WHITEPAPER

The Evolution of Mobility Services **- from a Substitute Player to a Game Changer**

VOYEGO
A COMTRADE COMPANY

Introduction

Over the past three years, Mobility Services have gone from zero to a low single digit market share of urban mobility. Two ride-hailing competitors which deserve special attention are Uber and Didi Chuxing. To date, they have accumulated capital of over $100B, whereas their capital back in 2013 didn't exceed $500M. This illustrates the rapid evolution and growth potential of Mobility Services, since this boom was only achieved within a rather small scope in between public and individual transportation.

Even though it is still unsettled where further development of mobility services will lead to, it is safe to say that expansion Mobility Services has not yet reached its peak. For the future, service offerings will have to encompass both public and individual transport in options in order to bridge the gap between those modes of transportation. Already today, ride hailing is accounting for about 20M trips per day - with potential for further growth.

At the moment, Mobility Services only function as a bridge between public and private transportation.

The big question is – what will lead to MaaS becoming mainstream and what is the next step towards it?

This white paper respresents a summary of our research on this topic.

Current state of the Mobility ecosystem

2.1 Urban Mobility challenges

Modern cities are often polluted, overcrowded and slow-moving. Nevertheless, the number of people migrating to cities keeps rising. The existing transportation network cannot keep up with this demand in an efficient way. And because public mobility offering cannot provide a comprehensive solution, the majority of city dwellers still choose private vehicles over mobility services. Society has been aware of this issue for some time, and a few things have already been changed and developed. Mobility system is currently going through a period of momentous shifts, with many parts of this complex and broad ecosystem changing in a non-linear way, faster than ever before. The core of this movement is the true acceptance of **digitalization** as the way to solve some of the biggest issues mobility system faces today. Digitalization of mobility is already taking place and services like **car sharing, ride sharing, shuttle services or private drivers are on the rise.**

To reap the full benefits of digitalization, mobility systems, especially those in urban areas, will need to move away from privately-owned vehicles towards shared, on-demand use of different mobility assets provided in the form of mobility services. The mobility user experience will start in the digital world, providing instant real-time aggregation of all relevant information and mobility services. Physical infrastructure will enable and support digital user experience.

The future mobility system will bring end users to the center of attention. It will provide seamless integration of all mobility sub-systems to power greater freedom of movement at a **significantly lower cost and with lower environmental footprint.**

2.2 Reasons for Mobility changes

Demographics, urbanization, enabling technology, climate change and the rise of the individual are just some of the megatrends that are hindering the growth of mobility in cities. In addition, heavy traffic, long commutes and environmental concerns such as air pollution and limited resources are major reasons to consider alternative concepts of mobility At the same time, new technologies, as well as political and financial reasons, are bringing urban mobility to the tipping point. Cities have a chance to provide inhabitants with easier and better ways to travel, while increasing sustainability and making their communities more livable. Seizing that opportunity will require the development of new types of mobility services.

In the present-day mobility system, transportation is costly. Even though a major share of every household's income is consumed by mobility expenses, not all mobility needs can be served in a sufficient way. Furthermore, current transportation solutions are not sustainable as they are the major causes of pollution, require significant infrastructural investments and occupy large amounts of space. This outworn system cannot scale to meet current and, most importantly, future needs and is already causing congestions, which in turn have a negative impact on GDP.

Extreme inefficiencies are especially prounounced in the field of individual mobility and high potential for crowdsourcing is often underutilized. The current mobility system is more focused on the modes of transport and vehicles, whereas the future system will put end-users at the center and build a mobility ecosystem around them. The results will be seamless and integrated mobility achieved at a significantly lower cost, as well as lower environmental impacts. On the journey, borders between individual and public transportation will be blurred and by 2025, passengers will be able to use a cohesive and well integrated mobility system.

At present, there is a significant gap between private and public transportation, which could potentially be filled with Mobility Services. However, a satisfactory merge of transportation modes requires new vehicles and various infrastructural changes. On top of that, there are almost no sufficient solutions for the "first mile/last mile" problem and modes of transportation are not well connected, making multimodal trip planning a hassle.

2.3 Current state of Mobility Services

Mobility Services are constantly growing and gaining popularity worldwide. Nevertheless, they are not well integrated into the mobility ecosystem and are still in their emerging phase. Over the past three years, Mobility Services have emerged and grown rapidly, powered by digital platforms. Their major advantage compared to older and more mature mobility options is that they can apply digitalization from the get-go and therefore gain popularity amongst customers by offering new mobility experiences.

