Paper ID EU-TP2320

Traffic Management as a Service

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Abstract

This paper presents Traffic Management as a Service (TMaaS), a neutral traffic management framework for urban mobility aimed at small and medium-sized cities. It accepts and connects multimodal data and services from different parties for monitoring, analysis and management and allows flexible adaptation and on-demand use of the system. TMaaS is an open urban traffic management marketplace that enables third parties to generate innovative solutions and business models and encourages citizen participation and co-creation in urban mobility. TMaaS is currently being demonstrated in real-use cases for the City of Ghent, a medium-sized city in Belgium. Selected replicator cities will be included in 2020.

Keywords:
Traffic management as a service, mobility management as a service, urban mobility

Introduction

In 2008, the population of urban areas worldwide outgrew the population of rural areas for the first time. This trend is expected to continue and growing cities are expected to become home to almost 5 billion people by 2030 (UNPFA, 2007). This poses a great many challenges, many of which relate to urban mobility. By way reference it is estimated that congestion in the European Union (EU) costs nearly 100 billion euros, or 1% of EU GDP (Gross Domestic Product) each year (Levy, Jonathan; Buonocore, Jonathan; von Stackelberg, Katherine, 2010; European Commission, 2019). The question of how to enhance mobility and quality of life while at the same time reducing congestion, accidents and pollution is a challenge that is common to all cities. Cities are exploring different ways to deal with this problem, whilst taking all the specific circumstances into consideration. This often goes hand in hand with limited resources available to cities, either in terms of budget, human resources or infrastructure. This is particularly relevant for medium-sized and small cities that often have limited resources but that nevertheless need to improve the mobility and consequently the quality of life in their area. Nonetheless, medium-sized and small cities represent almost 90% of all cities worldwide (UN, 2014) and while market options for mobility management focus mainly on cars and are designed for large cities, small and medium-sized cities want scalable mobility solutions that are able to significantly reduce traffic congestion, while increasing the use of collective and sustainable means of transport. Significant potential is offered in the exploration of data driven technologies, as this can lead to innovative ways of rethinking existing transport services and improving mobility. Some examples include a new generation of cooperative applications, digital infrastructures and personalized mobility services, which offer a significant promise of meeting the needs of urban mobility worldwide. In its Urban Mobility roadmap for 2030, ERTICO has identified the integration of multimodality and traffic management systems as one of major steps to achieve this (ERTICO, 2019). In this paper, we look at how this can be tackled through the implementation of TMaaS (Traffic Management as a Service), a neutral framework in a medium-sized Belgian town (Ghent), and the possibility of replicating the findings in other cities worldwide.

The paper is structured as follows; introduction to the TMaaS project, followed by a detailed overview of the Mobility Management as a Service (MMaaS) architecture and an example of the first TMaaS implementation in Ghent. Our main conclusions focus on the usability of the proposed framework and the prospects for future developments in this domain.

TMaaS

Traffic Management as a Service (TMaaS) is an innovative traffic management framework primarily designed with the needs of small and medium-sized cities in mind. The motivation behind a framework of this kind is threefold. First, substantial investments in the hardware installations typically needed to build a traditional traffic management center are unfeasible for smaller cities. Second, urban mobility is becoming increasingly complex, and today's traffic management centers focus primarily on car traffic. An increasing number of cities are building their Sustainable Urban Mobility Plans (SUMPs) around a multimodal and sustainable vision that is not consistent with traffic management systems that focus on a single transport mode (car) (European Commission, 2015). Third, with all the different solutions available cities often struggle to find compatibility with existing solutions as they are all dedicated to a specific mobility problem or transport mode. They also have problems trying to narrow the existing gaps by introducing open data and finding a balance in this landscape where compatibility is often restricted due to licensing. Hence for the concept of TMaaS. A neutral traffic management framework aimed at handling multimodal mobility information in a commercially neutral manner. In other words, it combines information about all the different means of transport with data in a single framework, which we will describe in greater detail in the following sections. However, the most exposed visual output of the TMaaS framework is probably the end-user dashboard.

