CUBIC™ | Transportation Systems

Mobility as a Service
Putting Transit Front and Center of the Conversation

INTRODUCTION

Over the last ten years, several converging market forces, social trends and advancements in technology have started to reshape the way we understand transportation, the way we want to experience it and the way we expect it to be delivered. Once a realm dominated by private vehicles juxtaposed with public transit, today transportation is a much more complex and multilayered topic, facing new, formidable challenges but also standing on the brink of vast new opportunities.

It is up to us and the generations that follow to reimagine the future of transportation. We already have the tools at our disposal – we now need an open and honest discussion about the underlying role of transportation in our society so that we can determine what the future of mobility must look like, who it needs to serve and how, as an industry, we can make our vision a reality.

We are not far from a world in which transportation is more sustainable and people-centered than it is today, a world in which it significantly enhances the user experience and even supports economic growth, all while realizing key policy objectives, such as eco-friendliness and accessibility for all, including low-income and underserved communities.

The transformation process has already begun. Our desire for a transit service that can realize those aspirations and at the same time keep up with our busy, fast-paced lives is what gave birth to the concept of "Mobility as a Service" or "MaaS." To date, the term "MaaS" has been used quite liberally to describe a general vision of future mobility – better, faster, more connected and personal transportation. Companies from across the world have already taken the first steps toward making that vision a reality.

So far, the transit industry has stayed on the back foot, to the detriment of the public transit system and its riders. A common definition of MaaS has yet to be agreed on, and a standardized narrative around it still needs to be established. Without it, any serious discussions about MaaS and its potential implementation are difficult.

Understanding what MaaS truly stands for is incredibly important for the future of our cities and communities. It is already a subject of great debate across the transportation spectrum. The conversations about MaaS are happening everywhere – in the government chambers, during industry events, in start-ups' product planning sessions, and even among the travelers. It is time for the transit industry to give MaaS another look and start playing a key role in driving it forward.

With this in mind, in this white paper I will aim to:

- Demystify what MaaS is and identify its key stakeholders

- Make the case for why public transit must be the backbone of MaaS

- Explain why the transit industry needs to be a key contributor to the MaaS conversation, and ultimately, its implementation

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In April 2011 Matt created and led the launch of the company's NextCity strategy. In 2016, he was recognized as a Top 10 Disruptor by the Eno Foundation and was named to Mass Transit magazine's "Top 40 Under 40" list. In 2017 he was named among San Diego's Top 500 most influential business leaders by the San Diego Business Journal.

Since its initial creation, NextCity is Cubic's MaaS strategy, envisioning One Account that integrates all forms of mobility and enables predictive and personalized individual journey management together with overall network management and optimization applications and analytics.

Cubic is the leading integrator of payment and information solutions and related services for intelligent travel applications in the transportation industry. We deliver integrated systems for transportation and traffic management, providing tools for travelers to choose the smartest and easiest way to travel and pay for their journeys, while enabling transportation authorities and agencies to manage demand across the entire transportation network – all in real-time.

EXECUTIVE SUMMARY

The concept of "Mobility as a Service" or "MaaS" is central to the idea of change in transportation. Generally understood as a vision of future mobility where travel happens through a combination of public, private and shared transportation modes, it remains an ambiguous term, originated from the private sector and often misunderstood, which complicates discussions about MaaS and its implementation.

This white paper aims to demystify MaaS, its key stakeholders and primary objectives. In doing so, it hopes to encourage a wider discussion about the role that transit agencies – the backbone of mobility – must play in driving MaaS forward and the unique density that only the transit mode brings. Current discourse around MaaS, predominantly dominated by commercial mobility service providers, propagates a vision of MaaS that does not adequately address the wider objectives of a city or a region; these are core values and objectives that have always been part of transit's equity mission. If MaaS is to truly make a difference and make transportation better, faster, more connected and more personal, we must think carefully about the role that transportation plays in our society and all of the people it serves. This paper proposes an alternative definition of MaaS, one that reflects on the true nature of the concept and one that places public transit at the heart of future MaaS efforts.

It also discusses profound trends taking place on the urban, technological and social layers that make MaaS applicable to today's transportation landscape and drive the discussion about the need for MaaS solutions forward, particularly as we address the current state of our infrastructure, its capacity and funding. On the backdrop of profound shifts taking place in each of the

MAAS CAN BE A GREAT POSITIVE FORCE FOR GENERATIONS TO COME – BUT TRANSIT AGENCIES MUST START PLAYING AN ACTIVE ROLE IN HELPING IT TRANSFORM OUR TRANSIT NETWORKS AND CITY SPACES NOW, RATHER THAN LET THE MAAS REVOLUTION UNFOLD INEFFICIENTLY BEFORE THEIR EYES.

three layers, MaaS can become the remedy to the issues that plague our cities, the answer to the challenges brought about by the technological revolution of the 21st century and the context for the new trends in consumption – but only if it is properly implemented, responsibly managed and well executed. Such an approach to MaaS presents the transit industry with a unique opportunity to bring value where it can't be found today, offering benefits to consumers, communities and cities, as well as to the transit agencies themselves, and in doing so makes the important point that people don't choose to ride the train or the bus, they make journeys.

The paper goes on to define the top ten objectives of a responsible, people-centered and socially inclusive MaaS, pointing to a key role that public transit agencies must play in realizing those objectives. It argues that public transit operators are best suited to lead MaaS implementation, given the level of integration and multimodality already achieved by many agencies around the

world, as well as their responsibility to provide transportation services that cater to all travelers, young and old, able and less able, the wealthy and the economically disadvantaged. It also touches upon the various complex challenges that MaaS players will need to overcome, which include improving integration, encouraging responsible, secure data sharing, solving issues related to the ownership of the customer, and, most importantly, finding a common language in what's likely to be a difficult task of agreeing on the right economic and pricing model for MaaS.

It proposes a vision for effective MaaS where major corridors are dominated by large transit vehicles such as commuter rail or bus rapid transit, while mobility in urban areas is supplied by the subway system or light rail and buses – whether those are autonomous or not – and in the case of buses, fixed route or on demand. It suggests that future cities will aggregate density of directional travel, keep a healthy balance of shared vehicles on roads, as well as encourage more active forms of transportation, such as walking and cycling, and in that way lessen the overall impact of transportation on the environment.

Further, it proposes that in suburban and regional areas we will still see the use of cars, both owned and shared, but these vehicles will progressively change shape, form and function as they become less driver operated. They will be used to take individuals or small groups from their homes to the transit corridor (or vice versa), where they can transfer onto higher density services. Such a transportation design will not be dependent on the silver bullet of autonomous vehicles, yet it will be enhanced when autonomous vehicles become truly available.

Regardless of how many of the market-structuring and other issues related to MaaS are resolved, this paper argues that no MaaS effort can be fully successful without a solid technological base to enable it. That base must be made up of three key platforms: a single account for all travel needs, an integrated, real-time journey-planning platform, and a centralized congestion management platform.

The paper concludes by discussing the role that local authorities and governments should play in the overall MaaS picture, explaining what responsibilities should remain in the hands of authorities and which can and should be outsourced to third parties. As governments and city authorities move from regulating transport as a sector to regulating transport as a service, they will need to think carefully about the role they can play in the MaaS discussions, recognizing the balance of priorities in the new transportation mix and acting as facilitators of partnerships, enablers of innovation and guardians of cities' and people's interests. MaaS can be a great positive force for generations to come – but transit agencies must start playing an active role in helping it transform our transit networks and city spaces now, rather than let the MaaS revolution unfold inefficiently before their eyes.

DEFINING MAAS

The concept of Mobility as a Service has permanently entered the public consciousness. More often than not, it has been used in relation to travel that happens through a combination of public, private and shared transportation modes. A closer look at the discussion surrounding MaaS reveals, however, that the term has come to mean several different things, and that where you stand on MaaS depends largely on where you sit.

THE LACK OF A COMMONLY AGREED DEFINITION FOR MAAS EXEMPLIFIES THE WIDER MISUNDERSTANDING OF THE CONCEPT ITSELF, ITS KEY OBJECTIVES AND ITS STAKEHOLDERS. THIS HINDERS SERIOUS CONVERSATIONS ABOUT THE FUTURE OF TRANSPORTATION AND PUBLIC TRANSIT, AND STIFLES PROGRESS IN EFFECTIVELY DRIVING MAAS FORWARD.

