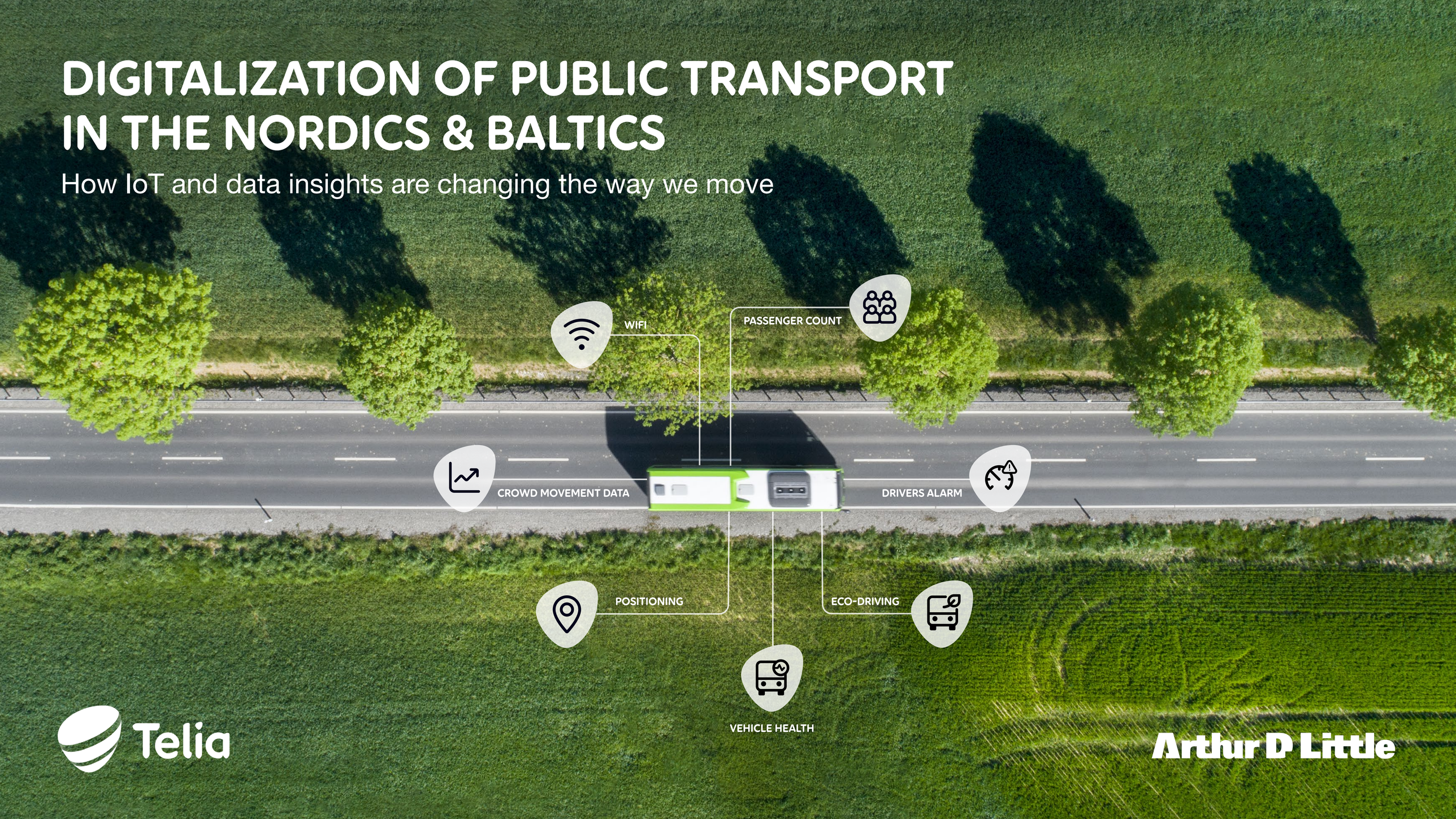
DIGITALIZATION OF PUBLIC TRANSPORT IN THE NORDICS & BALTICS

How IoT and data insights are changing the way we move



Telia

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PREFACE

Even before the COVID-19 crisis began, the public transport industry was faced with the challenge of stagnant passenger levels combined with rising operating costs. In this report, we examine the pain points of the industry in detail. We also look at how digitalization is not only overcoming these challenges, but also the new challenges that the post-COVID-19 era will bring.

This report is the latest in a collaboration between Arthur D. Little and Telia on how digitalization and the Internet of Things are changing industries in the Nordic and Baltic regions.

The findings in this report are based on in-depth interviews with decision makers from public transport authorities and operators as well as subject matter experts from Finland, Norway, Sweden, Denmark and the Baltics. These are combined with the findings from recent local and global reports as well as previous Arthur D. Little research including the Future of Urban Mobility study carried out together with UITP and the Arthur D. Little Urban Mobility Index.

We are tremendously grateful for the generous contributions of our customers and other outside advisors.

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Arthur D Little

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EXECUTIVE SUMMARY

The Nordics and Baltics have some of the world's most advanced and well-functioning public transport systems. Even so, they have struggled in recent years to increase passenger numbers despite increasing investment. This has been further compounded by the COVID-19 pandemic.

Increasing ridership by attracting new passengers while retaining existing ones is identified as a key goal for the public transport industry. Lack of ridership growth has a flow-on effect to limit ticketing revenues, which in turn increases the pressure on already tight profit margins. This is compounded by increasing competition from multi-national operators scaling to new markets and new digital-first market entrants, such as ride-sharing and eScooter services. In order to counter this pressure, cost reduction is identified as a second goal that the public transport industry must strive to achieve. The third main goal identified is to meet the high sustainability ambitions that the industry itself, and the cities that it serves, have set.

Public transport authorities and operators identify digitalization as having the potential to play a major part in meeting these goals. Applications that combine data from onboard the vehicle with external data sources are already providing real-time driver information and insights for public transport operators and authorities. Examples such as smart payment systems, real-time fleet management and predictive maintenance help to reduce operating costs and environmental impact and deliver a better experience for passengers.

Efficiency is highlighted as an area of extra focus. Examples here include eco-driving that has been proven to reduce fuel costs and associated emissions by up to 12 percent. Newly emerging digital solutions such as crowd movement analysis are identified as tools that can be used to understand passenger needs and optimize route planning.

Our analysis finds that a full deployment of the digital solutions available today could increase public transport ridership by 18 percent*. This potential will continue to rise as new digital possibilities emerge.

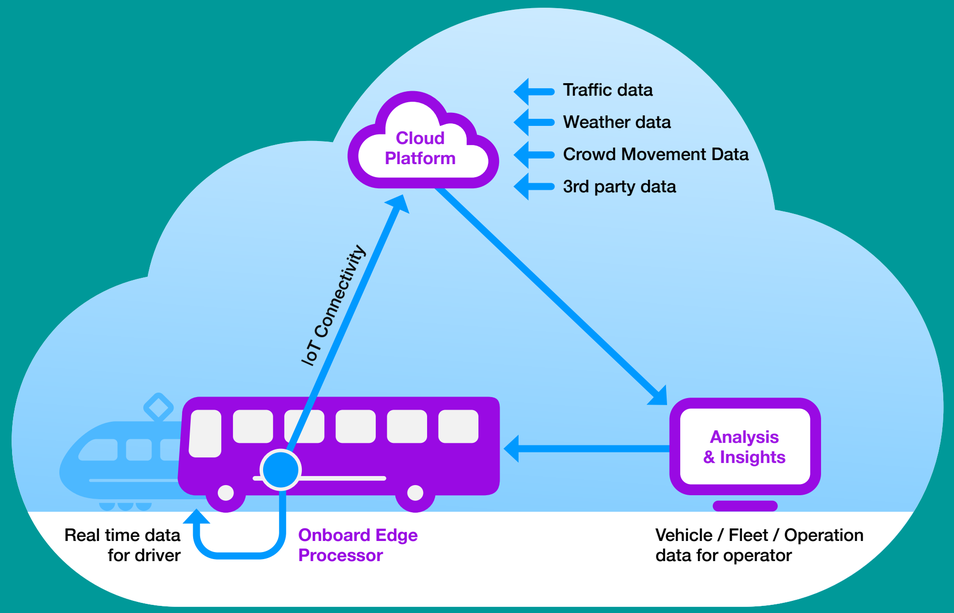
While the benefits of digitalization would suggest their adoption is, to a large degree, inevitable; public transport authorities, through the tendering process, will ultimately determine the pace at which it occurs. In preparation for this, public transport operators are building the competence and partnerships to be ready to fulfil these tender requirements as they emerge.

With an ever-changing competitor landscape and the significant impacts of the COVID-19 situation, making the most of the increased efficiency and service quality gained from digitalization is an opportunity the industry needs to prioritize.

