

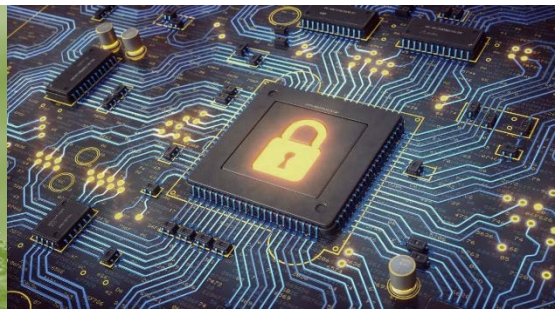

Big Automotive Data Analytics Scenarios

PART OF THE FFI BADA PROJECT

RI.SE
Research Institutes of Sweden

Big Automotive Data Analytics (BADA)

Scenario report

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Göteborg, 31 May 2017

Introduction

This report is part of the FFI[1] BADA project which explores future business models and ecosystems of 'Big Automotive Data Analytics'. The automotive industry is facing a digital revolution that is poised to change the competitive landscape fundamentally. Data driven services based on advanced analytics will play an increasingly important part. In a future ecosystem, it will likely be decisive to manage data and control the system, not to focus on individual vehicles.

The future holds great promise for OEMs, the public sector and society as a whole. Vehicles increasingly act as sensors in the road network, collecting vast amounts of data that can be combined with other types of data and used for a wide variety of purposes, increasing the effectiveness of the transportation system. However, there are several challenges for society and the automotive industry that must be met before such promises are realized. As future events unfold and influence each other, analysis becomes increasingly speculative and fuzzy. To better gauge the nature of these future events, and generate ideas of possible end states and their implications, a scenario planning activity was initiated.

Scenario Methodology

Scenarios provide a networked perspective on future developments in each context, here the development of Big Data in the automotive sector. Scenarios are not forecasts describing THE future but present plausible, consistent pictures of the future – alternatives of "what could be". Which of these alternative pictures will correspond to the actual future is uncertain, and most probably the actual future might include elements of several scenarios – and even elements that we cannot foresee today: new developments and trends, innovations and disruptive events.

Scenarios initiate the discussion and debate of objectives, strategies, tools and measures and foster long-term oriented, sustainable thinking and action. "How do we want to act, and how should we act?" This benefit materialises even when deriving conclusions from undesirable, negative scenarios. Each scenario will encompass negative and positive aspects, also depending on the perspective – and thus be in a good position for inspiring thoughts on new strategies and actions. The main benefit of scenarios is not the answers it provides, but the questions it inspires.

Scenario implications consider potential strategies of all relevant players in a field and should include also those strategies which – from today's point of view – are less probable or even undesirable. Therefore, scenarios should not be regarded as propositions. Neither should the reader expect that the measures described in the scenarios lead exactly to the depicted results.

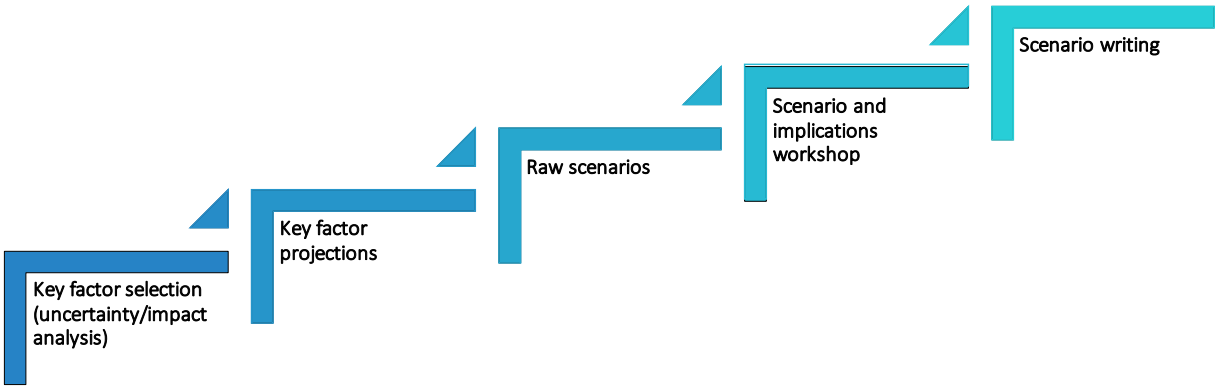
Last but not least, scenario projects are processes of communication, also because they greatly reduce complexity. Both the quality of the results and their acceptance – key requisites for a successful later use – depend on involving relevant internal and external

[1] Strategic Vehicle Research and Innovation (FFI) is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety.

experts from an early stage and “translating” the results into a language and format that can be easily used for dissemination among relevant target groups.

Development process

The three scenarios in this report were developed in a five step process including key factor generation and prioritization, key factor projection, raw scenario generation and eliciting implications and evaluation.



