Innovative mass transit options

04 May 2023

MobiliseYourCity Mastering Mobility Series

Mobilise Your City

Training Developed By

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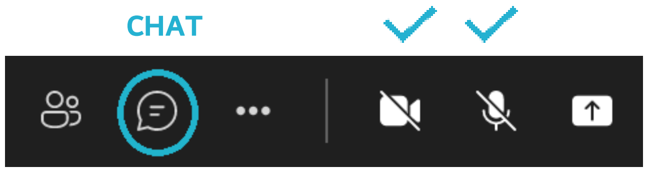
Some general notes on this session

Make sure you are muted and your camera is turned off



This session will be recorded. You will not appear in the recording if your camera is kept off

Include your questions in the chat, we will pose them in the Q&A at the end of the session

Don’t hesitate to share your ideas, comments and questions in the chat!

Learning objectives

- Gain a clear and unbiased picture of existing urban mass transit modes.
- Understand critical analyses needed to assess multiple urban mobility mass transit modes
- Get to know digital tools to optimise and enlarge service offers and their compatibility in each city

Contents

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Speakers

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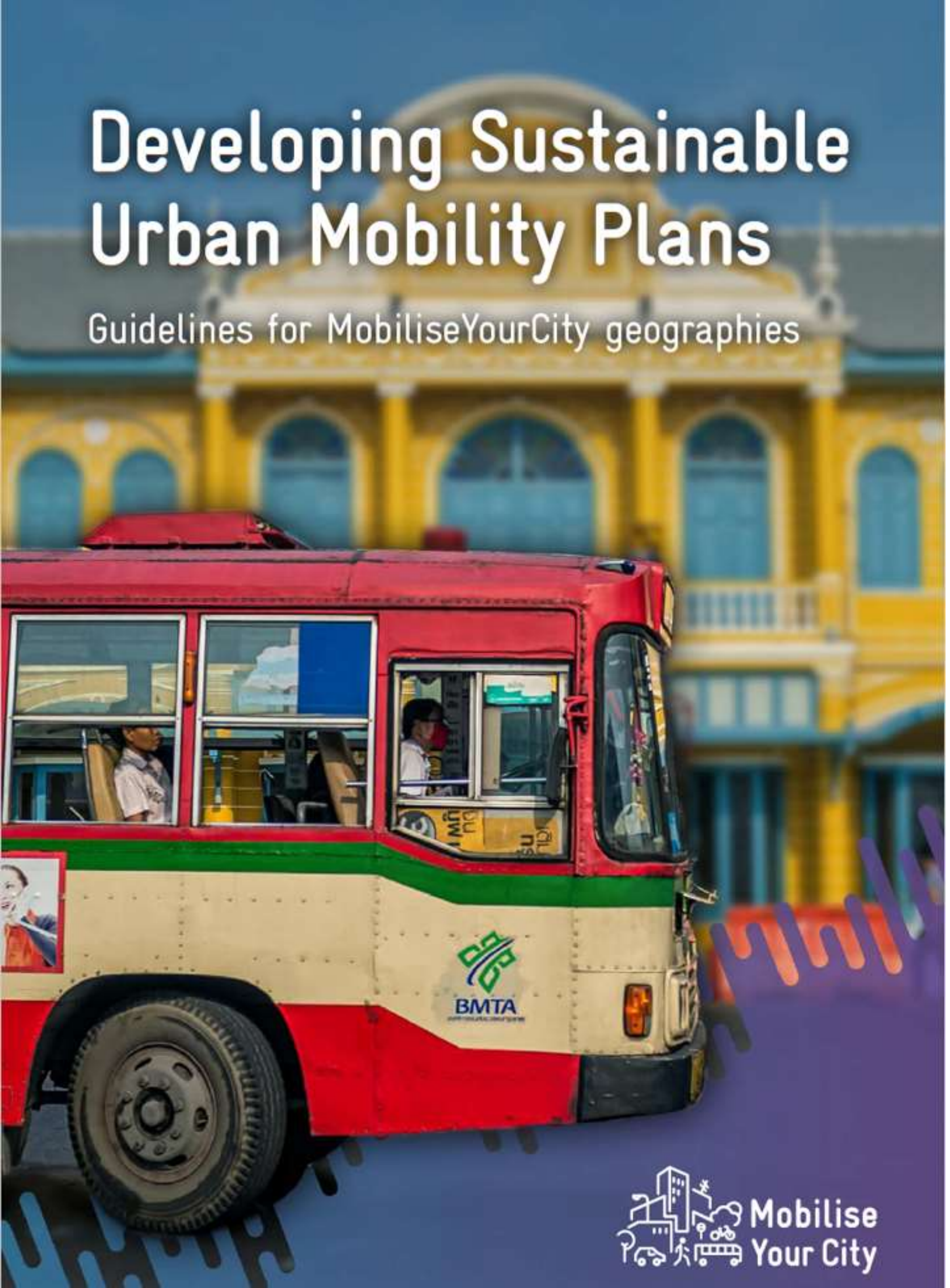

The MobiliseYourCity SUMP Guidelines

What is specific about the MobiliseYourCity SUMP methodology?

