Capgemini invent

CXO INSIGHTS

CXO TECH BRIEF FOR MOBILITY

1. SECTORAL EXEC SUMMARY

A SHORT PRESENTATION OF OUR EXPERTS (MU VP)

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THE MOBILITY INDUSTRY IS FACING PROFOUND CHANGES ACROSS ITS ENTIRE ECOSYSTEM AND WAS PARTICULARLY HIT BY THE GLOBAL HEALTH CRISIS, GIVING RISE TO FOUR KEY TRENDS:

1. SMART & CONNECTED EVERYTHING

Trains, cars, infrastructure, cities, etc. Across the length and breadth of the transport ecosystem, intelligence can now take over activities that were previously carried out by humans. **Everything can be connected and powered by AI and 5G** to become smart(-er), optimize all operations and interactions thanks to 'hyperautomation', aiming to reach the ultimate goal of **autonomous vehicles and infrastructure.**

2. DATA EXPLOSION

Data explosion is one of the consequences of ultra-connectivity, in terms of volumes as well as the categories and sources of information. This massive amount of data coupled with advanced analytics and AI **creates powerful insights** and **enables the creation of new services** like predictive maintenance, recommendation services, etc.

4 KEY TRENDS TRANSFORMING THE INDUSTRY

3. EMPOWERED INDIVIDUALS

Operators, drivers, customers, etc. can now access better information through new channels (AR, voice command, chatbot, etc.) and can access entirely integrated ecosystems through a single platform (Mobility-as-a-Service). This **redefines the individual's interactions** with transport companies and services, **whatever the mode of transportation**, allowing wider accessibility and personalized recommendations, accelerating maintenance operations or enhancing the abilities and safety of drivers and pilots.

4. ENVIRONMENTAL FOCUS

Reducing the carbon footprint of the mobility industry means promoting low carbon impact mobility services, as well as reducing the impact of every existing mode of transportation.

Many stakeholders of the ecosystem now promote new service offerings, encouraging passengers to **choose low carbon impact mobility services** for their end-to-end journey (i.e., shared mobility, Mobility-as-a-Service, etc.). On top of that, we expect a change in energy consumption, from the **electrification of our mobility solutions** (new battery technologies leading to electric vehicles) to the emergence of **new energy sources** (hydrogen, synthetic liquid fuels, etc.) transforming the industry.

1. SECTORAL EXEC SUMMARY

THE ECOSYSTEM OF THE MOBILITY INDUSTRY IS BECOMING WIDER AND MORE INCLUSIVE, IN PREPARATION FOR THE MAAS REVOLUTION

These 4 trends are visible across the **extended ecosystem** of the mobility industry, which now includes tech giants like Intel and Google, as well as digital start-ups along with the traditional players.

- For instance, **Intel bought Moovit** in 2020 for 900 million dollars[1] and partnered with Cubic to combine Moovit's multi-modal journey planner with Cubic's payment technology on mobile devices.
- Another example is the buyout of **Mappy** at the end of 2020[2], an internet pure player in planning and comparing itineraries, by **RATP**, a state-owned public transport operator, headquartered in Paris.
- Finally, **new mobility companies** have emerged through traditional players, such as Mobilize by Renault or Free2move by Peugeot.

MaaS revolution

The ecosystem is also becoming more intertwined with the next revolution in terms of transport service offerings: **Mobility-as-a-Service**. By integrating all transport service offerings (through APIs), from public transport services (trains, tramways, buses, etc.) to individual modes of transportation (shared cars, micro-mobility solutions like scooters, bikes, etc.), MaaS is becoming the main way customers interact with their transport service providers, through a **single, integrated application**, enabling them to search, book and pay for the entire trip.

EMERGING TECHNOLOGIES ARE AT THE HEART OF THE MOBILITY SECTOR TRANSFORMATION

To stay afloat, companies in the smart mobility and transport sector need to leverage emerging technologies to address the profound changes they are facing. The "Fit for NetZero" report by Capgemini[3] reveals how targeted investments in technology can accelerate innovation cycles to help tackle climate change. Here, we discuss the main technologies that need to be addressed by order of importance:

The multiplication of connected items with Massive IoT and Edge Computing, across the entire ecosystem, represents a great opportunity for the transport industry, **enabling market players to collect and compute an ever-increasing amount of data**, and to connect directly with every part of their ecosystem, run remote diagnostics, optimize their networks in real time or increase safety and security with better monitoring of their critical equipment.