The start was the compilation of a list of 24 influencing factors which determine the future development of BADA. In a workshop with BADA project participants, the long list was reduced to a short list of 11 key factors by selecting those with the highest impact and the highest uncertainty. In that same workshop, participants started developing future projections (trajectories) for each key factor, which were then consolidated by the RISE Viktoria project team. The criteria for identifying projections was plausibility, comprehensiveness, and mutual exclusiveness and the timeframe was set to 2030. The key factors along with their projections make up a so-called morphological box.

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Defacto Oligopoly	Compartmentalized infrastructure	Moderate privacy protection	Large player public funding	Step by step evolution	Fragmented society	OEM as fleet operators	Operators and integrators dominate	IT for green
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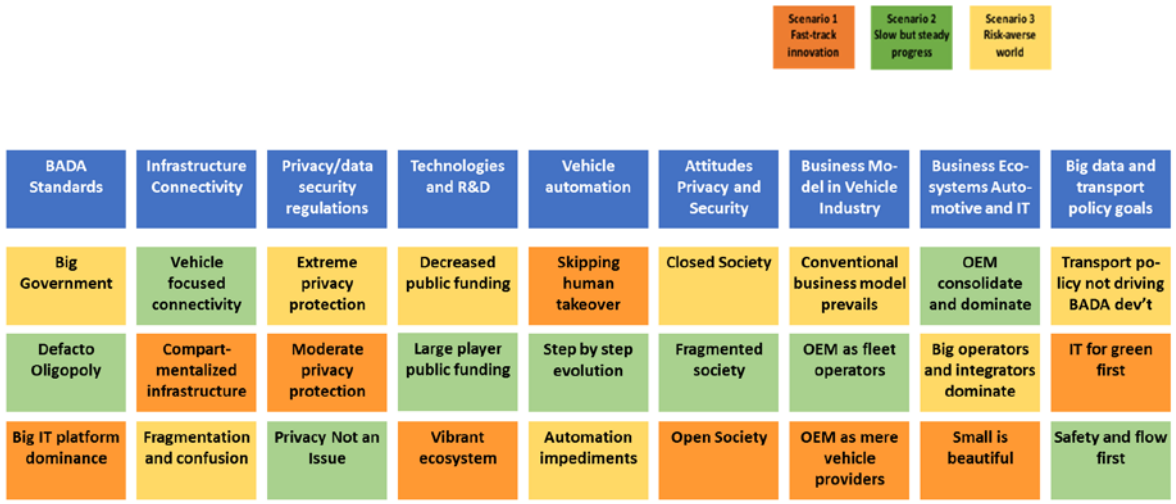
The project team then connected projections that are consistent with each other to plausible stories, resulting in 3 “raw scenarios”. While one scenario described a desirable (but not necessarily business-as-usual) future, the other scenarios paint pictures of alternative, even disruptive futures, in a positive or negative sense. The morphological box represents the raw scenarios as follows:



In a second workshop, these draft scenarios were then enriched to full-fledged scenario stories exploring each scenario's driving forces, risks and benefits, impacts for technology and transport systems, and implications for key actors. A version of the written scenarios was submitted to the project group and resulting suggestions and clarifications were applied. This report now represents the consolidated scenario stories in the form of consistent narratives as well as the implications and recommendations for BADA project members.

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Scenario 1: Fast-track Innovation

- Tech enthusiasm: Societal attitudes favor innovation
- Attracting a broad set of competencies and resources, generic Big IT is able to outpace and outcompete “traditional” automotive actors
- Public R&D becomes more open for small, dynamic players, resulting in a highly diversified landscape of innovators
- Struggling to compete in all niches of the mobility market, OEMs resort to becoming manufacturers of vehicles
- Automation efforts increasingly target a direct transition to level 4 and 5, skipping human involvement

The positive attitudes towards innovation associated with the accelerated digitalization revolution continues and Internet of Things continue unabated. Though reports of data misuse still exist, it quickly becomes an expected and manageable price to pay for the unprecedented productivity gains afforded.

As things increasingly become connected, the capacity to manage and analyse vast amounts of data rapidly becomes paramount. Though manufacturing sectors benefit tremendously from the digitalized “industry 4.0”, the significant gains are mostly coupled to incremental improvements of their extant manufacturing processes. Amidst a shortage of specialized knowledge workers, OEMs and the public sector struggles to acquire analytics competency. Data driven business models and players are rapidly becoming dominant in most fields, as incumbent actors are unable to exploit the full potential of the growing streams of sensor data for analytics and service design.

Recognizing the inertia of the existing structures, governments implement changes to their research funding strategy moving the emphasis from established industries and large multinationals to increasingly favour small innovative actors. Incumbent data driven firms vigorously invest in and buy many upcoming new businesses, but the rate of growth of new prosperous digital businesses is greater than their capacity to absorb

new additions. A virtuous cycle of small scale innovation and rapid growth shows no signs of weakening.