*This figure is based on full deployment of currently available digital solutions across the public transport systems in the region. It represents an increase from the current level of 28% ridership to a projected level of 33% ridership.

DIGITALIZATION DEFINED

Digitalization has many definitions depending on the context. At its most simple, it can be defined as: *the collecting and using of data to optimize, understand and automate processes and decisions*.



In the public transport context, the collection of data is usually done with a combination of:

SENSORS: collect data from the vehicles, streets, stations or other sources.

ONBOARD EDGE PROCESSOR: collects and processes data from onboard sensors to provide real-time feedback to the driver and to cloud platforms.

INTERNET OF THINGS (IOT): connects data from sensors to cloud platforms, for remote monitoring and analysis.

CLOUD PLATFORM applications that are hosted on remote computers and accessed digitally to enable the analysis of data and delivery of digital services.

ANALYSIS & INSIGHTS combining data from multiple data sources to enable data-driven decision-making

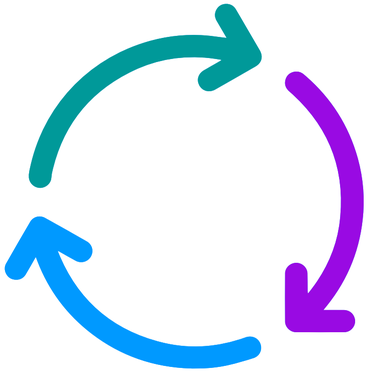
UNLOCKING THE VALUE OF DATA

The majority of public transport systems already rely on various sources of data to plan, operate and optimize operations. By adding richer, real-time data from real-world sources; transport operators are able to make data-driven decisions, optimize their asset and resource usage, and provide better services for passengers.

PLAN

Understanding passengers' needs, including the first and last mile, by measuring their behaviour.

Eg: Crowd movement data.



OPERATE

Using real-time data from vehicles, stations, passenger feedback, traffic, weather etc to improve efficiency & service quality.

Eg: Fleet management
Incident handling

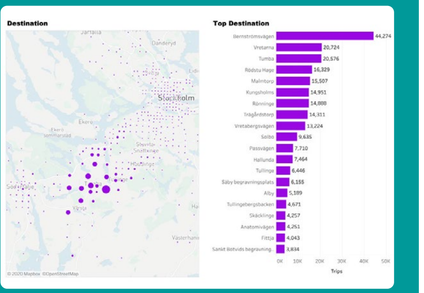
OPTIMIZE

Analyzing data from multiple sources to enable data-driven decision making

Eg: Predictive maintenance
Route optimisation

WHAT IS CROWD MOVEMENT DATA?

This is a newly emerged area that measures the movement of mobile phones as they connect to different base stations in a cellular network. In this way, it is possible to measure how many people move between different locations, when, and how. Because the data is anonymised and aggregated as part of the process, it does not endanger the privacy of mobile subscribers. The advantage of this type of data is that it is true measurement data that provides greater accuracy than traditional travel surveys and observations. Crowd movement data also capture the entire journey including the first-and-last mile – as well as the journeys of those who do not take public transport.



WHY PUBLIC TRANSPORT NEEDS TO BE TRANSFORMED

GOALS

INCREASE RIDERSHIP | REDUCE COSTS | REDUCE ENVIRONMENTAL IMPACT

Public transport is recognized as an enabler of more livable and sustainable cities. It has the potential to reduce car traffic and air pollution while increasing people's mobility and access to services. But in order to do this, it needs to scale up.

In recent years, public transport ridership levels have remained constant while operating costs have continued to rise. At the same time, the environmental impact of public transport operations has received a lot of attention.

To fulfil its potential, public transport must achieve three goals:

1. INCREASING RIDERSHIP

The key metric in any public transport operation is 'bums-on-seats'. However, in recent years, ridership levels have stagnated. For example, the share of public transport in Sweden remained unchanged at 31 percent between 2018 and 2019. Other Nordic and Baltic countries show a similar pattern despite significant investments.

2. REDUCING COSTS

Being *'cheaper than taking the car'* is a key benefit for public transport passengers. Cost efficiency is a key part of ensuring financial sustainability regardless of whether public transport is subsidized or not. Operational costs have increased by almost 50 percent in Sweden since 2009 and by over 70 percent in Norway between 2005 and 2016. Greater operational efficiency is needed in order to reduce these costs.

3. REDUCING ENVIRONMENTAL IMPACT

On a macro level, public transport is important to reduce the number of cars on roads and their corresponding emissions. On a micro level, every step needs to be taken to ensure that public transport operations themselves are as clean and sustainable as possible.

"When listing the main drivers for adoption of IoT enabled solutions, 60% of the interviewees highlighted cost savings as the primary driver"

THE PUBLIC TRANSPORT ECOSYSTEM

The most important stakeholders in any public transport system are the passengers who use, and ultimately, fund transport. Together with Public Transport Authorities (PTAs) and Public Transport Operators (PTOs) they make up the primary ecosystem. Road transport Authorities and Municipalities also have an instrumental role through their responsibility in planning, constructing and maintaining the urban infrastructure. These stakeholders will often procure companies to provide support functions such as constructing road infrastructure & support public transport operations.

PUBLIC TRANSPORT AUTHORITIES (PTA)
- Increase ridership
- Reduce costs

PRIMARY ECOSYSTEM

PUBLIC TRANSPORT OPERATORS (PTO)
- Fulfil obligations
- Increase profitability

POLICY MAKERS
- Meet sustainability goals at local, regional and national levels

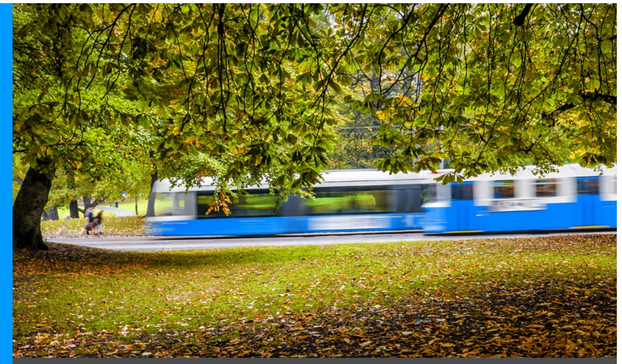
PASSENGERS
Get around quickly, easily and affordably

DISRUPTORS & MOBILITY SERVICE PROVIDERS
- Build a profitable business

MUNICIPALITIES & ROAD TRANSPORT AUTHORITIES
- Provide sustainable traffic and urban development

INFRASTRUCTURE & SERVICE DELIVERY
- Procured to construct road infrastructure & support public transport operations

THE PUBLIC TRANSPORT ECOSYSTEM AND GOALS OF EACH STAKEHOLDER.



SUSTAINABILITY IN FOCUS

Public transport is seen as a key enabler of sustainability on many levels:

At an **EU LEVEL**, public transport is a key part of the plan to reduce greenhouse gas emissions from transport to 60 percent of the 1990 levels by 2050.

On a **COUNTRY LEVEL**, it is seen in initiatives such as Norway's zero growth target for car traffic, which will mean increasing public transport trips by 50 percent between 2014 and 2030.

It is also seen at a **CITY & MUNICIPAL LEVEL**, with examples such as Copenhagen's CPH 2025 goal to increase walking, biking, and public transport to at least 75 percent of all journeys by 2025.

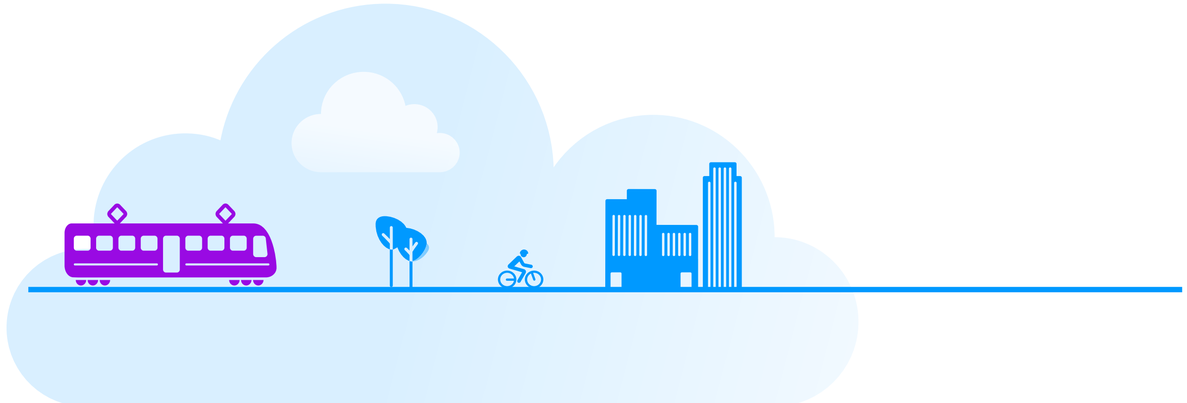
Most importantly, it is seen at a **CONSUMER LEVEL**, with members of the public becoming increasingly aware of the environmental impact of their decisions.

