UNJAMMING URBAN MOBILITY

How Mobility-as-a-Service Can Replace Personal Cars
Imagine that instead of owning the key that unlocks your personal car, you are handed a personal key to any given vehicle. This is where the promise of Mobility-as-a-Service (MaaS) lies — a seamless access point to the complete mobility spectrum.

MaaS is not just a novel and convenient way for travelers to move within and beyond cities. It’s also the most promising alternative to the private cars which cities seek to push out.

The concept of MaaS also carries a lot of misconceptions.

In this white paper, we aim to dispel the fog with what we call the MaaS fundamentals that are the key to unjamming urban mobility.

Martynas Gudonavičius
CEO & Co-Founder, Trafi
# Table of Contents

**Setting the Stage**  
4

**Purpose of Mobility-as-a-Service**  
6

**MaaS Fundamentals**  
8  
- Public transport as the backbone of the mobility network  
- Supplemented by a hyper-connected mobility supply  
- Systemic orchestration guaranteed by public authorities  
8

**MaaS Enablers**  
11  
- Application for citizens  
11  
- Policy management software for urban authorities  
12  
- Mobility analytics for decision makers  
13

**MaaS Roadmap**  
14  
- True MaaS adopted by the industry  
14  
- True MaaS adopted by residents  
15  
- MaaS impact showcased  
16
Setting the Stage

Several years ago, a joint research group of ten civil engineering, economics, and environmental experts, stretching from the University of East Anglia to the University of Sydney, published a sweeping paper analyzing the carbon footprint of the United Kingdom cities. Among the report’s main findings was that London City alone accounted for 15.5 tons of CO2 emissions every year. It also showed that Londoners from the adjacent borough of Newham produced on average 34% less CO2 emissions in the same period.

London's Square Mile is not known for heavy industry. It's choking on cars.

Moreover, it's not just about private cars. In a report made last October in Chicago, Mayor Lori Lightfoot published a long-awaited and publicly available analysis on ride-hailing companies operating in Chicago's downtown area. It opens with a seemingly benign insight: in the four-year window between 2015 and 2018, Chicagoans increased their reliance on ride-hailing companies almost three-fold, which is music to the ears of those fighting for lower car ownership numbers. However, this outcome comes at a high cost:

- Trips made with ride-hailing companies contributed to a significant decrease in public transport ridership — around 48 million rides annually,
- Half of the rides performed with ride-hailing companies started or ended in the downtown area, and thus reduced average public transport vehicle speeds,
- Moreover, rides to and from the downtown area were predominantly single-occupancy rides, and
- Ride-sharing was observed only in neighborhoods with a lower than median income.

In short, people with lower incomes tend to move in much more sustainable ways. On the other hand, affluent people tend to ride alone and significantly decrease connectivity for everyone else.
Urban centers are already so overloaded with vehicles that even walking down the street has become a lethal activity. Researchers at King's College London suggest that particles coming from car brakes are as harmful as fumes coming from exhaust pipes, affecting our immune systems. Regenerative braking, a default feature in electric cars now, should help tackle both dust and CO2 emissions. But, despite admirable strides in EV adoption, meaningful impact remains a long way off and urban dwellers will continue putting their health at risk for years to come.

On top of that, there's a nigh-inescapable car-centric outlook that pervades public imagination, discourse, and policy:

- **People:** most people continue to view the personal car as indispensable, liberating, and something to be achieved and desired,

- **Media:** media outlets have been primarily writing on developments in electric and autonomous vehicles and are only now starting to cover topics such as cycling infrastructures or rapid transit systems,

- **Policy:** the necessary changes in urban development continue to be evaluated through a car-centric lens.

Most of us have been on the receiving end of strong opinions about how the car is not the problem, it's about how we utilize the car or its design. However, the unending collective failure in utilizing the car the right way has made this distinction all but meaningless.