For some in the transit industry, MaaS represents a vision of the world that has retired private car ownership for the benefit of shared travel services, in that sense signifying "the next phase in the natural progression of motor vehicles."[1] The MaaS Alliance, a public-private partnership created by the European Union and aimed at laying the foundations for a common approach to MaaS, presents perhaps the most comprehensive definition of the term to date, including the implications of MaaS for vehicle ownership. It describes MaaS as "the integration of various forms of transport … into a single mobility service accessible on demand," which provides "an alternative to the use of the private car that may be as convenient, more sustainable, help to reduce congestion and constraints in transport capacity, and can be even cheaper."[2]

An alternative view of MaaS takes into consideration the broader context of the application economy. Here, MaaS represents the Netflix of transportation – a subscription service that allows customers to choose from a number of different transportation options and pay for them via a monthly or yearly subscription or as pay-as-you-go. With a focus on convenience and consumer choice, this understanding of MaaS "claims to offer a personal mobility package based on lifestyle needs and delivered through an IT model."[3] Others yet choose to define MaaS through the prism of its core functionality, describing it as a transportation service – either a journey planner or an integrated travel information platform. That is the view of the consulting firm Deloitte, which offers the following definition: "At its core, MaaS relies on a digital platform that integrates end-to-end trip planning, booking, electronic ticketing, and payment services across all modes of transportation, public or private."[4] In a similar spirit, KPMG defines MaaS as a paradigm where "every public and private transport option is presented in a single app, handling payment and bookings through the same platform and providing dynamic route-planning information to users."[5] Finally, many in the transit industry define Mobility as a Service simply in terms of the few MaaS applications that are in operation today, such as Whim, and to a lesser extent, CityMapper, Waze, TripGo or Moovit.

All of those definitions capture some of the many aspects of MaaS: its ability to decrease people's dependence on private vehicles, the ease of use and the choice it offers to users, as well as its many useful features, which make our daily commutes less of a hassle. None of them are entirely correct in characterizing its core mission. They do, however, have one more thing in common: They tend to omit the role of public transit

[1]   AutoTalk, MaaS confusion as everything changes: http://autotalk.co.nz/columns/maas-confusion

[2]   MaaS Alliance, What is MaaS: https://maas-alliance.eu/homepage/what-is-maas/

[3]   POLIS, Mobility as a Service: Implications for Urban and Regional Transport: https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/polis-maas-discussion-paper-2017---final_.pdf

[4]   Deloitte, The Rise of Mobility as a Service: https://www2.deloitte.com/insights/us/en/deloitte-review/issue-20/smart-transportation-technology-mobility-as-a-service.html

[5]   KPMG, Reimagine Places: Mobility as a Service: https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2017/08/reimagine_places_maas.pdf

agencies in the MaaS revolution. Few definitions of MaaS today mention the wider public transit sector. Even fewer touch upon the part that local and central government bodies might play in bringing MaaS to local communities. Although public transit is listed as one of the many types of transportation services available to users through MaaS, no further thought is given to issues such as ownership of the customer, governance and regulation, or social good. That is perhaps unsurprising given that in many regions, particularly in the United States, the conversation around MaaS has been dominated by the private sector. Private hire, car pool and ride-sharing companies have been very vocal in promoting a certain vision of MaaS – as technologically advanced with exciting multi-modal options, yet nevertheless demand-responsive and driven by commercial interests.

In other parts of the world, digital disruptors, including app providers, have led the discussion with some success. The most notable of those, MaaS Global, the world's first "commercial MaaS operator," made international headlines in 2016 when its app, Whim, transformed the way mobility services are delivered in the Finnish capital, Helsinki. It is important to note, however, that the success of MaaS Global was supported by the passing of new transportation laws which set out essential business and tax rules for MaaS providers. Notably, this happened in the only country in the world that regulates an open market for mobility services.[6]

Since the role of public transit operators has been largely absent from the MaaS discussion, for many transit executives MaaS remains a foreign concept that originated from the private sector, far removed from the public agencies' responsibility to provide sustainable, accessible and affordable

transit for all, and, in most extreme cases, one that could potentially hurt public transit ridership. The lack of a commonly agreed definition for MaaS exemplifies the wider misunderstanding of the concept itself, its key objectives and its stakeholders. This hinders serious conversations about the future of transportation and public transit, and stifles progress in effectively driving MaaS forward.

CUBIC'S DEFINITION

In order to adequately define MaaS, we must consider some important questions: What are the key drivers behind MaaS? What challenges does it need to face? Who are its key stakeholders? What benefits can it bring to consumers, cities and communities? And what objectives should it achieve to really make a difference? The answers, which I hope to provide in the subsequent pages, have helped us reflect on the nature of MaaS and arrive at a new definition of MaaS, one which we hope encapsulates its core mission:

"Mobility as a Service is a combination of public and private transportation services within a given regional environment that provides holistic, optimal and people-centered travel options, to enable end-to-end journeys paid for by the user as a single charge, and which aims to achieve key public equity objectives."

KEY MAAS DRIVERS

To properly understand MaaS, we must look at what makes it applicable to today's transportation landscape. There are numerous complex drivers that can be observed around the world which make the conversation about MaaS highly relevant. Those drivers can be classified into three major "layers" – of urban, technological, and social trends that influence the way we

manage our cities, use our technology, and define who we are as consumers. Although the shifts taking place in each of the three layers occur independently of each other, what happens in one of them might influence and intensify transformations in the other. All of them raise important questions about the role that MaaS might play in helping alleviate some of the problems faced by modern urban spaces.

The Urban Layer

Some of the most striking changes that set the scene for the MaaS revolution are happening to our cities. Rapid urbanization is a fact – more people are living in cities and their surrounding areas today than ever before. In fact, every week, three million more people move to cities around the world. By 2050, the urban community is expected to grow by 2.5 billion, which means that city dwellers will account for 66 percent of the world's population.[7]

This rapid growth of the world's urban spaces has significant implications for city life. Congestion, particularly at peak travel times, has reached an all-time high. The statistics speak for themselves: In the U.S., bumper-to-bumper traffic costs the economy $72 billion each year in lost time and wasted fuel.[8] In Los Angeles, one of

[6]   Intelligent Transport, Making MaaS work: overcoming the issues of governance: https://www.intelligenttransport.com/transport-articles/65230/improving-mobility-service-maas/

[7]   https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf

[8]   http://abcnews.go.com/US/story?id=94064&page=1

"MOBILITY AS A SERVICE IS A COMBINATION OF PUBLIC AND PRIVATE TRANSPORTATION SERVICES WITHIN A GIVEN REGIONAL ENVIRONMENT THAT PROVIDES HOLISTIC, OPTIMAL AND PEOPLE-CENTERED TRAVEL OPTIONS, TO ENABLE END-TO-END JOURNEYS PAID FOR BY THE USER AS A SINGLE CHARGE, AND WHICH AIMS TO ACHIEVE KEY PUBLIC EQUITY OBJECTIVES."

North America's most congested cities, drivers end up spending 102 hours a year stuck in traffic jams.[9]

The growing demand for mobility puts a huge strain on the existing transportation infrastructure. At peak times it often outstrips capacity, whereas at other times of the day there is excess capacity. While there is some evidence that working patterns can be flexed, we are far from adequately shifting peak travel demand. New roads or rail lines are simply not built quickly enough; meanwhile the resources run dry. In many countries, including the United States and Canada, road infrastructure is financed by tax duties collected on gasoline. Yet, years of no tax increases, advancements in fuel efficiency, and the growing popularity of electric vehicles have limited traditional ways of financing road infrastructure. When adjusted for inflation,

the cost per mile driven is less today than it was in the 1980s. As more cars go farther on less gas, governments and local authorities are searching for a funding mechanism that could not only continue to support the overall quality and safety of road services but also finance new, much needed roadway infrastructure projects. Currently considered solutions include raising the existing fuel tax, charging a flat fee for the use of electric vehicles, and introducing some sort of a mileage-based charge. Needless to say, none of those are popular with the general public.

However, even with a new funding mechanism in place, simply building more roads might not provide the answers we hope for. Studies have shown that when new roads are built, their impact on reducing traffic is questionable. Building new roads only temporarily reduces travel times, until it starts to create more demand – a phenomenon called "Braess's paradox." New roads encourage developments that rely on people having cars, and with more cars, the extra road capacity is filled up, creating more traffic. The evidence of economic benefit of new roads is also weak and research shows that economic gains are slower than expected or fail to materialize. Some economists even claim that building new roads may drive business away from city centers.

Simply increasing capacity on public transit is also not a straightforward solution and definitely not one that can be applied immediately – in most regions, building a new metro line might take decades. Even China, which seems to be adding new lines at breakneck speeds (1,500 miles of service lines have been built there since 2008[10]), still struggles with capacity issues at peak times. Furthermore, building new service lines takes considerable capital and in recent years

more public service agencies have faced shrinking allowances than budget increases. Today, several service lines, including evening and weekend bus routes in many American cities, are at risk of being cut due to the shortage of funds.

The continuous rise of urban populations is also bad news for the climate. Worsening air quality, particularly in larger cities, leads to a lowered standard of living and can cause serious health problems. According to the World Health Organization, outdoor air pollution kills 2 million people every year and motor traffic is one of the main culprits.[11] In the United States, it accounts for 29 percent of all greenhouse gas emissions, contributing to the poor quality of air in city centers and areas near roadways.[12] The newest research points out that apart from health problems traditionally associated with air pollution, such as asthma and other respiratory issues, bad air quality can also increase the risk of diabetes and even obesity.[13]

It is increasingly clear that our cities face multiple challenges. Half a century of worsening air quality, growing traffic and congestion, and deteriorating city infrastructure has undermined the urban spirit and led to a lower quality of life in city cores. If health prospects in cities are to improve, we will need to look for new energy sources, consider more fuel efficient transportation, review regulation and effect a change in people's behavior. MaaS, if well-planned and properly implemented, can be the remedy for many of those issues.

