Growth of the Connected Vehicle Data Market

The implications of personal data and emerging US legislation

May 2020

CtrlShift

“Connected and Autonomous Vehicles may be the biggest technological innovation and revolution of our time. It will completely transform urban spaces and the world generally. It has enormous environmental and road safety implications. The implications can be profound... it’s a transformative technology to the highest degree. I think it will touch every aspect of our lives and our economy.

Omer Tene
Chief Knowledge Officer
International Association of Privacy Professionals

Foreword.

In the wake of the huge impact that commercial leverage of data has brought to global economies, the rise of the connected vehicle has the potential to dramatically shift the economic balance of the automotive industry – and drive entirely new forms of value for business, consumers and society.

Modern vehicles are powerful computers, embedded with sensors, collecting information and creating rich, reliable and accurate streams of mobility data. An increasing proportion of a vehicle's total value will be in the content and services enabled by Connected Vehicle Data (CVD).

The value of a vehicle used to be mainly on hardware and a little on software. With connectivity and ADAS, this is shifting. Ultimately, this will be more like 40% hardware, 40% software and 20% content... when vehicles are autonomous."

Franck Louis-Victor, Renault-Nissan-Mitsubishi Alliance

CVD presents a significant new opportunity for data-enabled marketplaces

- The global connected vehicle market was is forecast to be worth over $355 billion by 2030 (source: *Vehicle Data Market: Global Study 2020*, Ptolemus Consulting).
- By 2030, 88% of cars sold worldwide will be pre-connected to networks via embedded devices and almost 100% of vehicles in the EU and USA will be connected. (source: Ptolemus Consulting)
- Connected car data volumes are already staggering, with an estimated 95 petabytes of data generated globally in 2019

OEMs need to capitalise on the benefits of the CVD revolution. Many OEMs and Tier 1 suppliers already use CVD to monitor, diagnose and improve vehicle performance, service and support. The broader opportunity to create equity from this data, by combining it with data from different markets, is enormous, yet largely unexplored. The intelligence derived from this can be used to improve journeys, reduce accidents, cut harmful emissions and unlock innovations across the automotive market, and in others.

The secure and trusted use of CVD can bring greater depth and richness to both existing services and new innovations in products and services - helping solve the biggest problems posed by the transition from 'personal transportation' to 'smart mobility'. Globally, there is an increased emphasis on protecting individuals from misuse of their personal data, leading to a greater focus on privacy-related regulation. The development of legislation must be designed to support economic growth at the same time as affording all interested parties the necessary protections.

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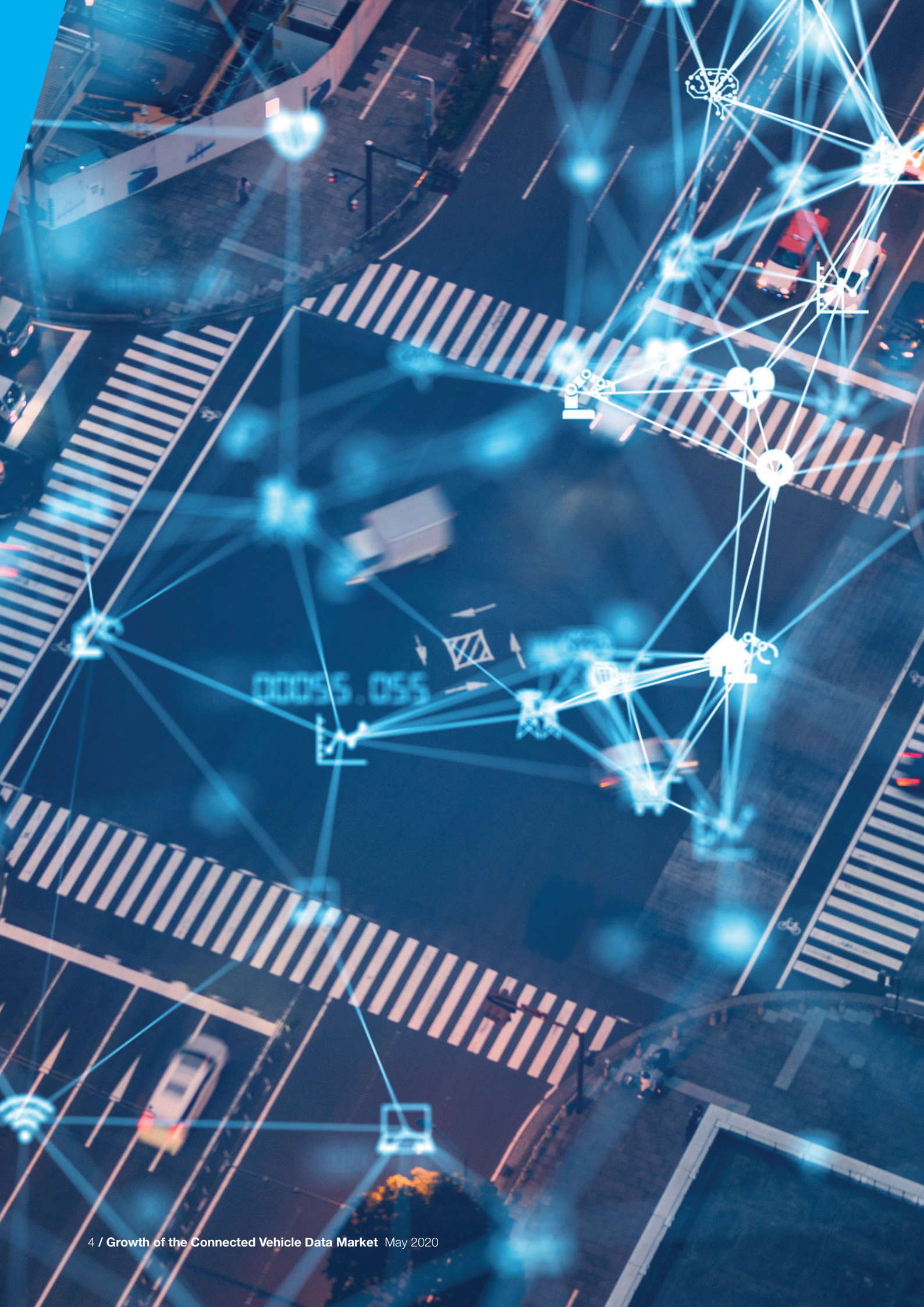
wejo commissioned Ctrl-Shift to study the CVD market and the implications of its use of CVD and PII and emerging US data protection legislation in the market's growth and governance. The purpose of the study is to provide analysis and perspectives to stimulate informed debate across all key stakeholder groups in this emerging market. The views expressed within this study do not necessarily reflect wejo's position or its business models or data practices.

The research is based on interviews and round-table discussions with experts in connected vehicle data; personal data and privacy, and data regulation, and upon Ctrl-Shift's knowledge base on the strategic use of personal data in business innovation.

We are very grateful to all who participated in the research and thank them for their invaluable input.



Contents.

Executive Summary.

The potential for value generation in the Connected Vehicle Data (CVD) market is profound.

Mhere will be over 67 million connected cars in the US in 2020, growing to more than 146 million by 2030 (source Statista). Major advances in on-board digital systems and connectivity not only mean that these systems and their content will soon exceed 50% of a vehicle's value, but they have created, in effect, one of the world's most powerful live data networks.

This platform offers significant social and economic potential. It is transforming the design and performance of mobility solutions, and has opened-up a rich market for digital services and data commerce.

The automotive industry currently uses CVD to drive efficiency in OEM supply chain operations and product development. Automotive digital services and data markets are now primed to expand dramatically.

A key enabler of this growth is the amalgamation of CVD with wider data sets from different aspects of people's lives, and other markets. These diverse data sets include Personally Identifiable Information (PII). Ensuring that this PII is used appropriately will be a key challenge for the sector.

The secure and trusted use of CVD and PII can bring greater depth, relevance and richness to digital services, stimulating entirely new forms of innovation in products and services, attuned to the needs and wants of consumers – and society at large.

The potential for value generation in the CVD market is enormous, and the opportunity is now. As observed by many participants in this research, if the automotive industry does not seize the strategic opportunity in data, the global data giants will.

As seen in other markets, this would relegate industry players to enablers of others' transformational growth, whilst left carrying the operational cost.

Societal Benefits

The fast-growing connected vehicle data market offers enormous untapped potential for society, enabling improved safety, greater efficiency and the reduction of emissions and new mobility solutions, including for less-advantaged people.

Safety

Participants in the study said safety is the most significant overall benefit from connected cars. They can enable improvement in the safety of vehicles themselves, road safety, driving behaviour and emergency services response.

Efficiency, Emissions and Environment

Participants also stressed that CVD can bring significant improvements in the efficiency of transport and material environmental benefits.

Efficiency can be increased by improved design and management of road systems, creating time and cost savings for travellers, and improving productivity. CVD can also enable efficient carpooling solutions and more effective multi-modal transport integration

These efficiency improvements can reduce the impact of vehicle emissions by optimising engine performance, reducing journey times, and so improve air quality.

Stakeholder Benefits

CVD-driven innovation will unlock significant consumer and economic value, delivering benefits to all participants and stakeholders in the market.

Stakeholder	Benefits
Individuals / Consumers	• Greater convenience and value in car ownership • Increased journey efficiency • Lowered costs in car ownership and transport including predictive maintenance and remote diagnosis and fault-fixing • Major innovation in in-car digital services through the combining of data from broader aspects of people's lives e.g. in-car payments and eCommerce services, and integration of connected cars with smart home systems • Increased personalisation within the vehicle environment, including infotainment content, journey plans and driver controls
Public services	• Plan journeys and manage transport infrastructure • Supporting emergency services and law enforcement
Automotive Manufacturers (OEMs)	• Advance OEMs' design and manufacturing efficiency through advanced data technologies, such as AI and machine learning • Transform after-sales product support costs and defect correction processes • Create new and deeper consumer relationships, bolster brand loyalty • Realise new revenue streams through consumer digital services and the broader commercial use of CVD in data markets and the automotive ecosystem
Automotive Service Providers	• Enable improved and expanded service offerings based on access to connected car data for a range of service providers in the ecosystem including vehicle servicing; dealerships, fuel and EV providers; roadside assistance
Financial Service Providers	• Insurers: Enhanced underwriting, usage-based insurance and enhanced claims analysis • Banks, lenders and lease providers: Improved asset valuation
Other Stakeholders	• Vehicle fleet management: Improved operations and reduced costs • Telecommunications: A dramatic increase in wireless network traffic and new services to connected vehicle ecosystem players e.g. data acquisition and storage, analytics • Parking providers: More efficient use of resources and better planning of future capacity • Retailers, restaurants, hotels and other geo-centric businesses: Better targeting of marketing messages and planning of the locations for new facilities

In the medium term, connected vehicle data exchanges will be able to manage huge volumes of lidar, radar and camera data to support high definition mapping required to support Autonomous Vehicle operations and other data intensive offerings such as ride sharing fleet optimisation.

The importance of consumer trust and data regulation to the CVD market

Maintaining consumer trust and complying with appropriate data privacy regulations, are increasingly important factors in the development of the market. .

Consumer Trust

Consumers are largely unaware of connected vehicle data use. Many consider it inevitable that the CVD market, and the use of PII within it, will soon become much more prominent. The risk is that it does so for negative reasons, as it has in other markets, such as social media. This could seriously compromise consumer trust, potentially leading to data access being constrained and further demand for privacy-related legislation.

There is an urgent need to stimulate consumer and regulator confidence by encouraging transparency and raising proactively the profile of the CVD market and the benefits it conveys.

Data Protection Regulation

The operation of the CVD market is affected by issues and concerns raised by failures of data use in on-line data platforms, notably social networking sites, and the regulatory response to failings in those markets.

If legislation fails to balance the need to protect privacy and ensure data security with the need to foster innovation and economic growth, then there is the risk of unintended consequences causing significant market opportunities and societal benefits could be constrained. Furthermore, data protection legislation that is influenced heavily by screen-based, internet and data platform models generally does not fit well with the ways in which users interact with in-car systems or the ways in which connected vehicle data is collected and used. If not addressed, these differences, could complicate the compliance challenge for automotive products manufacturers and potentially create an unintended advantage in the CVD market for the major data platform providers.

US Data Protection Legislation & Regulation

In the US there has been a shift toward more broad-based legislation, largely as a response to major data breaches and high-profile scandals in the personal data market. Legislative action is being led by individual States, as Federal legislation appears unlikely ahead of this year's Presidential and Congressional elections.

01
State Led Activity

A third of US states have enacted or are considering data legislation. California has been the prime mover in state-led legislation.

The California Consumer Privacy Act (CCPA) has a broad definition of PII and of what constitutes the sale of data. CCPA enforcement will start in June 2020. California may also develop more stringent regulation with the CPREA (California Privacy Rights and Enforcement Act), on the ballot for November 2020.

There is a risk that State-by-State legislation, and potential variances between States, will add complexity to the compliance challenge.

02
Federal Activity

Multiple privacy bills have been introduced at the Federal level in the US Congress. There is also the potential for intervention by the Federal Trade Commission.

It is expected that ultimately Federal data privacy legislation will be enforced to set a 'level playing field. This could provide positive stimulus for interoperability, innovation and growth in the market.

03
Industry Self-Regulations

Consensus-oriented dialogue with industry, and government has been shown to be effective in developing practical governance solutions.

To mitigate these risks, OEMs and other market participants must secure consumer trust and the effective regulation of data usage in the market they should:

- Stimulate consumer and regulatory confidence by raising the profile of the CVD market and proselytising the benefits of CVD
- Build consumer and regulatory trust through the advocacy and development of self-regulation
- Lead the market by engendering a culture of openness, transparency, informed choice, and consent
- Positively influence the development of legislation to support the beneficial use of CVD for all stakeholders, while also ensuring the necessary data protections

Market Development Challenges

Even with the vast potential of the CVD market, several factors could limit its development.

OEM Under-Investment

The costs associated with CVD are significant and systems need to adjust to increasing data volumes and complexity. Competing demands for OEMs investment in a challenging automotive market could restrict growth and open the door to competitors undermining the potential for manufacturers to capture the value of their data.

> *"OEMs are treading a careful path – they potentially have much bigger issues to address in the core operations at present… but they must avoid missing out on any new services, business models, and revenue from cc data OR being displaced in new relationships with the owner/driver resulting from these services… and not just left 'running the pipes.'"*
>
> John Verdi, Future of Privacy Forum

The Battle of the Dashboard

Automotive manufacturers' opportunity to obtain brand and wider economic value from the Infotainment platform is challenged in two ways.

First, devices brought into the car (notably smartphones) could come to dominate consumers' in-car digital experience if connected vehicle data is not actively developed by OEMs to deliver innovative services. However, dominance by bring your own (BYO) devices is seen as unlikely in the medium term because the value of core vehicle data and the use cases it enables, will continue to drive significant growth.

Second, the major cost of building and maintaining the embedded infotainment systems, and the difficulty of achieving critical mass for app development, means that many OEMs are looking to buy this capability from big developers, or allow drivers to mirror the software from a smartphone.

OEMs need to consider carefully the degree of integration of such systems to avoid losing value opportunity from core CVD, and so strengthening the platform provider's competitive position in the market.

Advertising Revenue Models

Vehicles have multiple data collection points that can be used to target or plan successful advertising ventures. Still, a person's car is regarded as a very personal place: many of the experts we interviewed suggested that consumers may resist targeted advertising in this environment.

Mandated Data Sharing

Interested organisations are lobbying for the extension of US Right to Repair legislation to include CVD. Sharing CVD data for improved vehicle safety could create new organisational costs for OEMs without significant corresponding direct return except for its obvious social benefits.

