User Consultation Platform

All EU Space Program components with an integrated market/user driven approach

EU SPACE WEEK 2023

IRIS² GALILEO EGNOS

Copernicus Europe's eyes on Earth EUSST

Bodies influencing the market → Navigation Signal Providers → Chipset, receiver → Devices → Content & applications → Users

Bodies influencing → Data and services provision → Storage and processing → Content & Applications → Users

8 parallel sessions

Agriculture and Forestry

Environment

Road and Automotive

Rail

Public Transport

Resilient societies

Space

SST

Market & User **Knowledge**

Extended **Market and technology** monitoring and forecasting

Extended and synergic **User Consultation Platform**

Better understanding the **MS needs** and adding Copernicus Other Users satisfaction survey

Demand Support & users

A common **market segments** approach for all EU space downstream

Extended key account with **main players** of the value chain

Offer Creation

Creation of new "made in Europe" products and services.

Large implementation of end-to-end solutions leveraging synergies.

Supporting entrepreneurship, SME and start-sups

#EUSpace

Report on Public Transport User Needs and Requirements

Applications covered in 2023 edition

Sub-segments	Applications	Types of Applica… Level of Investigation	
Bus	Fleet Management	A	●
	Passenger Information	A	●
	Driver advisory systems	A	●
	Driving monitoring	A	●
	Autonomous vehicle	A	●
	Transportation network planning and optimization	C	○
Tram	Fleet Management	B	◑
	Passenger Information	B	◑
	Autonomous vehicle	B	◑
	Transportation network planning and optimization	C	○
Urban Rail	Fleet Management	B	◑
	Passenger Information	B	◑
	Autonomous vehicle	B	◑

Legend

EO only application
GNSS only application
Hybrid/synergetic application (combined use of EO and GNSS)

A ● An in-depth investigation

B ◑ A partial specification

C ○ Will be analysed in next versions

#EUSpace

Public Transport session - Agenda

Public Transport session - Agenda

14:00	*Session Agenda presentation*	**Daniel Lopour**, EUSPA
14:20	*EU Space Programme Components current state and future services for users*	**Carmen Aguilera**, EUSPA
14.40	*The future of mobility towards more sustainable, resilient and human-centric urban mobility systems*	**Umberto Guida**, UITP
15.00	*GNSS applications in public transport operations – an application overview*	**Jochen Wendel**, INIT
15.20	*Added value of EGNSS for Public Transport Operators and users – innovative use cases from R&D*	**Nikos Tsampieris,** ERTICO ITS Europe
15:40	*GNSS usage in a city transport network: Sensing, capturing, and exploiting environmental and vehicular data systems*	**Luis Roda,** EMT Valencia
16:00	*User Requirements Discussion & validation*	
16:45 – 17:00	*Conclusions and next steps*	

KEY AREAS

Session Guidelines

Public Transport Session - Guidelines

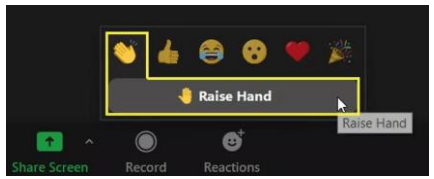
ZOOM rules

- **Raise your hand** for questions (menu bar - "Reactions" button – "Raise Hand") and simultaneously write your question in the chat ("To everyone")
- Wait for one of the sessions' **moderators to give you the floor**. Please note: due to time constraints, only some questions will be selected by the moderators
- Please remind to **mute yourself once finished** the intervention and **lower your hand** ("Lower Hand")
- If you are not a speaker, please **do not share your screen without** moderators' **consent**

Timing rules

- We kindly invite all participants to **respect the timing** indicated in the agenda. Not respecting our time constraints would have major impacts on the overall event
- To this end, we will let **speakers** know when their **interventions** shall be ending
- **Q&A/debate** sessions duration may vary depending on the time available. Please feel free to kick-off and feed the debates as soon as the floor will be open, to take advantage of the time at our disposal
- Reminder
- Please remember to fill in your information on the **list of participants** that is being circulating in the room

How to raise hand:

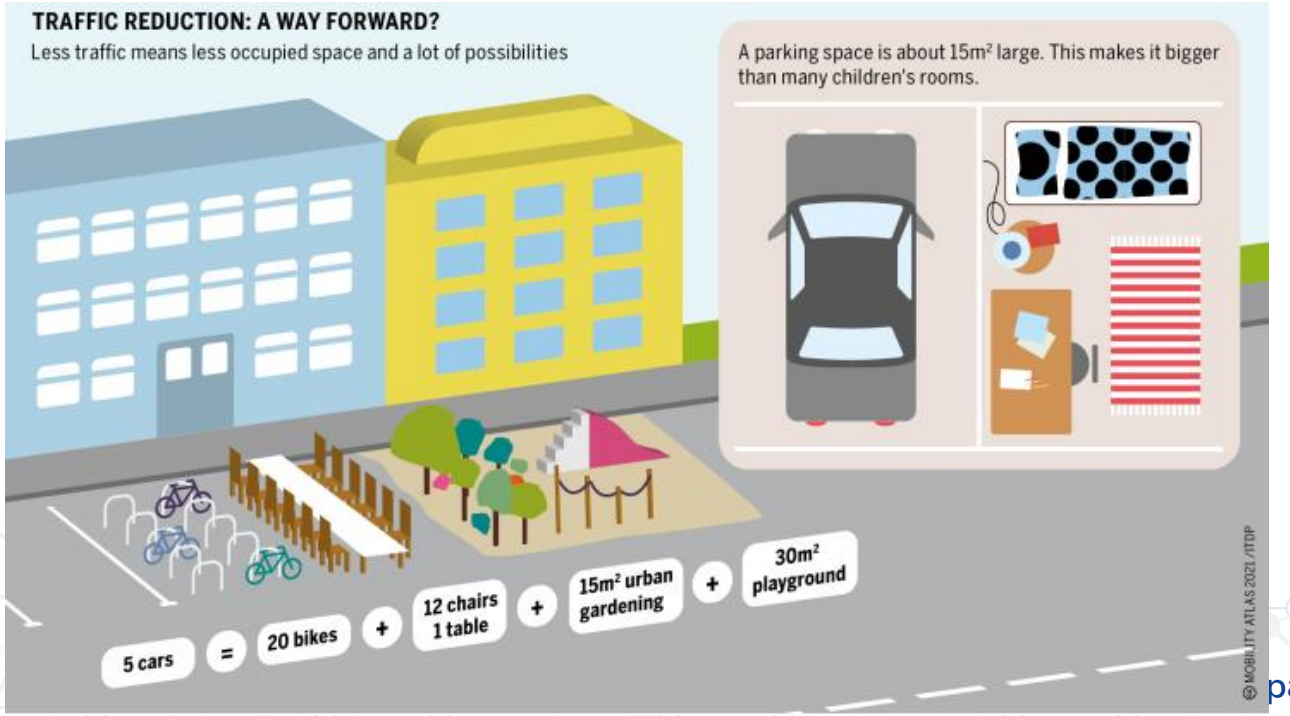


Thank you for your cooperation!

#EUSpace

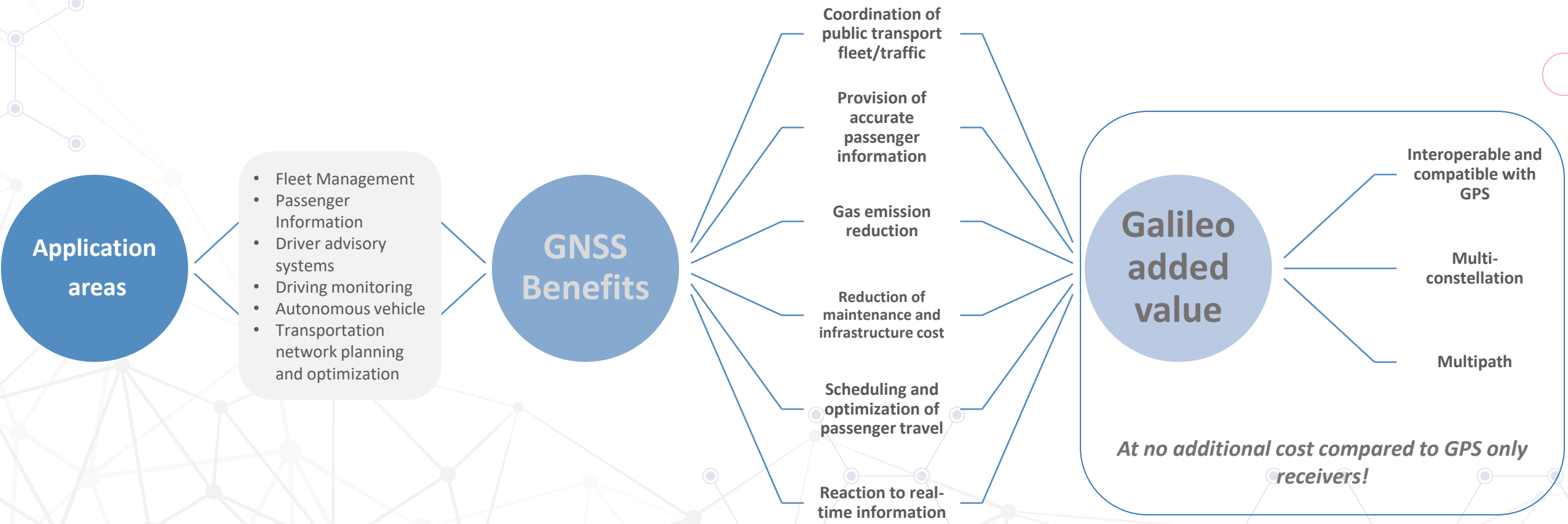
Public transportation in Europe in a nutshell

- **60 billion of passenger journeys** are made by public transport every year
- **2 million** people are employed in the public transport sector at a local level
- **€130-150bn** is the public transport's annual contribution to the economy (c. 1% of EU GDP)*
- Contribution to green deal:
  - Less congestion
  - Cleaner air
  - More green spaces
  - Less noise
  - More safe



*Source: UITP

Galileo benefits for public transport

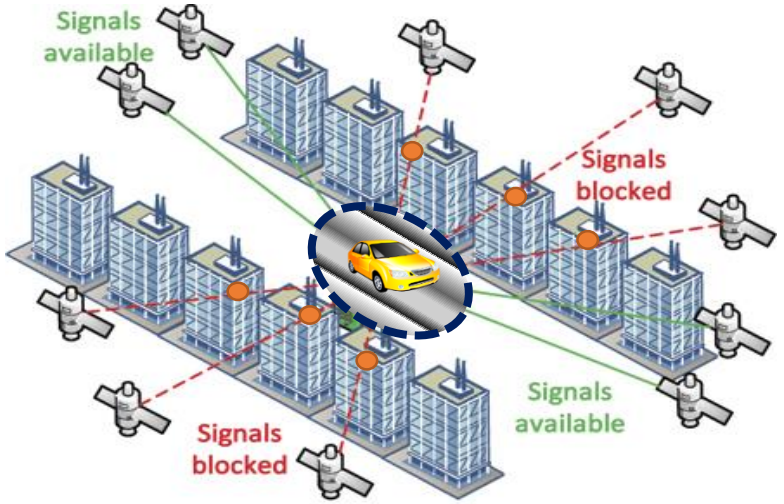


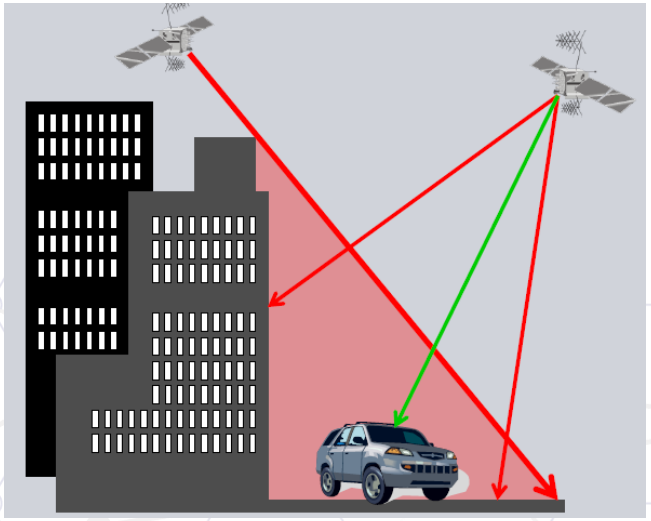
Benefits of multiconstellation and multifrequency GNSS

- ✓ *Multi-constellation*: When buildings block the signal and reduce the number of visible satellites, the availability of more constellations ensures a **much more accurate final position**

- ✓ *Multi-frequency* increases **robustness of the position against mass market jammers** because the interfering signal has a narrow bandwidth and the receiver can still calculate a correct position with the other GNSS signals. More so, it increases resistance to multipath and accuracy.

- ✓ *Multipath:* the strength of Galileo signal, together with an **advanced code modulations**, makes Galileo better mitigating multipath effects (especially in E5, but also E1: two times better than GPS L1*)





* Source: Broadcom tests

#EUSpace

Prague – DPP success story

- All trams will be **equipped with multiconstellation Galileo-enabled receivers** by the end of the year
- Test confirmed **achievable accuracies of 2.7 meters along the entire network** (Galileo-enabled receivers and IMU)
- **Multiple applications enabled**: from improved passenger information to automatic reduction of tram speed over the switches bringing tangible benefits to both users, service providers, network managers

"We have been using outdated satellite receivers in trams to determine the exact position of the vehicles for about 20 years, they work only on the GPS system. However, in the dense development in the centre of Prague, these devices very often showed and still show significant deviations from the actual position of tens to hundreds of metres."

Milan Slunečko, head of the Tram Vehicle Management Unit of the DPP

The benefits

USERS

Improved usage (better planification, reliability, etc) (also via 3rd party services such as google maps via GTFS RT data)

Google Transit

TRANSPORT OPERATORS

- **Service optimization**
- **More customers**

SOCIETY

Less private cars usage

GTFS RT = General Transit Feed Specification Real Time

https://www.euspa.europa.eu/newsroom/news/galileo-enabled-receivers-installed-prague-tramways

Our ambition

- EUSPA is committed to bring a Galileo receiver in each Public Transport vehicle in EU, so that relevant monetary and environmental benefits can be achieved
- To do so:

1. **We have enabled the technology** by partnering-up with ITxPT community to ensure that Galileo is featured in their standards architecture. As a result, the ITxPT standard specifications S0P03-GNSSLocation now includes the adoption of multi-constellation GNSS receivers to replace the previous ones requiring only GPS)
2. We are **engaging public transportation** operators in order to:
   - **Introduce Galileo benefits**
   - **Understand if procurement activities are in the horizon** so that we can influence for the EGNSS case
3. We support the development of **products and services** via R&D

EUSPA Horizon Europe call of 2023
(HORIZON-EUSPA-2023-SPACE-01)

Type of Action	Topic	Indicative budget (EUR mln)
IA	EGNSS - Transition towards a green, smart and more secure post-pandemic society	3.5
IA	EGNSS - Closing the gaps in mature, regulated and long lead markets	8
RIA	Copernicus-based applications for businesses and policy-making	7
RIA	Designing space-based downstream applications with international partners	6
IA	EU GOVSATCOM for a safer and more secure EU	10
	Total budget:	**34,5**

Deadline: February 2024

Innovation action (IA)

Activities to produce plans and arrangements or **designs for new,** altered **or improved products**, processes or services.

Research and innovation action (RIA)

Activities to **establish new knowledge** or to **explore the feasibility** of a new or improved technology, product, process, service or solution.

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KEY AREAS

#EUSpace

A new EU Space Programme

EU space activities **under one umbrella**

EGNOS

EGNOS "Makes navigation signals more accurate and trustable for Safety-critical applications"

Operational in **400+ airports** & helipads in 23 countries

Galileo

Global satellite navigation and positioning system (GNSS)

More than **3 billion Galileo receivers** worldwide

Copernicus

Earth Observation (EO) and monitoring based on satellite & non-space data

Nr.1 world provider of space data and information (>20TB/day)

GOVSATCOM

Secure satellite communications for EU governmental actors

Rapid support over crisis areas

Space Situational Awareness (SSA)

Space Surveillance and Tracking (SST)

Space Weather Events (SWE)

Near-Earth Objects (NEO)

Others

Access to Space

Research & Innovation

Entrepreneurship

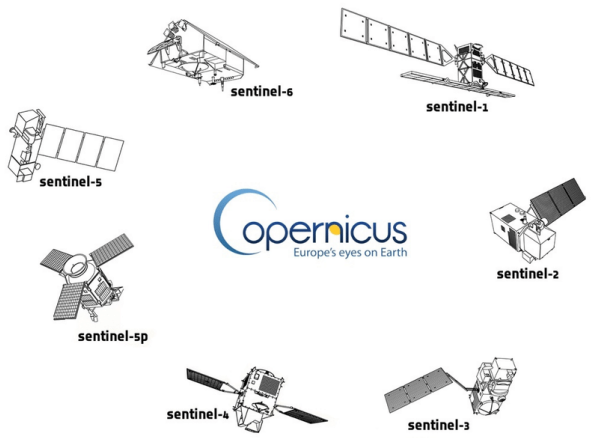
Certification & standardisation

Capacity Building

Copernicus

Copernicus components

SPACE



IN SITU

In Situ

SERVICES

Atmosphere Monitoring

Copernicus Marine Service

Land Monitoring

Climate Change

Security

Emergency Management

#EUSpace

Copernicus services

https://atmosphere.copernicus.eu/

IMPLEMENTED BY ECMWF

https://marine.copernicus.eu/

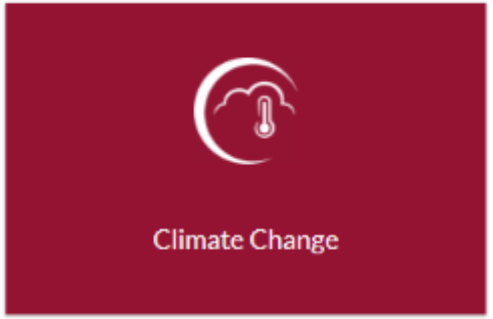
MERCATOR OCEAN INTERNATIONAL

https://land.copernicus.eu/en

European Environment Agency

Joint Research Centre JRC

https://climate.copernicus.eu/



IMPLEMENTED BY ECMWF

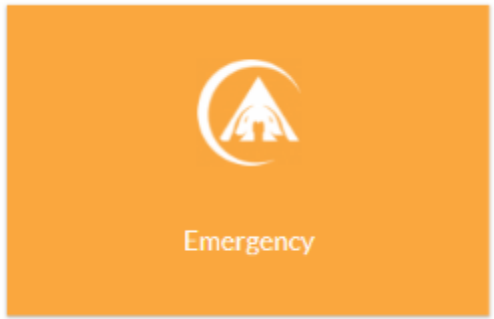
https://www.copernicus.eu/en/copernicus-services/security

SatCen European Union Satellite Centre

FRONTEX EUROPEAN BORDER AND COAST GUARD AGENCY

EMSA European Maritime Safety Agency

https://emergency.copernicus.eu/



Joint Research Centre JRC

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GALILEO and EGNOS

Galileo and EGNOS Services

Galileo Initial Services are provided to worldwide users **since December 2016**

Open Service (OS)	Freely accessible service for positioning and timing*
Public Regulated Service (PRS) – **Governmental Service**	Encrypted service designed for greater robustness and higher availability – secure satellite communication
Search and Rescue Service (SAR)	Locates people in distress and acknowledges that the distress signal has been received
High Accuracy Service (HAS)	Delivers high accuracy services, freely accessible
Under preparation	
Commercial Service Authentication (CS)	Delivers authentication services for commercial applications

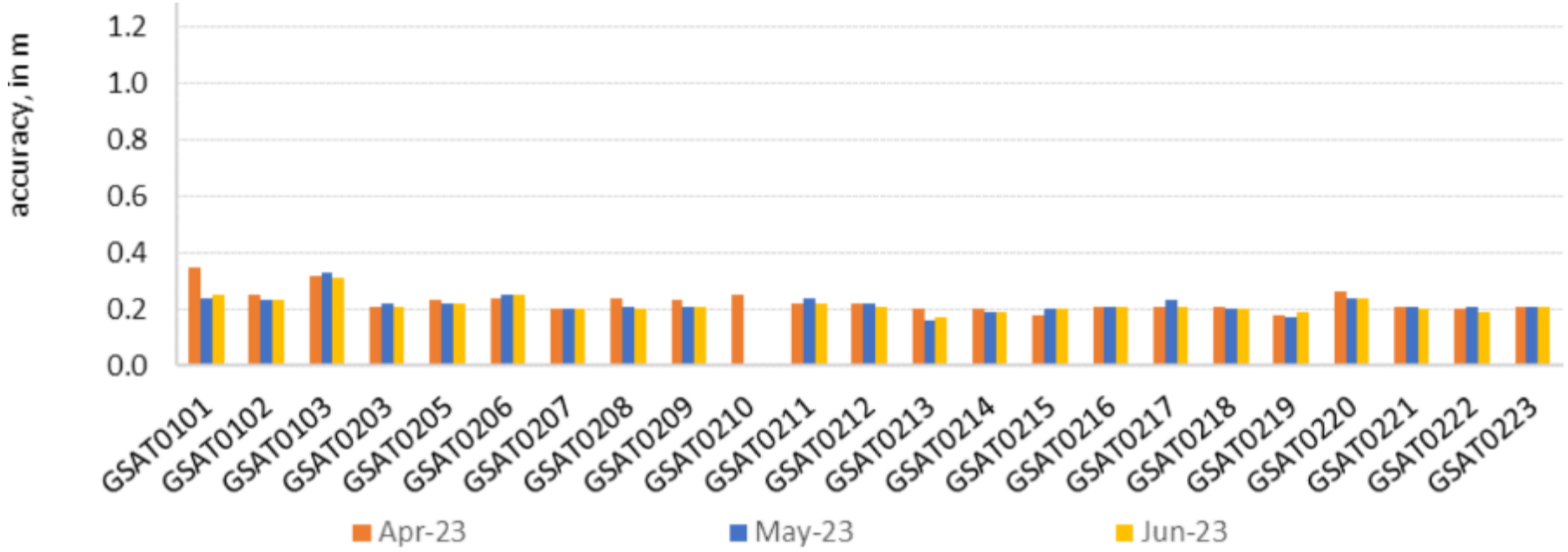
* OS Navigation Message Authentication (OSNMA) is currently under testing

EGNOS services are provided to users since **October 2009**

Open Service (OS)	Improving GNSS accuracy, intended mainly for high-volume satellite navigation applications for use by consumers
Safety of Life Service (SoL)	Providing a high level of integrity for users for whom safety is essential (e.g. civil aviation, in accordance with ICAO standards)
Data Access Service (EDAS)	Offering EGNOS data with greater added value through internet, intended mainly for professional or commercial use

Galileo Open Service

- Galileo entered Initial Operational Capability (IOC) phase in 2016. Since then, anyone with a Galileo-enabled device is able to use its signals providing free of charge outstanding seamless performance worldwide, in terms of ranging, positioning and timing.
- The Open Service ranging performance ranks first among all GNSS service providers.