Currently, there are three modes of MaaS: ride-hailing, ride sharing and car sharing. Out of these, ride-hailing is the most advanced and popular, but things have already begun to shift as the result of service offerings merging different mobility options. A good example of this is Uber X and Uber Pool where a company started off with ride-hailing services and after making a success, expanded its service portfolio with ride sharing and other services.

Digitalization as the driver of change

Digitalization is the main driver of change and a major enabler of innovation in mobility and transport models. It is revolutionising traditional business landscape amongst all industries by delivering agile digital business models and opening the doors to new revenue streams. As a result of digitalization, IT is undergoing a significat transformation, moving from a supporting role to the main, growth generating business function. For today's companies, it is essential to incorporate digital business models with efficiency and vigor, otherwise they won't be able to complete in the global marketplace. All major mobility players like big OEMs, have already have developed digital roadmaps for their business activities and are heavily investing in digitalizing processes across their organizations. It is clear that a shift of paradigms has occurred in the automotive industry. The center of attention has shiften from the vehicle to users. Instead of focusing solely on vehicle advancements, OEMs are increasingly adapting their activites around users' interests.

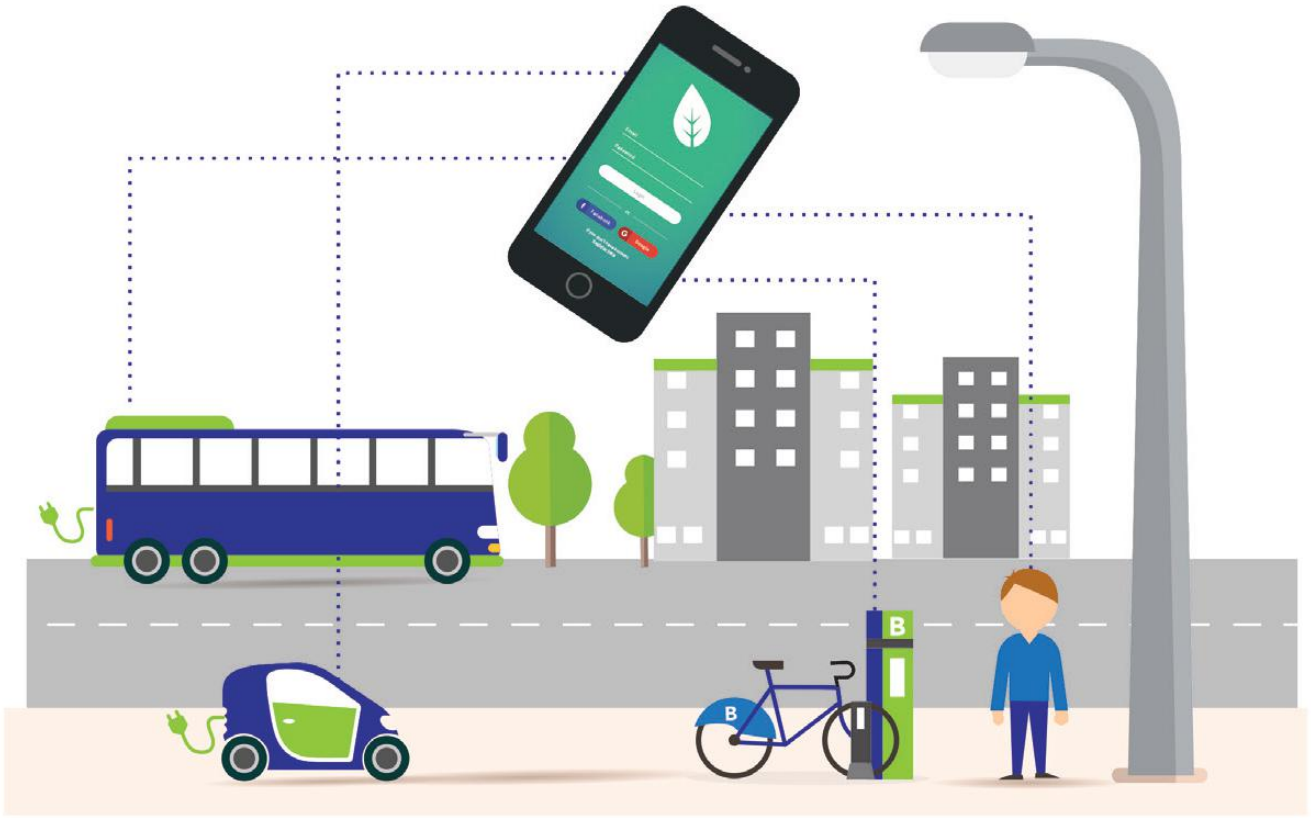
Digitalization enables users to constantly maintain contact with the system so it becomes their individual and unique daily mobility guide. With this support and system intelligence, a holistic approach that gathers all kinds of transport modes will soon add more value to a person's journey than to the private car. This will incentivize more people to use the MaaS system. With an increasing amount of users, further system advancements will be enabled. Digitalization is the stepping stone for bringing collective benefits to individual transport – in a way that has never been possible before.