Incumbent actors in big data analytics leverage their core competences to gain influence in the BADA sector. Automotive communication standards and digital platforms are increasingly developed by data driven actors outside the current automotive sector. As a consequence, a new and integrated cross-sectoral system outlook between actors in the automotive and IT as well as public sectors is established.

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Transport technology and business models

While purely digital businesses make inroads into automotive development and services, the OEMs retain competitive advantage in core areas such as deep learning for vehicle automation. However, these areas are essentially still within a vehicle manufacturing paradigm and OEMs cannot compete with actors specializing in mobility services and fleet management. As that industry accelerates, OEMs increasingly focus on core competence and eventually become suppliers of advanced hardware to service providers. They become more reliant on analytics services, but primarily to rationalize design and maintenance processes. Vehicles are increasingly not designed as stand-alone products, but as components of integrated mobility services.

ITS infrastructure development progresses and both dedicated short range communication and 5G infrastructures are deployed in a coordinated fashion. Governments find that added spending on DSRC helps mitigate certain aspects of increasing congestion and safety issues and while telecom and OEMs have largely favoured 5G, clear prioritizations of which types of functionalities go where are quickly set. There are clear and globally applicable guidelines for upper layer services deployment, which greatly facilitates development of V2I, V2V and V2X services.

As ITS infrastructure development is stabilized and deployed, advanced traffic control is implemented enabling detailed control of traffic flow to mitigate congestion and pollution issues through automated incentive structures to regulate infrastructure access. Mobility operators offer integrated solutions to citizens and freight owners creating a new and influential service industry. Limited privacy regulation means that detailed analytics on the resulting digital mobility patterns enable highly efficient infrastructure and urban planning as well as a market for services utilizing automotive data as input.

Implications

Overview

Life cycle excellence: mediators dominate the end user part of the automotive value chain. However, as cars ownership is becoming a rare occurrence, OEMs can utilize a wealth of data on actual usage to design ever more efficient and sustainable vehicles. Components are built to last and for ease of maintenance as well as catering for recycling, disassembling and upgrading.

Mobility as a service: Dedicated service operators can customize their offerings to citizens and corporate customers and offer a wide variety of service levels catering to almost all mobility needs. The necessary vehicle hardware is provided by OEMs through automated service level agreements. a

Sustainability first: An unprecedented access to high resolution data on all forms of mobility means that sustainability policies can be enforced through advanced traffic control, and analyses to follow up changes to local or national policy is available with little or no delay.

Open innovation: In a fast-moving technological environment, cooperation with cutting edge start-ups will be increasingly important. This poses a significant challenge for large established firms, public as well as private, who are used to a slow-moving landscape of established suppliers. Processes in e.g. purchasing and strategies for collaboration will need adaptation to cope.

Road Authority (Trafikverket)

- Market supplies both data and services and there is no need for stimulation, since there are adequate private market incentives for adequate service and data provision
- Increased automation and demands to control flow in urban areas will push authorities to promote development of V2I, but with preference of cellular infrastructure.
- Authorities will likely struggle to acquire skilled BADA workers. However, BADA competence will mainly be needed for purchasing of external services, not inhouse development or maintenance
- An abundance of data can be used for detailed and quick policy follow up and modification, leading to new forms of agile data-driven transport policy processes
- Very strong need for cooperation between public and private actors to promote sustainable transportation. But a fast-moving service provider landscape demands operational flexibility – authorities will have to learn to move faster to cooperate
- Increased focus on environmental issues will demand increased cooperative traffic management actions for where and when different kind of vehicles will be allowed to be used as well as different kind of incentives/penalties to encourage vehicles to follow common advice on where and when to be used.

- Mobility-as-a-Service will be a common part of public transport, and a producer as well as consumer of BADA data and services.

Car OEM (VCC)

- Digital platform development becomes dominated by non-automotive IT-actors and OEMs will cooperate in alliances or buy them off-the-shelf
- VCC will find it difficult to adapt quickly enough and will likely be forced away from Mobility as a service leadership.
- Focus on cars & Vehicle data (collected by the vehicle - usage, service, traffic, etc.) as MaaS-components for service operators
- Competing through automation and service/maintenance excellence instead of direct customer contact.
- There will be changes in organizational structure to accommodate fewer global service operators rather than thousands of dealers
- During a transition period, allow flexible leasing offers with subsidies for customers willing to participate in C2B-programs
- Vehicle maintenance becomes part of deals with operators.
- Vehicle designs will adapt to suit needs of service operators
- Automation leads to an even greater focus on sensor packages and superior in-car analytics rather than traditional physical and passive safety
- Data access negotiation will likely be the responsibility of fleet operators, not OEMs, who only operate the digital infrastructure (e.g. clouds) to facilitate this. For regulatory purposes, OEMs will still be accountable.
- VCC will continue innovation within the “connected car” area

Heavy vehicle OEM (Volvo, Scania)

- Platform development becomes dominated by non-automotive IT-actors and OEMs will cooperate in alliances and/or purchase.
- Construction vehicles and other products designed to operate in closed off areas (such as BRT) are initial cases on the way to automation.
- Commercial vehicles are already focusing on fleet customers and operators, but supplying transport capability as a service is still a big step. Commercial vehicle OEMs might try to move towards a service oriented BM.
- Will likely struggle to acquire enough skilled labour, but some specific skillsets pertaining to e.g. automation will still attract expert workers.