The Technology Layer
While several trends in the urban layer drive the conversation about the need for MaaS solutions forward, equally important shifts happening in the technology layer are changing our expectations about transportation service delivery in general.

9   https://www.forbes.com/sites/niallmccarthy/2018/02/08/the-cities-where-u-s-drivers-spend-the-most-time-stuck-in-traffic-infographic/#56c31b9a16d8
10   Arch Daily, The Breakneck Revolution of Chinese Metro Systems: https://www.archdaily.com/871713/the-breakneck-evolution-of-chinese-metro-systems
11   Smart Cities Dive, WHO: Air Pollution Kills More Than 2 Million People Each Year: https://www.smartcitiesdive.com/ex/sustainablecitiescollective/who-air-pollution-kills-more-2-million-people-each-year/29986/
12   Federal Transit Administration, Transit's Role in Environmental Sustainability: https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/transit-environmental-sustainability/transit-role
13   Berkeley Wellness, Is Air Pollution Getting Worse or Better?: http://www.berkeleywellness.com/healthy-community/environmental-health/article/air-pollution-getting-worse-or-better

Mobile, Big Data and the Internet of Things (IoT) have each transformed the way services are consumed today in a unique way. Across several industries, including retail, healthcare and mass media, increasingly tech-savvy users are learning to make the most of the new technologies, enjoying real-time information and personalized capabilities at the press of a button. The transportation industry is no exception. Used to the immediacy of services driven by the technological revolution, consumers expect nothing less, if not more, from their transportation service providers – and for good reasons.

Nowadays, connectivity is almost ubiquitous. In the United States, smartphone adoption surpassed 80 percent in 2016. Statistics show that 98 percent of people aged between 18 and 24 own a smartphone, as well as almost 70 percent of those aged 65 and older.[14] With a growing pipeline of innovations in connectivity, soon enough everyone will be plugged in and able to take full advantage of tomorrow's digital economy. The number of connected devices is also growing. The IoT revolution is steadily picking up speed, with analysts predicting 34 billion IoT devices by 2020. In 2017, nearly 60 percent of all IoT devices installed in cities were used in smart commercial buildings and in transportation.[15]

All this connectivity creates enormous amounts of data – ready to be harnessed, analyzed and applied to improve operations, efficiency and quality of life in cities, as well as drive further innovation. In 2017 alone, humanity generated more data than in the previous 5,000 years of our existence.[16] Even more will be created this year. Recognizing the value that data can bring to organizations, leaders in every sector,

including transportation, are increasingly turning to analytics to help them make the most of data insights. Machine learning and artificial intelligence (AI) are quickly becoming commonplace. Meanwhile, consumers expect greater data responsibility from corporations, and data security and governance issues are brought to the forefront.

The more people (and devices) are connected to the Internet, the faster the pace of innovation for transportation solutions. On the most basic level, advancements in connectivity mean that transportation operators can outfit vehicles with on-board Wi-Fi or other sensors to enable Internet connectivity during travel in order to enhance the user experience. On a more complex level, connectivity enables transit agencies to invest in vehicle-to-infrastructure (V2I) technology that helps vehicles and their drivers make better sense of their surroundings, analyze traffic and weather information, and make subsequent adjustments to the service, increasing its efficiency. Vehicle-to-vehicle (V2V) communication systems are also growing in popularity, helping reduce traffic accidents, improve overall safety on roads, and facilitate the sharing of real-time location data for the convenience of passengers. On the ultimate level, connectivity empowers the development of connected and autonomous vehicles (CVs and AVs). Numerous models of connected cars equipped with state-of-the-art technology have already been released by leading car manufacturers and technology companies, such as Ford, GM, and BMW, while more sophisticated cars with automated functions are released on the market every year. It is predicted that some 98 percent of vehicles will be connected to the Internet by 2020. By that time, they

will share the road with nearly 10 million autonomous cars.

The highly anticipated "driverless revolution" is already happening on the streets of Pittsburgh, Pennsylvania; Cambridge, United Kingdom; and Tokyo, Japan, where self-driving cars are being tested in pilot programs. The Boston Consulting Group estimates that by 2025, the driverless car market will be worth $42 billion.[17] Many expect self-driving cars will be the answer to the transportation industry's multiple problems. Car manufacturers hope mainly electric AVs will be better for the environment. City planners anticipate that driverless cars will transform urban spaces by eliminating the need for parking in city centers. Others expect that self-driving cars will help address the issues of congestion, decrease traffic and improve mobility options for entire generations. Self-driving cars are meant to make our streets safer, while platoons of self-driving trucks are supposed to cut down carbon dioxide emissions and improve efficiency. Whether or not those ambitions will be realized remains to be seen and should be debated now. Certainly, fleets of autonomous vehicles may help address some of the problems faced by modern urban spaces, but only when they form part

[14] Nielsen, Millennials are Top Smartphone Users: http://www.nielsen.com/us/en/insights/news/2016/millennials-are-top-smartphone-users.html

[15] Metro, The Benefits and Challenges of IoT in Public Transportation: http://www.metro-magazine.com/blogpost/722152/the-benefits-and-challenges-of-iot-in-public-transportation

[16] App Developer Magazine, More data will be created in 2017 than the previous 5,000 years of humanity: https://appdevelopermagazine.com/4773/2016/12/23/more-data-will-be-created-in-2017-than-the-previous-5,000-years-of-humanity-/

[17] Bloomberg, Driverless-Car Global Market Seen Reaching $42 Billion by 2025: https://www.bloomberg.com/news/articles/2015-01-08/driverless-car-global-market-seen-reaching-42-billion-by-2025

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of a bigger picture. MaaS might provide just the right context for the autonomous vehicles to thrive.

But smart cars will not be the only vehicles that hope to dominate the streets in years to come. The rapid acceleration of e-commerce and m-commerce has fueled the rise of online shopping and new business models, giving birth to an entire army of vehicles, delivering people and goods in high-frequency, low-density trips. E-commerce sales have nearly doubled in the past five years to $450 billion, accounting for 8.4 percent of all retail sales. According to transportation analysts, they will reach 17 percent within five years.[18] Because e-commerce is likely to support longer transportation distances and shorter delivery cycles, focusing shipments more on individual items, it increases demand for road space and parking, contributing to traffic, congestion and for now, also pollution. Uber alone offers a number of different services depending on location: UberRush, UberEats – even the somewhat controversial UberKittens. In the U.K., the company is already eyeing the country's £7.1 billion courier market. In Europe, bike-delivery services are booming, particularly in the fast food delivery market, where a number

of popular services, including Deliveroo, JustEat and Delivery Hero, are competing for customers. They won't disappear anytime soon; McKinsey estimates that the largest five companies in the sector globally have a combined valuation of more than €10 billion.

On top of encouraging on-demand services, e-commerce pushes transportation toward more precise pick-up and delivery times. Amazon is a pioneer here, with the Amazon Prime Now service promising delivery within the hour. In 2016, this retail giant accounted for 43 percent of all online purchases in the United States.[19] Rumor has it that the company is considering building its own fleet of autonomous pods, focused solely on delivering packages and groceries more quickly and efficiently. Traditional delivery trucks might soon be jostling for road space with fleets of autonomous vehicles, realizing high-frequency, short-term road occupancy and on-demand deliveries.

This, of course, is bad news for our cities, pushing city authorities and local governments to look for innovative solutions that can deal with the challenges brought about by the technological revolution of the 21st century. MaaS must form part of their considerations.

The Social Layer
Both the urban and technology layers are forcing city authorities, technologists and transit operators to rethink how future transportation services might need to be delivered. Meanwhile, the social layer is redefining consumption itself.

Many have tried to name the recent socio- economic shift that has reinvented how and what we consume. Some called it the "sharing" economy, the "gig"

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economy or the "application" economy. Others named it the "access" economy or the "on-demand" economy. All these terms boil down to one simple truth: We now live in a world where consumer demand, rather than any other driver, determines the delivery of services; where usage trumps possession; access rather than ownership is king, and where consumers' immediate needs can be satisfied with the tap of an app. This new economy currently attracts more than 22.4 million consumers annually and transportation is its second biggest category. Thanks to companies like Lyft and Uber, it claims more than 7.3 million monthly consumers and $5.6 billion in annual spending.[20]

At the heart of this new economy sits a markedly different way of matching supply and demand and a deep understanding of a trend called "collaborative consumption." In simple terms, collaborative consumption uses the power of the Internet to reinvent traditional market behaviors, such as buying,

[18] TalkBusiness, E-commerce pushes transportation industry toward same-day delivery, unheard of 10 years ago: https://talkbusiness.net/2018/01/e-commerce-pushes-transportation-industry-toward-same-day-delivery-unheard-of-10-years-ago/

[19] Texas A&M Transportation Institute, How Will E-commerce Growth Impact Our Transportation Network?: https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-17-79-F.pdf

[20] Harvard Business Review, The On-Demand Economy Is Growing, and Not Just for the Young and Wealthy: https://hbr.org/2016/04/the-on-demand-economy-is-growing-and-not-just-for-the-young-and-wealthy

renting and lending, through the use of technology. It does not simply redefine the way we consume; it encapsulates the very change in human nature – from the culture of "me" to the culture of "we." According to Rachel Botsman, trust researcher and author of "What's Mine Is Yours," human beings are naturally "wired" to share, so perhaps it is not a surprise that we like using social lending platforms, posting photos to social media sites such as Facebook and Instagram, or sharing a ride through UberPool.

