Introduction

Mobility has been very steady for many years, since the second industrial revolution, and the advent of cars and planes. In the past one hundred or so years, moving people and goods around has become more efficient, more people could afford to move, but the engine of moving around has not changed. Meaning the engine literally, with combustion engine dominating transportation. And the engine in terms of business models; in fact, the growth of private ownership of vehicles and collective transportation services operated by large monopolies or oligopolies, such as airlines, railways, public transit are still the primary business model. But negative externalities of this mobility model (pollution, congestion, traffic fatalities) are becoming a drag for the social and economic development of the world.

For example, urban freight represents a major economic opportunity for small and medium-sized businesses in the city, but it is also a challenge to be addressed. The increased fragmentation and growth of volume of delivery demand, coupled with the need to minimize inventories on the supply side, creates a mismatch that leads to suboptimal utilization of city logistics, in which many delivery trips are done with low load factors and backhaul trips are empty. More delivery trucks that are traveling half empty, roaming around looking for parking, or blocking narrow lanes to load and unload packages exacerbate congestion and pollution problems in cities. Traffic accidents are also a risk; for instance, Transport for London (TfL) research finds that heavy goods vehicles are involved in 63% of fatal collisions with cyclists and 25% of fatal collisions with pedestrians, despite only making up 4% of the overall miles driven in the capital. However, driving safety technology and training improved significantly in the past 20 years; according to the European Automobile Manufacturers Association, commercial vehicles — on average — are implicated in only about 10% of fatal road accidents.

These challenges coincide with the development of technological advances, such as electric engines with longer range, autonomous driving, digital products and services, and the advent of alternative business models, such as ride-hailing, ridesharing, micro-mobility, demand-based transit. The clash of mobility challenges and innovations is making possible to think a different future for passenger and freight transportation. A future where companies that are part of the transportation ecosystem can increase operational performance and deliver innovative products, while addressing the safety and cybersecurity risks of connected, autonomous, shared, electric vehicles (asset-centric CASE). A future, where moving people and goods is convenient, affordable, safe and environmentally sustainable (people-centric CASE).

Context

Transport was one of the European Union's first common policy areas. The Union has established a common transport market. Volumes of goods and passengers transported have increased as a result of the completion of the European internal market, the abolition of internal borders, the drop in transport prices as a result of the opening-up and liberalization of transport markets, and changes in manufacturing and stock management systems.

What challenges does European Transport policy face?

European transport policy still faces many challenges in the area of sustainability. The 2011 White Paper entitled ‘Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system’ (COM(2011)0144) recommended a 20% reduction in transport emissions (excluding international maritime transport) between 2008 and 2030, and a reduction of at least 60%

between 1990 and 2050. It also sought a 40% reduction in emissions from international maritime transport between 2005 and 2050. The 2011 White Paper urged that sustainable, low-carbon fuels should account for 40% of consumption in aviation by 2050, and advocated a 50% shift away from conventionally fueled cars in urban transport by 2030, with the aim of phasing them out totally by 2050.

What strategy is proposed for decarbonization and alternative fuels?

In 2016, the Commission proposed measures to accelerate the decarbonization of European transport, when it published a communication entitled 'A European Strategy for Low-Emission Mobility' (COM(2016)0501). The strategy aims primarily at reaching a zero-emission target, as set in the 2011 White Paper on the future of transport, with a view to adequately contributing to achievement of the COP 21 Paris Agreement goals.

The European Parliament recommended a more ambitious approach to renewables in transport than that proposed in the recast of the Renewable Energy Directive. This includes the creation of incentives for the deployment of sustainable alternative fuels for those transport modes that currently have no alternatives to liquid fuel. Following a Commission communication entitled 'Towards the broadest use of alternative fuels – an Action Plan on Alternative Fuels Infrastructure' (COM(2017)0652), Parliament adopted a resolution in October 2018 calling on the Commission to bring forward a revision of Directive 2014/94/EU on the deployment of alternative fuels infrastructure and to focus on its proper implementation.

The Parliament and the Commission – e.g. communication 'On the road to automated mobility' (COM(2018)0283) – are prompting European actors to join forces to take on a role as world leaders in autonomous transport.