- Data access negotiation will likely increasingly become the responsibility of fleet operators, not OEMs, who only operate the digital infrastructure (e.g. clouds) to facilitate this. The legislation authorities will still focus on the OEMs

Scenario 2: Coopetition and steady progress

- OEM gather forces by cooperating among each other, influencing and attracting R&D funding. This allows them to successfully expand their current business model into mobility services.
- Leasing an increasing share of their vehicles enables OEM to retain ownership and control of the fleet, facilitating data sharing and services.
- Eventually, OEM offer complete service packages including access to road and parking. Automation progresses stepwise eventually leading to widespread level 4 implementation. Most development focuses on low latency cellular communication and applications relying on DSRC are few.

As European OEMs realise that they must gather forces to accelerate technological development and counterbalance the growing dominance of the mostly American IT sector, they intensify cooperation among each other mainly, but not exclusively, in the areas of IT, Big Data and autonomous driving. They become able to determine the course of automotive IT R&D, secure a major part of public funding and even venture capital, and, at least in their core automotive applications, to outcompete major IT consortia. OEMs manage to create a dynamic, competitive research environment within their organisations and thus attract human capital to the European automotive hubs. Talented coders and developers no longer prefer Silicon Valley over Stuttgart, Gothenburg or Södertälje.

OEMs manage to become less dependent on large IT and electro-technical suppliers as they can increasingly incorporate most of the necessary competencies and capacities themselves. Start-ups and other innovators in automotive IT are usually being integrated into consolidated OEM “empires”, enabling them to streamline technology development according to their needs. They compete with IT companies in standardisation and platform development. A consolidated market, divided between a handful of actors, results in a de facto oligopoly, with some standards and platforms having their origin in the vehicle industry, others in the IT market.

By joining forces with competitors, OEM thrive and can free themselves from outside pressures. Their economic strength enables them to venture into a more service-oriented business model. They focus on the expansion of operational leasing, but also increase their proprietary car sharing services, even if more cautiously. Less and less cars end up in individual ownership, and OEM can retain control over many of their vehicles. This co-ownership, along with continuously lax data security regulations, greatly facilitates data sharing and services. OEM maximise their service and connectivity value, and competition among OEM is no longer focused on vehicles and technologies only.

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Transport technology and business models

Though OEM join forces, the lack of powerful binding regulations and standards from policy makers lead to a regionally fragmented deployment of BADA services. Despite progress in performance of ITS and traffic control – also due to increased data availability – the transportation system cannot keep track with an ever increasing number of vehicles which grows unabatedly due to a lack of regulation. After authorities – and manufacturers –recognise this gap, they begin pricing and taxing roads, travel slots, and parking more heavily. Soon car owners or operators do not only purchase or lease vehicles but also access to roads, parking, and information and navigation services. Saving time becomes the top priority of drivers and operators, and cost savings are willingly given up for time savings.

Solving clients' pains and increasing their gains means to cater to each driver's or fleet operator's specific local and time-based needs in an on-demand manner. This is greatly facilitated by various big data applications which tap on traffic flows, individual driving behaviour, and route management. OEM-owned clouds then enable manufacturers and fleets to exchange data securely. However, providing on-demand services requires OEMs to shift their product-based positioning on the market. Competition among OEMs is no longer about the product, but about services and service-enabling technologies.

A connectivity infrastructure bottleneck, originating in competing visions on dedicated shortrange or cellular 5G dividing OEMs, telecom and public sector actors is resolved in a de facto fashion. As OEMs have little interest in investing in external infrastructure, DSRC implementation V2I and V2X developments are bogged down in arguments about

cost distribution, leaving low latency 5G solutions as the preferred solution for most applications.

With OEMs determining the course of R&D the industry moves by adding more and more automated features, progressing through level 1 to 5, eventually ending up in full level 5 automation. Level 4 automation reaches technological maturity, while market introduction is gradual, and level 5 features are beginning to be deployed. As expected, a higher share of autonomous vehicles or functions significantly improves safety on the roads. Along with the limited access to road space – which reduces vehicle miles, crowding, and emissions – other transport policy goals are being catered to as well.

Implications

Overview

From manufacturer to service provider: This scenario describes a highly dynamic development for OEMs. Data-driven services become key components to new end-to-end business models of hardware production and maintenance as well as data driven mobility service design. Existing models such as leasing, carpooling, rentals as well as privately owned vehicles can be combined into tailored offerings. These are eventually completed with “access packages” to help drivers/users navigate highly regulated urban traffic environments and patchy regulation. Smaller manufacturers will likely need to cooperate in consortia to be able to offer a full complement of vehicle types to their customers cost effectively.

