RĪGAS TEHNISKĀ UNIVERSITĀTE

Towards Avoiding Traffic Jams in Large Cities

Aleksandrs Gorbunovs, Riga Technical University, Latvia
Scientific adviser: Guillaume Deffuant, INRAE, France

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TED4LAT

Funded by the European Union

The goal of this study

- To explore opportunities for optimizing the flow of private vehicle traffic in large cities

- To develop a comprehensive model that addresses the interests of private car owners, municipal authorities, and overall resident well-being

Introduction

Definition

There are so many definitions and explanations of the term «well-being», covering various domains of well-being;

However, let's pay attention to the definition provided by the World Health Organization that addresses human and society expectations the most:

- "Well-being is a positive state experienced by individuals and societies. Similar to health, it is a resource for daily life and is determined by social, economic and environmental conditions" / WHO, Health Promotion Glossary of Terms 2021; published on 6 December 2021/

The transportation issue –
a considerable component in the well-being structural system

Framework for examining interactions between sustainable development goals

The transport could be considered as the part of Infrastructure domain interacting with Well-being and Natural environment domains, as well with other subdomains within its Infrastructure domain.

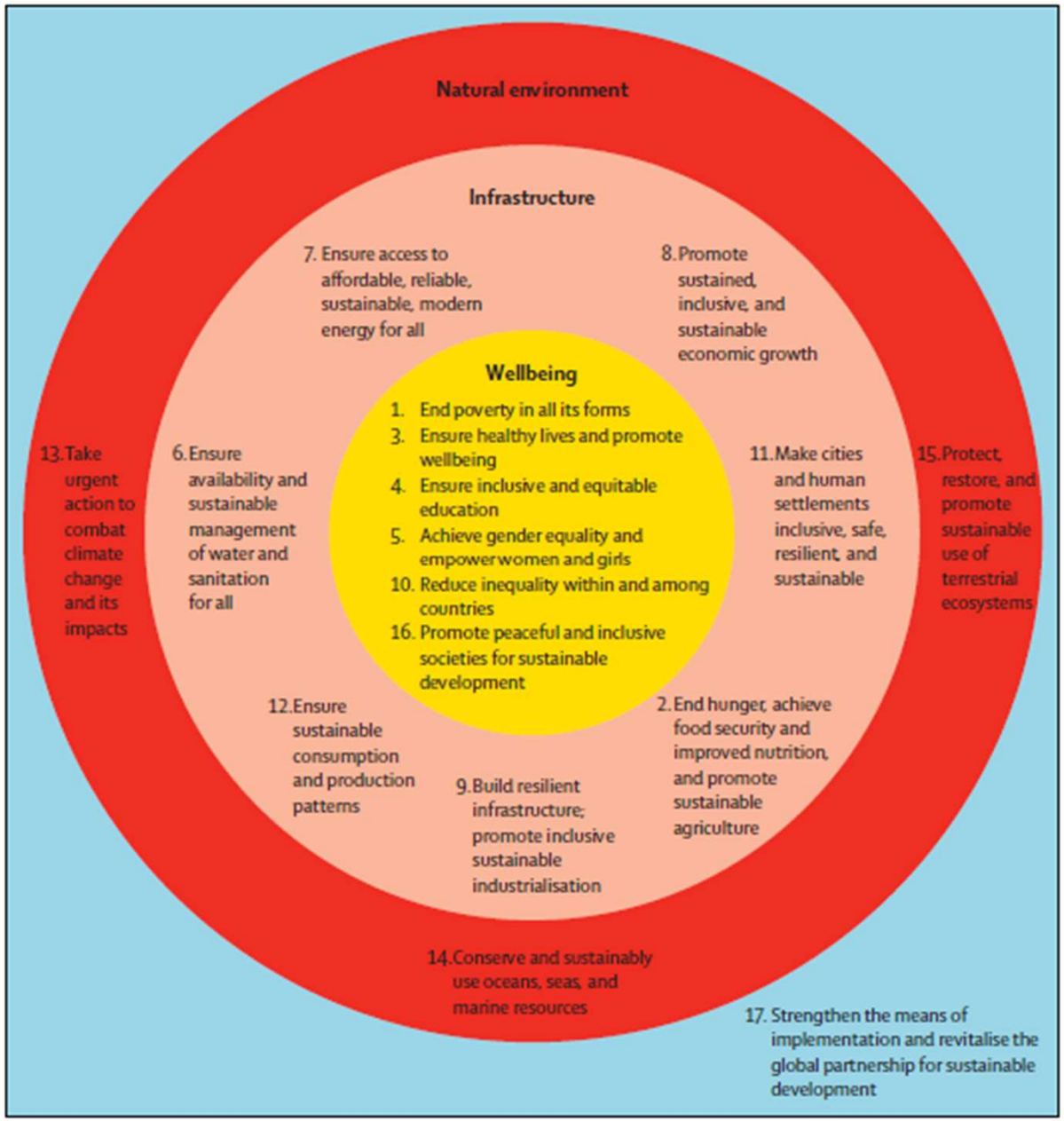


Fig. taken from:

Waage J, Yap C, Bell S, et al. Governing the UN Sustainable Development Goals: interactions, infrastructures, and institutions. *Lancet Glob Health 2015*; 3: e251–52.