All of these shifts are encouraging the growth of personalized, flexible, and sometimes informal mobility services. From obvious examples such as Uber to smaller, "micro transit" providers, the idea of on-demand transit has captivated transportation for good.

Today Uber operates in 83 countries and 674 cities across the world,[21] while micro transit services, such as New York's dollar vans, are popping up across America almost daily. For many the arrival of on-demand transit services has made life easier, and has also made transit more accessible and flexible. Bike shares, another alternative type of transportation, are also growing in popularity. As of 2016, there were 55 bike-sharing

systems in the United States; Americans used them to take almost 28 million trips – on par with the annual ridership of the entire Amtrak system, according to the National Association of City Transportation Officials.[22] Many city authorities in the United States are planning to introduce bike-sharing schemes in the near future, and some, like Los Angeles with the TAP system, have already made bike-sharing schemes part of the official public transportation network.

People from across the social spectrum use those shared modes of transportation, but there is compelling evidence which suggests that certain generations, such as Millennials and Generation Z, are particularly prone to making the most of shared mobility. In the last ten years, the number of people under 35 with a driver's license has decreased by six percent. According to *The Economist*, car sharing will reduce car ownership at an estimated rate of one shared vehicle replacing 15 owned vehicles.

While some demographics shun car ownership, others desperately rely on it. More than half of people aged 65 and older live in suburban settings, and just under a quarter in rural areas, both of which are characterized by limited or no transit options. Yet, as much as 26 percent of seniors don't have a car and many avoid driving altogether due to disabilities or other physical limitations that decrease their driving ability. Transit agencies try to cater to their needs by offering paratransit services and operating dedicated paratransit lines; however, these can be incredibly costly. In 2011, a typical one-way trip on a paratransit service cost $34.59. Sarasota, Florida spends 32.4 percent of its operating budget on paratransit, which is used by fewer than six percent of its riders. In Philadelphia, eligible paratransit riders over the age of 65 take, on

average, a single one-way trip every month.[23] By 2030 one out of five people in the U.S. will be 65 or older. As America's baby boomers age and isolation becomes an increasingly pressing problem, transportation providers will have to rethink how mobility services can be delivered to America's seniors.

Today the change in the consumer mindset driven by the on-demand economy is apparent. The transportation industry must recognize it is facing a new generation of users: affluent, tech-savvy, environmentally conscious and used to the immediacy of services. These are consumers who like to make informed decisions, and expect quick action, convenience and choice. For those of us who fall into that category, the vision of MaaS propagated by the private sector is indeed an attractive offer. On the other hand, we must not forget that effective future transportation should serve all, rather than leave behind those who might not be digitally savvy, the elderly and the disabled. For them, the demand-driven, technologically complex and profit-motivated mobility services won't bring any answers, again underlining the need for a careful reflection on the nature of future MaaS solutions.

MAAS BENEFITS
Careful evaluation of MaaS in the context of the big trends happening across the urban, technological and social layers presents the transit industry with a unique opportunity to bring value where it can't be found today. Properly understood and well-executed MaaS can benefit consumers, communities and transit agencies alike, and address many of the problems transportation is facing around the world.

Benefits to the Consumer
Put very simply, MaaS gives consumers the freedom to travel the way they desire, but it

[21] Business of Apps, Uber Revenue and Usage Statistics 2017: http://www.businessofapps.com/data/uber-statistics/

[22] National Association of City Transportation Officials, Bike Share in the US: 2010-2016: https://nacto.org/bike-share-statistics-2016/

[23] Urban Institute, Meeting the transportation needs of an aging population: https://www.urban.org/urban-wire/meeting-transportation-needs-aging-population

also changes the way consumers understand transportation. We need to remember that people don't choose to ride the train or the bus, they make journeys. Ultimately, for a regular traveler, the mode of transportation is of secondary importance – what counts is the experience of the journey itself and the ability to quickly and effectively move from point A to point B. Since MaaS is all about removing friction and offering choice in facilitating end-to-end journeys, it can get people to their destination in their preferred way.

Because MaaS encourages travelers to pursue other forms of transportation than the private car, it presents a cost-conscious transportation alternative to what is the most popular form of transportation in the U.S. The average car maintenance cost, including repair, insurance, fuel and taxes, stands at just over $9,000 a year according to the American Automobile Association[24], and is likely to rise. Yet, statistics show that actual average utilization of cars in the U.S. is only five percent, despite the fact that they cost an average household 17 percent of their income. MaaS allows those who so wish to opt out of the costly car ownership paradigm and adopt an on-demand solution that increases their mobility through better access to other transit means, without the overhead or the worry about issues such as car financing, insurance, tax or having to find and pay for parking. By reducing the reliance on the private car MaaS places more emphasis on the journey itself.

Since MaaS is all about options, it also allows those who already own vehicles to use them in a variety of new ways. In an ideal MaaS model, instead of tying up large amounts of money in a car that sits idle for 23 hours a day, consumers would have the option to subscribe to services that give them far greater levels of flexibility in the use of their

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personal vehicle, such as ride sharing or peer-to-peer car lending, at least until the popularity of personal cars starts to decline. According to the Rocky Mountain Institute (RMI), an environmental think tank, car ownership will peak as soon as 2020[25].

On top of that, MaaS puts integration at the heart of transportation. The needs of the individual – in the moment – are at the core of the solution, which means that rather than purchasing transportation means (e.g., tickets) from a number of separate providers, users can buy mobility services from a single source, regardless of the chosen means of travel. Because MaaS allows individual users to combine different journey legs, they can also benefit from the economies of scale of different mobility options catering to different needs (for example, our commute has different characteristics to our needs when doing the weekly grocery shopping) rather than investing in a single preferred mode such as a private vehicle, which they then attempt to use for all their journey needs. Commuters use a single account for all travel transactions and information – be it public transit, cycling or Uber – which gives them

easy access to journey-planning information and guarantees fare transparency. In models where MaaS is used by city authorities to promote more socially and environmentally friendly forms of transportation, it also gives travelers satisfaction in the form of social good while ensuring sustainability and a high standard of living.

Benefits to Cities and Communities
Although MaaS can be extremely convenient for individual consumers, its greatest value lies in the benefits it can bring to cities and communities. Since MaaS integrates a number of different transportation modes, it holds the potential to effectively limit the number of vehicles on the roads and help reduce congestion in cities in a few different ways. We know that MaaS reduces the reliance on private vehicles as a main means of transportation, which in itself can have a positive impact on road space. By encouraging people to travel by shared means of transportation or to enter their vehicles into car-pooling schemes, MaaS limits the number of private car trips and miles driven. For city authorities, this makes predicting traffic flows and reacting to traffic events much easier, and as a result, transit operations and their efficiency increases.

More efficient use of existing resources and capacity in a way that benefits all travelers helps, in turn, to defer investment in new infrastructure, allowing cities to prioritize areas where transportation infrastructure projects would truly make a difference in today's funding-poor reality. In addition, by partnering with different forms of alternative transit, such as micro transit, cities can start addressing the first/last mile problem. Employing services other than public transit to fill in the gaps in service and target niche customer bases enables cities to extend the coverage of transit networks. According

24 American Automobile Association, What Does it Cost to Own and Operate a Car: https://www.aaa.com/autorepair/articles/what-does-it-cost-to-own-and-operate-a-car
25 Rocky Mountain Institute, Peak Car Ownership: https://www.rmi.org/wp-content/uploads/2017/03/Mobility_PeakCarOwnership_Report2017.pdf

to the Public Transportation Partnership for Tomorrow,[26] features such as web-based trip-planning systems, electronic fare systems and multi-trip ticketing, as well as real-time arrival and departure information – all key MaaS capabilities – can also greatly increase the aging population's access to mobility services, indicating that MaaS may be the perfect solution to meet the mobility demands of the aging society.

The arrival of MaaS could also free up valuable real estate in urban areas, since fewer people would use private cars to commute to city centers. At the moment, parking lots are eating up city spaces: An average parking space requires about 300 square feet of asphalt (including alleys between parking rows and lost space to allow cars to move around), which is enough room to hold 10 bicycles.[27] MaaS would enable cities to get rid of those hollow spaces for recreational and economic activity. Cities would also reclaim valuable curbside space, which would not only increase street capacity but would also leave room for the introduction of more environmentally friendly solutions such as bike lanes and wider walkways.

Finally, the integration and aggregation of all transportation-related information from a variety of sources and modes would give cities unprecedented insight into travel patterns. They would be able to observe, analyze and draw conclusions about how travel decisions are made and what influences them. This would not only drive further efficiency of operations but it would also arm cities with the tools needed to encourage greater social responsibility, extending the benefits from the individual to the community as a whole. By having a complete view of one's journey, cities could introduce incentives that encourage socially responsible travel behavior. For instance, for

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>
> **...THERE IS ALSO A GREATER RISK THAT BY LEAVING MAAS TO THE FREE MARKET, PUBLIC TRANSIT PROVIDERS AND, BY CONSEQUENCE, CITY AUTHORITIES AND GOVERNMENTS, WILL HAVE A VERY LIMITED SAY IN SHAPING THE FUTURE TRAVEL BEHAVIORS OF THEIR CITIZENS.**

habitual drivers that can't imagine parting with their vehicles that could mean incentives to pool with other drivers. A full insight into our travel data would also help re-route demand to assist those portions of the transportation network that are struggling the most. With MaaS in place, cities would have the ability to advise when a preferred route is unavailable and offer useful alternatives that would get us to our destinations on time but that would also be the optimum choice for the entire network. Since the very nature of MaaS means that these options would be identified due to better service integration, the quality of route-finding services would greatly improve, enhancing the flow of traffic through major corridors.