- Prepare a readiness assessment
- Set objectives in favor of climate change mitigation and adaptation
- Make the most of innovation and digital technologies' potential
- Establish sustainable mobility observatories for monitoring and evaluation of the SUMP
- The Guidelines are embedded within a robust system of support for cities

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2

Existing urban transport modes around the world

Re-considering existing modes

How do we choose a mode?

What are the forces transforming individual mobility?

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Reconsidering traditional modes

Mass Rapid Transit (MRT)

Service Description

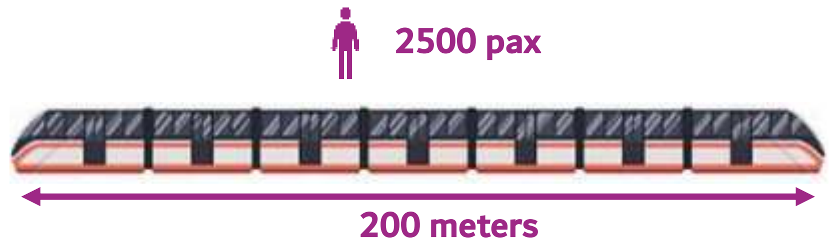
- **high-capacity** public **railway** transport systems
- found in **urban areas.**
- **Electrically powered** trains
- Operate on **exclusive right-of-way**
- **Underground, elevated** or (rarely) **at grade** railways
- Never intersect with roads.
- With MRT systems' **high operational abilities** usually come **heavy infrastructure** and **complex systems**, thus implying **heavy costs.**

Technical Characteristics

- **Commercial speed** 40 to 60 km/h
- **Typical transport capacity** 70 000 PPHPD
- **CAPEX per kilometer** USD 70 to 130 million/km

Jakarta MRT Phase 4, Egis Study

Typical MRT train



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Reconsidering traditional modes 2/5

Light Rapid Transit (LRT)

Service Description

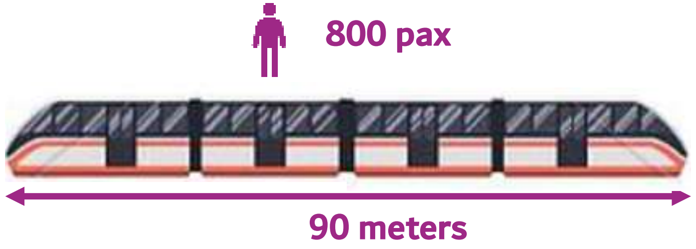
- LRT systems are public **railway** transport systems
- Found in **urban areas.**
- LRT systems similar to MRT but with lower **operational abilities**
- **Lower speeds**, **passenger capacities**, **frequencies** and **operational ranges** than MRT systems.
- These lower operational abilities are due to **technical** and **operational** differences: smaller **trains**, smaller **platforms**, fewer **underground railways**, more **intersections**, less **automation**...

Technical Characteristics

- **Commercial speed** 30 to 35 km/h
- **Typical transport capacity** 25 000 PPHPD
- **CAPEX per kilometer** USD 50 to 100 million/km

Palembang LRT, Egis Engineering

Typical LRT train



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Reconsidering traditional modes 4/5

Bus Rapid Transit (BRT)

Service Description

→ **Road-based** public transport systems with **dedicated roadways**

→ **Priority at intersections**

→ **Optimized bus access** for customers (off-board ticketing)

→ Vehicles are often fossil fueled but new systems tend to be **electrified.**

These technical and operational differences make BRT systems reach **higher operational abilities** than conventional bus systems : they usually reach higher **speeds**, **passenger capacities**, **frequencies** and **operational ranges** than conventional bus systems.

BRT systems can approach rail systems in term of **reliability** and **capacity** but the associated **costs are often far lower**.

Technical Characteristics

→ **Commercial speed** 20 to 30 km/h

→ **Typical transport capacity** 6000 PPHPD

→ **CAPEX per kilometer** USD 10 to 20 million/km

TransJakarta BRT

A TransMilenio station in Bogotá

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Reconsidering traditional modes 5/5

Conventional Bus

Service Description

→ **Road** public transport

→ Conventional buses travel on **public roads.**

→ These buses are still mostly **fossil fueled**

→ But can possibly be powered using **alternative energy vectors** (electricity, hydrogen, gas…).

They constitute the base of most public transport systems thanks to their **flexibility** and to the **low costs** associated to their implementation and operation. With often no dedicated pathway, conventional buses are subject to road congestion and even add up to it.