The key to a well integrated mobility as a service system that is based on a smart, digital platform, is the **open mobility cloud**. By leveraging its flexibility, organizations can build digital platforms that allow seamless integration of various mobility services and enhance the users' day-to-day travel experience. The main digital innovation will come from privately owned companies, including both start-ups and established players. At the same time, the major enablers of the aforementioned services will be data on transport trends and transportation-related infrastructure.

3.1 Mobility as a Service (MaaS)

Mobility Services are constantly growing and gaining popularity worldwide. Nevertheless, they are not well integrated into the mobility ecosystem and are still in their emerging phase. Over the past three years, Mobility Services have emerged and grown rapidly, powered by digital platforms. Their major advantage compared to older and more mature mobility options is that they can apply digitalization from the get-go and therefore gain popularity amongst customers by offering new mobility experiences.

Currently, there are three modes of MaaS: ride-hailing, ride sharing and car sharing. Out of these, ride-hailing is the most advanced and popular, but things have already begun to shift as the result of service offerings merging different mobility options. A good example of this is Uber X and Uber Pool where a company started off with ride-hailing services and after making a success, expanded its service portfolio with ride sharing and other services.



To achieve a well performing MaaS system, various new actors need to be involved. Those include mobility applications that provide passangers with an easy access to new mobility experiences. Digital mobility aggregators will thus lay the foundation for a new marketplace for different services .

The personalized mobility system will consist of mass transit options and individual mobility alternatives. These will be seamlessly and dynamically integrated and in most cases users will not have no make any choices. Mobility delivery system will predict where the person wants to go and which multi-modal settings fit best. Only in the case of special one-time trips, the user will need to select their destination manually. It will only be necessary to change the settings for the first trip. **The system will learn with time**.

The complexity of different mobility service providers will be hidden behind special aggregated pricing plans such as monthly mobility packages that include a certain number of journeys using different modes of transport.

In the current system, private cars account for almost the whole segment of individual transportation. In the future, this segment will be bolstered with new services, catering to a wider scope of mobility needs and preferences. As a result, customer experience will be elevated. The aforementioned services include ride-hailing, car sharing, ride sharing, on-demand shuttles, on-demand buses, parking services and more. These services will be unified on digital mobility service platforms.

Besides the availability of vehicles and access points to mobility services, digital mobility infrastructure also has to be adapted to the new system. This includes solutions for payment, ticketing, traffic information, charging infrastructure and more.

For further efficiency enhancement of the mobility ecosystem, additional support will be provided through other digital technology platforms that will, for example, introduce loyalty systems and predictive analytics solutions.

3.2 Predictive Analytics

Predictive Analytics is a set of techniques and technologies combining statistics, modeling, advanced mathematics and artificial intelligence with advanced data management to create and determine future performance patterns based on current and histiorical data. It is a set of business intelligence technologies, designed to uncover relationships and patterns through analysis of gathered data to determine if they are likely to emerge again. Predictive Analytics thus enable more efficient allocation of resources, with the possibility of making adjustments based on predicted events.

With the help of Predictive Analytics, two major areas will be drastically improved: user experience and operational processes. User experience will be enhanced through artificial intelligence that will collect data about their movements and consequently identify their routes choices and mobility habits. From then on, the system will be able to predict users' movements and plan their trips ahead of to achieve the most efficient utilization of vehicles by showing the quickest routes. As a result, the gap between public and individual transportation, which limits the user experience, will dissapper. With the help of Predictive Analytics, it will be possible to analyze personal, as well as collective mobility patterns. By combining these analysis, digital platforms will be able to assign the optimal combination of mobility options to each user.