Connectivity infrastructure: With a low level of state interference, slow development of connectivity infrastructure can lead to significant deployment gaps and stall development and dissemination of key applications. Policy makers and OEM should therefore push for parallel solutions, meaning developing and deploying both cellular and V2I based infrastructure to benefit from both technologies.

Regulation: Privacy protection is not a cause of concern in this scenario. However, as OEMs are positioned in direct contact with customers, the management of trust is still essential to their brands and care must be taken to avoid any perceived misuse of private data. As OEMs increasingly transform their business model to providing mobility service, issues of data ownership will be seen in a new light and political pressures to open up access to vehicle data will gradually disappear.

Data access: As OEMs assume an end-to-end responsibility for mobility services, massive amounts of data will likely be managed within these organizations rather than opened for a broader BADA ecosystem. Authorities and OEMs will likely have to be actively involved in keeping an innovative landscape open for new entrants and ideas to develop BADA services for environmental sustainability, improved traffic flow and safety.

Road Authority (Trafikverket)

- No centralized platforms on e.g. EU-level, cooperation with commercial partners necessary
- Able to exert some influence of innovation through R&D policies
- OEMs will be a gateway to automotive data access, not owners or fleet operators, which is similar to the current situation
- As DSRC development slowly grinds to a halt, Trafikverket will not be authoritative in the provision of ITS-connectivity. Instead low latency cellular communication will provide the backbone of most services V2V, V2I or V2X.
- As automation progresses steadily, Trafikverket will have ample time to expand their capacity to take advantage of mass scale automotive data when and if it appears.
- Since mass data provision is neither mandatory nor voluntary, applications for policy development and monitoring will likely develop slowly.
- Balanced focus between environment, traffic safety and traffic flow, and at the same time increased cooperation with commercial actors, means cooperative traffic management solving the same issues as today but in a much more efficient way.

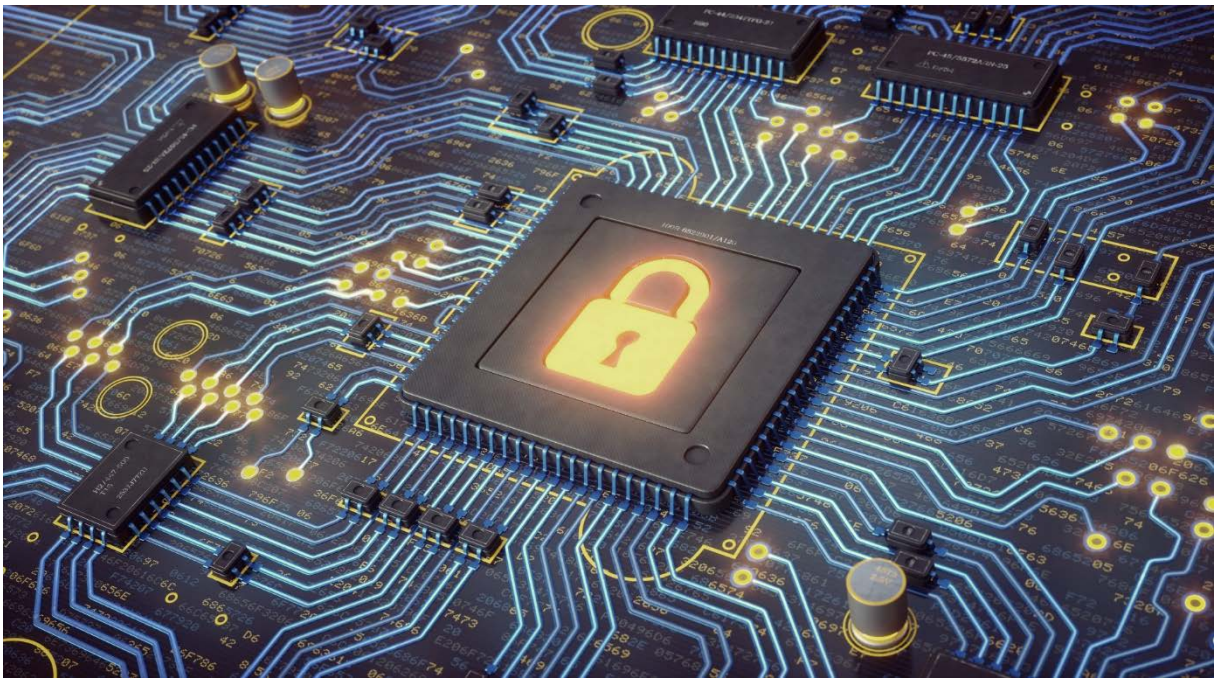
Car OEM (VCC)