The European Union also set aggressive targets to improve road safety and digital security. In fact, on average in the EU there are still 49 fatalities per 1 million inhabitants, which is better than other regions of the world, but still represent a big burden for the European society. The EU's long-term goal is to move close to zero fatalities and serious injuries in road transport by 2050. And the interim targets, responding to the call of the 2017 Valletta Declaration, are to reduce the number of road deaths by 50% between 2020 and 2030. The increased digitization of vehicles and transport infrastructure (e.g. railway switches, railway and road signaling systems, air traffic control systems) prompted the EU to include transportation companies to the list of critical infrastructure operators that need to comply with the Directive on Security of Network and Information Systems (NIS Directive).

How quickly is the transportation industry moving towards a convenient, affordable, safe and environmentally sustainable mobility?

The European Union Parliament and Commission policies and the Member States actions to align with those Europe-wide guidelines are pressuring the industry to change.

In their quest for success, European transport industry stakeholders face three main challenges:

- They must deliver value to stakeholders by improving operational performance and innovating services and customer experiences that can boost their revenues.
- They must deliver value for society by improving environmental sustainability.
- They must enhance physical safety and digital security.

- **63%** of European transportation executives consider " Reducing operational and/or product costs, streamlining processes" the top business priority for their organization, in 2020.
- The list of top three priorities includes "Attracting and retaining customers", at 60%, and "Driving Operational Performance (EBITDA, revenue, etc.)" at 58%. "Improving detection and resilience capabilities against digital attacks", is a close fourth at 57%.
- In the case of passenger transportation, 48% of executives think that "commitment to sustainability and social welfare" is important, against an average across all industries surveyed by IDC of 36%

Source: IDC European Tech and Industry Pulse Survey - conducted in Q3 2019 and including 98 postal and logistics, 33 passenger transportation and 5 travel related services IT and non-IT executives, across Europe

The transformation of the industry is happening along three lines of action:

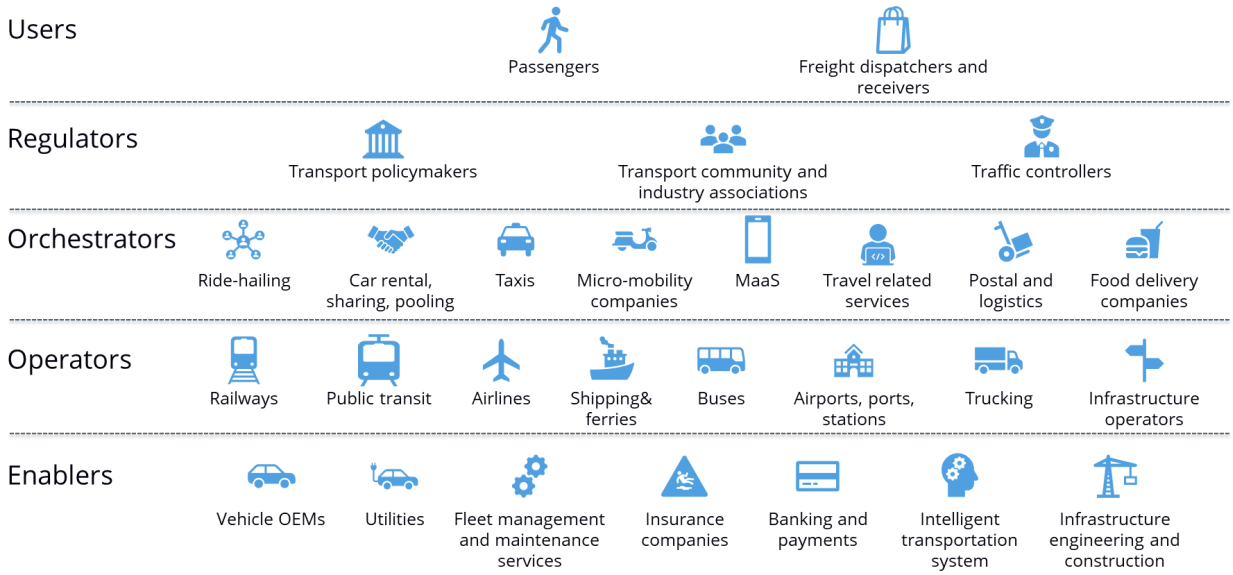
1. The technological innovation of vehicles and fuels. The convergence of advances in electric mobility (in particular battery technology) with connected and autonomous driving is changing the product and business model roadmap of vehicle manufacturers and related industries, such as fleet management, vehicle maintenance, insurance companies.
2. The transition from vehicle-centric passenger mobility, where each transport mode was considered in isolation, to multi-modal mobility experience.
3. The change in goods transportation, where more collaborative logistics models are necessary to increase efficiency, safety and environmental sustainability of freight.