Technical Characteristics

→ **Commercial speed** 10 to 15 km/h

→ **Typical transport capacity** 2000 to 2400 PPHPD

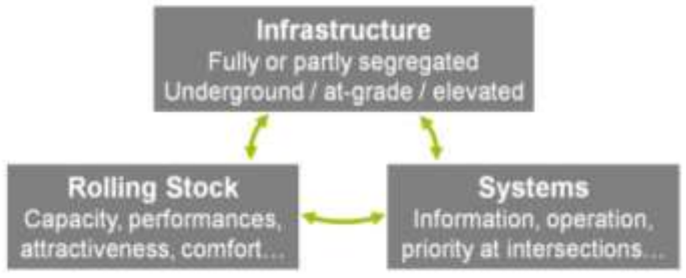
→ **CAPEX per kilometer** USD 1 to 2 million/km

Singapore SBS Transit bus

RATP Electric Bus - Paris

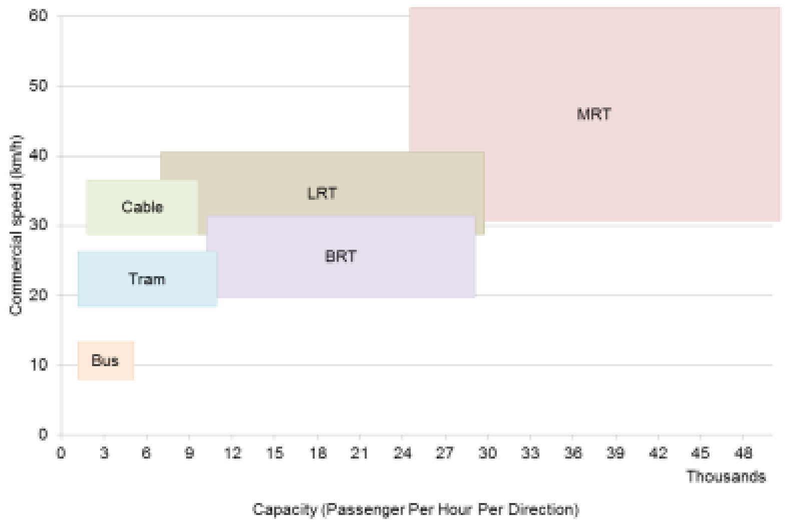
How do we choose a mode?

Understanding the differences between modes



- With each mode comes different **infrastructure**, **rolling stock** and **systems** concerns.
- These differences are what define the **operational abilities** and the **associated costs** for each mode.
- They have to be taken into account in order to find out what mode is the **most suitable** in a **particular context.**

Choosing a mode to meet one's needs



- **Commercial speed** and **passenger capacity** are particularly decisive variables to define the preferred mode.
- Once one's needs are **defined** and the possible modes to meet them **elected,** the **feasibility** of each scenario must be studied in order to formulate a **definitive choice.**

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What are the forces transforming individual mobility?

As A Product: Owned Vehicles	As A Service: Shared Vehicles

Individual mobility as a product

Active modes (walking, NMT)

Micro-mobility

Cars

Motorcycles

Individual mobility as a service

Stationary shared vehicles

Carpooling

Free floating shared vehicles

Ride-hailing

→ These modes can be developed through **public and private initiatives, adapted infrastructure, financial and social** incentives and **favorable regulatory framew**orks for both users and private companies.

→ Their development should be thought out to make them **complementary with public transportation** and should be made towards the most **environmentally, economically and socially** efficient modes

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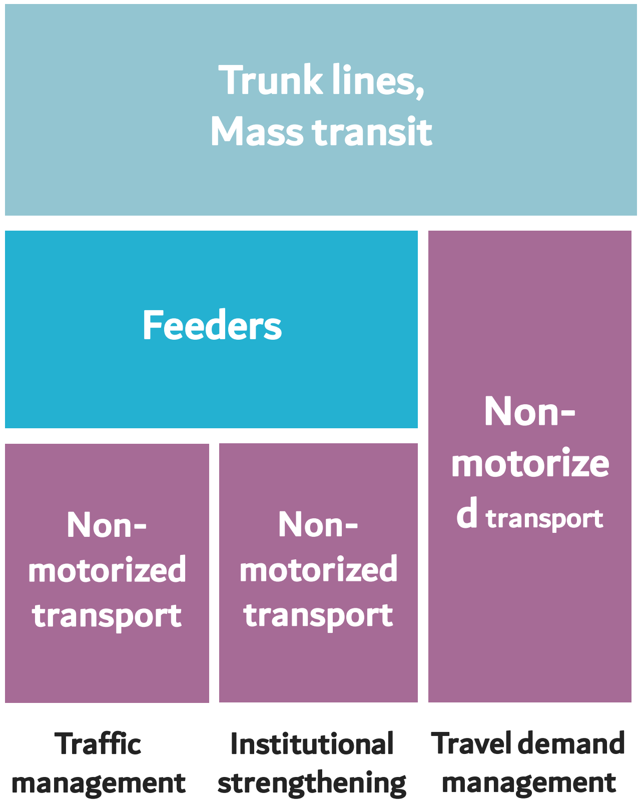
Synthesis of existing modes and their structure