Transportation issue: main aims of the use

- The movement of people,
- The delivery of goods,
- The provision of services,
- Emergency
- Private vs Public transport

…

Increasing the number of vehicles

- The global number of cars on the road … will nearly double by 2040, according to a report released by research house Bernstein .
- The number of cars possibly will reach the two billion mark by 2040
- Most of this transport growth is expected to happen in **emerging markets** (i.e. China and India), as global populations are set to rise by another two billion over the next 25 years to 9.2 billion
- Despite growing in emerging markets, demand in the US and Europe is expected to fall as both regions reached peak oil over ten years ago in 2005

Projected global transport growth till 2040

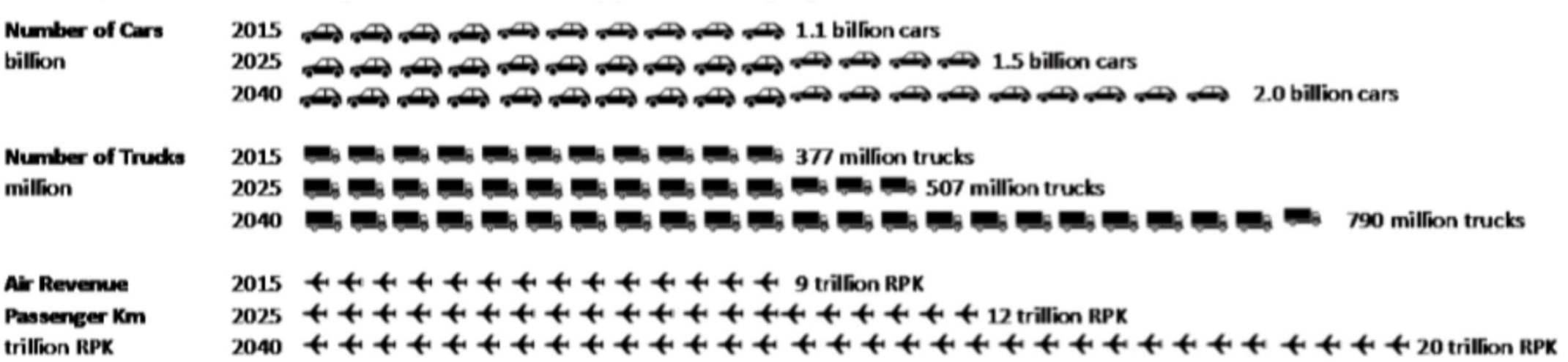


Image: Business Insider

Fig. is taken from:
Business Insider & World Economic Forum (2016),
https://www.weforum.org/agenda/2016/04/the-number-of-cars-worldwide-is-set-to-double-by-2040/

Increasing the number of vehicles: challenges

- As individuals prioritize their well-being, there is a corresponding expectation for improved living standards.
- Addressing these evolving needs requires the implementation of more efficient technological solutions, particularly in the transportation sector.
- The number of vehicles on our roads continues to rise steadily.

…

- While this growth may address certain aspects of well-being, it also presents challenges that can impede the effective fulfilment of these needs (particularly concerning capacity and timely services).
- This situation is notably acute in densely populated urban areas, where traffic congestion can result in delays affecting transportation, delivery of goods, and daily commuting.
- Additionally, the environmental implications of the increasing number of vehicles are significant, as road congestion contributes to air pollution through vehicle emissions.

Increasing the number of vehicles: challenges (cont.-1)

Hence, the main challenges according to Meneguette et al. (2018) are:

- Traffic congestion / traffic jams

More vehicles --> more traffic jams

It impacts travel times – makes it (much) longer

It increases frustration among drivers and passengers

The growing number of vehicles exacerbates the problem, creating a cycle of congestion that is hard to break

/I. Meneguette, R., E. De Grande, R., A. F. Loureiro, A. (2018). Applications and Services. In: Intelligent Transport System in Smart Cities. Urban Computing. Springer, Cham. https://doi.org/10.1007/978-3-319-93332-0_7 /

Increasing the number of vehicles: challenges (cont.-2)

Hence, the main challenges according to Meneguette et al. (2018) are:

- Mobility issues

Increased number of vehicles affects the overall mobility within cities

Public transport systems can become overwhelmed

The efficiency of travel on public transport diminishes

Therefore, the use of public transportation system decreases --> it leads to reliance on personal cars

And, the use of personal vehicles compounds the problem of congestion much more

Increasing the number of vehicles: challenges (cont.-3)

Hence, the main challenges according to Meneguette et al. (2018) are:

- Car accidents on the roads

More vehicles on the road correlate with a higher likelihood of accidents

More vehicles increase the density of traffic

More density can lead to more collision

Thus, more collision endanger lives, and

More collision also contribute to further congestion (as accidents block roadways)

Increasing the number of vehicles: challenges (cont.-4)

Hence, the main challenges according to Meneguette et al. (2018) are:

- Environmental impact

More vehicles - higher emissions of harmful gases

Air quality is getting worse

It impacts climate change

The environmental footprint of urban transportation systems is a growing concern

Increasing the number of vehicles: challenges (cont.-5)

Hence, the main challenges according to Meneguette et al. (2018) are:

- Financial Costs

Time spent in traffic translates to lost productivity,

The costs associated with accidents and environmental damage can be substantial

Cities may face increased expenses in managing traffic and maintaining infrastructure

Increasing the number of vehicles: challenges (cont.-6)

Hence, the main challenges according to Meneguette et al. (2018) are (cont.):

- Need for Intelligent Transportation Systems (ITS)