Currently, users have to plan each trip on their own, as well as to manually review schedules and mobility options. providers will be hidden behind special aggregated pricing plans such as monthly mobility packages that include a certain number of journeys using different modes of transport.

The system keeps user interaction at minimum and thus enhances convenience and comfort. They user only has to accept the proposed route and suggestions will be provided as notification pop-ups. For approximately 20% of trips that can't be predicted, the user will have to initiate interaction with the system. Nonetheless, the process will still be simple – the system will perform route planning and vehicle recommendation, providing a suggested route. Thereby, users will spend significantly less time on trip planning, especially in the case of multimodal trips.

With a mobility system supported by Predictive Analytics, around 80% of trips will be predicted and planned by the system.

With regard to operational processes, Predictive Analytics can help improve asset utilization and enable waste minimization. Through data collection and analysis, user demand can be predicted and assets can be allocated more precisely. As a result, there will be no unutilized assets. This will not only improve efficiency, but will also save a lot of space in cities and money for system operators. It will also have a highly positive effect on user experience, since demand prediction guarantees the availability of the vehicle and and responds to passengers' needs at all times. For those predictions, collected data on users' mobility patterns will be combined with weather, traffic or special events forecasts to further increase the accuracy of predictions. Real-time and dynamic adjustments of vehicle routes will help transit operators quickly react to changes.

3.3 Gamification

Gamification is defined as "the use of game design elements in non-game contexts". In addition to commonly used gamification in the current mobility system, there will be a gamification concept with a purpose to increase user loyalty and attract new customers. It will include basic gaming elements like points, badges and leader boards, as well as more advanced elements such as levels, paths, challenges, missions, feedback, and user powers. Gamification has been successful in many domains. It leverages fun, competition, rewards and game mechanics. With a good gamification system, user behavior can be influenced and certain actions provoked depending on current demand. One possible solution is to have a personal level for every user where he or she can track their progress from a beginner to expert level and collect awards for certain actions such as using bike sharing in the rain, reducing CO_2 emissions by a certain percentage or combining multiple modes of transport during a single trip. Furthermore, users can compare each other's scores, which display the average sustainability of their past trips. Each month, the best performing user can receive an award. It is possibly to build a truly unique gamification system through various extensions and modifications and thus attract the highest possible volume of users and increase retention rates.

3.4 Connectivity

Car 2 Car and Car 2 Infrastructure communication will enable numerous advancements in the field of individual mobility. Cars will be able to broadcast their location, speed, brake status and other parameters to vehicles around them and receive data in return. Furthermore, data will also be received from surrounding infrastructure. This would, for example, enable simultaneous start of movement of all cars at a traffic light, early warning system for obstacles or dynamic route optimization. In general, connectivity powers further advancement of technologies and realization of opportunities that come with digitalization.

When all parts of the mobility ecosystem are connected to each other, seamless mobility experiences are created and traffic flows are optimized. Multimodal trips will be less stressful for passengers, since V2V communication makes it possible to combine on-demand mobility with scheduled mass transportation without long waiting times. This is done with the help of accurate data on real-time vehicle movements and routes, combined with predictions made for all participants of the mobility sub-system.

It also helps that all services will be gathered in one system instead of being split among individually performing actors. Connected Corridors create a holistic approach that focuses on moving people and not just vehicles. The travel experience of each user is centralized, thinking beyond individual boundaries and assets of service providers and setting new benchmarks for success that take more than just one component of travel experience.1 into account.

1 http://www.newcitiesfoundation.org/improving-mobility-technology-connectivity/

3.5 Autonomous driving

Autonomous driving is one of the biggest trends in the automotive segment at the moment. There are five stages of autonomous driving that are defined from complete driver control up to complete autonomy of the vehicle. Technology is advancing along the levels and currently technology standards reach up to Level 3 of automation. Some added features only provide the driver with additional luxury components to enhance driver experience and convenience, but do not contribute to achieving greater autonomy of the vehicle.