Benefits to Transit Agencies

Taking into consideration that the early MaaS adopters come almost exclusively from the private sector, it is well overdue

that we discuss the value that MaaS can bring to public transit operators. Public transit has a lot to gain from MaaS solutions and it is important to take a closer look at those benefits.

One of the most threadbare arguments against the integration of third-party transit services into the wider public mobility offering is the fear that they will cannibalize conventional public transit. Contrary to this common misconception, studies have shown that even in areas where public transit networks are well developed, people still choose to drive or use alternative transportation options (Uber has one of the highest pick-up rates in New York, a city with a well-developed public transit network), but where multi-modal transportation options do exist, the use of public transit increases.

A quick look at the recent literature on this topic seems to confirm this. A number of research papers exploring the future of cities have found that alternative transportation modes in fact complement rather than harm public transit, maintaining and even actively increasing ridership. Since complementary mobility services have the potential to remove the first/last mile barrier and more easily serve routes that typically require a higher level of public transit subsidy (e.g., paratransit), they can "increase the coverage and attractiveness of transit services"[28] and act as agents connecting people living on the outskirts of the city to main transportation corridors. In that sense, the uptake of MaaS can be seen as beneficiary not only to consumers and cities as a whole but also to public transit agencies themselves, driving increases in revenues and helping to redirect funding and investment back to core transit services.

[26] APTA & Public Transportation Partnership for Tomorrow, Mobility for the Aging Population: http://www.apta.com/gap/policyresearch/Documents/seniors.pdf

[27] City Lab, How Parking Spaces Are Eating Our Cities Alive: https://www.citylab.com/transportation/2014/07/how-parking-spaces-are-eating-our-cities-alive/374413/

[28] Journal of Public Transportation, Lies, Damned Lies, AVs, Shared Mobility, and Urban Transit Futures, Vol.21 No.1 [2018] pp.19-30

Similarly, integrating with private transportation operators allows public agencies to augment or change their service offerings to better tailor transportation solutions to the ridership, meaning agencies would no longer be forced to deliver a standard service based only on the availability of infrastructure, e.g., running a double-decker bus on a route with lower density of usage, when an integration with Uber would deliver a more personal service to those lower-density journeys at a fraction of the cost.

Conversely, public transit agencies that don't take notice of the rise of alternative mobility services and don't show interest in investing in a common vision of mobility risk losing relevancy in the fast-moving transportation market. Open competition with private players will most definitely result in a loss of riders, as consumers default to personal vehicles or alternative providers in search of efficiency, quality and convenience. Fierce regulatory battles will follow, as public transit tries to fend off private companies who tend to have deeper pockets and a more aggressive approach to innovation. There is also a greater risk that by leaving MaaS to the free market, public transit providers and, by consequence, city authorities and

governments, will have a very limited say in shaping the future travel behaviors of their citizens. That's a risk that neither transit nor city authorities and governments can take, given their collective responsibility to solve the challenges we face on the urban layer and shape the evolution of our mobility systems in the right way.

Alternative transportation services clearly have the potential to disrupt the existing urban mobility ecosystem. Therefore, it is imperative for public transit agencies to work together with the private sector toward a common MaaS vision, since both parties stand to greatly benefit from such a collaboration and arguably both will ultimately suffer from competition.

MAAS OBJECTIVES

The ultimate function of any well-designed mobility system in a city is to better connect people to opportunities such as jobs, education and more. City Innovate Foundation, an organization that brings the private, public and academic sectors together to innovate and create solutions to urban problems, and Miami-Dade County Department of Transportation and Public Works (DTPW), further define mobility as "the ability to move around town with ease, the ability to access opportunities, and the ability to access quality of life."[29] From the perspective of transportation, future MaaS solutions should serve each and all of those purposes. In order to do that and to deliver many of the benefits to travelers, communities, cities and agencies that have been discussed earlier, all MaaS efforts need to operate within a set of clearly drawn objectives. It is the role of the transit agencies and other key MaaS stakeholders to ask themselves what outcomes they want to achieve through MaaS and what success should look like. Without a set of

common objectives, MaaS efforts will remain fragmented and unable to fulfill their civic function. **With this in mind, I propose ten key objectives, which I believe any future MaaS initiatives should look to achieve:**

1) **Limit congestion, particularly during peak travel periods**

2) **Reduce car ownership, car usage and the number of vehicles on roads**

3) **Use existing infrastructure more effectively and create economies of scale**

4) **Ease pressure on the transportation network**

5) **Enable better traffic and capacity management**

6) **Improve the customer experience by presenting the transportation network as an integrated system**

7) **Cater to all travelers, young and old, able and less-able, the wealthy and the economically disadvantaged**

8) **Create a model that supports the funding of infrastructure**

9) **Lessen the overall environmental impact of transportation**

10) **Work in a driver-controlled and autonomous environment**

TRANSIT AS THE BACKBONE OF MAAS

The easiest and most logical way to fulfill all of the outlined objectives is to place public transit at the heart of the MaaS effort.

In order to **reduce congestion and car usage (objective 1)** as well as **decrease the number of vehicles on public roads (objective 2)**, MaaS must prioritize an increase in density of usage. Limiting reliance on a personal car is a great potential benefit

29   City Innovate, Designing Mobility for the Multimodal, Data-driven Society

of MaaS, with many social gains in terms of public health, productivity and road safety; however, those benefits are lost if alternative mobility services generate greater traffic and new road mileage instead. The best way to create density as a response to a growing demand for mobility is by utilizing the existing public transit networks.

Data shows that even the most popular alternative transportation modes cannot compete with public transit when it comes to increasing density. For instance, in California, the average occupancy of an Uber vehicle in traffic was found to be 1.66, including the driver. This means that an Uber carries on average 0.66 of a passenger per trip, which further means that a third of all Uber vehicles on roads carry no passengers at all at any given time.[30]

Relying on autonomous vehicles to reduce congestion is also a flawed logic. No matter how narrow the lanes or how well-platooned the autonomous vehicles are, a freeway will never be as efficient at moving people as a rail line or bus rapid transit (BRT), since even a fleet of autonomous pods cannot create similar passenger density as a fixed-route bus at full or near capacity. An AV can only carry a finite number of passengers, which for the roomiest SUVs sits at around eight. A typical subway car can carry 100 passengers. Assuming a train has ten cars, that's 1,000 passengers per train. At a frequency of one train arriving every two minutes (in some cities, such as Moscow, Russia, trains can run as frequently as every 95 seconds during peak times) that gives us a capacity of 30,000 passengers per hour. Now, let's imagine the same number of commuters trying to cram into a fleet of autonomous pods, at eight per vehicle, and make their way to Lower Manhattan during the Monday morning rush hour. It would take

3,750 autonomous pods per hour to keep up with that demand, and the New York city subway serves nearly six million passengers a day. As *The Economist* rightly points out, "even after [autonomous vehicles] arrive, mass transit systems will often remain the best way to move large numbers of people swiftly."[31]

Furthermore, in most cities and surrounding regions public transit already has the largest market share of modal mix, and statistics show that it is by far the most used shared mode of travel. Research conducted by the Shared-Use Mobility Center (SUMC) for the American Public Transit Association (APTA) demonstrates that approximately 65 percent of riders identify public bus or train as the single shared mode they use most often when traveling. Twelve percent said the same of car sharing, eleven percent of bike shares and ten percent of ride-sourcing. As the most used shared mode of travel, public transit is well placed to manage the direction and development of MaaS ideas and products, and to serve as a focal point for all mobility endeavors. Through smart partnerships between the public and the private sector and by outsourcing strategic parts of the city's mobility networks to complementary service providers, MaaS will not only be able to **use existing infrastructure more effectively (objective 3)**, but it will also **ease the pressure on transportation networks (objective 4)**, thus **enabling better traffic and capacity management (objective 5)**.

Additionally, many transit agencies are already investing in integrated fare payment, journey planning, and network and operations management technologies – platforms that present the transit network as an integrated system and enable the linking of various accounts into a single

identity for the user. Those solutions are often technologically sophisticated and designed in a way that ensures each agency receives the right amount of revenue, even in scenarios where fare structures are extremely complex. They could easily become the core of future MaaS solutions, not only allowing transit operators to extend the technology to alternative transportation providers but also securing some quick wins for the city, and allowing the agencies to get a return on investment, while **improving the overall customer experience** for citizens **(objective 6)**. Furthermore, many of those platforms are also accessible through web and conventional telephone, allowing all types of customers to benefit from those innovations, making them even more suitable to become the backbone of future MaaS systems.