There are two main components of the transformation across all three lines of action. The first element consists of the blurring lines of the industry boundaries (see figure 1) and the redefinition of business models:

- In air transport, where a vertically integrated, government-controlled industry experienced the decoupling of customer related activities, such as booking and payments, and entry of new players, in the past 20 years.
- In logistics, where horizontal collaboration models, in which delivery companies set up conjoint routes, share warehouses, share capacity in trucks, including filling up backhauling trips are emerging.
- In public transit, where ride-hailing, car-sharing and micro-mobility have impacted ridership, but also created induced demand – IDC predicts that "By 2023, 35% of large transit authorities will have integrated with transportation network companies to improve and expand passenger services and to reduce transit agency inefficiencies and service gaps".
- In vehicle manufacturing, where original equipment manufacturers (OEMs) are expanding into new business models to compensate for the slowing demand for vehicles – IDC predicts that "By 2021, 70% of OEMs will expand the reach of their data management and monetization partnerships to open new business opportunities and reduce the impact of external data market pressures".

This ecosystem transformation includes both transportation incumbents and new entrants, and requires vehicle original equipment manufacturers, insurance companies, utilities, policymakers and many other stakeholders to re-imagine their role.

Figure 1 – The Transportation Ecosystem



Source: IDC

The second component consists of technology innovation, including electrification of vehicles and digital technologies that are impacting everything, from customer facing operations, to asset management, to automation of driving. European transportation executives are embracing digital technologies to transform operations, customer experience and assets. For example, shortage of capacity in the rail network is pushing railway companies to invest in automating operations and integrating operational technology systems, such as signaling, with information technology systems, such as timetable and asset management. In passenger transportation, emerging Mobility as a Service companies, like Moovit and Whim, are building businesses based on their ability to integrate massive amount of data across modes of transportation and then analyze the data to offer personalized advice on the most convenient, affordable and environmentally sustainable route.

European transportation industry spending information and communication technology products and services is expected to grow from $21.7 billion in 2020 to **$24 billion** in 2023

Source: IDC Worldwide ICT Spending Guide Industry and Company Size, January 2020

Analysis

What will enable digital transformation of the transportation ecosystem?

European transportation executives expect digital to make the biggest impact in terms of customer satisfaction, speed/agility of IT innovation and operational efficiency. But they need to collect and aggregate accurate customer and asset data. Data that needs to be feed into advanced analytics and AI

that can deliver insights to improve customer experience, efficient use of assets, intelligent traffic management, and environmental sustainability, while protecting privacy and safety of moving around.

How will cloud computing empower innovation?

In the IT back end, the European transportation sector is adopting cloud computing as a way to increase agility and scalability of infrastructure so that it can enable innovative:

