the on-board device or other wireless devices via the network. Connectivity is needed to match the device with various network standards. It is needed to ensure that the data messages are delivered to the appropriate service providers. Service integration provides for the conversion of device protocols to formats that can be understood by service providers. Customer management provides billing and invoicing services, vehicle and customer data management, provisioning services, and customer care services.

## The Non-linear Connected Car Value Chain

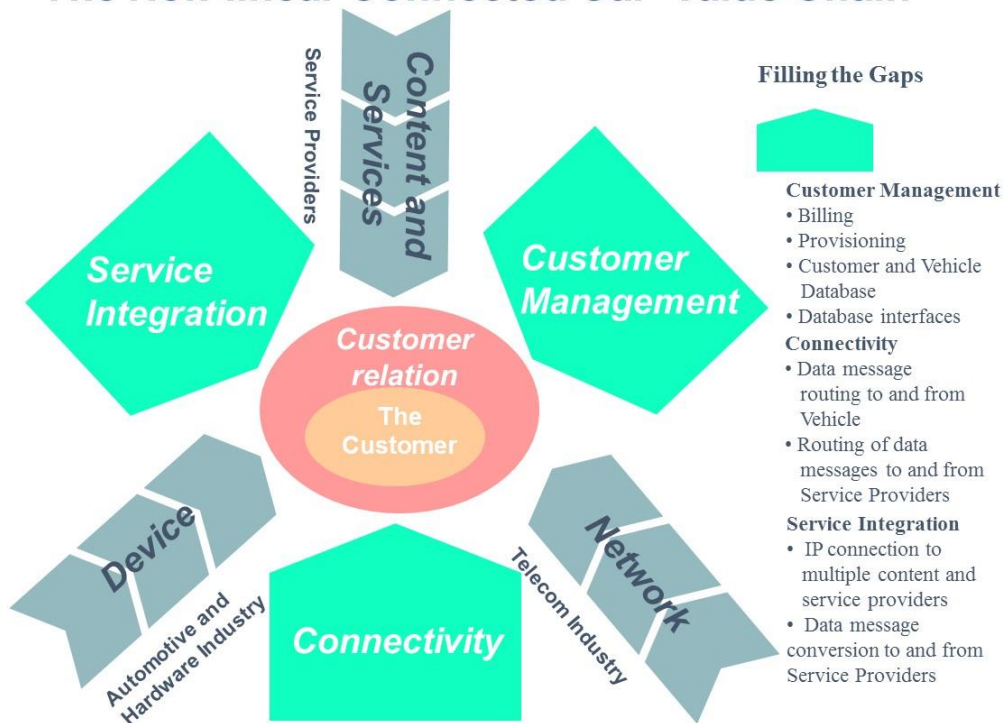


Figure 6 – Non-linear Connected Car Value Chain (Source M.L. Sena Consulting AB)

While ‘value chain’ was initially used to refer to the many parties involved in developing and delivering connected services, it gradually became clear that the term ‘ecosystem’ was more appropriate.

## 4.2 What is an Ecosystem

The concept of a business ecosystem is attributed to James F. Moore, a Senior Fellow at Harvard Law School. He developed the strategic planning concept of a business ecosystem in his book, *The Death of Competition: Leadership and Strategy in the Age of Business* (1996). He defined a business ecosystem as follows:

*“An economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles.”*

The term ‘ecosystem’ is itself borrowed from ecological science and refers to a community of living organisms in conjunction with the non-living components of their environment (e.g. air, water, soil, etc.) interacting as system. Moore used ecological metaphors to make his point, writing that a company is ‘embedded in an environment’, that it must ‘coevolve’ with other companies, and ‘the particular niche a business occupies is challenged by newly arriving species.’ Business therefore need to develop ‘symbiotic’ relationships with customers, suppliers and even competitors.

## 4.3 Overview of the connected car ecosystem

There are multiple ways to view the connected car ecosystem. Below is a view that looks like a galaxy with solar systems and their revolving planets and moons around their planets. Starting with five major focus areas – technology, industry, services, infrastructure, and regulatory – this visualization breaks down the ecosystem into a taxonomy that is easy to grasp. The connected car ecosystem is often used to describe the whole business enabled by connected cars. Data exchange and possible Big Data analysis are part of the connected car ecosystem. By offering a direct channel to the vehicle and the customer, OEM’s will strengthen their brand relation and aftermarket sales and enabling new business models and revenue streams for actors in the ecosystem.

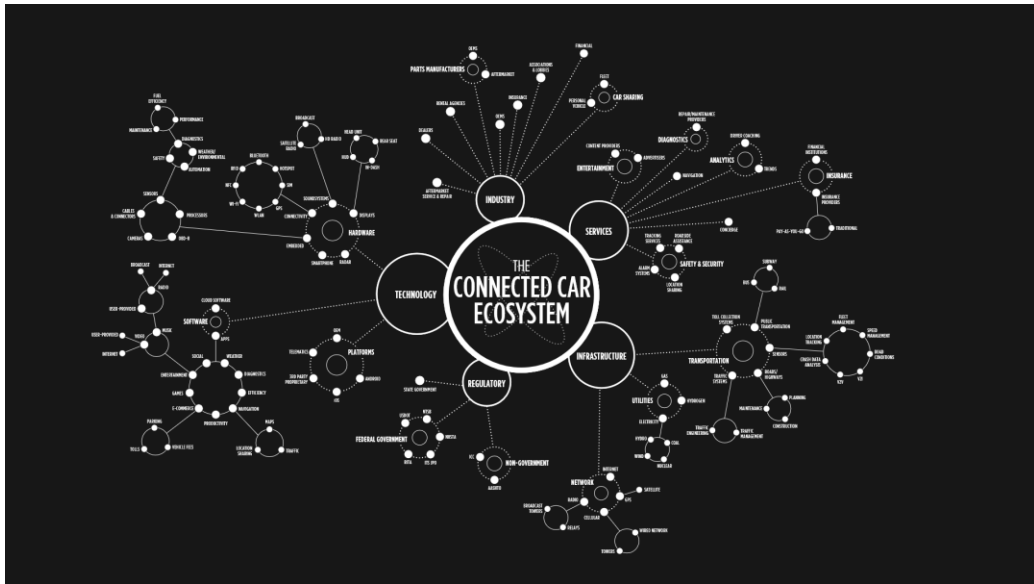


Figure 7: View of the Connected Car Ecosystem developed by Citizen Inc., Portland, OR.

The connected car ecosystem can be divided into a number of sub-ecosystems like park-&-pay, navigation, advanced driver assistance services and traffic hazard warning. The connected car ecosystem also overlaps other ecosystems, like the connected traffic ecosystem, the traffic management ecosystem, the infotainment ecosystem, the traffic information ecosystem, the usage based insurance ecosystem, the goods transport ecosystem and many others.

There are as many views of the Connected Car Ecosystem as there are companies offering products, services or advice to other members or to those outside trying to enter. Ericsson’s view below is significantly simpler than the comprehensive image produced by Citizen, Inc. Its purpose is more to classify areas of focus for its own service offerings.

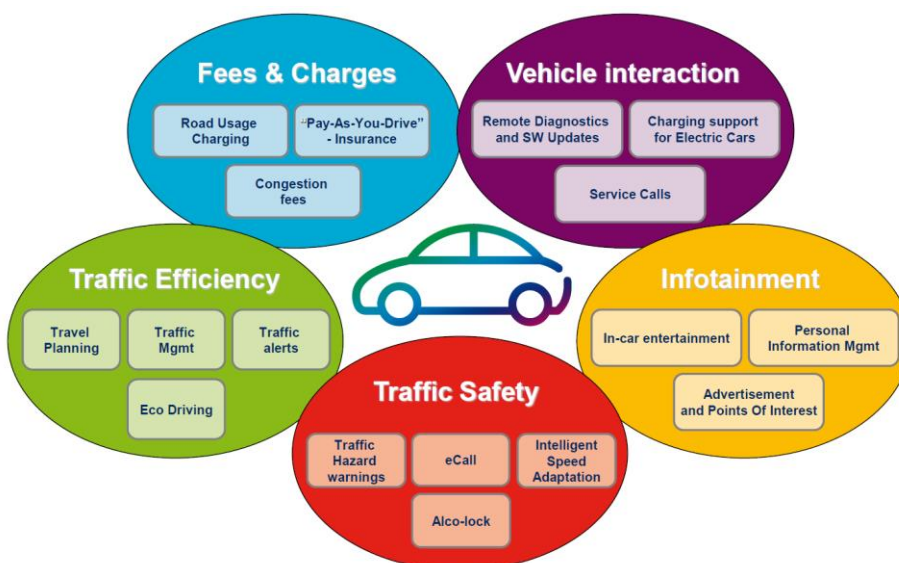


Figure 8 – Ericsson view of the Connected Car Ecosystem

The business related to the connected car ecosystem is expected to grow fast in the coming years. In a report from SNS Research called “The Connected Car Ecosystem: 2015 - 2030 - Opportunities, Challenges, Strategies & Forecasts” the key findings are:

- By 2020, research estimates that connected car services will account for nearly \$40 Billion in annual revenue, driven by a host of applications
- The proportion of connected car service revenue for driver assistance systems and autonomous driving applications is expected to dramatically increase from merely 5 percent in 2014 to over 11 percent by 2020
- Largely driven by connected car services, Big Data and analytics technology investments in the automotive sector are expected to reach \$5 Billion by 2020, following a CAGR of over 14% between 2015 and 2020
- The connected car ecosystem continues to consolidate, with larger players investing in acquisitions to increase their market share, capability, revenue and geographic reach
- Many mobile operators have expanded beyond their traditional role as connectivity providers, to offer end-to-end connected car platforms directly to automotive OEMs and aftermarket suppliers

#### 4.4 Overview of actors in the Connected Vehicle Ecosystem

As stated, the **Connected Vehicle Ecosystem** comprises multiple industries and institutions, from manufacturers of cars and wireless communications devices to emergency call centres. They form clusters and inter-connected spheres, buying and selling services to one another, complementing and supplementing, sometimes partnering and sometimes competing. Categorizing actors in the Connected Car Ecosystem is not always easy as we have a variety of actors in all sizes and categories which oftentimes overlap one another.

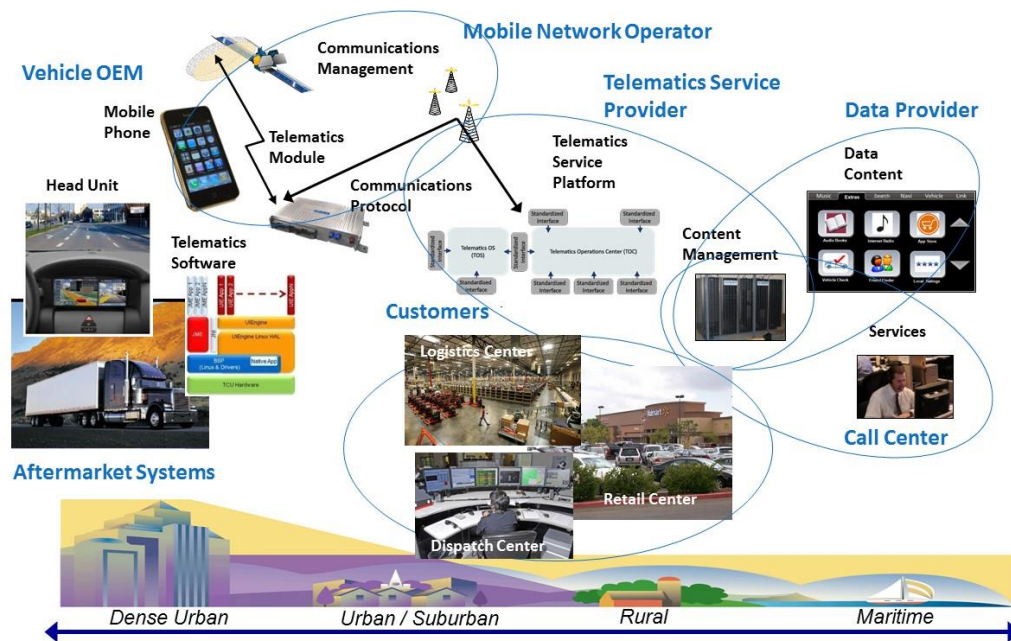


Figure 9: Example of Actors in the Connected Vehicle Ecosystem (Source M.L. Sena Consulting AB)

#### 4.4.1 Vehicle OEMs

Vehicle OEMs and drivers of their cars and trucks are the focal points in the ecosystem for embedded connected systems. They serve in the key role of integrating the systems, providing the principal contact with customers and distributing payments to all other members of the ecosystem. Even with aftermarket and tethered solutions, the vehicle OEMs often provide points of sale, service and information.

Vehicle OEMs are still not totally comfortable with their role as providers of services. As will be explained in Section 5.5.1., they initially viewed connected vehicle systems as a source of revenue, like navigation options had become. They believed that customers would pay for subscriptions, which would also expand revenue streams. Their business is based on selling as many vehicles as they can produce, keeping their factories running at close to capacity and keeping their costs as low as practicable. Acceptance of connected vehicle systems has been a very slow process among the car manufacturers, with the exception of a few who began early and moved ahead, in spite of obstacles.

Examples of Vehicle OEMs: Volvo Cars, Volvo Trucks, Scania, BMW, Daimler, Peugeot, JLR

#### 4.4.2 Mobile Network Operators

Mobile Network Operators are in the business of recuperating the huge investments made in their networks and in obtaining territorial licenses. They do this by selling time and capacity on their networks. Since every network has a finite capacity at any given time, pricing must be designed to encourage usage up to the network's capacity. Prices that are too high cause customers to flee to competitors, while prices that are too low encourage over usage resulting in connection delays, dropped calls and, eventually, customer dissatisfaction.

MNOs have liked the idea of selling data, versus just voice air time, because data offers more possibilities to find inventive ways to differentiate themselves from their competition. Adding content, such as music, books, newspapers and maps, by allowing the downloading or pre-installation of applications that deliver it, makes their connectivity services even more compelling to users.

MNOs do not cooperate with other parties; they use them to get to and invoice the ultimate consumers of their services. This includes the OEMs. Thus far, they have been more interested in acquiring TSPs to attempt to control more of the ecosystem. Verizon bought HTI and Vodafone in Europe has bought Cobra Telematics. These moves will not necessarily ensure more connected car business, as OnStar's move to AT&T from Verizon has shown. In the end, the consumer will choose which mobile network operator he wants, when regulations are changed to stipulate that a SIM cannot be tied to any specific MNO.

Examples of Mobile Network operators: AT&T, Verizon, Vodafone, Telia, Telenor.

#### 4.4.3 Content Providers

Navigation guidance, traffic data, parking information and points of interest are all desirable infotainment services. Traditional map data providers, Here and TomTom have added these services to their standard map delivery. They charge for their services on a per usage basis or on the basis of the number of vehicles connected to a call centre and the number of operators delivering services. Google is an alternative source of infotainment services, and charges in a similar way as Here and TomTom for call centre service applications.

There are three options for content provision available to an OEM when setting up a connected car program:

- Pay for content directly to the provider and build it into other agreements, such as on-board navigation data and traffic information;
- Give the responsibility for paying for content to the TSP, assuming it is the TSP that provides the call centre operator workstation application; or,
- Give the responsibility for paying for content to the call centre service provider.

It only makes sense for a call centre operator to create a content service delivery mechanism and to contract with service providers if the connected car OEM is going to pay for these services. Also, setting up the data feeds and usage management systems can be costly, so the greater the number of customers using these services, the lower are the unit costs. If the TSP has a workstation application, it is usually more cost-effective to let them take the costs of content. It is even more likely that content will be delivered directly to the vehicle via Internet and smart phone integration, obviating the need for content integration at the call centre or the TSP.

Examples of Content Providers: Google, Here, TomTom, INRIX, MediaMobile.

#### 4.4.4 On-board System Providers

There are two types of connected car system providers: those that deliver a black box and let the OEM handle everything concerning interfaces to the service infrastructure, and those that attempt to provide value-added services as part of their system. In the former category are most of the on-board connected car system providers, including Actia (Volvo and JLR), Novero (VW), LGE (OnStar), Peiker (BMW) and Ficos (Renault). In the latter category are Continental (Mercedes-Benz) and Harman (Audi).

Hardware suppliers generally do not cooperate with other members of the connected car ecosystem. They make their money as Tier One suppliers of hardware and have no experience with selling services. Neither Continental nor Harman have made any headway with their service businesses.

Examples of On-board System Providers: Actia, Peiker (acquired by Valeo, Dec. 2015), Novero, Ficos, Continental, Harman

#### 4.4.5 Telematics Service Providers

##### 4.4.5.1 *Who they are and what they do*

Filling the gaps between the three principal components of connected car provision is the telematics service provider. TSPs like WirelessCar and Verizon Telematics deliver customer management, connectivity and service integration in varying degrees. In some cases they have the customer relationship, in others they are subsidiary to one of the other providers.

TSPs fall within four quadrants:

- OEM hosts its own service platform and is primarily focused on safety and security, with infotainment as a supplement. OnStar is the primary example of this category because it is wholly owned by GM;
- OEM hosts its own service platform, which is built with internal resources or with the assistance of IT companies like Accenture and T-Systems, and is primarily focused on infotainment, with safety and security as a supplement. BMW is the primary OEM example of this category;
- TSP performs all hosting tasks with a platform that is focused on safety and security. WirelessCar and Verizon Telematics are the two principal examples of this category; and,
- TSP does the hosting with a platform that is focused on infotainment. Ericsson provides its services to Volvo Cars. Here and TomTom deliver navigation and traffic services.

While the TSP would seem to be in the least replaceable role, changes and improvements to on-board and communications technologies with more usage of Internet protocol, will make the proprietary interfaces supported by the TSPs, like WirelessCar and Verizon Telematics, less necessary.

There are six key competencies that a TSP should possess:

1. Understanding of the complete end-to-end processes for delivering wireless services to vehicles
2. Detailed understanding of and first-hand experience with the communications requirements
3. Knowledge of different hardware message protocols and direct experience with providing converters from and to the vehicle.
4. Experience with the development and operation of a customer service delivery platform
5. Experience with the requirements for being a Tier One supplier to a vehicle manufacturer

6. Knowledge of the regulations and operating requirements in Continental Europe, China, North America, South America, Australia and the Middle East.

As the diagram below shows, a number of TSP have ceased to function, and many have changed owners. OnStar has persevered the longest, which could well be the result of having a single owner since its inception, which also happens to be its one and only customer. WirelessCar is second in terms of durability, and although it has gone through many governance forms, one of its owners, AB Volvo, has been the same since its inception and is its single largest customer.

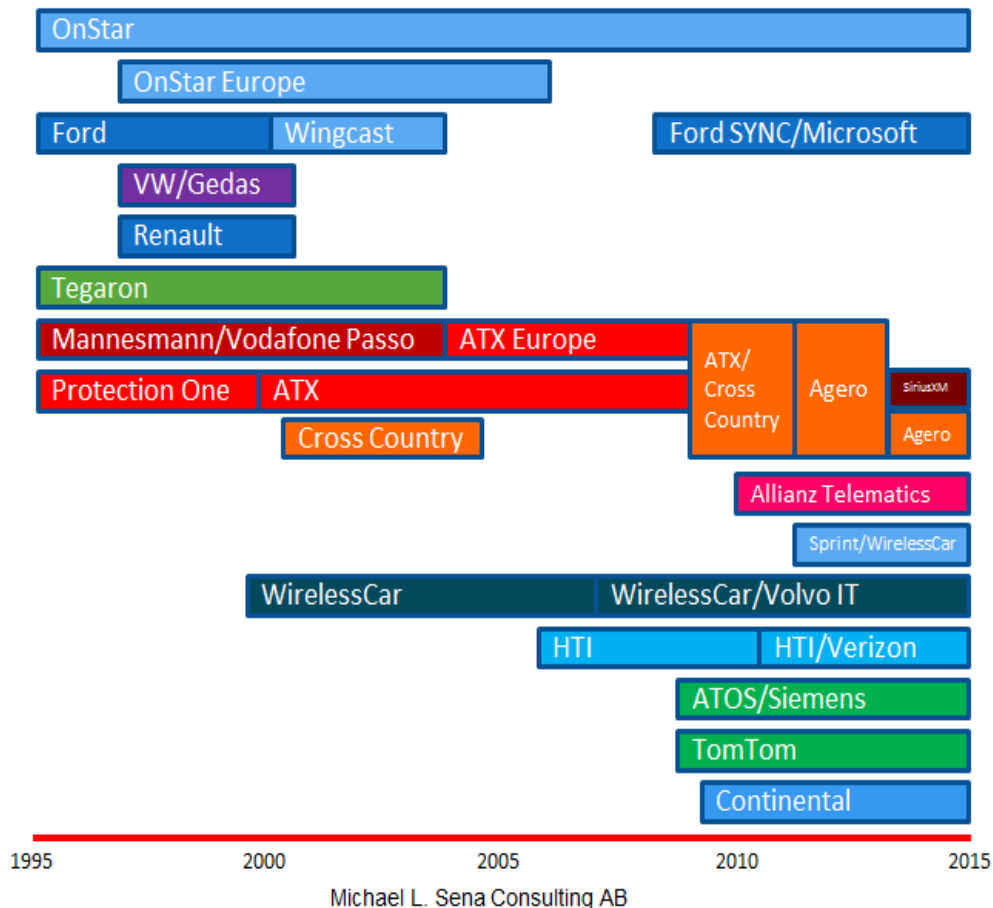


Figure 10: Telematics Service Providers through the Years (Source M.L. Sena Consulting AB)

The four top TSPs working in North America, OnStar, Verizon Telematics, WirelessCar and SiriusXM Telematics, have different approaches to business and how they make money, and these approaches will impact the way they can be partnered with. Ericsson is working in North America with Volvo, while ATOS is included in the table below as one of the major European TSPs.