• Level 0 (No Automation): The driver completely controls the vehicle at all times.
• Level 1 (Driver Assistance): Individual vehicle controls are automated, such as electronic stability controlor automatic braking.
• Level 2 (Partial Automation): At least two controls can be automated in unison, such as adaptive cruise control in combination with lane keeping.
• Level 3 (Conditional Automation): The driver can fully cede control of all safety-critical functions in certain conditions. The car senses when conditions require the driver to retake control and provides a "sufficiently comfortable transition time" for the driver to do so.
• Level 4 (High Automation): The vehicle performs all safety-critical functions for the entire trip, with the driver not expected to control the vehicle at any time. As this vehicle would control all functions from start to stop, including all parking functions, it could include unoccupied cars.
• Level 5 (Full Automation): Other than setting the destination and starting the system, no human intervention is required. The automatic system can drive to any location where it is legal to drive.1

The mobility sector is preparing to reach levels 4 and 5, which include complete autonomy of vehicles, and are expected to open up some groundbreaking opportunities. Computer-based decision making uses more information and is performed at unparalleled speed. In combination with V2V and V2I communication, this advantage is even greater. Autonomous vehicles enable passengers to utilize travel time more productively. Another key benefit is the ability to efficiently manage traffic flow, combined with a reduced need for traffic police, vehicle insurance etc. With the system based on MaaS, autonomous cars will constantly be utilized, picking up people who are in need of transportation . As a result, the need for parking spaces will diminish and cars will only require charging facilities, in case they are powered with electricity. With the help of demand analysis based on the Predictive Analytics system, driverless cars could spread across the city in accordance to predicted demand, eliminating traffic jams and reducing passangers' waiting times. As a result, the need for parking spaces will diminish and cars will only require charging facilities, in case they are powered with electricity. With the help of demand analysis based on the Predictive Analytics system, driverless cars could spread across the city in accordance to predicted demand, eliminating traffic jams and reducing passangers' waiting times.

2 http://www.sae.org/misc/pdfs/automated_ driving.pdf

Mobility Infrastructure

The aforementioned system is based on technology advancements and a drastic change of mobility behavior. But many infrastructural requirements for such a seamless multimodal system are yet to be met. New infrastructure parts are likely to emerge, albeit it is still not clear what those new components will comprise. For example, we could have new types of vehicles, infrastructure or of urban areas to which people will be transported to. Combined, those components will pave the way to shared, digital and cost-effective transportation. As a result, we will have more specific solutions for different commutes and trips. When looking at the future mobility infrastructure, the following aspects should be taken into consideration:

4.1 First- and last mile

The first and last mile problem is a major issue that has not been adequately addressed so far. Despite the privately owned car, the most common solutions include walking and cycling. Through holistic Mobility as a Service offerings, the existing transport options will be expanded with stand-up paddling, E-scooters, E-bikes and micro cars.

Stand-up paddling is a quick and attractive solution for a city with a central river to have a direct route across the city whilst keeping users active and entertained.

E-scooters are gaining popularity among users. They don't consume large amounts of space, can be taken onto buses and other modes of transport and with maximum speed of 20km/h represent a good alternative to bikes. But to unlock the full potential of e-scooters, various instrastructural and legislative changes need to occur. At present, e-scooters are not to be used on public roads and cycling lanes, as well as on pavements, since they move at high speeds and could seriously injure pedestrians in case of collision.

E-bikes are a good solution for crossing short and medium distances in the city at a relatively high speed. The cruise support is helpful to overcome elevations and facilitate cycling at a higher speed. To ensure safety of all cyclists, it is reccomendable to have additional lanes dedicated to faster cycling. E-bikes are a convenient opition for senior citizens, supporting them to cycle further distances than with ordinary bikes. E-bikes can easily be added upon existing bike sharing fleets.

Micro cars are autonomous shuttles designed for a single person that can be used to take people from the transportation hub to their doorstep. Those vehicles are particularely useful in case of accidents/injuries or inclement weather conditions.

4.2 Short distance commutes

For short and medium distance commutes, there are multiple suitable modes of transport. One option is the above mentioned micro car that can be used for city breaks.

Electric cars can also be used for those types of trips, but they have to be designed for the shared economy and incorporated into the system. Nowadays, electric car sharing is already evolving nowadays and has to be integrated with other modes of transportation to create a seamless mobility experience.