NORDIC & BALTIC TRENDS IN PUBLIC TRANSPORT

The digitalization of society is creating new possibilities for operators and new expectations from passengers. At the same time, the ability for large multinational companies to upscale their business is changing the competitive landscape. All of this is happening in a context of increased focus on sustainability.

Our interviews revealed four trends impacting public transport in the Nordics and Baltics.

INDUSTRY TRENDS IMPACTING EACH OF THE PUBLIC TRANSPORT GOALS



TRENDS IN THE NORDICS & BALTICS

1. NEW TRAVEL MODES FOR THE FIRST AND LAST MILE

The first and last mile of the public transport journey have long been recognized as crucial challenges to overcome. New modes of transport, from ride-sharing to e-scooters, give people flexible new options through a smartphone app. These include digital-first disruptors like Lime, Voi, and Tier that have revolutionized short-distance urban transport in many cities. These services offer both a complement and a competitor to public transport services. Better understanding of their impact and how they can complement public transport over the full passenger journey is needed in order to increase ridership.

2. MOBILITY AS A SERVICE

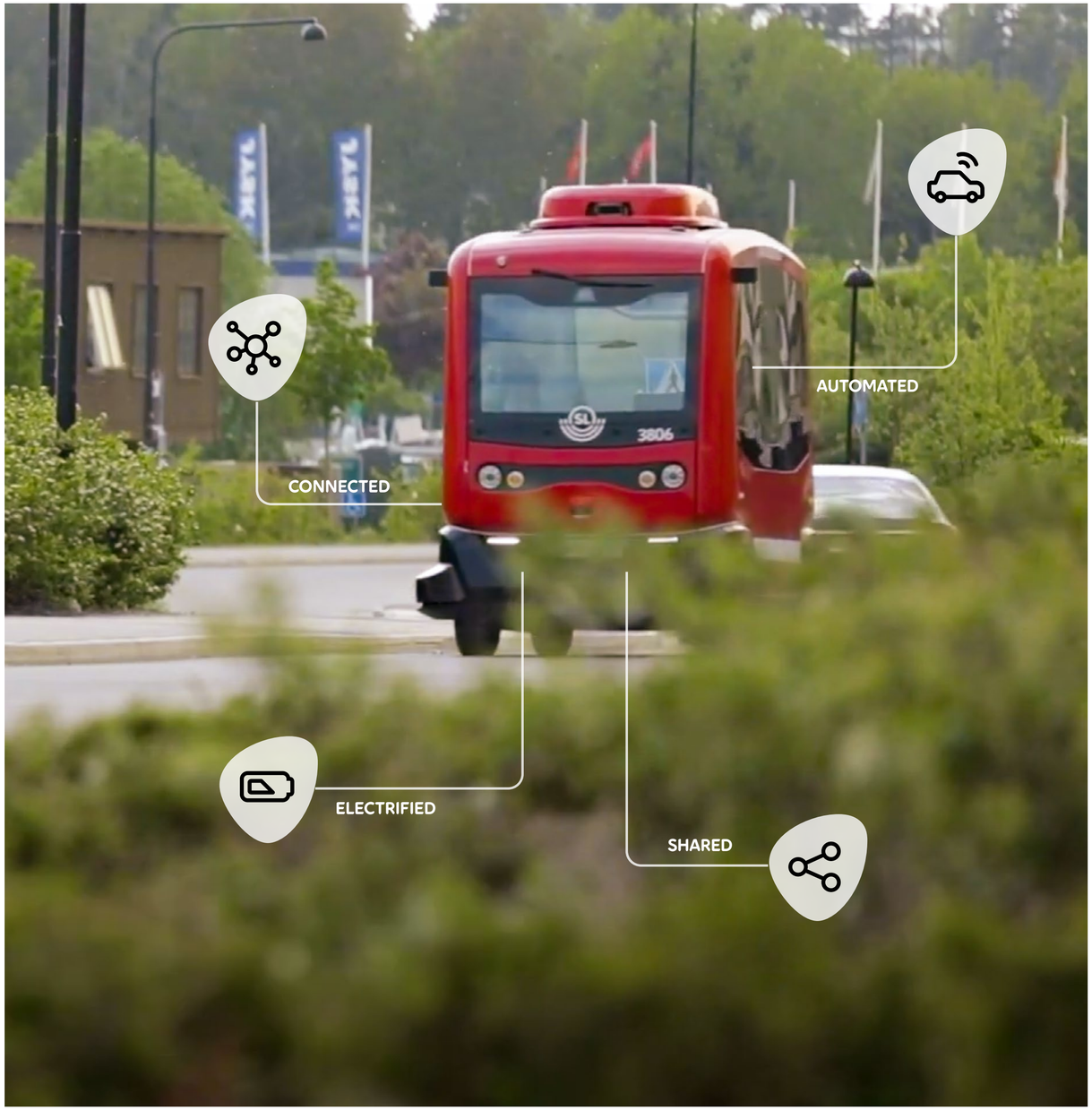
Digital-first services, such as those mentioned above, are raising passenger expectations of a customized and flexible travel experience that can be easily managed via an app. These expectations are also growing to include multiple modes of transport from a consolidated application. Services such as Whim in Helsinki, offering Mobility-as-a-Service (MaaS), allow passengers to access buses, trains, bikes, taxis and rental cars from the same subscription. Early results indicate that Whim addresses ridership pain points. However, it is unclear how the MaaS model will work long term.

3. PRESSURE ON PROFIT MARGINS

Local tender evaluation models increasingly emphasize cost, which puts pressure on already low operator profit margins. This is compounded by an increasing number of multinational PTOs who have entered local Nordic and Baltic markets in the past few years. Their scale enables them to achieve economies-of-scale that force local PTOs to price-match. The combination of these factors increases pressure on local PTOs' ability to bid and operate profitably.

4. SUSTAINABILITY FOCUS

Focus here is on both public transport's potential to reduce the number of cars on the roads and the industry's own environmental footprint. Innovations that increase sustainability at vehicle, fleet or operational level are important in both reducing emissions and securing the financial support accorded to public transport as an enabler of sustainability.



TECHNOLOGY MEGATRENDS IN PUBLIC TRANSPORT

At a technology level, public transport is currently under a gradual transformation that will continue during the next decade and beyond. It is based on both technological advances and changes in commuter behavior. The industry sometimes refers to four megatrends known as the “CASE” trends - Connected, Automated, Shared, Electrified. The Nordics and Baltics are no exceptions to the development and have had early deployments with electric buses, driverless metros, e-scooters in urban environments etc. over the last couple of years.

CONNECTED	Connectivity between vehicles, operators, passengers and drivers enables data flows that provide a deeper understanding of customer needs and more efficient ways of addressing them.
AUTOMATED	Self-driving vehicles are part of an emerging autonomous public transport ecosystem. Combining real-time data with AI will enable a system that can adapt to varied and variable needs as they emerge.
SHARED	New modes of first-and-last mile transport such as e-scooters and ride sharing offer one-to-many asset sharing.
ELECTRIFIED	As the climate focus sharpens, and battery life and prices improve, public transport will increasingly move from fossil fuels to electric power.

What will 5G mean for public transport?

5G may be more hype than reality at present, but as it becomes more readily available, it will offer new opportunities for public transport.

Three main characteristics of 5G will make a difference:

HIGHER DEVICE DENSITY

HIGHER DATA RATES

LOWER LATENCY

Higher device density

5G will support many more connections in a given area than ever before – up to a million devices per square kilometre as opposed to a few thousand today. In a city context, this means every ‘thing’ can be connected: road sensors, parking spaces, traffic lights. Essentially, anything that generates data will be connectable.

Many of the data sources will only provide small amounts of data. For example, a parking space only needs to report if it is vacant or full. For these purposes, the 5G standard includes two Low-Power-Wide-Area (LPWA) connectivity types (NB-IoT and LTE-M) that can connect over long distances and deep underground and have a battery life of up to 10 years.

Higher data rates

When all of the devices in a city have been connected, small amounts of data will result in massive data feed. This is when 5G’s speed benefits will kick in. To put 5G’s data rates into perspective, people’s mobile phones will only be able to use a tiny fraction of 5G’s capabilities. When everything you do on your phone is instant with no perceptible load time, you don’t need faster than that. Taken a step further, a single 5G-enabled onboard WiFi gateway will let an entire bus or train load of commuters streaming in high definition, game interactively, or even explore other worlds using mobile virtual reality – without buffering, glitching or ever making them wait. The only thing that will come close to using 5G’s full data capabilities will be when millions of sensors and data sources are combined to enable real-time-big-data analysis.