5G promises great benefits in terms of **bandwidth, speed, availability, latency**, and so on, and is starting to become a "must-have" technology for the transport industry. Enabling **new use cases** that require very low latency and the transmission of ever-increasing volumes of data, 5G is the technology that will enable all the key transformations in the transport industry, from smart networks (smart cities, smart ports and airports, smart railroads, etc.) to fully autonomous vehicles.

The number of AI projects are multiplying and proving their value for many key processes and parts of the value chain, leading to the **hyperautomation of the value chain**. AI makes it possible to extract enormous value from existing data, to provide the right insights, at the right time and at the right place, across the value chain.

Today, Augmented Reality has reached the maturity level where it can be **embedded in cars and aircrafts**, to enhance the efficiency and safety of drivers and pilots thanks to upgraded windshields, be deployed for maintenance workers for optimized and safer work and be used for customer navigation inside trains and/or stations.

By providing an **unprecedented computing capability**, quantum computing helps tackle the "travelling salesman" problem, a computing problem that used to require months of calculation to identify the most effective paths to reach several destinations once and return to the original location. With Quantum computing, this optimization can be combined with real-time traffic data to enable **unprecedented optimization**.

2.1 HOW IS THE VALUE CHAIN DISRUPTED BY TECH?

AN INTERTWINED MOBILITY ECOSYSTEM

Passengers

- **Aggregation of transport services** and an **end-to-end seamless journey** thanks to Mobility-as-a-Service (MaaS) platforms
- **Enhanced customer service and ease of navigation** inside train stations thanks to AR and Chatbots
- **Optimized traffic and reduced health risks** by preventing crowding at public places thanks to AI and Computer vision

Vehicles

- **Connected vehicles (V2X - Vehicles-to-Everything)** with 5G and Massive IOT
- **Remote-controlled or autonomous vehicles** (cars, trains, boats, etc.) with 5G, AI, Edge Computing and Massive IoT – the autonomous train project by SNCF
- **New service offerings** with AI and data analytics and with 5G (e.g., in-car infotainment)

Infrastructure

- **Intelligent connected infrastructure** with massive IoT, Edge Computing and AI to optimize utilization, traffic and flow
- **Infrastructure digital twins** with building information modelling ("BIM")

Operators

- **Empowered drivers and pilots** with AR integrated into the windshields of cars, buses, trains, planes, etc.
- **Empowered maintenance workers** (on-site and in-plant) with AR and mobile devices to increase productivity and safety
- **Holistic supervision** managing the entire connected ecosystem (infrastructure, vehicles, etc.)

Authorities & regulations

- **Aggregated data platforms and data visualization** for every mode of transport to optimize transport services
- **Protecting the public interest** in the extended ecosystem, as a trusted partner, to certify the shared data thanks to blockchain
- **Policies to promote low-carbon impact** mobility services and products

$9.5 trillion
Estimated market capitalization of MaaS by 2030[4]

470 Million
connected cars by 2025[5]

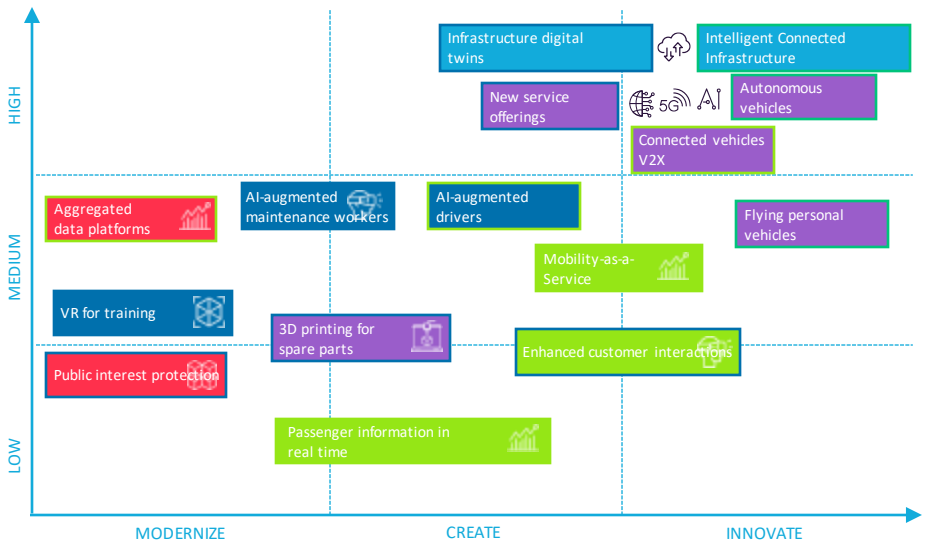
25%
reduction in travel time in Pittsburg[7]