In order to achieve this ambitious project involvement of all stakeholders has been necessary. The current TMaaS initiative is represented by a quadruple helix model (Cavallini, Simona; Soldi, Rossella; Friedl, Julia; Volpe, 2016) gathered around the TMaaS project (TMaaS consortium, 2019). The TMaaS project is a joint venture involving a range of partners from different fields such as TomTom and Be-Mobile; end-user representatives such as the European Passenger Federation; SME's including De Staatse Ruiter and WayLay; research partners such as Ghent University and KU Leuven; and the urban authority of Ghent, Belgium, we plan to include three more urban authorities in the scaling-up and TMaaS replication phase (Figure 1). The project started in February 2018, after receiving the support of Urban Innovative Actions (UIA, 2019), an EU (European Union) initiative. It will continue for three more years. During the first year it was already recognized by the Civitas network (CIVITAS network, 2018) as borne out by the Civitas Bold Measure award. This was followed in April 2019 with the Belfius Smart Belgium Award (Belfius, 2019), an acknowledgement of the interest from both urban authority networks and industry in the potential for a neutral traffic management framework.
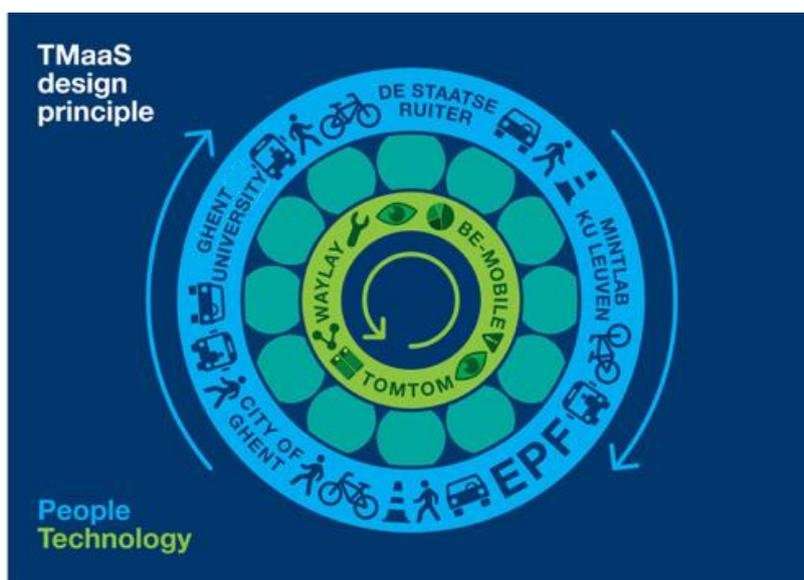

Figure 1. TMaaS quadruple helix context

The MMaaS architecture
In order to meet the above-mentioned ambitions, we needed to develop a framework that would satisfy the needs of multiple stakeholders (urban authorities, companies, mobility managers, citizens' initiatives, citizens, etc.). The framework needed to be flexible therefore, scalable and compatible with existing initiatives and solutions. This also meant that if cities already worked with some form of traffic management solution, open data policy or sensor network, the proposed framework had to be able to accommodate their needs. Not long after the launch of the project, we realized that our goal exceeded the initial traffic management scope and the following descriptions were drawn up that encapsulate a more holistic Mobility Management as a Service (MMaaS) frame. Figure 2 shows the MMaaS architecture that has been implemented in order to meet these needs. The architecture is composed of four layers that are portrayed by different data characteristics:

1. L_0 raw data,
2. L_1 standardized data,
3. L_2 data based insights (or processed data),
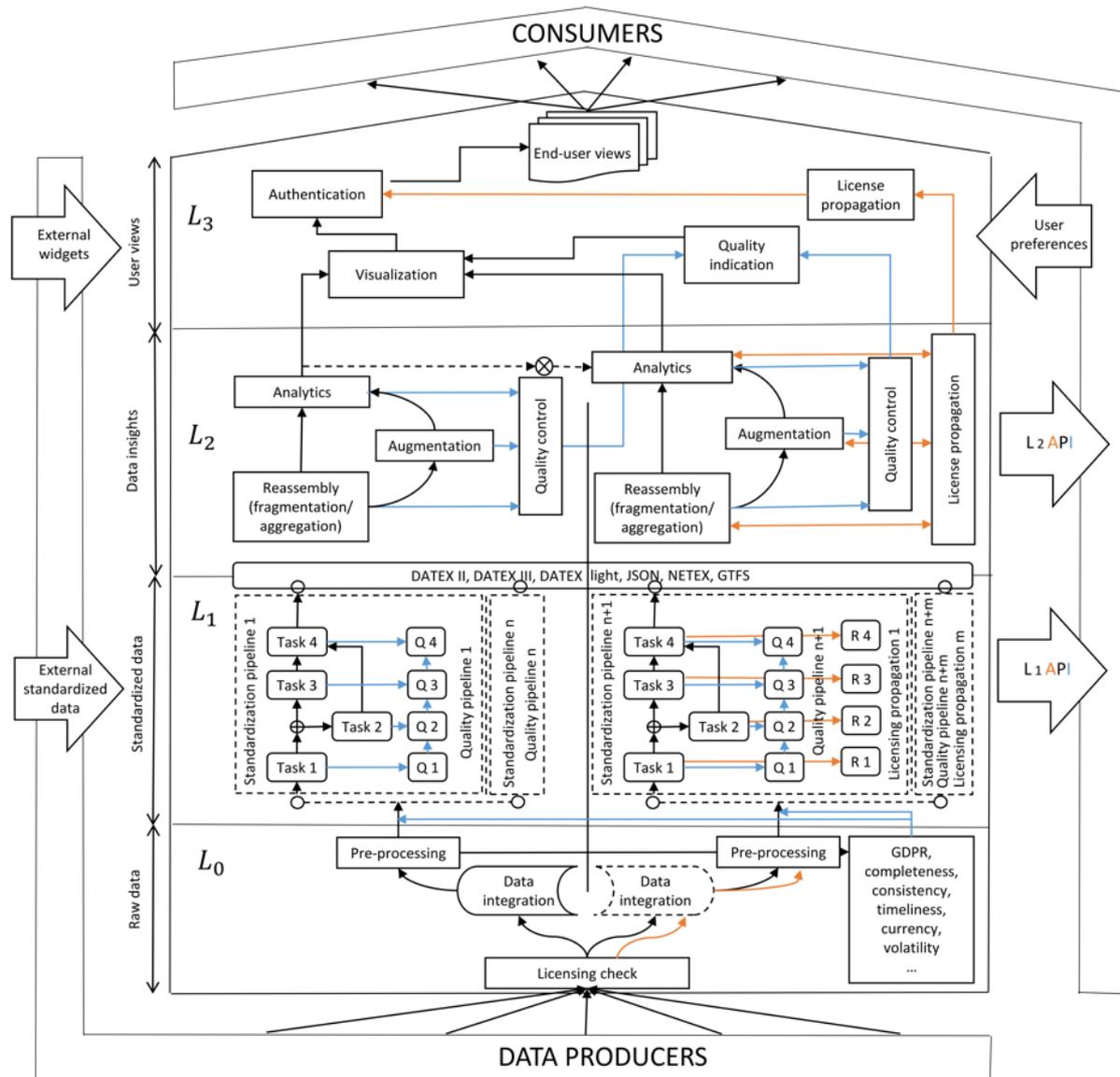4. L_3 end user views (or visualized data and insights).

Figure 2 MMaaS architecture

Data entering the architecture first passes through the licensing check, this means that data with no restrictions follows a generic processing flow where data is stored internally, to allow any historic data analysis, pre-processed with indication of data properties and characteristics such as completeness, consistency, privacy (local urban authority ensures compliance with local regulations), timeliness and other data quality dimensions (Bronselaer, De Mol, & De Tre, 2018). Following the data quality check, data enters the L_1 level where it is standardized. There are two aims to the standardization process: (1) to generate data in one of the MMaaS-accepted generic data formats and (2) to control and note the data quality (blue arrows) in each processing step as these might cause change in the reliability, relevance or applicability of the resulting data. The MMaaS-accepted generic data formats are considered to be:

- DATEX II, DATEX III, DATEX light - EU standards for the exchange of traffic related data (EC, 2019),
- JSON – general lightweight data-interchange format (Crockford, 2019),
- NETEX – EU standard for exchanging public transport schedules and related data (CET, 2019),
- GTFS – generic data specification for exchange of public transport schedules and associated geographic information (General Transit Feed Specification, 2019).