Artificial Intelligence (AI) applications will be able to combine data from all of a city’s sources: from low-data carpark sensors to high-definition traffic analysis cameras. They will then be able to enable real-time traffic management systems.

Gridlock and traffic jams could become a thing of the past with traffic management systems that adapt to the real-time situation and control the flow of traffic. By altering the stop/go sequence of traffic lights, traffic flows could be regulated and dynamic speed limits used to slow traffic throughout the system rather than having bottlenecks that stop it completely. Real-time traffic management systems will also make it easier to provide traffic prioritization for public transport and make it a more attractive choice

Lower latency

Autonomous buses are already in operation in locations across the Nordics and Baltics. These use local sensors in the vehicle to sense and react. By adding the capabilities of AI, these vehicles will be able to integrate with the traffic system. In order to interact with the real world, they will need to interact with cloud platforms in real time. 5G will deliver the ultra-low latency to enable this. Situation-based decision-making by cloud-based AI algorithms will help to make autonomous vehicles safer and make public transport systems more efficient and reliable. ■

The 5G Ride project focuses on how 5G and control towers can enable the safe introduction of self-driving, electric buses in urban areas. This pilot was run in Djurgården in Stockholm, Sweden.

PUBLIC TRANSPORT ON DEMAND

When these 5G characteristics are combined, real-time information flows will enable ‘on demand’ public transport services. Commuters will notify where they want to be picked up from and where they are going via their mobile app. Then a network of autonomous vehicles will follow dynamically created routes to collect passengers in the most effective pattern and take them to their destinations. This will be somewhat similar to the ‘airport shuttle’ concept that is common today, but enabling real-time re-routing and serving many different destinations.

NORDIC & BALTIC PUBLIC TRANSPORT OVERVIEW

The Nordic and Baltic public transport industry is one of the most forward leaning in the world. Here is an overview.

RIDERSHIP: increase in bus and rail passengers in 2015-2018 according to Eurostat data. The data indicate stagnation in the larger countries despite ambitious targets and new investments.

COST: changes in cost relative to revenues, based on interviews and other research. Our findings show a consistent pattern of growing costs in all countries which negatively impact the ecosystem regardless of whether the costs erode balance sheets, margins or are passed on to end consumers. In the latter case, rising fares will reduce the overall attractiveness of public transport.

ENVIRONMENTAL IMPACT: initiatives identified to reduce the negative environmental impact of public transport. Our review reveals that Norway and Sweden are frontrunners in this area.

GENERAL CHARACTERISTICS AND TRENDS

Public Transport Authorities (PTAs) in the Nordics and Baltics generally contract Public Transport Operators (PTOs). The 4th European railway package will lead to further privatization of Nordic rail passenger traffic through mandatory tendering.

The region is dominated by a few major PTOs who mainly operate in larger cities, e.g. Nobina, Arriva, Vy (fd Nettbuss), Transdev and Keolis. In recent years, major global players such as MTR and Arriva have entered the Nordic and Baltic markets.

While smaller players exist in local markets, the PTO landscape is consolidating due to increasing PTA requirements. Meanwhile, competition is increasing and margins are getting lower.

	PTA SET-UP	RIDER-SHIP	COST	ENVNT IMPACT	MARKET MOVEMENTS AND UPCOMING TENDERS	TECHNOLOGY INITIATIVES
SWEDEN	21 regions	→	↗	↘	• Stockholm Metro tender expected in 2021 • Continuous flow of bus tenders with 50+ tenders in 2020-2024	• Industry experts single out Sweden as the Nordic country most mature in the field
NORWAY	5 regions	→	↗	↘	• Started to tender public train operations in 2019 • Plans to tender for more franchises around Oslo estimated 2021 • Steady flow of bus tenders	• National transport plan 2018-2029 allocates state funds for transport purposes – first reform states that new ITS technology should be implemented faster • All buses in Oslo run fossil free since 2020
DENMARK	6 regions	→	↗	→	• Passenger train tendering wave is expected 2023 • Several international players in tender market	• Copenhagen has implemented a drive of smart city solutions since 2016 • Increase in electric buses
FINLAND	Per municipality, except Helsinki	↗	↗	→	• Public train operations were to be opened for tenders in 2019, but got paused by the Finnish government • Contracts for bus operations are tendered by municipalities	• Finland's roadmap towards fossil-free transports expected towards end of 2020 • Business Finland's Smart Mobility program ongoing in 2018-2022, with 100 mEUR budget
BALTICS	**Estonia:** 15 counties **Latvia:** Per municipality **Lithuania:** Per municipality	↗	↗	→	• Latvia renews contracts every 10th year, and recently closed bidding for 2021-2030	• Lower starting levels but expected to accelerate when established solutions become more affordable

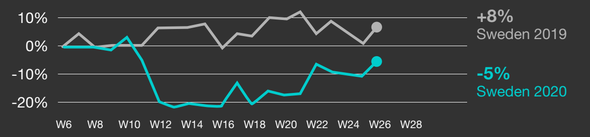
Source: European Committee of the Regions, Eurostat, industry experts, Movia, Arthur D. Little analysis

COVID-19 and public transport

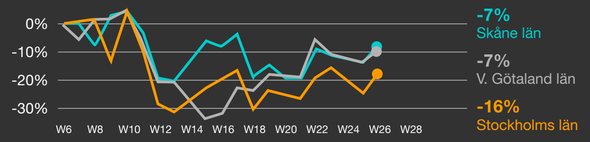
ANALYZING THE RESPONSE TO COVID-19 MEASURES

Crowd movement data have been used by Health Authorities in Finland, Sweden, Norway and Denmark to measure the movement of their citizens during the COVID-19 crisis. Because the crowd movement data is aggregated and anonymized, it cannot be used to track specific cases, but by measuring all trips and comparing with pre-COVID-19 levels, authorities are able to understand the effectiveness of the measures taken to reduce travelling. Looking ahead, crowd movement data will also enable transport authorities to measure the demand for public transport and optimize route planning on a day-by-day basis. This will enable them to provide the right level of service needed to enable passengers to follow social distancing guidelines.

Change in the number of daily trips within Sweden
Compared to week 6 (3-9 February)



Change in the number of daily trips to, from and within three major counties Compared to week 6 (3-9 February)



Public transport poses a paradox in the COVID-19 context in being both an essential service and a potential ‘super-spreader’.

COVID-19

The industry’s rate of recovery is uncertain, relying on further spread, duration, containment measures and not least consumer perception and willingness to return to previous habits.

Public transport authorities and operators are taking steps to ensure the health and safety of workers and passengers and not contribute to the spread of the virus. Meanwhile, they need to address a sharp decline in ridership and the emergence of a “new normal”.

Of the goals identified in our research, increasing ridership is most likely to be impacted in the immediate term due to changing circumstances and travel behaviors. Cost efficiency remains an essential goal, not only to survive in the short term, but also to secure competitiveness and profitability beyond the crisis. The goal to reduce environmental impact also remains in focus.

The question remains: how to attract customers to return to public transport? Also, when they do return, how will their travel habits have changed?

Nordic and Baltic PTOs initially reported declines in passenger traffic of 40-70 percent, with the decrease in ridership largely correlating with the country’s restrictions. Sweden, for example, took a less stringent approach than its neighbors and has in turn seen a smaller drop in passenger numbers. The industry’s rate of recovery is uncertain, relying on further spread, duration, containment measures and not least consumer perception and willingness to return to previous habits.

PTOs have tackled the pandemic and the sharp decline in demand by initiating several strategies, including:

- More frequent and thorough vehicle cleaning.
- Greater control of passenger flows.
- Workforce training and improved communication and information.
- Reducing capacity and frequency of departures.
- Adaptive flexible ticketing vs monthly cards.