Apple, Google, Microsoft, Amazon and Facebook are added to the table as possible future telematics service providers. Any of them can deliver similar connectivity solutions to those of Ericsson and Atos/Siemens. Google is already providing mapping and traffic information services in competition with TomTom. As more services are

added to smartphones which act as both modems and application platforms, displaying the results on the head unit, but using the smartphone as the driving engine, these Internet platform companies will play an increasingly larger role in the full service delivery chain.

**Table 2: Telematics and Infotainment Service Providers and how they make money**

TSP	How it makes money	Sustainability
WirelessCar	Charges the OEM a fee for every vehicle that is connected to the WirelessCar platform.	This is the easiest payment approach for the OEM and fits its policy for parts
Verizon Telematics	Collects a subscription fee from the end user of the OEM's system and takes a portion of this fee for all services that it manages. A part of the fee is paid to the OEM	This is the most convenient for OEM, and possibly the most profitable, but the OEM is not in control.
SiriusXM Telematics	Either collects a subscription fee or receives a fixed sum per vehicle for every vehicle it handles.	A combination of WirelessCar's and HTI's approaches
ATOS	Receives a fee for service management from the OEM and brokers services to customers, receiving a portion of the fee	Puts the OEM in full control but offers revenue opportunities.
Ericsson	Receives a fee for service management from the OEM	Lack of detail
OnStar	Collects a fee from each subscriber for services and telecommunications traffic; charges the OEM (GM) for each connected vehicle and data delivered from it.	OnStar claims to be profitable and has approximately 7 million subscribers in North America

There are OEMs that contract with a telematics service provider, and then the TSP does all of the subcontracting for services. Mercedes-Benz has done this with Verizon Telematics. When this occurs, it is the TSP that sends the requests for proposals, rather than the OEMs, and the call centre is then in a supplier-client relationship with the TSP. TSPs, including both WirelessCar and Verizon Telematics, have attempted to create their own service teams, including call centres and hardware, in order to promote an end-to-end service to OEMs. In the end, the OEMs want to be able to have full control over the choice of all service providers, and to be able to replace any one of them, including the TSPs, if circumstances demand it.



*Figure 11: Global Telematics Service Providers (Source SBD and M.L. Sena Consulting AB)*

Examples of Telematics Service Providers: WirelessCar, Verizon Telematics, OnStar, ATOS, Ericsson.

**4.4.5.2 WirelessCar – The Swedish long lasting TSP**

WirelessCar, based in Gothenburg, Sweden, was the first true telematics service provider. Today, it is a department within Volvo Group Telematics, which had been a division within AB Volvo IT prior to Volvo sale of part of its IT company to HCL Technologies, an Indian IT company. WirelessCar started life in 1998 as a joint venture among three Swedish companies, AB Volvo (when Volvo Cars was part of the Group), Ericsson Venture Capital and the Swedish telecom before it became Telia Sonera. Slow start-up, investment capital difficulties during the dot.com bust and the problems of starting a completely new business, a telematics service provider, in an industry that still did not understand the concept of selling services, caused the company to first downsize and then to become incorporated into AB Volvo.

Being part of a larger company and delivering to that company key services which have now become core components of Volvo Trucks, Volvo Bus and Volvo Construction Equipment has offered WirelessCar a secure environment. Its clients have grown from only Volvo Cars and AB Volvo as late as 2006 to include JLR, Audi China, BMW (now only in China through China Unicom). Mercedes-Benz signed on in November, 2015 for fleet management applications. Nissan and Subaru, still unofficial, will be added soon.

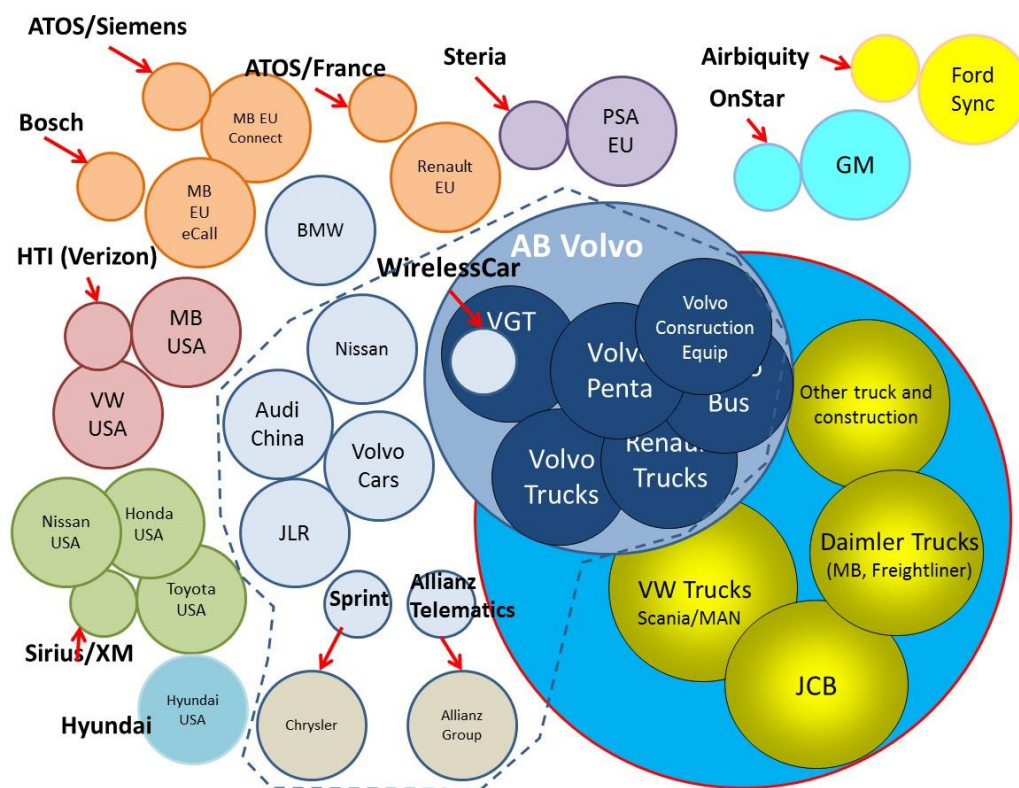


Figure 12: WirelessCar within the Global Telematics Spheres (Source M.L. Sena Consulting AB)

#### 4.4.6 Integration Platform Providers

Providers of telecommunication equipment like Ericsson and Huawei, and suppliers of consumer products, like Bosch, have a goal to be part of connecting everything to the Internet, including vehicles. They are interested in expanding the use of their current products and also expanding their businesses into more advanced products like the Connected Traffic Cloud. Integration Platform Providers provide a cloud services, including hardware and software, which enables an easy integration of all actors and all types of data in the extended Connected Car Ecosystem.

Today, these actors have a minor role in the Connected Car Ecosystem. Ericsson has entered the business as an Internet TSP for Volvo and has licensed its platform to AT&T in the US. Huawei offers products for communicating with the car. As the numbers of companies requiring these services increase, and as the amount of data being transferred expands, the complexity of integrating all of the components also increases. This is where the opportunity lies for specific Integration Platform Providers in the Connected Car Ecosystem. As of today Telematics Service Providers also provide the Integration Platform, and the difference between a Telematics Service Provider and an Integration Platform Provider is diminishing.

Examples of Integration Platform Providers: Ericsson, Huawei, Bosch

#### 4.4.7 Traffic Management Centres and Road Operators

Traffic Management Centres (TMCs) need data in real time to be able to manage traffic and to provide traffic information to vehicles and travellers. Traditionally, a TMC monitors traffic and identifies problems with the help of data obtained from fixed roadside equipment, such as cameras and radar, and with verbal reports from private car drivers, commercial truck drivers, the police and others who witness traffic events.

Today, a TMC is mostly reactive, informing drivers and travellers about the current traffic situation. Information channels are primarily radio, web, apps and variable message signs on the roads. The Connected Car Ecosystem will enable more individually adapted traffic information to be directed towards the vehicle/driver/traveller. Individualization of traffic information might be done via service providers. Using Connected Cars acting as real-time probes in the road network will provide totally new opportunities for TMCs to become more pro-active traffic management centres by using large amounts of data, predicting traffic and steering traffic in space and time to a much larger extent than today.

Examples of Road Operators: National Public Authorities, Municipal Authorities, Highway operators for example ASFINAG, ASFA. A road operator can also be a private company that has concession for a period of time.

Formulating traffic rules is another role we haven't explicitly described here although it is important and it is strictly held by public authorities on national, regional or local levels.

#### 4.4.8 New roles

##### 4.4.8.1 *Big Data analysers*

The amount of data related to traffic and transport increases rapidly. One major reason is the increasing numbers of connected cars. Already today different categories of Service Providers process large amounts of data in real time and using historical data. The role “Big Data Analyser” will be more important in the future and one can foresee that actors specialised on Big Data Analytics will enter the Connected Car Ecosystem.

Mark Boyadjis, senior analyst at IHS Automotive highlights the importance of the role Big Data Analyser, when saying that “It is important to understand how data from intelligently designed systems will drive billions of dollars of annual revenue between data assets, analytics, and end-user services.” The HIS Automotive study identified five core categories of data that will be most important to automakers, their suppliers and their customers. These categories are:

- Diagnostics
- Location
- User experience
- ADAS
- Autonomous driving.

Example of possible Big Data Analysers entering the Connected Car Ecosystem are IBM, SAP and SAS Institute. These actors will compete with today’s Service Providers like INRIX, TomTom, HERE in Big Data Analytics.

See chapter 5 for more information on Big Data Analytics in the Connected Car Ecosystem.

##### 4.4.8.2 *Mobility providers*

Most of today’s Car manufacturer work with strategies on how to fit in to tomorrow’s business. Should they stick to their old role as car manufacturer or should they be a mobility provider or both. All kind of vehicles and especially Autonomous Vehicles can be resources in the Mobility Ecosystem. Services promoting mobility are already offered by Service Providers and we already have Car sharing as a growing service. Some pilot tests has also been performed offering Mobility-as-a-Service by using all kind of transport modes, e.g. UbiGo in Göteborg. The San Francisco based companies Uber and Lyft is global actors offering services via mobile apps. Uber is more similar to taxis and Lyft offers peer-to-peer ridesharing. GM has invested in the ridesharing app flinc and BMW is another OEM working in this field.

These kind of mobility services will grow in the near future and one can expect new actors entering the market and the development of new business models. More about Mobility and Mobility-as-a-Service can be found in chapter 6 below.

Example of possible Mobilty Providers: BMW, GM, Ford, Volvo, Uber, Lyft, Google, Apple, Virgin, etc.

## 4.5 Heavy vehicle OEM telematics offer

Scania is used to exemplify a heavy vehicle OEM telematics offer for fleet management. Scania has been offering telematics services since early 2000. Initially, the focus was on transport management and improving customer operations. With products such as Scania Order Support and Driver Log, it was possible to tailor make an efficient logistics operations. Approximately 5000 trucks were connected, but larger volume was difficult to achieve due to the need of tailoring for each specific customer need. In 2008, Scania shifted strategy and focused on telematics for everyone, offering basic, easy-to-use solutions, and the possibility to sell and support the offering by the local Scania salesforce.

### 4.5.1 Freemium business model

Since 2011, all new trucks are standard-fitted with a telematics unit. The offer includes a free subscription to the basic fleet management system (FMS) services consisting of a basic PDF-report and a services planning module. In order to access the services, the customer (vehicle owner) needs to sign up for a subscription. To access more advanced services, the customer pays a monthly subscription. This is a classic freemium business model.

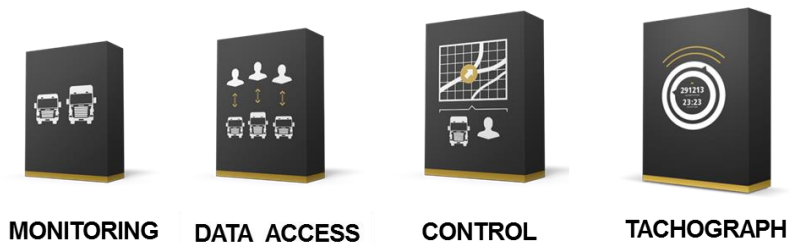


Figure 13: Scania services offer

- 1) Monitoring package, which is the free services offer
- 2) Data access package, which enables access to API but no portal access.
- 3) Control package, which consist of range of services to improves transport company productivity
- 4) Digital tachograph services, which focus on providing services related to tachograph management

Scania offers today a range of services aimed at transport companies with the aim of improving the productivity within the individual company and the industry as a whole. Working with traditional salesforce, we encourage them to up-sell customer to the higher level package. The user can access the services in a range of different devices, depending on needs and work procedures.



Figure 14: Scania user interaction interfaces

#### 4.5.2 Multi-side business model

Scania also uses the benefits of a connected product in its internal processes and services, improving internal productivity and enabling new services. This includes improved operation in repair and maintenance, an area which is a traditionally a strong business area for truck OEMs. Data from the connected vehicle can also be utilised in other business processes, such as R&D, vehicle sales and out-bound logistics flow. Here, the business is motivated by reduced cost, which might lead to improved sales in those services.

#### 4.5.3 Scania Architecture

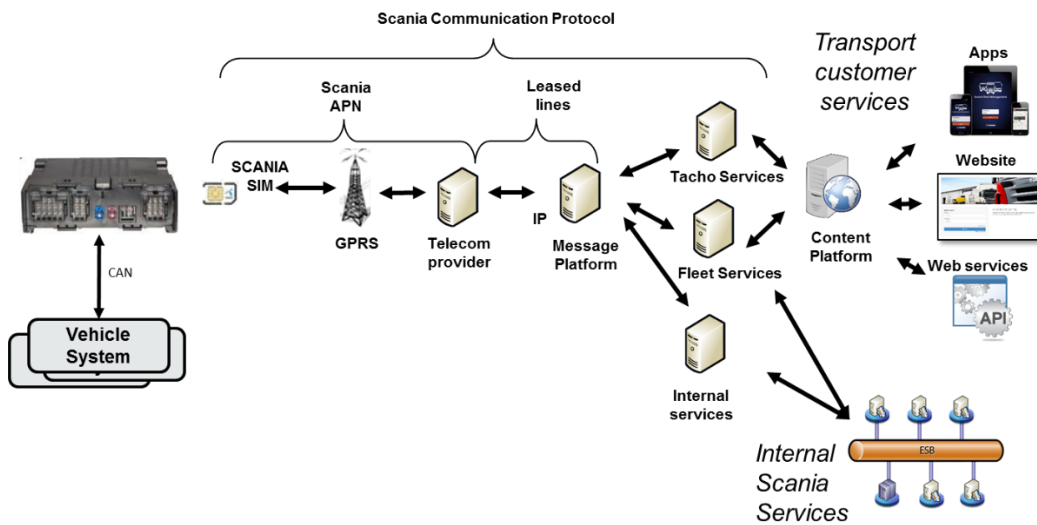


Figure 15: Scania architecture schematics

The Scania system in many ways resembles the one found in personal car companies. A major difference is that large parts of the solution have been built in-house, with tailor-made applications eventually becoming part of the standard system.

The Scania on-board system is connected to the vehicle electric system. It is also possible to mount the Scania system in other truck brands utilising the FMS-standard<sup>3</sup> data connection. The ECU is sourced from a tier-1 supplier with Scania-specific application software and is a fully integrated part of the Scania electrical system.

The telecom solution is provided by different providers depending on market served, with a dedicated Scania SIM. The data is routed to a messages handling platform which delivers the messages to the appropriated services provider. In Scania’s case, most of this is in-house development together with different partner suppliers of different IT-solutions.

Content from the different services provider is made available on the content platform to customers. The content platform interfaces with the subscription and user management solution to enable access to the content.

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#### 4.6 Heavy vehicle OEM's future connected offers

There are promises of a very large business potential for future services within the connected car eco-system. However, most of this potential remains undiscovered today. A great deal of technical research is ongoing in the areas of Cooperative ITS, V2X, Big Data Analytics, autonomous driving and other intelligent cooperative systems in or to identify where to focus future development.

An example of an initiative that has been of major interest from traffic authorities, car and vehicle OEMs is platooning or road trains. Platooning is system of vehicles in which the driver of the first vehicle manually drives and makes certain that the following vehicles follow a safe path on a highway. The drivers in the following vehicles leave the control of both the longitudinal and lateral control to the vehicle's system. This fully automated control enables very short following distances. Driving in a platoon brings benefits in fuel consumption, safety and driver convenience.(Reference is needed to substantiate this claim.)

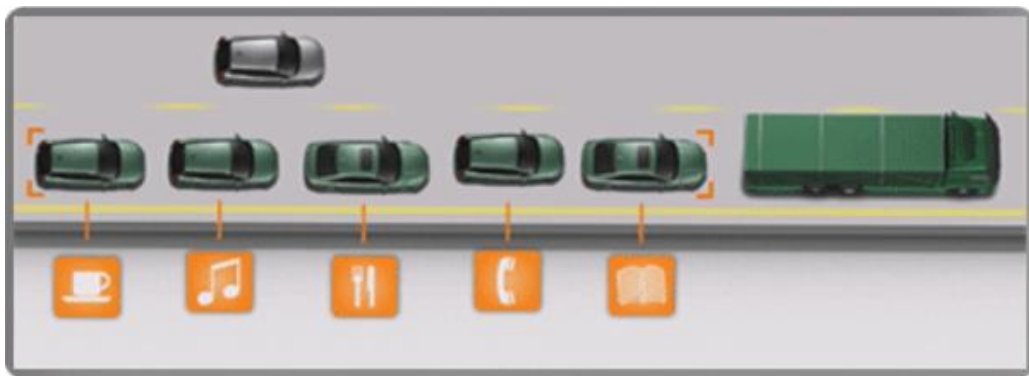


Figure 16: SARTRE Platooning concept

Source: <https://www.youtube.com/watch?v=tQnVGOoVvVk>

An EU FP7<sup>4</sup> project named SARTRE, SAfe Road TRains for the Environment (2009 – 2012) was aimed at developing strategies and technologies to allow vehicle platoons to operate on normal public highways. Seven project partner were involved, including: Applus+ IDIADA, Institut für Kraftfahrzeuge Aachen (ika), Ricardo, SP Technical Research Institute of Sweden, Tecnalía, Volvo Cars, Volvo Technology. The project resulted in a demonstrator in Sweden that was shown to public and press in (when?).

The overall concept of SARTRE was to have a group of vehicles (cars and trucks) driving together with a lead vehicle, driven by a trained professional driver, and several following vehicles driven fully automatically by the system with small longitudinal gaps between them. The SARTRE platoon system was designed using pre-existing and market-available systems. These systems were then coordinated and programmed to achieve the automated driving function that allowed platooning on unmodified roads together with normal traffic. The concept at this time used vehicle-

<sup>4</sup> Framework Programme 7

to-vehicle communication and Ethernet to communicate position, speed and other variables.