Enhanced Digital Capabilities

As OEMs seek to access the new opportunities in connected vehicles, they will require enhanced OEM digital and customer-centric capabilities. These key areas include:

Data centricity
To improve the efficiency of R&D and manufacturing operations with advanced digital capabilities in areas such as machine learning/AI and analytics.

Digital centricity
The car will become a “living product” with continuous upgrades in lifecycles of months, if not weeks. To deliver this, OEMs will need to apply digital, business and technology skills throughout the development, production and support phases.

Consumer Centricity
Delivering consumer data-enabled services opens up a new direct and ongoing engagement between OEMs and consumers. Maximising this opportunity will require the development of new forms of consumer engagement and management capabilities.

Factors Advancing The Cvd Market

Enablers which can strategically advance the connected vehicle market were identified as:

Data Marketplaces

Have an important part to play in stimulating market growth. They can facilitate the ‘data liquidity’ required to ensure an efficient overall market for connected car data, supporting interoperability and standardisation.

There are multiple use cases for CVD data. Companies such as wejo connect OEMs with marketplaces by establishing relationships with partners in fields including Mapping & Navigation; GIS & Location Data Services; Government Authorities; Transport & Infrastructure; Entertainment & Retail; Emergency Services; Insurance; Finance & Leasing; Fleet and Urban Planning.

The marketplace operator can offer consent and privacy management to the OEM and data buyer, providing access to a broad range of data sources.

Some marketplaces, such as wejo’s, can also enrich the data so that it provides end-users with insights, products and solutions instead of just access to data.

Communications

Continued improvements in cellular communications technology offer higher transmission speeds, broader and more reliable coverage, and higher costs efficiencies.

This will be vital in enabling expanding data volumes, driven by the growth in connected vehicle numbers greater variety and frequency of data.

Developments in Vehicle-to-Vehicle and Vehicle-to-Infrastructure will offer new innovation opportunities in car safety, transport efficiency and the development of smart cities.


VHKJ79DSG
CtrlShift

01

Overview of the study.

This study has examined the development of the connected car data market, and the potential implications of emerging US data protection legislation for the market's growth and governance.

The purpose of the work is to provide informed analysis and perspectives on the key themes and issues that will materially influence the market's development. The objective is to stimulate debate across all stakeholder groups to help realise its enormous economic and societal potential of the connected car data market.

The study was carried out by business innovation consultancy Ctrl-Shift, commissioned by leading connected vehicle and mobility data company wejo.

This Final Report will be made publicly available and shared proactively with those looking to shape effective policy in this market.

1.1 Approach

The research engaged a select group of more than 50 experts in connected car data, including leading figures in: OEMs; trade bodies; academia; specialists in data privacy and security; automotive industry lobbyists; strategic advisors and commentators, and international economic organisations.

The study has also drawn heavily on Ctrl-Shift's knowledge base on the strategic use of personal data in business innovation, and on wejo insights into connected car data marketplaces.

Participants were engaged through in-depth interviews and round-table discussion. The interviews were framed around key aspects of connected car data and implications of the use of PII, including the potential benefits and risks created for all stakeholders in the connected car ecosystem. Round table discussion provided the opportunity to examine and debate, in detail, important issues that will impact market development.

We are very grateful to all who took part in the research and would like to thank them for their invaluable input. A full list of participants appears in APPENDIX B.

1.2 About wejo and Ctrl-Shift

Ctrl-Shift is an innovation consultancy specialising in the strategic value of personal data in the digital economy. Since 2009, Ctrl-Shift has been helping organisations realise the growth opportunity in trusted personal data by creating strategies that enable the delivery of new value in people's lives. Ctrl-Shift works extensively with governments to influence the policy debate on personal data.

wejo creates journey intelligence to transform the way we live work and travel. wejo works with automotive manufacturers and like-minded, ethical partners to organise the streams of authentic, connected vehicle data, unlocking its value for all. wejo processes, normalises and enhances CVD to make it more accessible, benefiting drivers and passengers; public and private sector organisations; automotive manufacturers and their partners.

02

The connected car data market.

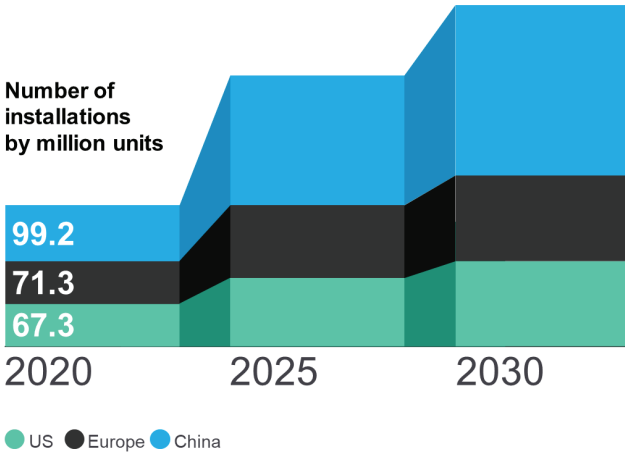
Connected Car Data has the potential to transform journeys by improving safety, reducing emissions and congestion.

The data can also provide broad insights into how vehicles are used by people – information that has value to a broad range of potential users from urban planners to insurers, healthcare to retail.

This section provides an overview of the scale and structure of the market, and a description of the information types that comprise connected car data. It goes on to provide a classification of the key stakeholder groups used in this study to analyse the value that can be created by using vehicle data.

2.1 Scale of the connected car market

In May 2019, International Data Corporation (IDC) estimated that worldwide shipments of connected vehicles would reach 51.1 million units in 2019, an increase of 45.4% over 2018.



By 2023, IDC expects worldwide shipments to reach 76.3 million units with a five-year compound annual growth rate of 16.8%. The largest geographical markets for connected cars are the United States, Europe and China.

IDC expects that nearly 90% of new vehicles in the United States will be shipped with embedded connectivity by 2023.

In terms of the total number of connected cars in the market, 2017 data from Statista suggests that there will be over 67 million connected cars in the US in 2020, growing to more than 146 million by 2030.

The automotive data specialist Acerta estimates that in 2019, the world's connected vehicles generated up to 95 petabytes (PB) of data (excluding image data). Applying Acerta's approach to the Statista volumes suggests that US connected cars will generate c. 32 PB of data in 2020.

This number is set to grow not only due to the increase in the number of connected cars, but also due to the increase in the data generated per car. Industry estimates suggest that the number of sensors in new cars could rise from 60-100 per car in 2017 to around 200 by 2020 (Source: Automotive Sensors and Electronics Expo 2017).

The potential for creating value from this data is enormous.

£33Bn value by 2025

Frost & Sullivan suggest a value of £33Bn by 2025, for new revenue opportunities enabled by providing new driver-centric services.

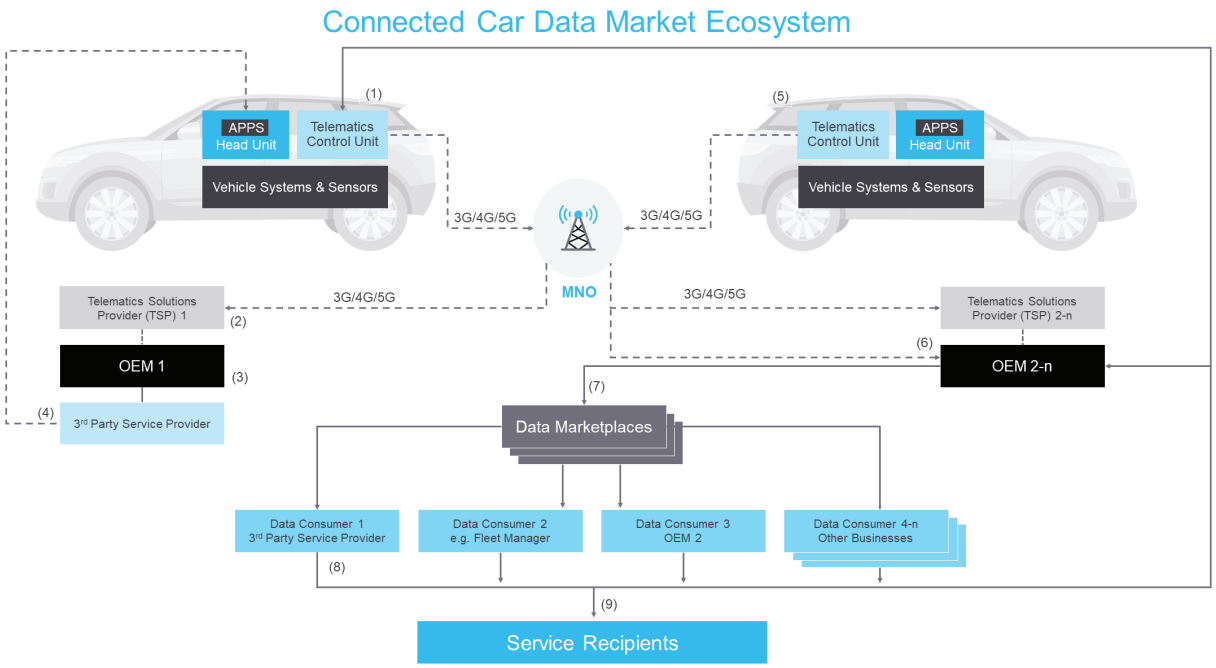
£750Bn value by 2030

McKinsey forecast up to $750Bn of value generated in the connected car market by 2030.

2.2 The Structure of the Connected Car Data Market Ecosystem

Connected vehicles are equipped with technology that enable them to communicate and exchange information wirelessly with other vehicles, infrastructure and devices outside the vehicle including external networks.

The structure and main elements of the connected vehicle ecosystem are set out in the diagram below:



The vehicle on the left of the diagram represents a simple connected car data flow.

1. Data from the vehicle sensors is collected via the Telematics Control Unit (TCU) and prepared for transmission via the vehicles in-built cellular capability. Data is transmitted via a Mobile Network Operator (MNO) using 3G/4G LTE/5G protocols.

2. The data may be transmitted to a Telematics Solutions Partner (TSP). This is an optional, specialist partner organisation that provides a number of services to the OEM, potentially including supply of the in-car telematics capabilities as well as data collection, formatting and storage services.

3. Having been processed by the TSP, the connected car data is sent to the OEM. Here it can be analysed and used for internal operations purposes, and can also be used to provide services to drivers directly or through selected 3rd parties.

4. The OEM may also operate with one or more 3rd party service providers. The 3rd party service provider uses the data to provide services back to the vehicle driver (e.g. live traffic information) or to other organisations.

This model requires the OEM to manage potentially hundreds of new contractual relationships for the provision of data and requires data buyers to engage separately with each OEM.

Partly as a response to this complexity, the market is evolving to include Data Marketplaces that can receive data from multiple OEMs and aggregate and standardise that data, so that connected vehicle information is accessible to a wide range of potential markets without them having to approach each OEM separately.

These market building and facilitation capabilities are services that the OEMs may not be well equipped to deliver.

The flow of data in scenarios where data marketplaces facilitate greater use of vehicle data is represented on the right of the diagram:

5. The data from the vehicle is again collected and sent back to the OEM (either directly or via a TSP), as above.

6. The OEM (or their TSP) send data to one or more Data Marketplaces. The scope of the data sent is defined by the contractual agreement between the OEM and the Data Marketplace.

7. The Data Marketplace offers a number of services including aggregation, analytics, anonymisation etc. that add value to the data to Data Marketplace's clients (the Data Consumers).

   The Data Marketplace may source additional data from other OEMs or other organisations (within the motor industry and beyond), further combining and processing the data to increase its utility to Data Consumers.

8. The Data Marketplace then provides data, insights or other products to consumers. Data Consumers may be a variety of organisations these include:

   - 3rd party service providers which acquire data from the Data Marketplace (processed to their specification) and use it to develop services for drivers, vehicle owners, or other stakeholders in the Connected Car Data Market.
   - Data Consumers that acquire the data to support their own operations e.g. organisations with vehicle fleets may use it for a variety of applications to ensure effective and efficient fleet operations.
   - OEMs that use a Data Marketplace to bring together and standardise data from different vehicle models with different telematics capabilities, or even from different vehicle brands within the OEM.

9. Service Recipients: the services developed by the Data Consumers can be for the benefit of a variety of stakeholders, both within the motor industry and beyond e.g. vehicle dealerships, OEM suppliers, urban planners, media companies, law enforcement agencies, etc. The Connected Car Data Market stakeholders, and the benefits enabled by connected car data, are explored further in Sections 2 and 3.

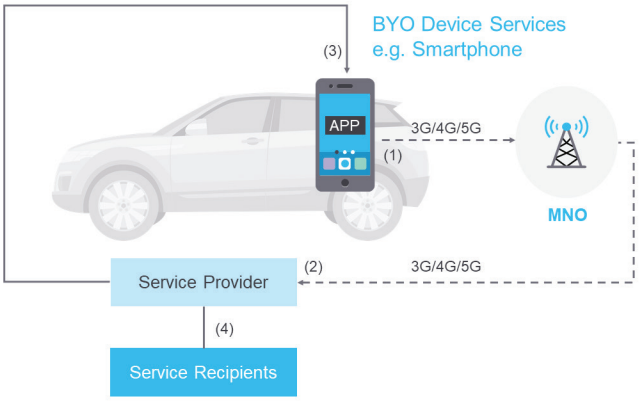
Note that these basic market roles can be undertaken by a variety of different players e.g. a TSP could develop and provide services for drivers on behalf of an OEM; MNOs could provide data collection, analysis or marketplace services; an OEM could do everything in-house (from data collection and analysis through to providing new data enabled services to drivers).

Bring Your Own (BYO) Device Ecosystem

Data-enabled services for drivers and other stakeholders can also be provided via devices that are not built into the vehicle but brought in by drivers (e.g. smartphones) or fitted by 3rd parties (e.g. wireless dongles connected to the vehicle's On-Board Diagnostics (OBD) port). These are broadly described as 'Bring Your Own' (BYO) devices.

These are not strictly part of the core connected car data ecosystem and limited in terms of the vehicle data they can access but, they are important to consider as they provide services that are similar to – some connected car data enabled services, e.g. navigation services.

A simple representation of this ecosystem is provided below.



Using the smartphone as an example:

1. The Service Provider's app on the smartphone collects data via the smartphone's in-built sensors and capabilities (e.g. accelerometers, geolocation services) or driver inputs. The data is transmitted via the smartphone's cellular connection, using the chosen MNO using standard 3G/4G LTE/5G protocols. Note that the app may also provide some elements of the service in 'standalone' mode without connectivity, based on this data.

2. The Service Provider uses this data both to develop the service itself (e.g. collecting data to baseline a Usage Based Insurance service), and in the operation of the service.

3. Having processed the data, the relevant service elements are provided back to the driver via the app e.g. real-time traffic information as provided to users of navigation apps.

4. The Service Provider may also provide services (or the data itself) to stakeholders other than the driver e.g. Uber shares data with cities in which it operates as part of its licencing agreement.

Generally, smartphones can only offer a narrower, less detailed data set than that provided by native connected car data systems. Smartphones can often only offer proxy versions of the connected car data types (listed in Section 2.3) e.g. for speed, journey start/end, fuel level, crash detection etc. The data is also typically updated less frequently and with lower reliability due to signal loss.

In future, manufacturers may allow increasingly deep integration of mobile phones with their infotainment systems, and potentially with underlying vehicle data too. This is covered in further detail in Section 6.2.