Effective MaaS must also ensure good economics and affordability for cities and individuals. It must increase travel choices for all consumers and improve mobility access for those that are currently restricted by age, wealth, disability, digital access or geography. This mission has been the premise of the public transit industry since its very existence, which makes it ideally placed to lead the MaaS efforts in the direction of **overall accessibility (objective 7)**, as opposed to private mobility

30   Journal of Public Transportation, Lies, Damned Lies, AVs, Shared Mobility, and Urban Transit Futures, Vol.21 No.1 [2018] pp.19-30

31   The Economist, It starts with a single app: https://www.economist.com/news/international/21707952-combining-old-and-new-ways-getting-around-will-transform-transportand-cities-too-it

players, which are commercially motivated. A good example of how this pans out in practice is the difference of approach to fare pricing between public and private operators. There have been a number of studies that examine the impact of fare changes on transit ridership. Although individual results varied depending on the size of the cities, time of day and other factors, according to Joel Volinski, the author of "Implementation and Outcomes of Fare-Free Transit Systems," sensitivity to rising fares on public transit oscillates between -0.3 and -0.7 (meaning a ten percent fare increase would result in between a three to seven percent drop in ridership).[32] City authorities tend to take great care to price transit services at the right level. In many cities, transit is heavily subsidized by various levels of local and central government, in order to make it affordable to the disadvantaged and low-income communities. For instance, Miami-Dade Transit offers free passes to the homeless, low-income residents and veterans, as well as discounts for seniors and students. Data from the Bureau of Transportation Statistics shows that between 1990 and 2002, transit in the United States received $7.31 billion of net federal subsidy.[33] Commercial mobility operators, however, don't qualify for subsidies (although whether or not future MaaS models will change that is another story), nor do they care about the impact of fares on ridership if, in the aggregate, they make more profit from a fare increase. Uber surge pricing, which according to the company "helps quickly connect each person who needs a ride with a driver to help them get to their destination," is in fact a way to take advantage of increased demand and charge premium prices during constrained supply for what is otherwise a fairly affordable transit service. In a similar fashion, private mobility providers are not bound by any laws that

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ensure accessibility of service. In fact, they tend to target specific demographics, since they only hope to attract a limited percentage of the traveling public (MaaS Global, for example, is only looking to collect 12 percent of the traveling public in Helsinki). Typically, the target group is comprised of the more affluent and digitally savvy consumers, poignantly illustrated by the operations of Lyft Shuttle in San Francisco, which strategically avoids low-income areas.[34] There is a risk that commercially driven MaaS will fail to recognize that city streets are civic spaces that must be managed in the interest of the public and in doing so, will violate transit's equity mission. Rather than increasing mobility choices and being economically sustainable, that version of MaaS would "reinforce existing damaging patterns of social exclusion in poorer and more isolated communities."[35] As a result, if MaaS is to cater to all travelers, any future funding model and policy needs to promote the efficient use of the network over the private gain of any particular operator.

By assuming the role of facilitators of the MaaS transformation, public transit agencies can also ensure that MaaS initiatives **support the funding of existing infrastructure (objective 8)**. Through smart use of existing industrial corridors, roadways, walkways, parking, etc., in the future mobility mix, transit agencies can drive revenues toward maintenance of key transportation infrastructure. For instance, cities that incorporate private ride-hailing services into the wider public mobility offering might redistribute some of the revenue earned through such schemes toward the maintenance of public roads or the public transit network. Or, in a different scenario, they might charge the private operator for the privilege of using the road – a public asset – in pay-per-mile schemes. Fees might be dependent on several factors. Electric cars, cars with more than one passenger, or vehicles serving typically underserved areas might pay less. Those operating in city cores during peak hours might be charged more. Or, cities might allow ride-hailing companies to make use of public parking in order to limit congestion on the streets and eliminate unnecessary traffic caused by circulating Uber or Lyft cars in exchange for a fee, sharing data or some other benefit. Sao Paulo, Brazil is one example of a city that's already experimenting in this direction, while in Chicago, city authorities already charge a 67-cent tax on each ride-hailing trip. Furthermore, public transit agencies can help promote and protect the subsidization of transit and supplement or replace it by re-directing existing personal transportation expenditure away from the car and toward modes that support improving the density of travel.

32   "Implementation and Outcomes of Fare-free Transit Systems", by Joel Volinski, Transit Cooperative Research Program, p.13

33   Bureau of Transportation Statistics, Federal Subsidies to Passenger Transportation: https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/federal_subsidies_to_passenger_transportation/pdf/entire.pdf

34   City Lab, Private Mobility Services Need To Share Their Data. Here's How: https://www.citylab.com/transportation/2017/07/private-mobility-services-need-to-share-their-data-heres-how/532482/

35   House of Commons Transport Committee: Mobility as a Service inquiry, Response from Campaign for Better Transport

Ultimately, effective MaaS will see a world where major corridors are dominated by large transit vehicles such as commuter rail or BRT, while mobility in urban areas is supplied by the subway system or light rail and buses – whether those are autonomous or not – and in the case of buses, fixed route or on-demand. Future cities will aggregate density of directional travel, keep a healthy balance of shared vehicles on roads, as well as encourage more active forms of transportation, such as walking and cycling, and in that way l**essen the overall impact of transportation on the environment (objective 9)**.

In suburban and regional areas we will still see the use of cars, both owned and shared, but these vehicles will progressively change shape, form and function as they become less driver operated; they will be used to take individuals or small groups from their homes to the transit corridor (or vice versa), where they can transfer onto higher density services. Such a transportation design will not be dependent on the silver bullet of autonomous vehicles (and could be **achieved in both a driver-controlled and autonomous environment) (objective 10)**; yet, it will be enhanced when autonomous vehicles become truly available.

MOVING TRANSIT FROM PARTNERS TO LEADERS

The view that public transit must be the backbone of future mobility is slowly gaining traction but we must strongly advocate for it in order to hasten the realization. It is being increasingly recognized not only by the transit industry itself but also by the private sector players. A good example of the changing perspective is what happened to Uber and Lyft in Austin, Texas in 2016. In a somewhat controversial ruling, residents of Austin voted the two ride-hailing companies out of the city after concerns about consumer safety and their unwillingness to share data with city officials. Although both companies were very popular, Austin actively voted against them, making a statement against corporate behavior that ignores city rules. After a change of law, both companies were back within a year, but with an attitude to make things right.

A similar situation took place in 2017 in London. The city revoked Uber's license, holding the view that the company was offering services that were detrimental to the public transit network and that it wasn't doing enough to guarantee passenger safety. In February 2018, Uber announced it was introducing a number of changes to enhance safety for both drivers and passengers in the hope of winning the appeal to have its license reinstated. In a statement, Tom Elvidge, the general manager of Uber U.K., said, "We're determined to change the way we do business, so we'll carry on listening and plan to make other improvements over the coming months." That same month, Uber joined the MaaS Alliance. It was an act of recognition that true MaaS must help realize public policy objectives and an act of support for a vision of future mobility that "provides accessible, affordable and on-demand service that globally connects people to the existing transportation infrastructure."[36]

The actions of Uber are of particular significance. As the largest player on the private shared mobility market and an unquestionable trendsetter, the company's actions point to a new direction in thinking about the relationship between public and private players in the wider MaaS context. They open a window of opportunity for public transit agencies to take complete ownership of MaaS and define how future mobility offerings will interact and connect with transit to deliver MaaS in the future.

CONFRONTING KEY CHALLENGES

Having public transit agencies lead the discussion about MaaS and help drive the implementation effort will certainly make sense in many regions. Public transit's accountability when it comes to issues of affordability, access and environmental sustainability will help keep cities on track to becoming more livable spaces, while a focus on more efficient use of existing infrastructure will help secure some quick wins. That's not to say, however, that implementing MaaS will be smooth sailing, even with public transit at the helm. MaaS players will need to overcome a number of challenges to improve integration, encourage responsible and secure data sharing and solve issues related to the ownership of the customer. Questions of governance, technology and different, often conflicting, stakeholder perspectives will need to be considered. Institutional, operational and regulatory challenges will need to be assessed and overcome. Most importantly, public transit agencies and private operators will need to find a common language in what's likely to be a difficult task of finding the right economic model for MaaS.

Dis-integration

One of the key tenets of MaaS is the aggregation of all services, including booking and payment under a single mobility account

36 MaaS Alliance, MaaS Alliance partners with Uber to support shared mobility: https://maas-alliance.eu/maas-alliance-partners-uber-support-shared-mobility/

Small Steps

As cities get tougher on private mobility providers that don't want to share data, more companies are recognizing that sharing is, in fact, caring. Allowing city planners and authorities access to anonymized travel data from private operators not only helps to enhance traffic management and inform planning decisions but it also improves the often contested relationships between public and private mobility entities.