What Sartre accomplished was only a start. Plenty of serious complications remain. For example, work is needed to indicate how integration with real road infrastructure and other drivers will be accomplished, how improving automation will allow drivers to relax, whether it is possible to eliminate reliance on a lead vehicle, how cars can spontaneously form platoons, how regulatory barriers can be overcome, and choosing whether to mark platoon-specific highway lanes.

Another EU FP 7 project still ongoing is COMPANION (2013-2016), which is a European research project aimed at identifying the means of applying the platooning concept in practice in daily transport operations. Project partners include: Scania, OFFIS EV, Volkswagen AG, Trans-cerezuela, Idiada, Science and Technology BV, Kungliga Tekniska Högskolan, Science and Technology AS.

The objective of the COMPANION project is to develop co-operative mobility technologies for supervised vehicle platooning. The proposed idea is to develop a new energy-efficient and user-friendly integrated framework to coordinated driving of heavy-duty vehicle. The idea is to develop a real-time coordination system, which will define an optimized flow of vehicles that will dynamically create, maintain and dissolve platoons according to an online decision-making mechanism. It will also take into account historical and real-time information about the state of the infrastructure.

When and if platooning will be successful in the future transport infrastructure is too early to say. It is however clear that these kinds of new business opportunities will be part of the connected car eco-system and in need for shared V2V information most likely in future cloud-based solutions.

#### 4.7 Public Authorities role in the Connected Car Ecosystem

Public Authorities have different roles that can benefit from being part of the Connected Car Ecosystem. Analysing large amounts of historical data, partly based on vehicle sourced data, will give valuable input in areas like:

- Safety on the road by analysing accidents and incidents
- Environmental impact
- Design and construction of the road infrastructure
- Adjusting traffic rules based on real traffic patterns
- Establishing disincentives, such as congestion charging in order to reduce traffic in otherwise crowded areas
- Information campaigns attempting to change travellers' behaviour.

Traffic Management Centres are usually operated by public authorities and for this study the role of a TMC in the Connected Car Ecosystem might be the most interesting. A TMC will use both historical data and data in real time. A public authority may also operate other services, such as websites and apps for traffic information, that will benefit from being part of the Connected Car Ecosystem.

By analysing both historical data and data in real time a Traffic Management Centre can benefit in areas such as:

- Improve traffic efficiency
- Steer traffic to other roads and sometimes to other means of transport

In section 4.4.7 the benefits for a TMC being part of the Connected Car Ecosystem are described in more detail. These include having access to data from vehicles (e.g., via brokers) for traffic management purposes and having channels to the vehicles (e.g., via TSPs) for providing individually suited traffic information to the travellers.

The role for public authorities is changing rapidly from being the only source for most traffic-related data towards being one of the several actors that is both producing and consuming data (See Figure 13 below). In spite of the fact that a public authority is still responsible for traffic management and promoting a sustainable traffic environment, cooperation with all of the actors in a well organised Ecosystem will be the key for successful traffic management.

Today private traffic service providers use traffic information from authorities in their own services, but otherwise there is very limited cooperation between public authorities and their TMCs and private traffic service providers. Much more cooperation will be needed in the future of the Connected Car Ecosystem. Today the role of different road authorities in relation to private actors regarding traffic information is not clear. To what extent an authority should steer traffic in space and time is also not clear. Public authorities in different countries may also have different views on their role.

The Connected Car Ecosystem enables new possibilities, but there remains the need to clarify who will be responsible for what and how to cooperate in order to enable and promote a sound development towards a safe, environmental friendly and smooth traffic situation in urban and rural areas. Public authorities will have a specific responsibility to clarify their role in order to set up clear rules for the market players.

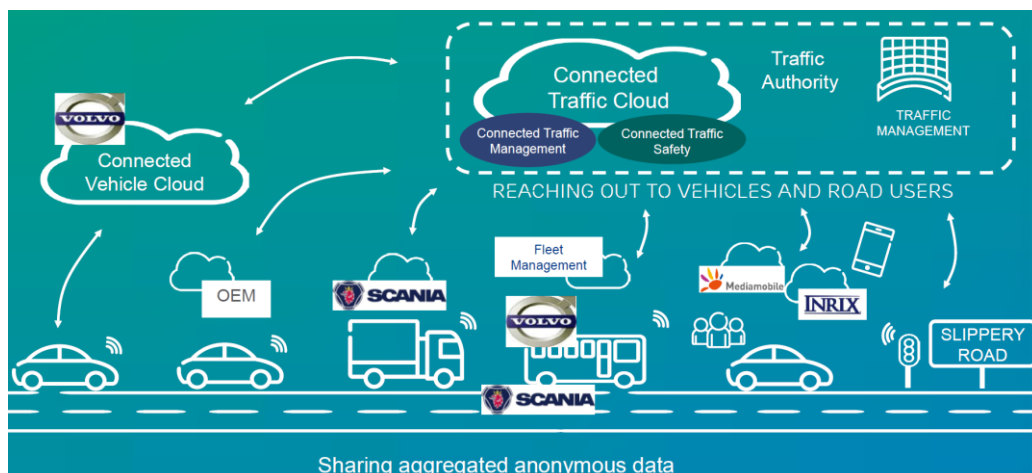


Figure 17: A public traffic authority as part of the Ecosystem sharing data with private actors (Ericsson picture)

Several other kinds of actors, such as map data providers and weather reporters, could be added to Ericsson's picture for a more complete view of the ecosystem around the traffic cloud.

#### 4.8 Strictly Competitor's in the Connected Car Ecosystem

There is no company that provides an end-to-end connected car solution on its own. OnStar comes closest with its turn-key offer to General Motors, its parent. But even OnStar outsources most of the components of its systems and services, including hardware (LG and Delphi) MNO (AT&T and Verizon) and its call centres. All of the content is also outsourced, from maps to apps.

Looking at who OnStar does not buy services from provides an indication of who OnStar sees as its principal competitors. OnStar does not buy services from Verizon Telematics, WirelessCar or the telematics business in Sirius/XM (recently acquired from Agero). Verizon Telematics entered the business as Hughes Telematics, Inc. in 2006 with the goal of being a multi-vendor version of OnStar, delivering systems, connectivity and services to any OEM. Verizon changed its approach in 2009 when Chrysler did not renew its contract following its emergence from bankruptcy proceedings and Mercedes-Benz decision to continue to source its hardware from Continental. It never built its own call centre operation either, preferring to outsource this to several different companies, including Noel. Even though it has been purchased by Verizon, a mobile network operator, it continues to offer services to devices with SIM-chips/cards from competing companies, such as AT&T.

WirelessCar is also not a current or potential supplier to OnStar. OnStar devices communicate only with OnStar's back end. There are many different hardware devices from multiple suppliers (e.g., Delphi, Motorola/Continental, LG) and software versions for each of the devices. It is OnStar's back, which was originally built by Electronic Data Systems when it was owned by GM, that maintains all of these connections.

As Protection One, the SiriusXM telematics division in Texas was aligned with Ford, GM's principal competitor in the race to initiate services in the mid-1990s. Also in that mix was Motorola, who were the primary supplier of telematics on-board units well into the 2000s, and OnStar has bought systems from them at different times. However, there was no chance that OnStar would source either connectivity or call centre services to a company that was competing directly with it, and this lack of cooperation has continued.

#### 4.9 Frenemies in the Connected Car Ecosystem

*Any company working in the field of connected cars has no permanent allies or enemies, only permanent interests.<sup>5</sup>*

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<sup>5</sup> This is a loosely paraphrased and re-adapted expression attributed to Lord Palmerston, British Prime Minister in the mid-nineteenth century, when Britain was at the height of its power. He said: "Britain has no permanent allies or enemies, only permanent interests." This has always been true in government, and it is equally true in business today.

There are times when enemies must become friends, that is, ‘frenemies’. An example in the consumer device industry is Apple buying microchips from its main competitor in smartphones, namely Samsung. The two are in court suing each other while they are working closely together in a buyer-seller relationship. Obviously, it is possible to divide the groups who are warring from the groups that are playing together amicably, and the lawyers for the companies handling the law suits probably demand that there should be no communications between the groups within the company lest their clients’ cases be compromised. Nevertheless, cooperation in the car industry is very common. The costs of developing new cars, especially with the increasingly fast development cycles demanded by all of the electronics being fitted, means that even the most resource-rich companies must find ways of sharing the costs. Outside of mergers (Fiat and Chrysler) and overlapping ownership (Nissan and Renault), there are examples of companies sharing platforms (Renault and Mercedes-Benz) and sharing major parts, like engines (PSA and BMW for diesel engines).

Within the Connected Car field, forced cooperation is the rule. Ericsson won the contract for Internet connectivity to the Volvo Cars Sensus Connect system in competition with WirelessCar. As a result, WirelessCar and Ericsson had to create physical linkages between their respective systems in order to allow each of their systems to communicate with the different parts of the on-board devices. WirelessCar requires the interface with Ericsson in order to provide connectivity to the Volvo On Call Mobile App, and Ericsson requires a secure interface to WirelessCar in order to be able to synchronize the central Volvo Cars customer database with the Volvo On Call customer database maintained by WirelessCar.

The illustration below shows the extent of the physical linkages required between Ericsson and WirelessCar. These physical linkages necessitate constant cooperation and close working relationships for development, testing and operations. The competition between these two companies is very high because of several factors, including the possibility that one or the other will be chosen to take over the entire connectivity function. Both companies must perform at their peak and not give any indication that they are sabotaging the efforts of the other. Similar situations exist between WirelessCar and XM/Sirius with several clients in North America, and between WirelessCar and Verizon Telematics in China.

## Volvo On Call Systems North America and Europe

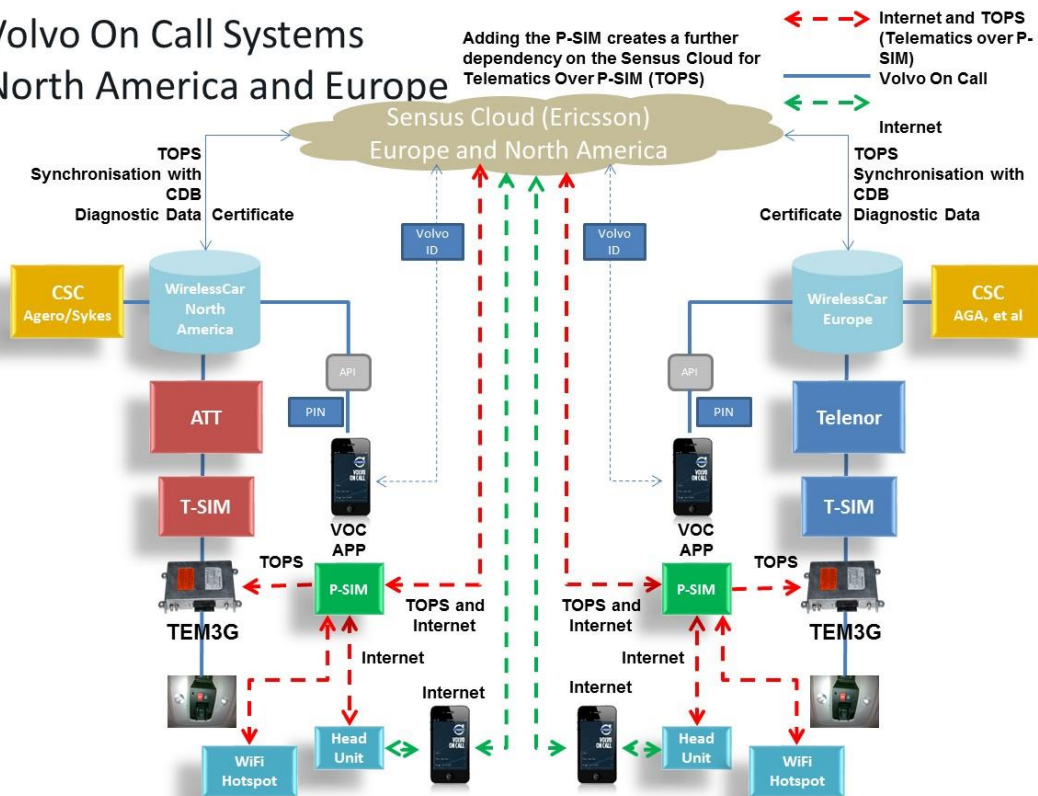


Figure 18: Telematics Service Providers for Volvo On Call (Source Volvo Cars)

In several countries in Europe and in China and Russia, Volvo has chosen to work with one company as its Volvo On Call customer service centre and with another as its roadside assistance provider. In all cases, these two call centres compete on one level or another. Both BMW and Mercedes-Benz are using Bosch Security Services as their telematics call centres, and Bosch must work together with BMW’s and MB’s roadside assistance operators in case the emergency requires roadside assistance.

### 4.10 The Integration Platform – the heart of an Ecosystem

#### 4.10.1 Introduction

Volvo Car’s implementation of its Connected Car combines components from WirelessCar, Ericsson and Volvo Cars IT into an integrated platform. Mercedes-Benz integrates its own systems with Verizon Telematics, Siemens-Atos, Bosch, among others. BMW has taken its platform completely in-house, but still includes outside suppliers in those markets where it is necessary, as in China. One common element among all of the car companies is that they are moving to a model that places more functionality on systems that are shared by all members of the ecosystem, rather than on individual, proprietary systems that require complex interfaces. This model is called Cloud Computing.

#### 4.10.2 Cloud Computing

*Cloud Computing* in general means that either the programs being used or the data that is generated—or both—are accessed via the Internet and stored on OPCs (*other*

*people's computers*) and not our own. The National Institute of Standards and Technology<sup>6</sup> defines Cloud Computing as follows:

*A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models and four deployment models.*

**Essential Characteristics:**

*On-demand self-service.* A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

*Broad network access.* Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

*Resource pooling.* The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data centre). Examples of resources include storage, processing, memory, and network bandwidth.

*Rapid elasticity.* Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

*Measured service.* Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts)<sup>7</sup>. Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

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<sup>6</sup> National Institute of Standards and Technology, U.S. Department of Commerce.

<sup>7</sup> Typically this is done on a pay-per-use or charge-per-use basis.

**Service Models:**

*Software as a Service (SaaS).* The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure<sup>2</sup>. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

*Platform as a Service (PaaS).* The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming<sup>3</sup> languages, libraries, services, and tools supported by the provider.<sup>3</sup> The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

*Infrastructure as a Service (IaaS).* The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

**Deployment Models:**

*Private cloud.* The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

*Community cloud.* The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

*Public cloud.* The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

*Hybrid cloud.* The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

As described in the NIST document, a cloud infrastructure is the collection of hardware and software that enables the five essential characteristics of cloud computing. The cloud infrastructure can be viewed as containing both a physical layer and an abstraction layer. The physical layer consists of the hardware resources that are necessary to support the cloud services being provided, and typically includes server, storage and network components. The abstraction layer consists of the software deployed across the physical layer, which manifests the essential cloud characteristics. Conceptually the abstraction layer sits above the physical layer.

#### 4.10.3 Implementation of Integration Platforms

Today, each actor in BADA has its own cloud to store data and to process data. Data in the cloud come from vehicles and a number of other sources. VCC has its own cloud, AB Volvo has its own, Scania has its own, etc. To really be able to make use of the large potential in data collected from vehicles of different brands, communication between clouds is necessary. Common clouds for several brands and actors might also be an option. An interesting question related to business models is on what level common clouds could be relevant. The capabilities and the functionality of a cloud or integration platform can vary significantly among providers.

Ericsson offers infrastructure and functionality to connect data and services from a range of sources in their Connected Vehicle Cloud, as shown in the figure below. However, for Volvo Cars, it is WirelessCar that is the interface to the majority of the services listed in the figure, with Ericsson connecting only certain content providers to the vehicle's head unit.

FPI – Big Automotive Data Analytics

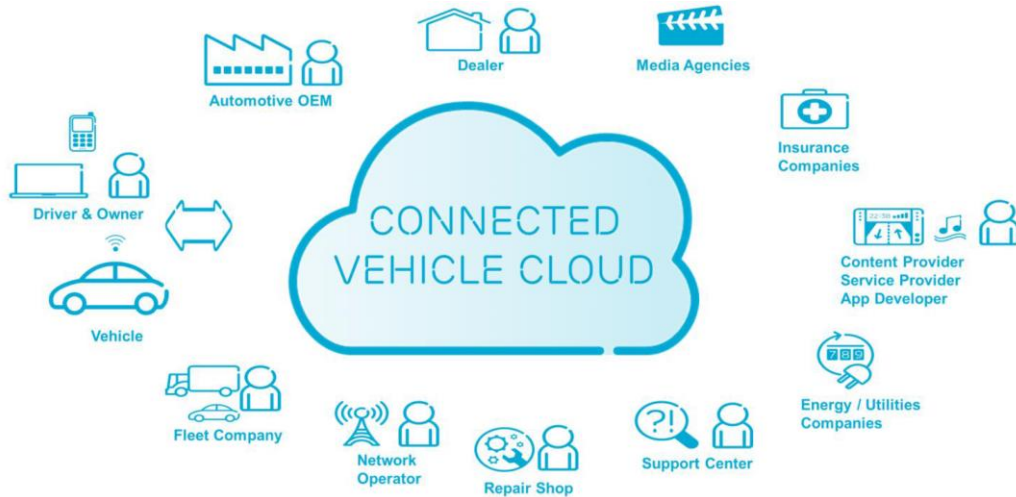


Figure 19: The Ericsson connected vehicle cloud powering their automotive customers' ecosystems (Source Ericsson)

While Ericsson's Connected Vehicle Cloud consists of tools to be able to make use of data from various sources and offer functionality and apps to vehicles and partners connected to the cloud, it is using only a small portion of this capability today in the Volvo ecosystem. WirelessCar and Volvo IT systems are needed to provide the full range of services.

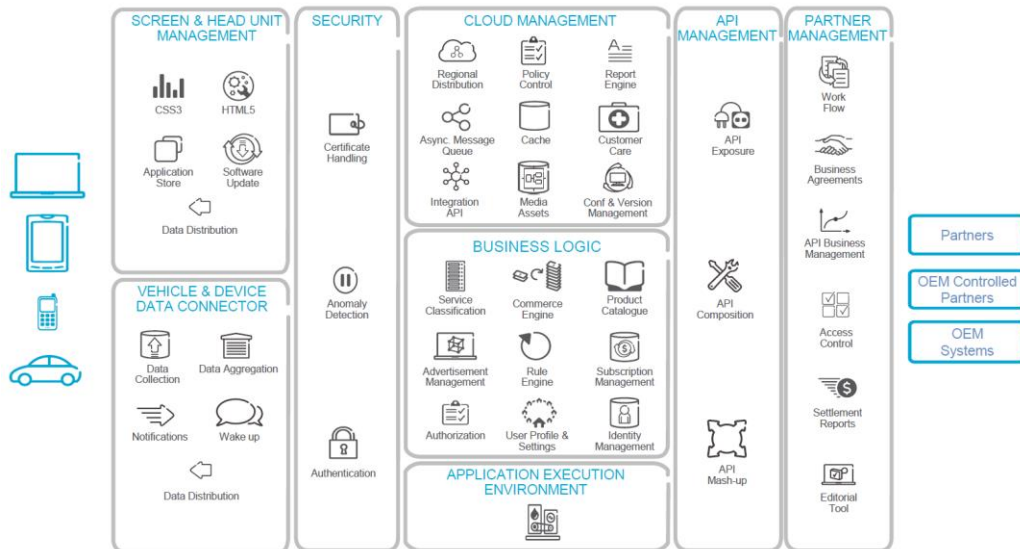


Figure 20: Ericsson's Connected Vehicle Cloud components (Source Ericsson)

## 5 Big Data Analytics

### 5.1 What is Big Data?

The concept of Big Data is not new, but there are two very different views on the topic. One view is that the term is a market analyst's buzzword. The CEO of SAS Institute, Jim Goodnight, expresses this standpoint:

*"We were there before the term was invented. The reason we're all talking about big data is because some analyst made all the money they could off of cloud, and they had to move on to the next buzzword. It was data warehousing, and then software as a service, and then cloud computing, and everyone put their money into cloud startups until it was time to change the topic."*

The other view is articulated by one of those market analysts referred to by Goodnight. Shomit Ghose of ONSET Ventures said:

*"Despite the current level of visibility and frenetic activity surrounding Big Data, it turns out the concept was first pioneered in the 1940s by Hari Seldon, professor of mathematics. At Streeling University. On the planet Trantor. In Isaac Asimov's **Foundation** science fiction trilogy. The premise underlying Asimov's books was that Professor Seldon had developed a branch of probabilistic mathematics that allowed the future to be accurately predicted. This is, as it turns out, exactly the promise of Big Data: predicting what will happen next based on analysis of enormous volumes of historical data."*

What Mr. Ghose points out is that Isamov, who was a professor of Chemistry at Columbia University in New York when he was not writing books, illustrates why Big Data is of such great interest today among Silicon Valley entrepreneurs and investors. "Big Data promises to be for the 21st Century what oil was to the 20th: the fuel driving all that we do", Ghose said. This fuel is being created in fantastically large volumes, with 4.4 zettabytes ( $4.4 \times 10^{21}$ ) of data produced in 2013, and that volume growing to 44 zettabytes of data produced in the year 2020<sup>8</sup>. In 2013, 22% of this annual data volume had semantic value, but only 5% of it was actually analyzed, according to EMC. By 2020, 35% of the 44 ZB of data will have semantic value. "The challenge and opportunity of Big Data will be to find a way to make sense of all of that valuable data," said Mr. Ghose.