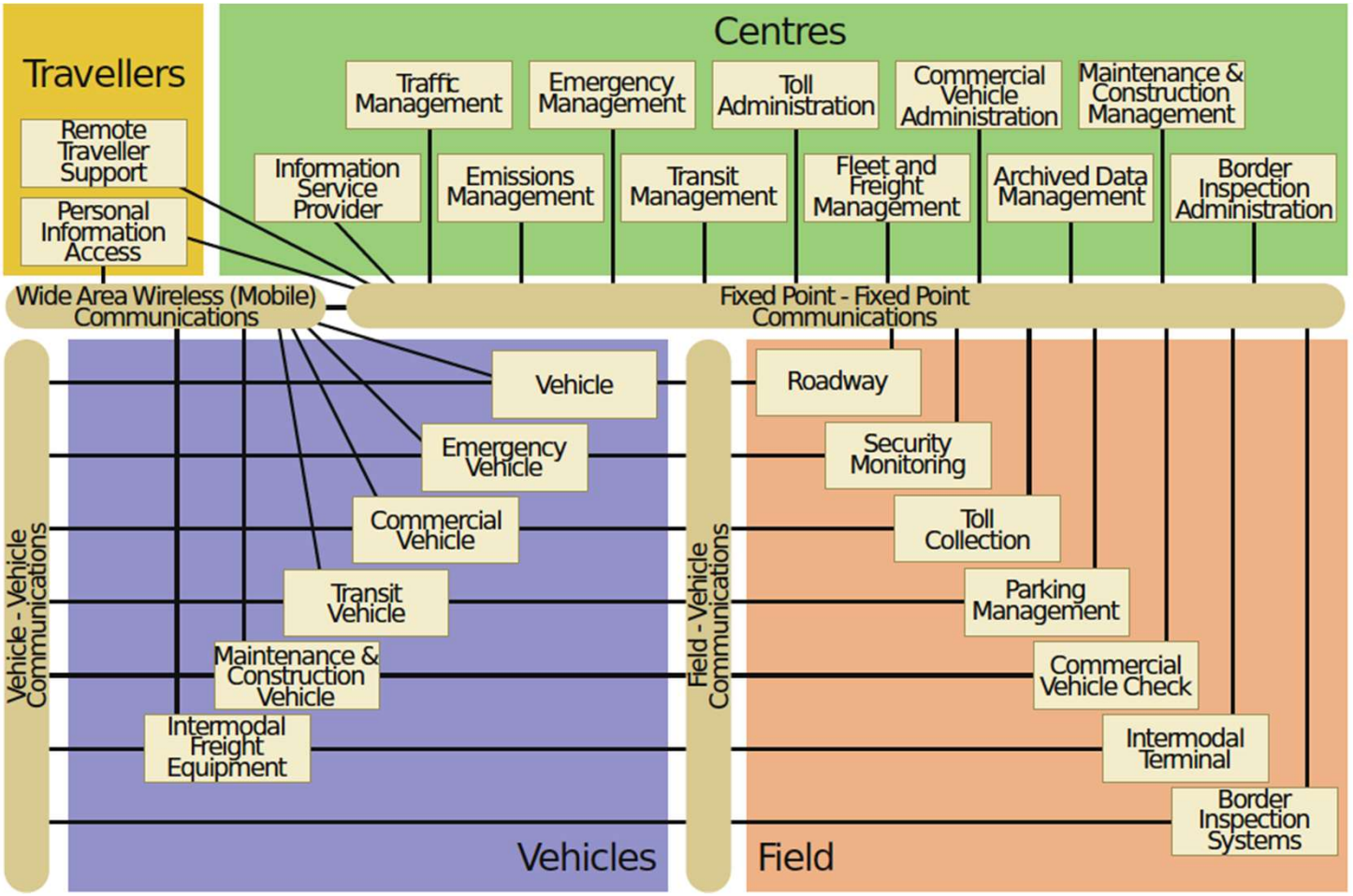
To solve noted before challenges, there is an urgent need for advanced technologies and services, such as Intelligent Transportation Systems (ITS)

These systems can help:

- monitor and manage traffic flow,
- improve safety,
- reduce environmental impacts by utilizing vehicular networks and data dissemination techniques

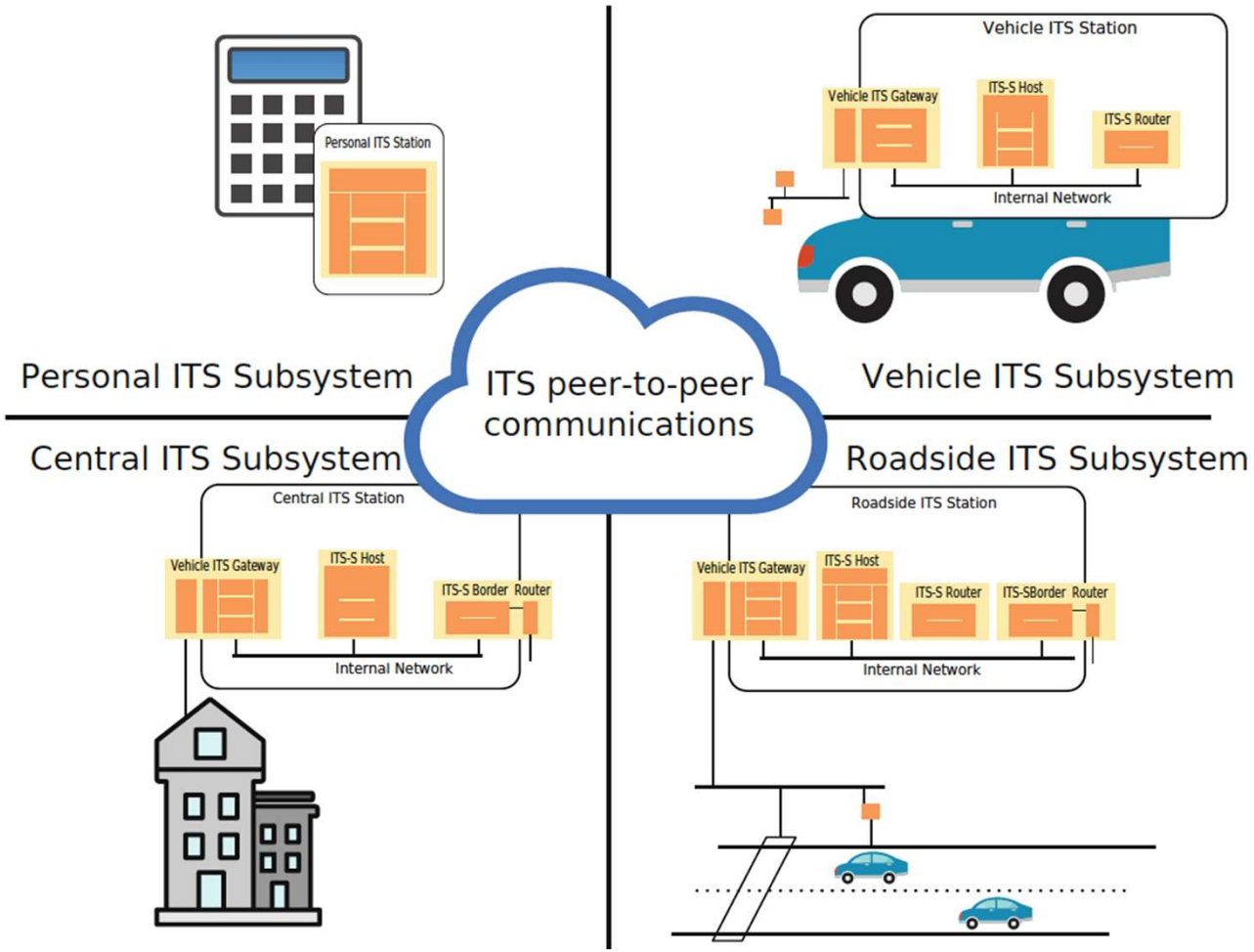
- Initial Intelligent Transportation Systems Concept – proposed last century /Alam M, Ferreira J, Fonseca J (2016). Introduction to intelligent transportation systems. *Springer, Cham*, pp 1–17/

