Quantified Cars: Digital services and business implications based on vehicle data

BITKOM Big-Data.AI Summit 2018

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Quantified Self -> Quantified Car

Quantified car companies

Beneficiaries, use cases, platforms & ecosystems

Trust and privacy

Vehicle Data Value Chain demonstrator @ Virtual Vehicle
Quantified self -> quantified car
SCOTT - Secure Connected Trustable Things
scottproject.eu (H2020-ECSEL IA)

"Building Trustable Connected Services"

<table>
<thead>
<tr>
<th>UC05 – Secure cloud services for novel connected mobility applications</th>
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<tbody>
<tr>
<td>UC01 – Air quality monitoring for healthy indoor environments</td>
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<tr>
<td>UC02 – Managed wireless for smart infrastructure</td>
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<td>UC03 – Secure connected facilities management</td>
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<td>UC04 – Logistics management using collaborative robots and DevOps methodologies</td>
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<td>UC07 – Trustable wireless in-vehicle communication network</td>
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<td>UC08 – Secure car access solution</td>
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<td>UC09 – Vehicle-as-a-sensor within smart infrastructure</td>
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<td>UC10 – Secure wireless avionics intra communications for sensing and actuation</td>
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<td>UC11 – Safe freight and traffic management in intermodal logistic hubs</td>
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<td>UC12 – Autonomous wireless network for rail logistics and maintenance</td>
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<tr>
<td>UC13 – Smart train composition coupling</td>
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<td>UC15 – Assisted living and community care</td>
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**Key Facts**

- 57 project partners
- 12 countries
- 39 Mio. EUR project budget
- 15 Industrial use cases from different areas
- Coordinated by Virtual Vehicle (AT)
Some definitions..

“A key contemporary trend emerging in big data science is the quantified self (QS)-individuals engaged in the self-tracking of any kind of biological, physical, behavioral, or environmental information..” (Swan, 2013)

“The behavioral patterns of self-tracking can be transferred to vehicles, which capture sensory data about themselves and about their environment, thus becoming ‘Quantified Vehicles’” (Stocker et al., 2017)
From quantified self to quantified car

- Some (big) players & tech startups...

THE QUANTIFIED SELF:
Fundamental Disruption in Big Data Science and Biological Discovery

Melanie Swan
MS Futures Group, Palo Alto, California
Modern cars offer access to data enabling the creation of (useful) services

Data from the vehicle
- **On Board Diagnostic (OBD) data / = (rather) open** (emission relevant data, limited data, e.g. speed, rpm, ..)
- **Controller Area Network (CAN) data = (rather) closed** (access to a plethora sensors and measurements, e.g. gear shifts, steering wheel movement, ADAS usage …)

Data from the vehicle driver
- Smartphone data
- Smartwatch data
- Smart glasses data
- Social networking data
- Camera data
- …
Quantified car companies
Value Proposition: Connect your car to Dash, to make driving smarter, safer, greener and more affordable.

Funding: 1,9.- Mio USD venture capital
Source: Crunchbase.com
**Value Proposition:** The Leading Cloud Platform for bringing smart car functionality to any car on any lot, in any fleet, or in any shop.

**Funding:** 6,5.- Mio USD venture capital

Source: Crunchbase.com
Value Proposition: Smartphone-powered road safety analytics for fleets, insurers, and you.

Funding: 20.- Mio USD venture capital

Source: Crunchbase.com
INTRODUCING

Automatic Pro

Unlimited car monitoring, zero fees. The only connected car adapter with unlimited 3G included.

GET PRO

Value Proposition: Unlimited car monitoring, zero fees. The only connected car adapter with unlimited 3G included.

Funding: 24.- Mio USD venture capital
Source: Crunchbase.com
Value Proposition: The Leading Open Platform for Connected Cars.

Funding: 40,6.- Mio USD venture capital

Source: Crunchbase.com
Value Proposition: Your fleet. Only safer and smarter.