Whether or not the term, 'Big Data', is a buzz word or not, connected cars are already generating huge amounts of data, and by 2020 there will be an estimated 152 million actively connected vehicles on the roads. While this will be a fraction (0.8%) of the total number of 18 billion Internet of Things devices, these cars will be generating an estimated 11.1 petabytes<sup>9</sup> of connected car data by 2020.<sup>10</sup>

<sup>8</sup> EMC annual Digital Universe Study: The Digital Universe of Opportunities (April 2014).

<sup>9</sup> 1 Petabyte (PB) = 1000 Terabytes (TB); Terabyte = 1000 Gigabytes

<sup>10</sup> IHS Automotive Study: Emerging Technologies: Big Data in the Connected Car (

In a 2001, META Group (now Gartner) analyst Doug Laney defined data growth challenges and opportunities as being three-dimensional, increasing in volume or amount of data, increasing in velocity, or speed of input and output of, and increasing in variety, or the range of data types and sources.<sup>11</sup> In 2012, Gartner updated its definition as follows: "Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization." A new V, for 'veracity' (reliability, accuracy) was added by some organizations to describe it.

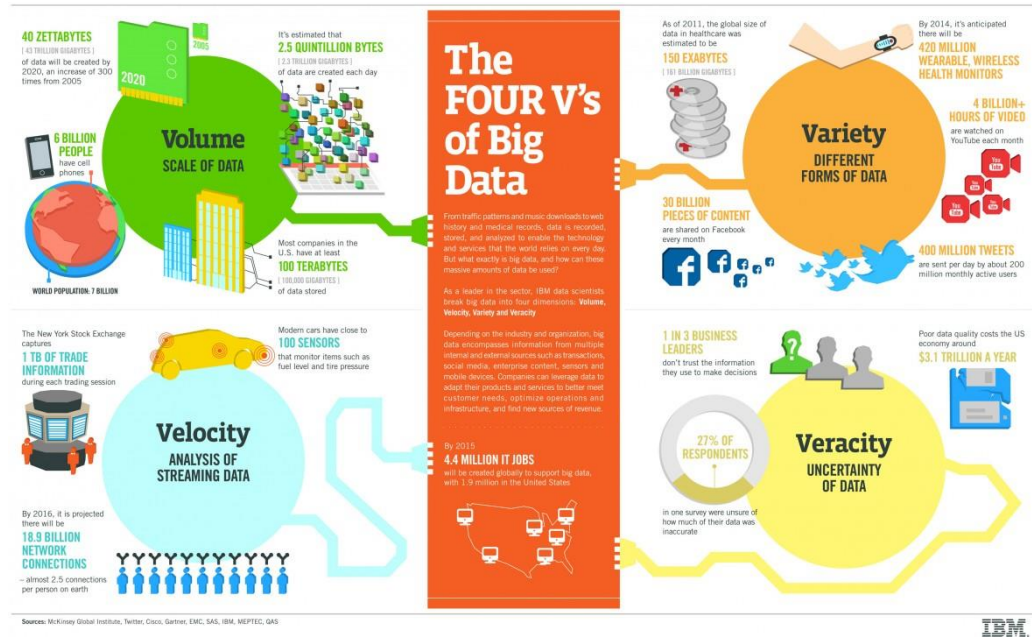


Figure 21: The Four Vs of Big Data (Source IBM)

## 5.2 Big Data in the Automotive Industry

Mark Boyadjis, senior analyst of infotainment and Human-Machine Interface (HMI) at IHS Automotive, has gone one step further. He said: "... without understanding the fifth 'V,' value and the value proposition, the collection of data from the connected car is literally a waste of time. It is important to understand how data from intelligently designed systems will drive billions of dollars of annual revenue between data assets, analytics, and end-user services." The HIS Automotive study identified five core categories of data that will be most important to automakers, their suppliers and their customers. These categories are:

- Diagnostics
- Location
- User experience
- ADAS
- Autonomous driving.

Frost & Sullivan presented a case study of a diagnostics big data solution provided to Volvo Cars by Teradata, a California-based company that "helps customers get more

<sup>11</sup> Laney, Douglas. "3D Data Management: Controlling Data Volume, Velocity and Variety". Gartner. (2001)

value from data'. Volvo wanted to better understand mechanical performance of its vehicles under actual driving conditions. A legacy data warehouse system made it impossible for analysts to integrate diagnostic readout data with design and warranty information held in the existing data marts. Teradata's solution was to consolidate product design, warranty and diagnostic readout data into a data warehouse from Teradata, reducing response times from hours—and, in one case, weeks—to minutes and extending access to 300 users across four departments. As a result, design, manufacturing, quality assurance and warranty administration divisions could share a single view of product data.

This work started in 2006. "We had a warranty data warehouse in one database," recalls Bertil Angtorp, senior business analyst at Volvo, "and we were starting to build a new, separate data warehouse for the diagnostic readout information. Then we realized that what we really needed was to integrate those data sets. We knew there was business value to be gained if we could eliminate manual integration, and if we could easily match warranty claims against diagnostic data from actual service records. We tried to bring the diagnostic data onto the existing warranty platform, but the performance was unsatisfactory. So we began building a business case for a platform upgrade." That was when Teradata entered the picture.

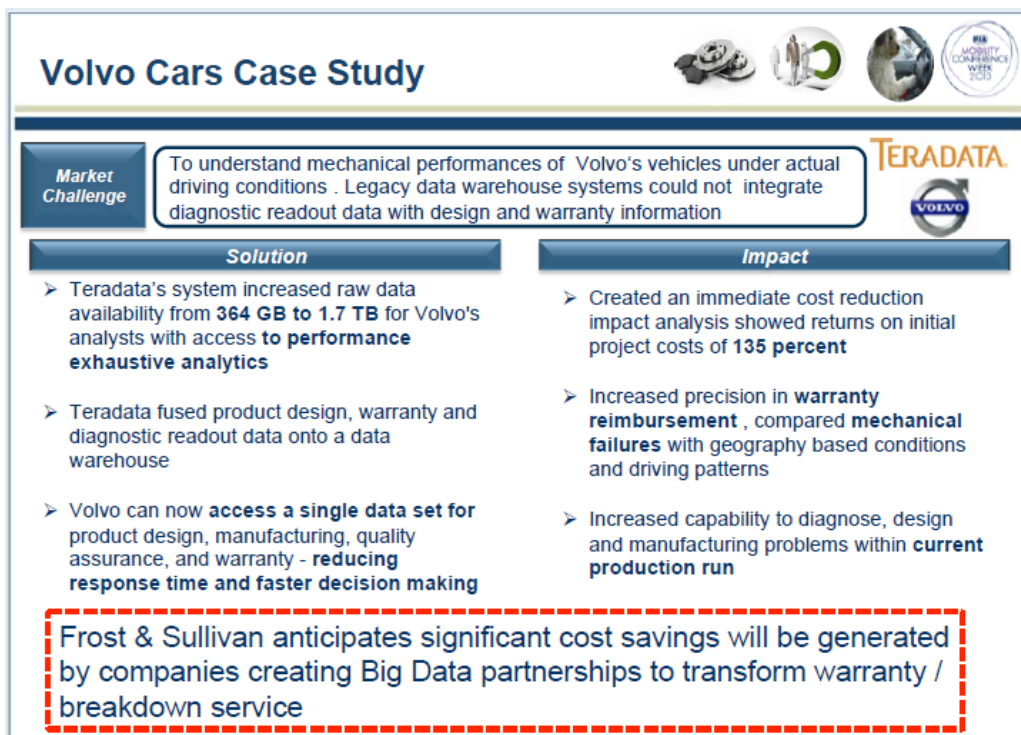


Figure 22: Frost & Sullivan presentation; (Source Graeme Banister, The Hague, 12 Sept. 2013)

### 5.3 How to perform Big Data Analytics

Solid research is underpinning advancements in the field of Big Data. Advances started in the sciences, especially particle physics, astronomy and genomics, where massive amounts of data must be analysed. Commercial applications began well

before the social media revolution. Information feeds from Walmart’s bar code readers and cash registers all over the world resulted in just-in-time store shelf replenishing and a totally new way of operating consumer retail logistics. Today, with all human activity recorded online, and with business models becoming highly personalized, massive data processing and analysis is essential. These needs have given rise to the field of ‘data science’, which looks for insights in large data sets of disparate data sources.

The principal problem addressed by Big Data research analytics developers is the classic three-dimensional trade-off faced by most systems designers. Architects work with size, quality and cost, usually telling clients they can have two of the three, but getting all three will be very costly. Transport designers work with time, comfort and cost. Big data analysis attempts to optimize time to process, quality of the answer and resources required. A high-quality answer, meaning that it is more verifiable and incontrovertible, may take more time to generate and take more resources, but may be only marginally better than a medium-quality answer that is obtained more quickly and at less cost. IBM, one of the leaders in the Big Data field, has developed the following classification schema to assist analysts in making choices as part of the trade-off exercise.

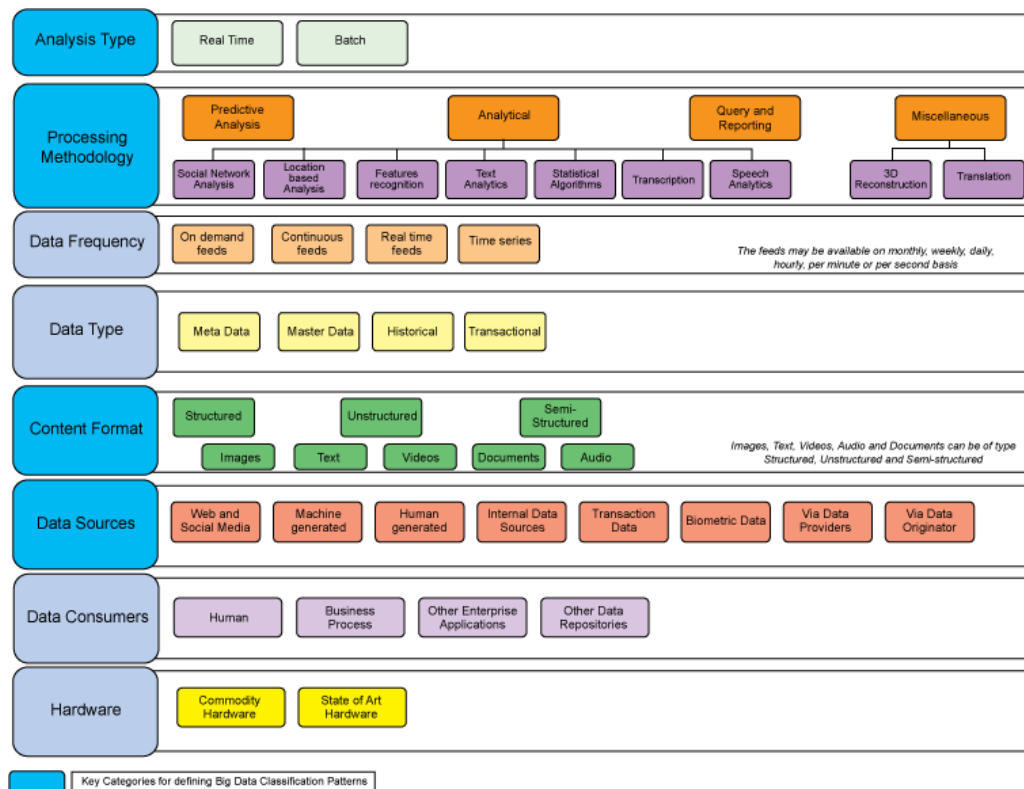


Figure 23: IBM Big Data Classification Schema (Source IBM)

## 5.4 The Open Data Platform Initiative

In July, 2015, fifteen industry leaders in the Big Data space announced the intent to create a new industry initiative, identified as the Open Data Platform Initiative (ODPI), to promote open source-based Big Data technologies and standards for enterprises

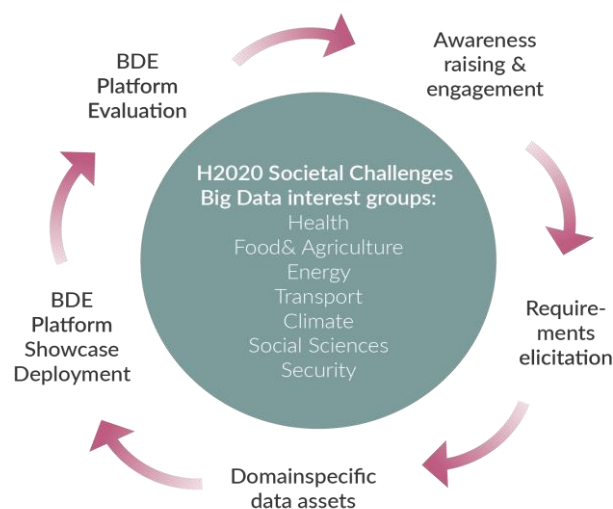
building data-driven applications. The initial group of member companies provides a listing of the leaders in Big Data analysis: GE, Hortonworks, IBM, Infosys, Pivotal, SAS, AltiScale, Capgemini, CenturyLink, EMC, Splunk, Verizon Enterprise Solutions, Teradata, Vmware and an unnamed large international telecommunications company. (See [www.opendataplatform.org](http://www.opendataplatform.org)). ODPI is a shared industry effort focused on promoting and advancing the state of Apache Hadoop® and Big Data technologies for the enterprise.

The following are ODPI’s first year objectives:

- An industry standard and open data management core. Initially focused on Apache Hadoop®, the Open Data Platform will develop and promote a set of open, enterprise focused Hadoop® standards and technologies. This translates to immediate benefits that will increase stability, capabilities, and compatibility among Hadoop® distributions.
- Certifying a common reference core. The Open Data Platform will deliver a certified, packaged, and tested reference core--giving the industry a coveted “test once, use everywhere” solution. With the entire industry enabled to create big data offerings using this reference and consistent implementation, software applications will be more likely to run on any distribution based on the Open Data Platform’s Hadoop® core, reducing risk and vendor lock-in while focusing vendor resources toward more innovation.
- More support and contributions for the Apache Software Foundation. The Open Data Platform is expected to be complementary and beneficial to the efforts and stewardship of the Apache Software Foundation (ASF), using the existing ASF processes to contribute code, perform testing, integration, infrastructure support as well as increase participation in events and collaboration with the developer community.

## 5.5 Big Data Europe

An EC-funded project is in the process of building a Big Data processing platform to enable European companies to ‘build innovative multilingual products and services based on semantically interoperable, large-scale, multi-lingual data assets and knowledge, available under a variety of licenses and business models’.



Big Data Europe aims to:

- Collect requirements for the ICT infrastructure needed by data-intensive science practitioners tackling a wide range of societal challenges; covering all aspects of publishing and consuming semantically interoperable, large-scale, multi-lingual data assets and knowledge.
- Design and implement an architecture for an infrastructure that meets requirements, minimizes the disruption to current workflows, and maximizes the opportunities to take advantage of the latest European RTD developments, including multilingual data harvesting, data analytics, and data visualization.

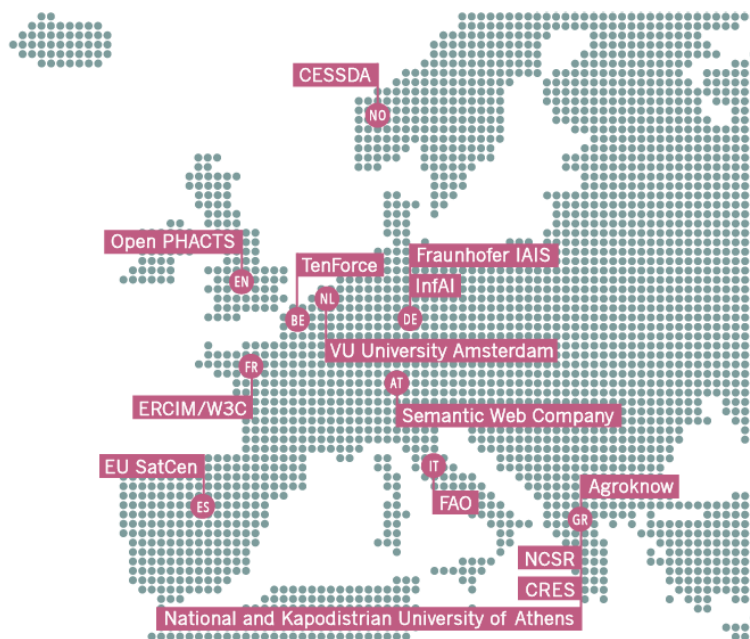


Figure 24: Big Data Europe Partners (Source Big Data Europe)



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement n°644564 – BigDataEurope.

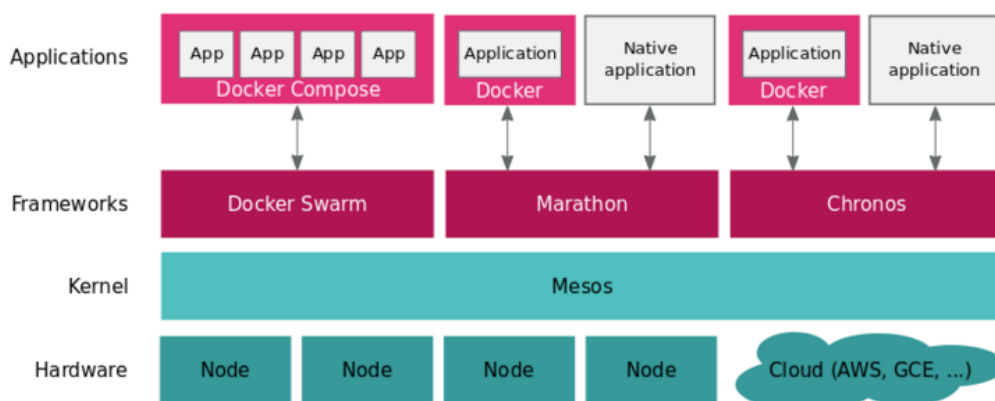


Figure 25: Big Data Europe Reference Architecture (Source Big Data Europe)

The base layer of the BDE platform is a set of machines. Regardless of where they are located physically, BDE makes an abstraction of them, currently using Mesos. Given the constraints of these machines, work can automatically be sent to the most optimal nodes. The setup of such a platform may be complex, so the project team have tried to cater to the needs of developers by supplying a Virtual Machine containing a micro-version of the platform. For cluster administrators, it offers *Chef* recipes.

The work being executed is packaged in *Docker* images. These are like tiny Virtual Machines for Linux, without the large overhead. The project's approach has been to try to ensure that all code is bundled, and that it does not interfere with other software that is been installed on the system. The team is trying to make these *Docker* images as easy to construct as possible. For this, they are building base images for various technologies. Developers extend the image, plug in the code that they need for their specific algorithm, and let the *Docker* ecosystem manage the packaging and deployment of the new component.

The *Docker* images are built at a lower granularity than the whole system. One such component could be the implementation of a database; another could be an algorithm to detect man-made changes in a set of images. BDE considers a system that groups all the components needed to tackle a practical use case to be a *pipeline*. The *pipeline* therefore consists of a set of *Docker* images and how their instances need to connect to each other. The net result is that BDE can deploy a network of pre-developed components to solve a Big Data problem.