2.3 Connected Car Data and Personally Identifiable Information

Overview of Connected Car Data

A wide range of data points are generated by connected cars including:

- Vehicle identity: VIN, OEM, brand, model, model year, engine type and specification version
- Geolocation: longitude/latitude, road being followed, heading, speed, journey start/end
- Environmental: temperature, light and precipitation outside the vehicle
- Vehicle state: fuel range, oil levels, tyre pressure, wiper state and speed
- Engine state: transmission, RPM, fuel pump status, engine load, torque and oil temperature
- Service diagnostics: component performance status, notification of service due or required
- Vehicle dynamics: acceleration, braking, steering angle slope
- Exceptional state: crash detection, airbag state, extreme acceleration, emergency braking
- In-cabin and media: air-conditioning status, infotainment status, smart phone pairing

The volume of data collected and the frequency of transmission varies by vehicle manufacturer, model (some cars have more built-in data capability than others) and data type e.g. some data, such as vehicle location, is more useful in near real-time, while other data can be batched for periodic transmission at a later time.

Autonomous Vehicles

AVs are broadly defined as being capable of driving themselves without human intervention. Vehicles with some levels of autonomy do not necessarily need to be connected, and vice versa, although the two technologies can be complementary.

Autonomous cars will produce material volumes of valuable data that will serve many of the same use cases as other connected vehicles.

Connected Car Data and Personal Data

This study has assessed the data in the connected car market to aid analysis of its usage and the ways in which value is derived.

Although much of the raw data generated by connected cars does not constitute personal data, if this data is linked to a vehicle owner, personal data can be derived.

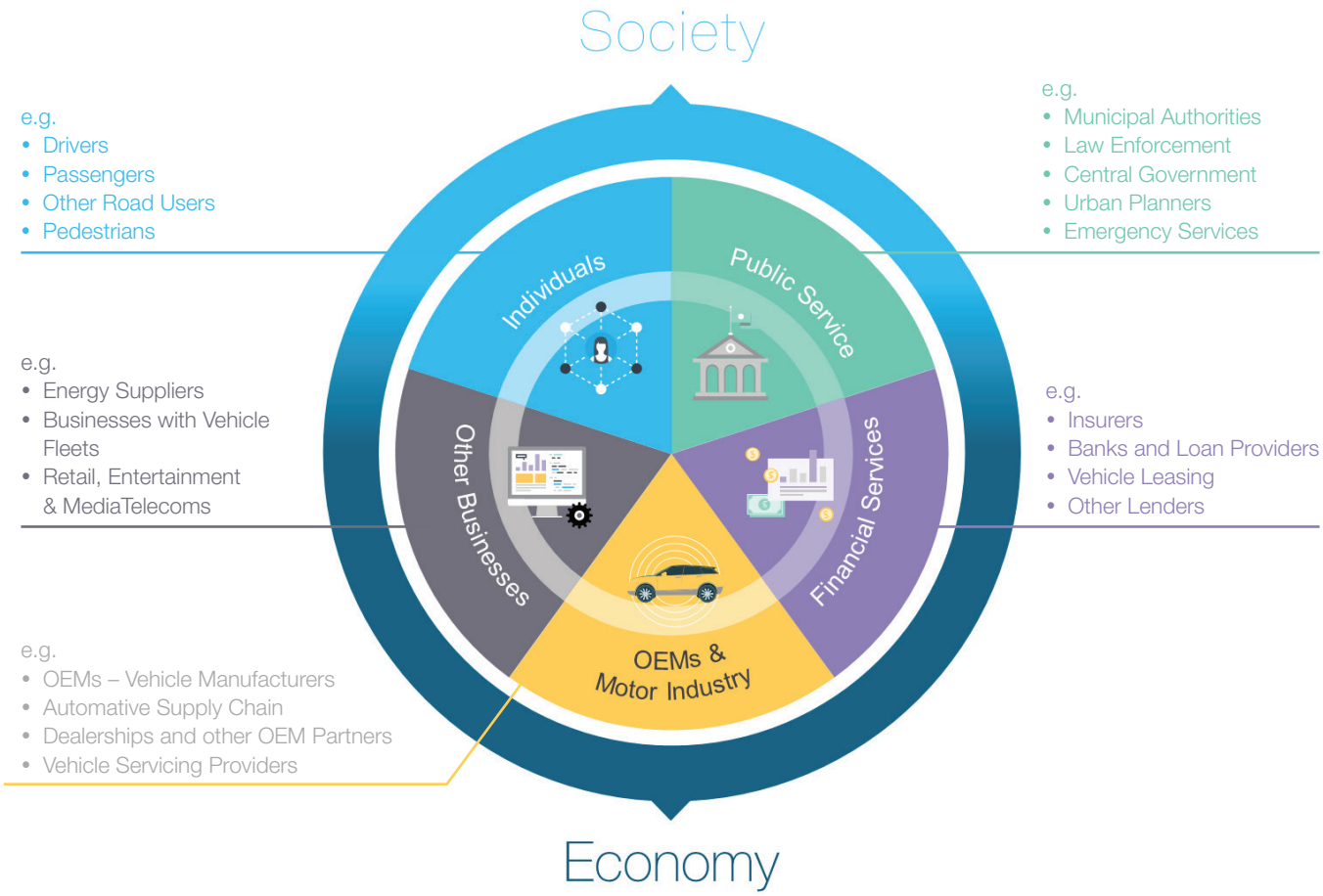
There is no universal definition of PII as yet, but the US National Institute of Standards and Technology (NIST) definition is widely used:

PII is any information about an individual maintained by an agency, including (1) any information that can be used to distinguish or trace an individual‘s identity, such as name, social security number, date and place of birth, mother‘s maiden name, or biometric records; and (2) any other information that is linked or linkable to an individual, such as medical, educational, financial, and employment information. .

2.4. Connected Car Data Market Stakeholder Groups

This study classified the key stakeholder groups in the connected car data market.

This classification was used to examine the benefits and opportunities that can accrue to these groups and the broader societal and economic advantages to be gained from the connected car data market. This analysis is presented in Sections 3 and 4.



The stakeholder groups include the following entities:

Individuals

- Drivers
- Passengers
- Other road users
- Consumer groups (representing individuals' interests)
- Privacy groups (representing individuals' interests)

Public Services

- Government
- Regulators
- Municipal authorities
- Smart cities
- Urban planners
- Road infrastructure providers
- Parking providers
- Emergency services
- Law enforcement

Motor Industry

- Vehicle OEMs
- Dealerships
- Vehicle servicing providers
- Automotive components suppliers
- Auction providers
- EV charging providers
- Roadside assistance and recovery

Financial Services

- Insurers
- Banks and other loan providers
- Vehicle leasing and fleet solutions providers
- Credit reference agencies

Other Business

- Businesses with fleets
- Retailers and restaurants
- Energy suppliers
- Fuel companies
- Media and radio
- Telecoms providers
- Parking providers
- Mapping and navigation providers

03

Societal benefits & opportunities from the connected car data market.

Introduction

This section explores the benefits and opportunities that the connected car market can deliver for society. Connected Car Data has the potential to transform journeys by improving safety, reducing emissions and congestion.

Key Findings

The fast-growing connected car data market offers huge untapped potential for consumers and society at large.

Safety

Cited by participants as the greatest overall benefit for connected cars, enabling improvement in the safety of vehicles themselves, road safety, driving behaviour and emergency services response.

Transport Efficiency and Environment

The connected car can bring significant improvements in the efficiency of transport and material environmental benefits:

- Use of connected car data to improve the design and management of road systems, creating time and cost savings to travellers, and improving productivity.
- Reducing the impact of vehicle emissions by optimising engine performance, improving journey times and efficiency, and dynamically monitoring air quality
- More Effective Use of Key Resources: enabling more efficient car pooling/sharing, and more effective muti-modal transport integration.

Mobility re-integration

Innovative services enabled by connected car data to help introduce mobility to excluded or isolated groups, enabling them to become more socially and economically active.

The most important topics in the societal context identified by the research were:

- Safety benefits
- Transport efficiency & environmental benefits
- Mobility reintegration

> *Most effective change [in the context of the exploitation of data] happens when data is collected and used for very tangible, graspable reasons, answering questions like "How does this make things better?" and then determining what data you need to pull together to do this. For example, "Improving Car Safety" needs to pull together OEM car performance data, information on accident blackspots, driver behaviour data, etc, etc. Car people need to think about "social physics" and the wider societal basis for successful change."*

Professor Sir Nigel Shadbolt, Oxford University

3.1. Safety Benefits

Participants in this research unanimously highlighted improved safety as the biggest overall benefit of connected cars and their associated data.

> *The ability of the automotive industry to use this data to help them design and build safer product is going to be very important."*

Harry Lightsey, Hawksbill Advisors

NHTSA statistics show that in 2017, more than 37,000 people were killed in road traffic accidents in the US. An additional 2.35 million people are injured or disabled. It is estimated that road accidents cost the US c. $230 billion per year.

Connected car data can drive safety improvements and reduce these impacts in a number of different ways:

- Vehicle safety
- Road safety
- Driving behaviour
- Emergency Services response

Vehicle Safety

Connected cars allow safety critical vehicle components such as the braking system to be monitored in real-time with issues flagged to the driver immediately and fed back to OEMs as input to the ongoing R&D processes that improve car safety (e.g. enhancements to ABS design).

Currently it can take a significant time for an OEM to understand and address a defect because of the inefficiency of the feedback loop from customers and dealers. If the defect involves a safety issue, the production fix is typically available in c. 18 months – whilst for less critical defects, it may take two years or more. Meanwhile, new cars coming of the production line could still carry that known flaw.

Connected car data can be used to drastically reduce the time to identify and fix safety issues in new models and apply such fixes Over-The-Air (OTA). This both reduces the number of recalls required and potentially increases the proportion of cars/ drivers reached by recall actions.

> *The whole concept of being able to address an issue through software downloads into the vehicle has always been viewed both by the federal regulators and by the industry as something that could substantially improve safety.*
>
> *Tesla has been able to do this for several years now. In a typical recall situation, a manufacturer considers the response to be substantial if it gets over 50% of the vehicles actually come into the dealers to be repaired.*
>
> *The Takata airbag recall - which is the largest recall that the industry's ever undertaken and is now into several years and on which the industry has spent untold millions - still has response rates of only 60-70 percent. So, you can see the huge potential."*

Harry Lightsey, Hawksbill Advisors

Combining data across OEMs has the potential to further improve vehicle safety. For example, in 2013 several OEMs initiated large scale safety recalls because of misfiring Takata airbags, but it is thought that the problems could have started up to a decade previously.

“

Almost every single automaker in almost every single car around the world were using Takata airbags, which would deploy randomly… sending shrapnel inside the vehicle cabin and causing serious injury. It could have been avoided if automakers could have collected the exact parameters of when these airbags were deployed so they were able to analyse what had happened.”

Michelle Avery, World Economic Forum

Many vehicles are already fitted with advanced driver assistance systems (ADAS) that can take over safety-critical functions from the driver under certain circumstances e.g. autonomous emergency braking (AEB).

Future AEB implementations based on V2V (Vehicle to Vehicle) communications will be able to detect and react to possible problems sooner.

Road Safety

Connected car data can be used to improve the design and operation of roads to reduce accidents. This includes:

- Analysis of historical traffic flows can inform road and related infrastructure planning, ensuring roads are ‘fit for purpose’ for the projected volume of traffic.
- Analysis of accident data, including data from vehicle Event Data Recorders (EDRs), can be used to inform road design, at both a specific (e.g. was a particular accident due to a flaw in the road layout?) and aggregated (e.g. identification of accident ‘blackspots’ – based on both actual collisions and ‘near misses’ suggested by heavy braking behaviour) level.

In a V2I (Vehicle to Infrastructure) context, when connected cars are able to communicate with city infrastructure like ‘smart roads’ (e.g. with adaptable lighting, signage and lane markings) and traffic control systems (e.g. traffic lights), accidents are likely to be significantly reduced. Ultimately it may be possible to all but eliminate collisions by having smart infrastructure proactively control the flow of traffic i.e. the speed of cars and the distance between them.

Other data enabled services could improve road safety by informing the driver in real-time about adverse surface weather conditions (combining meteorological data with data from aggregated vehicle light level, precipitation and other sensor data) or even warn of heavy pedestrian traffic based on data acquired by vehicle cameras or infra-red sensors.

“

Data is being generated at a rate where the 2nd order benefits are not being fully considered or evaluated. For example, what can CAVs [Connected and Autonomous Vehicles] environmental or contextual data tell us about what’s happening OUTSIDE the car? How can car data input to and help with some of the problems in the ‘external’ space?

Professor Sir Nigel Shadbolt, Oxford University

Driving Behaviour

By using various parameters on vehicle dynamics (e.g. braking, acceleration, steering input) and data from other sensors (e.g. lidar/radar/camera inputs on proximity to other cars), connected car data can determine how safely a particular driver is using a vehicle.

An important example of the use of this data is in Usage Based Insurance (UBI), where data gathered about how a vehicle is driven is used to inform the insurance premium to be paid.

Widespread adoption of UBI should result in an increase in safe driving as drivers become much more aware of, and can influence, how their driving impacts the cost of insurance.

Emergency Response

eCall (Emergency Call) became mandatory across Europe in 2018, and the NHTSA (National Highway Traffic Safety Administration) is reviewing whether similar services should be available in the US.

eCall speeds intervention by emergency services in the event of a severe traffic accident, opening a voice call to the emergency response number and automatically sending critical data to emergency services, including VIN, vehicle type, vehicle location and direction of travel.

eCall is expected to reduce the response time by emergency services by 50% in rural areas and 40% in urban areas, leading to a reduction of fatalities – estimated at up to 2,500 saved lives per year across Europe.

Future connected data enabled services could extend the utility of eCall e.g. by detecting multi-vehicle collisions and putting hospital emergency units on standby, advising response teams on the number of occupants in vehicles, or (with appropriate consent) ensuring that any relevant health data about occupants is available to response teams.

Usage Based Insurance (UBI)

Usage Based Insurance is often cited to be one of the driver-centric use case with the highest potential value in the developing connected car data marketplace.

Frost & Sullivan estimate the value opportunity of UBI to be $25-$40 per car per annum – making the US market potentially worth some $3.7-£5.8 Bn pa. by 2030.

What is Usage Based Insurance?

One form of UBI is based on measuring how much a driver is actually using the vehicle – this is Pay As You Drive (PAYD) insurance. It is most useful for low mileage drivers or when there is pooled use of a vehicle.

Another form of UBI measures how someone drives, and determines whether their driving behaviour makes them more or less likely than average to have an accident – this is Pay How You Drive (PHYD). PHYD and PAYD models can be used together to provide a full insurance service.

In PHYD, a baseline is established by using anonymised and aggregated data on many drivers, with analysis to define the risk of different driving behaviours. A specific individual's driving is then compared to this profile to determine their specific risk, and an insurance premium is set accordingly. The amount a driver actually pays can then vary monthly – increasing for poor driving behaviour, or decreasing with good driving behaviour.

What Driving Behaviour is Measured?

The fitting of 'black boxes' to collect data on driving behaviour is not new – especially as a way of offering insurance to newly qualified drivers with no other 'track record'. Early approaches typically focused only on where and when a car was being driven. These are known risk factors in existing underwriting models.

Connected car data offers a much more granular understanding of individual driving behaviour, based on:

Vehicle dynamics analysis

Input from connected car sensors e.g. how gentle or aggressive is vehicle acceleration, braking or steering.

Vision based analysis

Input from connected car cameras or other sensors e.g. how close is a vehicle driven to the one in front/behind, lane changing, what is the speed relative to other vehicles, how often does the driver become distracted (diverting their eyes from the road or instruments)

Commercial applications

In commercial applications (e.g. Fleet Management), other metrics are added e.g. adherence to speed limits, frequency of breaks. These tend to be viewed as unacceptably intrusive for personal drivers.

Current Examples of UBI

Toyota's UBI offering is based on driving behaviour deduced from vehicle dynamics data. Drivers are provided with a safe driving score and tips after each journey. Gamification is also enabled e.g. drivers shown their national ranking in terms of safe driving score, or how they compare to drivers of similar vehicles.