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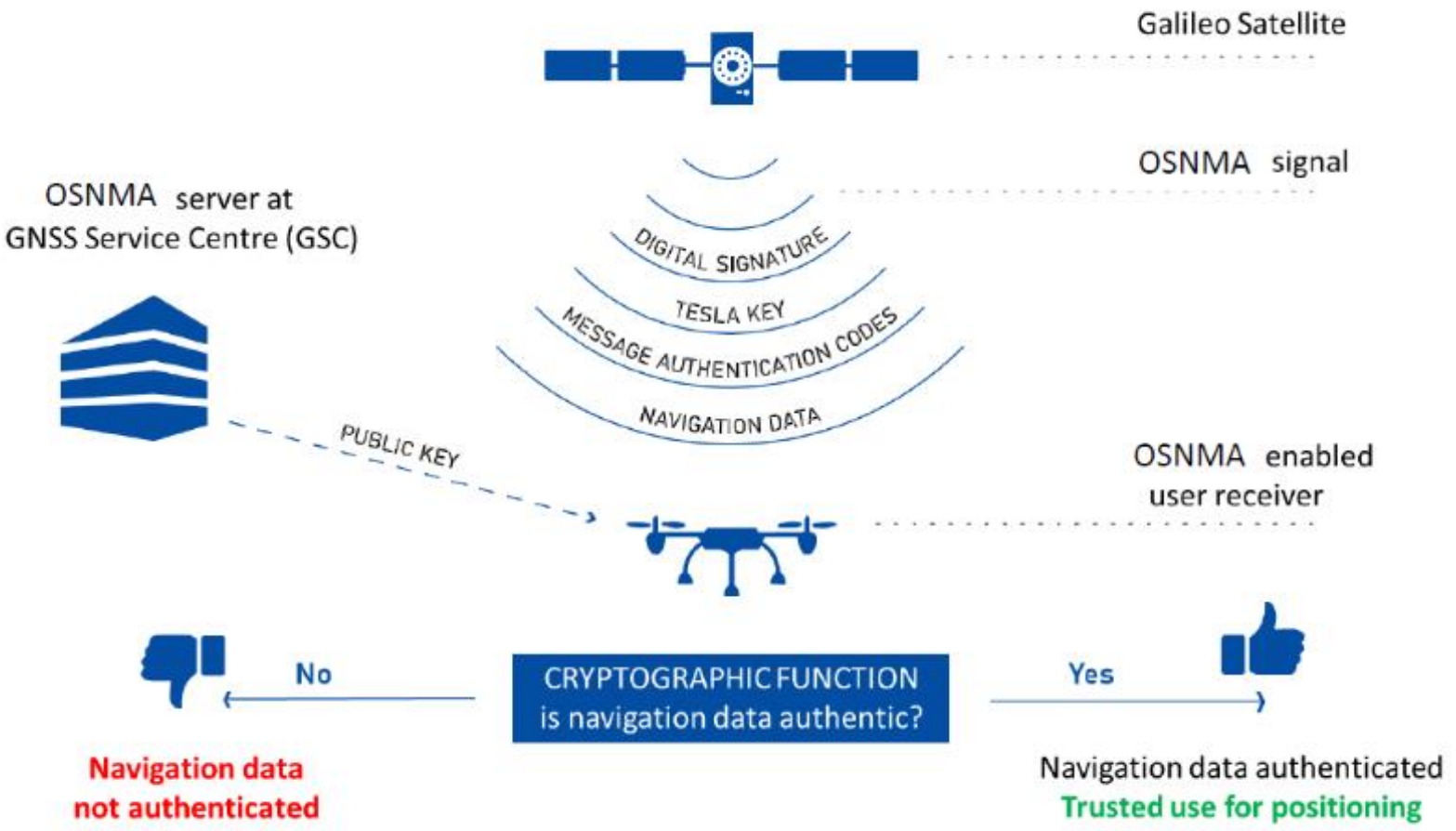
Galileo Open Service

- Galileo OS users can already benefit from an improved navigation message, being broadcast by the Galileo constellation since mid-2023, which considerably boosts their performance in terms of robustness and Time To First Fix (TTFF)

- An update of the Galileo Open Service (OS) Service definition Document (SDD) is planned for the end of this year.
- This fourth issue of the OS SDD will bring to the users:
  - new MPLs (e.g. Ranging rate accuracy, Ranging accuracy at high percentiles)
  - improvements of existing MPLs, such as the timeliness of certain Notice Advisory to Galileo Users (NAGU)
- This updated OS SDD will also introduce the OS Extended Operation Mode, which is characterized by a gradually degrading ranging accuracy with respect to the nominal operational mode, even in case the Galileo Ground Segment is affected by certain issues, thus increasing the robustness of the OS.

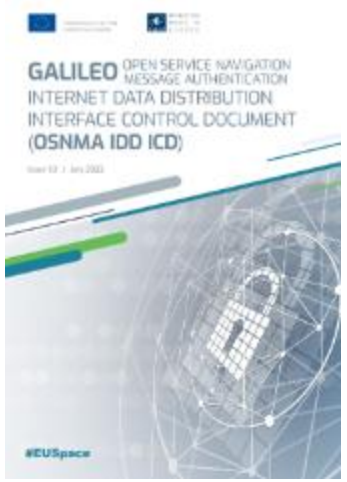
Galileo OSNMA

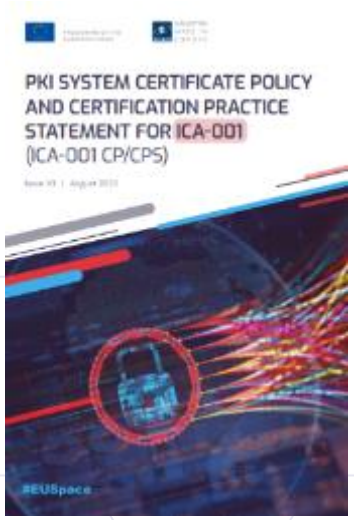
Scope



OSNMA status and roadmap

- OSNMA SiS ICD (final format) and Receiver Guidelines published in Dec'2022
- Transmission of SiS as per OSNMA SiS ICD (final format) since August 2023
- Operational cryptographic data to be published by end 2023
- Initial Service Declaration (Service Definition Document publication and signal switch to 'operational' mode) foreseen by Q1'24





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What is the Galileo HAS

Galileo HAS provides precise corrections for satellite orbit, clock and signal biases

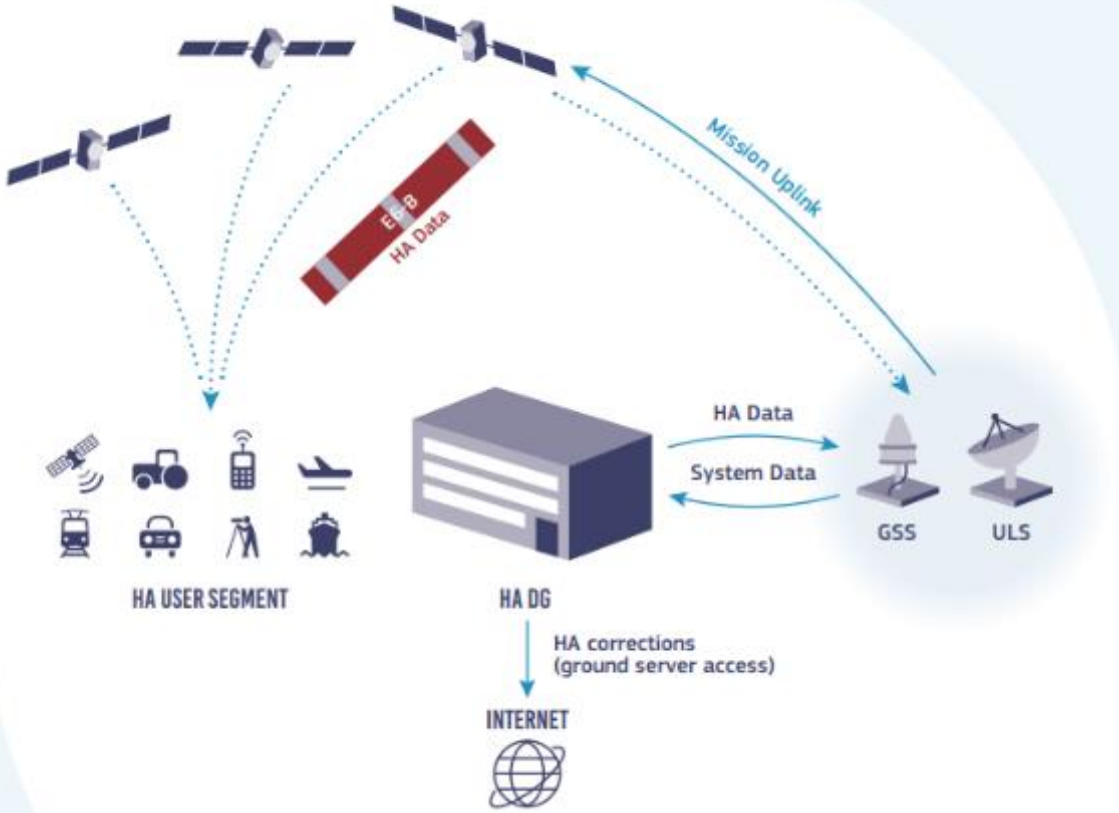
Galileo HAS corrections distributed via

Galileo satellites, E6-B signal (1278.75 MHz)

Internet

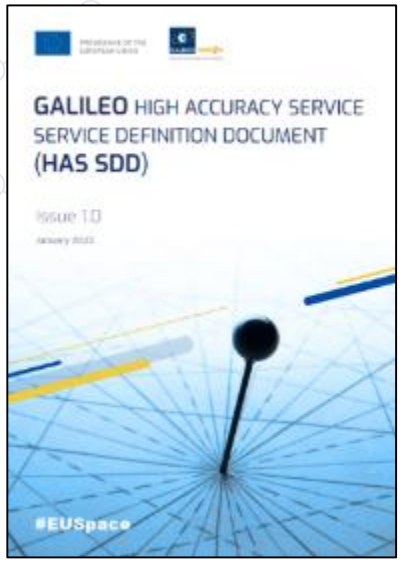
Typical accuracy in the decimetre level (after convergence), with Precise Point Positioning (PPP) receivers

(Almost*) global coverage and free



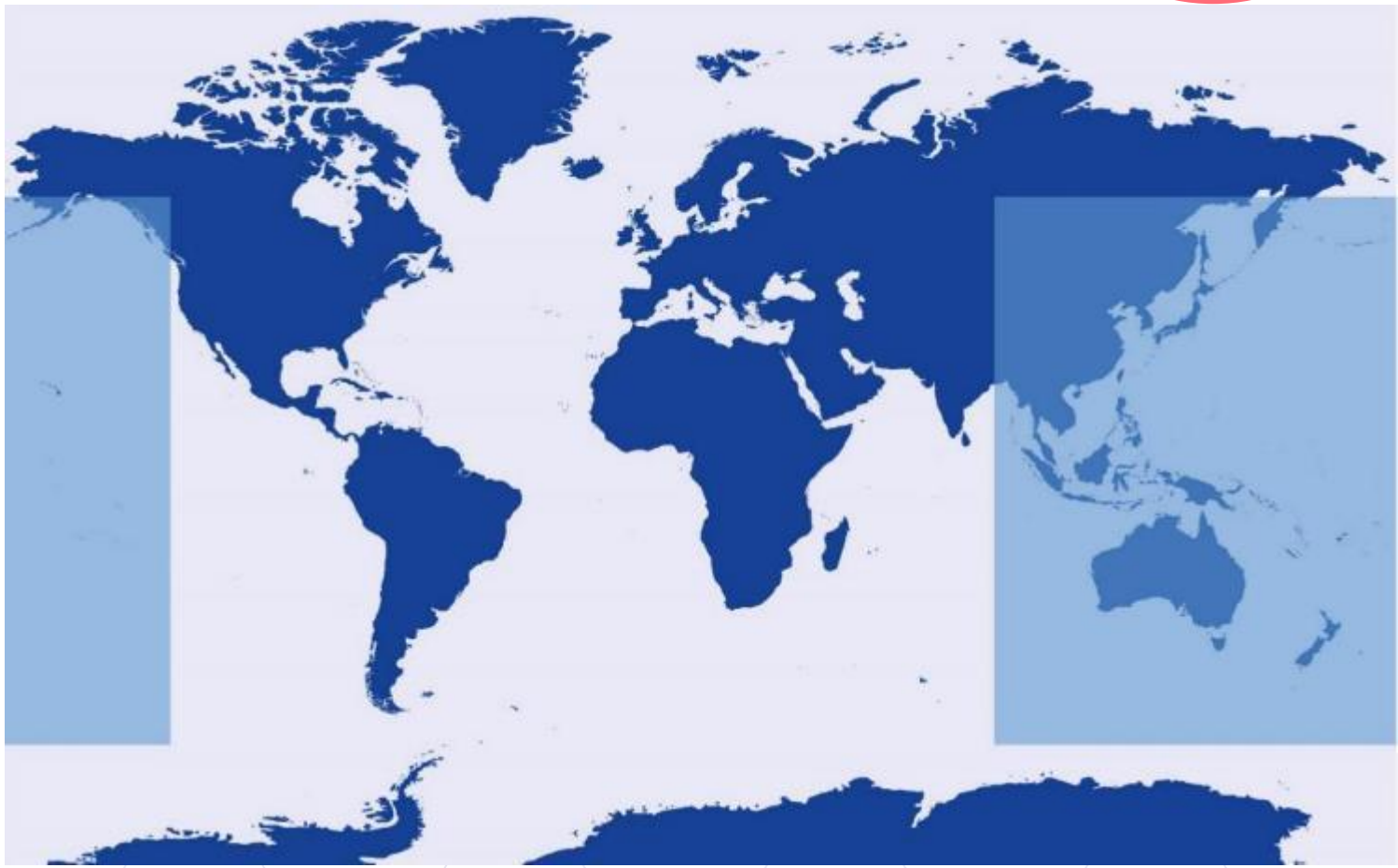
**global coverage of corrections but no global performance commitment yet*

HAS – Initial Service Area & Initial Service Performance



European Union Agency for the Space Programme (EUSPA), *HAS SDD [Online]: https://www.gsc-europa.eu/sites/default/files/sites/all/files/Galileo_HAS_SDD.pdf*

HAS Quarterly Performance Reports regularly published at the GSC website (https://www.gsc-europa.eu/electronic-library/performance-reports/galileo-high-accuracy-service-has)



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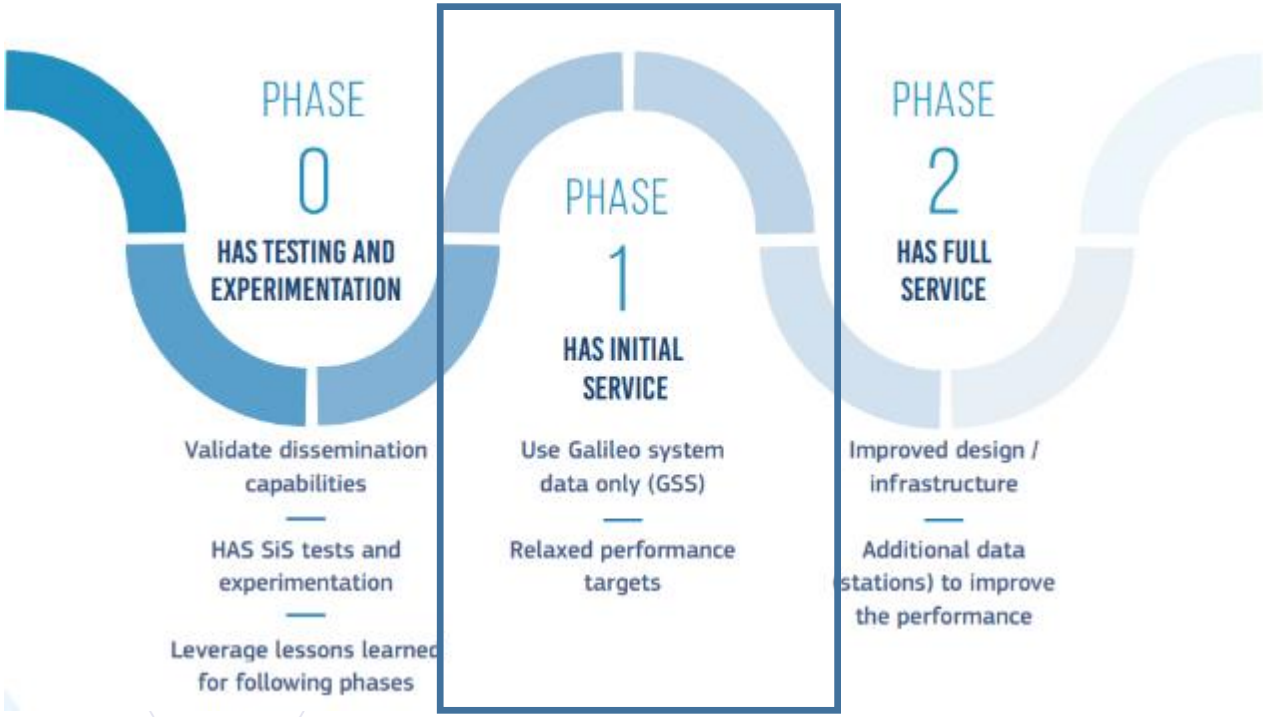
What comes next?

- Short-term: use it!
  - User segment development
    - More HAS-enabled receivers
    - HAS R&D actions
    - HAS Reference Algorithm publication
  - HAS based applications development

- Mid / long-term: HAS Full Service
  - Increased global performance (e.g. better accuracy)
  - Faster positioning in EU (atmospheric corrections)
  - HAS authentication and error characterization



https://www.gsc-europa.eu/electronic-library/programme-reference-documents

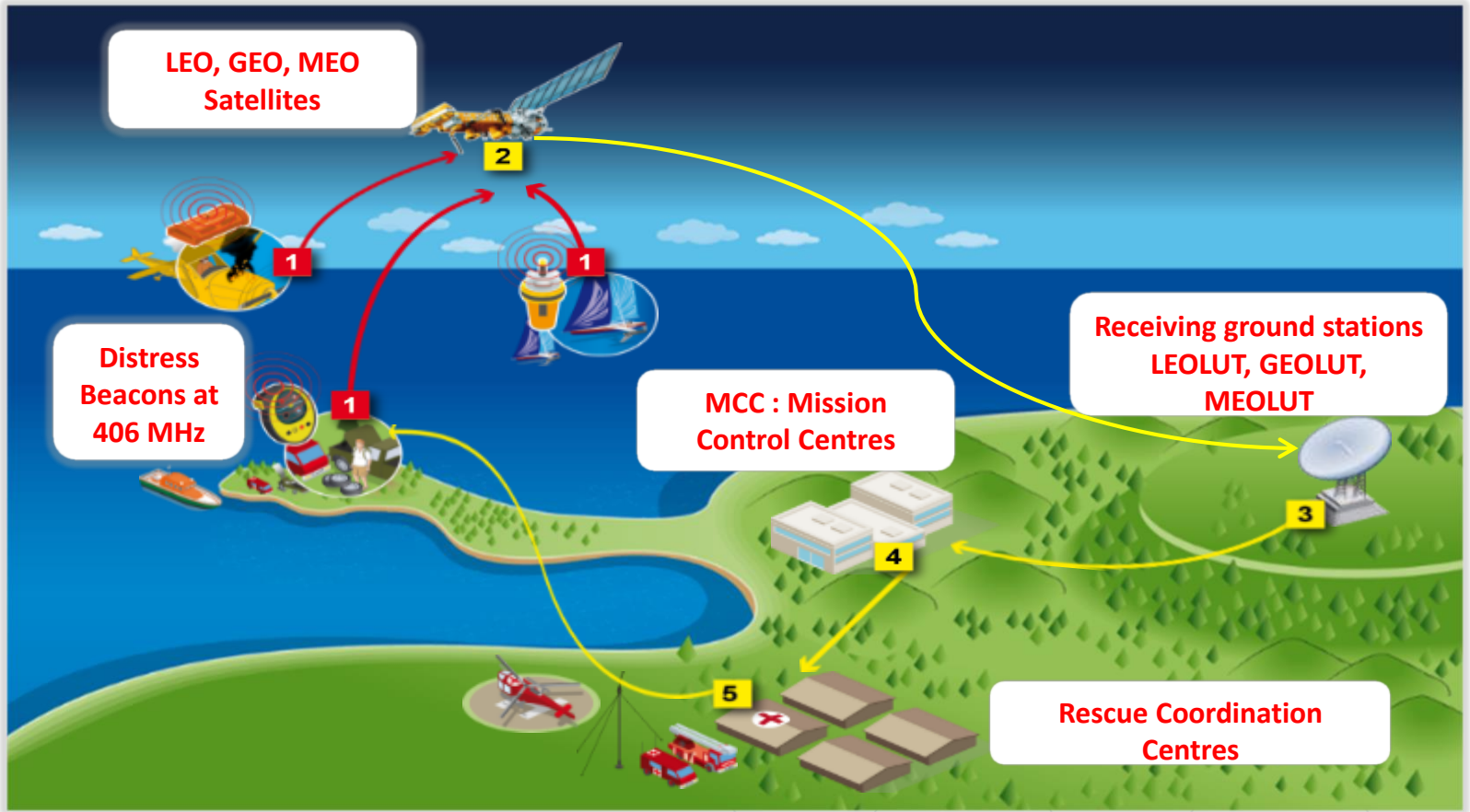
Galileo Search And Rescue

2000: Initial Discussions on SAR and Galileo

2006: Cooperation Agreement on Development

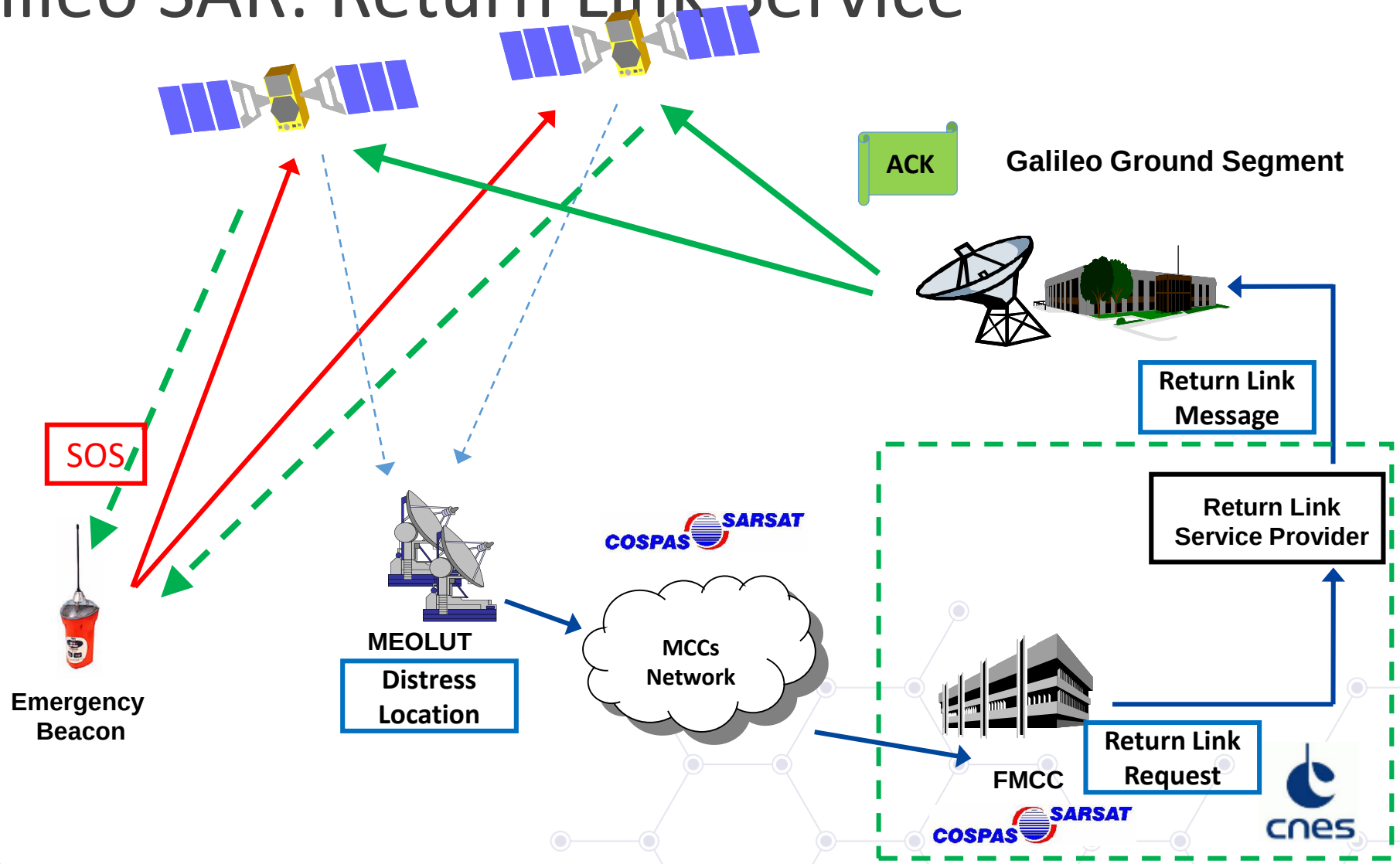
2016: Cooperation on Service Provision: Localisation of Distress Alerts