## 6 Mobility and Mobility-as-a-Service

### 6.1 Services for mobility

The world of mobility information and infrastructure comprises all forms of transport, from walking and cycling to road and rail transit, to private cars and commercial vehicles. It also includes ancillary services, such as parking space identification and payment, traffic management, road and rail maintenance. Increasing the deployment of ITS services and their usage must take into account all these forms of transport and ancillary services. This is not a simple matter, as mobility services directed at in-vehicle systems for any type of road or rail vehicle, whether factory installed or aftermarket fit, are very different from those for mobile devices, such as smartphones, which have no direct interfaces to a vehicle and its internal systems.

Mobile devices and so-called ‘mobile apps’ are proliferating and are providing users with the ability to navigate, obtain position-related information and book and pay for travel. Taxi booking and payment apps (e.g. Uber and Lyft) can be found in cities around the world. These systems require only an Internet connection to both download the applications from app stores like *Google Play* and *Apple’s App Store*, or directly from developers, and to use them. Some on-board devices used for information and entertainment operate in a similar way as mobile devices, requiring only an Internet connection. However, most on-board devices communicate using a special purpose infrastructure, and here is where the complexity lies. The OEMs want to ensure safe usage and a clear relationship between the services and the brand.

### 6.2 Volvo Sensus Connect

Volvo Sensus Connect and its Ericsson-provided Volvo Cloud is a case study example of this.

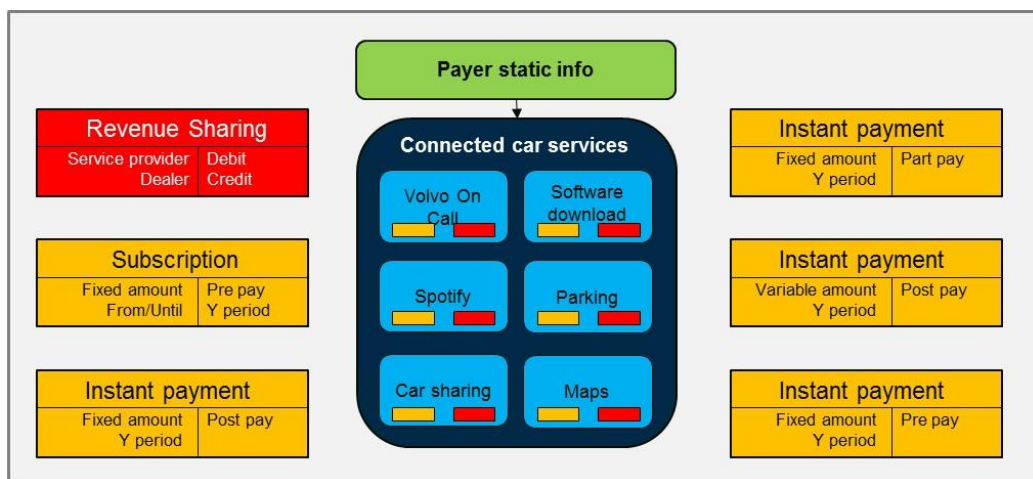


Figure 26: Volvo Sensus Connect Services and Payment Methods (Source Volvo Cars)

Volvo’s car services are enabled by Ericsson’s Connected Vehicle Cloud include a Park & Pay solution, Connected Service Booking and infotainment applications, such as Spotify, Rdio, TuneIn and Stitcher among many others. There are also placeholders for car sharing and over-the-air software download when they become available.

There are three methods of payment: revenue sharing, as is the case with Volvo On Call; subscription payment for infotainment services; and, instant payment for parking, maps, eventual car sharing and software download. The payment processes are shown in the diagram below.

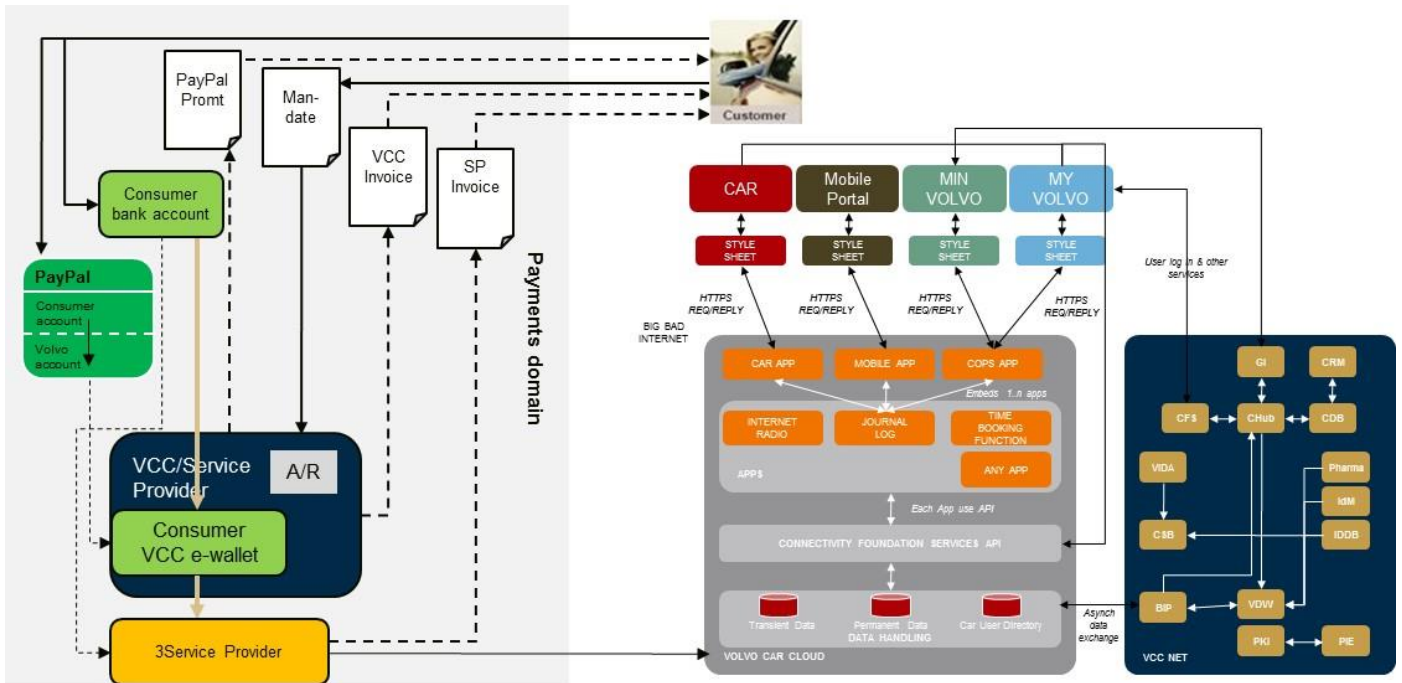


Figure 27: Volvo Sensus Connect Payment Processes (Source Volvo Cars)

The solution is implemented and operated by Ericsson as a managed service of a global cloud-based solution with regional and central nodes. Volvo claims that its ‘Volvo Cloud’ offers greater flexibility to adjust capacity and local presence of content based end-user demands. Ericsson’s systems integration capabilities have been critical in solution design and integration into Volvo Car’s information systems-IT environment and to the head unit in the car. The solution covers all Volvo Cars markets around the globe.

What is most interesting about the contents of the Volvo Sensus Connect Payment Processes diagram is that none of the service providers were suppliers to Volvo—or any car maker—a mere five years ago, and some did not even exist. This is all new ground for the car makers (including the dealers), the suppliers and the customers.

### 6.3 Electric vehicle-related services

Another area of eMobility relates to electric vehicle-related services. So-called ‘range anxiety’ is a real problem for electric vehicle owners. Anyone who has driven a car on ‘empty’ late at night with no sign of a filling station in sight understands what range anxiety is. *Do I need to charge before I leave in order to make it to the next charging waypoint? Will I be able to get to the next charging station before I run out of energy? Where is the nearest charging station and will it have a space for me when I get there? Are there other stations close by?* As the number of electric cars grows, the availability of charging spaces becomes more acute as more cars compete for a space.

Having a value for expected range at the start of trip is not always a good indicator of actual energy use when the vehicle is on the road. There are many variables, such as wind, traffic congestion, slope, climate control usage and number of passengers that affect how far a vehicle can travel on a charge.

Tesla's Model S super-sized display shows the driver a warning if the battery is getting low, and displays the location of charging station—which must be one of Tesla's own since they use a proprietary charging solution. The navigation system provides a route to a selected station. A recent update to the Tesla navigation system software provides real-time data on the conditions at the charging stations so that the driver can choose the best option. The next step is to reserve a space at one of these stations and then pay for the charge.

## 6.4 Services to Drivers

Today, a company offering services to on-board devices either must offer its own devices to consumers or it must deliver the services to a telematics service provider (TSP) that communicates with a specific set of on-board devices. Automobile or truck OEMs that embed devices in their vehicles have contracted with telematics service providers, or they have built their own TSP platforms (e.g., GM/OnStar and Volvo Group WirelessCar). Service providers, such as insurance companies offering usage based insurance, have either contracted with a device manufacturer that also provides TSP services, or they deliver their own devices and have their own TSP (e.g., Allianz Telematics). The customers of vehicle OEMs or service providers who deliver systems are entirely in the hands of the system providers. The system supplier creates the content and service eco-system, and this is what is available to the customer who agrees to have the system installed in his or her vehicle. If a consumer wishes to have a different user experience with a different set of content and service providers, he or she must purchase a new brand of vehicle or have a new system installed in the vehicle—or else obtain services via a smart connected consumer device.

There are two reasons for this. First, vehicle manufacturers in particular see integrated mobility services as a core and highly strategic part of their business—and having invested heavily in their development, they have a strong interest in gaining the most out of the systems' increased market acceptance. OEMs do not want to give up control of the differentiating features that distinguish their vehicles from their competitors. Equally important, for reasons of safety, security and the maintenance of their customers' privacy, the OEMs are obliged to keep mission critical systems or data with trusted third parties. Automotive grade applications demand full control over the end-to-end data flow, from inside the vehicle between all of its components through the telecommunications network and the telematics service provider. This is a strong reason for keeping the in-vehicle systems private and proprietary, fully under the own control of the OEM and its trusted suppliers.

Buyers of General Motors vehicles will increasingly be able to use in-car mobile broadband systems via the standard OnStar system—whether or not they are OnStar

service subscribers—to book hotel rooms, cut deals on driver insurance, pay for data usage and conduct a host of other transactions. Each time they do, GM will get a small commission from the seller, just like Google or TripAdvisor. This is in addition to taking a percentage of the fee for the mobile telecommunications services that are paid via OnStar to AT&T, the provider of the 4G LTE SIM-chip.

Taking a percentage of e-commerce transactions conducted on in-car systems is one obvious revenue generator, but automakers also expect that software upgrades pushed through a broadband connection will one day save them hundreds of dollars per car in repair costs. And they are looking at developing other features as well, such as automatic order placement when a car approaches its driver’s favourite coffee shop or fast-food outlet. All major automakers are investing heavily in hardware and software to connect drivers to the mobile web. But it hasn’t been clear how the manufacturers would generate revenue from their connected cars, or how that money would be divided among the service partners.

Apparently, GM debated whether it was wise to publicly reveal its profit target. Phil Abram, GM’s director of the company’s connected car strategy, said: “In the end, the company decided that pulling back the curtain was part and parcel with painting a vision for the future. It also could help GM with investors who question whether we risk being undermined as cars become increasingly digital devices.”

## 6.5 Mobility-as-a-Service

Some pilot tests has been performed offering Mobility-as-a-Service by using different kinds of transport modes, e.g. UbiGo in Göteborg. The San Francisco based companies Uber and Lyft are global actors offering services via mobile apps. Uber is more similar to taxis and Lyft offers peer-to-peer ridesharing.

GM Opel announced in July, 2015, that it would invest in the ridesharing platform *flic*. GM Ventures (GMV), the investment division of General Motors, will lead the investment. The technology used for *flic* will play an important part in extending Opel’s mobility service offer throughout Europe. Here is how *flic* works:



Enter a ride offer or ride search at *flic*: Start, destination, time, done!



*flic* will automatically find somebody nearby with a suitable destination.



Somebody wants to share a ride with you - we will immediately send you a message!



Confirm and look forward to your *flic* ride.

Figure 28: Ridesharing with *flic* (Source *flic*)

Opel and *flic* are already working together successfully. A pilot project including an internal ridesharing platform for Opel employees in Rüsselsheim was launched in

March. Currently, 9,000 rides per month are shared via the app-based platform, with an upward trend. In June, the partners also announced an expansion of the cooperation. From 2016, flinc will provide the technological platform so that rides can be shared via Opel's CarUnity.

Daimler AG has been working with car sharing since 2008 with its Car2Go service. It started in Ulm, Germany and has spread to eight countries and twenty-nine cities with 13,000 vehicles (Smart Fortwo) and 1 million customers. The business model works like this: The company charges a per-minute rate, discounting fixed rates for hourly and daily usage. The rates are all-inclusive and cover the use of the vehicle, fuel (electricity and petrol), insurance, parking in authorized areas and maintenance. In some markets, a low, fixed annual fee is charged. Mobile apps offered by Daimler and third parties allows users to locate and reserve vehicles. When reserving, the user sees the status of the fuel gauge or electric charge.

Mobility-as-a-Service is expected to grow in the near future. Connected cars are a basis for this growth. The possibility to process large amounts of data (Big Data Analysis) will pave the way for mobility-as-a-Service. One can also expect new actors entering the market and the development of new business models.

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*Mobility-as-a-Service – Future expectations of the next generation of drivers will be different from those of this one. Car and ride sharing, or on-demand transport (We would call it taking a taxi.) will exist in larger proportions alongside car ownership and own-car driving. Added to this, several non-traditional car makers, including Google, Apple and Virgin, have already unveiled plans to develop cars or dropped unmistakable hints that they intend to enter the market. It is still unclear what level of disruption these trends will cause, but it is certain that there will be more ways to travel in the future than at present, and that both travel and vehicles will be viewed more as a service.*

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## 6.6 Crowdsourcing

### 6.6.1 Overview

Crowdsourcing is a popular concept where ideas, content or any tasks or services humans can provide are obtained from a large group of people. This typically takes place using Internet services and applications that enable the distribution of the task in small pieces to several performers. Estellés-Arolas & González-Ladrón-de-Guevara (2012) give the following comprehensive definition for crowdsourcing:

*“Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open*

*call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage that which the user has brought to the venture, whose form will depend on the type of activity undertaken.”*

Doan et al. (2011), in turn, give a classification of different kinds of crowdsourcing activities as shown in Figure 28.

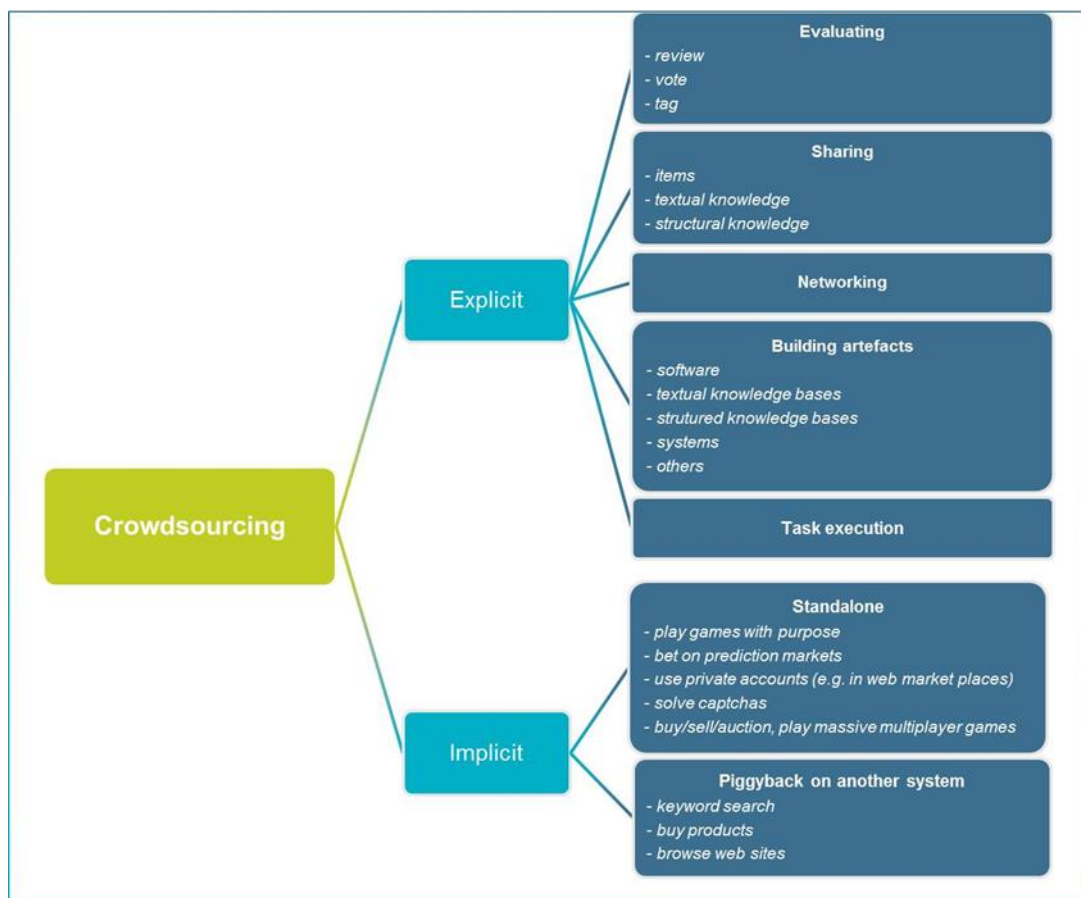


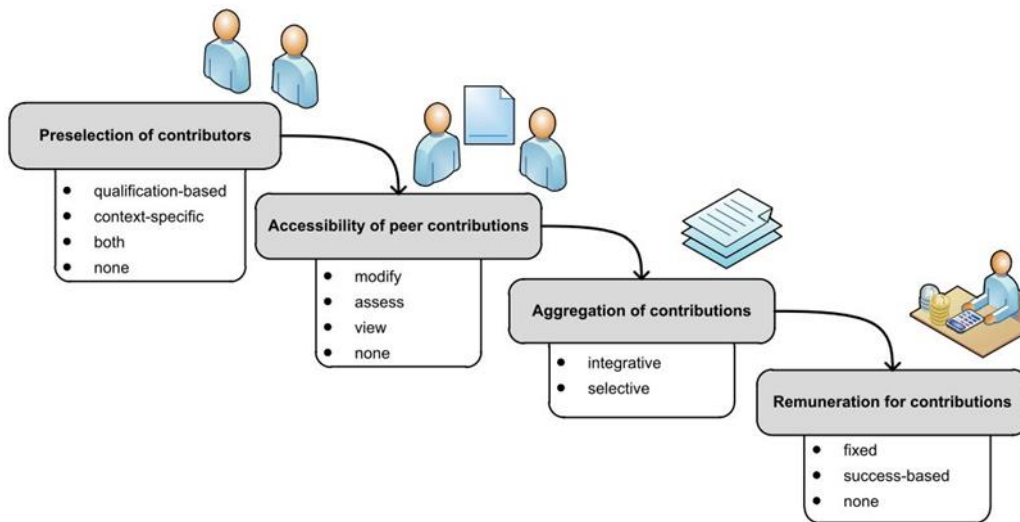
Figure 29: Crowdsourcing classifications according to Doan

Geiger et al. (2011) depict the typical crowdsourcing process as four dimensions of activities as depicted in Figure 29. In the first dimension of crowdsourcing process specifies what kind of criteria is set for the potential contributors. The criteria may be based on the skills or knowledge of potential contributors (qualification-based preselection) or restrict out contributors having certain background, e.g. belonging to the organization performing the crowdsourcing activity or belonging to some demographic group characterized by age, country, gender etc. (context-specific preselection). In some cases, both kinds of restrictions are applied. In most cases, no preselection is done to allow as much diversity among the contributors as possible.

The second dimension distinguishes crowdsourcing processes by the extent

contributors can access each other’s contributions. The categories none, view, assess, and modify defines the increased accessibility degrees in the process.

The third dimension describes how the contributions received in the crowdsourcing process are used by the organization exploiting the results. In integrative approach all the received results are used unless they fail to meet the set quality requirements. In the selective approach, in turn, the received contributions are compared and only the best of them are used.