FICO – more well known as a provider of fraud detection services in the Financial Services industry – has used their data analysis capabilities to develop a Safe Driving Score. This predicts the likelihood of future driving incidents by evaluating driving behaviour (acceleration, braking, cornering, speeding, smartphone distraction). The service is primarily aimed at the Fleet Safety Management market – but could readily be adapted to UBI. FICO's approach is interesting in that data is gathered via a partner smartphone app (using the phone sensors). Whilst this data is poorer quality than connected car data, it means that the identity of the driver is assured e.g. fingerprint authentication to the app. This is not currently easy to do for non-smartphone based UBI.

Implications for the Motor Insurance Industry

This is a major development for the motor insurance industry. Not only does it fundamentally change the basis for risk analysis, but it promises to improve the actual driving behaviour of road users, reducing accidents. Together with the other safety benefits of connected car data use, the impact is expected to be significant.

> *"Connected car data will significantly reduce the cost of insurance – not necessarily because Usage Based Insurance will make premiums cheaper, but the improvements in safety that will be possible will reduce the number of accidents and thus claims."*
>
> Ian Adams, Vice President of Policy, TechFreedom


CtrlShift

3.2. Transport Efficiency and Environmental Benefits

Improved transport efficiency and the associated environmental impact were the second major category of societal benefit that was cited by participants in this research. The key advantages were seen as:

- Time and cost savings for drivers and passengers
- Increased productivity for people and public services
- Reduced pollution with associated health and environmental benefits
- More effective use of key resources in urban environments

Time and Cost Savings for Drivers and Passengers

The use of connected car data can materially reduce journey times, and so save on the cost of fuel. There are several ways in which this can be achieved.

Analysis of connected car data can be used in smart infrastructure to enable active management of traffic and congestion by changing traffic routing dynamically in response to accidents or other events that may cause congestion. Drivers can be notified of traffic issues on their journey ahead, allowing them to follow an alternative recommended route.

V2X communications will enable the 'platooning' of vehicles (especially those with some degree of autonomy) – controlling their speed and separation. Research by the University of Cambridge suggests that such 'co-operative' approaches can increase the volume of traffic using a given road network by 35-45% without lengthening average journey times.

Aggregated connected car data also has an important part to play in improve the design and operation of roads and the associated traffic control infrastructure to improve the flow of traffic.

Increased Productivity for People and Public Services

A consequence of reducing average journey times and optimising resource use is increased productivity (and the associated economic benefits), including:

- Workers spending less time travelling to/from work are able to devote some or all of the time saved to work activities, and may arrive at work less stressed than previously.
- Commercial drivers (e.g. buses, cabs, ride-hailing services, haulage companies) are able to complete more journeys in a given period due to the reduction in journey times.

Reduced Pollution and Associated Environmental and Health Benefits

The desire to contain the damaging impact on health and environment helped drive the introduction of the connected car as California laws regarding vehicle emissions in 1994 created a need for telematics.

Pollutants emitted from transportation contribute to poor air quality. These pollutants include particulate matter, nitrogen oxides, volatile organic compounds, and compounds that are known or suspected to cause cancer or other serious health and environmental effects. Examples include benzene, formaldehyde, and diesel particulate matter.

Transportation is also a major source of greenhouse gas (GHG) emissions in the US, with c. 30% of national GHGs directly attributable to transportation.

The US Environmental Protection Agency (EPA) already has in place programs aimed at reducing pollution from transportation that is projected to prevent, annually, 40,000 premature deaths, 34,000 hospitalizations and 4.8 million workdays lost in the US by 2030.

Connected cars will make a major contribution to reducing the impact of vehicle emissions:

- Fuel consumption, engine performance and other data can be used to improve the fuel efficiency of the vehicle itself, with the potential to dynamically update engine maps to ensure optimum efficiency in certain conditions e.g. in various climates.
- Delivering the journey efficiencies outlined in Bi and Bii above will also have a positive impact. Reducing journey times by 10%, and making that journey less 'stop/start' is likely to yield more than a 10% reduction in the fuel burnt emissions released.
- New connected car data enabled services can help to monitor air quality in a dynamic way, not just in urban areas but more widely.

> *"Some partnerships are likely in this space – maybe for gathering environmental or air quality information in a very dynamic way to plan/inform environmental protection action. Some fleet managers are using temperature, altitude, etc. sensors in this way already."*
>
> Jessika Lora, CEO & Founder, CarForce.io

More Effective Use of Key Resources in Urban Environments

Connected car data can lead to fewer vehicles on the road by enabling car pooling and ride sharing or refining the scheduling and routing of transit systems. In time, the notion of car ownership may change completely especially if AVs become widespread and could lead to fewer privately owned vehicles operating in urban environments.

Analysis of historical and real-time connected car data enables more effective multi-modal transport integration optimising the use of public transport e.g.

- Informing which journeys/routes would benefit most from improved public transport.
- Identifying areas where alternative transport approaches could be incentivised because they are more effective than driving e.g. micro-mobility solutions, cycle lanes or further pedestrianisation
- Better integration (e.g. scheduling frequency and timing) of transport options.

Other resources that can be optimised using connected car data include:

- Parking – connected car data can be used to inform the amount of parking capacity required, the geographical location of parking facilities (e.g. 'park and ride' facilities to encourage public transport use), dynamic routing of vehicles to available parking, , and dynamic parking pricing.
- Kerb time – in particularly busy environments, time at the kerb to load cargo or passengers is valuable and can be a cause of congestion as vehicles 'double park' or re-circulate when they cannot find space. Connected vehicles can engage with smart infrastructure to identify vacant space or allow for pre-booking.
- Congestion and emissions zones

"

In NY, Chicago and elsewhere you have micro transportation, commercial deliveries & ride sharing companies – that leads to a battle for kerb space – dropping off passengers vs deliveries. It is becoming a public infrastructure challenge to not have this impeding traffic. How do you get an outcome that helps everyone?"

Anonymous Motor Industry Executive, Detroit

3.3 Mobility re-integration

Innovative services enabled by connected car data could deliver considerable social and economic benefits by re-integrating excluded groups into mobility.

Estimates suggest that in 2018, social isolation (of which loss of mobility is a key contributing factor) adds about $6.7 billion annually to Medicare's costs. Source: Coalition to End Social Isolation and Loneliness.

"

There's a lot to be said for the resurrection of dead capital associated with those who are not otherwise involved in the economy due to mobility issues…. Say the elderly, who are not fully integrated and there is a cost associated with that - not only in terms of what productivity they can bring, but also in terms of the real medical cost to isolation.

Social isolation is something I think that connected vehicles – and especially autonomous vehicles - can help address… we can talk about safety all day long, but enabling mobility and social isolation are the ones that are not immediately apparent, I find, to a lot of policymakers."

Ian Adams, Vice President of Policy, TechFreedom

By far the largest group in this context is the elderly – who may become isolated because they lose access to the mobility that allows them to get out and see family or friends or go shopping. Others who for any reason may not be able to get a driving license, might find it difficult to go to/from – or even get – work.

Re-mobilising these groups will make them more economically active, either by enabling them to re-enter the workplace, or by increasing their ability to be active consumers.

Mobility-as-a-service (or transport on demand) enabled by connected vehicles and delivered through services such as ride sharing can start to make a beneficial impact in this space.

04

Benefits and opportunities for key stakeholder groups.

Introduction

This section explores the benefits that can be delivered for the key stakeholder groups in the connected car market.

Key Findings

Connected car data-driven innovation can unlock great economic potential in this market – driving performance and efficiency gains in design, production and service delivery, and new forms of consumer service and engagement that open up entirely new market value.

These innovations can bring benefits and opportunities to all participants and stakeholders in the market:

Individuals

Bringing greater convenience and value in car ownership and journey efficiency, and reducing car ownership and transport costs.

Public Services

Using data on vehicle journeys to help plan, and manage transport infrastructure. Supporting emergency services and law enforcement, ensuring appropriate level of response and effective intervention in control of a vehicle when required.

OEMs and Automotive Service Providers

Use of connected car data to advance OEMs' design and manufacturing efficiency, transform after-sales product support costs, and create new, deeper consumer relationships – strengthening brand loyalty and creating opportunity for major new service revenue streams.

Enabling improved and expanded service offerings based on access to connected car data for a range of service providers in the ecosystem including vehicle servicing; dealerships, fuel and EV providers; roadside assistance

Financial Service Providers

For insurers, the use of connected car data for enhanced underwriting, Usage Based Insurance and enhanced claims analysis. For Banks, Lenders and Lease Providers – improved asset valuation.

Other Businesses

- Vehicle Fleet Management: improved operations and reduced costs.
- Telecommunications Providers: a projected 40-fold increase in wireless network traffic and new services to connected car ecosystem players e.g. data acquisition and storage, analytics, data brokerage.
- Parking Providers: more efficient use of resources and better planning of future capacity.
- Retailers, restaurants, hotels and other geo-centric businesses: better targeting of marketing messages and planning of new facilities.

This section examines the benefits and opportunities, in addition to the societal benefits described in Section 3, for each of the five key Stakeholder groups in the market

- Individuals
- Public Services
- OEMs and Automotive Service Providers
- Financial Service Providers
- Other Businesses

4.1 Individuals

The benefits to individuals were principally in the areas of:

- Safety
- Environment
- Convenience & Value
- Cost savings

Safety benefits are addressed in Section 3.1. and Environmental benefits are addressed in Section 3.2

Key topics in the other two categories are set out here.

Convenience & Value

Vehicle Support

- Evidence-based notification of issues requiring attention (Predictive Maintenance) e.g. service due, component wear, reducing time off the road to correct problems as service centres can be notified of details and parts ordered in advance.
- Analytics applications can access vehicle status/performance data from vehicles of a given year / model and combine it with warranty repair trends. Enabling he service provider to advise the driver/owner on any preventative action required.
- Remote diagnosis and repair of an increasing proportion of vehicle issues, negating the need to visit a dealership or service centre.

Real-time Geolocation-based Services

- Continuously updated maps, active and dynamic route planning (traffic avoidance, instant notification of accidents ahead, etc.).
- Current parking or POI information, petrol/gas station proximity and fuel availability, etc.
- Geolocation data or other motoring related information can be combined with datasets related to other aspects of people's lives to provide better targeting of services in-car (taking into account non-motoring preferences). For example, both Toyota and GM allow control of some vehicle functions via home hub services such as Amazon Alexa and Google Home.

> *"Connected cars can exchange data with a smart home hub so lighting or heating can be switched on when the car nears home, or data can be shared with payment mechanisms so that cars can act as an electronic wallet, automating the payment of road tolls, fuel purchases or other motoring related expenses."*

Doc Searls, Berkman Klein Center, Harvard University

“

If I rent a car, I go through this awful dance where I have to sign off that I really do have car insurance and it’s from this company…. that should be linked so that the rental agency knows automatically that I’m covered by Liberty Mutual. And if I’m then in an accident, the insurance company should be automatically informed and can represent me, which is what I paid them for.”

“

All these benefits should be private and shared only under the driver’s control and direction.”

Doc Searls, Berkman Klein Center, Harvard University

Integrated Payments and eCommerce Capabilities

Based on the combination of connected car data with wider personal datasets, allowing automatic payment for road tolls, fuel and other motoring related expenses or enabling shopping via the in-car display.

GMs Marketplace, introduced in 2017, is now available in c. 3 million Chevrolet, Buick, Cadillac and GMC cars. Using their touchscreen, drivers can place for food and drink from selected merchants, pay for fuel, or make restaurant reservations, without having to leave the car.

Similarly, Fiat Chrysler plans to deploy a new mobile wallet in the 2020 Chrysler, Dodge, Jeep and Ram vehicles equipped with connected services. This “Uconnect Market Platform” can be updated over-the-air and can be used to order food, make reservations and pay for fuel or parking.

Personalised In-Car Experience

- Driver / passenger personalised settings and preferences, including infotainment preferences, journey plans, driving position and climate control.
- Ability for the user to port between vehicles

Other features include remote operation (e.g. unlock, start, reverse out of a parking bay)

Cost Savings

- Enhanced monitoring of key service items, increasing the time between service visits.
- Reduction in fuel costs resulting from reduced journey times (improved navigation) and more economical driving behaviour (comparison to an ideal profile).
- Insurance premium reductions, either enabled by improved safety or by improved propositions based on driving behaviour.

4.2 Public Services

Public Services are key beneficiaries of the societal benefit areas set out in Section 3.

Further benefits for Public Sector organisations are set out here.

Urban Planners, Municipal Authorities and Highway Agencies

Data on vehicle journeys (journeys start/endpoints, journey times, traffic hotspots, accident blackspots, etc.) can help urban planners and municipal authorities with a range of decisions e.g. location of new residential and industrial or business developments, public transport infrastructure, timing of roadworks and where to focus increases in urban road capacity.

Similar data can provide highway authorities with insights helping to inform (very expensive and potentially highly disruptive) investment decisions on road infrastructure.

Movement data can also assist authorities with disaster planning and disaster response in the event of roads becoming inaccessible due to fire or flood or large numbers of vehicles needing to be re-routed as a result of natural disasters.

Emergency Services & Law Enforcement

For the emergency services, real-time data on the number of cars and number of passengers involved in accidents enables better matching of ambulances or fire trucks to crash sites. This data can be shared and updated by first responders to incidents so that the all relevant resources (hospitals, law enforcement, traffic redirection) can be aligned where necessary.

Connected car data is already enabling stolen vehicle tracking and recovery e.g. once a driver reports a stolen vehicle to GM's OnStar service, advisors can use GPS technology designed to locate the vehicle, alert law enforcement authorities, and in some cases, remotely slow down the vehicle.

With Remote Ignition Block, OnStar can also remotely prevent a thief from restarting a stolen vehicle. Some sensors (dashcams, internal cameras) could evolve to support the identification of vehicle thieves.

4.3 OEM & Automotive Industry

The benefits and opportunities highlighted for OEMs and Automotive Service Providers fall into seven categories.

OEMs – Improving Design and Manufacturing Process Efficiency

OEMs can use connected car data to improve the design and optimise manufacturing processes both internally and throughout the supply chain - significantly improving the efficiency and reducing the cost of their operation.

Connected car data can have a significant impact in 'closed-loop manufacturing' (which uses structured processes and continuous data flow that starts with R&D, moves through design and prototyping, production, aftermarket services and circles back to R&D) by providing rich insights into how the car is being used, how it is performing and issues with its systems or components that might need replacement or re-design.

OEMs – Post-sale Operational Cost Reduction

The opportunity to reduce after-sales costs associated with fault identification and repair was cited by many interviewees as the most significant tangible benefit to OEMs.

Connected car data can bring huge benefits to the recall and defect correction processes. The data can increase significantly the efficiency of fault diagnosis and the development and delivery of the most effective response.

> *"The Business case for adding the telematics capability was predicated on the ROI achievable via leverage of the data. It was a walk in the park – mainly because of the operational benefits of remote diagnostics and OTA servicing in our business model, where we want to avoid the need for cars to physically visit a dealer."*
>
> David Green Lynk & Co.

An ever-increasing number of vehicle operations are controlled or enabled by embedded software – from operation of precipitation and light sensors through infotainment to core engine/gearbox/braking system management. The forecast value of this software will rise to c. 30% of the total vehicle value by 2030 (McKinsey). Over-The-Air (OTA) servicing using the connected car infrastructure can play a major part in cost-effectively managing and maintaining these vital systems.

These remote diagnostic and service solutions could provide the cornerstone of an ongoing relationship with the driver that engenders trust, loyalty and influences future buying behaviour.