70%
reduction in maintenance time for car manufacturers[8]

25 GB
of data generated by a car every hour[6]

2.2 FOCUS ON TECH DELIVERY MATURITY & BUSINESS VALUE

BUSINESS VALUE



Value chain positioning:

Passengers | Vehicles | Infrastructure | Operators | Authorities and regulations

Timeframe — Today — Tomorrow — In the near future

AI/Machine learning · 5G Network · Blockchain · Quantum · Virtual reality · PWA
Augmented reality · 3D Printing · Cloud / Edge · Robotics · Data analytics · IoT

TAKEAWAYS FROM TECHNOLOGY ROADMAPS

We have identified key technologies to drive future transformations:

- **Must-have technologies:** Massive IoT, Data Analytics, and AI are at the heart of the transport ecosystem.
- **Future must-have technologies:** 5G in the short term will improve the quantity and latency of data transferred to support many use cases, and in the longer term, Quantum will bring the computing power enabling the development of many use cases.

3. FOCUS ON VALUE CHAIN BLOCKS ALONG WITH USE CASES

PASSENGERS

MaaS is expected to reach a market capitalization of $9.5 trillion by 2030 [4]

MaaS aggregates all mobility services

Renewed channels to interact with customers

MaaS, AR, and Chatbot

- **Trend#1**: Mobility-as-a-Service will become normalized with the emergence of multimodal transportation apps, enabling passengers to plan, book and pay for their end-to-end journeys, all in one place.
- **Use case:** The application Jelbi[9], created by Trafi, is a successful example in Berlin of a MaaS offering. It connects more than 10 mobility services, both public and private, through an Open API offering called Open Trafi (see description further in the document).
- **Trend#2:** Emergence of new ways of interacting with passengers (voice command, chatbot, AR, etc.) all along the journey, from searching, booking and paying for the journey, all the way up to helping passengers navigate within and across the infrastructure's different nodes (train stations, airports, etc.).
- **Use case:** SBB CFF (a Swiss train company) has designed an AR application[10] to help customers navigate stations (see description further in the document).

VEHICLES

470 M connected cars by 2025 [5]

Every vehicle will be connected and software-based

5G to accelerate the development of use cases

IoT, AI and 5G

- **Trend#1:** Increase the data flow of every type of vehicle (trains, cars, etc.) for the coming years, creating new data-related business models and revenue streams.
- **Use case:** John Deere offers remote diagnostics and troubleshooting services for its tractors, as well as advice on optimizing equipment performance and predictive maintenance through dedicated subscriptions.
- **Trend#2:** Rise of software-based vehicles, providing new ways of interaction and better integration with our ecosystems, reaching the V2X (Vehicle-to-everything) connectivity: connectivity and communication with the infrastructure, other vehicles, home, service providers, OEMs and dealers, and drivers and passengers.
- **Use case:** Tesla is leading the way towards software-based and ultra-connected vehicles, by already offering driving assistance features for comfort and safety, and over-the-air battery capacity increase through software update[11].

INFRASTRUCTURE

25% reduction in travel time[7]

Intelligent Connected Infrastructure now ready to be deployed

Hyperautomation with 5G and Edge

5G, AI, Edge, and IoT

- **Trend#1:** AI and IoT, coupled with Edge and 5G, create Intelligent Connected Infrastructure, to produce, collect and analyze data, for the infrastructure to become smarter, more connected and responsive to a given situation in real time, to dynamically optimize vehicle and passenger flow.
- **Use case:** The city of Pittsburg, in the USA, implemented a smart artificial-intelligence-fueled traffic signal[7] (see description further in the document).
- **Trend#2**: A digital twin of the infrastructure can also be created to optimize the entire life cycle, from design to building and maintenance, fueled by IoT and 5G, to maintain an accurate and up-to-date digital copy of the infrastructure.
- **Use case:** The Hamburg harbor is fully covered with 5G network and has created a digital twin of the harbor.
- **Trend#3:** Infrastructure management is evolving thanks to the convergence of Operational Technology and traditional IT, paving the way towards Industrial IoT and the cloudification of OT, to bring more agility and flexibility.