2020: Agreement on provision of Return Link Service



#EUSpace

Galileo SAR: Return Link Service



EGNOS Services

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EGNOS System state-of-play

EGNOS V2 is the current System in Operations

Delivering SoL service for Aviation since 2011, based on GPS-only augmentation

Constant improvement in answer to user needs (e.g. coverage extension, service for Maritime, robustness improvements)

Need to extend the service provision of EV2 to ensure the handover with EV3 including risk of additional delay LIFEX 1&2 System Releases to be procured by EUSPA to TAS-F

Security enhancement: initial SECMON capability at GSMC

EGNOS V3 is the new generation of EGNOS

Bringing Galileo use into EGNOS System and SoL services

Augmenting both GPS and Galileo

Improved performance and geographical coverage thanks to dual-frequency & dual-constellation

Built-in security (with SECMON from GSMC)

Future extensions to Africa and neighbourhood (e.g. Ukraine, North Africa)

EGNOS services perspectives

Primary means of navigation for Aviation in 2030

- Performance Based Navigation (PBN)
- Better availability (99.9%), more resilience, EU autonomy (with Galileo)
- New Airspace users (helicopters, small aerodromes, drones, …)

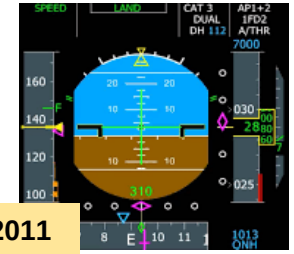
Maritime

- Initial service in 2023 for maritime and in-land navigation
- Towards autonomous vessels navigation and zero-emissions shipping
- Not only EGNOS: end to end solutions using HAS/OSNMA and Copernicus

Rail

- Making ERTMS accessible on all lines
- R&I substantial investment to prepare railway operators and signalling industry
- A new service under preparation, facing the challenge of Rail safety standards

Agriculture since 2009



Aviation since 2011

Maritime in 2023

Rail in preparation

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Secure Satcom

IRIS²

Infrastructure for Resilience, Interconnectivity and Security by Satellite

Regulation 2023/588 in force since 20 March 2023

Signature of the Regulation by EP President and Swedish Presidency

REGULATIONS

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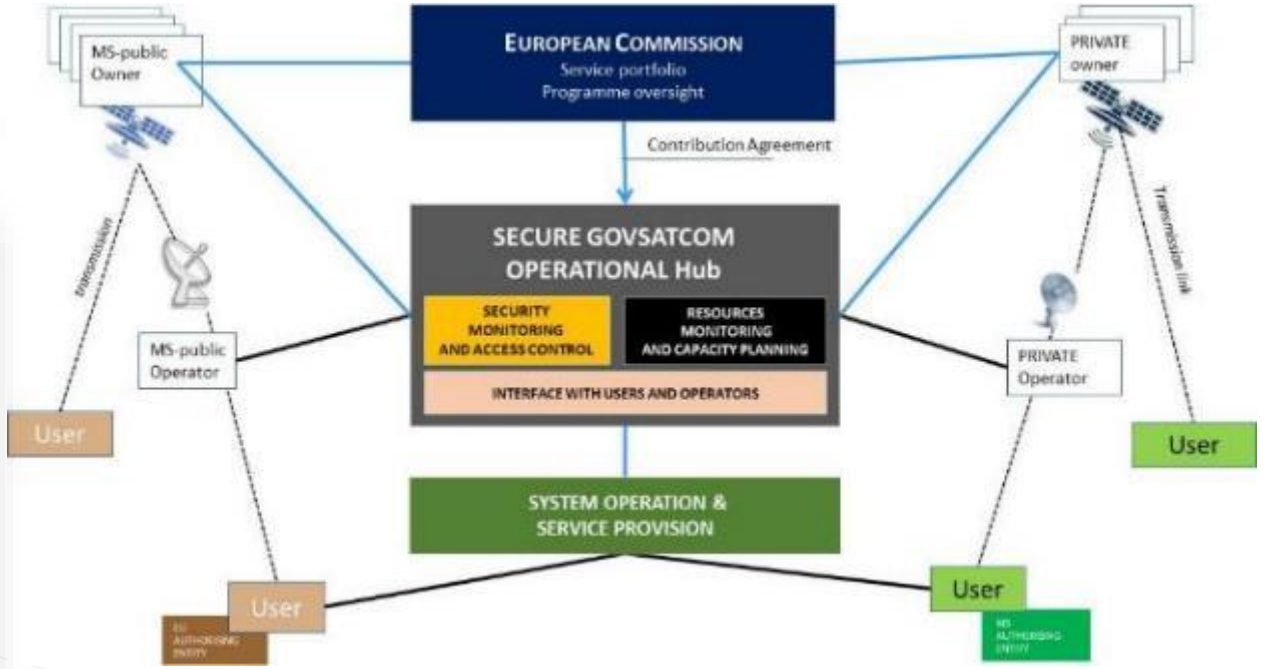
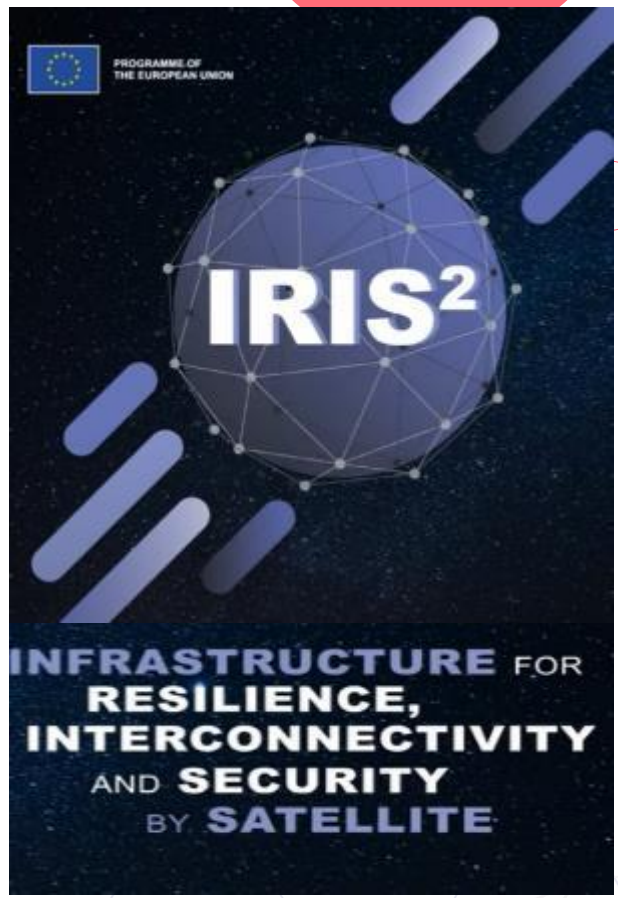
Governmental Satellite Communications






CRISIS MANAGEMENT


SURVEILLANCE


KEY INFRASTRUCTURE

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Space Surveillance and Tracking (SST)

Space Surveillance and Tracking (SST) Front Desk

- EUSPA manages and operates the **EU Space Surveillance and Tracking (SST) Front Desk**
- The Agency cooperates with the **SST Partnership** to provide **space safety services**:
  - **Collision Avoidance (CA):** risk assessment of collision between spacecraft or between spacecraft and space debris
  - **Re-entry Analysis (RE):** risk assessment of uncontrolled re-entry of artificial space objects into the Earth's atmosphere
  - **Fragmentation Analysis (FG):** detection and characterization of in-orbit fragmentations, break-ups or collisions

Space Surveillance and Tracking (SST) Front Desk

Users

200 ORGS

402 Satellites

- **Services and Coordination Platform**
  portal.eusst.eu
- **Performance Reporting**

- **SST Helpdesk**
  sst.helpdesk@euspa.europa.eu
- **SST Taskforce**

- **User Consultation Platform**
  7th Nov 2023 afternoon
- **Communication**

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#EUSpace

Contents

- Introduction of UITP
- Challenges of Urban Mobility
- Future of mobility: sustainable, resilient, human centric
- GNSS as main enabler of Position based services in Public Transport
  - Passengers information
  - Fleet management
  - location-referenced operations
  - On Demand Transit
  - Automation
- GNSS receivers
  - IT Standard Architecture on-board (ITxPT)
- Galileo benefits for GNSS requirements of PT

UITP ADVANCING PUBLIC TRANSPORT

EU SPACE WEEK 2023

The only **worldwide network** to bring together all public transport **stakeholders** and all sustainable transport **modes**.

+1,900
MEMBER COMPANIES

FROM
100
COUNTRIES

14
OFFICES

#EUSpace

2023 TOPICS & PRIORITIES

UITP ADVANCING PUBLIC TRANSPORT

EU SPACE WEEK 2023

Addressing the transformation of the labour market

Public transport business model

Transition to Net Zero

Redefining public transport

Digital Transformation

Promoting women in public transport and **engaging with women** in the promotion of public transport and decarbonisation

Committees and Platforms

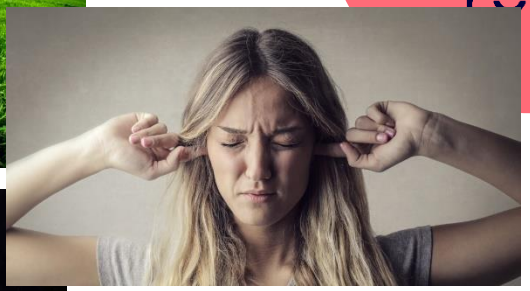
Projects

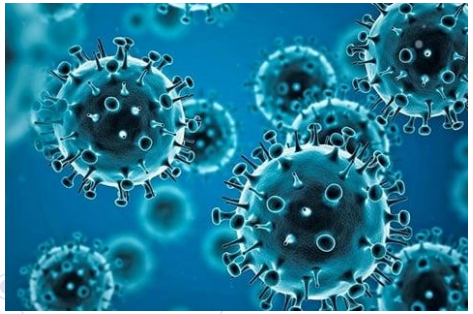
Policy and Knowledge Papers

#EUSpace

Challenges of Urban Mobility

- OLD Mobility Challenges
  - Climate crisis, Local Pollution, Noise, Congestion, urban space scarcity
- “NEW” Mobility Challenges
  - Sanitary crisis, security, energy scarcity, financial crisis
- Change of mobility needs…
  - Different mobility patterns, more personalized mobility solutions, high quality of service

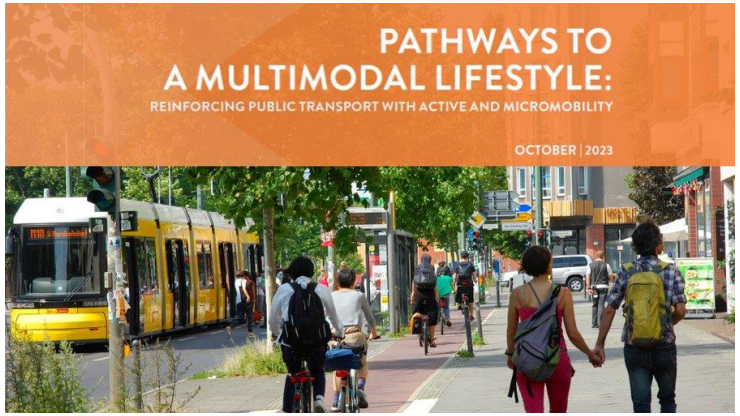

#EUSpace

The Future of Mobility towards more sustainable, resilient and human-centric urban mobility system

- Traditional Mass public transport services alone do not meet all citizens' needs
- The Mobility of the Future requires the intelligent use of Multimodality to support Citizen health, decarbonisation, urban space scarcity, road safety, funding crisis…
  - combination of different modes in their optimal area of service: from soft modes (bike, walking) to shared and mass transport solutions,
  - integrating all aspects of mobility into Sustainable Urban Mobility Plans; from governance and policy to physical and digital integration and finance.
  - answering the needs of all type of users (implementing "Mobility for All")
- Geolocalisation is a key enabler of Urban Public and Shared Mobility

Several reference papers about Multimodality

- UITP Policy papers



- ERRAC RIA on Multimodality (in preparation)
- ERTRAC/ERRAC/ALICE Roadmap on Urban Mobility

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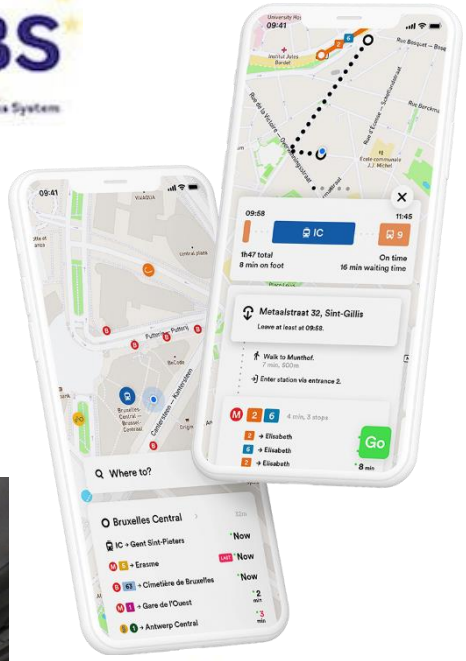
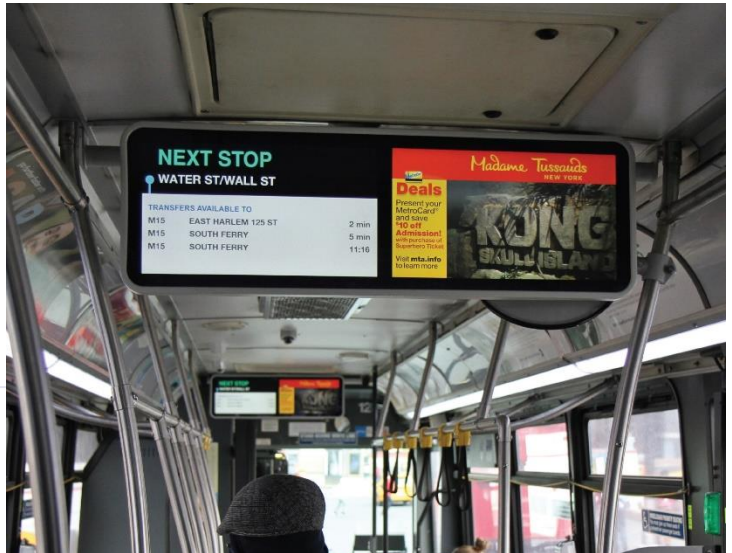
Information & services for travelers

- At the Bus stops
  - Near real-time arrival time
- In personal navigation applications
  - Journey planning (door to door)
  - Real time information of vehicle position
- On board vehicles
  - Touristic and commercial information
  - Selected fare





#EUSpace

Vehicles & Fleets Operation

- Fleet monitoring and management
  - Status of vehicle operations (planned service, timetable…)
  - SOC and forecast of consumption (traffic, auxiliaries, occupancy rate…)
  - Help planning and dynamically use the chargers, by regulating vehicle access according to SOC and vehicle relevant information
- Remote diagnostic and predictive maintenance
- Location based operations
  - Switch propulsion based on Geolocalisation
  - Review / Adaptation of operation profile
  - Smart navigation and Precise docking

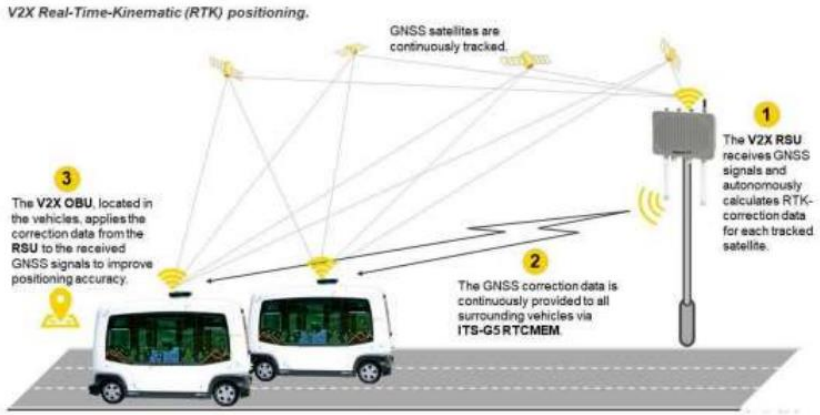
Shared and on-Demand Responsive Transport

- Personal mobility is moving more and more towards Shared and On-Demand mobility solutions

- Geolocalisation used for service booking, billing and control (business area)
- Match position of user and vehicle
  - **Shared mobility solutions:** moving user vs static vehicle
  - **On-Demand Transport:** moving vehicle vs (ideally) static user

Automated Shuttles and Buses

- Integration of GNSS with other sensors on board and in the infrastructure (ex; traffic management)
- SHOW project: GNSS technologies have been used at the demo locations of automated shuttles in Europe.
- In particular technology of GNSS Real-Time Kinetics (RTK) for precision improvements for automated shuttles has been testing by using different digital links to deliver RTK signals:
  - Radio Technical Commission for Maritime Service, or Real-Time Correction Message (RTCM) over V2X, cellular lines and satellite links, or NTRIP
- Plan is to use Galileo High Accuracy Services (even complementing RTK) in Karlsruhe, Gothenburg/Lindholmen, Trikala, Geneva sites
- An analysis has been performed to evaluate performances in Galileo-only use (no other GNSS Constellations).

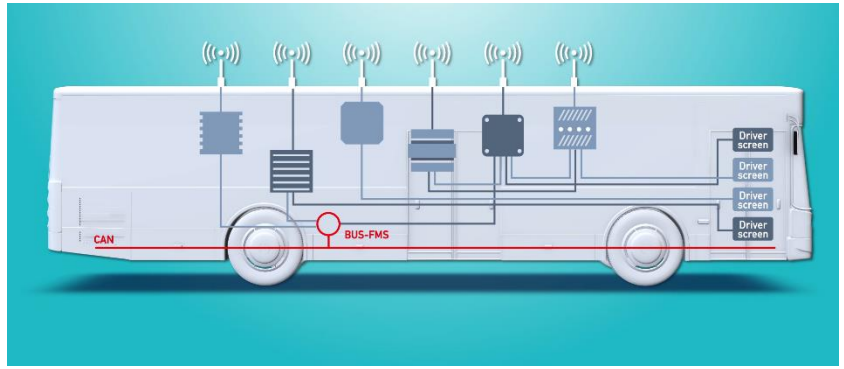


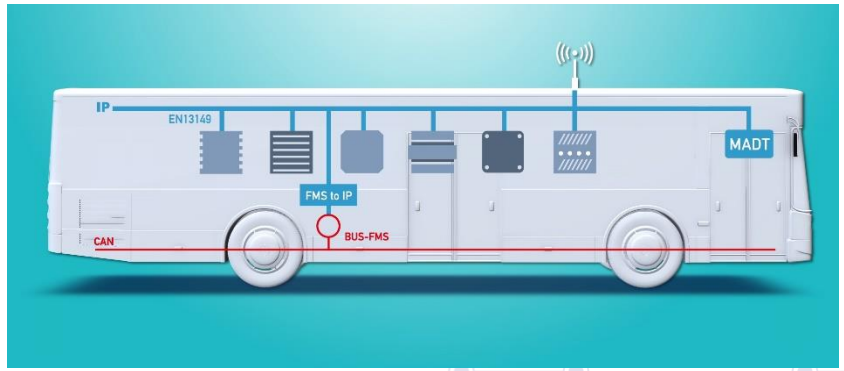
SHOW D8.2: Solutions for on-site digital and communication infrastructure

#EUSpace

GNSS Receivers and on-board Standard

- GALILEO enabled receivers are well on the market
  - New buses very often install Galileo-enabled receivers
  - Considered also during the Bus IT refurbishment moment (around half-lifetime)
- Approaches (vehicle level)
  - No-standardized IT architecture brings a Proliferation of antennas, one for each IT equipment
  - Standardised IT architecture (ITxPT) brings positioning as a service shared to different systems for the development of IT applications
    - no need for multiple receivers
    - GNSS Information shared on CAN interface
  - ITxPT Technical Specifications provides Operators and Authorities with recommendations and requirements to support the purchase and integration of IT systems, that can be used as Reference for tendering process





ITXPT

Main outcomes and lessons learned from past R&D

- The incorporation of Galileo positively impacts existing applications of GNSS in urban mobility services and measurable increases in the quality of the service provided have been proven
  - TMB, Since 2016 more than 1,000 buses equipped with multi-constellation on-board equipment.
  - The positioning error in the most challenging sections of the route went down from 40/60m to 2/5m.
  - Higher accuracy in the location of the fleet in real-time allows an optimisation the service provided.

- Improvement in the quality of the service has been demonstrated in DRT, bike-sharing, micromobility services, tramways...

Conclusions

- Geolocalisation is more and more important in Urban Mobility and Public Transport services
  - To enable personalized, more sustainable and resilient services
- Needs from the PT sector about Geolocalisation
  - Robust, reliable, secure information and services
  - Easy to integrate data and services from different sources and sensors
  - Taking into account all EU strategies guiding the mobility transition
  - Supporting the mobility transitions with added value and a positive ratio benefits vs cost
- GNSS is the key enabler of positioning function, alone or jointly with other sensors providing more precision or covering areas not served
- EGNSS is proven to provide added value to mobility transition

GNSS "Best Application" is the one that is "coming tomorrow"

THANKS FOR YOUR ATTENTION!