Intelligent Transportation System (Canada's example)



ITS architecture for Canada subsystems and communications /Transportation Association of Canada (2017) ITS architecture for Canada/

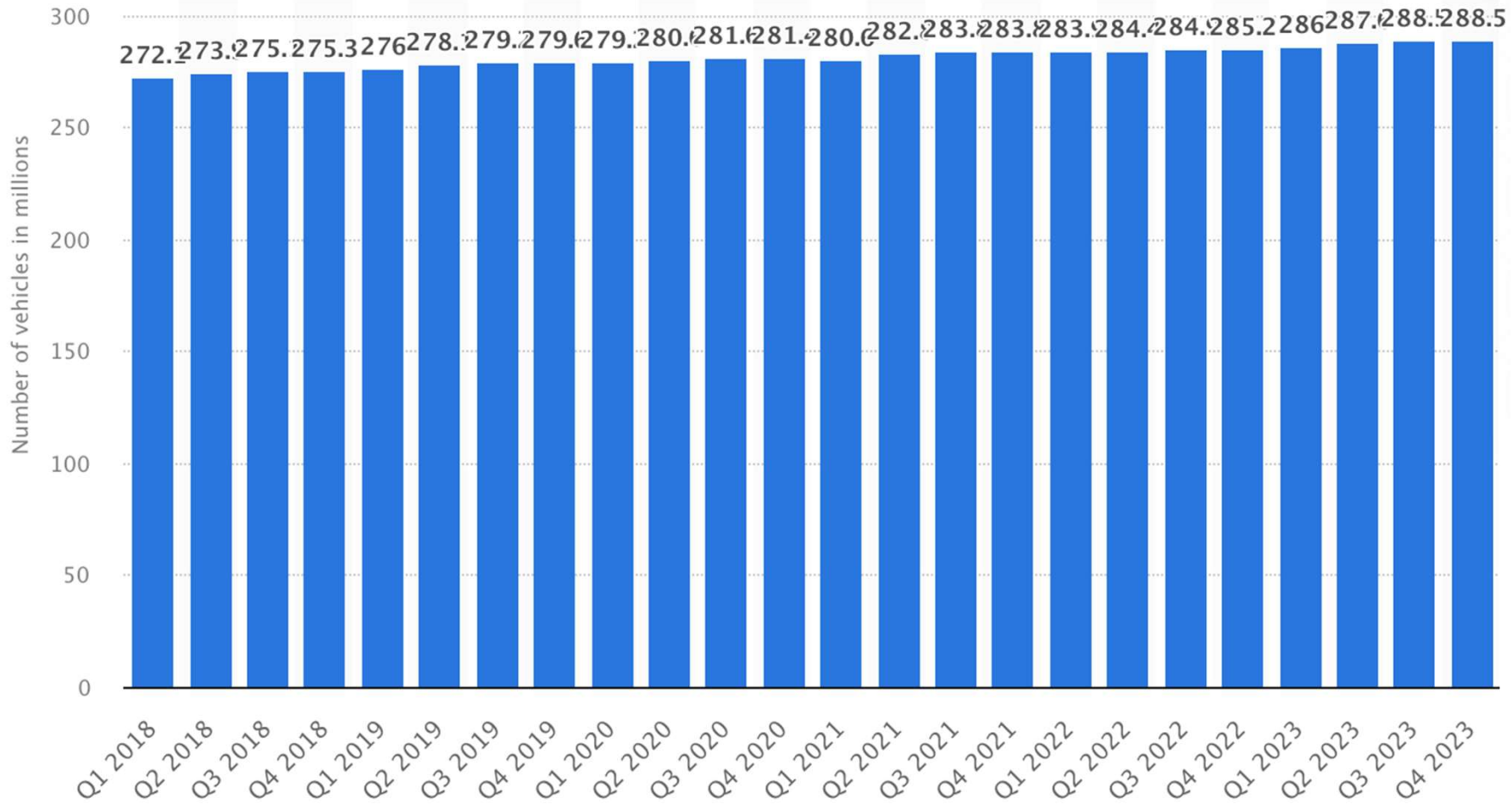
Intelligent Transportation System (example: European ITS architecture)