- Close cooperation between OEMs to design and standardize basic digital platform elements and standards
- There are a small number of competing platform alliances
- Platform consortia will be either OEM or IT-dominated
- Volvo will have to decide on joining one dominated by bigger OEMs or non-automotive actors.
- Could move from selling cars via lease to selling mobility services. This change will fundamentally change the nature of the organization. The bridging of two logics: production and service provision will be a constant source of tension.
- Big data will have to be applied to better understand the customer's mobility needs. Analytics of sensitive information from a privacy perspective such as travel patterns will have to be considered.
- CRM will have to shift from traditional ownership to also incorporate usership.
- As a service provider, a small OEM like VCC would likely have to collaborate with other OEMs to provide a full complement of vehicles types.
- Selling mobility as a service rather than products transforms car maintenance from revenue to cost.

- Focusing on low latency 5G and V2V, OEMs can prune and rationalize their innovation portfolio developing cost efficient services based on a lean and standardized digital infrastructure
- OEMs retain their influence of public R&D streams and control the innovation landscape

Heavy vehicle OEM (Volvo, Scania)

- Close cooperation between OEMs to design and standardize basic digital platform elements and standards
- There are a small number of competing platform alliances
- Platform consortia will be more dominated by OEMs than in the car sector. Volvo and Scania could either lead, follow or collaborate.
- Could move from sell products via lease to selling of mobility services. This would fundamentally change the nature of the organization. The bridging of production and service provision could be a source of tension.
- OEMs will provide transport services, but not primarily directly to transport costumers, but rather through logistics actors. These will choose transport services to fit their demands and combine OEM offerings as they see fit.
- Selling mobility as a service rather than products transforms vehicle maintenance from revenue to cost.
- Focusing on low latency 5G and V2V, OEMs can prune and rationalize their innovation portfolio developing cost efficient services based on a lean and standardized digital infrastructure
- OEMs retain their influence of public R&D streams and control the innovation landscape



Scenario 3: Risk-Averse World

In the wake of increasing concerns about cybersecurity and the proliferation of digital traces from citizens, unregulated digitalization eventually reaches its limit. Mutually reinforcing trends move society towards a protective and risk averse stance.

Rising concerns of privacy issues makes a growing number of people minimize exposure of digital traces in social media and elsewhere. For those who remain connected, data about their everyday life is being shared with little discretion, generating a "little brother" society. Identity theft is a common issue.

A series of unfortunate incidents including unintended accidents involving automated test vehicles and deliberate exploitation of connected vehicle security breaches have a profound impact on the perception of connected and automated vehicle development. At the same time, continued urbanization and associated congestion challenges reach critical levels, and increasingly vocal protests demand political action.

- Big IT continues proliferating personal data for analytics, eventually provoking significant public concern for privacy and data safety.
- Government eventually responds by implementing strict interpretations of data privacy and safety regulations; it also attempts to introduce strict BADA-related standards.
- Patchy coverage and uncoordinated national strategies means that various actors attempt to implement overlapping services in both short-range and cellular infrastructures, slowing down innovation.
- Technological progress inadequate to convince public or government about the feasibility of full automation.
- OEMs cannot find a profitable path to digitalization and servitization, leaving e.g. fleet operations and services to other players.

Citing reasons of security and safety, authorities become actively involved in the development of both automated and connected vehicles. In a few years, the collective

perception of digitalization has morphed from being hailed as the prime driver of open society economies to being viewed as a very real threat to the same.

As a response, governments introduce strict interpretations and enforcement of regulations that affect all things digital, affecting major players in the IT sector and the BADA sector alike. The recently introduced General Data Protection Regulation (GDPR) is used to demand strict adherence to distinct consent for each use case, and the right to be forgotten. The effects are felt not only in the social media and search sectors, but also in the fledgling BADA sector. OEMs are further discouraged from developing their digital portfolio of vehicle sensor data as the delegated act on free access to traffic related data[2] is implemented in a comprehensive manner, effectively eliminating private incentives. The EU C-ITS platform initiative accelerates pushed by public sector agendas. However, the prioritization between infrastructural options is often at odds with vehicle manufacturer and telecom interests and there is no definite resolution.

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Transport technology and business models

As the pace of maturation and acceptance levels of vehicle automation seems increasingly discouraging, OEMs and others active in the field decide on a modest gradual and low impact strategy. Automation development generally stops at level 2. Some isolated instances of level 4 reach maturity, but they have limited impact on the global transportation system.

Though there is a clear pressure on municipalities to enhance the urban traffic environment, the digitalization of traffic control is sluggish. Echoing the troubled development of the e-Call ITS service, further development of advanced ITS services develops into a protracted deadlock between commercial forces dominated by OEMs and telecom on the one hand and authorities and government on the other hand. Developments of dedicated short range communication infrastructure and cellular low latency are uncoordinated. Nations and regions choose to implement various standards

[2] The delegated Regulation (EU) No 886/2013 "data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users"

for varying services. ITS data supply becomes scarce, patchy and fragmented in terms of information standards.