Umberto Guida
Head of UITP Projects Strategy
umberto.guida@uitp.org

Public Transport session - Agenda

14:00	*Session Agenda presentation*	**Daniel Lopour**, EUSPA
14:20	*EU Space Programme Components current state and future services for users*	**Carmen Aguilera**, EUSPA
14.40	*The future of mobility towards more sustainable, resilient and human-centric urban mobility systems*	**Umberto Guida**, UITP
15.00	*GNSS applications in public transport operations – an application overview*	**Jochen Wendel**, INIT
15.20	*Added value of EGNSS for Public Transport Operators and users – innovative use cases from R&D*	**Nikos Tsampieris,** ERTICO ITS Europe
15:40	*GNSS usage in a city transport network: Sensing, capturing, and exploiting environmental and vehicular data systems*	**Luis Roda,** EMT Valencia
16:00	*User Requirements Discussion & validation*	
16:45 – 17:00	*Conclusions and next steps*	

KEY AREAS

#EUSpace

Agenda

- Public transport systems landscape
- Standardizing IT systems in public transport
- GNSS related research projects
- The JULIA project
- Conclusion and outlook

INIT at a glance

+1.100
employees worldwide

+130
ITCS/RTPI-systems

+30
locations worldwidet

+200.000
vehicles equipped

+40
years of experience

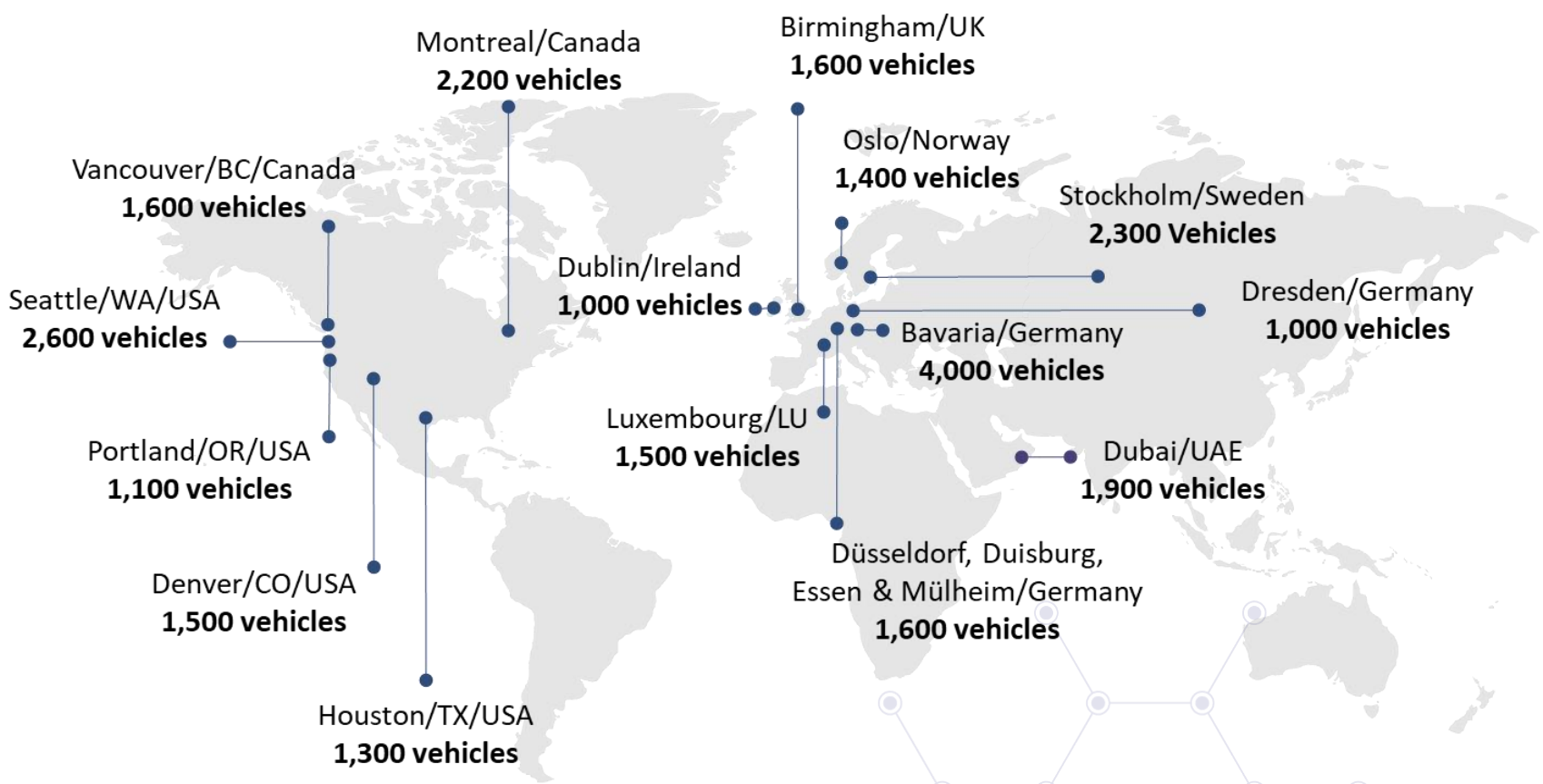
+140
ticketing systems

+1100
transport providers

+300
passenger counting systems

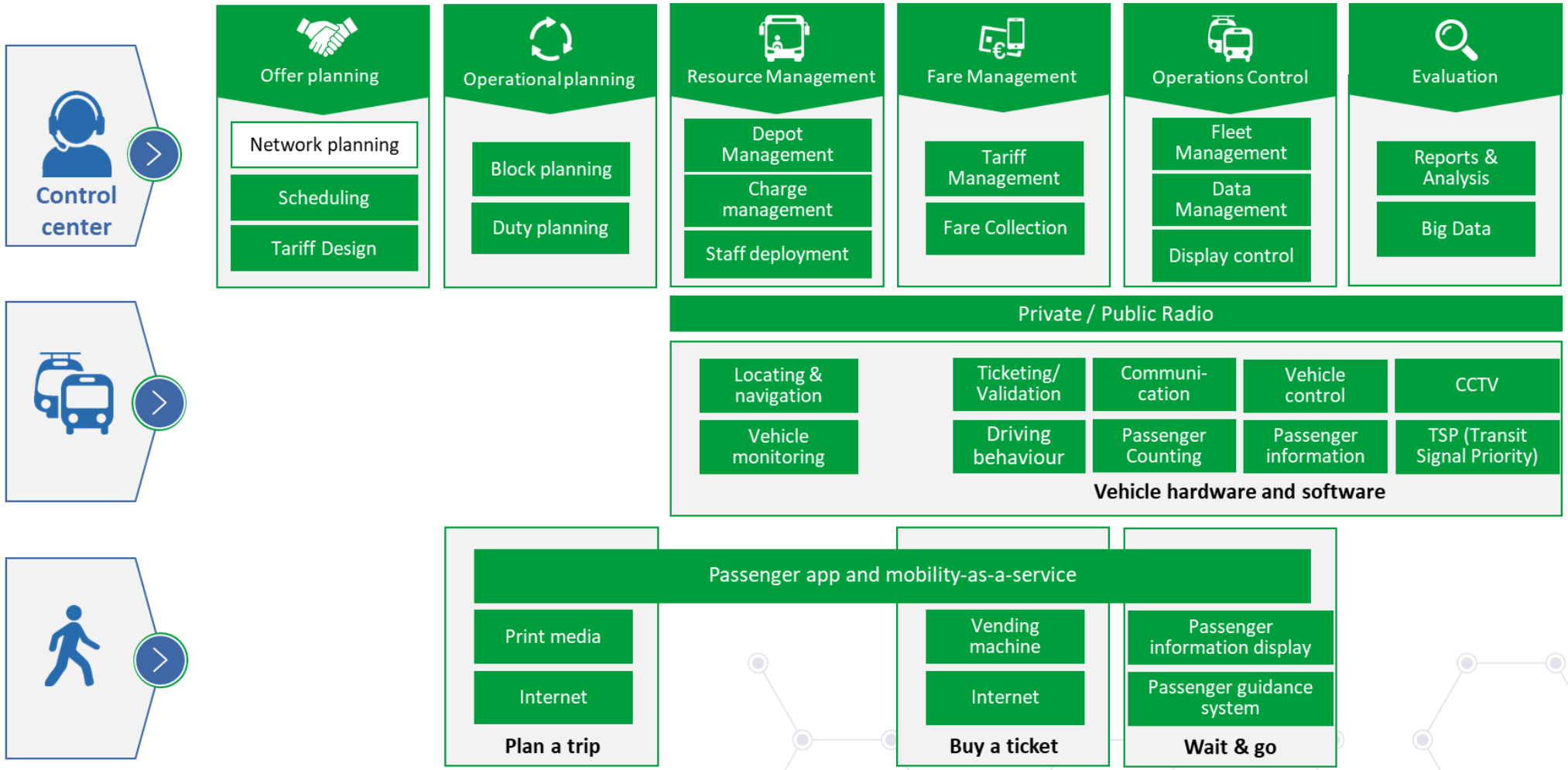
#EUSpace

INIT at a glance



#EUSpace

Public transport systems landscape



#EUSpace

Public transport systems landscape

Vehicle equipment

- Onboard unit (OBU)
- Cabin cameras
- Fast Ethernet in the vehicle
- Train LAN Modem
- IP-Communication gateway
- Traffic signal priority request (TSP)
- Passenger information displays
- Ticket vending machine
- Automatic passenger counting (APC) systems
- Bluetooth and Wi-Fi
- GNSS services

APIs

- Ticketing platforms
- Data hubs
- Web apps and REST APIs
- Mobile Apps
- Standards: ITxPT, SIRI, VDV, ISO etc..

Communication

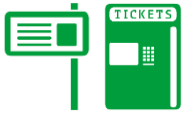
- Data transmission
- Radio
- Telecommunication (3G|4G|5G|1XRTT)
- Voice-over-IP
- Wi-Fi and Bluetooth

ITCS Intermodal Transport Control System

Center data broker

Data statistics and reporting

- Data Science
- Workflow- and event management
- Reporting
- Spatial Analysis
- System Monitoring
- Accounting and ticketing
- Business Management



Station and track equipment

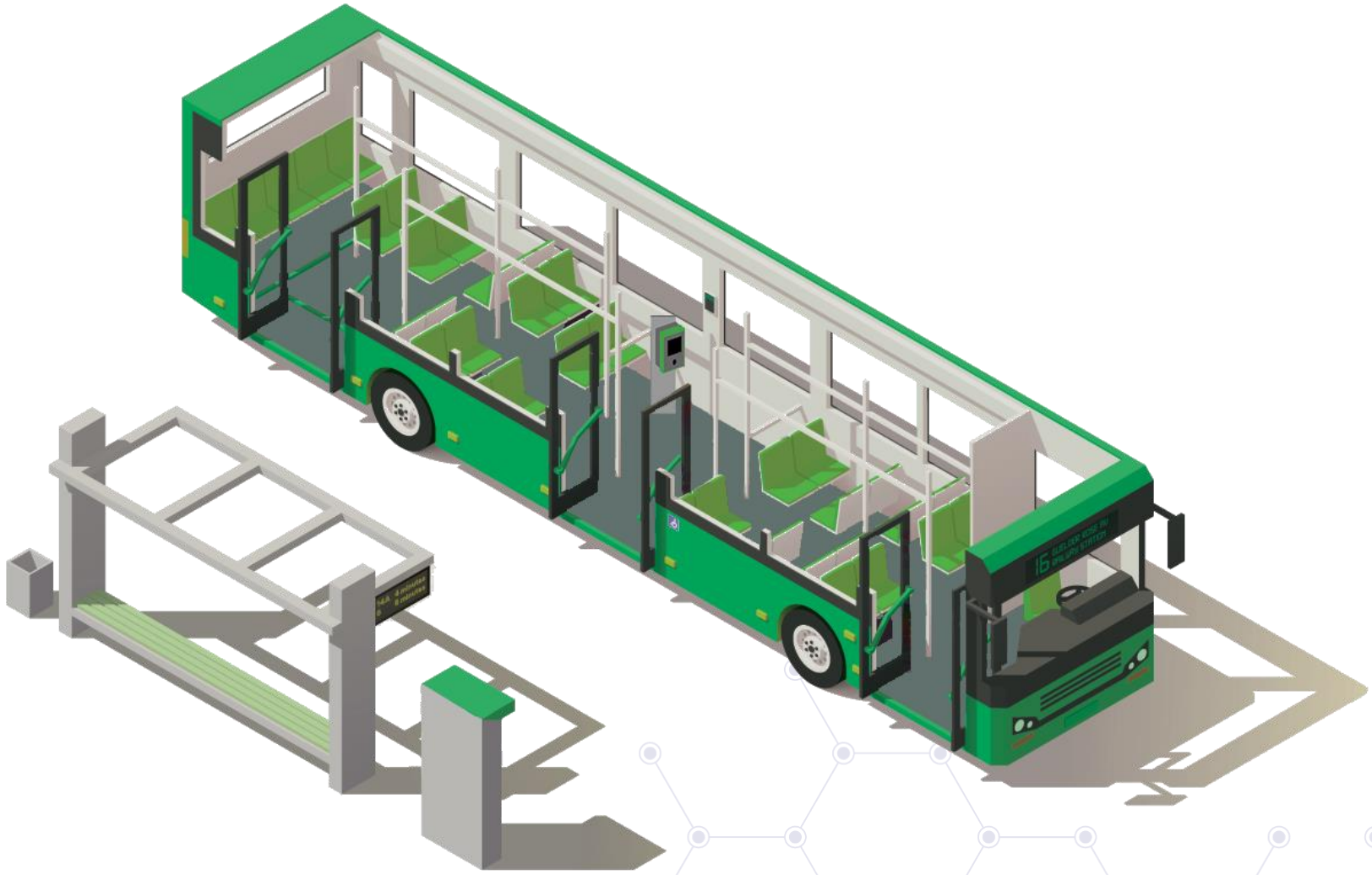
- Passenger information displays
- Ticket vending machine
- Bluetooth and Wi-Fi

Planning Systems

- Depot Management
- Transport planning systems
- Personnel planning

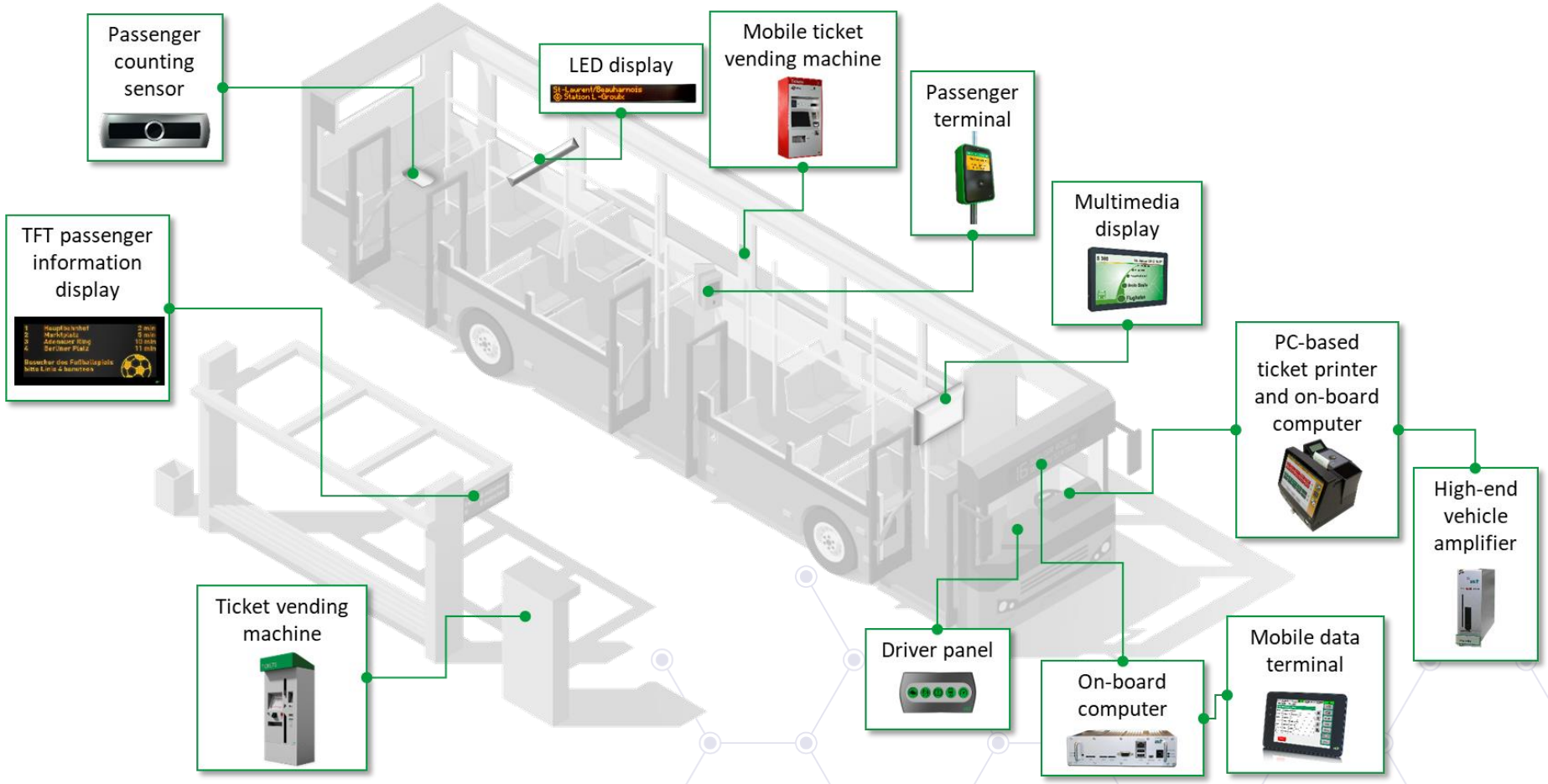
#EUSpace

Public transport systems landscape



#EUSpace

Public transport systems landscape



#EUSpace

Standardizing IT systems in public transport

- Many standards already exists (national, EU, international)
- ITxPT (Information Technology for Public Transport) was launched in 2021 by the UITP (now over 160 members)
- Aims at a standardized specification of IT architecture with open interfaces that enable interoperability
- Next to commercial projects, several related research projects to ITxPT implementation exist:

EBSF

3iBS
intelligent, innovative, integrated Bus System

EBSF 2
EUROPEAN BUS SYSTEM of the FUTURE 2

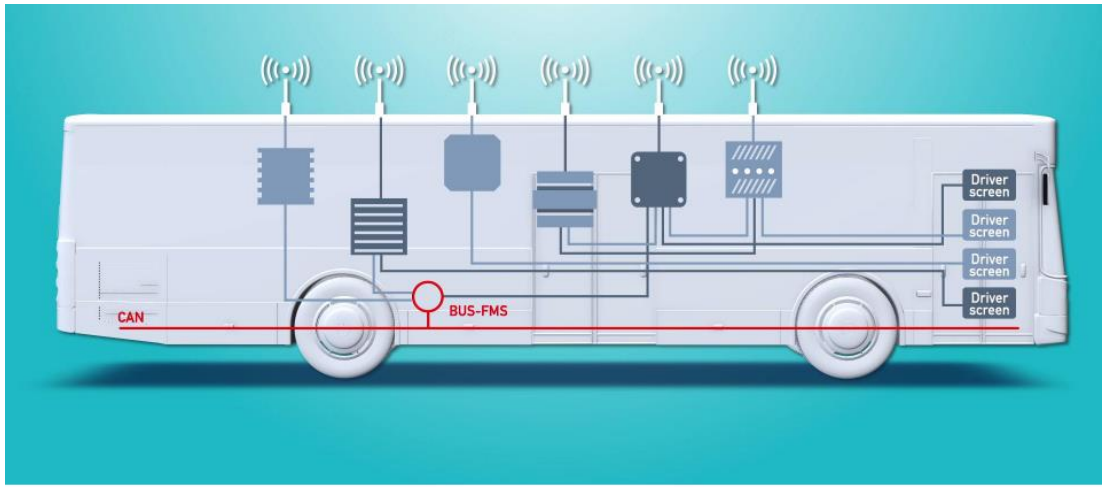
OPTICITIES

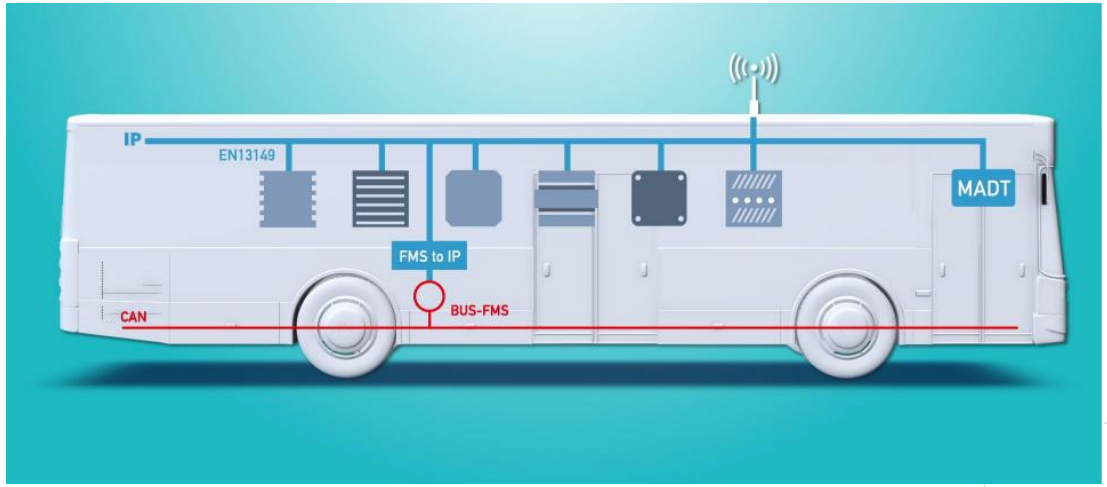
EUROPTIMA
Tickego

IP KOM ÖV

#EUSpace

Standardizing IT systems in public transport





https://wiki.itxpt.org/images/5/57/ITxPT_Vehicle_with_IP_network.png

Technical specification

S 01

Installation Requirements
Power Supply Interface
FMS Interface
Other Interfaces (audio, antenna, wireless, etc)
IP network
Space
On-board IP
Harness

IP network and hardware layer

S 02

On-board
0 Protocols DNS and MQTT
1 Module Inventory
2 Time service
3 GNSS Location
4 FMStoIP
5 VEHICLEtoIP
6 AVMS
7 APC
8 MADT
9 MQTT Broker

Inventory
- to be provided by
- to be subscribed to

S 03

Back-Office
TRANSMODEL ecosystem
NeTEx (Network Timetable exchange)
SIRI (Service Interface for Real-time Information)
OJP (Open Journey Planning)

S03P01 – TiGR (**T**elediagnosis for **i**ntelligent **G**arage in **R**eal-time)

Useful protocols

Governed by CEN, Facilitated by ITxPT

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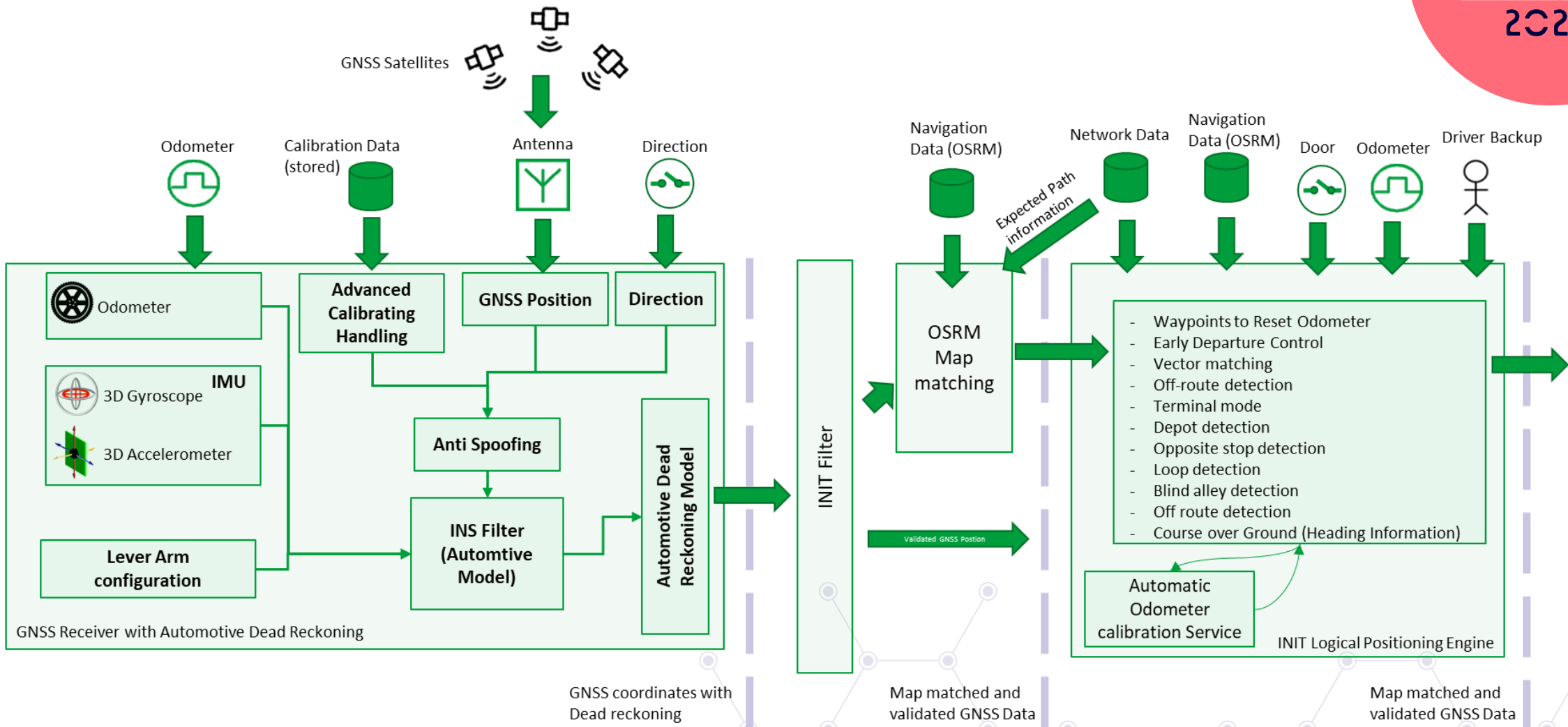
ITxPT and GNSS location services

- GNSS Location specification
  - Raw/pre-processed data is consumed and provides in UDP protocol (multicast)
- Multi-constellation GNSS receivers at processing rate of 1/s or 2/s
- Defined ITxPT use cases:
  - Location algorithms use the geolocation data to calculate the position of the vehicle on the public transport network
  - Fleet Management applications use the geolocation data to monitor the vehicles position on the public transport network
  - Passenger Information modules use geolocation data to display vehicle location on the public transport network and next stop onboard the vehicle.