- Mass Rapid Transit
- Light Rapid Transit
- Bus Rapid Transit
- Monorail
- Cable Car

- Automated People Mover
- Direct Service BRT
- Medium And Small Buses
- Paratransit
- Autonomous Vehicles

- Walking
- Bicycle
- Scooter
- Electric Personal Movers

→ Network coverage **widening**

→ Passenger travel **comfort improved**

→ Trunk accessibility **increased**

→ Passenger's costs **lowered**

→ Seamless transit **ensured**

→ Passenger willingness to shift **increased**

→ Comprehensive mobility **improved**

What urban modes could you welcome as a city of the future?

Objective

Offer **new perspectives** and critical analyses on the multiple modes of **urban mobility** that are implementable or not.

Existing Urban Transport

A **recapitulation and check on the modern proven transport modes** that are operated worldwide to break perceptions.

Main Drivers Of Innovations

The **main driver for innovation remains energy efficiency**, although in a digital age the user's habits must be accommodated more and more.

The Future Must Be Prepared Now

Tools are offered to authorities and operators to **optimise and enlarge their service offers**, and would that work in your city?

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Break (5’)

3

Main Drivers of Innovation

Disruptive technologies in urban transport

What are we trying to achieve by innovating?

What are the challenges in urban transport innovation?

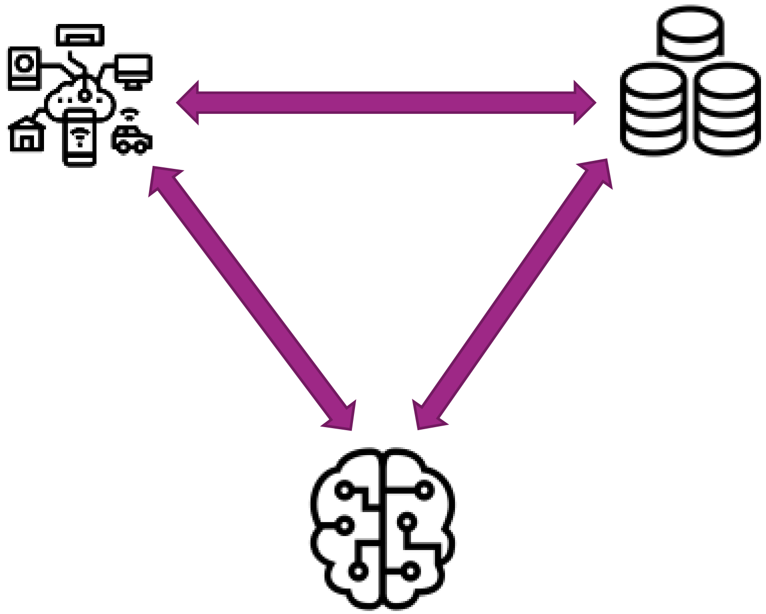
What levers to use to trigger and generate innovative mobility?

Energy consumption
Developing optimization techniques for alternative and fossil vectors of energy.

Alternative fuels
New processes for the production, distribution and use of alternative fuels.

Regulatory tools
Laws and regulations experimented in similar contexts to achieve the goals of innovation.

Internet of things (IoT)
System of objects, processes, data and people connected with each other via sensors, and controlled remotely using the internet.



Big data
Complex data characterized by high volume and requiring the use of advanced analytics for processing.

Artificial intelligence (AI)
Computer science which aims to enable machines to imitate the functioning of the human brain.

What are we trying to achieve by innovating?

Innovate Urban Transport = Decrease Resources Necessary

The main resources to operate a trip are **time** and **energy**. The rationalization of these resources is the constant driver of innovation in urban transport: spend less time with less energy for a similar trip.

Travel Time Decrease: Time spent by travelers on a given trip for: planning, getting information, accessing and egressing, traveling, purchasing ticket…

User-oriented innovations

Energy Decrease: Energy and related costs spent in the operations of a mode for a given trip are decreased thanks to improved technology and fuels, for lower internalities and externalities.

Owner-oriented innovations

Innovations not taking into account one or all of these drivers are likely to fail in their implementation and/or commercialization.

Implementing urban transport systems is an opportunity to have modern modes that are more time-efficient for users and energy-efficient for owners & operators

Innovations decrease one or multiple costs of transport

Decreasing time and energy spent allows cost savings for its users & owners (internal costs), but also multiplying the improvements for communities (external costs).