So, let's finally say it together out loud: car-centricity is the problem.
Purpose of Mobility-as-a-Service

The car is still considered to be the most flexible option to get around seamlessly — it promises you empowerment to ride anywhere at any moment. Yet struggling to find a parking spot will grind the gears of any car owner. In those moments, car ownership can be compared to dragging around a rock shackled to your leg. This is precisely the reason why, in 2001, Bernd Meurer coined the notion of Mobility-as-a-Service, arguing that “ownership and use do not necessarily have to be one and the same”.4

Even though this argument for flexibility is usually implicitly directed against public transport, as much as for owning a personal car (most recent example — Ford's ad for their new SUV5), we cannot forget that public transport carries a significant volume of people every single day. For this reason, we spent time learning as much as we could from public transport authorities (PTAs).

What did we learn? PTAs are increasingly convinced that MaaS is the adequate alternative to owning a car, promising even more expansive flexibility: if you were to have a personal master key to any transport option in your pocket, why would you ever rely only on one specific vehicle? This is further supported by ever-accelerating public and private tenders looking for software companies to provide working MaaS solutions.

This excitement is nonetheless tainted with three extremely pervasive issues:

1. A significant number of actors in the mobility industry are basing the necessity for MaaS in a causal relationship with the emerging sharing economy: if everything is now shared, why not also share transport? For us, this seems to be a misguided approach, as a truly valuable solution has to have a clear purpose to exist — a proper vision and clear objectives.

2. Most academic, public policy or purely corporate marketing material constantly reduces MaaS to a transport-agnostic consumer-facing mobile app that enables riders to book & pay for their rides in a single environment, which is either of a private, public, or hybrid nature. On face value, these criteria sound reasonable until you consider how different mobility modes can be compared to each other: an electric bike is more sustainable than a petrol car, and a full bus is more effective than a taxi ride. This suggests that certain modes of transport should be prioritized and incentivized.

3. In addition to this, continuous debates directly stifle the immediate and impactful development of MaaS solutions. Industry players, public transport authorities, politicians, and even academia disagree if we should immediately start with an intercity, intracity, regional, nationwide or even global MaaS solution and if we should keep such a solution closed, or make it completely or partially open.
Comparing solutions, without first going over and prioritizing the actual challenges these solutions ambition to solve, is a futile endeavor. The following elements constitute the key challenges that any MaaS solution is expected to address:

- **Sustainability**: prioritizing walking and cycling is a strategic public health objective that is difficult to achieve in cities where breathing has become increasingly problematic and even lethal,

- **Safety**: private mobility providers are rarely intrinsically incentivized to ensure safe movement, and pedestrians, as well as cyclists, are carrying most of the burden in trying to avoid traffic accidents,

- **Equity**: mobility networks embed inequities — less well-off people rely on public transport while more affluent people revert to private options or hail rides, thus adding to the network congestion,

- **Effectiveness**: mobility networks exist to help people and goods move around, and the lower the volume of passengers and parcels vehicles can carry, the less effective such mobility networks become,

- **Connectivity**: people from underserved areas rely on private or sporadic alternatives to access the network, thus significantly reducing their ability to take a full part in the urban community life.

All of these challenges suggest that MaaS is much more than just another app in your already overloaded phone screen. If a city is looking to provide a master key to access any transport option for their residents as a better alternative to owning a car, this key has to make urban mobility networks more sustainable, effective, equitable, connected, and safe. This also implies that the main challenges now lie in urban centers, which is not to say that rural areas or intercity traveling are not important. On the contrary, these use cases have many significant challenges that would require new solutions to supplement urban, intracity MaaS.

These issues and the current understanding of MaaS are at odds, which is why we believe the definition of MaaS and its understanding should be broadened up and unpacked into a clear developmental roadmap.
MaaS Fundamentals

In an ideal world, we would teleport ourselves to our destinations. As that is still out of our reach for the foreseeable future, we have to rely on the next best thing — transportation. It either brings us what we need or gets us to where we need to go. In this section, we stress our ideal scenario and measure other mobility options against it.

Public transport as the backbone of the mobility network

Public transport brings obstacles to the convenience and comfort of people getting where they need to go: they need to wait for it, share it, sometimes transfer and walk to and from it. Hence, it's unsurprising that people striving for personal convenience would rather rely on affordable demand-responsive services, such as shuttles, which would guarantee that one is driven directly from their origin to destination.