3. FOCUS ON VALUE CHAIN BLOCKS ALONG WITH USE CASES

OPERATORS

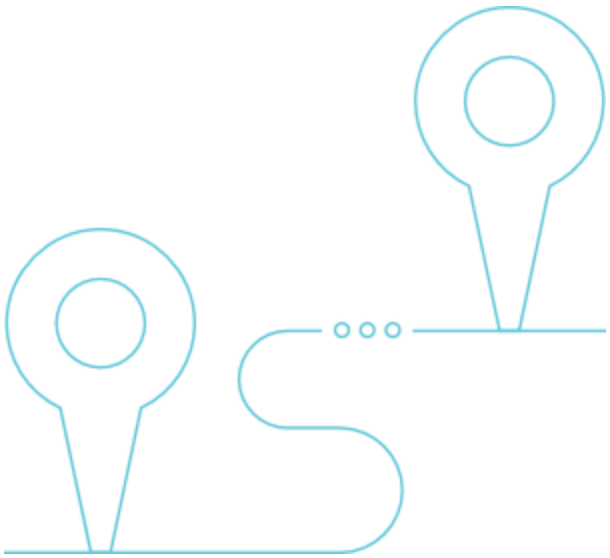
- 70% reduction in maintenance time by BMW workers [8]
- AR can be deployed for workers AND within vehicles of any kind
- AR is becoming mainstream
- AR and IoT

- **Trend#1**: Augmented workers, maintenance staff and drivers, thanks to Augmented Reality that brings them relevant information (instead of carrying around hundreds of pages), provides expertise at the right time and at the right place through decentralized expertise centers, and enhances safety and security, regardless of where they are. AR can also be integrated within windshields to enhance the efficiency and safety of drivers and pilots
- **Use case#1:** BMW's maintenance workers use AR to reduce their in-shop maintenance time by 70%[8] (see description on the next page).
- **Use case#2:** In-car holographic AR technology developed by Envisics to empower drivers and provide relevant information, increasing safety and efficiency.
- **Trend#2**: The extended intertwined ecosystem calls for a holistic supervision of the entire ecosystem, visualizing and supervising the infrastructure, tramways/trains, cars, etc.

AUTHORITIES & REGULATIONS

- 25 GB of data generated by a car every hour[6]
- Data needs to be leveraged to help and protect users
- Emergence of new players and tech giants needs to be monitored
- Data platform and AI

- **Trend#1**: Become a trusted central party by aggregating the data produced by different players and sources (location of people and vehicles, usage, traffic, etc.) to ensure the compliance of data regulations and offer new services. The "Territorial Data Trust" concept puts the territory in charge of complying with data regulations and of setting up the IT infrastructure, including open APIs for data exchange with other parties and blockchain for improved data quality.
- **Trend#2:** Leverage available data to regulate the market and adapt the transport offering to better suit the user needs.
- **Use case #2:** Padam start-up and Ile-de-France Mobilité, the authority that coordinates and controls transport in the Parisian region, are offering demand-responsive transport services to meet user needs.
- **Trend 3#:** States and authorities are also promoting an encouraging set of policies to help the spread of carbon-free mobility.
- **Use case #3:** In Norway[12], thanks to the government's aggressive policies (tax exemption, free parking spaces and no motorway fees), the market share of electric cars rose to 54% in 2020 (see description further in the document)



4. FOCUS ON USE CASES AND ASSOCIATED TECHNOLOGIES

#MAAS

PASSENGERS

Mobility as a Service

- **Multimodal mobility services platform**
  - **Description:** Trafi[9] is a Lithuanian company that develops mobility aggregator apps for governments such as Berlin or Munich. Through aggregation platforms, it can connect the city's mobility offerings. The company also offers a MaaS application in Switzerland, covering mobility services in Zurich, Bale and Berne.
  - **Result:** The application connects more than 10 mobility services, allowing customers to plan, track and pay for their journey directly from the app. Last May, the company raised €7M to deploy its services in the French market.

MARKET TECHNO IMPACT

Market and techno rationale:

- Ongoing development in many markets
- API and microservices integration mandatory for its development
- High impact to be expected in the future

TECHNOLOGIES API & MICROSERVICES

Key success factors:

- Ensure stakeholder buy-in through the right MaaS model that brings the most added value
- Set up a strong technology foundation and focus on micro-services and APIs to ensure openness and easy integration

#CONSUMER EXPERIENCE

PASSENGERS

Augmented reality to navigate the station

- **Renewed customer interaction with the entire transport ecosystem from within the train station**
  - **Description:** SBB CFF (a Swiss train company) has designed an AR app[10] to display the train's occupancy rate, and to help passengers navigate inside and outside train stations, providing information on where to find other modes of transportation (bikes, cars, etc.).
  - **Results:** With 476k people moving through Zurich station everyday, the application increases the information available to passengers and optimizes train occupancy.