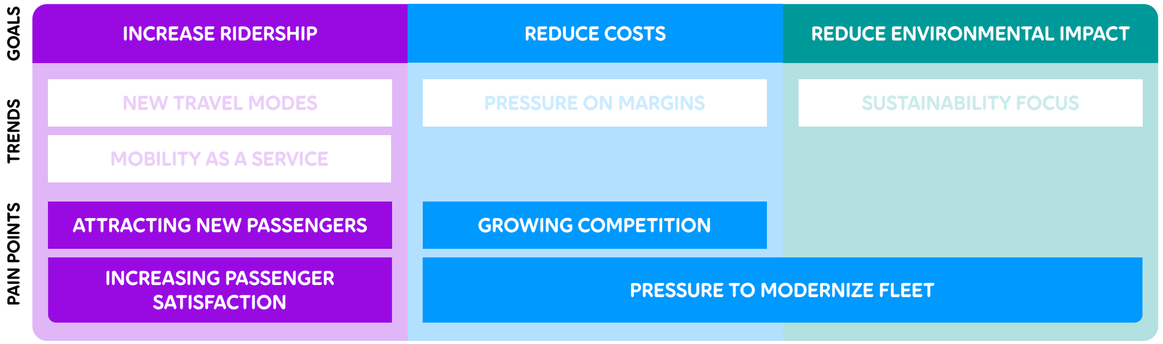
40-70%
Reported decline in passenger traffic

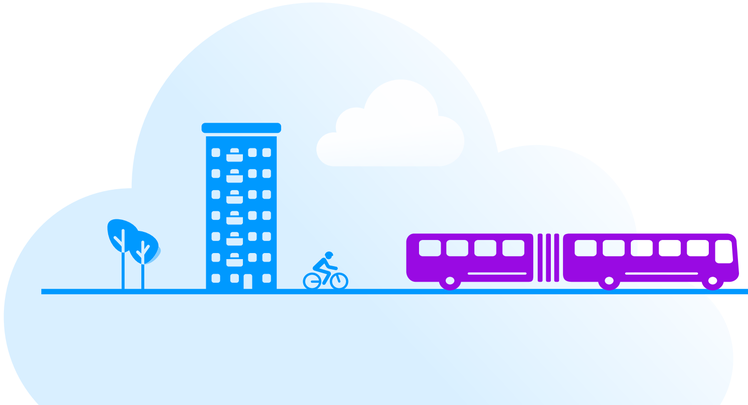
TO HELP THE INDUSTRY MOVE FORWARD:

- A better understanding of changing travel behaviors will be needed to encourage ridership while simultaneously minimizing the risk of further spread. Therefore, accurate and current data as well as crowd level forecasts are required.
- PTAs may consider temporary relaxations of ridership-based compensation schemes to enable PTOs to keep more traffic running. All stakeholders share an interest in increasing ridership to previous levels – as long as it can be done safely.
- New safety measures should be put in place to secure the trust and support of passengers and to speed up transition in the recovery phase.
- Higher operating costs – of maintenance, administration and fuel – should be reviewed and actions taken to reduce these to compensate for lost revenues.

INDUSTRY PAIN POINTS

Our interviews with public transport authorities and operators in the Nordics and Baltics, revealed four primary pain points for the industry. In the sections that follow, we look at each of these pain points in detail, and at the digital solutions that address them.





STRATEGIES TO ADDRESS THEM

PTAs and PTOs have four primary strategies to remedy the pain points. In the following sections, we look at existing, non-digital means of executing these strategies as well as examples of new means enabled by digitalization.

EXPAND OR DENSIFY TRANSPORT NETWORK

for greater coverage, frequency of departures and increased availability

IMPROVE PASSENGER SERVICES IN VEHICLES & STATIONS

to attract new and retain current riders

IMPROVE INTERNAL OPERATIONS

updated and optimized operational processes to increase efficiency and generate cost savings

INVEST IN A MODERN HIGH-QUALITY FLEET

to increase asset efficiency while reducing operating costs and environmental impact

PAIN POINT 1:

ATTRACTING NEW PASSENGERS

In order to encourage people to choose public transport instead of taking the car, it needs to offer a convenient and easy-to-use alternative. This is an area that can be addressed at multiple levels from user experience up to the structure of the public transport network itself.

The main barriers identified to using public transport were:

KEY PAIN POINTS	STRATEGIES	NON-DIGITAL ACTIONS
Insufficient accessibility Takes too long to get to and from the station	Expand the network	• Increase service frequency • Create services to new residential areas
Complicated ticketing systems Too much hassle to plan and buy tickets	Improve customer services	• More ticketing machines • User friendly & multilingual interfaces • Provide support desks
Ever-changing travel needs Customer needs changing with new modes of travel emerging	Improve customer services	• Market studies and surveys • Promotion of services

Overcoming high barriers to attract new riders and the traditional actions to solve the problem.

Perhaps most notably, our interviewees mentioned ticketing complexity. With an increasingly wide range of travel options – each with different prices, travel times and quality – it can be difficult for travelers to know they have chosen the best option. Even when ticketing machines are available, not everyone is comfortable using them. Instead, many rely on support desks for information and for buying tickets – a costly alternative to maintain.

Similarly, PTAs are unsure how to operate alongside the new options for the first and last mile. Understanding customer preferences and behavior in this increasingly dynamic ecosystem is a clear pain point. Interviewees found that traditional surveys or tap-on/tap-off data were no longer sufficient to achieve the granularity and accuracy they require.

In the following section we outline currently available digital solutions that can help to attract new passengers →

DIGITAL SOLUTIONS TO ATTRACT NEW PASSENGERS

Our analysis indicates that connecting the different parts of the transport ecosystem through Internet of Things (IoT) and increasing the availability and usability of data, the industry can increase ridership by 18 percent across the Nordics and Baltics. This figure is based on full deployment of currently available IoT-enabled solutions across the public transport systems in the region.

"Nordic PTAs are ahead of their global counterparts. In Sweden, PTAs manage the ticketing system. In the UK, you rush to different suppliers to fulfil the specific bid requirements, and you end up with ten different smart cards from different suppliers"

- PTO operating in several global markets.

REAL TIME PASSENGER INFORMATION

Providing up-to-the-minute bus timetable information removes unknowns for passengers, gives them greater perception of control, and enables them to manage their time. Data is sent from vehicles in motion and can be displayed in timetable apps and on digital displays at stations, stops and aboard vehicles.

CROWD MOVEMENT DATA

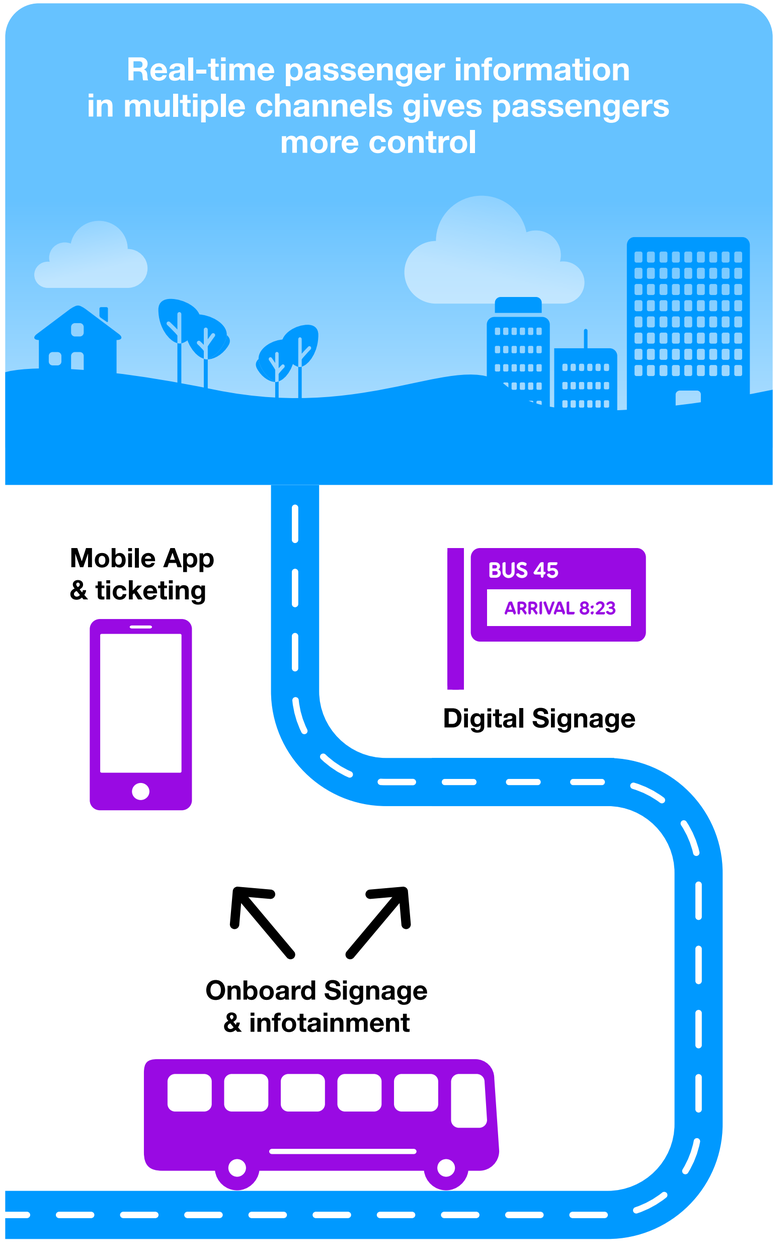
By analyzing the movement of mobile phones in a cellular network, it is possible to understand travel patterns – regardless of their mode of travel. This data, commonly referred to as crowd movement data, enable PTAs and PTOs to understand the first-and-last mile journeys of all potential passengers, find unmet needs and identify new route possibilities.