Internal Costs: Direct Impact for actors of urban transport

→ Time-saving for transport user

→ Energy saving for owners

External Costs: Indirect Impact on the communities

→ Reduction of environmental impacts

→ Reduction of air pollution

→ Increase of safety of users

Improving Sustainability of Urban Transport
=Towards Zero External Costs for Urban Transport

BEWARE! Improving travel time with fast travel technologies and modes can also increase externalities

→ Less fuel efficiency

→ Environmental impact

→ Urban landscape impact

→ Additional noise pollution…

Planning innovative urban transport and implementing it must be evaluated thoroughly thanks to cost-benefit analysis to ensure the benefits of the wider community are secured instead of benefiting limited groups of users.

Challenges of innovation in urban transport

Investment costs

Time Efficiency

- → New transport systems/vehicles
- → New infrastructure

Energy efficiency

- → Research and development
- → New transport systems/vehicles
- → New energy production infrastructure
- → New energy distribution networks
- → New fueling infrastructure

Market acceptance : users' familiarity

Time Efficiency

- → Modal shift
- → Invasive infrastructure
- → Time efficiency relative regulations
- → Potential higher costs

Energy efficiency

- → Modal shift to more energy efficient modes
- → Invasive infrastructure
- → Energy efficiency relative regulations

Regulatory Framework

Time Efficiency

- → New technologies imply new regulations
- → Speed limitations
- → Safety regulations

Energy efficiency

- → New technologies imply new regulations
- → Coherent taxation framework

Long term vision: Effects are never immediate

Time Efficiency

- → Important investment costs to bear without short term income
- → Long time implication before getting results

Energy efficiency

- → Important investment costs to bear without short term income
- → Long time implication before getting results

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Questions & Answers

5

The Future Must Be Prepared Now

Digitalisation and MaaS

Well known technologies, brand-new uses

Between innovation challenges and utopia

How to make use of the new tools and opportunities?

Operator Side

→ **Real-time routing:** The automatization **of real-time routing** requires a real-time mobile (onboard) connection on all involved vehicles. These vehicles should also be able to **communicate** between themselves, **the infrastructure**, and the **operator**.

→ **On-demand:** In order to offer **demand-dynamic mobility offers,** the operator should be able to **characterize** this demand, to **compute** how to answer it, and to **communicate** the result to the involved vehicles.

→ **Big data:** The use of Big data by the operator implies a strong and reliable **data collecting system** and a data **treatment** and **analyzing** force.

Passenger Side

→ **Big data:** The use of Big data also requires digitalization on the passenger's side to **enable passengers' data acquisition**, but also to offer him the **user-oriented models** built from the treatment of his data.

→ **Route choice and itinerary:** In order to offer optimized route choice and itinerary to the passenger, an **intermodal user interface** must be built. To offer **real-time resilient itineraries**, the operator should be able to **communicate** directly through this interface.

→ **Fare integration**: It should include a **common fare media**, such as a card allowing the customer to use any service and **integrated tickets** that enable the user to cover multiple modes/services on the same journey.

→ **Mobility-as-a-Service (MaaS):** Building a unique **service-oriented platform combining all of the previous elements** and more...

MaaS on operators and user's sides

Mobiliy-as-a-Service (MaaS)

Real-time routing:

→ **Mobility as a Service (MaaS)** is the integration of various forms of transport services into a single mobility service accessible on demand

MaaS offers commuters

→ A **single application** to provide access to mobility

→ A **single payment** channel

→ **Various forms of transport mode** (Bus, metro, or private operators like ride-hailing, taxis, ride-sharing) on a single interface for users.

→ Access to **real-time information**

The aim of MaaS is to be the best value proposition for its users, providing an alternative to the private use of the car that may be as convenient, more sustainable, and even cheaper.