> *"Diagnosis and maintenance - ultimately including OTA maintenance - is one of the biggest areas that answer the key consumer question "What does this do for me" that will motivate individuals to part with their data."*
>
> Jessika Lora, CEO & Founder, CarForce.io

OEMs – New Revenue Opportunities

In addition to operational benefit from connected car data, there is huge opportunity in its wider commercial use. New direct revenue opportunities are available by:

- Using data to enable new paid-for data-driven services to drivers, vehicle owners or other stakeholders. For example, GM OnStar In-Vehicle Safety and Security services and BMW Connected.Drive value added services are both available to drivers for a variable monthly fee, depending on the range of services taken.
- Selling connected car data directly to 3rd parties e.g. for marketing analysis or research purposes, or to enable value added services such as real-time traffic information.
- New indirect revenue opportunities are available by making connected car data available via partners or data marketplaces, and receiving a share of any revenue generated by 3rd parties using the data to provide new services to drivers, owners or other market players.
- Leveraging non-personal and anonymised datasets is relatively low risk as it largely avoids the legislative and associated challenges related to the use of PII (see Section 4). However, participants in the research felt that OEMs need to be mindful of not missing key opportunities by avoiding the use of PII – as this creates a gap that others may be prepared to fill.

Example Uses of OTA Capability

Issuing new services or upgrades remotely

BMW recently released an upgrade to some models that introduced an Intelligent Personal Assistant – "whose range of intelligent functions can now be expanded automatically and conveniently over the air". Other OEMs offering similar updates include Volvo and Ford.

Applying core performance upgrades

In 2018, in response to a critical review by Consumer Reports, Tesla issued an OTA upgrade to the braking system on its Model 3 that reduced the braking distance from 60mph by ~20 feet.

Tesla leads in this space currently, and regularly issues OTA vehicle updates.

Challenges to Widespread Implementation of OTA Fixes and Upgrades

There are a number of challenges to be addressed in the development of OTA solutions.

The question of whether customer consent is required before issuing a fix or upgrade, and whether customers are able to reject a change (if so, with what consequences e.g. if it is a safety upgrade).

This may be part of the contract of sale for the vehicle, or addressed more frequently and dynamically as part of a wider consent model for connected car data enables services.

There are typically robust 'type approval' regulations for vehicles, whereby a new model must undergo and pass stringent tests before being deemed fit for sale. Once type-approved, key vehicle components or systems may not be changed unless there is a new, or updated type approval. Rigorous testing will be required before OTA changes are made to safety critical or core operational systems in the vehicle.

“

A big part of the reason that these data experiences have not flourished already isn’t because of a lack of data. It’s because of a concern for potential legal exposure and liability. Any time we see these sort of bottlenecks, it does create a big open opportunity for third parties to come in and innovate… to use the data, take the time to go out and seek the express consent from the consumers and take on that risk.”

Jessika Lora, CEO & Founder, CarForce.io

OEMs - Deeper Customer Engagement

Connected car is a key opportunity to strengthen an OEM’s relationship with the driver by providing in-life upgrades, service notifications, novel features and subscription-based services e.g. at GM, via the services enabled by OnStar.

“

The connected car must be considered a ‘living product’, that continues to evolve during its lifetime with the customer.”

Franck Louis Victor, Renault-Nissan-Mitsubishi Alliance

Vehicle Servicing Providers – Improved Servicing Offers

3rd party businesses will be able to offer a range of services to drivers using connected vehicle data around engine, other systems and component diagnostics. These can be made available in ways that drive competition, improve efficiency and encourage innovation.

For example, Carforce collects this data remotely via the OBD port and apply their own analyses to fault codes and related data – the output is provided to independent dealers, enabling them to offer improved service offerings (including predictive maintenance) to consumers and businesses e.g. Fleet Managers.

Use of the data can also reduce the number of cars brought in for unnecessary servicing and repair/fault resolution.

OEMs and Automotive Service Providers

Dealerships – Deeper Customer Engagement

Dealerships will be able to develop and offer additional services to consumers, either via the in-car technology platform (if access is granted) or via brought-in platforms (e.g. smartphones) to deepen customer relationships and engender loyalty.

Fuel and EV Charging Providers – Proactive and Adaptive Offers

Access to car route data (e.g. volume of cars passing by, number of cars stopping at competitor’s stations) supports better decision-making on where to site new gas or EV charging stations and enables adaptive and dynamic pricing strategies.

With access to in-car data (e.g. fuel/battery levels, planned journey information) fuel or EV charging stations will able to offer targeted, dynamically priced services to approaching vehicles. Some aspects of this can already be seen in platforms such as Waze, where gas stations, EV charging points and other retailers/service providers are able to advertise and promote offers to nearby vehicles.

Roadside Assistance Providers – Proactive and Efficient Repairs and Recovery

As well as being notified of breakdowns automatically (bCalls), or potentially being able to identify and proactively resolve problems before they happen (in the same way as OEMs or 3rd party service providers), the ability to access diagnostic data prior to arriving at the vehicle should enable swifter resolution.

In the event of advance data indicating an irresolvable problem, it should also lead to more appropriate response – sending a tow truck to recover the vehicle in the first instance rather than an engineer in a van.

4.4 Financial Services Providers

Insurers – Enhanced Underwriting, Usage Based Insurance Offers and Enhanced Claims Analysis

Access to driver behaviour data enables insurers to price risk more accurately and develop innovative products, such as pay as you drive or insurance pricing that adjusts to reflect driving behaviour.

Other connected car data can help evaluate claims and identify potential fraud e.g.

- Dashcam or reversing camera data can show the cause of collisions
- Claims for whiplash can be informed by Event Data Recorder (EDR) information on the severity of the collision
- Data on driver behaviour, vehicle status and environmental condition can all inform the evaluation of claims e.g. was the driver exceeding the speed limit prior to an accident
- Collision impact data can make claims processing more automated with less need for damage assessment to be undertaken by a human e.g. automatically writing off a vehicle involved in an impact beyond specified g-force parameters.

Banks, Lenders and Lease Providers – Improved Asset Valuation

For banks and other vehicle loan providers, connected car data can provide insight into how the asset against which the loan is secured is being treated and maintained. This enables them to accurately estimate how much of the loan could be recovered should the owner default on payments and adjust risk provisions and future loan offers accordingly.

Vehicle leasing providers can use this information to better estimate residual values at the end of a lease, enabling refunds/ extra charges or bespoke pricing on subsequent leases. Leasing providers (and fleet managers) will also be able to determine whether certain lease restrictions are being breached and take appropriate action.

4.5 Other Businesses

Vehicle Fleet Management - Improved Operations and Reduced Costs

Businesses operating vehicle fleets will benefit from access to richer data that identifies ways to reduce vehicle maintenance costs. Connected vehicle data will significantly improve on the telematics that is already in commercial fleets by allowing this to be done more proactively and dynamically (real-time).

There are also significant benefits for haulage fleet operators, courier companies and others who can extend current telematics analysis to further optimise route planning and timing taking account of historical and real-time traffic patterns, environmental conditions, etc.

Telecoms Providers

Telecoms is an industry set to be impacted massively from increased connected car data:

A projected 40-fold increase in wireless network traffic will require investment in infrastructure capacity and create opportunities for new revenue streams from the connected car ecosystem e.g. data acquisition and storage, analytics, data brokerage, or data monetisation more generally.

Parking Providers

Parking providers can use traffic data in conjunction with their own information on parking space availability (from cameras, IoT sensors, etc.) to enable dynamic pricing, more efficient use of resources and better planning of future capacity.

Retailers, Hospitality and Other Businesses

Leverage of connected car data will enable many types of business to enhance existing services and offer new value, for example:

- Retailers, restaurants, hotels and other geo-centric business will be able to target marketing messages more accurately and dynamically e.g. precision targeting of both new prospects and existing customers with offers either when a journey is planned or as drivers approach one of their outlets.
- As with gas stations, route data analysis will also support better decisions on where to locate new sites.

This is exemplified by Waze, which offers personalised advertising e.g. about local amenities, when it detects that the car has been stationary for more than 3 seconds.

- Media and infotainment providers will also be able to provide more targeted content to drivers and passengers, delivering greater engagement. This will become increasingly important as the level of vehicle automation increases and less is required of drivers, meaning they have more time to consume rich media.

05

The importance of consumer trust and data regulation to the connected car data market.

Introduction

This section considers the key issues of consumer trust in the use of connected vehicle data and PII. Increasing public awareness of issues around data security and data privacy and emerging legislation in many jurisdictions may impact the development of the market and OEMs, data marketplaces and data consumers all need to consider their role and approach.

Key Findings

Personal data and consumer trust are critical to the growth of the market for connected vehicle data.

If trust is not earned and maintained by market participants, or if legislation fails to balance the need to protect privacy and ensure data security with the need to foster innovation and economic growth, then significant market opportunities and societal benefits could be materially constrained. There are wider risks where the operation of the market for vehicle data is impacted by issues and concerns with social networks' use of data and the regulatory response to failings in that market

To mitigate these risks participants in the connected vehicle data market need to ensure they secure both consumer trust and the effective regulation of the use of data in the market.

These include:

Stimulate consumer and regulator confidence

By encouraging transparency and raising proactively the profile of the connected car data market and the benefits it conveys.

Differentiation and leadership through trust

Opportunity, to lead the market through trust – based on best practice and putting the individual at the centre - 'transparency', informed and practical consent, choice and education.

Positively influencing developing legislation

To support the beneficial use of connected car data for all stakeholders, whilst ensuring the necessary data protections. There are a number of new data privacy acts being developed in US States as well as evolving understanding of the requirements of existing legislation such as GDPR in Europe and the unique characteristics and benefits of vehicle data need to be factored in to the design of legislation.

Self-regulation & Codes of Conduct

Opportunity for OEMs and other market participants to build both consumer and regulatory trust through the advocacy and development of self-regulation

Actively promote the benefits of the connected car data market

Stimulate consumer and regulator confidence by raising the positive profile of the connected car data market and the benefits it conveys,

Connected car data is hugely valuable and it is vital that data is used responsibly. Vehicle manufacturers using sensors to collect the data, marketplaces that use it, firms that provide services build on it, and the individuals and companies using products powered by that data need to know that they are using ethically sourced information.

Important factors associated with PII, notably consumer trust and data privacy legislation and regulation are increasingly key issues in the development of the market. Furthermore, there is a significant risk that if consumer trust becomes undermined, and/or if PII legislation does not balance the need to protect privacy with the need to foster economic growth, the significant market opportunities detailed in Sections 3 and 4 could be materially constrained.

5.1 Consumer Trust

Consumer attitudes towards the use of personal data has been changing rapidly. For many years the rapidly expanding use of PII by organisations, fuelled by the explosive growth in consumers' online activity, was low profile and therefore little understood, or focused on by most consumers.

However, high profile mass data breaches e.g. Equifax and, in particular, the Cambridge Analytica debacle have turned the spotlight on personal data privacy and on the behaviour of social networks and mobile phone applications in particular. The increase in the profile of personal data risks undermining trust and consumer confidence in particular in companies and in the use of data more broadly. This has led directly to the emergence of personal data privacy legislation (discussed in Section 5.2 below)

Connected car data has been collected for many years. However, connected car data remains generally opaque to consumers, who have limited understanding of the rationale for its collection, the purposes for which it is used, and little or no perception of the scale, complexity or significance of the data market.

In many respects the low level of public consciousness is comparable to that of the personal data market 4-5 years ago.

> *"I've been working for more than 10 years in the automotive data space - where OEMs have been collecting the data and dealerships have been intermediating the customer relationship. There's been an ongoing demand from customers to see the benefits from the data they KNOW are being collected."*
>
> Jessika Lora, CEO & Founder, CarForce.io

Many participants in this research consider it inevitable that the connected car data market, and the importance of PII within it, will soon become significantly more prominent.

The risk is that it does so for negative reasons - like the wider personal data market before it. This could seriously compromise consumer trust, increase demand for privacy-related legislation targeted on the automotive sector – and lead to greater consumer 'opt out'.

Consumer Trust Risks Issues

Risks to individuals stem from combining connected car data with some form of identifier so that it becomes PII. While this may enable more value to be created e.g. more personalised services – it also creates possible threat, which has the potential to undermine consumer trust.

Security risk

Failings in the collection, transmission or handling of connected car data could result in a data breach with information falling into the hands of bad actors. More seriously, malicious hacking of vehicle control systems could result in serious injury or worse.

Privacy risk

Connected car data enables driving behaviour, geolocation, etc. to be tracked, meaning detailed surveillance is possible – with all the 'big brother' implications and concerns that this brings. Connected car data could be merged with other datasets to enable re-identification of individuals.

Discrimination risk

Personalisation of offers or services could lead to discrimination against certain groups or behaviours. Where PII is used to target offers and services to individuals then the risks may be exacerbated.

The use of connected car data in automated decision making about the individual brings in the risk of algorithmic bias. This can lead to exclusion from a service or price discrimination.

Misidentification risk

If a system or process malfunction or erroneous data integration leads to inaccurate data being generated, there is a risk of harm to the individual due to flawed decisions being made. This risk is heightened by automated decision-making.

Inequity risk

The risk of connected car data being used to further the interests of businesses and their commercial partners rather than the interests of the driver.

For example, if a driver asks the in-car assistant for directions to a gas station and they are given directions to the station of a provider who has used ‘paid search’ to gain favourable promotion, the customer may not receive the best price possible and will incur additional cost as a result.

> *“We know we deal with privacy across the board in multiple settings that are not necessarily about connected vehicles… but the risks are the same risks. A lot of the data that cars are collecting, and will increasingly collect, are very sensitive - precise geolocation or biometric data for instance… when you overlay that with a very complex ecosystem - it takes a lot of parties to create this environment - it becomes clear that you have serious privacy issues.”*

Omer Tene, Chief Knowledge Officer, IAPP

5.2. Implications of Data Protection Legislation and Regulation

Legislation is being designed and enacted to protect customers from risks associated with the inappropriate or unapproved collection of data and the misuse, mishandling or unintended exposure of that data.

Some of this legislation has been developed over an extended period, such as the General Data Protection Regulation in the European Union. Other legislation has been advanced in the wake of major data breaches and personal data usage crises in recent years.

Even where legislation has been in place for several years its practical effects on markets are still emerging. And where legislation is hastily constructed there is an increased risk of unintended consequences for data markets.

Data protection legislation to date has been developed to address the broad market of personal data collection, storage and usage. Unsurprisingly the legislation is influenced heavily by screen-based / internet / data platform models.

There is a risk that this could create challenges for other types of data markets, such as the data from connected cars - constraining innovation in this emerging market.

> *"The threat to connected vehicles is that these laws are being drafted principally with the data platforms [Facebook et al] in mind and with safeguards in place for that context [where] people can more easily understand what's happening in terms of what data they are surrendering and how they can keep control over that data once it's been collected. This creates significant problems in the automobile context - automobiles are not smartphones on wheels."*
>
> Harry Lightsey, Hawksbill Advisors

Connected car data may contain PII but it's fundamentally different from phone and browser data which monitors preferences, purchases, browsing history, etc so the legislation may not adequately reflect those differences. Also, the orientation of legislation around current dominant digital platform models could also create an unintended advantage in the emerging connected car data market for the major data platform providers. This could lead to benefits not being shared proportionately among stakeholders, further stimulating data monopolies.

> *"The key question is 'What is PII'? Is it PII if it is used primarily for internal operations and optimization of vehicle performance? And should the CCPA be used as a model? The challenge for policymakers is finding the balance between providing consumers appropriate protections without creating unintended consequences for businesses that rely on certain types of data to enhance safety, security and quality of products consumers depend on. This nuance is challenged by certain legislative approaches but it remains a key concern for a number of stakeholders."*
>
> Charles Haake, Vice President and General Counsel, Global Automakers

The ways in which the user interacts with data and how it is presented to the user is very different in an automotive environment than it is using a smartphone. This creates significant challenges in implementing rights and obligations in a connected car setting. A major issue being the gaining of consent.

Consent

An effective and transparent consent model will be key in acquiring and maintaining consumer trust in this market. In the absence of such trust, the risk is that consumers will increasingly opt out of (or not opt in to) the collection and use of their data – limiting the development of the market.