European ITS architecture: communication subsystems

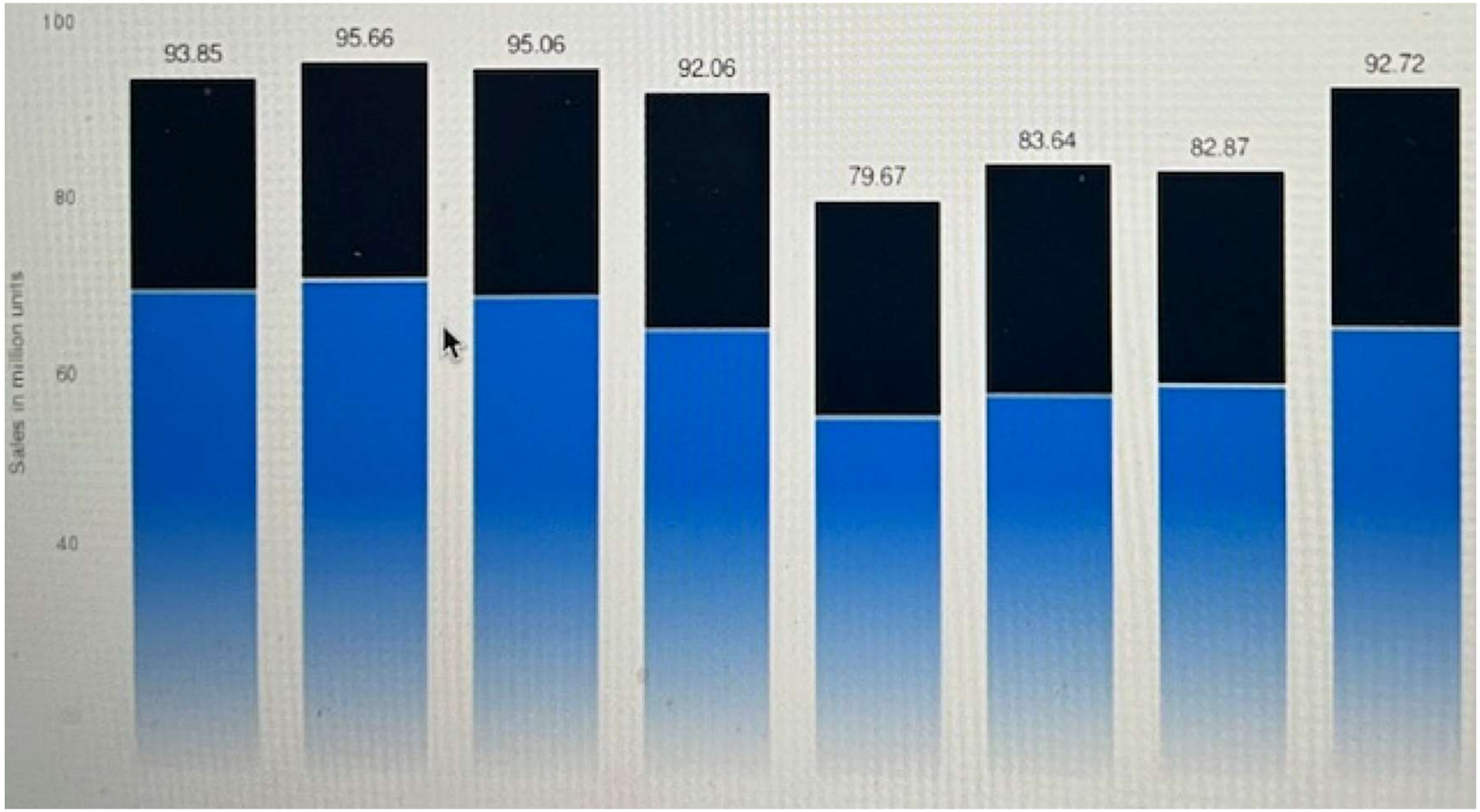
/ European Telecommunications Standards Institute (2010) Intelligent Transport Systems (ITS) communications architecture /

Number of vehicles in operation in the United States between 1st quarter 2018 and 4th quarter 2023 (in millions)



/Statista, 2024/

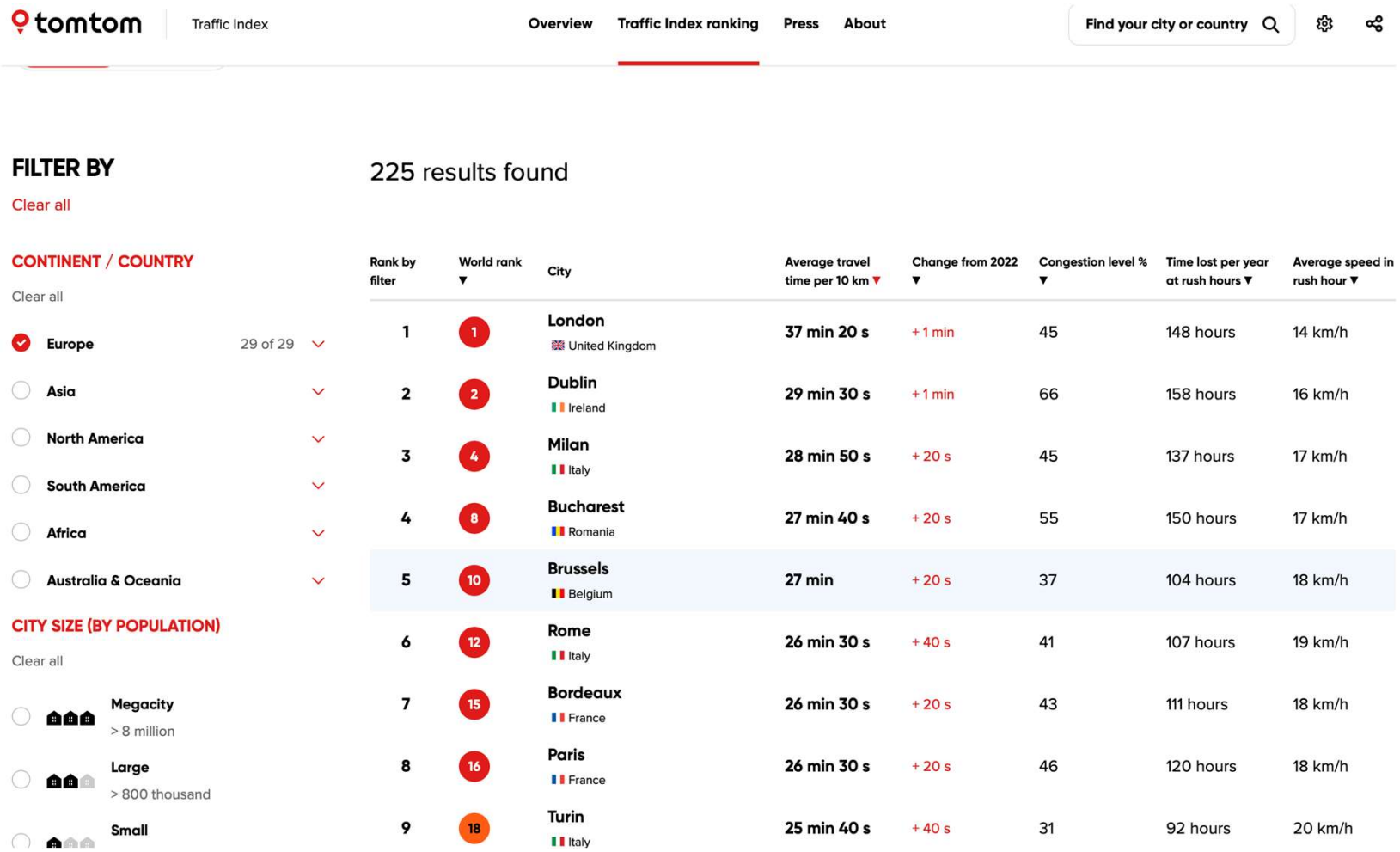
Global motor vehicle sales by type from 2016 to 2023 (sales in million units)