OEMs are successfully able to resist complete regulation of C-ITS. Ever stricter regulations are taking their toll on entrenched digital actors in social media and search, who gradually find their source of competitive advantage – user data – dented. In the absence of external pressure, OEMs can keep the current business model. There are no obvious incentives to push initial experimentation with servitization and circular business models to replace the current business model.

The combination of the above-mentioned factors drives BADA service development costs to levels requiring massive returns to merit investment. Few actors have the resources necessary and most major applications are used by, or heavily subsidized by the public sector, with limited interest in extending the use of data beyond the initially intended functionality.

Implications

Overview

Niched automation: BADA services are dependent on massive amounts of data from automated vehicles, and the slow growth of such data in this scenario leads to a slower growth of the field. However, for OEMs that cater for niche automation, such as cordoned off Bus Rapid Transport systems or construction equipment, there will be opportunities for data reuse for vehicle design process improvement and maintenance.

Business as usual: There will not be any significant incentives to switch business models for OEMs. Changes to the organizations and their core processes remain clearly within the current automotive paradigm. To mitigate potential stock value affecting negative publicity following incidents of any kind, any radical developments in automation and BADA services could be moved outside the OEM core to subsidiaries. For authorities, traffic control capabilities will progress, but at a slow pace. This further reduces the growth of available data for BADA.

Data access: Though an open standardized platform would, in theory, grant authorities access to a wealth of vehicle data, it would likely be prohibitively expensive as OEMs struggle to retain a competitive edge by implementing cordoned off digital platforms and capabilities in parallel. Such inefficiencies could paradoxically lead to lower amounts of data and BADA service development. From a government perspective, harmonization and non-invasive meta standardization is preferable, striking a balance between data accessibility and ensuring cost efficient development.

Coping with fragmentation: Given a highly fragmented infrastructure, local adaptation will become increasingly important. Actors that cater for specialized services and infrastructure to cope with this complexity will become winners and an indispensable component in service design and delivery.

Road Authority (Trafikverket)

- Trafikverket will be involved in the development of a mandatory standardized platform.
- Mandatory detailed standardization of platform and communication standard will enable easy integration of prescribed data sources across brands
- However, OEMs will struggle to retain competitive edge by developing parallel platforms, leaving standardization to conform with bare minimum demands. This will be costly and the amount and variety of data for BADA innovation will be negatively affected
- ITS connectivity continues, but not in a coordinated fashion. DSRC will enable advanced service implementation locally, but at a high cost. Data will frequently be locked into subsystems and difficult to utilize for BADA innovation
- A decrease in public funding will give less coordination of local efforts both nationally and regionally.
- The projection of traffic patterns will not change radically since automation development stalls. Future challenges will be much the same as those present today, but more acute.
- Automotive data access negotiation is the responsibility of the end-user. This affects data procurement methods and legal procedures.
- The data provided by standardized platforms have potential to drive policy development. However, privacy regulation and complex access negotiations encumber innovation.
- As cooperative traffic management will be difficult to establish, we will still see uncoordinated traffic information messages to travellers coming from public road owners vs. commercial service providers causing traffic flow problems and high emissions.

Car OEM (VCC)

- Heavy regulation of platforms and mandatory services make it difficult to differentiate branded platforms as well as offerings
- Differentiated data provision and innovation for service revenue will have to be implemented in redundant parallel architectures.
- Ensuring global vehicle compliance with ITS services implemented on various variants of DSRC and cellular implementations will be a continuous and costly activity.
- Customer trust is at stake as debates on commercial use of private data traces intensify, motivating a conservative or cautious approach to BADA.

Strict interpretations of GDPR means having to comply with right to be forgotten and privacy demands in all areas. BADA innovation will be subject to expensive protracted legal analysis case by case.

- BADA will primarily be used for internal purposes such as enhancing decision making within R&D, manufacturing and service contracts based on predictive algorithms.
- Mechanisms for removing digital traces of customers will have to be implemented to use automotive data. (i.e. only eCall active)
- Since automation development stalls, cars will resemble current technology levels in terms of number and types of sensors and data streams.
- The OEM business model will remain the same. Limited BADA innovation will not prompt a move towards a service oriented model.
- In a fragmented landscape of infrastructure, data standards and policies integrators will become crucial for BADA development

Heavy vehicle OEM (Volvo, Scania)

- Heavy regulation of platforms and mandatory services make it difficult to differentiate branded platforms as well as offerings
- Differentiated data provision and innovation for service revenue will have to be implemented in technically redundant parallel architectures.
- Ensuring global vehicle compliance with ITS services implemented on various variants of DSRC and cellular implementations will be a continuous and costly activity.
- Costumer trust is at stake and use of commercially sensitive data is risky, motivating a conservative or cautious approach to BADA.
- Some commercial vehicles (e.g. BRT or mining vehicles) will develop lvl4 automation, but most commercial vehicle types will not, affecting the incentives to add more sensors to vehicles.
- Since automation development stalls, vehicles used on public roads will resemble current technology levels in terms of number and types of sensors and data streams.
- The OEM business model will remain the same. Limited BADA innovation will not prompt a move towards a service oriented model.
- In a fragmented landscape of infrastructure, data standards and policies integrators will become crucial for BADA development

Summary

The scenarios and their implications are a result of workshop sessions and insights from experts in the field of big automotive data analytics representing cities, OEMs, telecom and authorities. The process of selecting key factors and gauging their possible projections is designed to facilitate the creation of plausible and distinct future scenarios.