Complications of consent and consent management, and emerging best practice

Consent and consent management needs to be clear and efficient. A poor user experience risks consumers becoming apathetic toward active consent management - negating the rationale for its existence. Consent must be granular to be specific, e.g. addressing consent to data collection, to data sharing or data sale, to the specific use cases for the data (as known now, and as can be anticipated in future).

Meeting these requirements presents challenges to the motor industry and the in-vehicle context, as the traditional approach of establishing an agreement with the customer at the point of sale of the vehicle does not address consent needs for data-enabled services. Within the vehicle, there are user interface and

user experience challenges to providing sufficient information, obtaining the necessary affirmative action or dealing with timely and dynamic consent.

> *"It's likely you have to collect permissions up front in a CC data context as 'just in time' may not be appropriate e.g. due to the nature of in-car interfaces and safety concerns. But will this satisfy legal requirements – what happens if you change your mind or new services are layered in?"*
>
> David Le Duc, VP Public Policy,
> Network Advertising Initiative

Other key consent issues in the automotive context include:

- The user varies: the driver may not be the owner what are the rights of another driver / passengers?
- The user context varies: private vehicle / taxi / fleet operators vs fleet drivers etc.
- How to deal with new services being added?
- Multiple consents, possibly from different providers may be needed to permission a service or action
- How does revocation work?
- What happens when the vehicle is sold on (especially privately)?
- What happens when an intermediary or service provider, with whom the data is shared, establishes a new use for the data?

Emerging Industry Solutions for Managing Consent – BMW CarData and Connected.Drive

Approaches are beginning to emerge in the automotive industry which begin to address these consent challenges. One such example is BMW CarData.

BMW CarData allows drivers to manage and control connected car data collected from their BMW and Mini vehicles, and approve the sharing of this data with third-party service providers who use it to innovate new services for BMW and Mini drivers (see Section 7.3).

This approach to consent addresses many of the challenges outlined above. As part of this service, BMW and Mini drivers use their BMW Connected.Drive smartphone app to manage their consents with BMW and Mini on collection of data, and with the providers who use the data in delivery of their services.

A broader data marketplace provider could take this approach further - enabling a similar service facilitating all necessary consent operation across a much wider range of OEMs, service providers and consumers.

Development of best practice consent management in other sectors

Other forms of consent management are being developed, with the objective of simplifying the user experience.

These approaches could become relevant to the automotive sector. One leading example of this is the Indian implementation of Open Banking, which is regarded by many as emerging best practice.

In this approach, a new form of intermediary is introduced to simplify the consent process. An Account Aggregator manages the consents between the consumer and the providers of all of the different financial services they hold.

The consumer thus has one place to go to manage their consents and similarly, service providers need only to integrate with the Account Aggregator in order to undertake the required consent processes with all customers. This centralised approach also facilitates additional operations such as data portability – the consents associated with a service can be ported with a change in provider.

A motor industry equivalent might see a central consent management service intermediating between consumers, multiple OEMs (or other data providers) and companies using that data to provide new services.

Towards a Cross-Industry Approach

The Indian Open Banking initiative is part of a wider programme - "The India Stack".

India Stack is a set of APIs that allows governments, businesses, start-ups and developers to utilize a common digital Infrastructure to support presence-less, paperless, and cashless service delivery."

A key part of the India Stack is the 'Consent Layer' or Data Empowerment and Protection Architecture (DEPA). The intent to transform the current organisation-centric consent approach to an individual-centric one. DEPA gives individuals control over their data and enables the portability of trusted data between service providers across financial services, healthcare services, and other industries.

Business Implications and Risks

All businesses that handle data in the connected car evolving ecosystem face potential regulatory and commercial risk relating to the collecting, storing and processing of data as part of their business operations. The growing use of PII has the potential to increase these risks by orders of magnitude.

The costs of maintaining the necessary data security, process and governance will escalate. Failure in this risks material reputational damage, with impact on customer trust, brand and market profile and business performance. Punitive fines for non-compliance with data legislation will also apply. e.g. the maximum fine under the GDPR in Europe is up to 4% of annual global turnover.

> *"In terms of when there is a data breach - and I say when because unless you've taken very strong privacy protective measures, you're going to have a data breach - then the damage to your brand and to your reputation is enormous, staggering."*
>
> Ann Cavoukian, Global Privacy & Security by Design Centre

> *"We have seen privacy become a central concern for businesses… so OEMs and more remote parties like car rental firms need to work out how to do data. If they don't, they are inevitably undermining and risking their business strategy and growth and it will be a detriment to them when the story comes out on the front page of The Wall Street Journal… telling how they are creating some awful privacy risks, or a cyber security issue. Those cyber security risks are very present and ominous."*
>
> Omer Tene, Chief Knowledge Officer, IAPP

5.3 US Legislation and Regulation Related to Personal Data

The US legislative and regulatory landscape for the protection of PII has historically been fragmented. The US has generally regulated privacy primarily by industry, on a sector-by-sector basis.

There has, however, been a shift toward more broad-based action on consumer privacy, in the wake of major data breaches and high-profile personal data market scandals.

States have taken the lead in implementing new legislation and this situation is expected to continue in the short to medium term as no Federal legislation is likely to be implemented before the Presidential and Congressional elections in 2020.

State-Led Activity

Scope of legislation

The scope of the legislation enacted or being considered varies significantly in terms of the breadth of consumer rights enabled and business obligations imposed:

- Broad Scope: California, Hawaii, Maryland, Massachusetts, New York, Pennsylvania, Rhode Island, Texas and Washington
- Narrower Scope: Maine, Nevada, Illinois, Louisiana and New Jersey

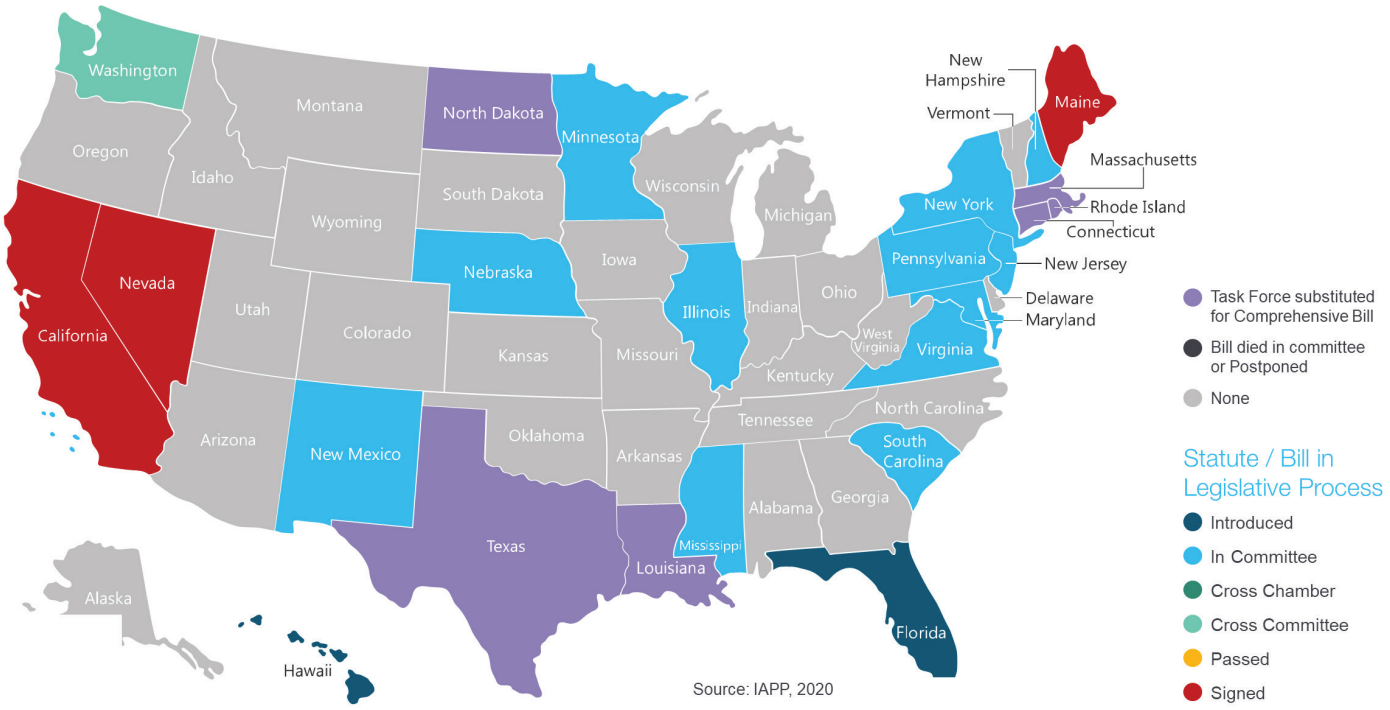
California CCPA

California has been the prime mover in State-led legislation. The California Consumer Privacy Act (CCPA), inspired in part by the GDPR, has a broad definition of PII and what constitutes the sale of data. CCPA comes into effect in January 2020 and enforcement will start in July 2020.

Approach in other States active on data legislation

According to IAPP, the most commonly occurring consumer rights being enabled in other states are the right to opt out of data collection, the right to access data and the right to delete data. Commonly recurring business obligations centre on the need to be transparent about data collection, and prohibition from discriminating against those who opt out.

There is a risk that state-by-state legislation, and potential variances between states, will add to complexity, and the compliance challenge to businesses that operate across a broad geography. However, this could be mitigated by a 'domino effect' with States replicating similar models to the CCPA - reducing inconsistencies across states.



Federal Activity

Whilst Federal legislation is unlikely in the near term, multiple comprehensive privacy bills have been introduced at the Federal level in the US Congress.

Whilst data privacy does not appear to be a partisan issue, the timing and potentially the nature (robustness) of Federal legislation will have a dependency on the outcome of the 2020 governmental elections.

There is the on-going potential for action by the Federal Trade Commission. The FTC Act allows the FTC to impose remedies for unfair and deceptive practices. It can issue fines when a firm has failed to adhere to a violation of an earlier consent decree imposed by the FTC. The recent fine imposed by the FTC on Facebook was high profile. It is notable that the settlement required Facebook to take a number of significant actions which could be seen as a good practice that other organisations will be encouraged to emulate.

If Federal data privacy legislation is passed and provides a level playing field – or minimum set of standards then this could help address the 'patchwork quilt' issues likely to arise from State-led legislation. Done effectively, this could provide the stimulus for interoperability, innovation and growth in the market.

Industry Self-Regulation

In 2014, the Alliance of Automobile Manufacturers and the Association of Global Automakers collaborated with industry to develop a set of Consumer Privacy Protection Principles which have become widely adopted in the automotive sector. The principles are set out in Appendix B.

While these principles are voluntary, by virtue of automakers' public commitments, they are enforceable under the FTC's consumer protection laws.

This initiative demonstrates how consensus-oriented dialogue with industry, federal and state governments, and other stakeholders to address shared objectives, domestically and internationally can bring to bear practical, pragmatic and effective governance solutions.

5.4. Opportunities for Action on Trust and Legislation

The potential implications of consumer trust and data protection legislation and regulation for the US connected car data market suggest a number of inter-related areas where action could have meaningful impact on the development of the market.

Differentiation and leadership through Trust

There is an opportunity, to take the 'high ground' in this emerging marketplace and establish significant brand differentiation through trust – and putting the consumer at the centre. This could include:

- Demonstrably leading the market in the way that personal data is collected, stored and used with fair distribution of benefits to all stakeholders
- Living and breathing 'transparency', informed and practical consent, choice and education - including providing open access to tools that allow interested and expert parties to test security and privacy
- Working with recognised experts or organisations in the data privacy space to establish their advocacy - possibly including gaining specific 'accreditation' for particular products, services, processes and policies.

Actively promoting the benefits of the connected car data market

The opportunity to stimulate consumer and regulator confidence by raising proactively the positive profile of the connected car data market, and the benefits it conveys.

Recognising that consumers, generally have limited understanding of the rationale for data collection, and the purposes for which it is used, promoting the positive benefits of connected car data enabled services. In this way, contributing to building trust with consumers, on whose data the services depend.

Action in this area can help mitigate the risk and impact of the car data market becoming prominent for negative reasons that could seriously compromise consumer trust.

Working towards appropriate legislation

In addition to understanding and developing compliance strategies with legislation as it is enacted, there is the opportunity to positively influence developing legislation to support the beneficial use of connected car data for all stakeholders.

Potential focus areas include:

- Engage with state legislators to ensure that the unique characteristics of vehicle data and the beneficial use cases it facilitates are appreciated and reflected in new legislation.
- Work at Federal level to raise the profile of vehicle data and engage on a bipartisan basis to raise awareness and understanding of the sector.

Self-Regulation and Codes of Conduct

As vehicles are increasingly connected there is an opportunity for OEMs and other market participants to build both consumer and regulatory trust through reviewing and expanding their self-regulatory approach. This offers the potential to lead and influence collective thinking on the operation and regulation of the market through, the development of codes of conduct. Possible areas for exploration include:

- Potential refresh or further development of the auto industry Consumer Privacy Protection Principles to cover wider use cases of combined data types
- Extension of self-regulation to other industry players – building communities of interest

06

Market development challenges.

Introduction

This section highlights the broader challenges identified in the research that could materially limit or otherwise impact the development of the connected car data market.

Key Findings

OEM underinvestment

The costs associated with the transmission, storage and operational management of connected car data are considerable and growing as data volume and complexity increases. OEMs may choose to limit investment in developing the connected vehicle data market which would stifle growth.

However, the research indicates that whilst investment is being carefully managed across a range of priorities, connected car data remains high on the agenda for most industry players.

Competition for the Infotainment Platform

OEMs' derive brand and wider economic value from the Infotainment platform but are now challenged on two fronts:

1. Devices brought into the car (notably Smartphones) could come to dominate consumers' in-car digital experience if connected car data is not actively developed by OEMs to deliver innovative consumer services. However, dominance by BYO devices was seen as unlikely in the medium term because the value of core car data and the use cases it enables, will continue to drive major data market growth.

2. The major cost of building and maintaining the embedded infotainment systems, and the difficulty of achieving critical mass for app development, means that many OEMs are looking to embed this capability from Apple and Android or allow them to mirror the software from a smartphone. Android Automotive OS is gaining significant traction, bringing the advantages of the huge Android developer market and scale platform investment.

   OEMs need to consider carefully the degree of integration of such systems to avoid losing value opportunity from 'core' connected car data – and so strengthening the platform provider's competitive position in the market.

   Pressure to give up underlying vehicle data is likely to increase in future and OEMs will need to innovate and support the delivery of new services if they wish to maximise the value and benefits of their data.

Advertising Revenue Models

Of extracting value from vehicle data may face challenges that mean they may not become as significant in the connected car market as they have in other markets.

The car is regarded as a very personal place and many of the experts we interviewed suggested that consumers may resist targeted advertising in this environment.

Mandated wider sharing of connected car data

On-going lobbying for the extension of US Right to Repair legislation, and sharing data for improved vehicle safety could create new costs for OEMs, potentially without any corresponding direct return for the OEM, albeit society and others in the ecosystem would still derive benefits.

Enhanced Digital Capabilities

Will become critical to OEMs as they seek to access the new opportunities in connected vehicles, key areas include:

Data Centricity

To continue to improve the efficiency of R&D and manufacturing operations with advanced digital capabilities in areas such as machine learning/AI and analytics.

Digital Centricity

The car will become a 'living product' - with continuous upgrades in lifecycles of months, if not weeks. To delivery this, OEMs will need to apply digital business and technology skills throughout the development, production and support phases.

Customer Centricity

Delivering consumer data enabled services opens up a new direct and ongoing engagement between OEMs and consumers. Maximising this opportunity will require the development of new forms of customer engagement and management capabilities.