The list of the MMaaS-accepted generic data formats is extendable and flexible to enable the integration of additional well-defined transport data and generic standards identified as being necessary for the implementation of the framework.

The data that was linked to licensing rules in the first stage, follows a similar but separate processing path. This processing is carried out by a neutral party that commercial partners feel they can trust to accommodate and respect their licensing rules. Here, the licensing information (orange arrows) is propagated all the way through the MMaaS framework. This also means that the licensing information is propagated even if the data is made anonymous, fragmented or aggregated/augmented with other data sets (open or commercial) and that no processing and/or joining will be done unless the license allows this. Furthermore, the data will only be stored for historical analysis if the license allows this. Hence, the data standardization process also includes continuous notation and compliance with all licensing rules. External data providers can provide data already available in the MMaaS-accepted generic data formats horizontally, at the L_1 level. This data will only pass through the data quality and license check to ensure association with the correct processing path. Also, based on the authentication and the licensing rules, external data consumers can receive standardized data through the external API with the data quality and licensing information propagated.

Data in the standardized format can then use any of the integrated analysis, be joined or fragmented, augmented with additional data to create new data insights that meet end user requirements. External consumers can also, again based on the authentication and the licensing rules, access the results of these analyses. The purpose of this is to meet the needs of the wider group of stakeholders. Local app developers are thus able to use reliable data sources for mobility information, shop owners can integrate practical information on their website (e.g. real-time routing), logistic companies can integrate mobility information into their tools and/or analysis, etc. The consumer side of the framework can therefore, whilst respecting the licensing rules, act as a mobility market option.

At the highest level, data and generated insights are visualized in a user-friendly way. Based on the user preferences, different user views can be generated and accessed following the authentication process. For example, this allows urban authorities to create personalized views if they want to have dedicated insights - based on car parking availability for instance. Uniform visualization of data from different providers and commercial parties can also be provided as a unique map view. Furthermore, specialized services such as the police, or public transport companies, can create specific dashboard views or focus exclusively on a specific area or route. The geographic scalability also can be useful for different citizens' initiatives or scientific projects with dedicated end-user views. Citizens can create personalized views for their mobility. The user preference interface also allows end users to generate alerts, so that traffic management centers can receive alerts when car parks or travel times reach alert-worthy levels. This also means that citizens can receive a personal alert when, for example, there are disturbances on their commute route; they can receive messages advising them about alternative routes based on their preferences. At this level, external data providers can also integrate/offer their dedicated widgets to be used in dedicated views. An important option is the integration of communication channels into the

framework. One example of this is the option for citizens to contact urban authorities and receive feedback about their comments. This may relate to simple reporting (e.g. pothole and obstacles) or indicating traffic congestion or other relevant information. At an urban level, it ensures uniform reception of messages from different communication channels (e.g. SMS, social media etc.) and the possibility to group and analyse these based on location, severity, etc.

How is the first TMaaS platform being used?