SMART TICKETING PAYMENT SYSTEMS

While ticketing systems have developed from paper tickets to mobile applications, PTAs are still searching for the optimal ticketing solution – a solution that provides data to enable the improvement of services.

Traditional paper tickets provided very little data. The plastic cards that replaced them enabled PTAs to track passenger patterns, but created lock-in effects to ticketing system vendors. To avoid this dependency, most Nordic PTAs decided to develop their own mobile applications for ticketing. However, this led to higher costs and systems only working in limited areas.

Today, we are seeing a transition towards national ticketing systems in the Nordics, with evaluations currently underway in Sweden. Interviewees believe that future systems will be cloud-based and reliant on existing standards such as EMV (Europay, Mastercard, Visa). Skånetrafiken was the first Nordic PTA to introduce such a system.



First contactless payment ticketing system in the Nordics

Skånetrafiken was the first Nordic public transport authority to introduce a contactless payment ticketing system, in December 2019. The system, “Blippa”, enables passengers to purchase a ticket simply by holding their existing bank card against the ticket reader rather than needing a dedicated bus card.

The system, “Blippa”, enables passengers to purchase a ticket simply by holding their existing bank card against the ticket reader rather than needing a dedicated bus card.

The onboard ticketing system is part of Telia’s Smart Public Transport offering, with the ticketing platform delivered by the Estonian company Ridango. The solution is a contactless solution based on the EMV (Europay, Mastercard, Visa) standard. By using an existing, well-functioning standard for identification and payment, Skånetrafiken did not need to reinvent the wheel.

The launch of ‘Blippa’ was not entirely friction-free. As was the case with previous major changes – from paper tickets to plastic and from plastic to mobile applications – criticism arose about usability and security.

“*What came as a surprise was some people’s strong resistance to using their regular payment cards. They felt it was not secure and were afraid of ‘skimming’. They criticized the fact that we had eliminated the option of plastic cards which they could pre-charge: something they felt much more secure with*”, says Johan Frithiof Karlberg, VP of Digitalization and IT at Skånetrafiken.

Key learnings from this case are the need to be clear on which demands the new solution will meet, and to test it with pilot users before market launch. ■

44 percent of industry interviewees claim standards are critical to further accelerate uptake of IoT in the industry

THE NEED FOR INDUSTRY STANDARDS

The Skånetrafiken case reveals an important prerequisite for many digital solutions: the need for industry standards. The Swedish National Ticketing Standard: BoB (Biljett och Betalstandard) was developed to create interoperability between ticketing systems. It includes definitions and interfaces that enable more flexible solutions. Another Nordic organization, “Bus Nordic”, provides a recommended standard for functional requirements which is used for tenders in the Nordics, but its IoT- and digitalization-related content is limited. Instead, the pan-European organization ITxPT specifies a standard for how hardware and software can be designed to match in a coherent architecture. This is increasingly being adopted following the ITxPT 2.0 release in late 2017. Achieving widespread adoption of this standard will take time, but Oslo and Akershus’s PTA Ruter is seen as a front-runner, having expressed it as a strategic value. Oslo released 500 new buses with systems based on the ITxPT standard in the summer of 2019.

PAINPOINT 2:

INCREASING PASSENGER SATISFACTION

The variable conditions in which public transport operates make it impossible to keep all passengers happy all of the time. There will always be unexpected traffic jams and mechanical breakdowns. But operators can do a lot to prevent and mitigate these obstacles.

KEY PAIN POINTS	STRATEGIES	NON-DIGITAL ACTIONS
Low reliability and punctuality Not being able to trust the service to be there when it should	Improve internal operations	• Proactive maintenance • Fast response to minimize downtime • Mitigation planning for unforeseen situations
Insecure traveling conditions Not feeling safe while on, or waiting for, their ride	Improve customer services	• Surveillance cameras and signs • Lighting and design
Lacking traveling comfort Having less comfort, cleanliness and entertainment options than the car	Improve customer services	• Choice of interiors • Regular cleaning between journeys • Onboard magazines and music
Perceived long travel times Perception of longer traffic queues and increased risk of delay	Expand the network	• Increase number of vehicles in traffic • Modeling tools to optimize scheduling

Passenger satisfaction challenges and traditional means of overcoming them.

We work with both tendered traffic and with coaches […] The tendered traffic is much more regulated, which might slow down the development of smart solutions. With our coaches, we are able to come up with any new solution and test it easily and quickly. For instance, we have developed our own system for booking and infotainment"

CIO, Nordic bus operator

In the following section we outline currently available digital solutions that can help to increase passenger satisfaction. →

DIGITAL SOLUTIONS TO INCREASE CUSTOMER SATISFACTION

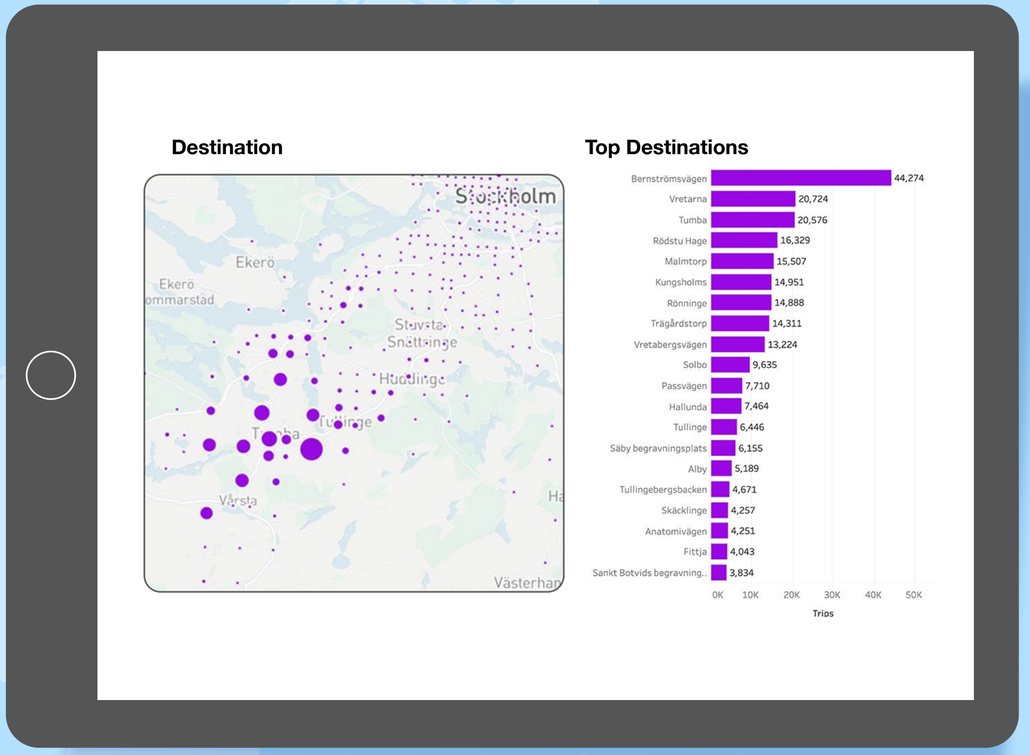
Mobile devices have created new possibilities for passengers to entertain themselves or work while travelling. Many other digital solutions address other causes of passenger dissatisfaction.

ONBOARD WIFI AND INFOTAINMENT

Keeping passengers informed and entertained as well as being able to work efficiently on their commute can improve their experience enough for them to decide not to take the car. The foundation for this experience is **onboard WiFi**, which enables passengers to use their mobile phones onboard without having to use up their own data. **Infotainment** systems deliver context-relevant information to passengers. This can include current traffic status, weather reports, community information and news. In some cases, the content is provided with advertising that can generate new revenue streams. **Personalized alerts** delivered via the passenger's travel app provide updates on traffic events that may impact their nominated travel itinerary. Some may even recommend the best alternative.

IN-VEHICLE SAFETY & SECURITY

Several digital solutions address in-vehicle safety and security. Some promote safe driving, such as the **breathalyze**r which prevents the vehicle from starting if alcohol is detected on the driver's breath. **Remote speed alerts** warn both the driver and operator if speed limits are exceeded. **Driver's alarms** enable the driver to send an alert and the GPS position of the vehicle to relevant authorities at the touch of a button. **Onboard camera surveillance** can provide a live feed, or an archived record for future reference, of any situations affecting the vehicle. The presence of these cameras can also directly discourage criminal or hostile behavior or vandalism. However, any surveillance of individuals must be implemented with respect for data privacy.



PASSENGER STATIONS AND STOPS

Smart stations and stops can create safer and more inviting environments where it is easier for travelers to interact. This includes smart building services such as **temperature and air quality monitoring**. Stations can also be equipped with water and gas leakage detection to improve the facility energy usage and reduce risks. **Remote camera surveillance** can be used to promote safety and deter criminal activity.