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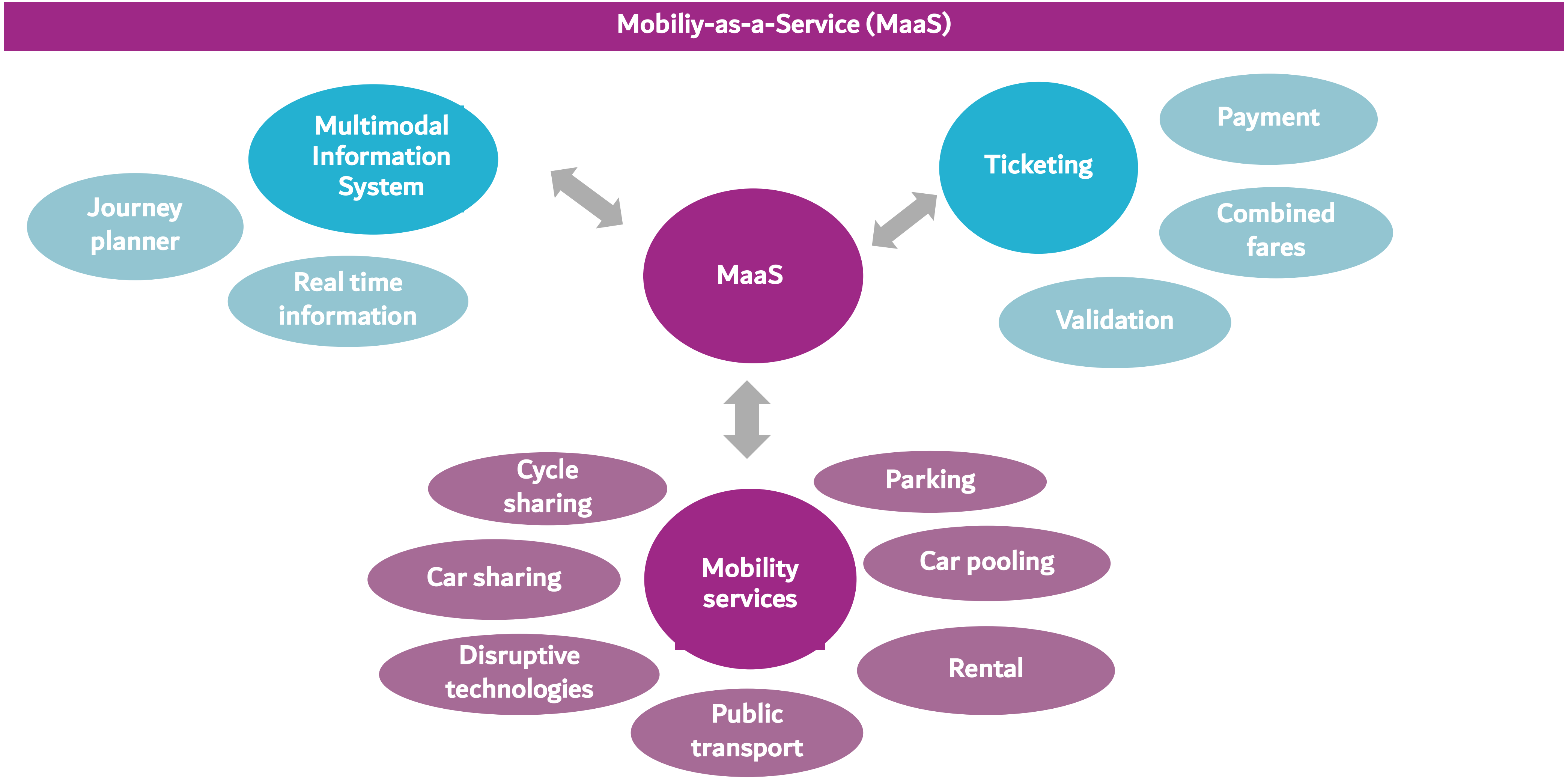
MaaS on operators and user's sides



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New solutions

Personal Rapid Transit (PRT)

Service Description

- **Small automated vehicles** (or pod cars) operating on a network of **dedicated guideways.**
- Provides **point-to-point on-demand** transport services to individuals or small groups.
- Used for cases of **fairly light**, time-fragmented but redundant demand of mobility.

Technical Characteristics

- **Commercial speed** 20 to 30 km/h
- **Maximum transport capacity:** 2000 PPHPD
- **Maximum travel distance:** 30 km

PRT of Masdar City, Abu Dhabi

- From a **car park station** to the **Masdar Institute of Science and Technology**, which constitute the only **2 stations**
- The pods travel along a **dedicated guideway of 1,2 km**
- **12 driverless pods** can each carry **6 passengers**
- **More than 1000 passengers** per day


Masdar Institute of Science and Technology station

Ultra Global PRT, Heathrow, UK

- From **Heathrow Terminal 5** to a **car park**, with a total of **3 stations**
- The pods travel along a **dedicated guideway of 4 km**, on the mainly elevated route
- **21 driverless vehicles** can each carry **4 passengers** and their luggage
- About **1000 passengers** per day


Ultra global pods in operation

New solutions 2/2

Group Rapid Transit (GRT)

Service Description

- → Similar to PRT but with **higher-occupancy vehicles.**
- → Potentially implies the need for **more stations** and can be operated as an all-stop service, an on-demand stop service, or an express service. .