/Statista, 2024/

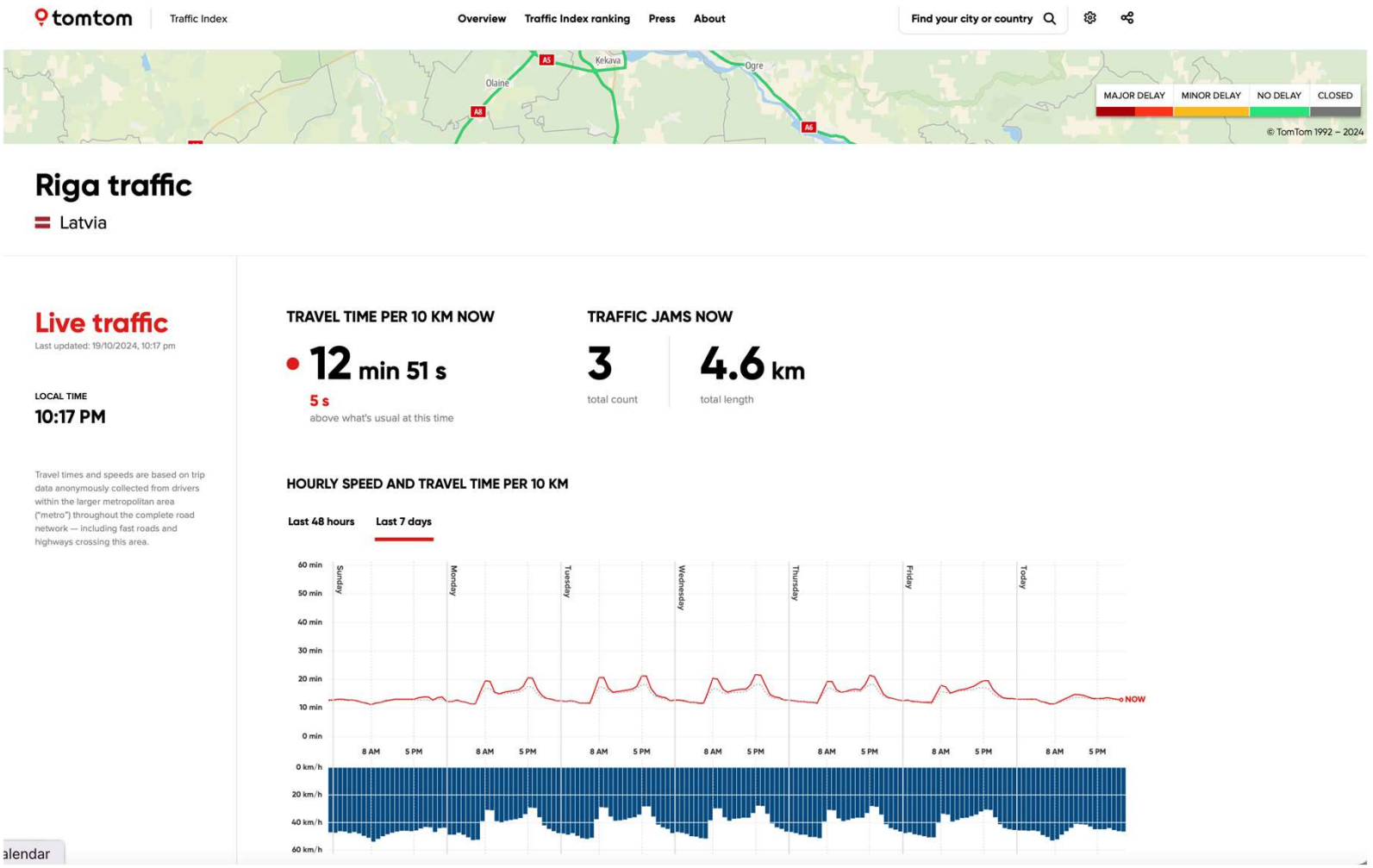
TomTom Traffic index

- TomTom Traffic Index evaluates average travel time, fuel costs, and CO2 emissions in 387 cities across 55 countries



https://www.tomtom.com/traffic-index/ranking/

TomTom Traffic index – cont.2 (example – Riga, Latvia)



https://www.tomtom.com/traffic-index/riga-traffic/

TomTom Traffic index – cont.3

Some data retrieved from the TomTom Traffic Index:

- London’s city center was the slowest to drive through in 2023, with an average speed of 15 miles/h throughout 2023
- Dublin is the most congested city at peak times in 2023, with daily commuters having lost 153 hours to traffic*.
- In 2023, average speed decreased in 228 of the 387 cities analysed, compared to 2022.

https://www.tomtom.com/traffic-index/ranking/

TomTom Traffic index – cont.4

- The TomTom Traffic Index is based on floating car data (FCD), collected from various sources.