INIT GNSS processing pipeline

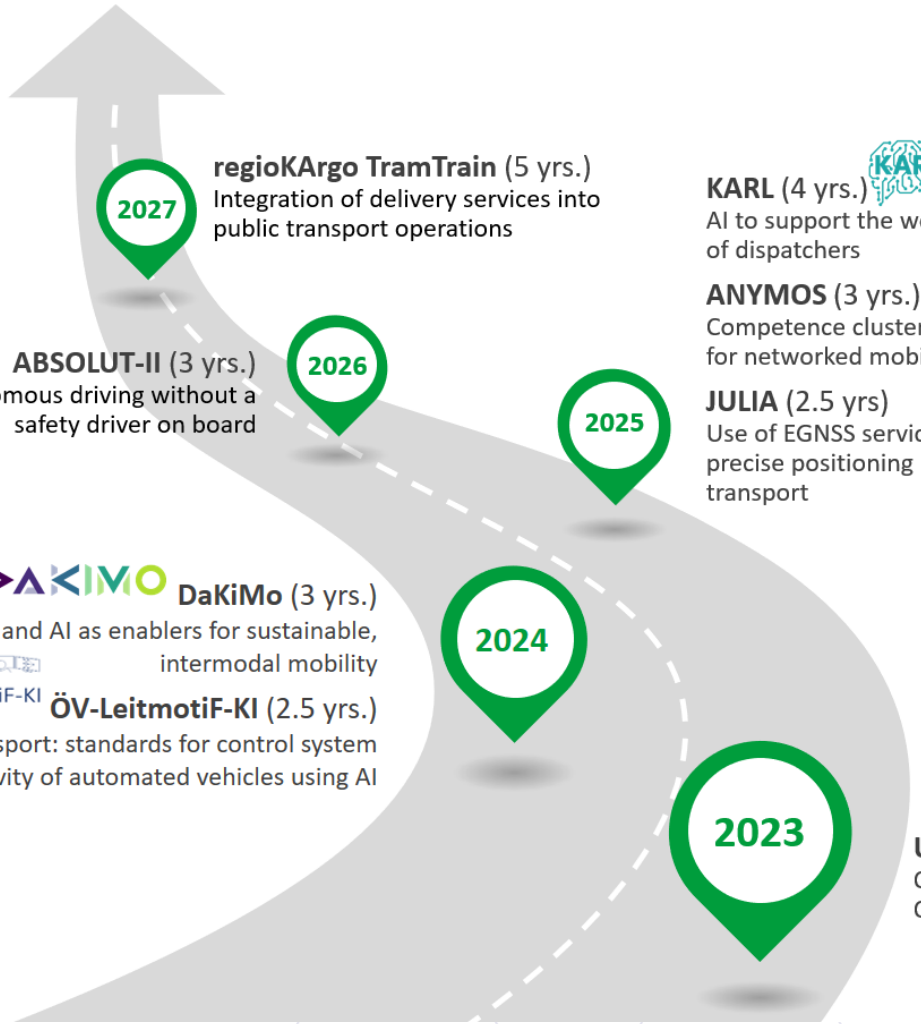


#EUSpace

GNSS related research projects

Research Roadmap

Ongoing



2027

regioKArgo TramTrain (5 yrs.)
Integration of delivery services into public transport operations

2026

ABSOLUT-II (3 yrs.)
Autonomous driving without a safety driver on board

2025

KARL (4 yrs.)
AI to support the work of dispatchers

ANYMOS (3 yrs.)
Competence cluster anonymization for networked mobility systems

JULIA (2.5 yrs)
Use of EGNSS services and data for precise positioning in public transport

2024

DaKiMo (3 yrs.)
Data and AI as enablers for sustainable, intermodal mobility

ÖV-LeitmotiF-KI (2.5 yrs.)
Public transport: standards for control system connectivity of automated vehicles using AI

2023

U-hoch-3 (4 yrs.)
Occupancy prognoses
Object recognition

LogIKTram (3 yrs.)
ITC platform for integration of cargo services

SDIKA (3 yrs.)
Secure, open and interoperable ID solutions

KIMonoS (2.5 yrs.)
AI- supported mobility on-demand-platform in Saarland

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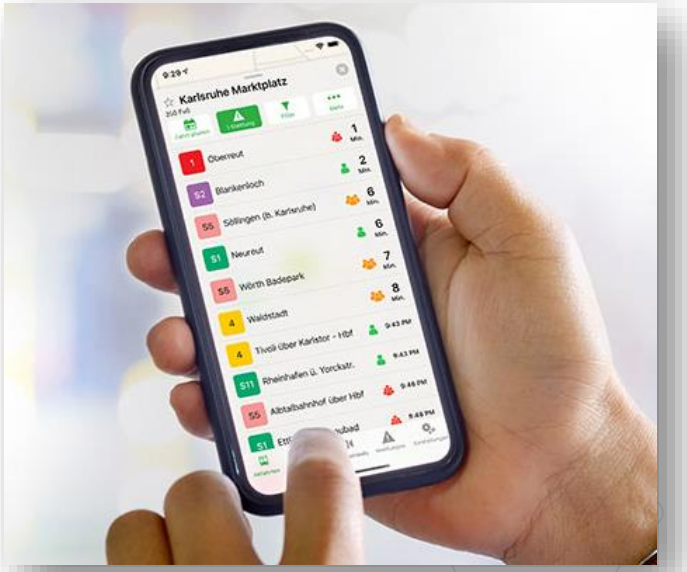
GNSS related research projects

Assistive mobility

MAVIS / ASSISTIVEtravel

Passenger information



MobileDataFusion / Uhoch3

Multimodal transport systems

regioKArgo

#EUSpace

GNSS related research projects

MAVIS / ASSISTIVEtravel

- Personalized travel companionship according to the user profile
- App design optimized for impaired users
- Bus driver notification
- Inside and outside speaker announcements
- T-Loop system for hearing aids

Inside the vehicle

Waiting/ boarding

Travel planning

Land Transport Authority
We Keep Your World Moving

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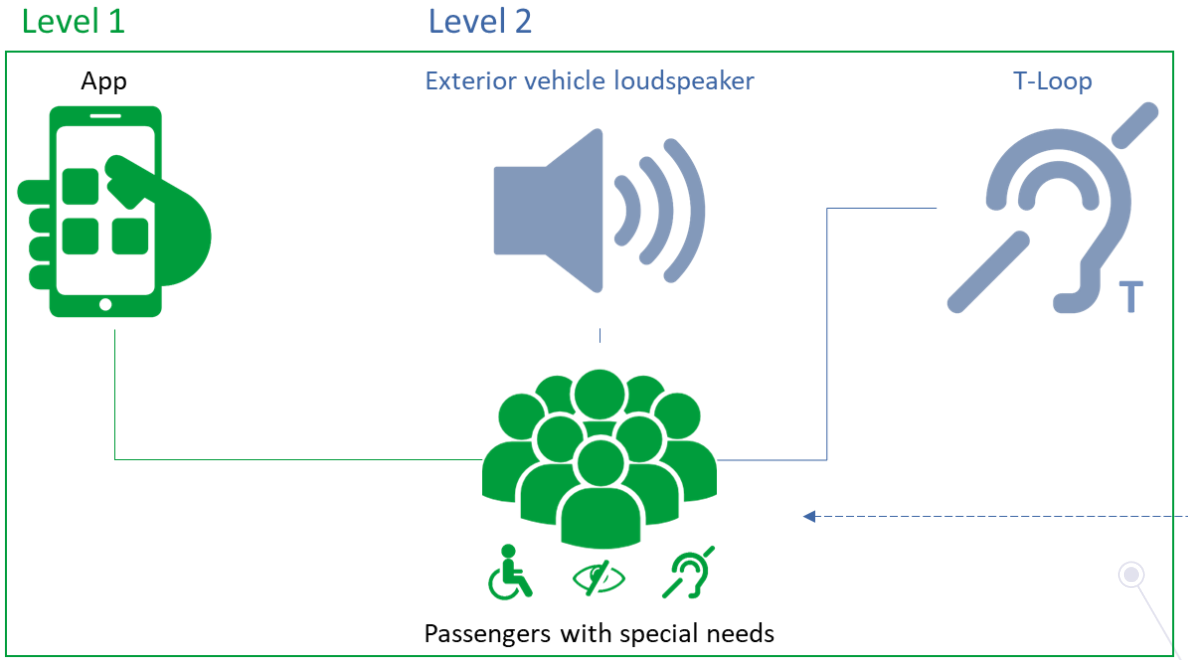
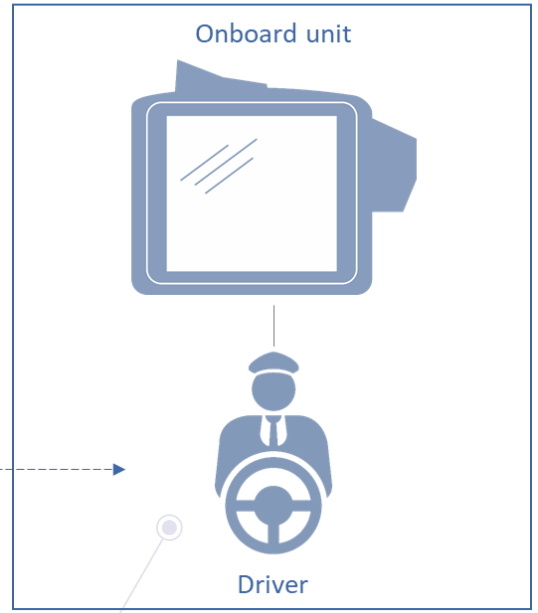
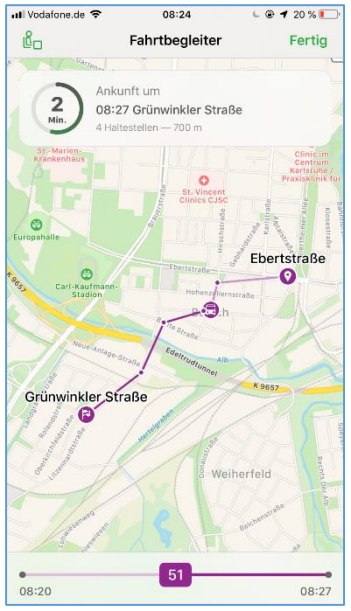
GNSS related research projects

MAVIS / ASSISTIVEtravel







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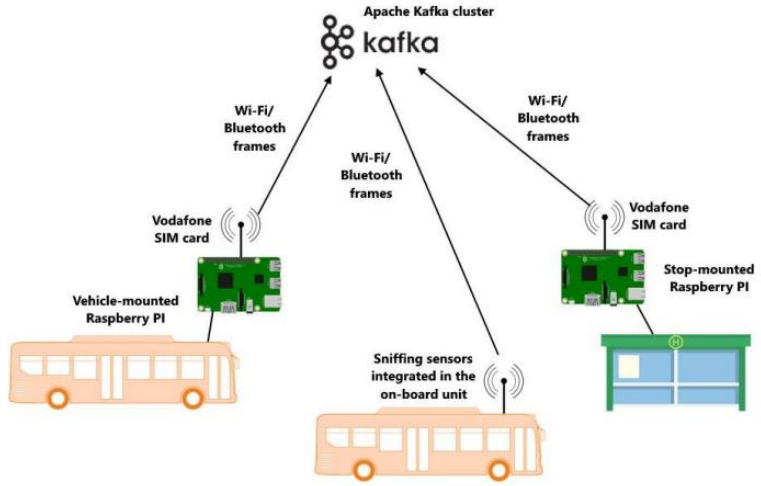
GNSS related research projects

MobileDataFusion (MDF)

- **Goal:** Determination of precise data on demand and passenger flows (passive)
- WiFi and Bluetooth probe requests
- Data Fusion: APC, GNSS, probe requests, weather, booking system requests
- Goal: More precise revenue splitting, better passenger information



MOBILE DATA FUSION

Bundesministerium für Verkehr und digitale Infrastruktur

init NVV BLIC Zukunft für Mobilität

WVI Verkehr Infrastruktur

Mobilität. Mit uns.

UNIKASSEL VERSITÄT

VERKEHRSPLANUNG UND VERKEHRSSYSTEME

Prof. Dr. Carsten Sommer

#EUSpace

GNSS related research projects

U-hoch-3

- **Goal:** Increased attractiveness of PT in urban areas
- Extended passenger information:
  - Punctuality
  - Real-time occupancy data
  - Real-time occupancy of multipurpose areas
  - Occupancy prognoses for future trips
- Data fusion approach: weather, event calendar, timetable information requests, spatial data

unbeschwert urban unterwegs

Bundesministerium für Bildung und Forschung

KVG NVV init DHL IVU TRAFFIC TECHNOLOGIES UNIKASSEL VERSITÄT

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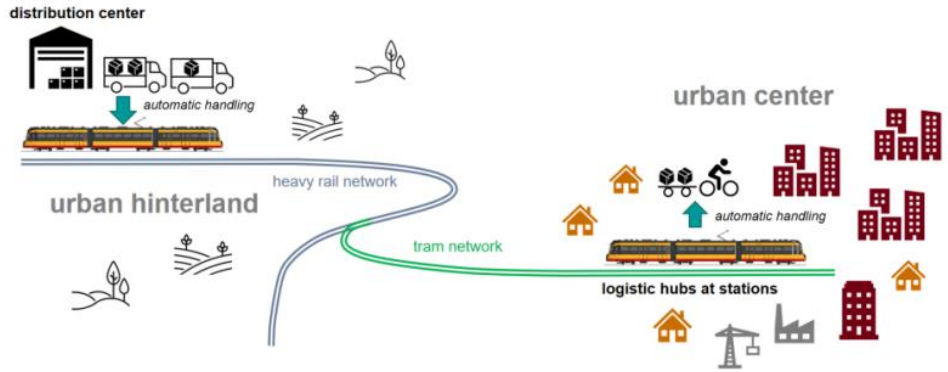
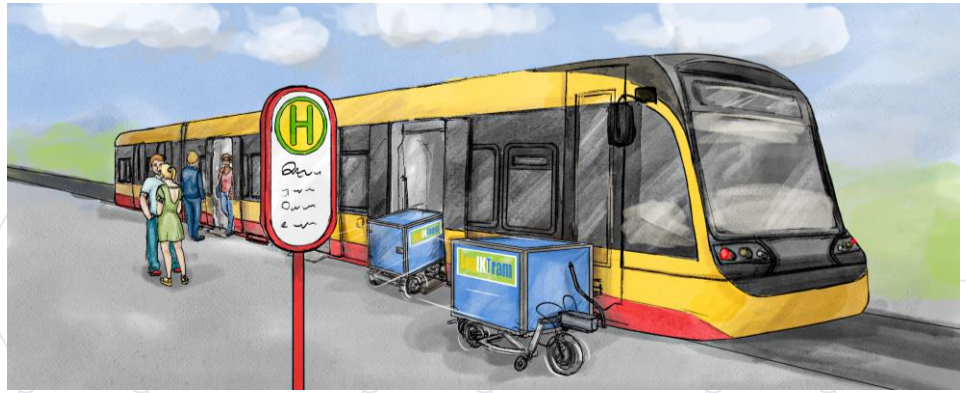
GNSS related research projects

logIKTram and regioKArgo

- **Goal:** Integrating delivery services into public transport through a common ICT-platform
- Combining logistics with public transport operational systems of planning, booking and operation control
- Development of physical loading unit and carriage for combined transport of passengers an goods
- Putting the concept into real operation in regioKArgo





Bundesministerium für Wirtschaft und Technologie

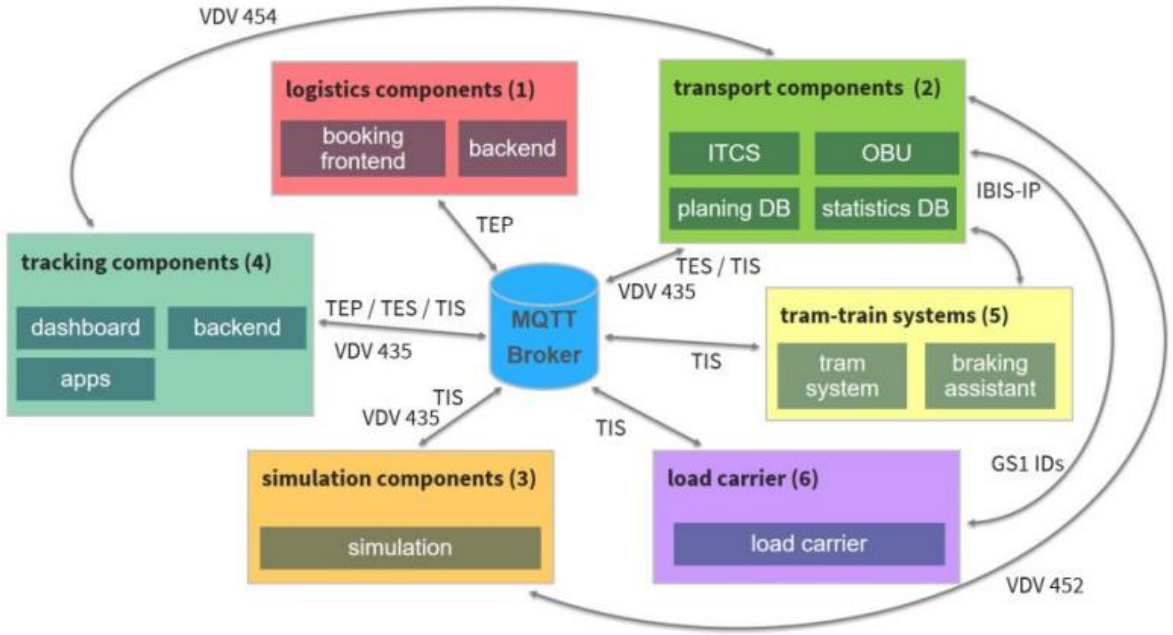
EUROPEAN UNION
Investing in our Future
European Regional Development Fund

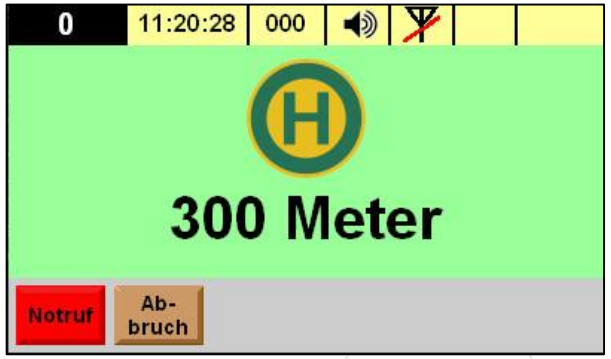
AVG Bewegt alle. VBK Bewegt alle. init FZI KIT Karlsruher Institut für Technologie
SIMPLAN MARLO Consultants DB
Hochschule Offenburg offenburg.university THALES DB Engineering & Consulting

#EUSpace

GNSS related research projects

logIKTram and regioKArgo





#EUSpace

The JULIA project

- **JULIA**: Joint developments for Urban resiLIence connecting users to public transport through spAce technology
- Funded by HORIZON-EUSPA (IA) starting in December 2023 (30month)
- Aim:
  - Integrating Galileo (E)GNSS services for increased accuracy (HAS-PPP), availability (multi-constellation GNSS), and authentication (OSNMA)
  - Application and Demonstration in bus, light rail and shared mobility transport
- **Pilot sites:** Barcelona, Spain, Ljubljana, Slovenia, Athens, Greece

#EUSpace

Conclusion and outlook

- GNSS localization and spatial data are at the core of public transport operations
- Location Based Services (LBS) play an important role
- New applications required reliable and accurate positional data
- Standardized open-data and services are needed (or need to be expanded)
- Public transit can be a valuable input / enabler for future applications (e.g. smart cities)

Thank you

Dr. Jochen Wendel
INIT Group

jwendel@initse.com

Public Transport session - Agenda

14:00	*Session Agenda presentation*	**Daniel Lopour**, EUSPA
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16:00	*User Requirements Discussion & validation*	
16:45 – 17:00	*Conclusions and next steps*	

KEY AREAS

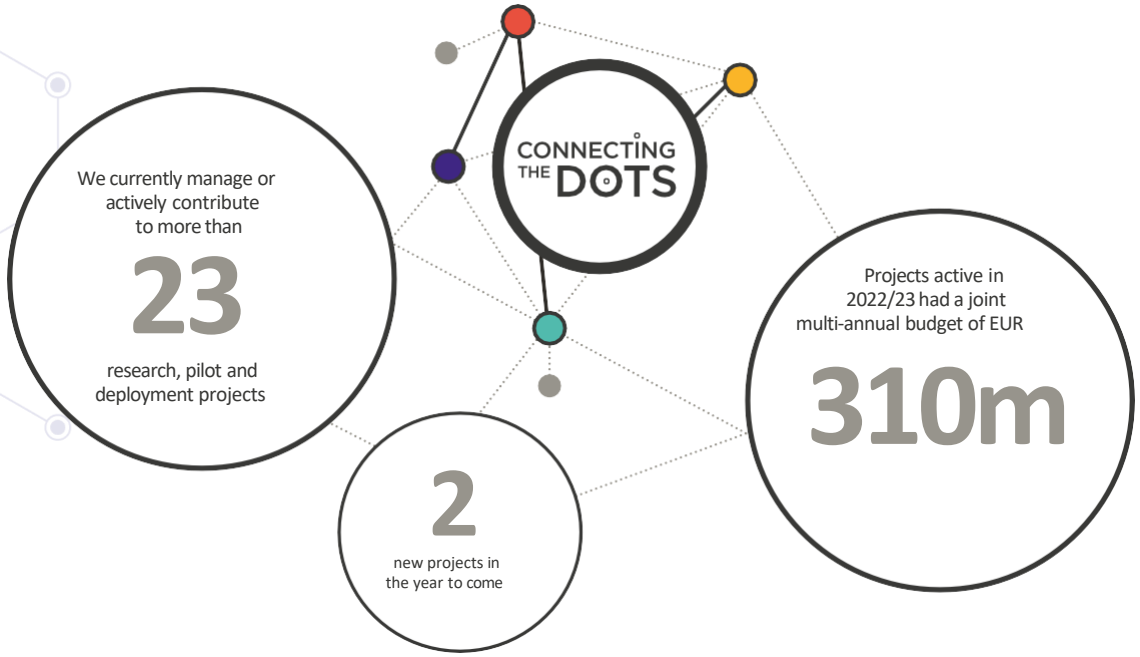
#EUSpace

ERTICO- Deploying Innovation

- Deploying innovation is central to make mobility smarter, safer and cleaner, working with ERTICO Partners across four priority areas: Connected, Cooperative & Automated Mobility, Urban Mobility, Clean and Eco Mobility and Transport & Logistics

- And Innovation is at the heart of ERTICO's activities as evidenced through our participation and leadership in a great number of emblematic European Commission R&I projects