*Figure 30: Typical crowdsourcing process by Geiger et al. (2011)*

The fourth dimension, remuneration for contribution, is dealing with the compensation of the crowdsourced work. The reward may be fixed, when everyone giving the contribution is rewarded, or it can be success-based when the value of the contribution determines the reward. In many cases, no direct compensation is provided for the contributors, which means that there must be some other catch to attract people for contribution.

In Figure 30, Geiger et al. (2011) give examples of crowdsourcing and clustering them according to the four dimensions introduced above.

Clusters of process types	Crowdsourcing examples with the same process characteristics	Aggregation of contributions	Accessibility of contributions	Remuneration for contributions	Preselection of contributors
Integrative sourcing without remuneration	Delicious, Digg, Facebook Translations, Fashiolista, TripAdvisor, YouTube, Amazon user reviews and ratings	integrative	assess	no	no
	Camclickr, Google Image Labeler, ReCaptcha, Hollywood Stock Exchange	integrative	none	no	no
	Wikipedia, OpenStreetMap	integrative	modify	no	no
	Angie's List	integrative	view	no	no
	eBay reputation system	integrative	view	no	context-specific
	Emporis Community	integrative	modify	no	qualification-based
Selective sourcing without crowd assessment	NetfliX Prize, InnoCentive Challenge Center, 99designs (private contests), Brainrack, Calling All Innovators, Crowdspring (private contests), Designenlassen.de (private contests), idea bounty	selective	none	success-based	no
	99designs (public contests), Crowdspring (public contests), Designenlassen.de (public contests)	selective	view	success-based	no
Selective sourcing with crowd assessment	Atizo (Atizo Community), Cisco I-Prize, Threadless	selective	assess	success-based	no
	Atizo (Own Community), InnoCentive@Work	selective	assess	success-based	context-specific
	Dell IdeaStorm	selective	assess	no	no
Integrative sourcing with success-based remuneration	Android Market, Apple AppStore, Yahoo! Contributor Network	integrative	assess	success-based	no
	iStockphoto, YouTube Partners	integrative	assess	success-based	qualification-based
	99designs ready-made logo design	integrative	view	success-based	qualification-based
	Coolspotters	integrative	modify	success-based	no
	Iowa Electronic Markets	integrative	none	success-based	no
Integrative sourcing with fixed remuneration	e-Rewards, Microtask	integrative	none	fixed	context-specific
	LiveOps, Castingwords	integrative	none	fixed	both
	Mechanical Turk	integrative	none	fixed	no

Figure 31: Crowdsourcing examples by Geiger et al. (2011)

### 6.6.2 Geo-socializing

Geo-socialization is predicted to be the next big trend in social networking and among the top global mega trends to 2020 (Frost & Sullivan, 2010). Geo-socializing combines social networking and geographic services (e.g. location services) so that social activities get a geographic context. With mobile location-aware devices this also bridges the real and virtual when a user with a location-aware application on his smart phone bumps into interesting location bound digital objects (e.g., recommendations from the user's peer communities).

As social networking and related activities are bound to locations, the service providers get invaluable information about users' whereabouts and their activities in those locations. This, in turn, creates possibilities for, among other things, targeted marketing, planning business according to consumer behaviour and tailoring campaigns and special offers that are bound to context. Here, effort has to be put into convincing the customers that privacy and security aspects are appropriately managed.

As an example of geo-socializing services, *Foursquare* (<https://foursquare.com/>), and associated mobile application *Swarm*, lets users publish their locations to their fellow users as check-ins to different kind of locations. It also gives the possibility to review places and give tips. For business users, it allows the ability to claim a location for themselves and provides tools for managing information related to the locations. In this way, they and their offering can be seen by the nearby *Foursquare* or *Swarm* users (Figure 28).

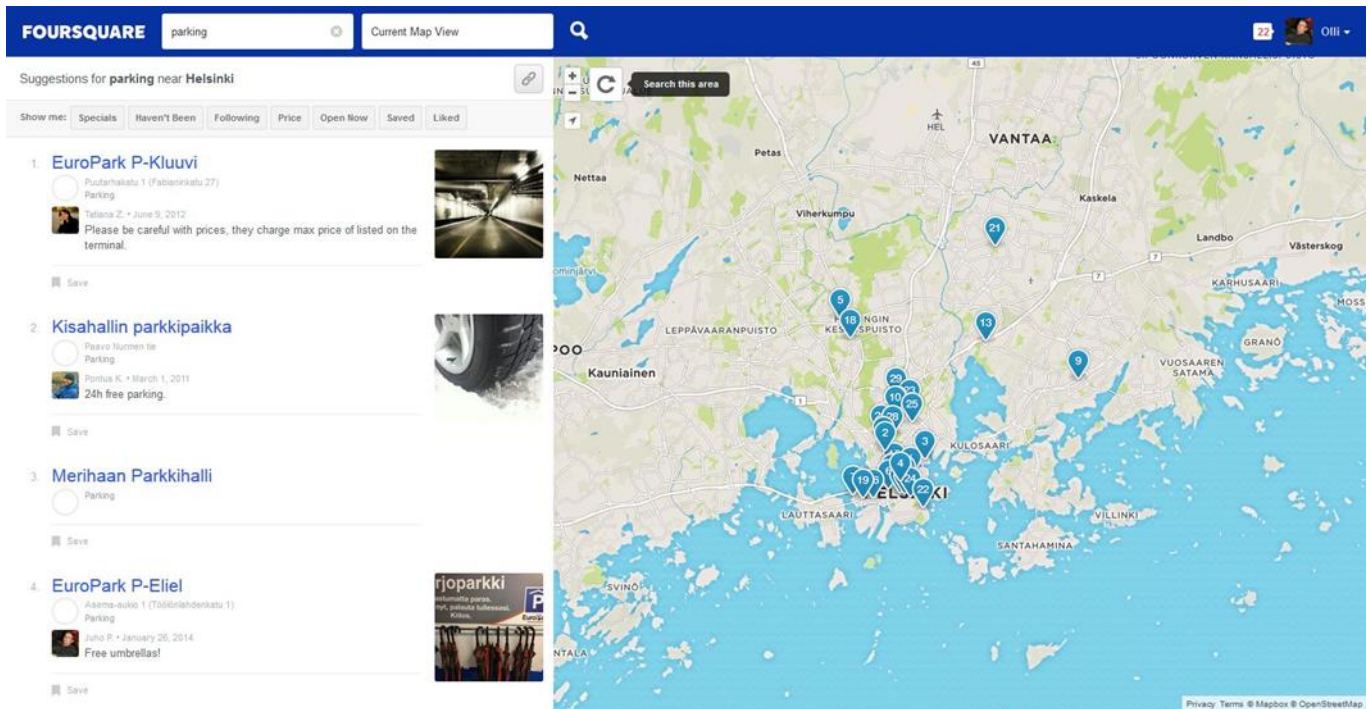


Figure 32: Foursquare is an example of geo-socializing services allowing collaborative aggregation of geographical information.

In the mobility service genre, Waze (<https://www.waze.com/>) is a good example of how geo-socializing can be harnessed into collaborative work and crowdsourcing as users contribute to map editing as well as providing traffic incident information. At the same time, it allows users to coordinate their mobility with others by seeing each other's location.

When Waze started, its stated strategy was “to work in cooperation with drivers worldwide to create the world's first live driving map, providing users with the real-time road intelligence they need for better every day driving.” It took three years before it began to monetize its product. The venture funding it obtained was used to build up its operational infrastructure to process and deliver data worldwide and to expand its corporate and marketing capabilities. It moved its headquarters from Tel Aviv to Palo Alto in anticipation of an acquisition, which was made by Google in 2013 for \$1.1 billion. Why Google bought Waze:

- Waze, as a crowdsourced location platform, gives Google an additional, very mobile-based angle on this concept, letting users not just share places (i.e. sites) visited on the web, but actual places they have visited. The CEO of Waze, Naom Bardim said: “What search is for the web, maps are for mobile.” By this, he means that most of the searches you do on mobile have to do with location, and Waze is one of the few companies that brings that kind of search together with actual map data and a social layer.
- Competition. Waze gives Google a wedge into the mass of consumers who are already using the Waze app on iOS devices. It also gives Google a way of controlling how companies like Facebook could use Waze's assets. As Waze had pointed out, it is not a mapping company, but a **big data** player. Facebook, making its own big push on mobile, would have been a natural

home for a socially-focused company like Waze, which also happens to be one of the few home-grown mapping databases around. This will mean that Facebook will need to have to continue to use third-party data for its own location-based searches and information, or less look to acquire elsewhere.

Geo-socializing features may increase attractiveness of applications for end users by adding location-awareness to their social software. Users adopting location-aware services into their use provide great benefits for B2C service providers as they are provided with invaluable information about their customers' behaviour and contextual needs. When this customer information is not collected by separate service providers but instead by the platform supporting services, the benefits of the information would be even greater. This is because the platform operator can act as a trusted party who, before giving this information to anyone's use, anonymizes and manipulates the user related information so that no privacy is violated. In addition, when information is not in service specific silos, the information covering all the services gives a better view on user's behaviour by vastly increasing the amount of available data.

## 7 Business models - overview

### 7.1 Overview and Definitions

Noted management consultant Peter Drucker described a business model as the answer to the questions: Who is your customer; what does the customer value; and, how do you deliver value at an appropriate cost? Clayton Christensen, Harvard Business School professor, researcher and author of a number of books and articles on 'disruptive technology', says that a business model should consist of four elements: a customer value proposition; a profit formula; key resources; and, key processes. Ramon Casadesus-Masanell, also of Harvard Business School, and Joan E. Ricart of the IESE Business School in Barcelona, have performed extensive research on the subject of business models and have offered a refinement of previous formulations: a business model consists of a set of managerial choices and the consequences of those choices<sup>12</sup>.

Every choice that management makes has a consequence. A *policy choice*, such as choosing the location of a company's office (centre city or suburban office park) has consequences for the cost of space, amenities that can be offered to staff and visitors, and the types of staff the company can attract. An *asset choice*, such as whether to build an internal workforce or outsource production, has consequences in transportation costs, quality control and vulnerability to political upheavals. A *governance choice*, such as whether to own or lease the equipment and facilities used by the company, has consequences in the eventual value of the company.

The term **business model** has been used interchangeably with both **strategy** and **tactics**. These terms are not interchangeable; each has a distinct and explicit meaning, and each is essential for the successful operation of an enterprise. A business model is based on a selected strategy, or what could be called the logic of the company. Strategy is concerned with building competitive advantage in a specific industry or market niche. The business model follows from the strategy. It reflects the choices and consequences of those choices embodied in the strategy. It describes how the company operates in order to deliver its products or services and generate profits and value for its stakeholders. *Tactics* are the choices that can be made once the business model is chosen. As an example, a car company that chooses to sell its cars directly to customers, as Tesla Motors does, cannot use added incentives to dealers, such as higher commissions, to increase sales. Nor can it benefit from having a customer who required roadside assistance service seeing the latest offerings at the dealership when picking up his or her vehicle after service. Those tactics are closed to the direct sales company. Therefore, the business model determines the tactics that can be used to compete.

The following diagram illustrates the relationships between strategies and business models, and business models and tactics.

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<sup>12</sup> Casadesus-Masanell, R. and Ricart, J.E., "How to Design a Winning Business Model"; Harvard Business Review (January-February 2011).

## Strategy, Business Model and Tactics

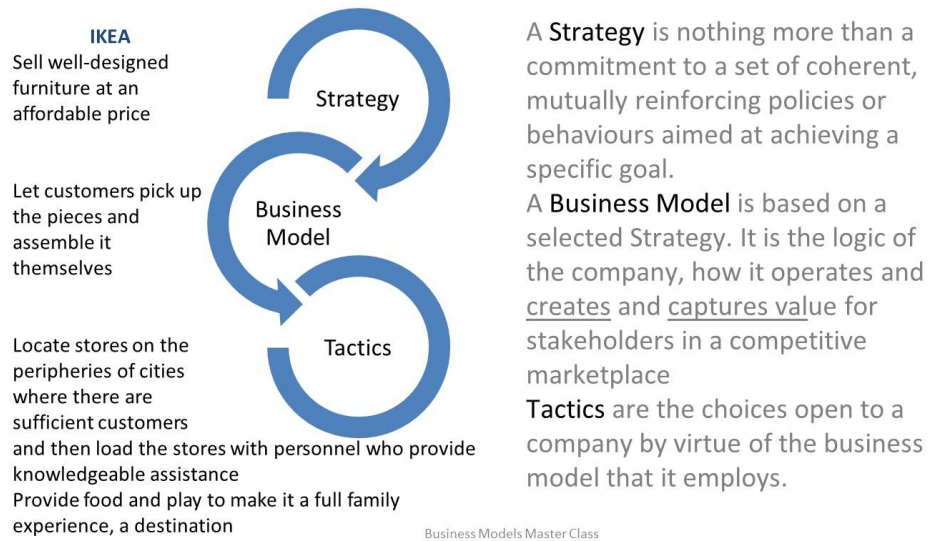


Figure 33: Strategy, Business Model and Tactics (Source M.L. Sena Consulting AB)

What constitutes a good business model? Firstly, based on the premise that a business model evolves from the company's strategy, a business model must fit the company's overall goals. IKEA is a textbook example of a company with a clearly defined strategy, a totally consistent business model and brilliant tactics tailored to the business model.

Trying to adopt the business model of a competitor or of a successful company in another industry without changing the company's own objectives can only lead to disastrous results. Consider how some airlines have reacted to low-cost rivals, like Ryanair, by simply dropping fares and removing services from their flights. The successful low-cost airlines have created their business model based on the strategy of being the lowest cost alternative for air travel. Everything is designed to be the lowest cost from the ground up (literally and figuratively): Spartan headquarters; non-unionized workforce; secondary airports; low fares; nothing is free<sup>13</sup>. A Ryanair business class would be as unthinkable for Ryanair as paying for a drink in first class on Singapore Airlines.<sup>14</sup>

Airlines that have continued to offer full services to some customers and on certain routes have had no chance to compete with a business model that matches Ryanair's. Ryanair has the lowest unit costs of any European airline and one of the lowest of any airline in the world. Whether measured by cost per available seat kilometre (CASK), cost per seat, or cost per passenger, Ryanair's production of capacity and traffic costs it less than that of any of its competitors.

<sup>13</sup> Michael O'Leary, the CEO of Ryanair, jokes that he will make the toilets pay-per-use. Many believe that it is not a joke.

<sup>14</sup> Following initiatives to improve customer service, Ryanair has also recently (2014) launched its *business traveller* product. This is a bundled product offering a range of features for a single fee, including booking flexibility, fast lane security, choice of reserved seating in 'premium' rows (front row, over wing with extra legroom), and a checked bag.

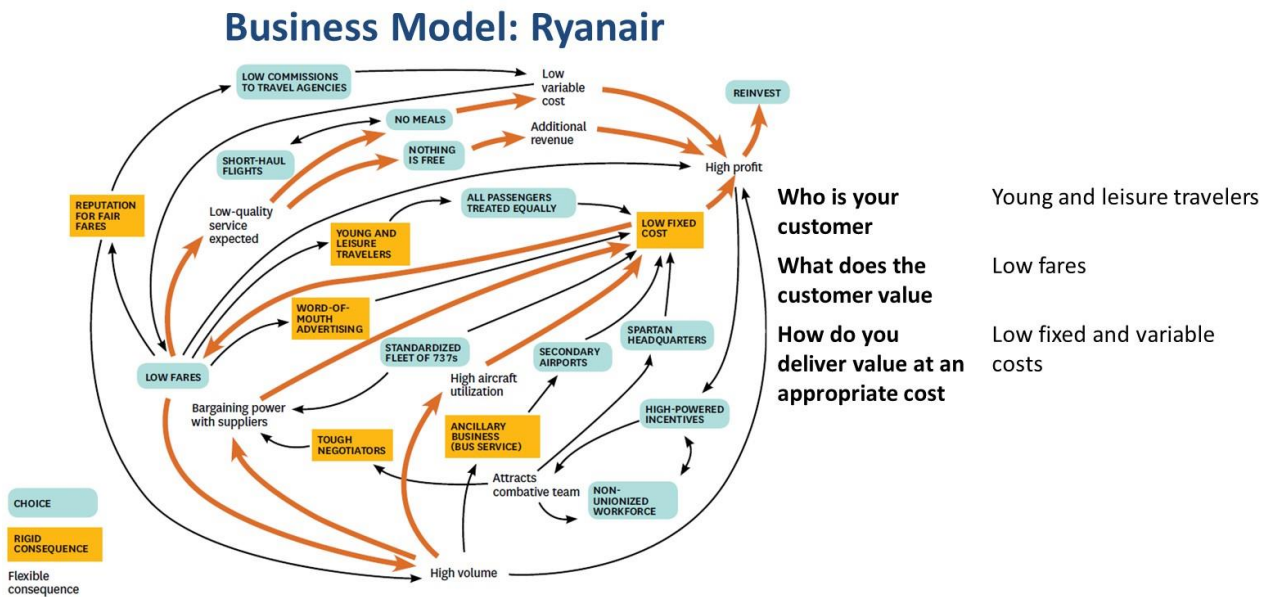


Figure 34: The Ryanair Business Model (Source Harvard Business Review)

Secondly, a good business model must be internally consistent and self-reinforcing. Dell Computer revolutionized the PC industry when it began selling its computers directly to customers. It applied just-in-time techniques developed by the automobile manufacturers to reduce storage space costs, and it developed standardized components that could be mixed and matched in ways that allowed them to create tailored products to meet specific customer demands, while still delivering relatively low prices. If Dell had opened up a chain of stores to match Apple’s retail outlets, or if it had delivered finished computers to retail outlets like HP and Compaq, it would have been an inconsistent and counter-productive policy choice.

Thirdly, a good business model must be able to withstand the big four threats<sup>15</sup>:

- Imitation – If competitors can copy your business model—and adapt your strategy—the model is flawed. IBM lost its position as a supplier of computer hardware not only because it continued to focus on expensive mainframe computers, but also because other companies entered the market with the same strategy and business model and competed better on price and service.
- Hold up – If your customers or suppliers or other players can capture part or all of the value you create because they have a superior bargaining position, you need to close the leakage. Automobile companies are notorious for pushing their suppliers to give progressive price reductions in return for being awarded contracts. Government agencies often demand caps on profits and allowable expenses.
- Slack – Companies can become complacent and miss opportunities to increase market share and profitability. Companies must constantly search for new ways to revitalize their business models. Car OEM Tier One suppliers have tried to benefit from the OEMs’ quest for fewer suppliers by acquiring adjacent businesses and delivering larger components (e.g. a fully integrated dashboard

<sup>15</sup> Ghemaway, Pankaj and Rivkin, J.W.: Creating Competitive Advantage; Harvard Business School Note 798-062.

instead of just an audio system).

- Substitution – Competition does not always come from similar products. New products or services that accomplish the same result can be a major threat. The printed road atlas and road map business was relatively safe as long as navigation systems in cars were luxury items, but as soon as less expensive portable navigation devices appeared, sales began to drop. When street maps started being delivered on smart phones equipped with GPS positioning, both paper map sales and the sales of PNDs withered.

## 7.2 Business Model Canvas

The Business Model Canvas, developed by business consultant Alexander Osterwalder, is a convenient tool for designing and implementing business models. By describing nine building blocks, the tool provides a single page overview (the ‘canvas’) of how an organisation creates, delivers and captures value in relation with the external domain (i.e. customers, partners and suppliers).