Technical Characteristics

- → **Commercial speed** 15 to 25 km/h
- → **Maximum transport capacity:** 4500 PPHPD
- → **Maximum travel distance:** 10 to 15 km

Rivium Park Shuttle, Rotterdam, Netherlands

- → From a **metro station in Rotterdam** to the **Rivium business park**, with **5 stations.**
- → The pods travel along a **dedicated guideway of 1,8 km** crossing traffic at **5 intersections.**
- → The **6 driverless pods** can each carry **24 passengers**
- → Between **1000 and 2000 passengers** per day
- → Vehicles are interacted with the passengers with an **elevator-like operating system**

Park Shuttles in station

Bois De Vincennes' Shuttle, Paris, France

- → Across the city of Vincennes to the famous **Château de Vincennes**, with a total of **8 stations** and **6 km**
- → The pods travel on **dedicated guideway** until having to cross a **highly frequented intersection**
- → **3 driverless vehicles** can each carry **11 passengers** at an average commercial speed of **13 km/h**

The shuttle in operation

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Well-known solutions, brand new use cases

Cable Car

Service Description

- Cable transport in which cabins, cars, gondolas or open chairs are **hauled above the ground** by means of one or more **cables.**
- Relevant on **point-to-point** transportation crossing a physical constraint such as a natural obstacle.
- Infrastructure composed of **pylons cables and stations.**

Technical Characteristics

- **Commercial speed** 20 to 25 km/h
- **Maximum transport capacity:** 300 to 5000 PPHPD
- **Maximum travel distance piles:** several kilometers

Mi Teleférico, La Paz, Bolivia

- A **31 km** transit network composed of **10 cable car lines** serving **36 stations** throughout the city
- Each of the **1398 gondolas** can hold **10 passengers** and reach a average commercial speed of **22 km/h**
- These lines each have a maximal transport capacity between **3000 and 4000 passengers** per hour

Mi Teleferico's red line

Brest's Cable Car, France

- Crossing the **Penfeld coastal river** on an **420 meters** long cable and a highest elevation of **70 m**
- Each of the **2 cabins** can hold **60 passengers** and reach an average commercial speed of **14 km/h**
- Maximal transport capacity of **1200 passengers** per hour

Brest Cable car from the "Ateliers" station, an Egis project

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Well-known solutions, brand new use cases 2/2

River Shuttles

Service Description

- Water shuttle or water taxi is a public passenger mean of transportation by **boat** on **various water bodies** (lakes, seas, rivers, harbors, canals...).
- Boats follow a **predefined route and schedule** between **passenger adapted piers**.
- Water body is -in most cases- already existing and the infrastructure needed includes **priers, docks** and access to these.

Technical Characteristics

- **Commercial speed:** 6 to 12 km/h
- **Maximum transport capacity:** upto 500 PPHPD
- **Maximum travel distance:** 1 to 12 km

Bat3, Bordeaux, France

- A fleet composed of **2 catamarans** with passenger capacities of **65** each
- A **single line** of **6 km** with **5 stops** across the city on the Garonne river
- **240 000 passengers** per year
- **Intermodal tickets** at usual fare valid on board

L'Hirondelle" crossing the Garonne river

Waxholmsbolaget, Stockholm, Sweden

- A fleet composed of **24 vessels and ferries** with capacities between **100 and 300 passengers** each
- A wide network composed of **4 urban lines** and **28 metropolitan lines** in order to cover Stockholm's archipelago and harbor
- The **21 stops** and **30 km** of urban lines are served by **4 ferries**
- **3.9 million passengers** per year on the urban lines only
- **Intermodal tickets** at usual fare valid on board

The "Gällnö" – An Ice-strengthened ferry

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Between innovation challenges and utopia

Hyperloop	Sky Taxi

Hyperloop

Service Description

→ Transport concept based on the travel of **pods** powered by **linear induction motors** in a **low air pressure sealed tube** in order to reduce air resistance.

Technical Characteristics

→ **Commercial speed** 1000+ km/h

→ **Maximum transport capacity:** 420 PPHPD

→ **Maximum travel distance:** Not defined yet

One of Hyperloops' design concept

Sky Taxi

Service Description

→ **Remotely** or **autonomously piloted flying vehicles** used for **Urban Air Mobility (UAM).**

Technical Characteristics

→ Commercial speed 100+ km/h

→ Maximum transport capacity: 1 to 6 pax per flight

→ Maximum travel distance: 25 to 100 km

CityAirbus eVTOL

What other mode can you imagine for your city ?

6

Questions, Feedback and Farewell?

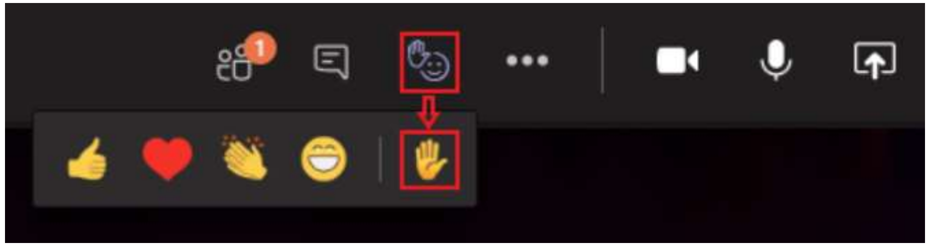
Q&A

Chat

→ Post your questions in the chat and we will include them in the Q&A

Speak

→ Select “Show reactions” in the meeting controls, and then choose “Raise your hand”. Everyone in the meeting will see that you've got your hand up.