The component of the MMaaS framework that is dedicated to traffic management is called TMaaS. The goal of the TMaaS project was to carry out the first TMaaS implementation within the first two years by joining forces with the Ghent traffic management department. Figure 3, describes the city case for Ghent, where the aim of "helping citizens make smarter choices before starting their trip" is identified as one of the goals in their urban mobility vision. A full set of available open data about the city (e.g. counting loops, variable message signs, public transport information, etc.) was integrated together with the data from the commercial partners in the same area. This data, based on the licensing information, followed its own processing path and resulted in standardized data and generated insights. It also includes information provided by citizens with regards their personal preferences with regards personal mobility habits and attitudes. Data is processed in a license propagation-based neutral framework. This means that original licensing rules for each data source are noted and propagated through the whole processing chain. This may include licensing restrictions, for example which other data sources can (or cannot) be integrated, or mapping restrictions (e.g. on which map background specific data can be shown), or rules as to what extent end users can be notified of each individual data point source etc. The aim of the TMaaS processing chain is to deliver innovative mobility insights that meet the needs of urban traffic managers as well as those of citizens in terms of their personal preferences for mobility information, within a mobility framework in which industry partners feel comfortable about cooperating because it does not impose favorability over a specific industry party (no vendor lock-in is possible) or over the open data paradigm in a way that makes commercial data providers reluctant. Once the data is pre-processed, standardized and normalized, outside parties can also use the TMaaS external API's so that they can benefit from the data to build their own insights and/or integrate data into their own applications. The external API's also safeguard the original licensing rules as licensing propagation and data quality indication are also propagated to this point. And finally, the TMaaS insights are integrated into a traffic management dashboard, which allows the city to monitor and manage multimodal mobility in their area, based on a one-spot data-driven overview (Figure 4). From this point on therefore the responsible traffic management authority has to manage further possibilities for the local area. For example, it is possible that a decision is taken, depending on the local policy, to prioritize certain corridors within the city for specific options (e.g. bicycle traffic or public transport) and to send citizens alerts with incentives in line with the desired modal shift. Furthermore, decisions to redirect traffic via VMS (variable message signs) can be implemented and the impact of the measure can be directly observed. Traffic managers can update the data flow (e.g. after the road works have been completed) and this information gets propagated to the data providers who can update their services before they would usually be alerted by floating car data for example or updates from the road works database.
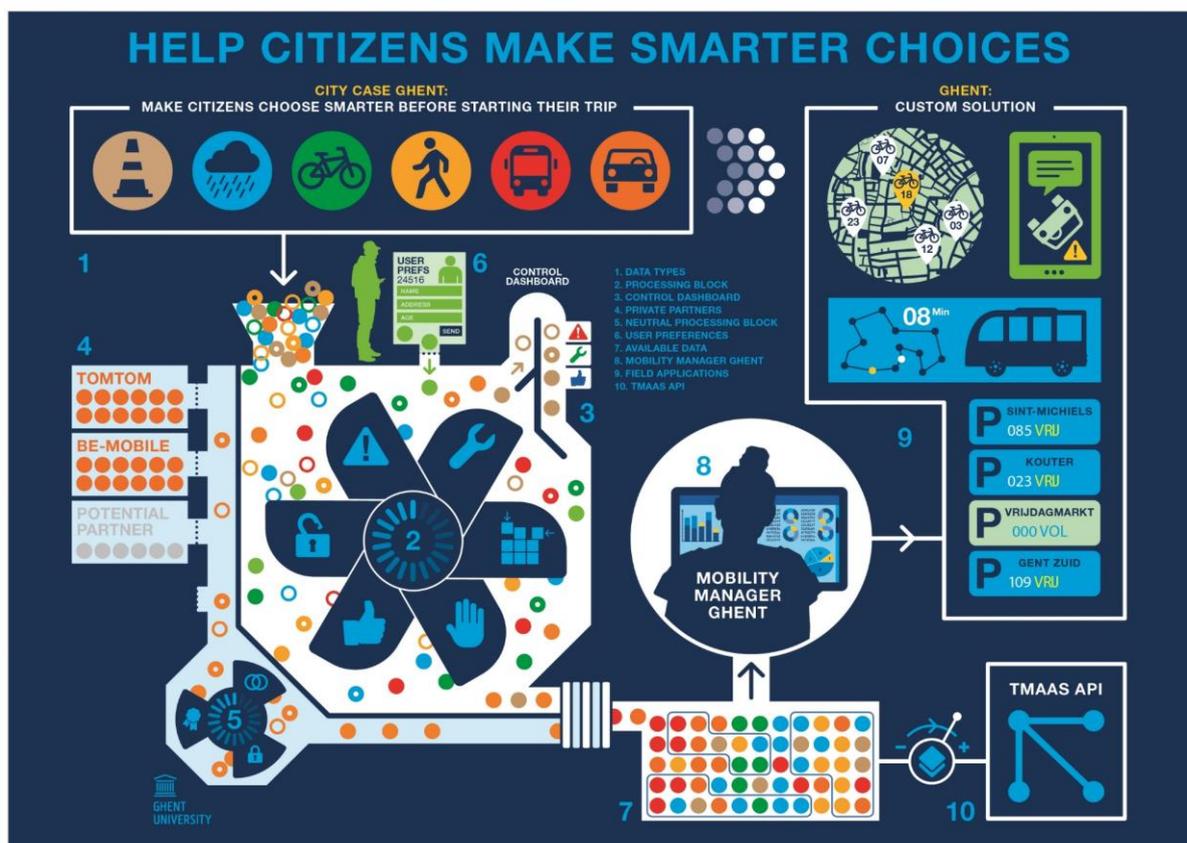
Figure 3. TMaaS framework (city case Ghent, Belgium)