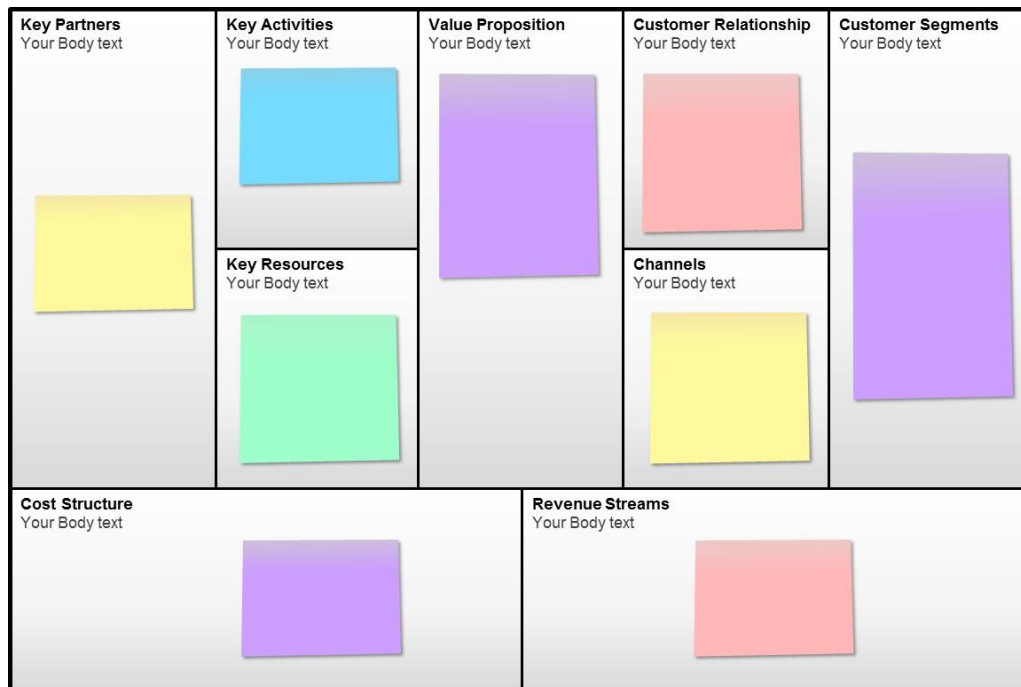


Figure 35: Business Model Canvas (Alexander Osterwalder)

The nine basic building blocks show the logic of how a company intends to make money, or to achieve its goals in case of a not-for-profit organization. The nine building blocks cover the four area of a business: customers, offering, infrastructure and financial liability:

1. Customer segments: defines different groups of people or organizations an enterprise aims to reach and serve;
2. Value propositions: describes the bundle of products or services that create value for a specific customer segment;
3. Channels: describes how a company communicates with and reaches its customer segments to deliver a value proposition;
4. Customer relationships: describes the types of relationships a company establishes with specific customer segments;

5. Revenue streams: represents the cash a company generates from each customer segment;
6. Key resources: describes the most important assets required to make a business model work;
7. Key activities: describes the most important things a company must do to make its business model work;
8. Key partnerships: describe the network of suppliers and partners that make the business model work;
9. Cost structure: describes all cost incurred to operate a business model.

What the canvas does not show are the relationships among these building blocks indicating how value is created, what choices are available and what the consequences are of those choices. The simple diagram below provides an easy-to-grasp snapshot of the key partners, key activities, customer segments, customer relationships, channels and revenue streams. What is missing is the value propositions, resources and cost structure.

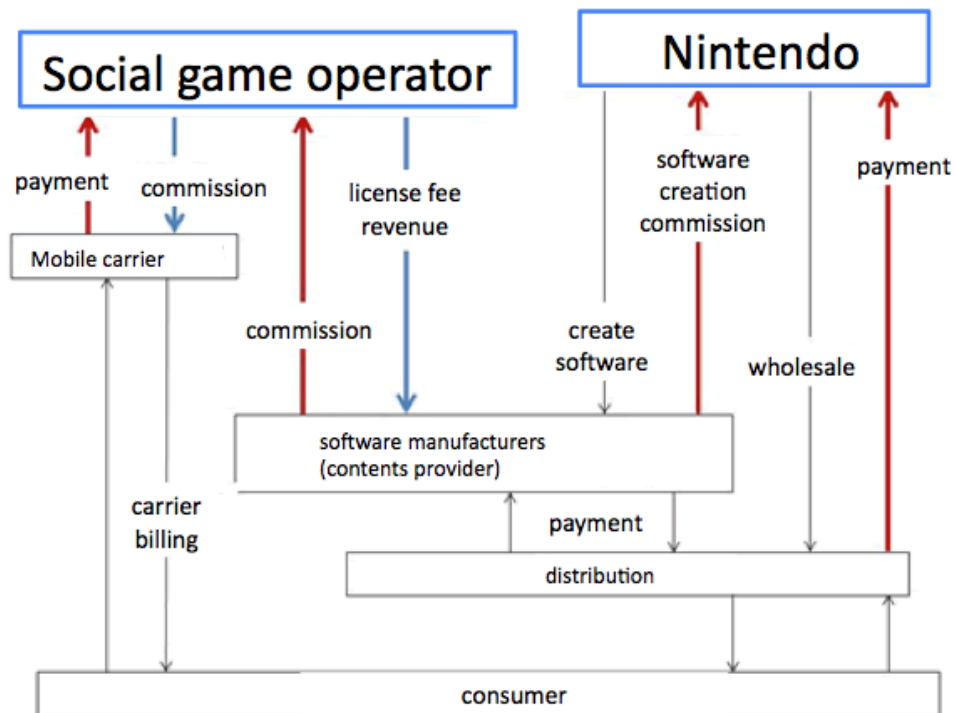


Figure 36: Revenue Flow Business Model (Source unknown)

The diagram below of the TomTom Connected Navigation device is similar to the revenue flow business model, but it adds the missing pieces. The value to the consumer is not the device, which is purchased from a retailer, but the ability to routed with up-to-date traffic information and the periodic updates to the map data. For TomTom, the value of selling a system is not only receiving payment for the system and payment for on-going services, but it is also receiving the probe data from the system which enhances the value of the traffic information for all customers.

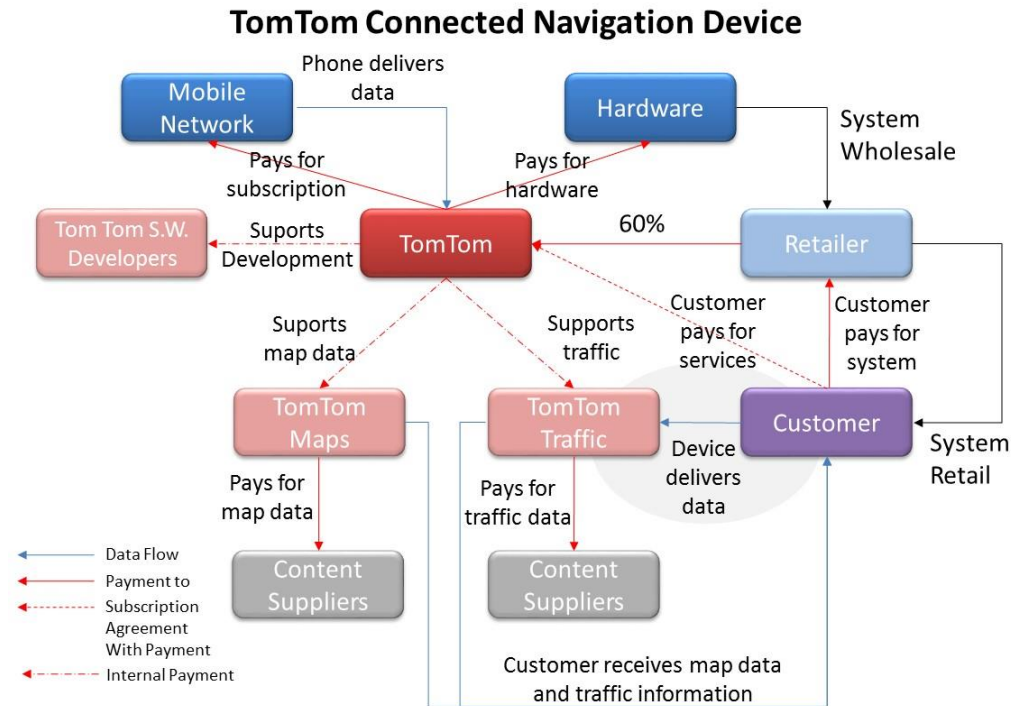


Figure 37: Revenue Flow with Value Propositions, Resources and Cost Structure (Source M.L. Sena Consulting AB)

### 7.3 Business models for profit organizations

Ultimately, the goal of a for-profit company like Scania, AB Volvo or Volvo Cars is to earn enough money to generate a profit and reward its owners and to have enough left over after all costs are paid to re-invest in research. The policies and behaviours that form the strategies of such companies are aimed at achieving the profitability goal. Any activity, whether it is encouraging customers to use OEM-owned service facilities or to choose a preferred supplier of insurance, is aimed at generating higher sales and, preferably, higher margins on those sales. For example, one of the principal benefits of an OEM-sponsored roadside assistance program is that when a call is made to the OEM’s roadside assistance supplier, the vehicle will be taken to an authorized OEM workshop, rather than the workshop of the tow truck operator, as would be the case if the customer phoned to a motor club or another third party assistance provider. At the authorized workshop, the parts and services sold will generate revenue for all members of the OEM’s ecosystem. And, as mentioned above, the customer will have the dealer will have the opportunity to present its new cars in ways that should appeal to the customer. The value generated from these direct sales and selling opportunities has been judged by the OEMs to outweigh the annual costs of the services which are paid to companies such as SOS International, Viking, Falck, Allianz Global Assistance among others for delivering roadside assistance.

The business of automobile OEMs includes:

- Selling new cars at a profit;
- Selling original options at a profit;

- Selling dealer services at a profit;
- Selling authorized parts at a profit;
- Selling soft services at least at breakeven; so that
- Customers are satisfied, return to buy their next car, give the company high marks on consumer surveys and recommend the car to their family and friends.

There are big differences among the car OEMs on how they accomplish these tasks, depending on the segments in which they compete (e.g., luxury, mass market, very low cost) and the geographic markets where they are most active. Nevertheless, they have the same basic business model, which is shown in the diagram below. New car sales are interlinked with aftermarket parts, services and accessories.

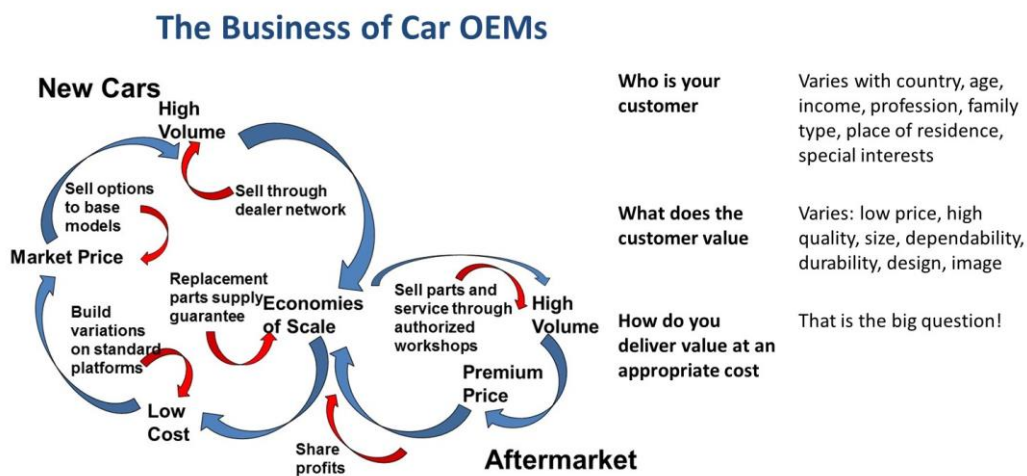


Figure 38: The Business Model of Car OEMs (Source M.L. Sena Consulting AB)

One of the reasons the automobile and truck industry companies in general have been among the lowest valued according to market capitalization<sup>16</sup> is that they are among lowest profit margin businesses. According to 2015 US figures compiled by New York University<sup>17</sup>, their net margin is less than one-half the industry standard (3.16% versus 7.84%). By comparison, Apple’s market capitalization in June, 2015 was \$729 billion. Google’s was \$537 billion. General Motors’ market cap was \$58 billion and Fiat Chrysler’s was \$20 billion. In July 2015, Uber, the multi-national taxi company, had a market capitalization of \$50 billion (although its shares are still private), its revenue projected to year-end 2015 is just under \$2 billion and it continues to lose money. GM had revenue of \$156 billion in 2014, and a net income of \$2.8 billion. Investors simply see a much higher upside to Apple and Uber compared to the car makers.

The question that vehicle manufacturers continue to ask themselves is whether there is something they can do to change the perception of investors, to make them believe that car and truck companies are totally undervalued and deserve a higher market capitalization. The Connected Car is finally being accepted by most car manufacturers

<sup>16</sup> Market capitalization is a method of assessing the value of a company by multiplying the number of shares by the stock market price.

<sup>17</sup> <http://www.stern.nyu.edu/~adamodar/pc/datasets/margin.xls>

as one way to increase their valuations by expanding beyond the business model they have had for most of their one hundred year history. Big Data could be the one key ingredient that is needed to help support new business models.

## 7.4 Business models for Governmental organizations

Do governmental authorities, like Swedish Transport Administration, have business models? Yes, they do.

*“...if an organization has a viable way to create, deliver, and capture value, it has a business model. It doesn’t matter whether an organization is in the public or private sector. It doesn’t matter if it’s a non-profit or a for-profit enterprise. All organizations have a business model. Non-profit corporations may not be providing a financial return to investors or owners, but they still capture value to finance activities with contributions, grants, and service revenue. Social enterprises may be mission-driven, focused on delivering social impact versus a financial return on investment, but they still need a sustainable model to scale. Government agencies are financed by taxes, fees, and service revenue, but are still accountable to deliver citizen value at scale.”<sup>18</sup>*

The goals that Swedish Transport Administration would like to achieve are:

- Reduced deaths and injuries from vehicle-related accidents
- Reduction in the amount of harmful emissions from all types of vehicles
- Improved flow of traffic on all roadways and especially to ensure that emergency vehicles can proceed unhindered to where they are needed.

There are metrics that can be applied to each of these goals, and the degree to which the goals are achieved can be measured in the same way monetary profitability can be measured.

## 7.5 Value propositions

### 7.5.1 Vehicle manufacturers

Obtaining Big Data from vehicles begins with fitting the vehicle with a device which both assembles data from the dozens of electronic control units or from the OBDII port and then sends this data at regular intervals, ideally in real time. The systems and the sending and processing of data are costly, so there must be good business logic behind the endeavour if they are to be placed in the vehicles at the initiative of the car OEMs. In addition to earning money on the sale of systems and services, there are five additional reasons why OEMs should want to connect their vehicles in order to increase their value to customers and their shareholders:

- Differentiate Company – Service offerings and new business areas are being developed in order to create a gap between the company and its competitors

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<sup>18</sup> Kaplan, Saul. *Business Models Aren't Just for Business*; **Harvard Business Review** (April 19, 2011)

that customers will view as advantageous, and this attracts new customers which should increase revenue.

- Lower Company Costs – Services are being offered that have a secondary purpose of lowering manufacturing and/or operations costs.
- Reduce Cost of Ownership for Customers – The customer receives verifiable benefits in the form of reduced operations cost and/or higher resale value of the vehicle, and this engenders customer loyalty.
- Gain Competitive Advantage – Actions are being taken to better position the company to increase market share at the expense of its competitors and to advance in new areas where the company was not previously competitive.
- Reduce Company Risk – New processes are being developed for designing, manufacturing, selling and servicing the company’s products that reduce financial and legal exposure.

### Why the OEMs Want to Sell Connected Cars

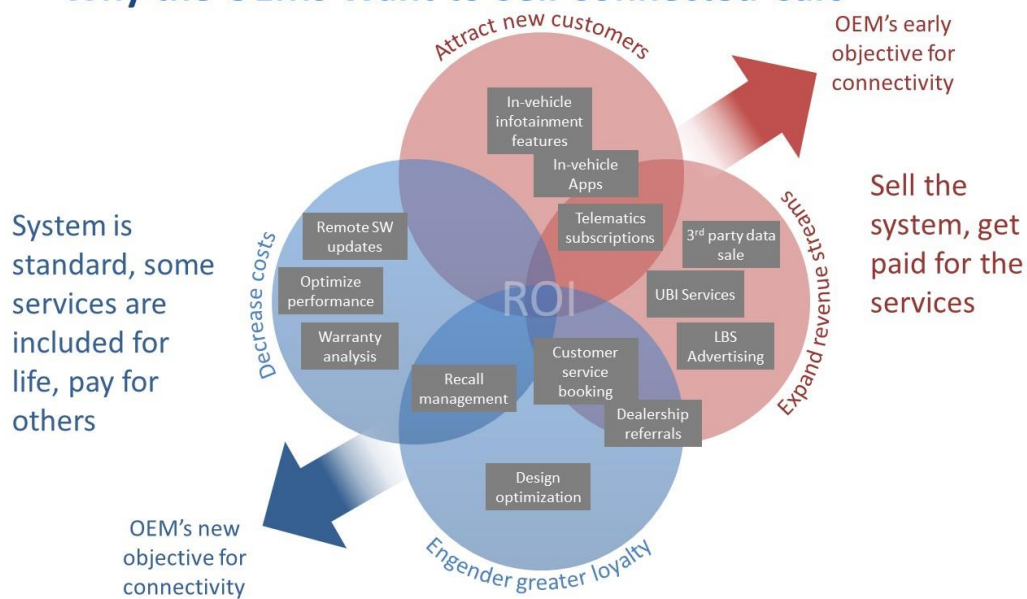


Figure 39: Objectives of selling Connected Cars for an OEM (Source SBD)

There needs to be something in the equation for the customers in order for them to value the connected systems. The most important considerations are what the car buyers want for themselves and their passengers, and what they are willing to pay for these services. Car customers’ purchasing decisions can be summarized in four value propositions:

- Total cost of ownership
- Peace of mind
- Comfort and entertainment
- Design

In the table below are some of the reasons offered for either purchasing or not purchasing a particular vehicle. Everyone has his or her own priorities which outweigh other considerations in any buying decision. Some individuals consider design much more highly than cost of ownership, while others are more concerned with safety over all other considerations.

**Table 3 - Reasons for purchasing or not purchasing a vehicle**

Value Proposition	Reason for Purchase	Reason for not purchasing
Total Cost of Ownership	I (usually) buy what I can afford.	It's too expensive (for what I get). It gets poor fuel economy. Consumer reports say it has high maintenance costs.
Peace of Mind	I buy as much safety as I can afford, and as much security as I need to get insurance.	It gets poor crash test ratings (Euro NCAP or US NHTSA). It's one of top choices of car thieves.
Comfort and Entertainment	I buy the best sound system I can afford and if I have some extra money I will top it up with a navigation system and other goodies.  All the creature comforts need to be included.	It doesn't have the creature comforts that I want.  It has irritating features that I don't like, like the air conditioning controls.
Design	I buy the car that feels right for me, the one that fits the image I have of myself (even if I might not be able to afford it).	It's not 'me'. My kids don't like it My wife/husband hates it It's too big/small It's too flashy/simple  I buy only American or German or British or Italian, etc.

It is possible to overlay the customer's value proposition with the advantages offered by a connected car, as in the table below.

Table 4 - Advantages offered by a Connected Car

Value Proposition	Advantages offered by a Connected Car
Total Cost of Ownership	I save money on fuel, insurance, repairs and communications costs for information.
Peace of Mind	I get help when I need it, where I need, and if I am unprepared for an event, I can ask for assistance.
Comfort and Entertainment	I am connected to all the information sources that I need for all of my different types of journeys, before I start, while I am travelling, and when I arrive.  I can use the devices and information sources that already help me to make my life more comfortable, enjoyable and efficient.
Design	I can tailor the services that I receive to those that I need, those I am willing to pay for and those I want built into the price of the vehicle.

### 7.5.2 Public authorities

As written in chapter 7.4 above the goals for a road authority in general are increased safety, decreased environmental impact and improved traffic flow. The tools and “value propositions” to reach the goals are:

- Provide an appropriate and safe infrastructure in terms of a useful road network equipped with signs, etc.
- Deliver legal frameworks and traffic rules
- Offer information campaigns and other methods to affect travellers in a desired direction
- Supply real-time traffic management and directing of traffic
- Provide accurate and relevant traffic information to drivers and travellers

Swedish Transport Administration works according to a method called the 4-step principle which means that in order to reach the goals and use tax money in a cost effective way, actions should be taken in this order:

1. Rethink and consider actions that can influence the need of transportation, how to travel and when to travel. Information is one of the methods used

make the public aware of different transport options. Legislative changes may also be used.

2. Develop methods for a more efficient use of current infrastructure. This step include better traffic management (and better traffic information) by using modern ITS-technology. Legislative changes may also be used.
3. Limit redevelopment of the infrastructure.
4. Make larger investment in new infrastructure when earlier steps won't work.