This study identified a range of wider market factors that could constrain or otherwise impact the development of the connected car data marketplace:

- Investment prioritisation by OEMs that may constrain market development and growth
- The competition for position in critical areas of the in-car architecture and the impact this might have on market development
- Potential changes to the advertising model of funding digital services
- Potential legislative moves, beyond those discussed in Section 5, on data sharing that might shift the dynamics of the evolving market ecosystem
- The digital capability shifts required of OEMs in particular to effectively grow and compete in the connected car data marketplace

6.1 Economic Risk – OEM Under-Investment

The costs associated with the transmission, storage and operational management of the resulting data are significant - and growing rapidly as the number of connected vehicles and the amount of data collected per vehicle per annum increases.

> *"I think one of the important things to understand with this data is …that the cost to retain the information is astronomically high and can destroy the business or the business model for retention."*
>
> Michelle Avary, WEF

> *"Data Access Requests [relating to PII] may become an issue… a lot of the car companies… realized when they were doing their data mapping exercises, that if they received a significant number of data access requests, then this was going to cost them a lot of money."*
>
> Joe Jerome, Policy Counsel,
> Centre for Democracy & Technology

There is a risk that OEM under investment will stifle growth. This could be manifest in different ways, depending on the strategic stance of each OEM e.g.:

- Some could de-prioritise investment in the wider development and monetisation of connected car data in the face of other challenges or opportunities – possibly deciding to take a 'watching brief' at this stage and focus investment on other priority areas e.g. EV or AV development.
- Others could revert to treating telematics and data purely as cost elements – minimising capabilities to address only mandated data provision.

Alternatively, investment could be focused solely on driving operational and performance benefits of core connected car data rather than the broader value. This would have the effect of decelerating but not stifling innovation and overall market development.

A possible outcome of OEM under-investment could be that a larger proportion of new value creation is left in the hands of those developing services on 'Bring Your Own' (BYO) or 'brought-in' devices – with smartphones (and smartphone-centric organisations) taking the primary position in the literal and figurative eyes of the consumer. This, despite smartphones frequently operating on lower quality data that that generated by the vehicle.

However, overall the research suggests that whilst investment is being carefully managed across a range of priorities, connected car data remains high on the agenda for most industry players. Amongst the long-established OEMs, some have invested significantly in the use of connected car data e.g. GM, Toyota and BMW. This is expected to extend to more OEMs as they establish the required capabilities (see Section 6.5).

In an increasingly competitive automotive industry, it is possible that driving operational efficiencies using connected car data may become 'table stakes' for OEMs. New OEMs such as Tesla have been 'data enabled' from the start and so well positioned to utilise data to drive operational efficiency and innovate new data-enabled services

OEM investment profiles are therefore more likely to affect the pace of growth in the market and the degree to which risk and revenue sharing approaches are used rather, than its fundamental structure.

6.2 Structural Risk – Infotainment platforms and the 'battle for the dashboard'

There has been much discussion of the 'battle for the dashboard' within the motor industry and the media - most of it focused on whether automakers or Global data companies (the 'data giants') will win out for control of the screen(s), and the associated data, in a connected car.

Broadly, there are two important subsets of value within the connected car data market:

1. The value driven from the 'core' or 'lower-level' connected car data, generated by a variety of sensors in the vehicle, and closely related to the operation of the vehicle.

2. The value derived from non-core or 'higher level' data related to the use of the infotainment system in the vehicle.

This is important for many reasons, including:

- This is a key part of the interface with the driver, both for the collection of data (e.g. a drivers navigation destinations, radio preferences, etc. – which may be considered PII, if it can be linked to the individual), and for the delivery of data-enabled services to the driver (e.g. real-time traffic information).
- The infotainment platform that the driver uses – or at least some aspects of it (e.g. navigation) – may not be the one embedded in the vehicle, but may be brought in by the driver e.g. a smartphone - either standalone or tethered to the in-car system using for example, Apple CarPlay or Android Auto.

The OEM is in prime position to leverage the value from the 'core' connected car data, but that is not necessarily the case for the value associated with the infotainment platform. While the core data set is of huge value and will underpin large markets, the higher-level data also has considerable value and the infotainment system provides the display on which many data-enabled services reach the consumer. it is the latter that this section explores in more detail.

There are potentially two platforms types capable of enabling the infotainment data value:

- A brought-in or BYO device – typically a smartphone.
- The vehicle's embedded or 'native' infotainment system.

There are important implications for the way that each of these might develop, and/or which may become dominant in the eyes of the consumer.

BYO / Smartphones Data Value

BYO devices are not dependent on access to data from the vehicle itself – a smartphone can use its own sensors and data to deliver some services similar to that enabled by vehicle data. For example, using its own location and positioning capabilities to deliver navigation services.

Whilst these capabilities may not typically be as high quality as the 'native' capabilities within the vehicle, BYO providers are likely 'fill the vacuum' if connected car data itself is not used by OEMs to innovate and deliver key consumer services.

Smartphones and their providers do have some clear advantages over the in-car platform. They have established, enormous and mature developer communities, delivering consumer apps. In the words of one industry executive:

> *"Can OEMs cultivate the app ecosystem on the native platform - surely the BYO platforms have already won this space?"*
>
> Anonymous Automotive Industry Executive

The wider model of smartphone providers also means that they are well-placed to provide seamless – or at least portable – services that join up different aspects of the consumers lifestyle, including motoring.

The general view amongst research participants, however, was that dominance by BYO devices was an unlikely scenario in the medium term. As discussed in earlier sections, the value of core car data and the use cases it enables, not only customer facing, but also B2B and B2B2C, will continue to drive major data market growth.

> *"There is generally a conservative approach (based on this data) at present, but automakers are definitely looking at this as an opportunity to gain valuable data insights that will further enhance vehicle safety, products, and services available to consumers."*
>
> Steve Gehring, Vice President Vehicle Safety & Connected Automation, Global Automakers

Native or Embedded Infotainment Platform Data Value

Many participants in the research felt that the more critical issue is who takes the prime position on the in-car (embedded or native) infotainment platform. (Whilst used primarily for running the infotainment system, embedded systems also control some aspects of the in-car environment e.g. air-conditioning/climate control.)

Historically, OEMs dominated this space by developing their own operating systems. One of the largest initiatives in this space being Automotive Grade Linux (AGL) - used by Toyota, Jaguar Land Rover, Nissan and others.

The continued development of multiple infotainment operating systems (either by individual OEMs or consortia) could mean that none reach 'critical mass' in the market. In particular, app development could be constrained – because developing services for multiple platforms is less cost-efficient, and each will have limited reach. This could restrict innovation and hence the range and richness of services available.

These factors, together with the significant cost of developing and maintaining sophisticated infotainment operating systems led the majority of the research participants to the view that OEMs will increasingly look to 'buy in' this capability.

Until recently, Blackberry's QNX Automotive was the leading option in this space, but there is an increasing trend toward the use of Android Automotive OS (developed by Google and Intel in conjunction with a number of OEMs). GM, the Renault-Nissan-Mitsubishi alliance, Volvo, VW Group having already adopted this approach.

Widespread adoption of Android Automotive OS could be a key enabler for this developing market:

- Bringing to bear the massive developer base already focused on building applications for this environment (offsetting the key smartphone advantage).
- Creating the environment for open innovation that has been the driver of success in the wider Android app market.

> *"We feel that as with smartphones, open innovation is critical to secure the biggest possible variety. It looks as though the industry will gravitate towards an Android platform and Google Automotive Services to achieve this although only time will tell."*
>
> David Green, Chief Digital Officer, Lynk & Co

In taking a 'buy-in' approach however, there are significant issues to be navigated by the OEM in relation to data access and preservation of value.

OEMs selecting a 3rd party infotainment platform contractually agree to share data with the platform provider. The range of functionality supported by the platform, and the degree of access to connected car data available to the platform provider are often subject to negotiation.

Whilst typically a third-party infotainment system would not have direct access the full range of 'core' connected car data, contractual agreements could involve OEMs sharing this data with the platform provider. In this there is the risk that the OEM dilutes the value that they themselves can derive from the connected car data – and that the platform provider's strength in the market is further enhanced.

As several contributors to the research put it: there is a risk that in data terms, OEMs are reduced to just providing a 'dumb pipe' through which others innovate the value.

6.3. The Advertising Revenue Model

Many digital services (e.g. smartphone apps) are seemingly 'free' to consumers. They 'pay' for the service by allowing the service provider to gather their data and by agreeing to receive advertising as part of the service. The advertisers pay the service providers for positioning and presenting the advertisements.

The most sophisticated data platforms collect data from all aspects of a person's digital experience in order to better target advertising to that person. This is big business - $24.1 billion of Google's $27.77 billion revenue for Q3 2018 was from advertising driven in this way.

Advertising-Led Services in Vehicles

There are already advertising-led services being provided in the connected car data marketplace. For example, Waze, the smartphone app navigation service, with 30m+ users in the US, offers personalised advertising about local amenities, when it detects that the car is stationary.

However, market-wide the use of advertising-based models based on connected car data is still in its infancy. Advertising models could be a major driver of market growth if privacy, security and driver reaction can be successfully addressed.

The in-car setting means different implications for the various aspects of advertising models. Data collection to build an understanding of generic, or specific user insights is readily facilitated by the connected car infrastructure. However, the presentation of advertising material is challenged by the fact that users are not continuously focused on in-car displays – and there are important safety implications. In future AV settings this limitation may be removed, enabling vehicle occupants to focus more fully on display screens.

Presentation is less of an issue for audio advertising, but the value add is likely to be more incremental to that which is already being generated by radio/content providers.

There are also advertising led services that could be enabled by vehicles but do not require the presentation of advertising material within the car. For example, the pricing of billboard space could be optimised if data was available for each location based on such factors as: number of vehicles passing, their origin and destinations, the quality profile of the vehicles. etc.

Considerations for the Connected Car Advertising Model

As OEMs prepare to share connected vehicle data with wider markets they will need to reflect on the debate about the ethical use of data. In particular:

- Customers are becoming increasingly aware of data collection, due to issues such as the Cambridge Analytica scandal.
- Data privacy legislation, such as the CCPA (in part, a response to such issues) may lead to significant numbers of consumers opting out of data collection or use. This would impact the advertising-led model at its very source.

The advertising industry has been lobbying for changes to emerging data privacy legislation to mitigate this impact. They have formed coalitions of interest to progress this (e.g. Privacy for America), with the further purpose being to educate and inform consumers of the benefits of the current advertising-led model.

In the in-car context, better targeted broadcast advertising would likely be seamless to consumers, who would not necessarily realise that the advertising was targeted at them. More overt targeting of content via say, the infotainment screens or even the dashboard of their vehicle might be more problematic – not only for reasons of safety or inconvenience, but because the car is regarded as a very personal place and participants in this research have suggested that people may not want adverts pushed to them in that context.

> *"People think of their cars as their second home and personalizing that with a barrage of different types of advertising, well... I get that there's some potential value there to companies - I just question whether that's really what users want."*
>
> Joe Jerome, Policy Counsel, Centre for Democracy & Technology

> *"Driving is a profoundly personal thing… and I can tell you right now there isn't a single individual that wants to be advertised to inside their car."*
>
> Doc Searls, Berkman Klein Center, Harvard University

Consumers may choose to opt-out of data collection in future. They are likely to still be able to access services but might find that there is reduced functionality or that payment is required to enable the product.

Ultimately, consumers that have defaulted to opt-out of data collection – realising the impact on their 'free' services – may decide to opt back in in order to continue receiving them, and avoid the incremental payments but it may be a painful journey for advertisers and advertising-led services along the way – and could impact significantly the way in which the market for some services powered by connected-car data develop.

6.4 Mandated Wider Sharing of Connected Car data

The mandated collection and sharing of vehicle data may impact on the way OEMs share data and on the commercial prospects of some use cases.

Mandated sharing of data is not a new phenomenon as the collection and provision of emissions data has been required since 1996 and Right to Repair legislation in Massachusetts in 2012 led to the development of a USA-wide approach for sharing data with independent repair shops and other parts of the aftermarket.

These earlier data sharing initiatives largely pre-date the connected car but lobbying for the sharing of connected car data is currently underway in both the EU and USA. The implications of any legislation in this area are likely to be important in the development of the market for a number of reasons, including:

- Wider mandated data sharing might impose significant new costs on OEMs without any corresponding direct return - as did the original requirement to provide emissions data. This might exacerbate the economic risk outlined in Section 6.1 above.
- It could change the economic value of some data e.g. if it is mandated that some OEM data must be provided free of charge to some other stakeholders, then the OEM's ability to get value from that data (at least in its raw form) will be reduced in some cases.
- By changing the nature of access to certain data, it might create the need for new players in the market (e.g. to facilitate the mandated sharing of data) or change the balance between players in the market.
- Wider access (potentially at no charge) would enable more players – including those beyond the motor industry – to innovate new services based on this data. This expansion of open innovation could stimulate market growth

Participants in the research highlighted two main areas where such wider sharing of data might gain greatest traction. These were the potential extension of Right to Repair legislation (discussed above) and the sharing of safety-related data.

Potential mandated sharing of safety related data

Whilst not as developed in a legislative or formal lobbying sense, there is also a body of opinion that suggests it should be mandatory for OEMs to share data that could result in improved vehicle safety.

The main precedent here is the Event Data Recorder (EDR), that records technical vehicle and occupant information for a brief period of time (a few seconds) before, during and after a collision, for the purpose of monitoring and assessing vehicle safety system performance. In 2013, the fitment of EDRs became mandatory on all cars sold in the USA and Canada irrespective of the country of manufacture. The format and a minimum standard for the type of data and sampling rates recorded by the EDR were also standardised.

In another safety related initiative in the European Union, from 2018 it became mandatory for all new cars to be able to communicate with emergency services automatically in the event of a collision (eCall), opening up a voice channel and providing data that would speed the emergency response in the event of an accident.

Calls for wider sharing of any data that might improve safety were further invigorated by the misfiring Takata airbag issue.

The wider mandated sharing of data has the potential to bring significant societal benefits, particularly in relation to safety. It can also positively impact consumers' support for, and trust in, the use of connected car data. As the source of the vast majority of the data, OEMs have a pivotal role to play. Fair compensation will be an important aspect of any future data-sharing model.

6.5 OEM Digital Capability Shifts

Services based on connectivity and connected car data are an increasingly valuable part of the vehicle proposition.

> *"The value of a vehicle used to be mainly on hardware and a little on software. With connectivity and ADAS, this is shifting. Ultimately, this will be more like 40% hardware, 40% software and 20% content... when vehicles are autonomous."*
>
> Franck Louis-Victor, Renault-Nissan-Mitsubishi Alliance

This transition in value toward software and content and connected car services (i.e. the connected car data market) is precipitating fundamental shifts in the automotive industry – with many OEMs focusing significant investment in this area.

Addressing this challenge requires enhanced capabilities, augmenting those typically held in the industry. Successful development of these capabilities is critical to the growth of the connected car data market – and to the core competitiveness of OEMs.

These capabilities are focussed particularly around data and customer centricity, as set out below.

Data Centricity

The industry is already using data at scale to drive and improve the largely automated manufacturing processes employed by modern automakers to build.

Improving the efficiency of R&D and manufacturing operations (applications focused in Level 1 in the data usage model described in Section 2) will require increasing use of connected car data and the application of machine learning/AI and analytical/insight generation capabilities.

The expanding provision of end-user digital services and the increasing value of PII in these services (operating at Level 3 in the model), together with the significantly higher level of customer engagement needed to make them successful will require OEMs to become responsive and creative in the way they allow data, including personal data, to be used.

They also have the opportunity to engage with data marketplace providers like wejo to enable the wider technology community to develop the innovative services and products powered by connected vehicle data operating within parameters set by the OEM. Either approach requires the OEM to understand the data and the ways it is being used.