- Travel time in different cities is a result of multiple factors, which can be grouped into 2 (the sum of both gives the travel time):

a) quasi-static factors (e.g., road infrastructure, such as street categories, capacities, and speed limits) determine the optimal travel time in the city;

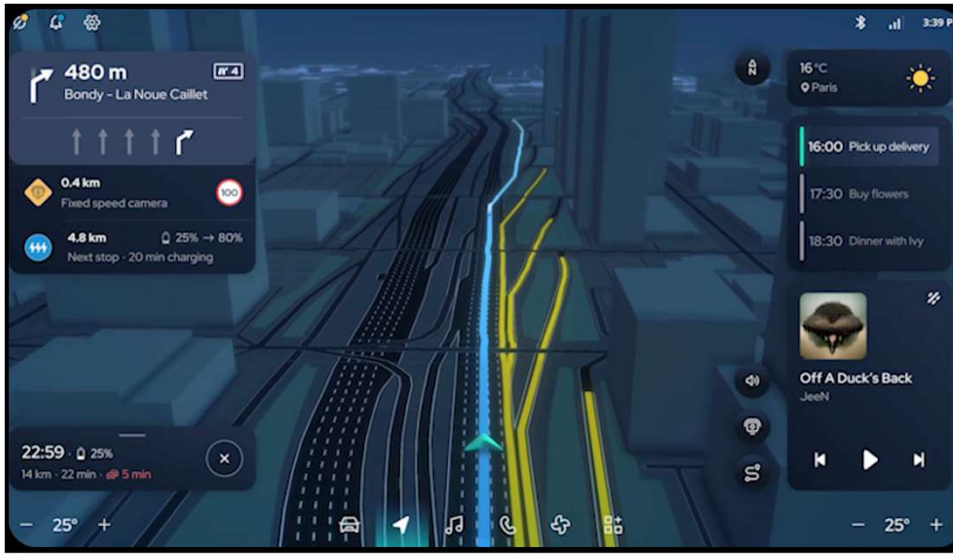
b) dynamic factors (e.g., traffic congestion and changes in flow) show the traffic flow changes.

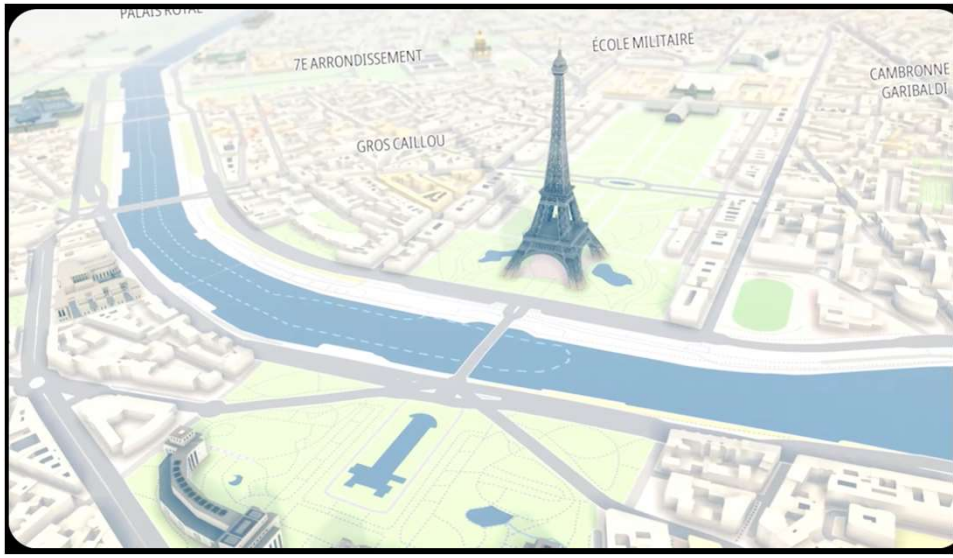
TomTom Traffic index – cont.5

TomTom Orbis Maps

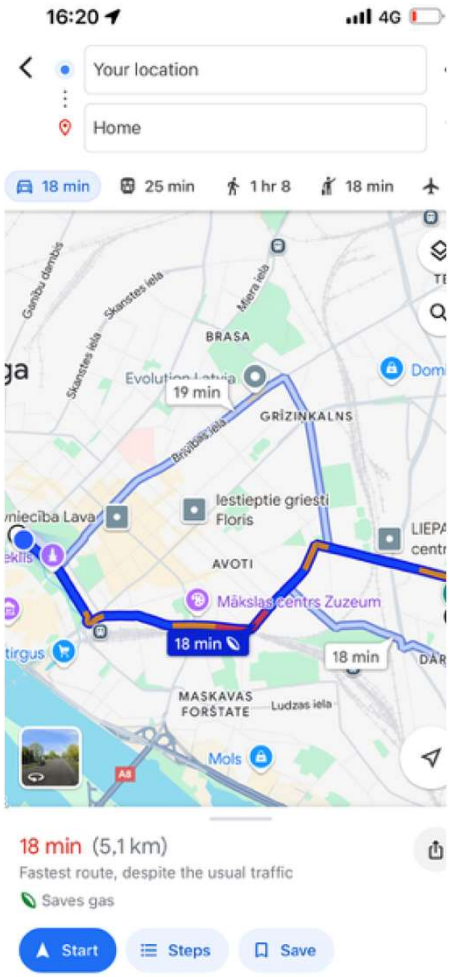
Integrate your own data into custom, private solutions

https://www.tomtom.com/tomtom-orbis-maps/





Example from Google Maps (Riga)



EU Regulations related to urban transportation

Several groups / frameworks / directions:

- Sustainable urban mobility
- … and Urban Mobility Framework initiative
- Sustainable urban mobility: planning and monitoring
- Urban public transport & shared mobility
- Active mobility: walking and cycling
- Urban Vehicle Access Regulations
- Zero-emission urban freight logistics and last-mile delivery
- Urban mobility and climate-neutral cities
- EU Urban Mobility Observatory
- CIVITAS
- Expert Group on urban mobility