Active Projects in 2023



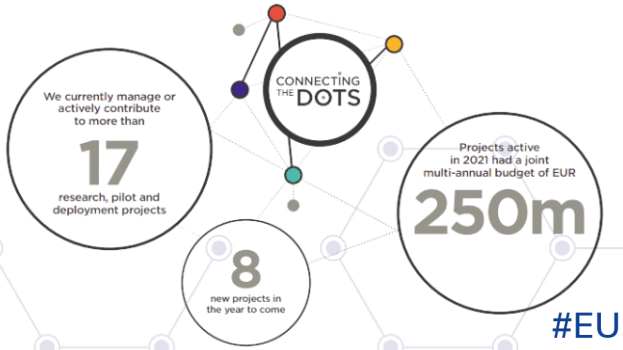
28 Projects in 2022 / 2023

EU SPACE

5GLOGINNOV · 5GMETA · eCHARGE 4DRIVERS · 5GMOBIX · eBRT · FAME · ENSEMBLE · FENIX NETWORK · IN2CCAM · ARCADE · modales · napcore · BOOSTLOG · Next ETRUCK · Ploto · PODIUM · HEADSTART · PRIVATEER · SHOW · PrepDSpace4Mobility · ICT4CART · solutions plus · STORM · SINFONICA · wetransform · V4SAFETY · SONRISE

ERTICO Partner's EC funding - 75m

Projects in 2022



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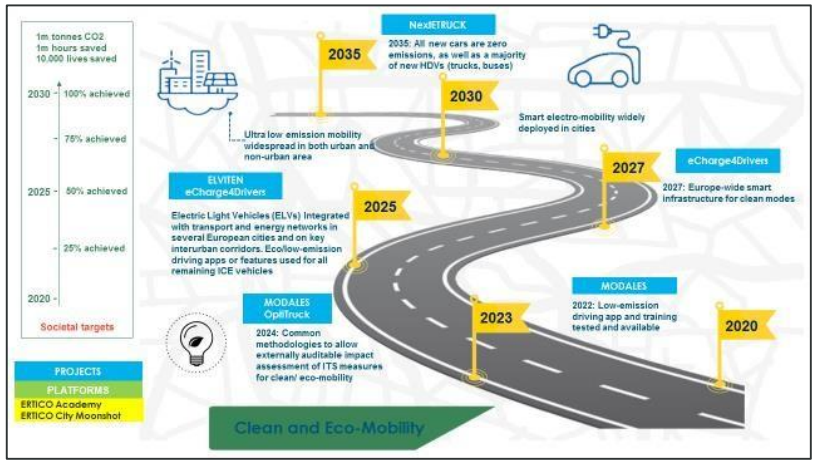
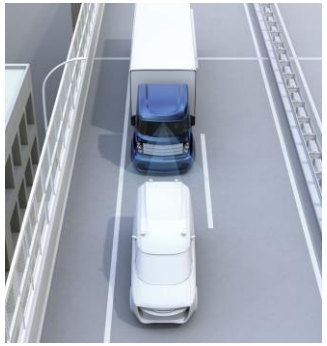
4 focus areas of mobility

➢ Clean and Eco-Mobility Roadmap

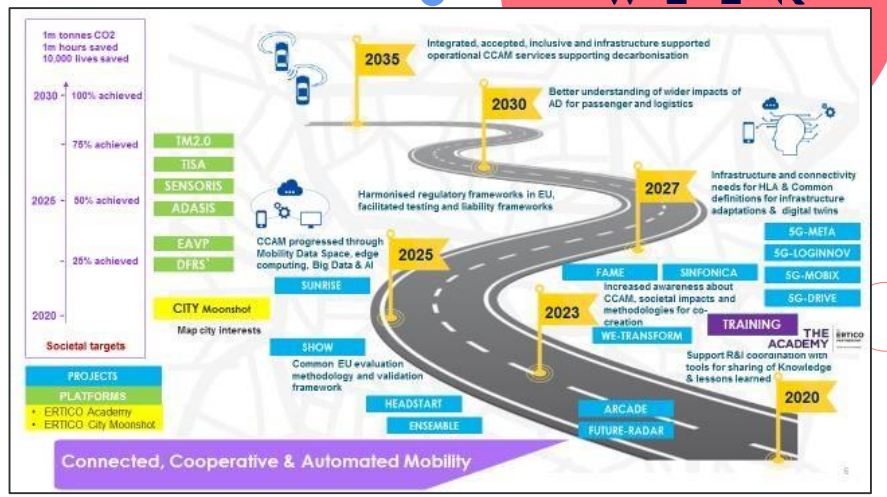
Reducing environmental impact



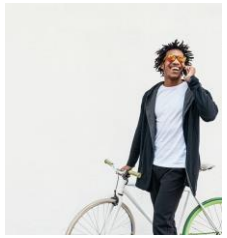
➢ Connected, Cooperative and Automated Mobility Roadmap



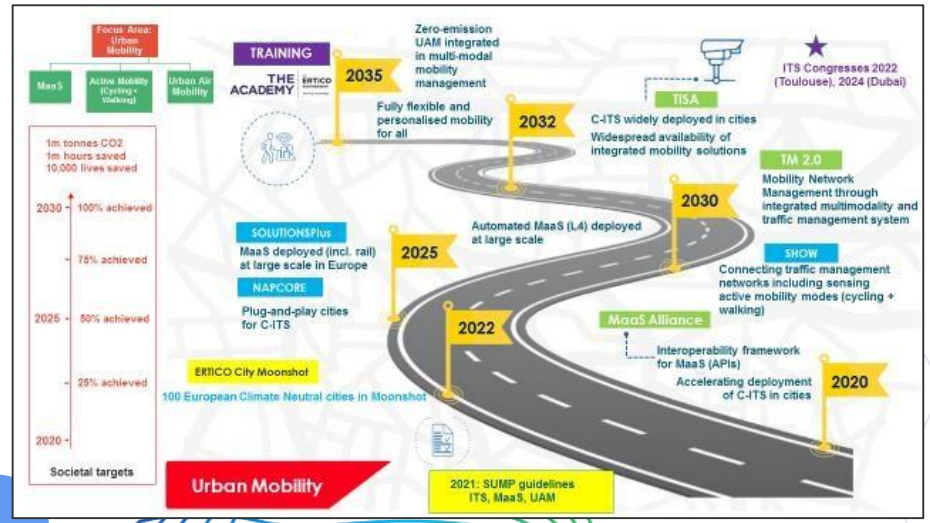
Accelerating automation and connectivity for safer and smarter mobility



➢ Urban Mobility Roadmap

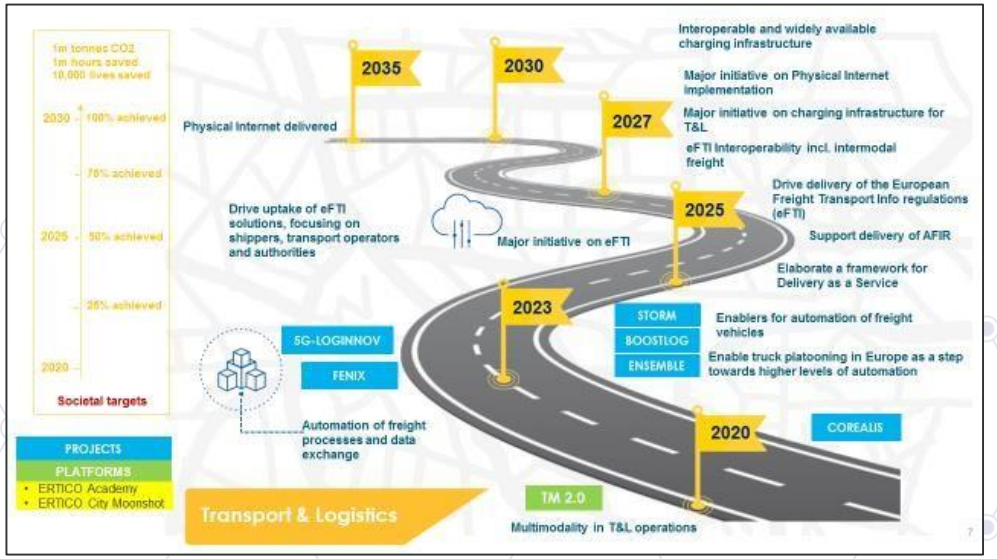


Delivering seamless mobility for all

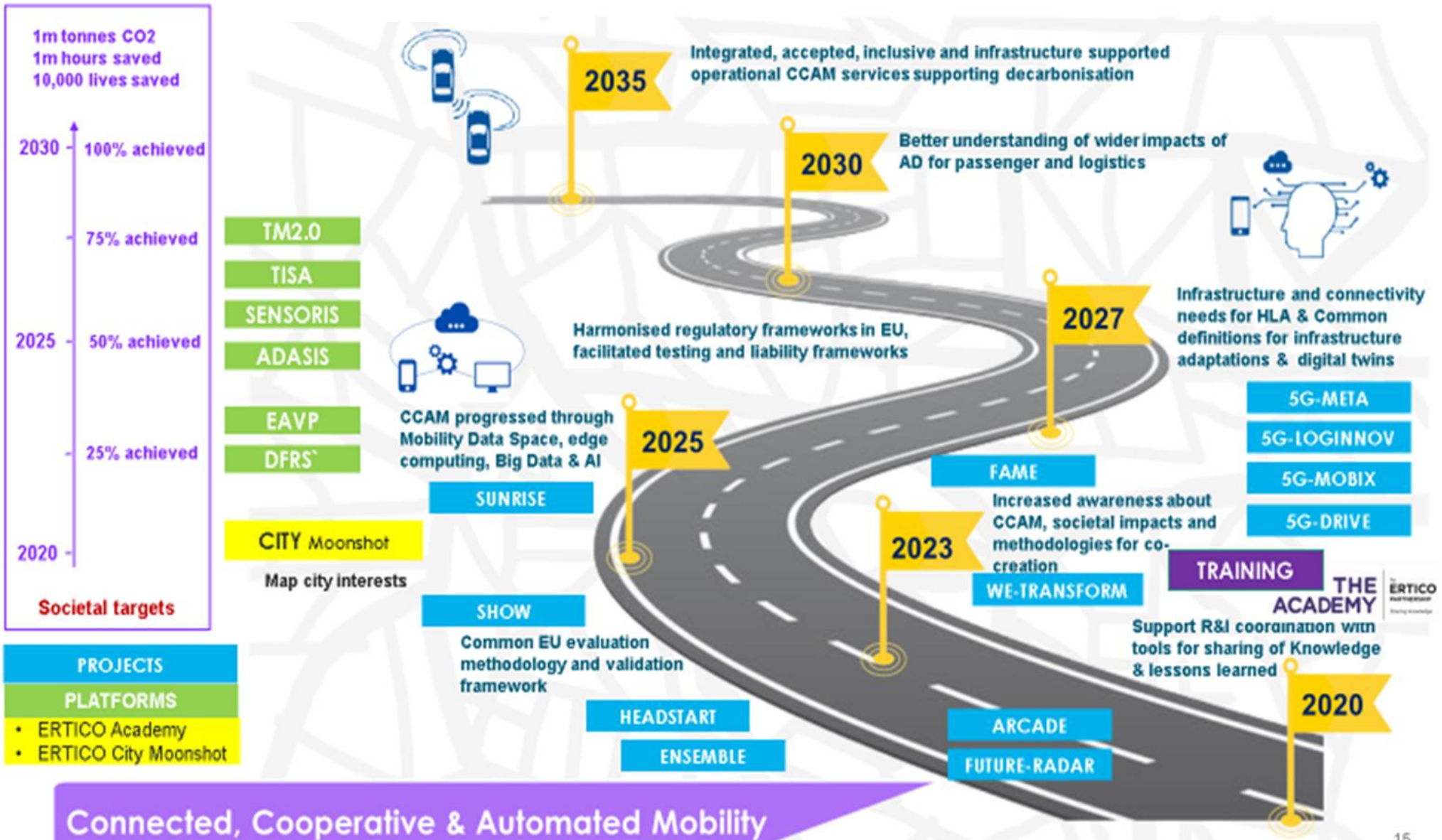


➢ Transport & Logistics Roadmap

Creating the digital infrastructure for freight transport and logistics operations



Roadmap - CCAM



GNSS/PNT in smart mobility

- Aside from providing navigation solution to self-driving cars, GNSS/PNT offers numerous opportunities to:
  - **plan** new infrastructure and improve the existing one based on measuring traffic flows – e.g. longitudinal traffic flow data informing future infrastructure investment decision
  - **decrease** CO_2 emissions coming from the transportation vehicles – e.g. smart bus stops and efficient phasing of traffic lights
  - **ensure** safety based on citizens' reports from certain locations – e.g. combining citizens' emergency reports with CCTV data
  - **improve** infrastructure monitoring, optimize maintenance intervals and reduce the costs for upkeep – e.g. combining data on the use of bridges and sensor-provided status of various elements.

Partners' ITS related activities/use cases

- Combined 4G/5G/satellite architecture to utilise the advantages of satellites- regarding **ubiquitous connectivity-** to realise the always-connected aspect of CCAM (Satellite and 4G/5G-driven autonomous vehicles),

- Car on vehicle sensors networked to the OEM's premises via satellite to constantly monitor vehicle's parameters; over-the-air updates, which would lead to smart update solutions for the entire vehicle, from the powertrain to infotainment systems

- Next generation positioning OBU for enabling highly automated driving such as the development of a precise positioning system for high levels of automated driving SAE-L4 and L5 for many vehicle types (e.g. cars, buses, trucks)

- Use of vehicle cameras and Intelligent image processing algorithms, as part of an integrated multi-camera system) –to provide an all-around view (360-degree visibility) of the vehicle environment from a bird's eye perspective; bird's eye view perspectives provided by satellites could enable cars of the future to identify a motorcyclist approaching rapidly from behind and the system could warn the driver or even prevent the vehicle from changing lanes as planned

(Selected) ERTICO Projects

EU SPACE WEEK 2023

5GMOBIX

An emblematic 3-year H2020 project, led by ERTICO, with 55 partners from 10 countries

- Evaluated the benefits of 5G within the Cooperative Connected Automated Mobility (CCAM) context
- Developed and tested automated vehicle functionalities using 5G core technological innovations
- implemented Edge Computing solutions at six different cross border trial sites

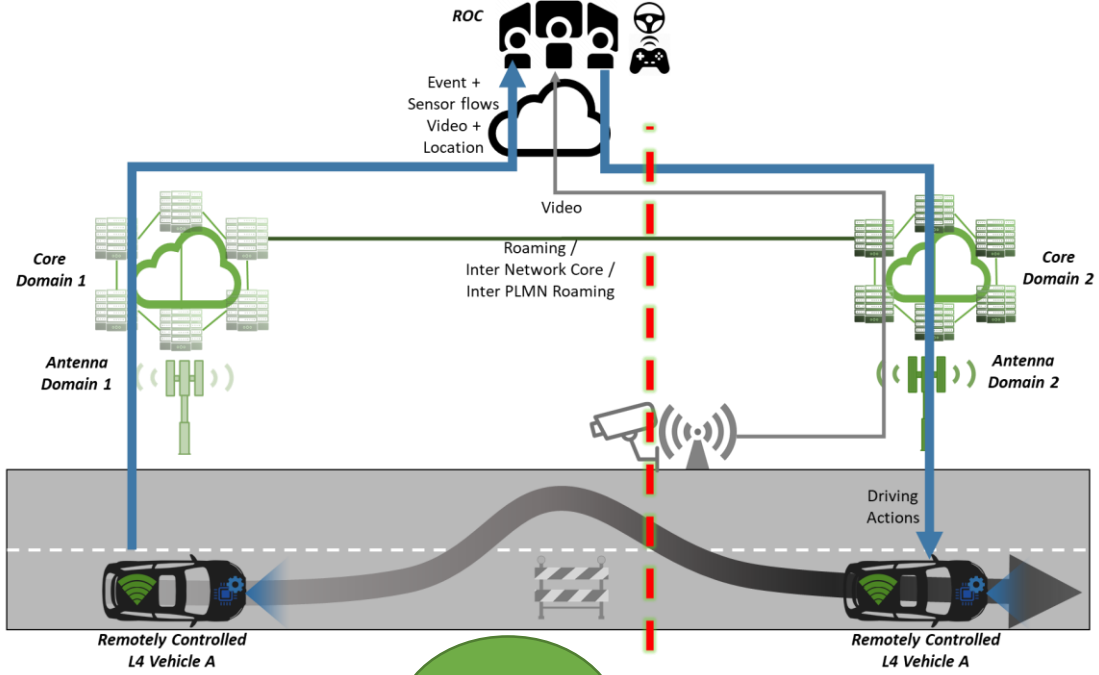
Service continuity for CCAM applications

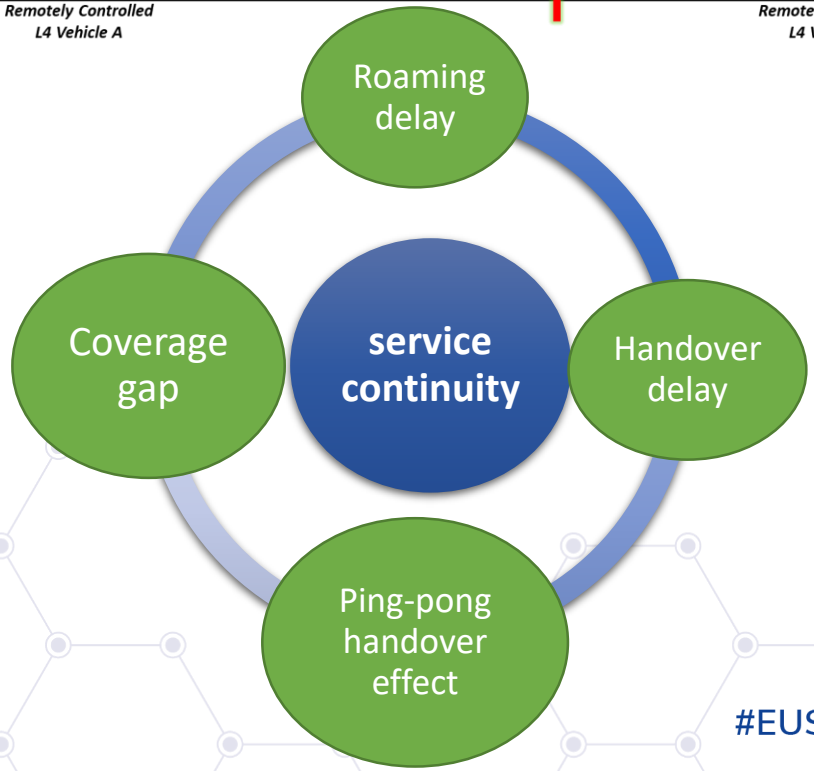
- Service continuity is a key requirement for 5G-Mobix applications, e.g., remote driving and advanced driving

- At the CBC environments, ensuring service continuity
  - Roaming delay
  - Handover delay
  - Coverage gap

- MNOs do not deploy sufficient 5G/4G infrastructure to CBC and rural areas ; this is currently not economically viable
  - SatCom may offer an economically viable alternative

- This is being investigated by MNOs such as Vodafone, BT and vendors such as Ericsson who are investing at NTN networks for remote and rural areas





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(Selected) ERTICO Projects

SHOW in a nutshell

Deployment of shared, connected and electrified automated vehicles to advance sustainable urban mobility

- Coordinated by UITP
- 70 partners from 13 EU-countries
- January 2020 – December 2023
- € 30 Mio. EUR funding from European Commission (GA No. 876630)

(Selected) ERTICO Projects

Expected Impact – Key Strategic Impacts

- SHOW aims to be the Game Changer in the path of urban mobility automation. *Targeting at:*
- Becoming the bigger ever showcase and living lab for AV fleets by transporting **over 1500000 people and 350000 containers** of goods through a combined AV fleet of **over 70 vehicles** (bus, shuttle, pod, car) in **17 cities** across Europe.
- **Setting the relevant Industrial standard**, by **enrolling the vast majority of AVs OEMs and operators (13 in total) in a single project** and in **some cases in the same Pilot site** (i.e. Transdev and KEOLIS in French and Swedish sites); thus resulting in a commonly accepted open system Architecture, widely adopted standardisation and policy recommendations and de facto proven interoperability protocols.
- **Involving the full value chain of autonomous PT mobility services throughout the project and in each of its Pilot sites.**

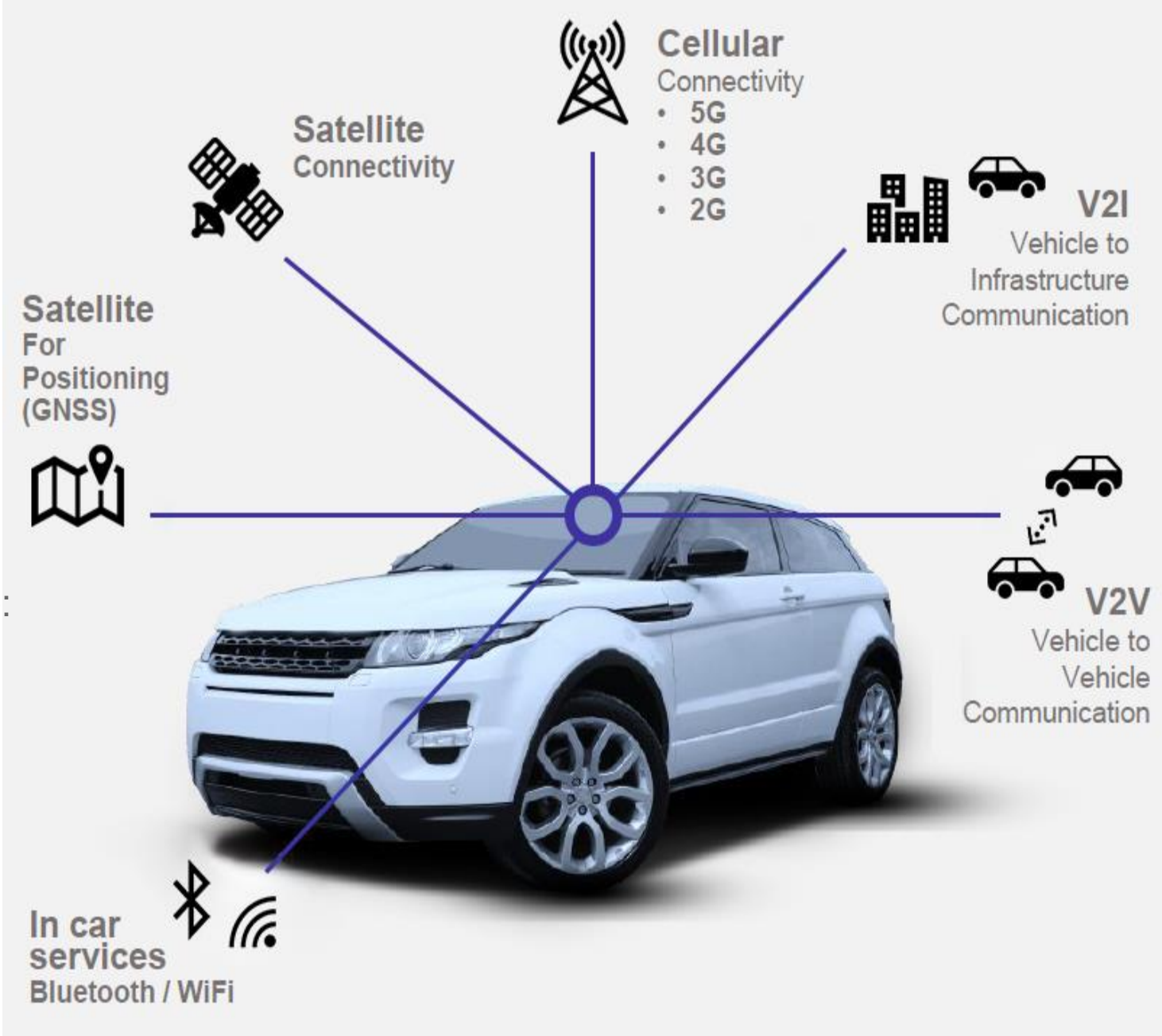
Always-On Connectivity

enabling always-on, everywhere connectivity and associated services: Infotainment, Vehicle Management, and Data Analytics.

Connected and autonomous vehicles are not the future, they are the present. As consumer expectation for on-demand data services increases, the new market differentiators become: Access, Data rate, & Reliability

.