Remotely-managed digital signs can provide valuable information to travelers, not just in stations but at all passenger stops along the public transport network. This is also possible for escalators, elevators and automated doors in stations. By connecting them, PTOs can be informed of breakdowns and take appropriate action.

CROWD FLOW

Crowd movement data can help PTOs to understand and improve the traveler experience in and around stations and stops. At a suburb and street level the data reveal how many people arrive, when and from where. The data can identify areas that people avoid and that may be unsafe or areas with many people who may need services such as washrooms or vending machines. Inside the station, this can be complemented with WiFi measurements to reveal any congestion points.

“When it comes to benefits of digital solutions, we get much more feedback in a faster and more convenient way than before, through new ways of communication. When everything is in a mobile app, it is easier to structure feedback.”

-Nordic PTA

SINGAPORE'S smart mobility plan

Singapore is considered a global frontrunner in public transport. The Future of Urban Mobility study by Arthur D. Little and UITP (an international organization for PTAs and PTOs) ranks Singapore first in maturity, innovativeness and performance of mobility systems. Since 2014, Singapore's efforts have been led by its "Smart Mobility 2030" master plan, where public transport is established as key to sustainable, long-term land transport. The Smart Mobility focus has had effect.

Singapore increased its daily ridership on public transport by 9 percent between 2015 and 2018, compared to an increase in population of 3 percent during the same period. The increase has been supported by a combination of smart technologies, initiatives such as pricing incentives to reduce peak-travel load and cooperation with major employers.

Smart technologies including Mobility-as-a-Service (MaaS) solutions, intelligent control systems and optimized bus services have been adopted.

92%

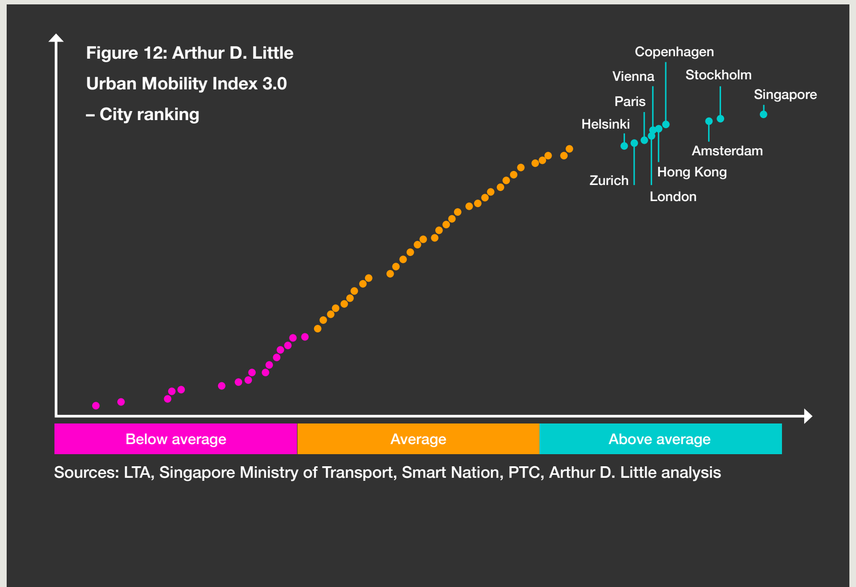
By analyzing of data from commuters' fare cards, the number of buses with crowding issues was reduced by 92%

For instance, by analyzing data from commuters' fare cards, the number of buses with crowding issues was reduced by 92 percent and the average waiting time shortened by 3-7 minutes.

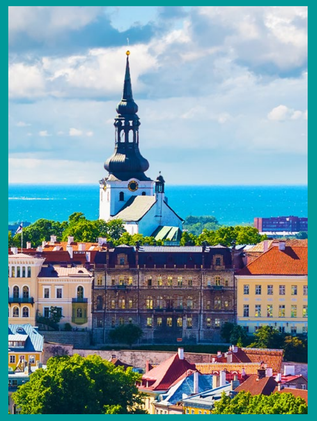
However, Singapore too is experiencing increased operating costs that cannot be fully offset by revenues from passenger fares. Other solutions are needed and technology is seen as key. For example, Singapore is integrating predictive maintenance in its rail network to decrease maintenance costs and increase the lifespan of trains.

Sustainability is a major part of the Smart Mobility 2030 strategy. Singapore is adopting electric vehicles in public transport and is also working to reduce emissions through increased efficiency with on-demand shuttles and optimized bus routes.

Singapore illustrates that with a clear and bold ambition, the rewards of investing in the right technology can be significant. ■



Sources: LTA, Singapore Ministry of Transport, Smart Nation, PTC, Arthur D. Little analysis



CLOSER TO HOME

Ever since Tallinn became the first capital city in the world to offer free public transport in 2013, the world has watched with interest. The move was made with the aims of reducing congestion on roads and increasing the social mobility of its citizens. Results indicate a sustained increase im ridership of between 10 and 14 percent. Tallinn City representatives state that the cost of the program is exceeded by the economic benefits it brings. In 2018 the scheme was expanded and 11 of Estonia's 15 counties currently offer free bus services in towns, cities and rural areas.

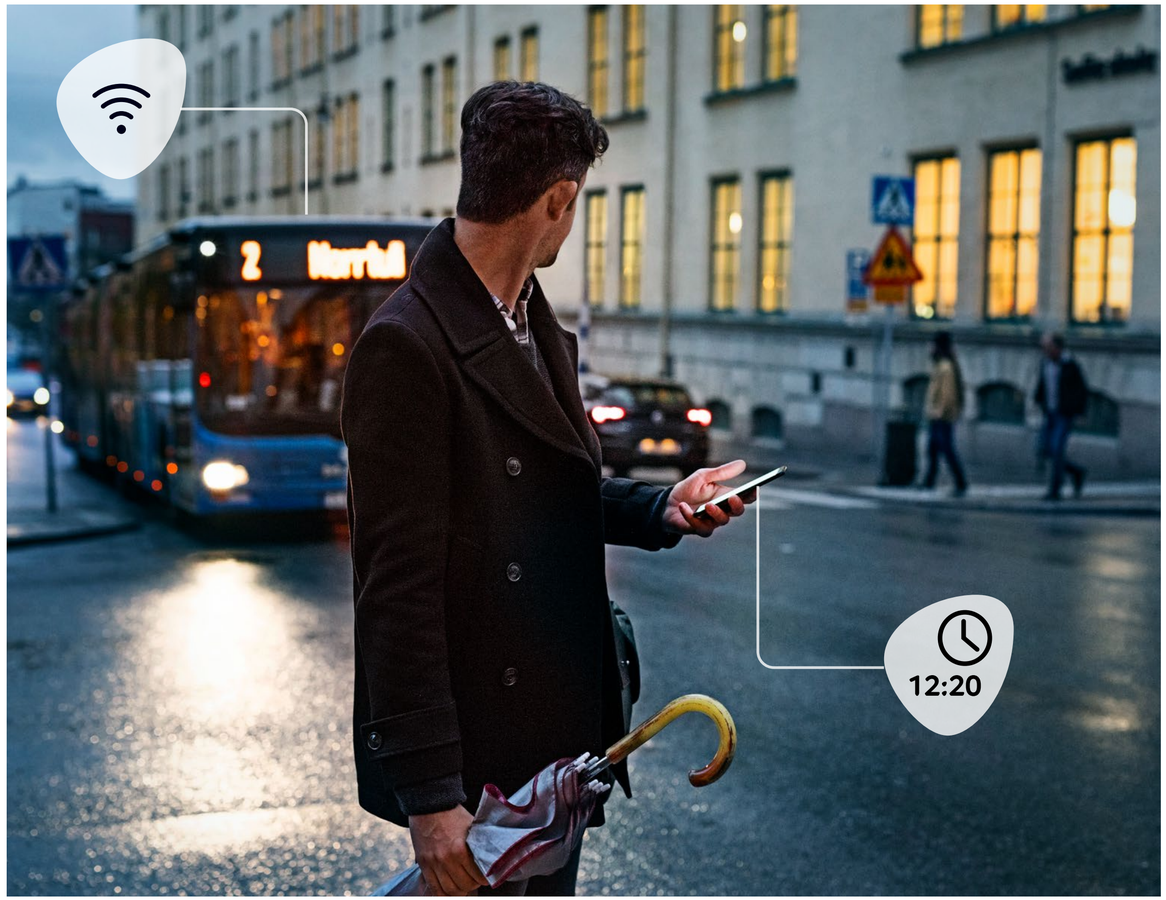
PAINPOINT 3:

PRESSURE TO INVEST IN A MODERN FLEET

As each generation of automotive and ICT technology delivers new capabilities and advances in efficiency and sustainability, there is an increased incentive to modernize. However, this must be balanced against the need to reduce costs

KEY PAIN POINTS	STRATEGIES	NON-DIGITAL ACTIONS
Outdated and worn fleet Frequent failures, lower efficiency unable to meet passenger expectations	Modernize fleet	• Modernization efforts • More frequent inspections and maintenance
Long and costly downtime Breakdowns result in unplanned downtime and impact service consistency	Improve customer services	• Larger buffers of vehicles on stand-by • Commercial agreements with other transport operators to fill temporary gap in capacity
High emission vehicles Growing pressure to reduce CO2 emissions to lessen the environmental impact	Modernize fleet	• Tender requirements for environmentally classified vehicles
Liability risks Increased risks of traffic accidents from poor maintenance and liability issues	Improve customer services	• Safety signs and information • Reduce speeds • Insurance

Challenges of older fleets and the traditional actions to solve the problems.