However, your destination doesn't fully match the destinations of other people that you share your morning commute with, thus it would also require to significantly reduce the vehicle sizes. The culmination of this train of thought is a swarm of small pods riding around the city, carrying everyone where they need to go. As prominent public transport expert Jarrett Walker has been asking for years now, “where will they all fit in the urban street? ... And when they take over, what room will be left for wider sidewalks, bike lanes, pocket parks, or indeed anything but a vast river of vehicles?”

It's clear that, given the previously discussed challenges, MaaS must depend primarily on mass public transport. It's precisely because it requires us to walk and share our rides, that it ensures the most effective, affordable, and sustainable option a mobility network can offer. More so: every MaaS solution should, first, take into account the existing physical infrastructure of public transport, create its digital twin, and, finally, enable city residents to navigate all public transport options digitally with ease and reliability. By providing real-time arrivals, departures, disruptions, and pricing MaaS must allow people to combine their rides between stops into full trip experiences by themselves or with trip planners. In short, **MaaS must entail nearly perfect public transport data and ticketing** — allowing residents to plan and execute their trips without any friction.
Supplemented by a hyper-connected mobility supply

For low access areas in the city outskirts, running a typical bus line is too expensive. In such cases, a reasonable alternative would be a demand-responsive service that should serve the underserved community needs and guarantee high connectivity, affordability, and equitable access. Similarly, in cases where introducing public transport in any capacity is unreasonable, additional mobility supply should supplement it, rather than compete with it. This is especially true with micro-mobility in high density and high access areas in city centers: launching public transport for short trips would not generate enough traffic, thus electrical or classic bikes, kick scooters, micro-cars and mopeds constitute the most logical option to get around.

Moreover, all of these mobility options must be able to communicate with each other and with the public transport system, i.e. exchange their positions, capacity, and occupancy, to allow network orchestrators to optimize the supply in real-time. This, together with public transport as a backbone, would guarantee that we always have a sufficient supply that allows us to book and ride any mobility option. However, to solve the aforementioned challenges, there is a significant missing component, one that would not allow such service to be agnostic to our transport choices.
Systemic orchestration guaranteed by public authorities

To build a truly equitable and safe mobility network, we need an entity to orchestrate it: one that by design would not have profit, but rather provision of fair and affordable access to the whole mobility network as its main goal. This would entail:

- Creating a digital twin for the whole transport infrastructure,
- Monitoring movement in real-time,
- Setting network parameters — restrictions and recommendations, e.g. speed limits, no parking or preferred parking zones,
- Introducing dynamic incentives and deterrents to choose one option over the other at any given time,
- Handling the sensitive personal data of all city residents moving in the network.

On a positive note, such orchestrating entities already exist — they are known as public transport authorities. They have already acquired and retained a sizable customer base, have planning skills and operational power, and, most importantly, a mandate to provide transport services for everyone at as fair of a price (if any) as possible. MaaS would, however, require for their mandates to be expanded and for them to start handling the whole mobility spectrum rather than just their public transit network. Some have already done that successfully: while private mobility companies or actors trying to launch MaaS struggle to cooperate and integrate other mobility providers to ensure a holistic mobility experience to their customers, public transport authorities like Berlin BVG or Munich MVG are attracting all mobility network companies to integrate in public MaaS solutions, thus bringing value to city residents as fast as possible.

If public transport authorities are the only entities who manage to attract and convince mobility providers to hyper-connect into the mobility network that is, first of all, based on public transport, then one could argue that neither private nor hybrid MaaS models can guarantee what MaaS strives to guarantee — to be a legitimate alternative to privately owned cars.

In other words, true MaaS seems to be public MaaS.
**MaaS Enablers**

If we follow MaaS fundamentals, it becomes self-evident that MaaS cannot be reduced to just one provider or just one app:

- City residents have to rely on a MaaS application to plan and execute their trips,
- Public authorities require a MaaS policy management software to orchestrate the mobility network, and
- Mobility providers need a comprehensive tool to analyze MaaS consumption patterns to optimize their fleets.