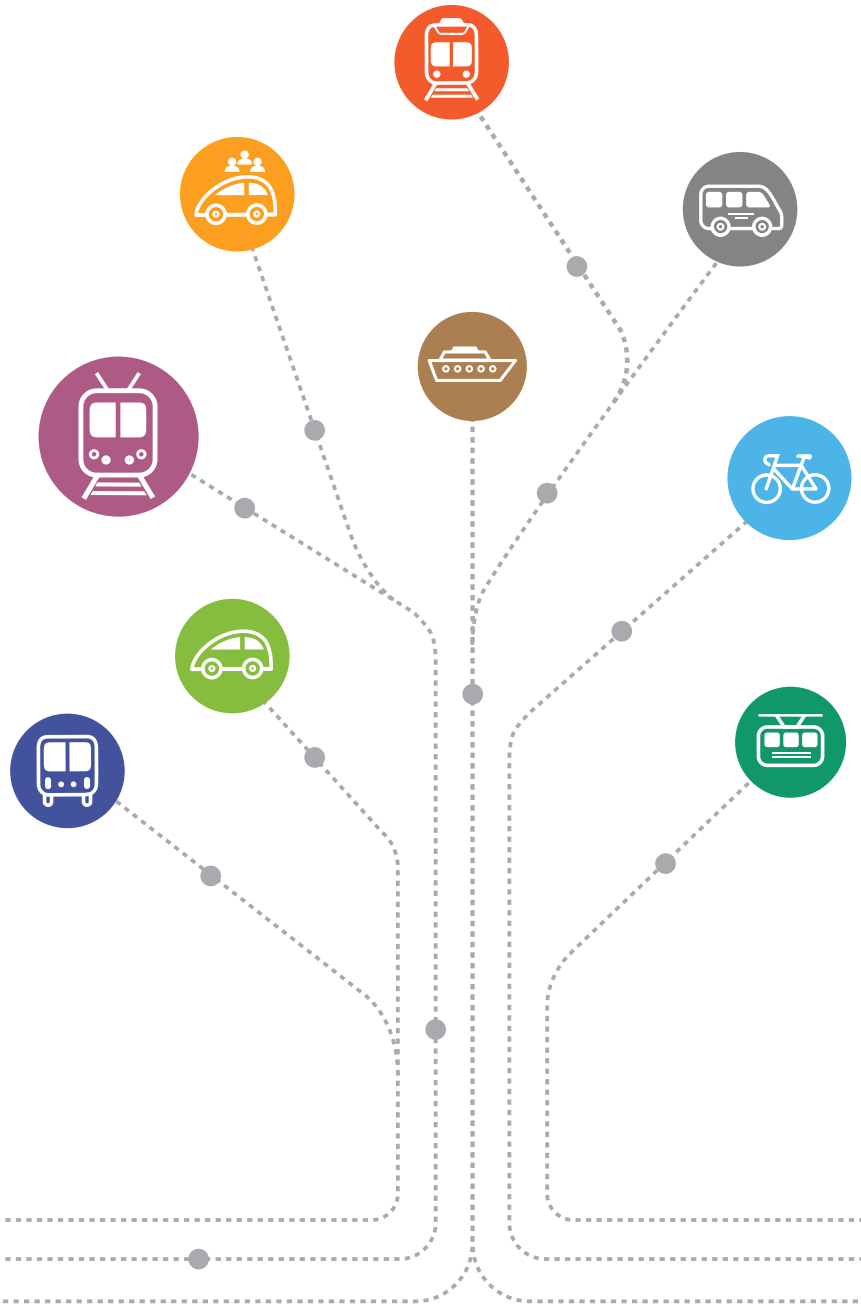
On-demand mini buses are a highly promising solution to narrow the gap between individual and mass transportation. These self-driving vehicles are powered with an electric drivetrain to increase sustainability. On-demand mini buses can operate based on predicted user demand, adjusting routes according to the user locations, and using the optimal route to pick up and drop off users. People would be grouped in shuttles depending on their pick up location and final destination. Additionally, they could also have a schedule and nearly fixed routes, depending on the spatial structure of each city as well as population density. The average speed of on-demand mini buses would most likely not exceed 40km/h and it would primarily serve routes of between 2 and 15 km.

4.3 Mass transit

The aforementioned smaller, specific purpose vehicles, will be joined by mass transportation that will serve mobility needs of a large number of cummuters on busy main routes. Mass transportation will be well connected to other means of transport, with possibilities to easily change transportation mode at transport hubs.