Funding: 173,9.- Mio EUR venture capital
Source: Crunchbase.com
Value Proposition: Koola meets all the conditions for launching your connected car service.

Funding: 50k EUR venture capital

Source: Crunchbase.com
Quantified car use cases platforms & ecosystems
Quantified Car Use Cases

- **Use cases for individuals (drivers)** in return for sharing (driving) data
  - Detect events from collected time series data (e.g. harsh breaking, harsh acceleration, harsh cornering, harsh line changing, speeding, standstill, parking, ..)
  - Detailed trip statistics and analytics as well as visualized events on maps, provide additional geo-information
  - Benchmarking & social interaction with other drivers
Quantified Cars
Use Cases

Use cases for Organizations

☐ Connected car platforms (e.g. for connected car service providers)
☐ Fleet analytics & benchmarking (e.g. for fleet operators)
☐ Driving assistance systems (e.g. for car manufacturers)
☐ Driving analytics and driver profiling (e.g. for insurance companies)
☐ Predictive maintenance (e.g. for service companies)
1. From applications to platforms
2. From platforms to digital ecosystems

“A digital ecosystem is an interdependent group of actors (enterprises, people, things) sharing standardized digital platforms to achieve a mutually beneficial purpose.” (Source: Gartner)
“Direct connections to the vehicle present a potential security risk, but access to vehicle generated data requires a connection. To minimize the risk, access to the vehicle must be limited to managed interfaces.” (Source: VDA)
A word on privacy
Source: MyCar MyData

- **Q1**: Who is the owner of the data?
- **Q2**: Who can use the data?
- **Q3**: How can the data be used?

**DATA PROTECTION**

Legislation should ensure informed consent on access to a car’s data. This means that consumers need to be fully informed about what data is being transmitted and for what purpose. Drivers should retain ownership of the data their car produces and control over how it is used for as long as they own the vehicle.

**FREE CHOICE**

Drivers should have the right to choose their preferred service provider and match the right products and level of service to their needs. The right to choose from a variety of safe product functionalities needs to be guaranteed. The service providers must also be changeable throughout the lifetime of the vehicle and without any additional administrative burden.

**FAIR COMPETITION**

A variety of service providers should have access to car data. This will foster competition and ensure the best possible service for drivers.

**BLOCKCHAIN? (smart contracts)**
## Chart of Data Categories in Connected Vehicles

<table>
<thead>
<tr>
<th>Data Categories</th>
<th>No Data Protection Relevance</th>
<th>Low Data Protection Relevance</th>
<th>Medium Data Protection Relevance</th>
<th>High Data Protection Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. The purpose limitation is regulated by law</td>
<td></td>
<td>OBD-II</td>
<td>e-call (EU)</td>
<td>event data recorder (USA)</td>
</tr>
<tr>
<td>B. Modern data services</td>
<td>anonymised services car to x</td>
<td>pseudonymised services car to x</td>
<td></td>
<td>Predictive diagnosis, remote display (e.g., electric vehicles)</td>
</tr>
<tr>
<td>C. Customer’s data / data introduced by the customer</td>
<td></td>
<td>Infotainment settings and convenience settings, e.g.: Seat setting, sound volume</td>
<td>Navigation destinations</td>
<td>Address book/Telephone personalized access to third-party services</td>
</tr>
<tr>
<td>D. Vehicle operating values generated in the vehicle and displayed to the driver</td>
<td>e.g. fill levels, consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Aggregated vehicle data generated in the vehicle</td>
<td>e.g. fault memory number of malfunctions, average fuel consumption, average speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Technical data generated in the vehicle</td>
<td>e.g. Sensor data, actuator data, the engine’s injection behaviour, the shifting behaviour of the automatic transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Framework conditions should allow customer-oriented and practical solutions**