**Application for citizens**

Once the complete mobility supply is integrated into a single application, PTAs are confronted with a significant usability challenge — how to present the supply in a comprehensive and comprehensible way? A true MaaS solution must remove friction in how people travel around the city and allow them to easily book & pay for the services in one environment with a single master account. This is where a significant distinction between user-centric and citizen-centric design arises:

- User-centricity requires to design a solution adhering to familiar patterns, adjust (as automatically as possible) to user’s consumption patterns, and, intentionally, incentivize sometimes even absolutely irrational choices;
- Citizen-centric design, however, relies on what is best in digital product development — creating an attractive, easy to understand and use interface — rather than adapting the solution to incentivize irrational behavior. It should promote active mobility, walking, public transport and micro-mobility over personal cars or car sharing.

In short, a user-centric design's goal is to get people to use the app itself, whereas a citizen-centric design's goal is to get people to use what the app offers. Any MaaS application has to be a daily travel assistant that takes the best from user-centricity and bases itself on what addresses real city challenges. At the end of the day, any MaaS application has to (a) become a reliable alternative to a personal car, and (b) promote more sustainable mobility.
Policy management software for urban authorities

It's important to remember that cities are already orchestrating their mobility networks by:

- legislating traffic ordinances,
- issuing licenses for mobility providers,
- managing public space usage,
- and organizing mass transit.

As recent research by the German Federal Ministry of Transport and Digital Infrastructure suggests, to be sustainable, mobility providers need to link up their supply to supplement public transport rather than to compete with it. Thus, cities must take the reins they already hold and start regulating, monitoring, and enforcing expected movement patterns in real-time with a dedicated policy management application that:

- unpacks how the network is utilized,
- suggests where certain inefficiencies are to be addressed,
- allows promoting specific modes and routes as more sustainable,
- issues direct mobility-related policies to provider systems,
- and directly incentivizes consumer behavior.

MaaS policy management, then, acts in tandem with any MaaS application: the latter taking the role of a receptacle for understanding how to move in a complex mobility network, while the former functioning as a delivery device to inform and nudge for the desired behavior.

Simply put, if we are focusing on car owners from underserved areas, they would be able to make a reasonable decision to leave their car in a park & ride lot and switch to public transport if a) they will know that they can do it, b) can do it seamlessly, and c) understand how much more convenient and cheaper it would be.
Mobility analytics for decision makers

Each mobility provider has to be able to understand how to optimize their supply. Today, however, every provider is pursuing optimization by taking into account their own fleets in particular. Naturally, this leads to mass inefficiencies — overloaded and competing mobility supply in urban centers, while city outskirts lay mobility-bare.

To address inefficiencies in supply distribution, a systematically functioning MaaS requires an anonymized mobility data exchange for all mobility providers — only then can we expect providers to stop operating in twilight conditions, and cities to start making evidence-driven policy-making decisions. It’s an idea that is etched into the new European data strategy. This suggests that all mobility providers will have to accept standardized and secure integrations to plug into city-led MaaS solutions.

Given the sensitive nature of movement data collected from the whole mobility network, public transport authorities would have to retain strict control of who should access that data. This, in turn, means that every single mobility provider would need to pass quality thresholds and gain licenses to operate in cities. However, it also suggests that taking a completely open, agnostic MaaS approach wouldn’t allow public transport authorities to have all the tools required to solve the challenges that their city has.
MaaS Roadmap

True MaaS adopted by the industry

A true Mobility-as-a-Service (MaaS) solution is more than a mobility application for consumers. MaaS rises as a response to the current state of urban mobility, it’s and has to be organized around public transport, and requires to assign the role of network orchestration to a public transport authority (PTA). In other words, a PTA moves away from Public Transport and becomes the urban Mobility Authority.

The PTA will have three responsibilities:

• Firstly, it should oversee the design of safe and easy-to-use mobility experience. Individual Mobility Service Providers (MSPs) are not incentivized to start there themselves, nor should the PTA do it for them. It should set the standard and require MSPs to follow it.

• Secondly, the PTA should ensure that MSPs guarantee equitable and affordable access to their services. We need to start with mass, not luxury, mobility. Moreso, the PTA should nudge MSPs to guarantee an even spread of access to mobility in underserved areas as much as in overserved ones.