Despite the deployment and rollout of 4G/5G, still huge areas where autonomy and critical services will not be accessible unless we harness the entirety of the connectivity that surrounds us, including **satellite data**, cellular and wi-fi.



Source: Continental

EGNSS for Public Transport Survey (selected) PTA/PTO responses

- Bus fleet use the GNSS to geolocate the position in real time to manage and control the routes, prevent incidences, provide real time estimations for our bus users and plan new needs.
- Live bus tracking for waiting time information on bus stops
- The GNSS system is mainly used in freight wagons to know their position and to know the kilometres travelled.
- Buses are equipped with satellite navigation receivers. Processing this real-time information (all types of transit data such as timetables, bus stops, and journeys these data is then transmitted to the displays at the stops, and even on their smartphone application. Passengers can see immediately if the bus is late and long waiting times at bus stops can be avoided
- Vehicle positioning, Tyre positioning
- Autonomous vehicles tracking

(Selected)R&D Use Cases and Applications EGNSS enabled

Rural areas with high car ownership and low usage of conventional public transport services from railway stations, resulting in low demand for the service

- Improve the geolocation on-board system for better time-of-arrival information to public transport users.
- EGNSS- based train positioning system, to provide a reliable and efficient solution for railway operations. It will allow for real-time tracking of the train, providing accurate and up-to-date information to both the operator and the passengers.

Accurate vehicle tracking with Galileo

Effective DRT pick-up process enhanced by Galileo

Safety of cycle routes connecting trips in public transport for the first and last mile and extending towards a wider part of the network.

AI- and computer vision-enhanced cycle lane assessment for safety with Galileo and Copernicus

(Selected)R&D Use Cases and Applications EGNSS enabled

- Demand-Responsive Transport (DRT) to connect semi- urban or/and suburban areas with the multimodal transport system.
- Copernicus- based real-time air quality assessment and forecast analysis in urban environment

AI algorithms for optimal transport planning and operation leveraging Galileo algorithms for better GNSS map-matching

Accurate vehicle tracking with Galileo

Effective DRT pick-up process enhanced by Galileo

Air-quality-based mobility decisions in public transport with Copernicus A-10. Climate-change monitoring in urban areas with Copernicus

- DRT service to connect low density areas with a suboptimal access to public transport with the regional bus network - promote multimodality by enabling the transfer to the train, regional bus, or the City Urban transport

Seamless public transport validation with Galileo

AI algorithms for optimal transport planning and operation leveraging Galileo

(Selected)R&D Use Cases and Applications EGNSS enabled

- Safety of cycle routes connecting trips in public transport for the first and last mile, producing a full report of the safety of the cycling infrastructure and a decision-making dashboard for mobility planners

Evaluation of autonomous shuttle routes with Galileo

AI- and computer vision-enhanced cycle lane assessment for safety with Galileo and Copernicus

Public Transport session - Agenda

14:00	*Session Agenda presentation*	**Daniel Lopour**, EUSPA
14:20	*EU Space Programme Components current state and future services for users*	**Carmen Aguilera**, EUSPA
14.40	*The future of mobility towards more sustainable, resilient and human-centric urban mobility systems*	**Umberto Guida**, UITP
15.00	*GNSS applications in public transport operations – an application overview*	**Jochen Wendel**, INIT
15.20	*Added value of EGNSS for Public Transport Operators and users – innovative use cases from R&D*	**Nikos Tsampieris,** ERTICO ITS Europe
15:40	*GNSS usage in a city transport network: Sensing, capturing, and exploiting environmental and vehicular data systems*	**Luis Roda,** EMT Valencia
16:00	*User Requirements Discussion & validation*	
16:45 – 17:00	*Conclusions and next steps*	

KEY AREAS

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Index

EMT VALENCIA

#1 Presentation:

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The **Empresa Municipal de Transportes (EMT S.A.U.)** has, as its main activity, the organization and provision of the public service of urban, collective passenger transport in **Valencia City** (mainly 487 buses, 1721 employees, over 100 million passengers carried yearly).

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Projects in which we have collaborated with EUSPA and others from which we have learned and shared experiences

EUSPA European Union Agency for the Space Programme

ARIADNA

Awareness Raising and capacity building Increasing ADoption of EGNSS in urbaN mobility Applications and services

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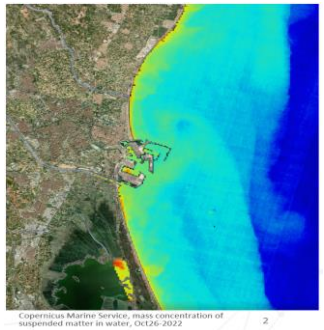
EBSF 2 EUROPEAN BUS SYSTEM of the FUTURE 2

EUROPEAN BUS SYSTEM OF THE FUTURE 2

EU SPACE WEEK 2023

Pilot Project with Valencia to demonstrate the added value of Space services and data for green and smart cities

EUSPA European Union Agency for the Space Programme



Copernicus Marine Service, mass concentration of suspended matter in water, Oct26-2022

wetransform

WETransform – TRANSFORMATION AGENDA FOR TRANSPORT AUTOMATION EU 101006900 analyzes the impact of Automation and Digitalization on Human Resources, Employee Relations and the knowledge and training requirements of mobility companies in the future.

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#2 Trust your Mobility

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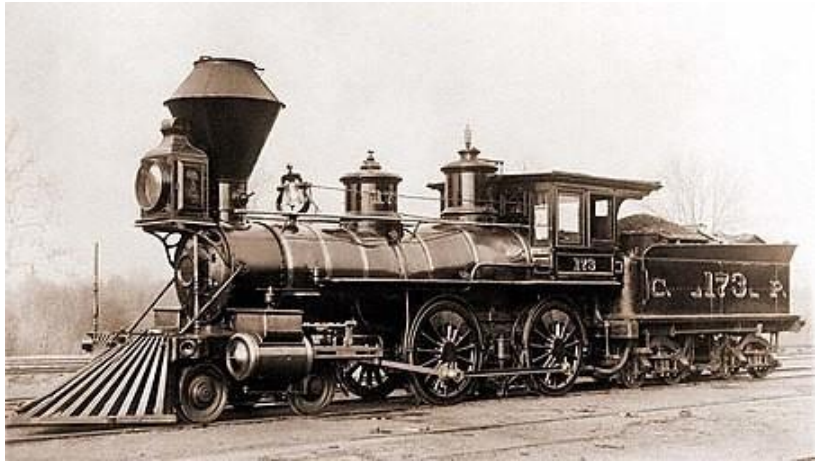
An interesting fact:

The ***Acceleration*** of Industrial Revolution was possible throught Railroad Timetables, Clock Reliability, Synchronization, and Standarization



Secret of our business: *Trust your Mobility:*

- I want to go from a convenient **point A** to a convenient **point B** … *for me*

  (*multi stage, multi modal* if … convenient)

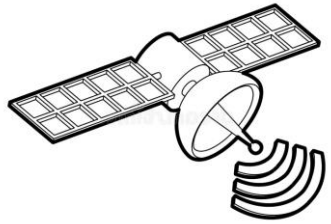
- **Life is to short** … travel time should be also.

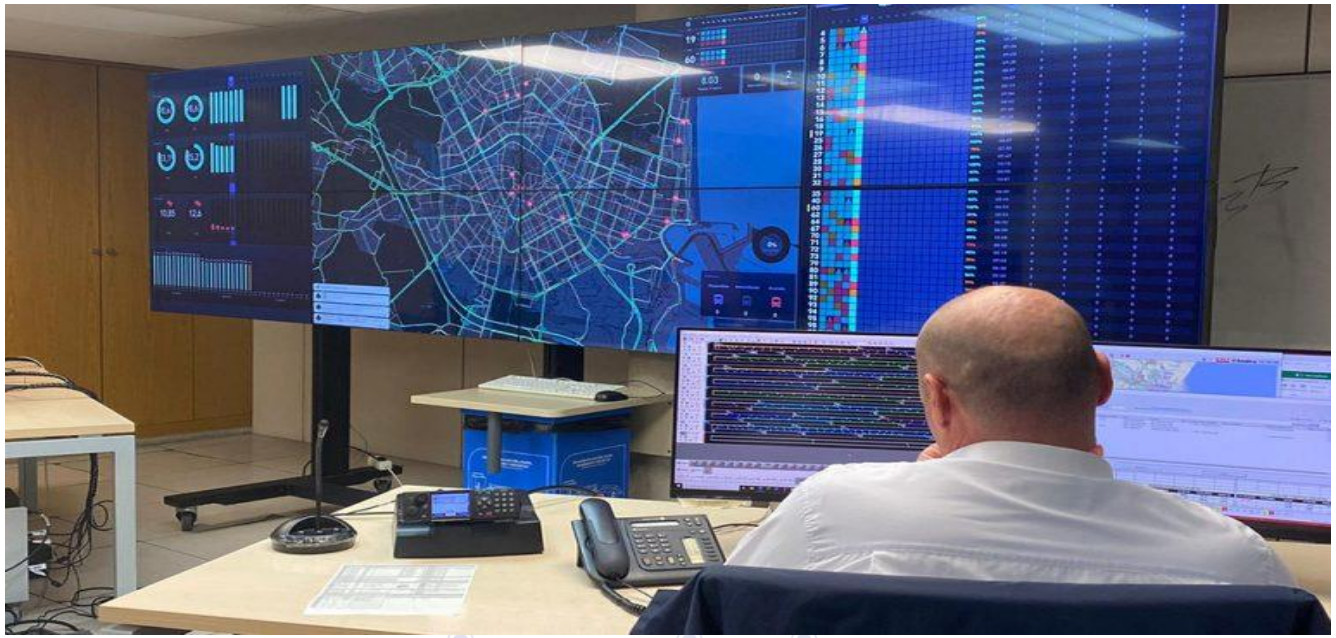
- **Mobility** should be Available, Reliable, Accessible, Frequent, Regular, Comfortable, Easy to use, Amiable, with efficient Station and On-board Services, Efficient, Sustainable, Safe & Secure, Socially Concerned, Gender Sensitized, and … Environmentally Aware.

- It must have a reasonable and justified price… and the User **must be able** and have the tools/means to make the **payment**.

What we do to ***EnTrust*** *your Mobility*?

- The ***Acceleration*** in *AI Revolution & Mobility* is possible throught GNSS Clock & Possition Reliability, IoT, Sensoring, Synchronization, and Standarization





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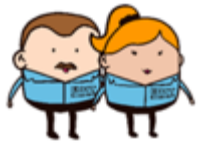
What we do to ***EnTrust*** *your Mobility.*



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valencia ciudadinteligente

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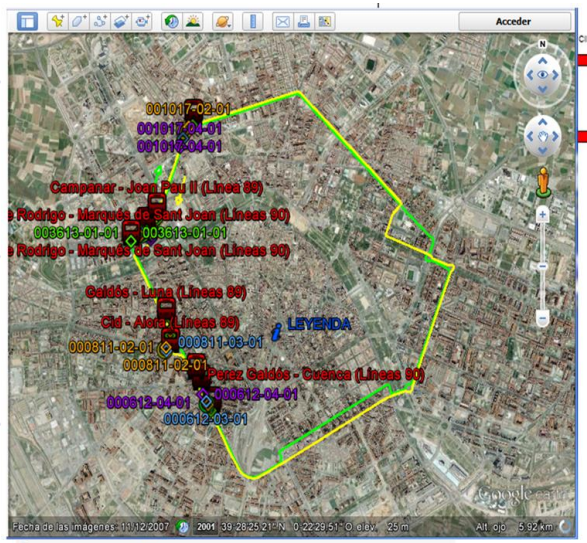

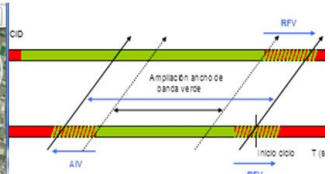

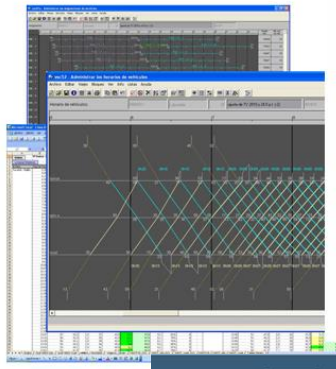

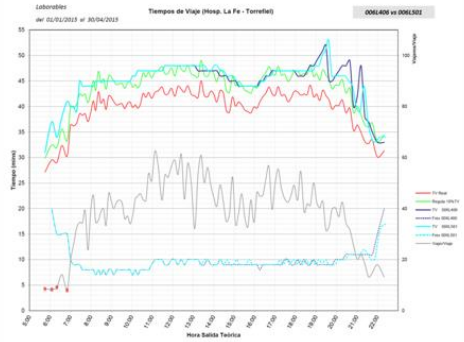

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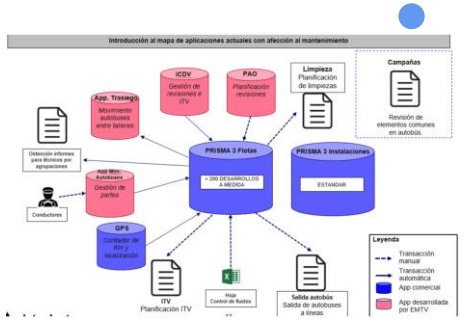
Introducción al mapa de aplicaciones actuales con afección al mantenimiento
ICDV
Gestión de revisiones e ITV
PAO
Planificación revisiones
Limpieza
Planificación de limpiezas
Campañas
Revisión de elementos comunes en autobús
App. Trasiego
Movimiento autobuses entre talleres
PRISMA 3 Flotas
> 200 DESARROLLOS A MEDIDA
PRISMA 3 Instalaciones
ESTANDAR
Obtención informes para técnicos por agrupaciones
App Mtto. Autobuses
Gestión de partes
Conductores
GPS
Contador de Km y localización
ITV
Planificación ITV
Hoja Control de Radios
Salida autobús
Salida de autobuses a líneas
Leyenda
Transacción manual
Transacción automática
App comercial
App desarrollada por EMTV


IT STANDARD INTRODUCTION IN EXISTING FLEETS
GREEN DRIVER ASSISTANCE SYSTEMS
VEHICLE DESIGN (CAPACITY, ACCESSIBILITY, MODULARITY)
6 Key areas for innovation
ENERGY STRATEGY AND AUXILIARIES
INTERFACE BETWEEN BUS AND URBAN INFRASTRUCTURE
INTELLIGENT GARAGE AND PREDICTIVE MAINTENANCE

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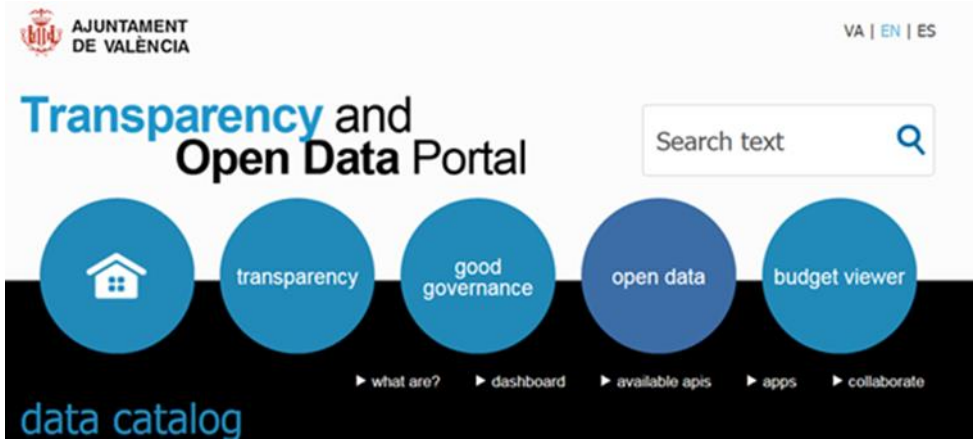

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#3

GNSS Clock & Position Reliability, Synchronization, and Standarization.

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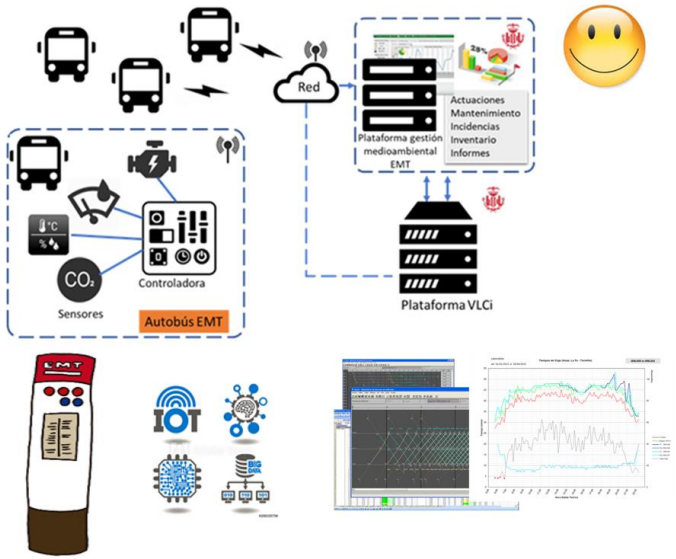
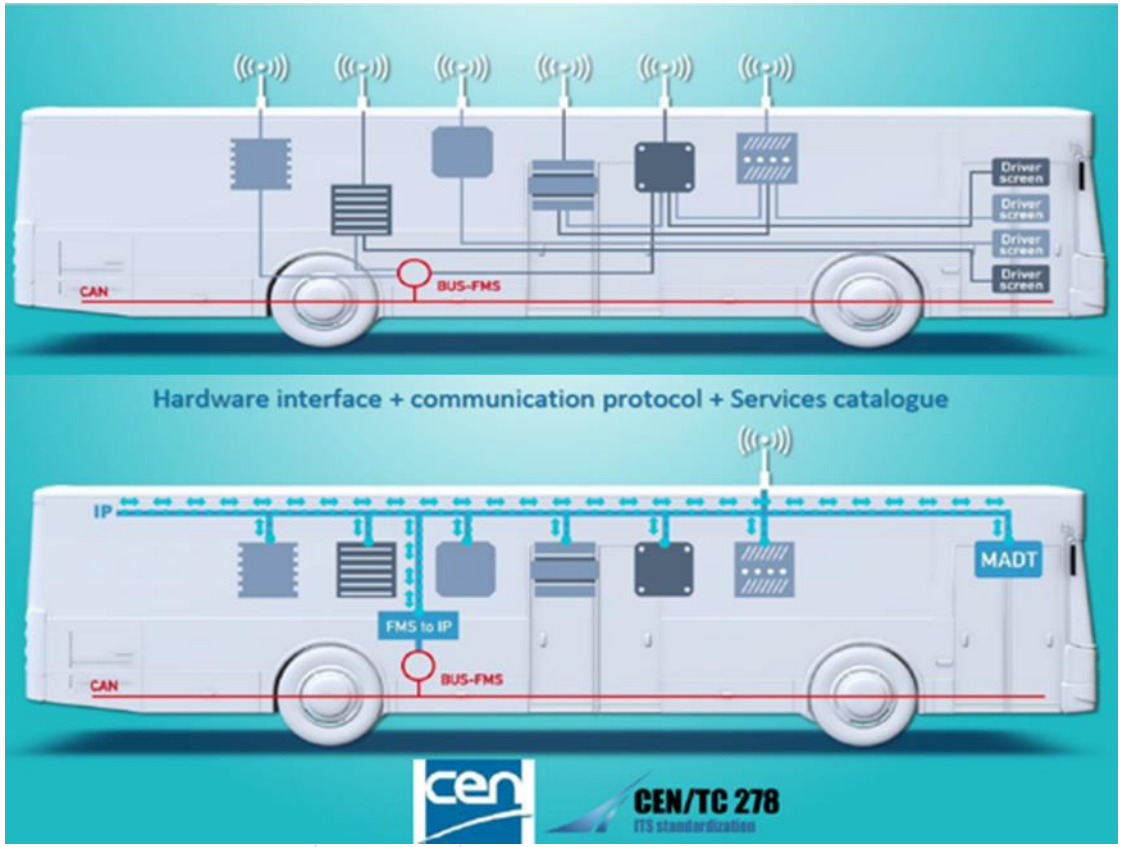
So … Where is the problem ?

GNSS Clock & Possition Reliability**, **IoT, Sensoring**, **Synchronization**, and **Standarization





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So … How we solve the problem ?

GNSS Clock & Possition Reliability, Synchronization, and Standarization

CEN/TC 278	ISO/TC 204
WG1: Electronic Fee Collection (EFC)	WG5: Fee and Toll Collection
WG4: Traffic and Traveller Information (TTI)	WG10: Traveller Information Systems
WG16: Cooperative ITS (C-ITS)	WG18: Cooperative Systems (C-ITS)
WG17: Mobility Integration	WG19: Mobility Integration
WG3: Public Transport	WG1: Architecture
WG7: ITS Spatial Data	WG3: ITS Database Technologies
WG8: Road Traffic Data	WG7: General Fleet Management and Commercial / Freight
WG15: eSafety (eCall)	WG8: Public Transport / Emergency
	WG9: Integrated Transport, Management and Control
	WG14: Vehicle / Roadway Warning and Control Systems
	WG16: ITS Communications (C-ITS, DSRC)
	WG17: Nomadic devices in ITS

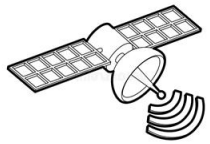
UNE-CEN/TS 13149-9:2020
Normas Vigente / 2020-06-01
Public transport - Road vehicle scheduling and control systems - Part 9: Time service (Endorsed by Asociación Española de Normalización in June of 2020.)

UNE-CEN/TS 13149-10:2020
Normas Vigente / 2020-06-01
Public transport - Road vehicle scheduling and control systems - Part 10: Location service (Endorsed by Asociación Española de Normalización in June of 2020.)

UNE-CEN/TS 13149-11:2020
Normas Vigente / 2020-06-01
Public transport - Road vehicle scheduling and control systems - Part 11: Vehicle platform interface service (Endorsed by Asociación Española de Normalización in June of 2020.)

UNE-CEN/TS 13149-7:2020
Normas Vigente / 2020-03-01
Public transport - Road vehicle scheduling and control systems - Part 7: System and network architecture (Endorsed by Asociación Española de Normalización in March of 2020.)

GALILEO



- ***Authentication:*** the ability of the system to assure users that they are utilising signals and/or data from a trustworthy source, and therefore that they are protected from spoofing threats
- ***Robustness to spoofing and jamming:*** a qualitative parameter that looks at the type of attack or interference which the receiver is capable of mitigating.
- ***Accuracy:*** the difference between the real and computed position or time.
- **Availability:** the percentage of time that the position or timing solution can be computed by the user.
- **Continuity:** the ability to function without interruption once the operation has started.
- ***Integrity:*** the measure of trust that can be placed in the correctness of the position or time estimate provided by the receiver.
- ***Time To First Fix (TTFF)*:** a measure of a receiver's performance covering the time between activation and output of a position within the required accuracy bounds.

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So … How can we solve even other or future problems ?

- **Galileo EGNSS Added Value: An authenticated signal** (TimeStamp / **GeoStamp**) not only provides more robustness, but it can even serve as **legal evidence** of the correctness of the GNSS position for liability issues.

- *Insurances costs, Accidents, Incidents, Ticketing System, Salaries, Customer Assistance, Users Complaints, Penalties in contracts, reliability, and maintenance. …*



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#4

Sensing, Data Capture, and Exploitation System for Vehicular and Environmental Data.

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Financiado por la Unión Europea NextGenerationEU

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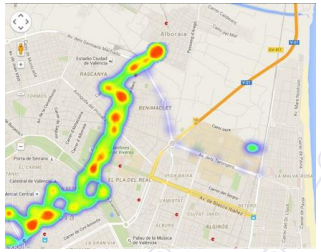
EU SPACE WEEK 2023

Sensing, Data Capture, and Exploitation System for Vehicular and Environmental Data: €1.2 million

This project will enable the capture and sensing of external and internal environmental (NO2, O3, CO, Temperature, Humidity, Noise and PM-2.5 and vehicular data in 250 hybrid buses and 20 electric buses, within the context of the strategic lines for enhancing public transportation.