Big Data Analysis using data from connected vehicles will be a valuable tool in traffic management and for providing relevant traffic information to travellers. Big Data Analysis will also provide new opportunities for all tools and methods used in the 4-step principle. Processing large amounts of statistical data collected from vehicles and other sensors will increase the understanding of how to build and redevelop the infrastructure in a way more optimized for today's vehicles and traffic. It will also give valuable input to people working with legislative changes as well as input to information campaigns.

## 8 Money flow and data flow for current business models

Money and data flow diagrams indicate who the members are of the ecosystem and what the relationships are among all of the members. When actual values are added for the monetary relationships, it is possible to see where margins are extracted, how profits are generated and how these profits are distributed.

### 8.1 Connected car model money flow

The diagram below illustrates the basic model for a connected car application operated by a vehicle OEM. Money obtained from the customer for the vehicle and connected car systems, along with payments for service subscriptions, flow from the dealer to the National Sales Company (NSC) and then to the OEM headquarters operations for distribution to hardware suppliers, mobile network operators and the service providers. The customer receives vehicle and driver/passenger-related services via the telematics service provider(s).

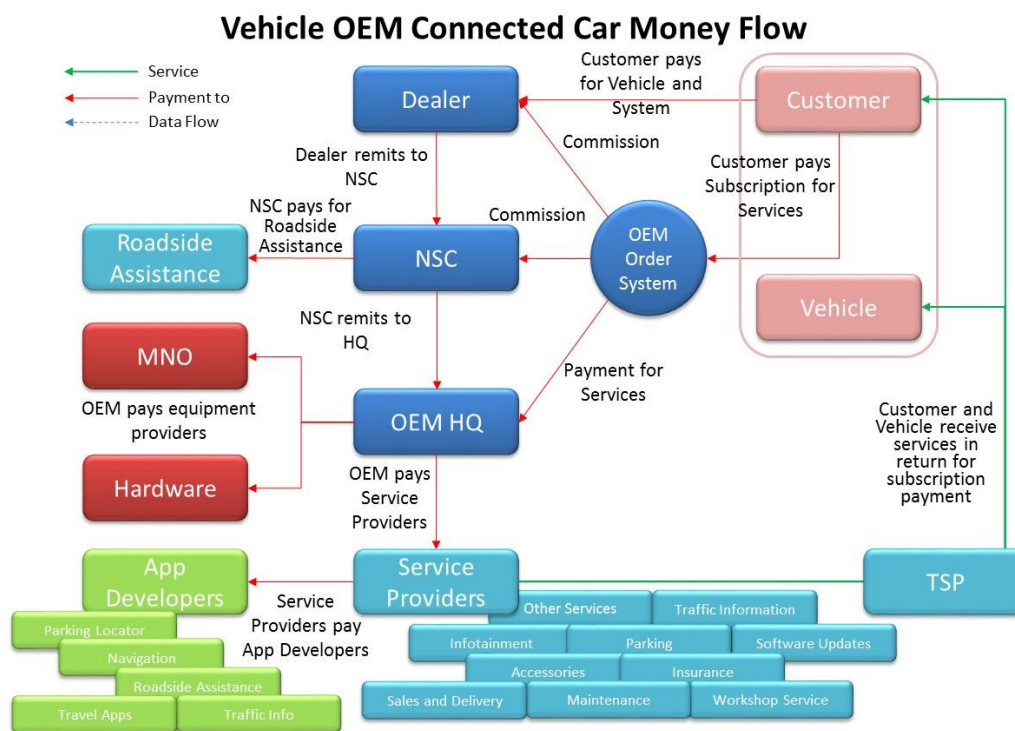


Figure 40: Connected Car Money Flow (Source M.L. Sena Consulting AB)

There are variations on this model applied by certain car OEMs. Mercedes-Benz, for example, turns the customer over to its TSP, Verizon Telematics, who collects the subscription fees and distributes the commissions. BMW pays for roadside assistance through headquarters contracting, rather than through the NSCs in each of the countries. Also, Truck OEM Connected Vehicle Money Flow is very similar to the above model.

## 8.2 Connected car money flow adding the vehicle as data source

What happens when the vehicle turns into a source of data, rather than as a medium for delivering services? A model for this is shown below. One outcome is that the customer can convert his or her vehicle’s data into currency by delivering useful data to service providers via the OEM and receiving payment in the form of services in return. An example of a data user is the traffic authority.

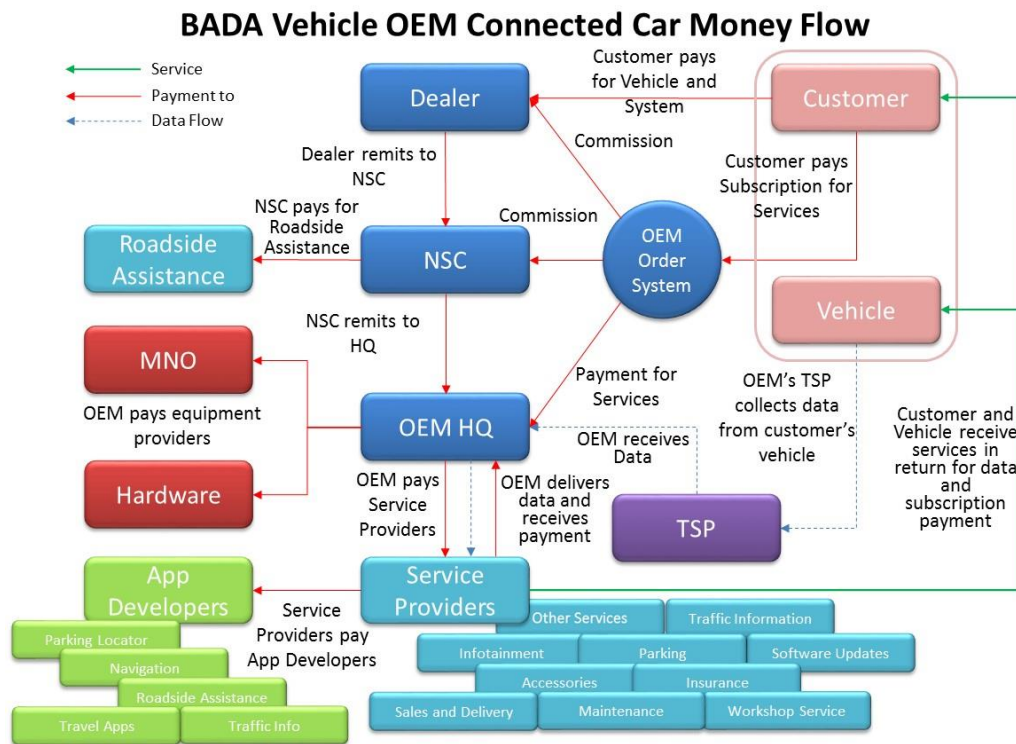


Figure 41: The Connected Car Money Flow adding data flow from the vehicle (Source M.L. Sena Consulting AB)

Another possibility is that the data is used internally by the OEM to achieve one or more of the objectives listed above: differentiation, lower costs, reduce costs of ownership for customer, gain competitive advantage or reduce company risk.

## 8.3 Public and Private Data Sharing

The diagram below shows a combination of societal, personal and financial benefits that flow from the sharing of data retrieved from vehicles. Data is sent from the vehicle via the TSP to the OEM’s Big Data Analytics processor. The data is anonymized, processed according to agreed methods and then passed on to a Service Provider’s Big Data Analytics processor or to the public transport authority’s Big Data Analytics processor. Traffic information and other services are delivered to both the vehicle and the driver, resulting in increased customer satisfaction as well as reduced emissions, fewer fatalities and improved traffic flow resulting from better traffic information.

### BADA Societal Value Flow

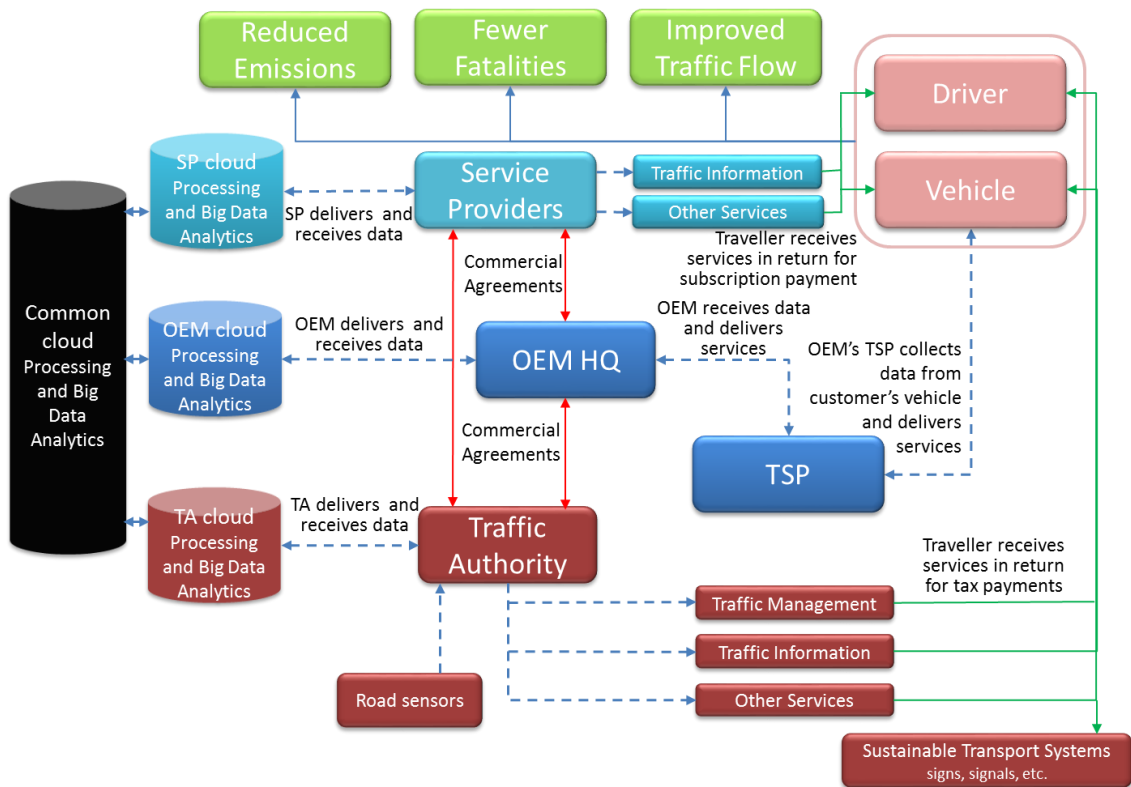


Figure 42: The Connected Car Societal Value Flow including money, data and benefits flow for OEM, Service Providers and a Traffic Authority (Source Swedish Transport Administration)

## 9 Data

### 9.1 Collection of Data

A large number of vehicle sensors are used to collect data at the vehicle. When origin for data is the vehicle the sensors in the figure below can be used to collect the data.

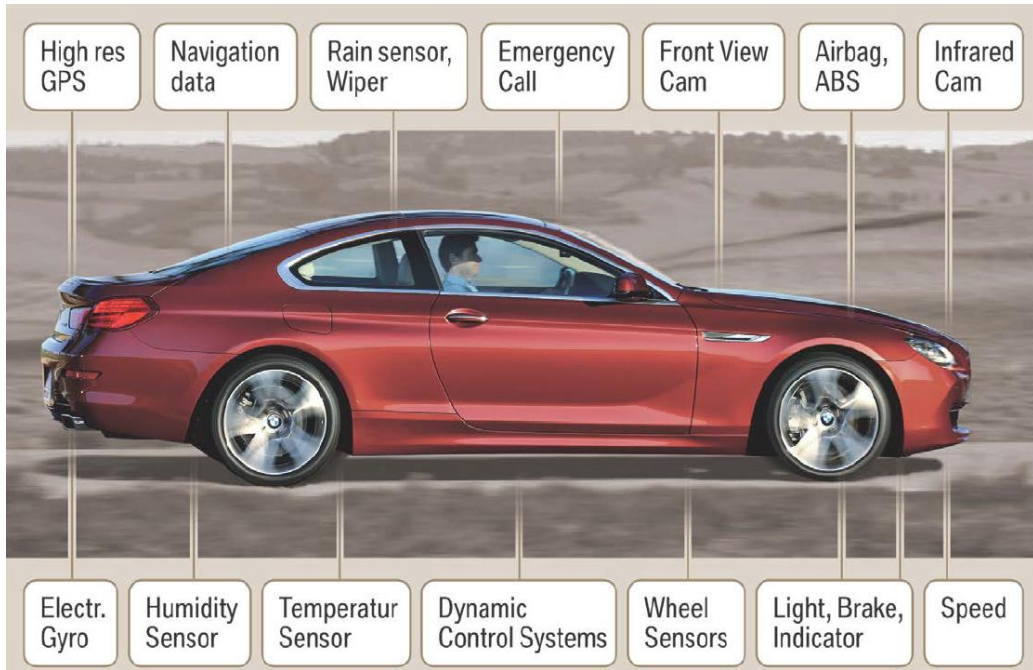


Figure 43: Vehicle sensors (source: BMW AG)

The vehicle sensors can collect an enormous amount of data, therefore it is really important to prioritize which data is most relevant to send to the server side and combine with data from other vehicles and from other kind of sources.

### 9.2 OEMs view on data

#### 9.2.1 Private vehicle

Today, Volvo Cars is storing, processing and sharing certain types of data to support the business, the customer experience and Volvo Car’s business partners. The data may be collected from various different sources, such as the cars, the factory, sales statistics or the customers themselves through CRM systems. The data that is collected is used in some cases to strengthen the current business, reduce costs and create new business opportunities. So far, the aim is not to sell and distribute the data itself, but create an attractive product or service that Volvo cars’ customers want.

As safety is important for Volvo cars and since the great majority of Volvo Cars’ revenues are coming from selling the vehicle itself, Volvo Cars aims to handle personal information or information that could be traced to an individual in a manner that the customer also feels safe and secure in the digital domain. Personal data is defined as data that is related to an identified or identifiable natural person. In order for Volvo to share personal data with a third party, an explicit consent is required. However,

anonymised data can be shared if it cannot be traced to an individual. To be able to collect data from the customer's vehicles, the key is to offer the driver a service that is attractive enough to create a wish from the customers to share their data with Volvo and sometimes other parties. Some examples of these services are the journal log in Volvo On Call for easier expense reporting, and Volvo In Car delivery that enables the delivery of goods from a third party to the trunk of the customer's car.

### 9.2.2 Commercial vehicles

When Scania collects data from its vehicles it is based on a contract with the customer that explicitly allows it, or it is part of an obligation on Scania's part to fulfil legal obligations. Scania views the data created when operating the vehicle to belong to the customer, who is the user or owner of the vehicle.

Today's vehicles are increasingly 'connected' in the sense that they can exchange information wirelessly with the vehicle manufacturer, third-party service providers, drivers, infrastructure operators and other vehicles. This increases comfort and convenience for customers, improves products and services and contributes towards achieving broader goals, such as improving road safety, reducing fuel consumption and facilitating traffic management. For all these purposes, vehicles may collect, store, process and/or transmit data.

Vehicles process data relating to the vehicle itself and its surroundings. Some of these data may be regularly overwritten while others may be stored for a certain period of time or aggregated in statistical form. For example, vehicle-recorded data may relate to:

- Safety and security (e.g., whether airbags have been triggered or whether doors and windows are locked or open)
- Vehicle functionality status (e.g., engine injection, transmission behaviour, fuel level, battery charging level, driver assist systems, malfunctions)
- Driving (e.g., fuel consumption, speed, use of brake and accelerator pedals, steering wheel movement)

Some of the data that are processed are definitely relevant in terms of data protection. Many other data are primarily of a technical nature. This depends on the extent to which they can be combined with other data that may permit the identification of a natural person.

## 9.3 Service Providers and Content Providers view on data

For now, we do not have input from any service providers or content providers regarding their view on data. As data are the core of their business, these actors want to have access to as much data as possible, but they are also very aware of integrity and privacy issues and try to avoid any kind of problem related to these issues. More input from service providers and content providers will come in later versions of the report.

## 9.4 Public Authorities view on data

Traditionally, public authorities have collected all data needed for their operations using their own sensors and detectors. In the last few years, public authorities have started to open up data and to share data with external actors. A change is presently under way and public authorities will not be able to collect all data needed for their operations. This means that extensive cooperation with external actors will be necessary. The overall data flow will change from the current one in which authorities deliver to private actors, to the future, in which private actors deliver data to the authorities.

The Swedish Transport Administration (STA) is prepared to pay for data, but not for financing the whole business of collecting data. STA will see itself as one of several consumers of data collected from vehicles and other sources. STA will also continue to be a producer of data, but not at all as dominant a producer as it has been. STA will continue to be the source for some kinds of data (e.g., regarding traffic rules and traffic management measures).

STA manages the Swedish National Road Database (NVDB) in cooperation with the Swedish Association of Local Authorities and Regions, the associations of Forest industries, the Swedish Transport Agency, and the Land Survey of Sweden

Responsibility for signposting at the roadside are:

- Swedish Transport Administration
- Swedish Municipalities
- Private Road Administrators

Organisations that formulate traffic rules are

- Swedish Transport Administration
- Swedish Municipalities
- County Governments
- Private Road Administrations (to some extent)

Traffic rules and traffic regulations that are not signposted. They are the responsibility of the Swedish Transport Agency (Transportstyrelsen) (Regulations, legislation)

Most of the traffic rules are contained in the Road Traffic Ordinance (1998: 1276)<sup>19</sup>. In addition there are local traffic regulations that municipalities and the county governments decide. Swedish Transport Administration decides traffic regulations on roads owned by the state.

From 1 January 2011, all traffic regulations are digitally represented in the Swedish Transport Agency's search function, STFS.

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<sup>19</sup>

The Swedish traffic rules correspond well with those in other countries. The foundation is a UN Convention from 1968, the Vienna Convention on Road Traffic. The Vienna Convention is published in the series *Sweden's agreement with foreign powers* (SÖ 1989: 1-5). As of today, no organisation in Sweden has the sole responsibility to deliver traffic rules or traffic signs by digital means.

Hopefully, private actors will find viable business models for working with data processing and data analysing. STA is prepared to buy processed data instead of doing all processing in-house, as it does at present. Nevertheless, STA will still need to be able to do its own rather extensive processing and analysing of data. For the data produced at STA and provided to external actors primarily as open data, the principle is to provide it as raw as possible and not to work with processing that can be done by external private actors on a commercial basis.

## 10 Laws and Regulations

### 10.1 Rules

Using new forms of communications, vehicles are capable of broadcasting or receiving data that allow them to communicate with each other and/or with the infrastructure. In addition to what drivers can immediately see around them, and what vehicle sensors can detect, all parts of the transport system will increasingly be able to share information. This broadcasting is an inherent part of the system and hence raises potential concern as to how to guarantee privacy and data protection. Because of the potential or indirect identification of the user, those messages are considered as “personal data”. The European legislation on Data Protection 95/46/EC is therefore considered applicable.

For OEM’s this means that information such as vehicle identification number, tachograph data, driver identification number, GPS position (location data) and all data connected to driver behavior, such as speed, brake usage, gear shifting, fuel consumption, acceleration/deceleration, and driving patterns etc. is consider as being personal data.

Any Vehicle Data generated by a customer truck or telematics services is the property of the Customer and the OEM cannot use such data without customer consent.

### 10.2 Privacy of data

A reformation of the EU data protection rules will be applied in 2016.

The new regulation will replace the existing EU legislation on personal data protection, Directive 95/46/EC3. Once the Regulation and the Directive receive formal adoption from the European Parliament and Council, the new rules will become applicable two years thereafter. More information can be found here:

<http://ec.europa.eu/justice/data-protection/>

Some other principles of data protection according to ACEA:

[https://www.acea.be/uploads/publications/ACEA\\_Principles\\_of\\_Data\\_Protection.pdf](https://www.acea.be/uploads/publications/ACEA_Principles_of_Data_Protection.pdf)

Data protection principles for connected vehicles according to the German Vehicle Industry:

<https://www.vda.de/en/topics/innovation-and-technology/network/data-protection-principles-for-connected-vehicles.html>

## **11 Questions as input to the next phase of the project**

TBD

## 12 References

List of references	Date
Ericsson presentations and white papers	
SNS Research - The Connected Car Ecosystem: 2015 - 2030 - Opportunities, Challenges, Strategies & Forecasts	July 2015
TBD	

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