MARKET TECHNO IMPACT

Market and techno rationale:

- Low number of AR use cases implemented in the market
- High use of new technologies based on IoT and mobile devices
- New ways of interacting with transport companies and the infrastructure

TECHNOLOGIES AUGMENTED REALITY

IOT

Key success factors:

- Guarantee data quality and data accuracy over time
- Ensure availability across multiple devices and platforms
- Facilitate the integration of new services and players to enrich the experience

4. FOCUS ON USE CASES AND ASSOCIATED TECHNOLOGIES

V2X #SOFTWARE-DEFINED-VEHICLES

VEHICLES

Connected and software-based vehicles

- **Rethink the car: TESLA**
  - **Description:** Tesla is seen as a software company that builds hardware. Its vehicles are designed to be connected to everything: your home, the road, the service provider, and even Tesla - the company can perform over-the-air updates to improve software and vehicle performance.
  - **Result:** When Florida was threatened by Hurricane Irma, Tesla was able to unlock extra battery life instantly with an over-the-air (OTA) update, temporarily extending the range of the vehicles to help drivers evacuate.

MARKET TECHNO IMPACT

Market and techno rationale:

- Only leading companies have fully connected vehicles – small market as of 2021
- High-level of technological innovation within vehicles, combined with data platforms and AI to offer innovative services
- Revolutionizing the way vehicles are built and experienced, putting technology at the center

TECHNOLOGIES

IOT

DATA ANALYTICS

5G NETWORK

Key success factors:

- Integrate software capabilities at the heart of a traditional industry
- Ensure network security and reliability
- Facilitate the integration of services to provide the maximum added value and create new revenue streams

#OPTIMIZED TRAFFIC

INFRASTRUCTURE

Intelligent road traffic signals [7]

- **Improved traffic management in the city of Pittsburgh**
  - **Description:** Carnegie Mellon University and Pittsburgh city engineers have developed a set of predictive systems based on AI technology that enable traffic signals to communicate with each other. Each traffic signal makes its own decisions by sensing the approaching traffic flows and coordinates traffic movement with nearby signals.
  - **Result:** The system helps reduce travel time by 25%, braking by 30% and idling by more than 40%.

MARKET TECHNO IMPACT

Market and techno rationale:

- Market: various use cases in place in different cities, but low penetration globally
- AI and Edge will greatly increase the intelligence of the infrastructure and its optimization

TECHNOLOGIES

IOT

AI AI/MACHINE LEARNING

DATA ANALYTICS

Key success factors:

- Ensure network security as well as the physical security of connected devices
- Get the approval of the authorities and the company handling the infrastructure and bring them on board

4. FOCUS ON USE CASES AND ASSOCIATED TECHNOLOGIES

#EFFICIENCY

OPERATORS

Maintenance powered by Augmented Reality [8]

- **Improve and accelerate the repair and maintenance processes in BMW centers**
  - **Description:** TSARAVision Smart Glasses (produced from Realwear HMT-1 glasses coupled with the Ubimax Augmented Reality Software) have the feature to provide live assistance when repairing a BMW car, along with contextual information.
  - **Result:** Smart Glasses helped improve the repair and maintenance speed by more than 70%. They improve efficiency by eliminating the need for technicians to stop work and log on to a desktop to look for information. The solution has been deployed in all 347 BMW centers in the US and for some chosen MINI car dealers

MARKET TECHNO IMPACT

Market and techno rationale:

- Market: Only leading companies have AR solutions to empower their workers
- Highly sophisticated technology (data, AR, 3D visualization, etc.)
- Greatly optimizing safety and the way of working

TECHNOLOGIES

IOT

AUGMENTED REALITY

Key success factors:

- High investment cost to gather data and train workers
- Ensure that data quality is maintained over time

#GREEN TRANSPORTATION

AUTHORITIES & REGULATIONS

Zero emission vehicles [12]

- **Norway's policies**
  - **Description:** With an objective of only having "zero emission" vehicles on sale in the market by 2025, Norway is leading the way towards clean energy vehicles. To reach this objective, the country has implemented an aggressive set of policies (tax breaks, free city tolls or the possibility of using public transit corridors).
  - **Result:** With 54% of the cars sold in 2020 being "zero emission", Norway is on track to reach its objective. The most popular cars sold are the Audi e-tron, Tesla Model 3, VW ID3 and Nissan Leaf.

MARKET TECHNO IMPACT

Market and techno rationale:

- Market share for zero emission cars is increasing year by year
- Battery capabilities are increasing year by year, but the technology behind electric vehicles is not new

TECHNOLOGIES

Alternative energy sources (electric/hydrogen)

Key success factors:

- Ensure network security as well as the physical security of connected devices
- Get the approval of the authorities and the company handling the infrastructure and bring them on board

Sources:
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Capgemini invent

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