Since its launch in 2009, Uber has earned a reputation for its unwillingness to share data with regulators. In California, it has even faced fines for failing to share pick-up data. Now, the company is extending an olive branch to city authorities, giving them access to Uber Movement – a tool which provides traffic analysis and allows cities to monitor the impact that Uber cars are having on urban transportation systems. More private players need to follow suit and facilitate the data exchange between the various MaaS stakeholders.

for the user. The transit industry has already taken serious steps to consolidate accounts across several operators in a given region. Systems like TAP in Los Angeles, Clipper in the San Francisco Bay Area, Oyster in London and Opal in Sydney have all been successfully operating for many years, despite differences in fare structures among the local agencies that share the systems. However, a lot remains to be done and many consumers still have to deal with multiple payment accounts across different modes of transportation, such as bike share, ride share, tolling, parking and more. A system where consumers have to book and pay for each of the modes (and thus each of the journey legs) separately is rigid and inflexible, and harms the image of transit as an integrated entity. It does not offer riders the ability to make informed travel decisions or give them the flexibility to change plans at the last minute. Riders who pre-purchase a rail ticket, cannot, for instance, exchange it for an Uber ride if plans suddenly change after purchase. Since incentivization of socially desirable travel behavior also relies on a single account to handle all payments and refunds, and to issue discounts and passes, a disintegrated system means riders can't be rewarded for making responsible travel choices, such as traveling only by electric bus and bike share. Integration of payment methods into a single, formally recognized, user-friendly platform is one of the key challenges that stand on the road to wider MaaS implementation, and one that will need to be resolved as a priority if we are to benefit from the vision of shared mobility.

The lack of integration is not only an issue of the underlying booking and payment systems. A similar problem plagues trip planning. At the moment, the transportation industry offers multiple, disintegrated ways of planning and booking a trip. Data exists in silos, controlled by individual

THE VIEW THAT PUBLIC TRANSIT MUST BE THE BACKBONE OF FUTURE MOBILITY IS SLOWLY GAINING TRACTION BUT WE MUST STRONGLY ADVOCATE FOR IT IN ORDER TO HASTEN THE REALIZATION. IT IS BEING INCREASINGLY RECOGNIZED NOT ONLY BY THE TRANSIT INDUSTRY ITSELF BUT ALSO BY THE PRIVATE SECTOR PLAYERS.

actors. Commercial trip planners might, for instance, choose to only provide users with data focused on their own operations. Even in instances where journey planners have begun to integrate multi-modal options, much of the information included is based on static schedule data simply because real-time network performance data either does not exist or has not been shared. Often, when data is shared, it is of poor quality, incomplete or not updated often enough, while real-time data might be inaccurate, or missing for certain services or locations. That is a big problem for MaaS because without a complete view of our mobility, cities won't be able to make informed decisions about service optimization or future service needs, and will be constrained in the development of new mobility solutions. For instance, they won't know if it is beneficial to convert a parking lot into a ride-hailing drop-off point and a charging station for electric autonomous vehicles if they lack information on driving statistics and car sharing for that part of town. Multi-modality or journey planning in itself is not very revolutionary if

it is not integrated and based on dynamic, real-time information. The absence of rich data and low levels of data sharing in the transportation sector certainly make it difficult for transit authorities to understand real mobility usage and demand patterns across a region, and thus to offer consumers services that truly make a difference.

Data and Ownership Issues

The issue of personally identifiable information (PII) security and management is critical to the evolution of future MaaS solutions. The necessity to maintain data security across all stakeholders will be a make or break for the system, and so protecting the personal information of mobility users needs to be a key priority in any future MaaS considerations. Mobility data can be extremely attractive to criminals: Ride-sharing information, location tracking data, navigation and payment details can all sell for a good price on the black market. Mobility providers will need to introduce sophisticated methodologies to manage the security of consumer data and ensure that none of the mobility stakeholders participating in regional MaaS schemes inadvertently release the data into the wrong hands. Establishing clear and fair rules for the control of information, data

anonymization and encryption, are only some of the many factors that will have to become front of mind.

Furthermore, transportation agencies and mobility providers will need to address the issues related to the ownership of the customer. At the moment, the transit industry still tends to refer to the traveling public as "users" of the system, while under the MaaS model driven by engagement and retention, the "users" of mobility service become "customers." Alongside the evolution of the customer, transit agencies will need to undergo a bit of repositioning themselves – from rail companies or bus companies to transportation services providers. In the future, where mobility services are delivered through a combination of public and private transportation providers, questions might arise about the ownership of the customer and who has the rights to that consumer's data. Some transit providers will want to maintain the ownership of the customer, even in situations where they don't provide mobility services directly to the traveling public but subcontract the delivery of operations through third parties. In turn, the subcontractors might argue that they should own passenger data since they are the ones providing the services and directly engaging with the customer. Since public transit companies hold the majority share when it comes to customers and are arguably better placed to protect consumers' interests (because of their public and equity interest objectives), there's a case to make that they should be the ones to retain the customer relationship in future MaaS models. In any case, as long as consumers are aware of who holds their data, how it is used and protected, who it is shared with and for what purposes, and as long as they can hold organizations accountable for the service they provide and data they collect,

the question of who owns the customer relationship can remain secondary to the MaaS discussion, at least for now.

Lack of Standards and Economic Models

In most countries there is a lack of regulation, legislation or even technical standards that would promote single payments accounts, multi-modal fare policies, multi-modal journey planning or multi-modal analytics. Data standards for certain modes don't exist or are incomplete. Current commercially led MaaS solutions do not fall under the same non-discriminatory laws that bind public transit providers. As mentioned earlier, the only country that currently regulates an open market for mobility services is Finland. Nonexistent standards and a lack of regulation prevent the adoption of effective mobility solutions and make it difficult for public and private transportation entities to find a common language in MaaS discussions. There's no doubt that regulation and management of the policies will require careful consideration and execution, depending on each city's and region's unique set of requirements and challenges.

At the same time, the economic model of MaaS has not been resolved. It is a complex challenge, one that will involve a careful balance and understanding of the different stakeholders and their objectives, which in a MaaS model can be directly at odds with each other. In many cities, the provision of transportation infrastructure has been traditionally the responsibility of the government. With new players entering the market, this is now changing, raising questions about how to tally the public good with commercial viability. Private MaaS operators must turn a profit, while the economic case for mobility services in many

cities might not directly translate into classic monetary value. The gains might be spread to other parts of the economic system, which is why public transit is heavily subsidized in the first place. These benefits may include reduced traffic congestion in the city, better quality of living, and more equitable access to opportunities for all citizens. As such, MaaS will most likely need to be set and regulated by a government entity, which will need to consider the ancillary benefits to the city itself above and beyond economic benefits to the MaaS operator.

Another key challenge will lie in finding a pricing system that incentivizes the optimum use of the network. Too much of the early MaaS conversation has focused on the subscription model, illustrating a scenario where private MaaS operators sell subscriptions and ultimately optimize the use of mobility inventory to make money. This is likely a fundamentally flawed model given that the objective of MaaS must focus on improving the density of transit. Since the densest mode (public transit) is heavily subsidized by the government, it is illogical that a private operator would profit (other than for performing a service as a contractor to government) from a tax-payer subsidized service. The subscription model is also

unlikely to incentivize the optimum use of the transportation network, since it makes payment and all modal choices thereafter (be it a public bus or an autonomous limousine) essentially a sunken cost in the eyes of the customer.

A pay-as-you-go model might be more appropriate, since it is likely to encourage a more sustainable and denser use of transportation services, and is more flexible when it comes to the changing models of employment, with more people working flexible hours or from home. In fact, transit agencies are already seeing a fall in the use of weekly and monthly passes (which are forms of the subscription model that have been used in transit for decades), because they are now less economically advantageous and less in line with people's changing personal situations than pay-as-you-go. Whatever solution we will arrive at, the need for new pricing models is evident.

BUILDING A TECHNOLOGICAL BASE FOR MAAS

Regardless of how many of the market structuring and other issues related to MaaS are resolved, no MaaS effort can be fully successful without a solid technological base to enable it. That base must be made up of three key platforms.

One Account

Firstly, MaaS cannot operate without what Cubic calls "One Account." One Account is a system where transportation service providers in a given region participate and agree to use a single account for the management and administration of fares and payments. By doing so, authorities and operators can manage all travel needs in one single point, while consumers can link all of their mobility accounts together to create a single user identity – an idea central to the

THE CORE TECHNOLOGY PLATFORMS NEEDED FOR MAAS – A SINGLE ACCOUNT, MULTI-MODAL JOURNEY PLANNING AND CONGESTION MANAGEMENT PLATFORMS – ARE BEST SPECIFIED, PROCURED AND MANAGED BY THE GOVERNMENT, AND POTENTIALLY, BY EXTENSION, BY TRANSIT AGENCIES, SINCE THEY ALREADY HAVE SIMILAR SYSTEMS IN PLACE, EVEN IF THE CAPITAL AND OPERATING COST OF THESE PLATFORMS IS RECOVERED VIA VARYING BUSINESS MODELS FROM BOTH PUBLIC AND PRIVATE MOBILITY OPERATORS, EITHER BEFORE OR AFTER THE INVESTMENT.

effective functioning of any MaaS system. A financial engine that links payments and accounts also enables consumers to seamlessly book and pay for any mode of transportation they choose through a single portal, all as part of a single trip, regardless of the mobility provider. It also allows consumers to choose from a range of options that take into consideration factors such as convenience, cost, time of travel,

and other factors such as walking distance, environmental impact, safety, reliability, quality and comfort.