Furthermore, in the first phase of implementation, the residents of Ghent can log in to the online platform and use the data to simplify their mobile lives. They can choose the data they want to see on their personalized dashboard. They can enter their favorite routes and obtain information about the traffic on those routes. This enables them to avoid traffic jams on their way to work, or to find out if there are delays affecting the buses or trains on these routes, etc. The advantages of the system for the city of Ghent and the residents who subscribe are myriad. Residents gain immediate access to information about the various means of transport or their favorite routes. Subscribers receive real-time and personalized traffic advice about their neighborhoods or journeys (i.e. accidents, traffic jams, delays, availability of vehicles in car-sharing networks, train timetables, bicycle parking, car parking spaces, weather updates, etc.). Commuters are informed about their journeys, and also notified of alternatives where necessary. Residents are thus able to travel in the most efficient, safe, sustainable and enjoyable way. Furthermore, traffic managers of the Ghent traffic management department are able to monitor all mobility data, benchmark their SUMP implementation and perform a dedicated (historical or real-time) analysis.

The long-term TMaaS vision is for every small to medium-sized city to be able to subscribe and immediately gain insights into mobility, manage traffic and communicate with citizens. For this, TMaaS requires high standards of flexibility and transferability. This is why a trial run of the TMaaS concept has been planned in a number of so-called 'replicator cities'. Ideally, we wish to test the concept in a series of radically different contexts in order to learn as much as we can. The replicator cities will be chosen based on their mobility issues, their ambitions for setting up a traffic control center, and the level of maturity of their existing traffic management solutions. The implementation of the replication

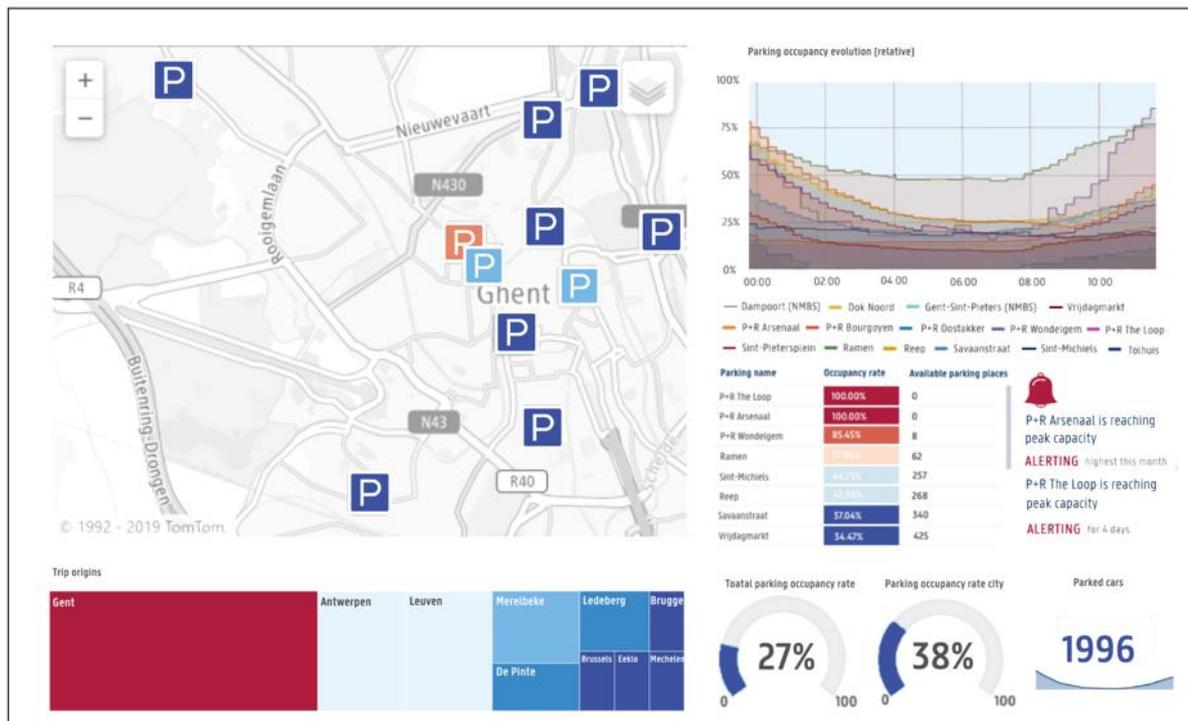activities is scheduled 2020 (TMaaS consortium, 2019).