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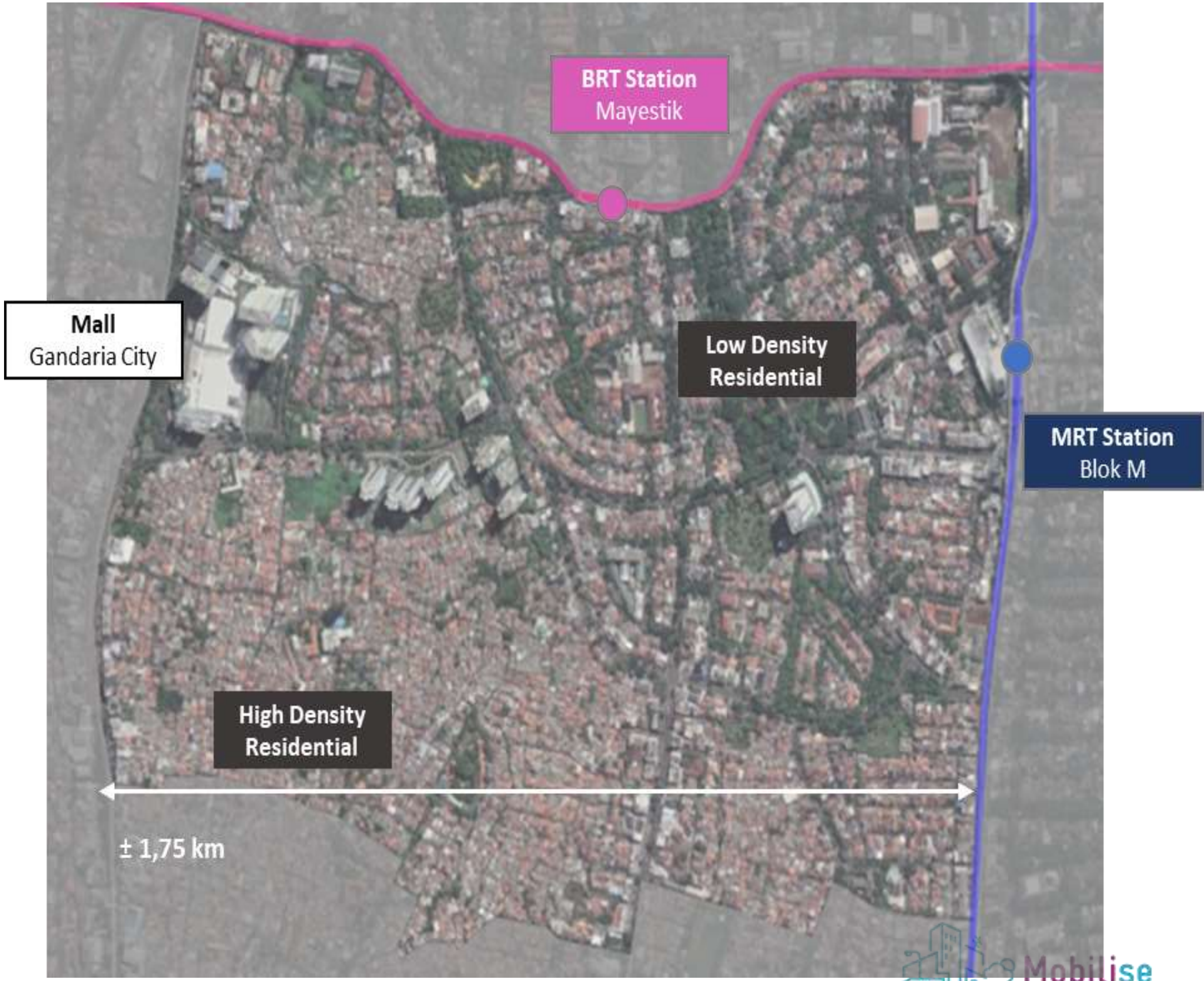
Case study exercise (optional)

A district not directly connected to a mass transit station has important generation of traffic for that line, for commuters (during peak hours) as well as regularly throughout the day (off-peak hours). The inhabitants of that district have heterogeneous motorization: 50% own a motorcycle, 40% use bicycles daily, while 5% have a car. 5% of the inhabitants do not own any vehicle.

Please propose different projects which could help connect the mass transit station to that district, and provide explanation for your choices



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