This will necessitate wide-scale implementation and operation of the robust data security, privacy, compliance and associated processes that apply in this space.

Digital Centricity

Consumer expectations are being set by the applications they use in a variety of different smart environments and they increasingly demand a similar experience inside their vehicle.

This is already a significant factor in vehicle purchase decisions and is only set to increase as Millennials become a larger part of the car-buying consumer base.

The use of connected car data, both at the operational level and in value added services also drives the evolution of the car towards a 'living product' that continues to develop throughout its whole lifecycle - with continuous upgrades and new services.

OEMs historically steeped in manufacturing skillsets and product lifecycles measured in years will need to apply digital business and technology skills throughout the development, production and support phases –aligning to software and service development lifecycles measured in months if not weeks.

> *"This is a major challenge for OEMs with more than 100 years of history, experience and culture of manufacturing hardware – they are not agile enough for 'digital cars'. There is a risk that they do not or cannot make this transition. The connected car needs to be considered as a living product with ongoing enhancement and new customer touchpoints."*
>
> Franck Louis-Victor, Renault-Nissan-Mitsubishi Alliance

Customer Centricity

Delivering connected car data enabled services to consumers opens up a new direct and ongoing engagement between OEMs and drivers (and between providers of data enabled services and drivers e.g. dealerships or 3rd parties). The frequency of contact will shift from the current yearly servicing touchpoints (or even longer car buying cycles) to potentially, daily interaction via in-car services.

These new services enabled by connected car data offer OEMs the opportunity to re-engage with the consumer/driver and, as a result, develop deeper brand loyalty. This will require the development of new forms of customer engagement and management capabilities – in everything from customer strategy through service delivery, into ongoing support.


CURRENT SPEED
SPEED
75
Km
Autonomous Scaning
Ai
19 cars
73%

07

Key enablers of market development.

Introduction

This section highlights key market development enablers identified in the research.

Key Findings

Enablers which can strategically advance the connected car market were identified in two main dimensions:

Communications

Continued improvements in cellular communications technology offer higher transmission speeds, wider and more reliable coverage, and greater costs efficiencies. This will be vital in enabling rapidly expanding data volumes, driven by the growth in connected car numbers, and greater variety and frequency of data. Developments in Vehicle-to-Vehicle and Vehicle-to-Infrastructure will offer new innovation opportunities, for example in car safety, transport efficiency and the development of smart cities.

Data Marketplaces

Innovation and wider market value can be stimulated by the amalgamation and synthesis of data from multiple different sources, enabled by interoperability or standardisation across the connected car data ecosystem. Data marketplaces have an important part to play in this by:

- Facilitating the 'data liquidity' required to ensure an efficient overall market for connected car data.
- Creating a central point of access through which data consumers can satisfy their data needs, and enabling them to innovate with new data combinations.
- Offering value-added solutions using the data in the marketplace e.g. providing real-time analytics to generate new insights

The research identified a number of key enablers that will facilitate the strategic development of the market development. These fall into two main categories:

- Improving connectivity and data transmission
- Data marketplaces and related 'open innovation'

7.1. Improving Connectivity

Improving connectivity will be a key factor in development of the market. Connected cars are adopting newer communications capabilities (e.g. moving from 2/3G and earlier network technologies to 4/5G) and network operators are extending the geographical coverage of higher speed technologies such as 5G.

Newer technologies offer faster speeds and reduced data transmission costs, which allows for the volume of data transmitted and received by the vehicle to increase, services to be updated frequently and for complex processing to be done in the cloud.

At present, the US connected car market is strongly dependent on older 2G/3G networks – but it is moving rapidly toward 4G. Key recent steps in the evolution of connectivity in the US connected car market include:

- The installed base of vehicles with embedded 3G/4G LTE capability reached c. 41 million by the end of 2018 - an increase of 22% from just over 33 million in 2017.
- Significantly, in 2018 the 4G LTE installed base surpassed that of 3G.
- 4G is forecast to exceed 80% of total in-vehicle communications technology by 2024.
- 5G enabled vehicles are currently being tested and will start to be rolled into production from 2022 onwards.

In the short-to-medium term, market innovation will be focused on services based on the dominant 4G in-vehicle technology. 5G enabled features will start to become available in this timescale, but will likely be pitched at premium brands/models in OEM product ranges.

Another important aspect of the evolution of connectivity relates to technology that enables Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Vehicle-to-Anything (V2X) communications.

Use cases based on V2V or V2I communications include:

Safety

V2V enabled vehicle broadcasts its location, heading and speed 10 times per second. All surrounding vehicles receive the message – this potentially allows the detection and assessment of dangerous situations (e.g. road obstacles, potential collisions) before they are noticed– either by cameras in the vehicle or by the driver.

Traffic Flow

Traffic lights could be used to assist drivers in maintaining speeds to optimise traffic flow and vehicle to vehicle technologies could allow for 'platooning' – where vehicles travel closer together at a common speed to increase road capacity.

Emergency Services

V2I communication can be used to enable traffic light pre-emption by emergency vehicles - ensuring that the lights are green when an ambulance approaches (and eliminating the risks associated with having to run a red light).

> *"Connected cars, especially in the context of high bandwidth connectivity enabled by 5G, might be considered as 'supercomputers on wheels' that just happen to carry people or cargo. Improved transport is only one element of the value that connected cars can bring – what can you do with a network of mobile supercomputers?"*
>
> Tony Verb, Co-Founder GreaterBayX

7.2. Data marketplaces

Many participants in the research were of the view that it is unlikely that 'stove-piped' services with strong central control (e.g. by the OEMs) will be the most successful way to develop the connected car data marketplace – instead suggesting that open innovation will ultimately bring greatest value.

> *"If everything is controlled from the centre, this is a bad market. It's the old mainframe market, it's not the personal computing or the smartphone market. The internet succeeded because it started at the edge – because there was nothing but the edge… and the edge is personal."*
>
> Doc Searls, Berkman Klein Center, Harvard University

Innovation can be stimulated by the amalgamation and synthesis of data from multiple different sources, enabled by interoperability or standardisation across the connected car data ecosystem. Data marketplaces have an important part to play in establishing this approach.

Data marketplaces connect providers and consumers of data via a platform that ensures quality, consistency and security.

Typically, data suppliers authorize the marketplace to license their information on their behalf, following defined terms and conditions. The marketplace itself makes money in various ways, typically by taking a share of the new value created from the data it offers.

The marketplace provider, or third parties can also offer value-added solutions using the data in the marketplace e.g. providing real-time analytics to generate new insights.

In the context of developing the market for connected car data, data marketplaces can:

1. Create a central point of access

Access through which data consumers can satisfy their data needs.

2. Create commercial scale

Marketplaces increase in value to both the OEM and end user if a deeper, more liquid pool of information is available. Some OEMs do not have enough connected vehicles to establish a market but by allowing data to be aggregated across OEMs they are able to participate to their own benefit and those of the data buyer and driver too.

3. Support interoperability and standardisation

Defining formats and abstractions that support cross-dataset, cross-organisation and cross-industry use cases.

4. Open up new commercialisation opportunities

Different types of data consumers will find new and innovative ways of using and combining data that were not obvious or relevant to the originating data providers.

5. Enable crowdsourcing

By combining information and analytical models to deliver new value, more data suppliers will be drawn to the platform (a virtuous circle)

6. Test and optimise different sharing models

OEMs are exploring a range of ways of sharing data. The Neutral Server approach is one being explored by a number or European OEMs which has characteristics discussed in more detail in the case study below and which, in particular, may address concerns around mandatory data sharing.

Other OEMs are adopting models that better support streaming data in near-real time which is particularly valuable for use cases around traffic, mapping, usage-based insurance and smart city performance.

Importantly, data marketplaces facilitate the 'data liquidity' required to ensure an efficient overall market for connected car data. This opportunity space has already been identified and there are several independent platform provider companies now offering this type of service for connected car data.

Data marketplaces can focus on a particular industry or opportunity space e.g. LexisNexis bring together multiple data providers and consumers to create one-to-many and/or many-to-many marketplaces to deliver a wider range of products from traffic and congestion through to advertising and retail. These more broad-based offerings, provided by firms like wejo, can be underpinned by a range of technologies including the neutral server solution service which is discussed further below.

Extended Vehicle Model and Neutral Servers

The extended vehicle model (developed by the European Automobile Manufacturers Association) is a way of sharing connected car data in a safe and secure way – and is an example of a standardised approach to a connected car data marketplace that is currently being used by some European OEMs.

Essentially, the 'extended vehicle' is a remote secure server where connected car data can be accessed without allowing third parties direct access to a customer's physical vehicle – addressing the significant security and safety implications that such direct access creates.

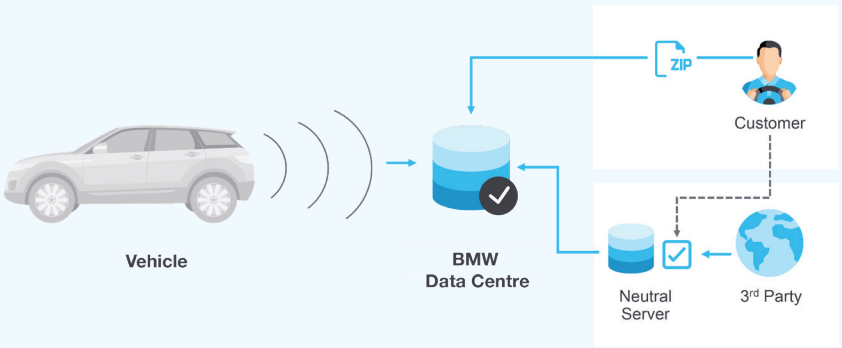
The approach allows for the establishment of 'Neutral Servers' – data centres that are not operated or funded directly by the OEMS. These can be set up to make vehicle data readily available to interested third-party service providers without the need for them to sign a contract with the vehicle manufacturer providing the data.

This approach also ensures customer choice – vehicle owners are free to obtain services from the vehicle OEM, the OEM's network of authorised repairers or any other service provider of the owner's choice. In this way, the neutral server starts to address the concerns from independent repairers about being 'locked out' by OEMs in the provision of connected car data enabled services such as predictive vehicle maintenance.

A neutral server also promotes open innovation by offering access to the data of multiple OEMs via one server, rather than needing to access the many servers of individual manufacturers.

Connected car data marketplaces utilising neutral servers

BMW launched its connected car system in May 2017 as an add-in for their ConnectedDrive store for connected data enabled services.



Transparent access for car owners to review and manage (e.g. consent) connected car data that has been transmitted to the BMW data centre.

With owner's consent, data is accessible by 3rd parties innovating to create new services.

The IBM neutral server includes analytical capabilities that 3rd parties can use to create new insights and develop new services.

BMW makes vehicle data available through its own platform 'CarData' and also makes it available to neutral server providers. There are a series of neutral server providers operating marketplaces for vehicle data including wejo, Otonomo and High Mobility.

BMW's approach allows drivers to manage and control connected car data collected from their BMW and Mini vehicles, and approve the sharing of this data with third-party service providers who use it to innovate new services for BMW and Mini drivers.

At present, the data that BMW provides includes 79 data points:

- 63 condition data points (fuel and fluid levels, GPS location, mileage, battery voltage, etc.)
- 14 usage data points (trip distance, charging status, average fuel consumption, etc.)
- 2 event-based data points (emergency and breakdown situations)

The Neutral Server is currently suited to uses that only require access to vehicle data at specific points in time e.g. at the point a repair shop wants to verify the status of a sub-system or if a fleet operator wants to check vehicle mileage once or twice per day.

Other OEMs also provide data to Neutral Server marketplace operators. For example, Daimler provides wejo, and other providers, access to data that supports use cases ranging from insurance, EV charging, fuel monitoring and smart mobility services.

One advantage for data buyers utilising a neutral server is that the neutral server allows access to data from multiple OEMs rather than the buyer having to establish their own 1:1 relationships with each manufacturer. This promotes competition and innovation in the sector.


CtrlShift

Conclusion.

This study has examined the growth of the connected vehicle data market and the implications for the use of PII including analysing the key benefits and emerging issues as they relate to stakeholders in the market.

The work has highlighted a number of ways in which market participants can work to ameliorate the issues facing the sector to ensure the considerable untapped value of connected vehicle data is fully realised.

The analysis summarises the opinions of influential thought leaders together with the industry expertise of Ctrl Shift and wejo.

We are grateful for all contributions and encourage continued debate on this rapidly evolving landscape.

“

Connected cars, especially in the context of high bandwidth connectivity enabled by 5G, might be considered as ‘supercomputers on wheels’ that just happen to carry people or cargo. Improved transport is only one element of the value that connected cars can bring – what can you do with a network of mobile supercomputers?.

Tony Verb
Co-Founder
GreaterBayX

Appendix A.

US auto industry consumer privacy protection principles.

In 2014, the Alliance of Automobile Manufacturers and Association of Global Automakers instituted a set of Consumer Privacy Protection Principles. These are as follows:

Transparency

Members commit to providing Owners and Registered Users with ready access to clear, meaningful notices about the collection, use, and sharing of Covered Information.

Choice

Participating Members commit to offering Owners and Registered Users with certain choices regarding the collection, use, and sharing of Covered Information.

Respect for Context

Participating Members commit to using and sharing Covered Information in ways that are consistent with the context in which the Covered Information was collected, taking account of the likely impact on Owners and Registered Users.

Data Minimization, De-Identification & Retention

Participating Members commit to collecting Covered Information only as needed for legitimate business purposes. Participating Members commit to retaining Covered Information no longer than they determine necessary for legitimate business purposes.

Data Security

Participating Members commit to implementing reasonable measures to protect Covered Information against loss and unauthorized access or use.

Integrity & Access

Participating Members commit to implementing reasonable measures to maintain the accuracy of Covered Information and commit to giving Owners and Registered Users reasonable means to review and correct Personal Subscription Information.

Accountability

Participating Members commit to taking reasonable steps to ensure that they and other entities that receive Covered Information adhere to the Principles.

Appendix B.

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Appendix C.

Glossary / Acronyms.

AAM	Alliance of Automobile Manufacturers (US)
ABS	Antilock Braking System
ACC	Adaptive Cruise Control
ACEA	European Automobile Manufacturers' Association
ADAS	Advanced Driver Assistance System
AEB	Autonomous Emergency Braking
AGA	Association of Global Automakers (US)
AGL	Automotive Grade Linux
AI	Artificial Intelligence
API	Application Programming Interface
AV	Autonomous Vehicle
B2B	Business-to-Business
BYO	Bring Your Own
bCall	Breakdown Call
CAVs	Connected and Autonomous Vehicles
CCPA	California Consumer Protection Act
C-ITS	Cooperative Intelligent Transport Systems
CPREA	California Privacy Rights and Enforcement Act
DSRC	Dedicated Short-Range Communication
DTC	Diagnostic Trouble Code
eCall	Emergency Call
ECU	Electronic Control Unit
EDR	Event Data Recorder
EPA	Environmental Protection Agency
EU	European Union
EV	Electric Vehicle
ExVe	Extended Vehicle concept
FTC	Federal Trade Commission
GDPR	General Data Protection Regulation (EU)
GHG	Gree House Gas
IP	Intellectual Property
LKA	Lane Keeping Assistant
LTE	Long-Term Evolution
MNO	Mobile Network Operator
NHTSA	National Highway Traffic Safety Administration
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer (Automakers in this context)
OTA	Over The Air
PAYD	Pay As You Drive
PHYD	Pay How You Drive
PII	Personally Identifiable Information
POI	Points of Interest
R&D	Research and Development
TCU	Telematics Control Unit
TSP	Telematics Solutions Provider
UBI	Usage Based Insurance
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-everything (incorporating V2I and V2V)
VIN	Vehicle Identification Number

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