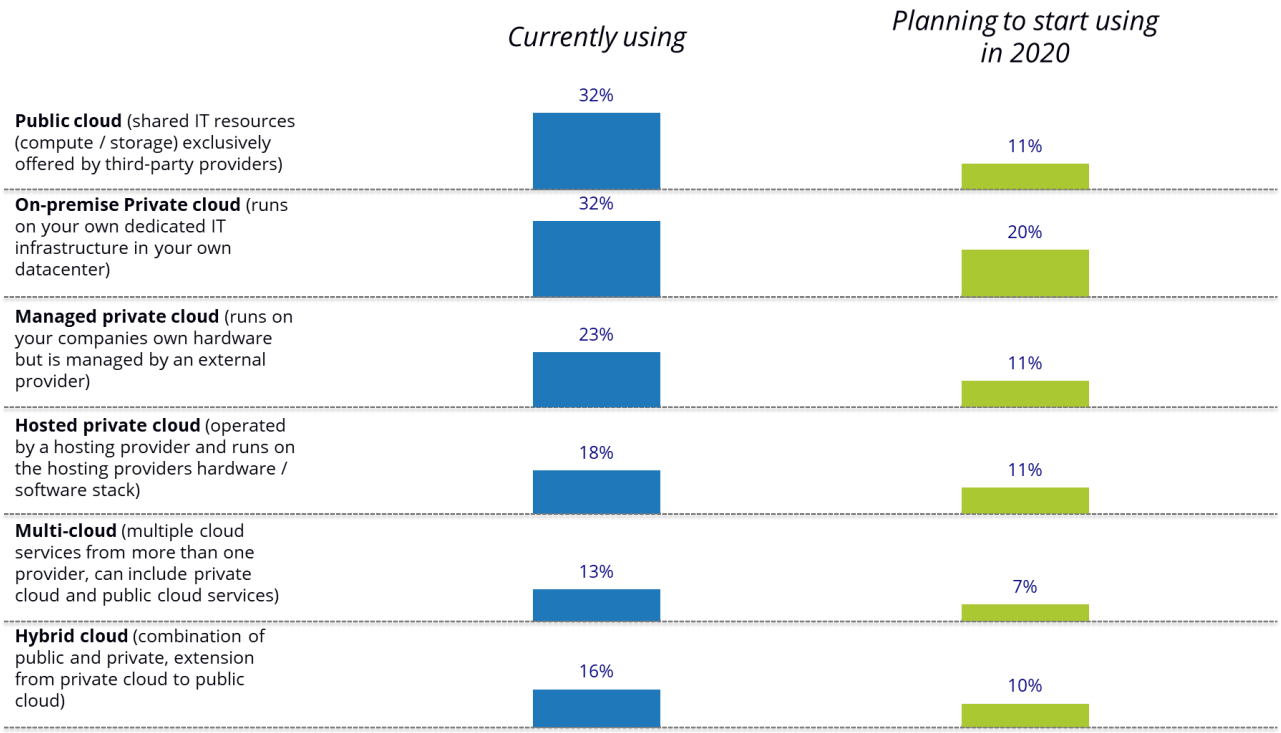
- Customer services – Maersk uses IoT to track and monitor 380,000 refrigerated containers so that customers always know where their shipments are, and their conditions.
- Asset management – SNCF reduced error rates and saved time of rebuilding bogies, by applying digital to spring replacement projects.
- Data management that can cope with the growing data volumes about passenger counts, bookings, fare collection and preferences, asset conditions and location, so that insights can be made available to employees, managers and the ecosystem – Transport for London leverages cloud computing to make open data available through APIs to foster developer of innovative services.

Demand-side analysis

Transportation industry adoption of cloud-based services lags other industries.

European transportation enterprises have adopted all types of cloud computing deployment models, from public cloud, to on-premise private clouds (see figure 2); thus, they organically built more complex hybrid, multi-cloud environments.

Figure 2 – European Transportation Sector's Adoption of Cloud Computing by Deployment Model



Source: IDC European Tech and Industry Pulse Survey - conducted in Q3 2019 and including 98 postal and logistics, 33 passenger transportation and 5 travel related services IT and non-IT executives, across Europe

Notwithstanding the progress, cloud adoption in transportation remains well below that of other industries, like education institutions, retail and manufacturing companies, where rates of adoption of public cloud surpass 30%. The top barriers to transportation cloud adoption include:

- **Policy and regulatory concerns** – Public sector executives need to comply with EU regulation like GDPR and the NIS directive that protect privacy of personal data and resilience of critical infrastructure.
- **Architectural constraints –** The consequence of the complex ecosystem of enablers, operators, orchestrators and users of transportation services is that legacy, proprietary systems have proliferated, thus making difficult to migrate applications and interchange data by leveraging cloud computing architectures.
- **Organizational barriers** – Many European transportation enterprises, for instance in logistics, are small (according to the Alliance for Logistics Innovation through Collaboration in Europe or ALICE, 85% of short-distance truck companies have fewer than five employees). They have limited budget to acquire or train technical and business skills to develop, deploy and manage cloud services. Also, there is a reluctance to use transportation ecosystem platforms, because many stakeholders are experimenting with new business models and are afraid of giving away a competitive differentiator by sharing too much data. For instance, vehicle OEMs, which are experimenting with car-sharing and fleet management services, collect data about vehicle usage patterns, wear and tear, and to offer more innovative capabilities to customers; but they are reluctant to disclose data (e.g. real-time locations, even at the aggregate level) with Mobility as a Service companies or public transit agencies, because the insights extracted from that data could direct customers to find other more convenient transport options, or could be disclosed to other vehicle OEMs. Similar concerns are creating friction between micro-mobility (scooters and bike sharing) operators, which want to use data to increase their customer base and reduce churn, and cities, that want to use the data to plan for new micro-mobility lanes and parking and to enforce traffic code.