In a MaaS model, public and private mobility service providers come together to use a single platform for all payments, bookings and user accounts. Since such systems already exist in many cities today, and form the foundation for travel on public transit networks, the easiest way to get to a single account for all mobility needs is by extending the existing systems used in transit to new modes and providers.

Journey-planning Platform

A second requirement for MaaS is a true multi-modal journey-planning platform that unbiasedly exposes all choices, including both public and private services that are potentially in competition with one another. Such a multi-modal trip planning and tracking platform must be able to provide real-time, location-based route tracking features as well as offer real-time route updates, alerts and rerouting options, based on live data and AI predictions. The platform must also offer travel options across all modes when planning, and must be customizable to users' individual preferences, such as mode, travel time, comfort or cost.

Regional Congestion Management Platform

Finally, MaaS requires a regional congestion management platform. As MaaS adoption in cities grows, a proliferation of different modes, vehicle types and service options will require careful monitoring and management to ensure the most optimal flow of traffic through city streets and to limit congestion. Cities will need access to a centralized platform that provides a holistic view of all travel in the region, so that traffic can be managed, controlled and forecasted effectively. Being able to bring mobility metrics and individual plans into a centralized planning platform would also

allow authorities to optimize traffic in real time, redistribute resources to parts of the network that struggle the most, identify congestion hot spots and redirect traffic away from accident sites, as well as give preference to the modes carrying the densest load, especially during peak hours.

THE CONTINUING ROLE OF THE GOVERNMENT

The idea of MaaS as an exclusively private-industry-led initiative is slowly retiring, and it needs to. Many of the considerations about the drivers of MaaS, its benefits, challenges and objectives, point to a similar conclusion: Public transit, and by extension, the government, can and should play a central role in MaaS discussions and in its implementation. But what exactly should that role be? How far should governments go in regulating future mobility solutions?

On the one hand, if a city takes complete ownership of MaaS delivery, then it can control and regulate the services that are provided under MaaS and influence the development of the multi-modal environment. That's beneficial for many reasons – it gives cities control and a say over how public assets such as roads, walkways and parking lots are used, it enables them to ensure mobility services in the city serve the wider interest of the public, and it helps them protect those consumers who might be left behind by the rapid growth of on-demand mobility services or a host of other social disadvantages. Because the city or the agency needs to consider the impact of the service provision on the city as a whole and on the environment, only through control and regulation can it provide a mechanism for delivering MaaS in a way that supports the wider city objectives.

On the other hand, regulation can be rigid and oftentimes slow to adopt. Imposing strict regulatory systems for the provision and operation of new mobility services might slow the pace of change and choke

innovation. Over-regulating mobility may even discourage private providers and new players from entering the market, thus taking away opportunities for better mobility services from citizens and slowing the much needed transformation of urban spaces. Leaving the market to sort itself out is also not desirable because private companies would develop urban transportation solutions according to their own wishes, serving a narrow customer base and doing so without regard for the wider city or regional mobility goals. It is also unlikely that private organizations would put both optimization of mobility for the individual and the entire transportation network ahead of their own corporate gain.

In order to achieve desirable outcomes, city authorities will need to pitch regulation at the right level and send the right policy signals to the private sector. They will need to create a level playing field for mobility providers, which encourages (but not maximizes) competition, as well as collaboration, and participation from the private sector, while keeping consumers' best interest in mind.

There are some responsibilities that should not be outsourced or contracted out by the government. Those include regulation, policy, planning, environmental protection, funding, revenue collection, subsidization and distribution, and security. Affordable and sustainable transportation is critical to the economic vitality of a city and a region. Transportation of people and goods is a major component of the U.S. economy, accounting for between eight and ten percent of Gross Domestic Product (GDP) each year. This is a responsibility that cannot be outsourced to a third party. Equally, the government must ensure social equity and inclusion, neither of which can be guaranteed by leaving things to the free market. The economics and subsidization of infrastructure development, maintenance and funding must also be coordinated by government policy in order to ensure the optimum use

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and agree the metrics by which success will be measured. They should also encourage and promote investment, while ensuring that the new transportation environment doesn't compromise the safety or security of consumers, and make sure any mobility efforts are aligned with broader social equity goals. As a general rule, governments should play the role of responsible and encouraging guardians: stepping in and correcting the course when necessary but allowing cities to arrive at their own solutions without a negative impact on innovation.

There likely won't be a "one-fits-all" approach to MaaS planning and implementation. Depending on the market, country, region or city, varying levels of government regulation and control might be needed to successfully deliver MaaS that serves the public good. In some places public transit agencies themselves might deliver a MaaS system. In others they might allow private players to take ownership of particular projects, or they might simply retain strategic control over a system delivered entirely by a third party or a mix thereof. In Europe, where the mobility market is arguably more advanced and developed, and where transit modes are already well established and popular, it is likely that the third scenario will become the main model for MaaS adoption. As more public authorities on the Old Continent move beyond their conventional role of infrastructure providers and become enablers and promoters of mobility services delivered by private companies, we will see a more open MaaS market, with major partnerships between government agencies and technology companies, as is already happening in Hamburg, Germany; Manchester, U.K.; Stockholm, Sweden, and many other European cities.

In the U.S., where the private car still dominates as the main mode of transportation, the MaaS model might be more regulated and more inclined toward

of space and funds. In addition to economic and pricing policy, there are also many other standards related to safety, security and other critical topics that the government is already responsible for managing and best placed to do so. The core technology platforms needed for MaaS – a single account, multi-modal journey planning and congestion management platforms – are best specified, procured and managed by the government, and potentially, by extension, by transit agencies, since they already have similar systems in place, even if the capital and operating cost of these platforms is recovered via varying business models from both public and private mobility operators, either before or after the investment. Finally, governments are also best placed to own the customer relationship and provide the

needed data protection and "best interest" assurances to the public.

However, there are also those elements of MaaS that can and even should be contracted out in order to create an environment where innovation thrives. Those include the operational aspects of mobility services, the development and maintenance of infrastructure and technology, and even the performance of government responsibilities (e.g., congestion management control rooms). To ensure best results for MaaS, government bodies should, at the minimum, set the scene for MaaS implementation, bringing all the various stakeholders to the table. They should help define the vision for MaaS in a given region, set common objectives for the said region,

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careful control of a mix of private and public mobility solutions with an emphasis placed on the use of public transit. Ultimately, the level of market freedom will depend on the set of unique circumstances of a city or a region – each will need to determine the extent to which local government should be involved in the journey toward better mobility. City-or region-specific solutions and financing models will be likely. The key to success will lie in ensuring that conversations about MaaS are happening in collaboration with transit agencies, city authorities and private players, and with social equity in mind.

CONCLUSIONS

More and more cities are starting to explore the integration of public and private transportation networks. Some are testing the waters with piecemeal integrations. Recent examples include Chicago's Ventra card testing integration with the Divvy bike share, the launch of LA's TAP-integrated Metro bike-share system or Atlanta's MARTA link-up with Lyft and Uber. These partnerships demonstrate the first attempts

at integrated MaaS in the U.S., and start to seed the idea that combined mobility is truly an option in the traveling public's mind.

Private mobility providers are also starting to recognize that they cannot combat urban challenges alone and that MaaS cannot happen with public transit as an afterthought. Both Uber and Lyft are keen to work with public transit to bring MaaS to the general public together. After all, the majority of their income comes from base fares with limited mileage journeys – in Paris, France, 65 percent of Uber trips start or end within 700 feet of a metro station. While alternative transit services can offer riders convenience and on-demand travel options, they will never be able to reduce congestion or improve travel in the city alone, especially since in the U.S. ride-hailing apps don't serve the same purpose as public transit. For now, they are more often used for social trips than everyday commuting. In Boston, for instance, only 15 percent of all Uber and Lyft trips account for the rush hour commute. However, when private companies become partners in regional MaaS schemes alongside local transit providers, their role can start to evolve.

Shifts on the urban, technological and social layers will continue to change our cities and our ideas about transportation. In the coming years, we will witness a growth in bespoke transit services and an increase in on-demand solutions that aim to address the first and last mile connectivity problems and get people on to the first node of the public transport system. We will see greater consolidation of accounts and users will be able to quickly find optimum solutions for themselves based on personal preferences for travel options. The individual mobility providers will focus less on complete ownership of individual users, and more on the ability to aggregate and link their customers to other mobility providers to deliver holistic solutions. Finally, we will see an increase in utilization of public transit, as early adopters take to the

MaaS offerings. The service variety will then broaden as the customer base broadens.

The relationship between regulation and innovation is a difficult one and will continue to pose challenges on the road to MaaS implementation. As governments and city authorities move from regulating transportation as a sector to regulating transportation as a service, they will need to think carefully about the role they can play in the MaaS discussions, recognizing the balance of priorities in the new transportation mix and acting as facilitators of partnerships, enablers of innovation and guardians of cities' and the public's interests.

I have no doubt that MaaS is a great candidate to help solve the challenges brought about by the shift in consumer preferences and empower cities to cater to a new type of citizen. As our society becomes more mobile, transit agencies across the country need to invest in a more people-centered mobility paradigm, so that they can play an active role in the transformation of our transportation networks and city spaces, rather than let the MaaS revolution unfold inefficiently before their eyes.

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