However, these scenarios are not to be mistaken for predictions or forecasts. Scenarios fill a different purpose than strict trend analysis striving to estimate the probability of a given future end state. Instead scenarios allow for the generation of plausible thought provoking futures, each with a distinct set of implications that can be used by participants and others to generate a broad contingency plan.

We have presented three distinct futures with varying threats and opportunities for all actors in a future BADA ecosystem. While the ecosystem model of the main BADA project report will look similar in all scenarios, the relative importance of the components of the ecosystem will be very scenario-specific. OEMs and public actors will assume radically different positions, occupying several or few niches in the ecosystem, and their opportunities for action will be influenced accordingly.

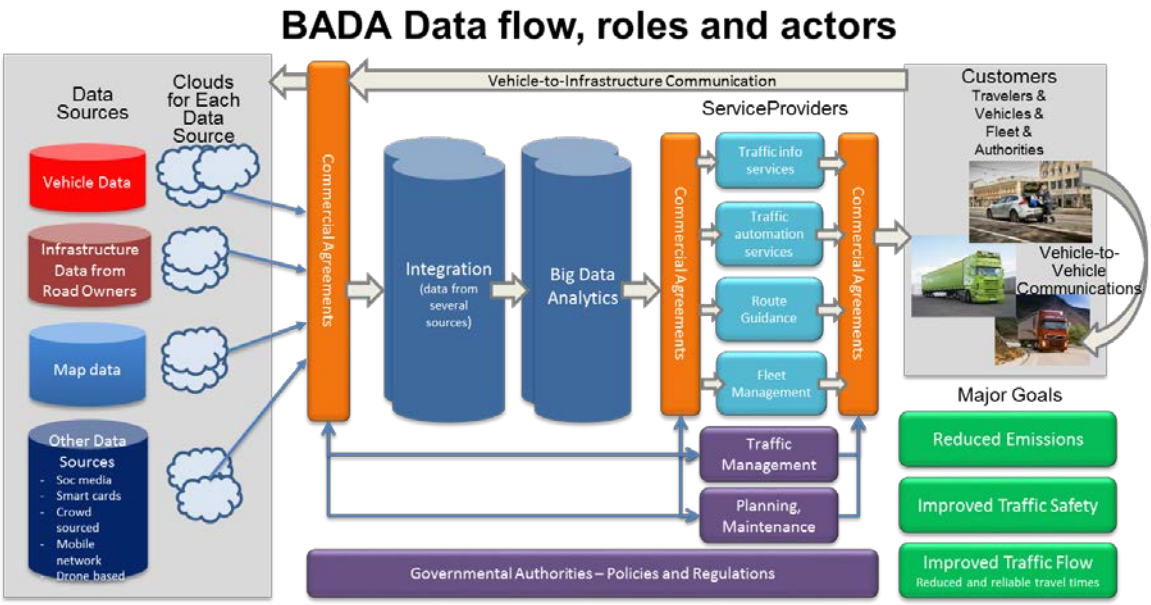

Figure from BADA Business model main report, draft version

In scenario I, OEMs will excel in automation and maintenance, whereas authorities will not see the need for costly intervention and development as the quickly growing BADA market will cater for much of their needs. In scenario II, OEMs will expand their areas of expertise to cover most niches in the ecosystem including both manufacture and mobility services, whereas authorities would struggle with the introduction of any next generation ITS services dependant on DSRC due to the lack of comprehensive standards. In scenario III, OEMs would operate more or less as they do today, whereas authorities assume an authoritative role in standardization and development via regulations.

Summarizing, the development of the future BADA ecosystem is dependent on a wide variety of contingencies, each with several possible outcomes. The topic is highly contested with several actors having potentially diverging incentives and strategic imperatives. The full spectrum of possible long term futures is therefore prohibitively complex and therefore very difficult to discuss and plan for. This report describes a structured attempt to facilitate such discussion and strategic foresight by applying scenario planning tools.

The resulting scenarios indicate that changes in the surrounding landscape has a decisive impact on the strategies available to the different stakeholders. Policies, political environment and developments outside the automotive sector heavily influence how technologies can be developed, deployed and promoted. Consequently, it is advisable to develop contingency plans covering a broad range of possible futures.