• Finally, more holistic mobility supervision would enable the PTA itself to operate more effectively and rely on less traditional and experimental approaches in addressing connectivity challenges.

MaaS will become tangible – private car rides will be replaced with sustainable and active mobility options – if its fundamental requirements and the reinvented role of the PTA will be adopted industry-wide:

• The consolidation of dispersed mobility offerings will make the whole mobility network significantly more resilient, i.e. urban residents could rely on mobility options in every situation.

• Collaboration on standardization does not impede competition on implementation, i.e. each provider could still promote mobility offers in MaaS applications or their consumer applications themselves.

This suggests that the next item on the MaaS roadmap is the discovery of a new legal framework that would allow standardizing all business requirements and technical implementation. In particular, to ensure that every MSP would not have to over-customize their services to each city. This, in turn, would allow us to move towards a situation where any mobility option could be opened with the same master key.
True MaaS adopted by residents

Next, the crux of it all – urban residents who want to move in their cities as seamlessly and effortlessly as possible. Today, this creates mass inefficiencies, as everyone seeks a convenient option that suits them the best. This is only amplified with products that are user-centric and don't take into account the needs of the whole network.

For MaaS to work, we need to focus on how to help city residents adopt MaaS applications:

• Firstly, any MaaS application has to provide a complete trip experience and be reliant on immediately familiar patterns.

• Secondly, every single city has to own a resident-focused MaaS application.

• Finally, people have to know and understand that they can rely on these MaaS applications more than on personal vehicles.

Currently, most PTA or public transport operator (PTO) owned applications are designed for a single mode - fixed transport. So, cities have mobility products, but their product design is not equipped to support the multiplicity of mobility modes and providers that MaaS promises to deliver:

• Trip planning is dedicated to unimodal, public transport rides without an adequate engine to compare free-floating mobility. How will I be able to compare fixed and free-floating mobility?

• Public transport schedule information, real-time trip updates, and ticketing are closely knit together. However, how should they be complemented with e-bikes or kick-scooters?

• Finally, if my typical morning commute is disrupted, how will the product know what option to recommend me, and, more importantly, when?

There exist off-the-shelf products that can support public authorities in launching MaaS solutions in cities as fast as possible. More than that, these solutions are constantly tested and continuously improved in different geographies with different use cases. Choosing a battle-tested product guarantees quicker user adoption and less maintenance than a custom solution.

The real challenge here, and the next item on the roadmap, is educating residents to switch over to MaaS rather than to stick to unimodal private mobility. What should follow, then, are measures that significantly affect car-based travel, and an extensive campaign spreading the message that moving with sustainable, affordable, and safe means is more sensible and appealing than sticking to current private options.
Finally, if we have the buy-in from the mobility industry, and if city residents are adopting MaaS, then we can have a complete picture of how the urban population moves. Not just for the sake of enjoying data visualizations, but rather to achieve something counterintuitive: how to make sure that people would be able to rely on mobility less and less, and can reach their destinations in a hyper-proximate walking distance.

With a non-pervasive and holistic understanding of where people travel and why, city authorities would finally have all the tools to design cities in such a way that public services would be accessed either from home or nearby, and businesses would be incentivized to spread out evenly in all urban areas, not just in high density and high access urban centers. Thus, urban residents would gain access to where they need to go without ever needing a car.

It's a wonderful picture.

Agreeing on the problems is the first step to making it a reality. The second - choosing the right solutions.
True MaaS is Happening

Trafi’s technology brings together both public and shared mobility services to create a Mobility-as-a-Service alternative to city-straining modes of transport. As of 2019, Trafi powers the most extensive MaaS deployment in the world managed by Berlin’s public transport authority BVG. Trafi works shoulder-to-shoulder with some of the most complex cities in the world such as Munich and Jakarta, as well as leading companies like Apple, Google, Lyft, and Gojek.
References


3. Air pollution from brake dust may have same harmful effects on immune cells as diesel exhaust (2020), in King's College London News Centre, accessed at https://www.kcl.ac.uk/news/air-pollution-from-brake-dust-may-have-same-harmful-effects-on-immune-cells-as-diesel-exhaust