The goal is to achieve an improvement in air quality in urban environments through measurement and optimization of urban transport, among other objectives.



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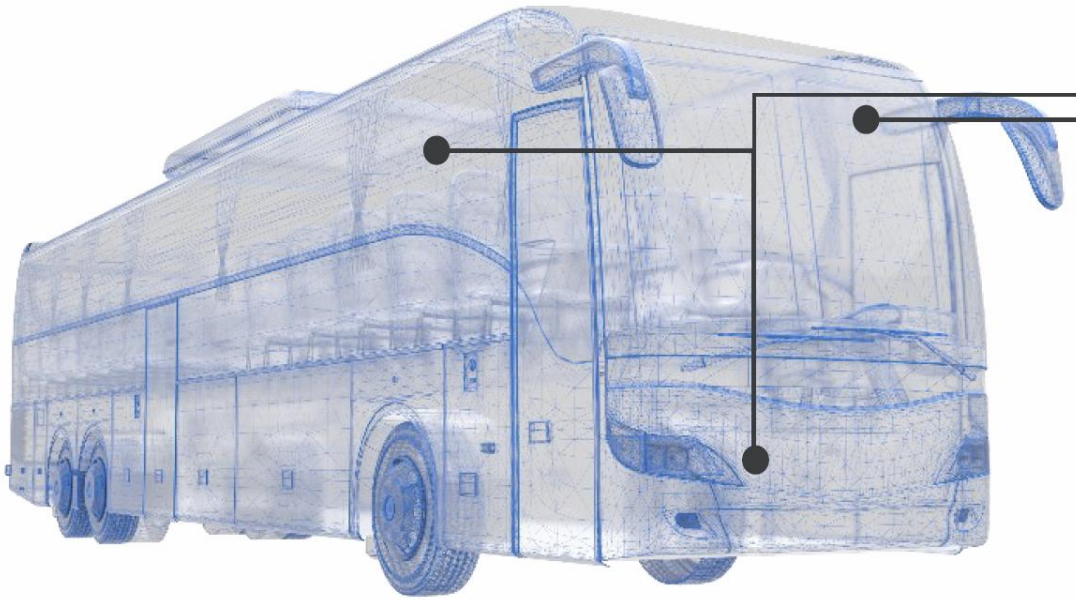
Hardware



AIR QUALITY STATION

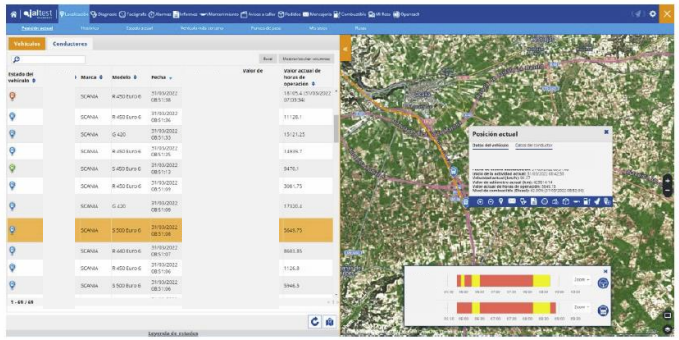
T-VOD

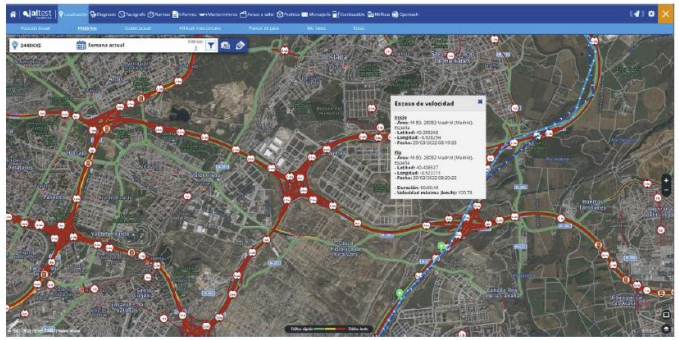
OTROS DISPOSITIVOS

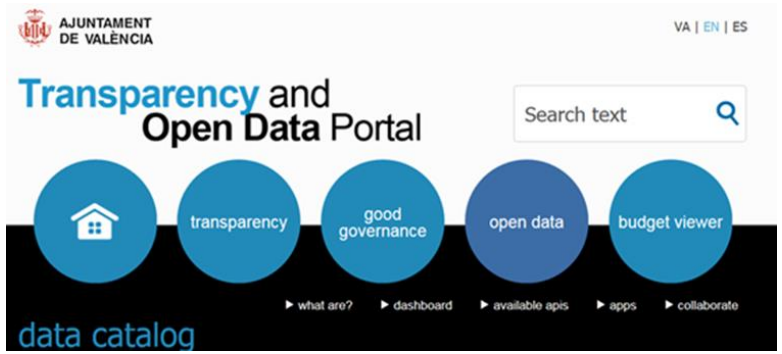
Sensores de temperatura/temperatura & humedad/temperatura & humedad & luz bluetooth.
Sensores de temperatura y humedad por cable.

Sensor de combustible.
Sensor inductivo.
Sensor de apertura y cierre de puertas.
Sensor de iluminación.
i-Button.
etc.

DATA INTAKE → DATA IN CONTEXT → ANALYTICS → INTELLIGENCE







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Avalaible Data:

- Average, instantaneous, maximum speed, and speed intervals.
- Total kilometers traveled.
- Engine and key state activity times.
- Idle times.
- RPM intervals.
- Acceleration/brake, brake/acceleration events.
- Consumptions.
- Fuel level.
- AdBlue level.
- Total/average consumption per hour/and every 100 km. …

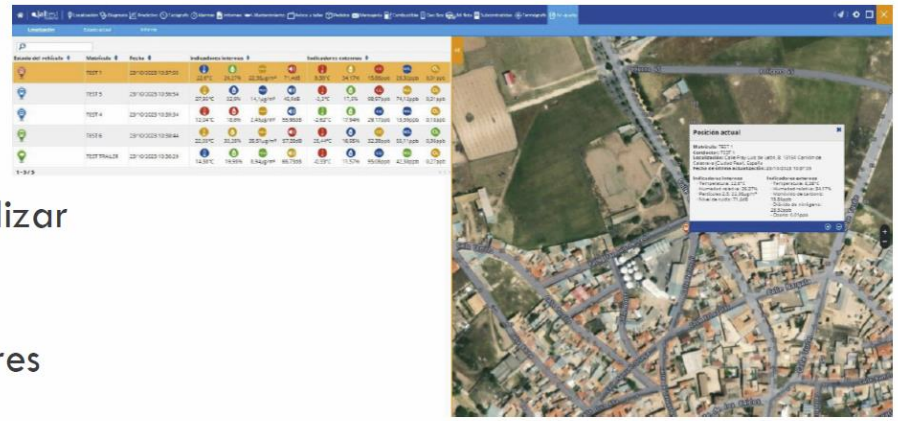
Example of proposed alarms for MAN A37 Hybrid buses:

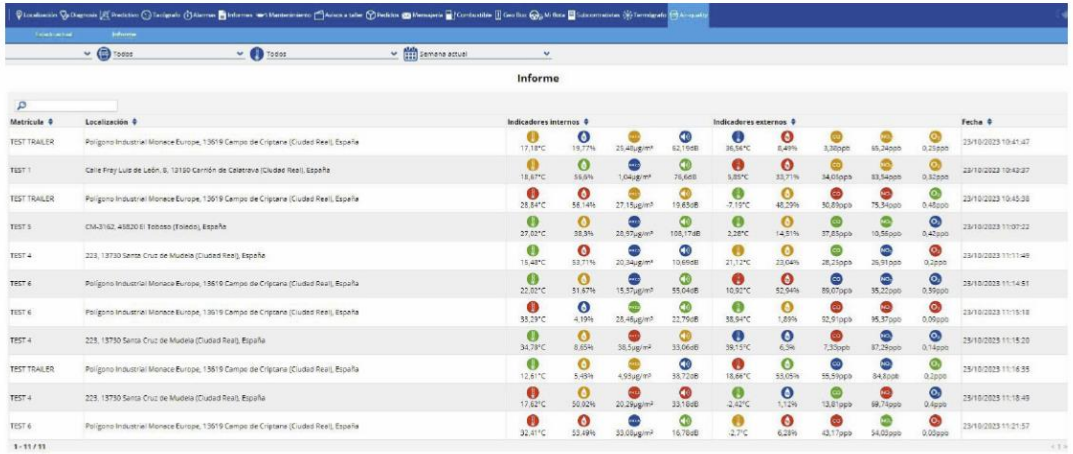
- Alarm for errors in Combustion Engine.
• Alarm for errors in Electric Motor.
• Alarm for errors in Brakes.
• Alarm for errors in Inverter Systems.
• Alarm for errors in Battery System.
• Alarms for errors in Instrumentation.
• Alarms for errors in Electrical Leakage System.
• Alarms for errors in Central Computer.
• Alarms for errors in Emission Control System.
• Alarms for errors in Door Systems.
• Alarm for low-quality AdBlue.
• Alarm for brake wear: If the percentage of remaining brake pads read every X minutes by the T-VOD unit is less than the configured percentage.
• Alarm for low battery voltage: If the battery voltage read by the T-VOD unit when activating the ignition or during the journey is less than or equal to X V.
• Alarm for excess battery temperature: If the battery temperature read every X minutes by the T-VOD unit exceeds the configured value.
• Alarm for fuel level: If the fuel level read every X minutes by the T-VOD unit is less than the configured percentage.
• Alarm for coolant temperature: If the coolant temperature read every X minutes by the T-VOD unit exceeds the configured value.
• Alarm for engine oil temperature: If the engine oil temperature read every X minutes by the T-VOD unit exceeds the configured value.
• Annual maintenance alarm. An alarm is set for annual maintenance, and a warning will be given with the configured period in advance of the expiration.
• Engine oil and filter change alarm. An alarm is set for maintenance, configurable by time, kilometers, and engine hours. A warning will be given with the configured period, kilometers, and engine hours in advance, alerting when either of them reaches the set margin first.
• Gearbox oil and filter change alarm. An alarm is set for maintenance, configurable by time, kilometers, and engine hours. A warning will be given with the configured period, kilometers, and engine hours in advance, alerting when either of them reaches the set margin first.
• Alarm for replacement of flow sensor ref. MAN 51.09413-6000. An alarm has been set with a maintenance interval of X km. A warning will be given with an advance notice of the configured kilometers.

… and so on …

Calidad del aire

- Estaciones de calidad del aire tanto interiores como exteriores.
- Introduce la posibilidad de capturar, monitorizar y analizar datos medioambientales en tiempo real.
- Los indicadores ofrecidos por cada DEM (Dispositivos Embarcados Medioambientales dependen de los sensores que se incluyan.
- Ejemplos de indicadores interiores:
  - Temperatura.
  - Humedad.
  - Partículas en suspensión 2,5.
  - Ruido.
- Ejemplos de indicadores exteriores:
  - CO.
  - NO2.
  - O3.
  - Temperatura.
  - Humedad.





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Datasheet: Where is Galileo … ?

POWER SUPPLY		
Nominal voltage:	9 - 36 VDC	
Operation modes	Normal	
	Sleep	
Typical consumption	12V	300 mA (nominal)
		950 mA (peak)
		2 mA (sl…
	24V	150 mA
		450 mA
		1.5 mA (

AUXILIAR BATTERIES	
Backup for RTC	CR2032 cell
Optional Li-Ion 3.7V	2050 mAh

CPU	
Microprocessor	ARM Cortex-A8 @ 800 MHz
Non volatile memory	256Kb + 4 GB e-MMC
Volatile memory	64 Kb + 256 Mb DDR3L

EXTERNAL MEMORY	
EEPROM	64 Kbit serial EEPROM
Micro SD	Up to 32 Gb SDHC

GENERAL INTERFACES	
RS-232	1
CAN 2.0B	3
1-WIRE	1
Analog inputs	Up to 6
Analog inputs range	0 - 36 V
Digital inputs	Up to 6
Digital inputs logic low	< 1.5 V
Digital inputs logic high	> 2.5 V
Digital inputs max voltage	36 V
Digital outputs	1
Digital outputs type	Open drain
Digital outputs max voltage	36 V

European Global Navigation Satellite Systems Agency

Digital outputs max current	150 mA
Power outputs	Up to 2
Power outputs min voltage	(KL30 - 1) V
Power outputs max current	1A
	ct) + 1 (Multiplexed)
	tiplexed)
	tiplexed)
SAE J1708	1 (Multiplexed)

GNSS	
Chipset	Qualcomm MDM 9206 (LTE CAT M1 variant) Qualcomm MDM 9207 (LTE CAT 1 variant)
Constellations	GPS, GLONASS, BeiDou/Compass, Galileo, QZSS
Antenna	Active

GPRS/LTE CAT 1 … GPRS/LTE CAT M1/LTE CAT NB1	
Standards	3GPP Release 11 (CAT 1)
	3GPP Release 13 (CAT M1)
	GPRS Class 12
Bands Europe (2G)	850/900/1800/1900MHz@GSM
Bands Europe (LTE CAT 1 variant)	B1/B3/B7/B8/B20/B28A@LTE FDD B1/B8 @WCDMA
Bands North America (LTE CAT 1 variant)	B2/B4/B5/B12/B13@LTE FDD
	B2/B4/B5@WCDMA
Bands Global (LTE CAT M1/NB1 variant)	B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B28/B39@CAT M1/NB1
Data throughput	LTE CAT1: Max. 10Mbps (DL)/5Mbps (UL)

ALIMENTACIÓN		
Tensión de operación:	9 - 36 VDC	
Modos de operación	Normal	
	Off	
Consumo de corriente	12V	1.5 A (max)
	24V	1 A (max)
Temperatura de almacenaje	-40ºC a +80ºC	
Temperatura de operación	-30ºC a +65ºC	
Temperatura de operación para sensorización	-10 a +50ºC	
HR máxima de operación	80%	

CPU	
Procesador	ARM Cortex-M
Memoria integrada	RAM / Flash

ECU INTERIOR – INTERFACES DE COMUNICACIONES	
CAN 2.0B	1
RS232	1

ECU INTERIOR - SENSORES	
Temperatura – Rango	-10 a +50ºC
Temperatura – Resolución	+0.01 ºC
Temperatura - Precisión	±0.5 ºC
Humedad – Rango	0 – 80% HR
Humedad – Resolución	0.01 %HR/LSB
Humedad - Precisión	±5%
PM2.5 – Rango	0.3 – 2.5 µm
PM2.5 – Precisión	0-100 µg/m³ -- ±5 µg/m³
	100-1000 µg/m³ -- ±10 µg/m³
Ruido – Rango frecuencial	100 – 10000Hz
Ruido – Sensibilidad	-44 dB

ECU EXTERIOR – INTERFACES DE COMUNICACIONES	
CAN 2.0B	1
RS232	1

ECU EXTERIOR - SENSORES	
Temperatura – Rango	-10 a +50ºC
Temperatura – Resolución	+0.01 ºC
Temperatura - Precisión	±0.5 ºC
Humedad – Rango	0 – 80% HR
Humedad – Resolución	0.01 %HR/LSB
Humedad - Precisión	±5%
NO_2 – Rango	0 – 10 ppm
NO_2 - Resolución	0.1 ppm
NO_2 – Precisión (aire puro)	±0.1ppm
NO_2 – Repetitividad	< ±2%
O_3 – Rango	0 – 5 ppm
O_3 - Resolución	0.02 ppm
O_3 – Precisión	±0.5ppm
O_3 – Repetitividad	< ±2%
CO – Rango	0 – 100 ppm
CO - Resolución	0.5 ppm
CO – Precisión	±10ppm
CO – Repetitividad	< 1%

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because the most important thing … is just You!!

EU SPACE WEEK 2023

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Public Transport session - Agenda

14:00	*Session Agenda presentation*	**Daniel Lopour**, EUSPA
14:20	*EU Space Programme Components current state and future services for users*	**Carmen Aguilera**, EUSPA
14.40	*The future of mobility towards more sustainable, resilient and human-centric urban mobility systems*	**Umberto Guida**, UITP
15.00	*GNSS applications in public transport operations – an application overview*	**Jochen Wendel**, INIT
15.20	*Added value of EGNSS for Public Transport Operators and users – innovative use cases from R&D*	**Nikos Tsampieris,** ERTICO ITS Europe
15:40	*GNSS usage in a city transport network: Sensing, capturing, and exploiting environmental and vehicular data systems*	**Luis Roda,** EMT Valencia
16:00	*User Requirements Discussion & validation*	
16:45 – 17:00	*Conclusions and next steps*	

KEY AREAS

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Debate objectives

- To support the development of the GNSS and EO public transport community
- To collect user needs and requirements
- To address the main gaps and barriers
- To gather suggestions on possible solutions
- To establish priorities for future

The outcomes of this session will be published in the User Requirements Report, which is a public document.

Participants survey

Join at menti.com use code 8932 6934

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EO role in public transport

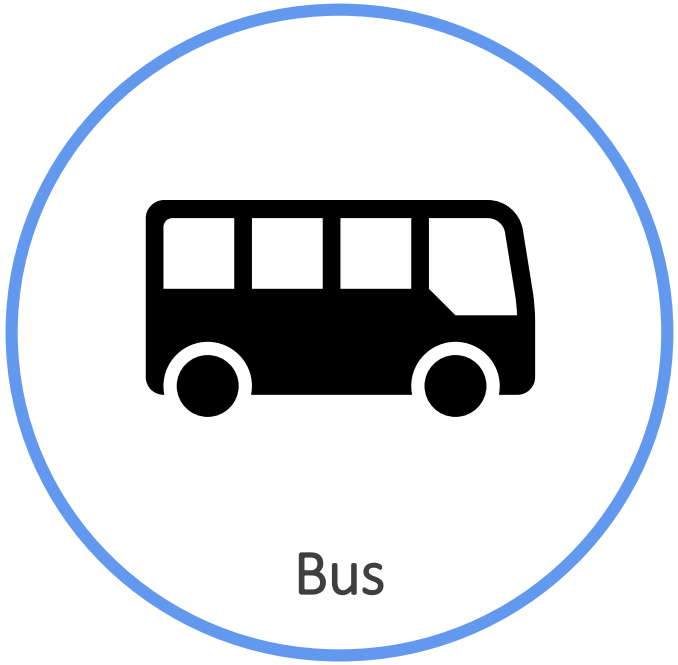
Debate topics

Discussion	Application	Questions
EO role in Public Transport	Transportation network planning & optimization	1. Are you aware of the use of EO for transportation network planning and optimization? 2. What are the main challenges of EO use for this application? 3. What do you think is lacking for EO to be more used with this purpose?

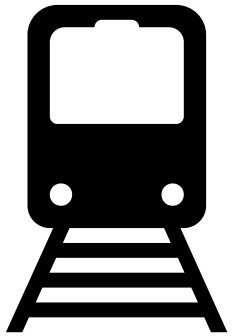
- Do you know any other Earth Observation public transport application?
- Do you see the use of Copernicus as a potential disruptive technology to improve public transport services?

GNSS applications

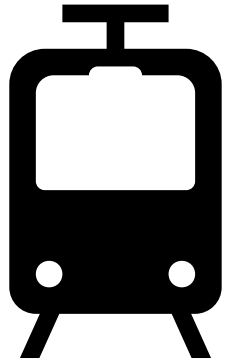
Public Transport Sub-sections



Bus



Urban rail



Tram

GNSS Bus Applications

- Fleet Management
- Passenger Information
- Driver advisory systems
- Driving monitoring
- Autonomous vehicle

Fleet Management

- **Real-Time Bus tracking**: GNSS allows operators to track the real-time location of each bus.
- **Route Optimization**: GNSS data is used to optimise bus routes and resource management by analysing historical travel patterns and real-time traffic conditions.
- **Maintenance**: GNSS usage enables tracking of buses usage and performance, facilitating predictive maintenance scheduling.
- **Safety**: real-time tracking improves passengers and drivers safety. In the event of an incident, authorities can quickly locate and respond to the affected bus.

Passenger Information

- **Real-Time Bus Tracking:** GNSS enables real-time communication of the vehicle's location to passengers, facilitating features such as dynamic trip planning through mobile apps.

- **Arrival and Departure Predictions:** GNSS data helps to calculate real time arrival and departure predictions based on the current buses location and traffic conditions.

- **Service Alerts:** GNSS is used to develop automated alerts in case of delays, detours, or service disruptions.

- **Bus Stop Announcements:** inside the bus, GNSS is used to communicate automated announcements of upcoming bus stops.

Driving monitoring

- **Real-time Bus Tracking:** GNSS enables the tracking of buses' position contributing to calculating optimal driving routes and managing traffic congestion.

- **Energy-Efficient Driving:** GNSS enables DAS to give advice on energy-efficient driving. With the analysis of the real-time bus information, such as speed and location, DAS will recommend the necessary adjustments to minimise fuel consumption and reduce emissions.

- **Safety:** GNSS enables DAS to provide real-time alerts to drivers about potential hazards, accidents, and adverse weather conditions.

- **Data Analytics:** GNSS contributes for the collection of driver behaviour data helping the identification of driving trends and areas for improvement

Driver advisory systems

- **Driver Behaviour Analysis:** GNSS equipped systems continuously monitor driver behaviour, including speed, acceleration and braking. With the analysis of these data, operators can identify unsafe driving practices.

- **Route Compliance:** the use of GNSS ensures that bus drivers comply with predefined routes. If a driver deviates from the designated path, the system can generate alerts.

- **Safety:** GNSS equipped monitoring systems can send real-time alerts to the driver and the central control centre in the event of unsafe driving behaviours, such as speeding.

- **Emergency:** in the event of an accident, GNSS data can provide information related, for example, to the location and speed of the bus at the time of the event.

- **Reporting:** with GNSS data operators can develop reports on driver performance, evaluating variables like routes and schedules compliance, and fuel consumption.

Autonomous vehicles

- **Bus Positioning:** GNSS provides high-precision location data, allowing autonomous buses to know their exact position on the road.
- **Real-Time Mapping:** GNSS continuously updates digital maps of the buses surroundings, helping to prevent collisions by providing data on road layouts, traffic signs, vehicles, pedestrians, etc.
- **Geofencing:** GNSS allows autonomous buses to stay within predefined operational areas.

GNSS Bus Applications

Bus applications	Use Cases	Questions to debate
Fleet Management	Real-Time Bus tracking, Route Optimization, Maintenance and Safety	• Are you using GNSS in any of these applications? • Why are you using GNSS for these applications? • Which gaps and barriers have you identified in these applications? • What would be your suggestions to address what is missing?
Passenger Information	Real-Time Bus tracking, Arrival and Departure Predictions, Services Alerts, Bus Stop Announcements	
Driver Advisory Systems (DAS)	Real-Time Bus tracking, Energy-Efficient Driving, Safety and Data Analytics	
Driving Monitoring	Driver Behavior Analysis, Route Compliance, Safety, Emergency and Reporting	
Autonomous shuttle	Bus positioning, Real-Time mapping and Geofencing	

GNSS User requirements

Methodology – User requirements

Availability	Accuracy	Reliability
Position fix availability	Horizontal accuracy	Position Integrity
Position fix rate	Vertical accuracy	Time-to-Alert
	GNSS Time accuracy	

User Requirements for GNSS Bus Applications

Availability	Position fix availability	Better than 99.9% (High)
	Position fix rate	<10Hz
Accuracy	Horizontal position	m-level
	Vertical position	m-level
	GNSS time	1us
Reliability	Position Integrity	Medium-High
	Time to Alert	10-30s

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KEY AREAS

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Conclusions and next steps

CONCLUSIONS

Thank you for your active participation to the Public Transport User Consultation Platform!

Your feedback and inputs are of key importance to us, as they will feed into the **Report on Public Transport User Needs and Requirements.** The report will be published in **early 2024** (on EUSPA website)

NEXT STEPS

- The **minutes** of today's session will be soon made available online

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