Figure 4 TMaaS end user view example (parking view, Ghent, Belgium)

Conclusion

The challenge involved in the implementation of the MMaaS and TMaaS is not merely technological, but organizational. Traditional traffic systems are still all closed systems in which data and platforms are offered and managed from one single company. Given that the problems in our cities are becoming increasingly complex – multimodal mobility, urban logistics, the environment, energy, etc. – these types of monolithic systems are becoming inadequate. Breaking open these systems, together with the industrial partners of the TMaaS project is a major mission.

The innovative aspect has always been quintessential to the development of the framework. From day one, the goal of TMaaS was to offer a forward-thinking alternative to the traditional traffic control room. Our goal is to become a new, user-driven and future-proof concept for the analysis, management and communication of mobility data.

TMaaS tackled several challenges therefore:

Connected mobility data
TMaaS goes beyond ad-hoc development for integrating local mobility data. This requires flexibility in data governance (centralized/decentralized; external/open/proprietary data) in order to ensure "One-road-for-all mobility". TMaaS combines data sources enabling connected analysis of all mobility. This entails being able to connect the data sources, single out certain parts of the data and enable this information to travel through the system. There is one road and all activity passes through it. If the data sources are not aligned and their properties are unknown, it is impossible to integrate them. It is possible for example, that reports do not come in simultaneously. This meant that TMaaS had to apply certain standards for the refresh rate and the quality of the data to be taken into account, so that it would be of value to others. Furthermore, optimal efficiency was required of the internal data structure to ensure that integration would be as simple as possible. This is especially important when it comes to scaling up the platform.

Mobility data analytics and management
TMaaS goes beyond closed systems for mobility data processing. TMaaS is seen as a neutral framework that can process services from different providers. In this context, it supports the connection of different providers in order to evolve from the single-system practice by ensuring a documented API that allows third parties to offer new services to the platform and by safeguarding and propagating data licensing, privacy and data governance.

Promoting mobility co-creation and an open urban traffic management marketplace
TMaaS goes beyond top-down management and single systems. TMaaS provides not just local authorities but also all stakeholders with flexible mobility tools to enable them to co-create urban mobility solutions and the TMaaS consortium is looking to find new business models in connected urban traffic management.

Promoting open innovation in traffic management
TMaaS could be considered as a modular cloud-based platform therefore that brings together existing data about urban mobility from different stakeholders. It not only visualizes, but also interprets the mobility data that it is fed and alerts operators when necessary. Operators and cities can set thresholds and configure preferences for those alerts. They can see the real-time status of all transport modes on a dashboard and can go back in time. The targeted user group for this platform includes the city and its traffic operators as well as its residents.

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