Top cloud use cases

European transportation cloud adoption is not equal across use cases. Different applications have different needs in terms of regulatory compliance, architecture and organizational attributes. The combination of all factors determines whether transportation run some of their systems on their own on-premise cloud data centers versus hosted private cloud and public cloud services.

Top use cases for public cloud include ERP, CRM, collaborative tools, such as conferencing and file sharing, and storage.

The growing adoption of IoT, AI, edge computing and DSRC or 5G to connect vehicle and transportation infrastructure is also creating a demand for cloud computing capabilities, in fact, according to the IDC European Tech and Industry Pulse Survey, 14% of transportation executives are already running IoT workloads in the public cloud and another 17% are planning to deploy them in 2020.

Supplier analysis

The European transportation ecosystem purchase cloud capabilities and services from a variety of channels, from local resellers to cloud marketplaces. It must be noted that industry-specific solution providers play a particularly important role in the transportation ecosystem. These include:

- Intelligent traffic management system providers, such as Miovision, Kapsch, and Swarco.
- Transportation payment/fare collection solutions, such as Transcore, Conduent and Cubic.
- Location-based services, such as TomTom, Waze and Here.
- Autonomous driving solution providers, including specialists, such as Waymo and Intel's Mobileye, and OEMs, like Tesla, Daimler and Toyota.

Federated supplier analysis

Federated and cooperative cloud platforms are more in demand in freight transportation. The need to optimize asset usage and improve customer service has driven demand for cloud-based federated platforms that offer data exchange capabilities, such as:

- xChange is a marketplace for shipping container logistics., connecting users and suppliers of container equipment. The cloud marketplace enables empty and unused container ships to be lent out in the same area instead of re-routing to a new area. Features include smart search and data-powered proposals that look for potential matches. Tracking, data connections, and online negotiations are also on the platform.
- MixMoveMatch, a Norwegian company born out the EU's iCargo research and demonstration action, offers a software-as a-service solution to shippers and logistics service providers to ship their products to a warehouse where different transport orders are mixed (mix) and loaded onto trucks for long-distance transport (move), then sent to a distribution center, where they are sorted and palletized for final delivery to the customers (match). In early pilots of the solution in 2014 and 2015, 3M cut its logistics costs by 35% and carbon footprint by 50%, while DHL doubled truck fill rates.

In the passenger sector, mobility as a service companies, such as Moovit (Israel) and Whim (FI), are offering solutions that federate data exchange for passenger transportation.

Conclusion, challenges, opportunities

The European transportation ecosystem is evolving rapidly. In Europe there is a strong vehicle manufacturing industry, there are well-functioning public transport services and a large number of SMEs that operate in the ecosystem. The European Commission should build on those strong foundations to empower the enablers, operators, orchestrators and policymakers of the mobility of the future to embrace cloud computing as a trigger of innovation.

The European Commission cloud computing policy should intervene in three areas:

- The European Commission must ensure that ENISA works closely with cloud operators to define technical and governance guidelines that enable to design, manage and consume cloud-based services that align with GDPR and the NIS Directive requirements. And it should ensure that there are mechanisms to enforce those policies.
- The European Commission must build on the work started by International Data Space and more recently GAIA-X to address technical, semantic and organizational interoperability. The European

Commission can be the unbiased third-party that helps ecosystem stakeholders how they can benefit from data sharing, by starting with real-life use cases that enable to build practical data exchange solution.

- The European Commission must make sure that usage of cloud computing is an opportunity that European SMEs can leverage. This includes two streams:
    - European tech SMEs: there are opportunities for European startups and more established SMEs to build industry specific solutions for both passenger and freight transportation. Companies like Blickfield in autonomous navigation, Ovinto in supply chain safety and optimization, Whim in mobility as a service, need to be able to use cloud infrastructure and platform services to scale their business. These SMEs will need secure and interoperable cloud services.
    - European transport ecosystem SMEs: in fields like logistics, micro-mobility and vehicle sharing, autonomous and electric vehicles design and manufacturing there are many small and medium enterprises. They will need secure, interoperable cloud services, but also digital skills to be able to use cloud services to accelerate digital products and services.