EU Regulations & Vision

- **Sustainable urban mobility**

Over 70% of EU citizens live in urban areas (cities, towns and suburbs) that generate 23% of all transport greenhouse gas emissions. There is the necessity to reduce these emissions (by at least 55% by 2030 and by 90% by 2050) /https://transport.ec.europa.eu/transport-themes/urban-transport/sustainable-urban-mobility_en /

- Consequently, the **EU Urban Mobility Framework initiative** proposes measures to encourage EU Member States to develop urban transport systems that are safe, accessible, inclusive, affordable, smart, resilient, and emission-free /European Commission (2021). The New EU Urban Mobility Framework, https://op.europa.eu/en/publication-detail/-/publication/ad816b47-8451-11ec-8c40-01aa75ed71a1/

EU Regulations & Vision

- **Urban Vehicle Access Regulations (UVARs)**

(such as low emission zones, zero emission zones, tolling/congestion charging, pedestrian areas, parking schemes and limited traffic zones)

/https://transport.ec.europa.eu/transport-themes/urban-transport/urban-vehicle-access-regulations_en /

Regulations can help cities to comply with EU air quality standards and to limit congestion and traffic-borne emissions and increase safety.

Access usually dependens on the vehicle type, emission class and payment of tolls or fees.

In Europe, 73% of UVARs are low (and zero) emission zones /EIT Urban Mobility (2021). Urban Mobility Next 6; Urban vehicle access regulations: from design to implementation, October 2021, https://www.eiturbanmobility.eu/wp-content/uploads/2022/10/EIT-UrbanMobilityNext6_HD2.pdf /. – The first report on UVARs

PTV Group

- PTV Group, together with Econolite, is part of Umovity, a global market leader for end-to-end traffic management and transportation technology that takes a holistic approach to providing safer, smarter, and more sustainable Mobility for Humanity

- “Around 4.4 billion people - more than half of the world’s population - live in urban areas today. Cities are denser than ever before, yet urbanization continues to increase. By 2050, 58% of the world’s population will be living in cities, and by 2100 it will be 85%” /PTV Group, https://www.ptvgroup.com/en/application-areas/urban-mobility)
- Proposes forecast and design urban mobility systems using a **digital twins** of cities approach.

Road Infrastructure Department of the Ministry of Transport, Republic of Latvia

- The Department is working on development of new Regulations:
- The draft law on road tolls provides that from 2030, a road infrastructure toll will be introduced, which the vehicle owner must pay for using the national highway infrastructure, depending on:

- the distance travelled, and
- the type of vehicle, ensuring the application of the "user pays" and "polluter pays" principles , thus replacing the current road use fee for time (vignettes)

- The Department says that the draft law on road tolls has come from the requirement of the European Union (EU) directive for member states to introduce a road infrastructure toll from 2030
- The changes that are planned to be introduced from 2030 will apply to trucks over 3 tons, while currently no changes are being considered that would also apply to passenger cars.

Discussions

Possible solutions for model development to avoid traffic jams in large cities, save the time, reduce air pollution:

→ Review and change the regulations in which vehicles can enter the central part of the metropolis:
- access regulations;
- permits issued on residence basis (paid passes);
- permits issued depending on time of day and peak hours (paid passes – mobile payments);
- offering multiple incentives to drivers to discourage them from using private cars in the city centre
- improvement of public transportation system (frequency, quality, safety)

Discussions-2

Possible solutions … / cont.-2):

→ Mobility planning and facilitation on regular basis
→ Creation and launching Intelligent Transportation System in order to monitor and manage traffic flow, improve safety, reduce environmental impacts:
- sensors, smart traffic lights, video surveillance equipment 24/7, etc.
→ ITS integration in the Smart City concept, including AI tools and 6G technologies
→ “Vox Populi” – majority of city’s citizens may express their thoughts about more suitable solutions both for citizens-car-drivers, citizens-pedestrians, and municipality

Discussions-3

Possible solutions … / cont.-3):

→ Need to find out / take into account (for the city transportation infrastructure developers):

- Average travel time of 10 km during peak hours: generally it is longer than off-peak due to congestion. For instance, according to the TomTom Traffic index, it takes 20 minutes 20 seconds to drive a 10 km section in the central part of Riga during the peak of congestion.
- Peak hour toll: reasonable amount and exact timeframe on dedicated road sections to enter a congested area
- Off-peak toll
- Maybe – also motivational component for drivers: Public transport refund (vouchers) as the part of road toll payment
- Area where public transport vouchers can be used to pay for public transport tickets
- Possibility for the voucher owner to transfer public transport coupons to someone else (e.g. friends)

Discussions- 4

Ar the moment, this research ought to be considered as a position sight to be further developed to propose possible ways to avoid traffic jams challenges, and consequently improve human well-being in large (overcrowded) cities.

Possible journals for publication (if the research is reached the goals/time management)? TBD:

- International Journal of Urban and Regional Reearch

https://onlinelibrary.wiley.com/page/journal/14682427/homepage/fundedaccess.html

(indexed by SCOPUS (Q1))

Open Access cost: 3300 EUR

or

- Proceedings of the 16th Int.Scientific and Practical Conference “Environment. Technology. Resources” (indexed by SCOPUS); cost: 300 EUR.

or

- …

Invitation

The **16th International Scientific Conference "ENVIRONMENT. TECHNOLOGY. RESOURCES**”

Dates: **June 19-20, 2025**, Hosted by Rezekne Academy of Technologies, Rezekne, Latvia

Registration is available at the homepage of the conference https://conferences.rta.lv/index.php/ETR/ETR2025/login . The registration is possible using on-line form only.

- Registration and abstract submission (up to 300 words) until 10.02.2025.
- Notice of acceptance of abstracts and the request to prepare a scientific article to 17.02.2025.
- Submission of scientific papers in English until 24.02.2025.

All accepted papers will be published in conference proceedings (indexed in SCOPUS database).

Acknowledgement

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Thank You!