E-buses are a promising mobility offer for the future. They give users a chance to travel across the city in an environmentally friendly way, Moreover, e-buses help increase energy efficiency, lower pollution and improve the quality of life in urban areas through less traffic noise. Larger buses will become an essential part of the mobility system, proving a way to transport large numbers of people – for example from suburbs to the city center.

Other options for sustainable mass transit include trains, subways and ropeways. Their use and added value depends on specific infrastructural circumstances of every city. Generally speaking, Mass transit should have some express routes across the city and connect them with suburbs, as well the busiest city routes. Mass transit system will benefit from Predictive Analytics, creating a more efficient offer and increasing the efficiency of asset utilization.



Conclusion

One of the most important challenges for the new mobility system is to complete a successful transformation from a vehicle-centric to a user-centered system. To achieve effient and sustainable usage of multiple modes of transport while sharing mobility assets, the system has to be perfectly aligned with users' requirements. People will be more inclined to choose this system over private vehicles when a single point of access via a mobile app is well connected to a platform that combines all available modes of transport.

Predictive analytics solutions add more value to the system by increasing asset utilization and anticipating user demand. The more users a system has, the more collective benefits will emerge. When all citizens use the same holistic mobility service platform, collective benefits reach their peak and enable further optimization of the service offering. There will no long be a division into public and private transportation. Instead, we will have one seamlessly connected transportation system with automated trip planning and real-time adaptions and information. The limited amount of mobility options from today will be expended, creating new opportunities for urban mobility. The whole system will be based on shared, on-demand mobility, supported by new autonomous vehicles, infrastructure and predictive analytics. This mobility ecosystem will make urban transit more **cost-effective, faster, safer and more sustainable.**

Vision

A glance into the future of mobility

The current mobility ecosystem is mainly built upon the requirements of vehicles towards the system and infrastructure. This vehicle centric system has established a hierarchy of transportation in which infrastructure is mostly dedicated to cars. And even though people should be at the center of the system with infrastructure centered on their needs, pedestrians and cyclists face a lot of restrictions in their freedom of movement. With the new mobility ecosystem, this hierarchy will be reassembled to put a clear focus on people. The system should follow a "digital first" approach, which implies the rearrangement of the business model and the value proposition. In this course of restructuring, the user is put in the center and becomes the focus of attention. A satisfactory mobility experience is majorly supported by Predictive Analytics, and in most cases there is no need for user interaction. The system will shift away from an asset based to a service based approach, providing people with shared, on-demand mobility that is a lot more convenient than the now predominant vehicle ownership. With a high degree of connectivity and integrated modes of transportation, multimodal trip planning will become a lot more convenient, making multimodal commutes a reasonable option. In stark contrast, today's multimodal trip planning requires significant amount of time and effort. All modes of transportation within the new mobility system will be holistically integrated and operated, drastically increasing efficiency and vehicle utilization. Furthermore, the application of digitalization to service-based concepts will enable crowdsourcing synergies can be generated and their value can be maximized throughout the whole mobility system. In comparison to today's mobility usage, the share of mass transit will rise, as well as the amount of trips served by mini buses. There will be a more diverse offering for the first and last mile, while car usage will shrink significantly. To enable those changes and effects, the mobility business model will have to be transformed, shifting away from ownership towards shared asset utilization. This will free up a lot of areas that are now used for parking places and roads, and can be converted to green areas and leisure zones for citizens. On top of that, vehicles will be powered by electrical powertrains, making pollution plummet and increasing the quality of life in urban areas.

All modes of transportation within the new mobility system will be holistically integrated and operated, drastically increasing efficiency and vehicle utilization. Furthermore, the application of digitalization to service-based concepts will enable crowdsourcing synergies can be generated and their value can be maximized throughout the whole mobility system. In comparison to today's mobility usage, the share of mass transit will rise, as well as the amount of trips served by mini buses. There will be a more diverse offering for the first and last mile, while car usage will shrink significantly. To enable those changes and effects, the mobility business model will have to be transformed, shifting away from ownership towards shared asset utilization. This will free up a lot of areas that are now used for parking places and roads, and can be converted to green areas and leisure zones for citizens. On top of that, vehicles will be powered by electrical powertrains, making pollution plummet and increasing the quality of life in urban areas.

VOYEGO
Penthouse, Blackthorn Exchange, Bracken Road,
Sandyford Industrial Estate, Dublin 18, D18 P3Y9

www.voyego.com

VOYEGO
A COMTRADE COMPANY