- As far as possible the data collected in the vehicle should be and should remain "technical data".
- With some of these data the data controller may have an overriding legitimate interest in terms of vehicle and product safety.
- A combination of data can lead to data protection relevance.
Demonstrator for a vehicle data value chain at Virtual Vehicle

- Capture data generated in the vehicle with a data logger
- Transform raw vehicle data to trip data
- Analyze trip data for safety-relevant events (harsh breaking, acceleration, and cornering) and store them in a database
- Visualize stored events as an overlay on a geographic map
Demonstrator for a vehicle data value chain at Virtual Vehicle

Trustable Vehicle Data Logging System
© Virtual Vehicle
Demonstrator for a vehicle data value chain at Virtual Vehicle

TripDataVisualizer © Virtual Vehicle
Demonstrator for a vehicle data value chain at Virtual Vehicle

TripInfoDashboard © Virtual Vehicle
Conclusion

- Vehicle Data offers huge Potential for services & ecosystems
  - Many (innovative) tech startups have demonstrated the benefits
- The role of the OEM as data provider (owner?) for third parties is under discussion
  - OBD data is very limited, CAN data offers far more potentials for services
- Applications show many trust & privacy concerns
  - Data is very valuable for different stakeholders (e.g. insurers)
  - Using only a few features allows to create a driver profile and even distinguish drivers based on their driving style
- Impact = technology x adoption
  - Adoption of quantified car is slower than adoption of quantified self
## Global & specific driving style, indicator & measure (Sagberg et al 2015)

<table>
<thead>
<tr>
<th>Global driving style</th>
<th>Specific driving style</th>
<th>Indicator</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressive</td>
<td></td>
<td>Combination of indicators below</td>
<td>Speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% time driving &gt; speed limit</td>
<td>Lane used</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% time driving on the left lane</td>
<td>Horn activation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Honking rate exceeding predefined criterion</td>
<td>Highbeam flash activation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of driving with headway distance &lt; X m to the vehicle in-front</td>
<td>Headway distance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of driving with time headway &lt; X sec</td>
<td>Time headway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% time with longitudinal / lateral jerk &gt; threshold criterion</td>
<td>Longitudinal/lateral jerk or acceleration</td>
</tr>
</tbody>
</table>

### Global driving style

- **Score above certain level (e.g. often or always)**
- **Score on frequency scale (e.g., never to always)**
- **Overall score on “calmness” factor**
- **Score on 6-point frequency scale**
- **Overall score on “careful” factor**
- **Score on 6-point scale of fit to driver’s feelings/thoughts/behavior (“not at all” to “very much”)**
- **Overall score on “aggressive” factor**
- **Score on visual analog scale of agreement (“not at all” to “very much”)**

### Specific driving style

- **Speeding**
- **Responding to pressure from other drivers**
- **Always ready to react to unexpected maneuvers by other drivers**
- **Get a thrill out of breaking the law**
- **Tend to overtake other vehicles whenever possible**

### Indicator

- **Factor score above predefined criterion**
- **Item score below certain level, e.g. <3**
- **Factor score above predefined criterion**
- **Item score above certain level**
- **Item score below certain level**
Vehicle Data
Source: VDA

Category 1
Data for improved traffic safety
Traffic safety relevant data
Data for e.g. public traffic management institutions.
Fire Department, Police, 911, ...

Category 2
Data for cross brand services
None differentiating vehicle data
Non-discriminatory data access to third parties. #2, #3
Product

Category 3a
Data for brand specific services
Vehicle data differentiating and IP relevant for OEM
OEM or Partner on OEMs behalf
Dealer, Subsidiary

Category 3b
Data for component analysis and product improvement
Vehicle data differentiating and IP relevant for OEM and supplier
OEM or Partner on OEMs behalf
Product

Category 4
Personal data
“Right of access” granted only to the parties authorized to process data by law, contract or consent
Customer selected partner
Customer

Data usage categories

The customer #1 will be informed of data usage and OEMs will provide the customer with decision options which the customer can reverse at any time, unless the function is required by law