To achieve cost efficiency and reduce environmental impact, the common practice has been to demand more from vehicle suppliers during tenders. To cope with technical failures, PTOs also demand better maintenance, for example through frequent inspections and capabilities to quickly resolve technical failures. Risks of failures are also managed by providing short-term alternative means of travel, by contracting other public transport providers. By having access to more timely and granular vehicle data, these technical failures can often be prevented.

In the following section we outline currently available digital solutions that can help to modernize an existing fleet →

RETROFITTING DIGITAL SOLUTIONS TO EXISTING FLEET

To manage the cost and benefit balance, many PTOs take the middle road and digitalize their existing vehicles instead of replacing them. This involves connecting the vehicle's onboard systems to an onboard edge processor that delivers real-time data to the driver and to the cloud-based transport management systems. This enables a variety of digital functions, including: remote tachograph monitoring, vehicle and location monitoring and driver identification and communication.

PREDICTIVE MAINTENANCE

The ability to monitor vehicles remotely enables PTOs to manage maintenance in a proactive manner. Rather than relying solely on physical inspections; key indicators are monitored and logged. These can then be measured against performance parameters such as the number of driving hours or the number of open or closed passenger door cycles to determine when maintenance should be carried out.

ECO-DRIVING

An example of onboard data usage is eco-driving, a solution that has been deployed for several years in many regions. By giving drivers real-time feedback on how their acceleration, braking and coasting patterns affect fuel consumption, drivers can adapt to reduce fuel consumption and emissions. This also reduces the impact on vehicle mechanics and maintenance. An example of this is Swedish operator Nobina, a company that is reducing fuel consumption by up to 12 percent. Finnish operator Onnibus estimates its potential fuel savings to be 275,000 liters per year.

"We use sensors to control the engine and equipment. There is much money to be saved from not having buses standing still. Predictive maintenance is important"

Major Nordic PTO

PAINPOINT 4:

GAINING A COMPETITVE EDGE IN PUBLIC TRANSPORT

Public transport operators face increasing competition. Digitally enabled, asset-sharing services such as e-scooters, Uber and Lyft provide more than just first-and-last-mile solutions. They are also a new breed of competition. At the same time, large international PTOs are entering new markets with economies-of-scale that put pressure on local PTOs to price match.

While it's less of a concern for PTAs, most local PTO interviewees are challenged by growing competition. There are two clear pain points. Firstly, the price pressures trigger aggressive pricing and erode margins. Secondly, with price as a key parameter in tender evaluations, the natural action is to take cost-cutting measures. Therefore, the ability to maintain quality and a competitive edge becomes increasingly difficult.

KEY PAIN POINTS	STRATEGIES	NON-DIGITAL ACTIONS
Increased price pressure Multinational PTOs in local tenders force price pressure and erode margins	Improve internal operations	• Develop scale advantages to compensate for lower prices with lower total cost base • Regional focus to avoid head-on competition with too many peers
Inability to gain competitive advantages The ability to gain competitive advantages diminishes	Improve internal operations	• Develop more customized offerings with local knowledge and workforce • Deeper understanding of customers' needs and local regulatory environment
Multiple systems that can't interact Expensive to maintain multiple siloed systems and difficult to use their data	Improve internal operations	• Consolidate sourcing • Standardize data requirements

Challenges of a growing competitive landscape and the traditional actions to address them.

Digitally enabled, asset-sharing services such as e-scooters, Uber and Lyft are a new breed of competition.

In the following section we outline currently available digital solutions that can help to provide a competitive edge.

DIGITAL SOLUTIONS TO INCREASE THE COMPETITIVE EDGE

A number of digital solutions available on the market today provide tangible ways to lower operational costs and deliver competitive advantages.

VEHICLE & FLEET OPTIMIZATION

Vehicle monitoring systems connect output data from the components of the vehicle to provide remote status and performance updates. This enables the health of critical components to be monitored and potential problems that may lead to unsafe situations or downtime to be mitigated. By combining historical data, failure rates and current asset status; predictive maintenance becomes possible.

> **"There is great potential in predictive maintenance, especially with trains, as this area is heavily regulated."**
>
> - Commercial Manager, Nordic PTO

Real-time **vehicle positioning and tracking** data that can be fed into existing fleet management tools enable more granular fleet management and increased ability to adapt to variable traffic conditions and unforeseen situations.

Smart heating of vehicles uses connected temperature sensors and control systems to ensure that buses are at their optimal temperature when they are due to enter service each day. Nobina installed smart heating on 2,000 buses and is able to save 22 GWh per year, equivalent to the output from two mid-sized wind turbines.

Automatic passenger count enables PTOs to optimize passenger loads and scheduling. This is particularly relevant in regard to COVID-19 and the need to manage passenger loads. Real-time passenger data measure how many people are on board at any given time. This can be combined with **crowd movement data** to provide the broader picture of all travelers at a specific time in all modes of transport. This enables PTAs and PTOs to carry out deeper analysis into their addressable market and identify unmet customer needs.

One example is Helsinki Regional Transport Authority. They used crowd movement data to measure how new feeder lines to their extension of the subway between Espoo and Helsinki changed the behavior of commuters. Measurements showed that car traffic between Espoo and Helsinki was reduced by 8 percent, which is equivalentl to approximately 13 tons of CO_2 per day.

By enabling before-and-after comparison, PTAs can measure, and justify, the environmental and financial impact of their decisions regarding, for example, new lines or the positioning of line stops.

> **"Passenger counting is important, as many business decisions are based on that data. Now, new types of passenger measurement tools are emergent, as are new requirements for real-time data, for example."**
>
> - Product Manager, Nordic PTO

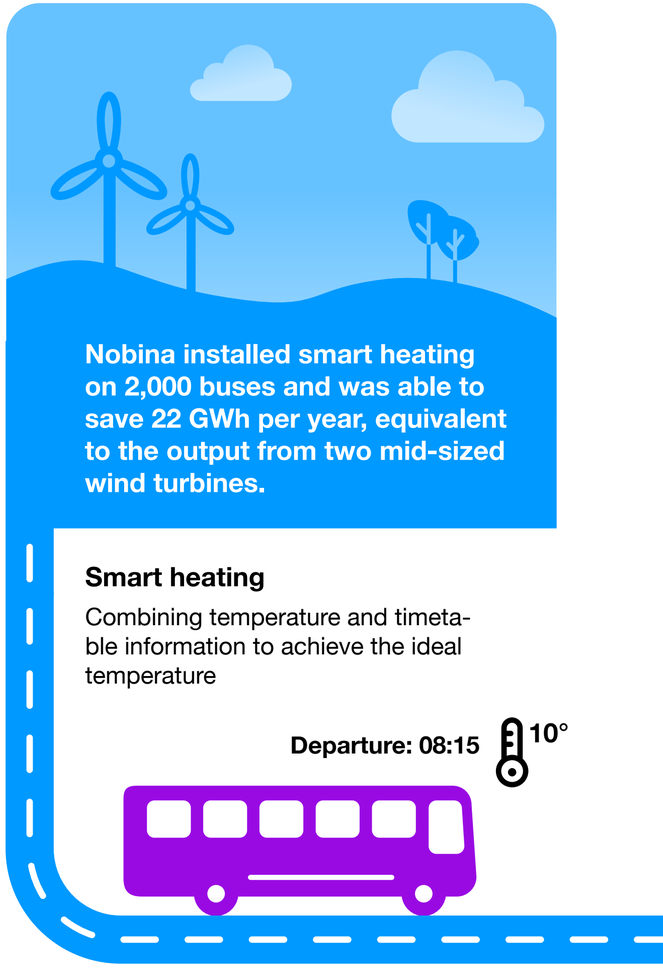
ORCHESTRATION OF MULTIPLE SYSTEMS

In order to address the problem of multiple systems that do not interact, a smart orchestrator can capture the data from multiple independent systems and external data sources. This provides PTOs and PTAs with a consolidated source of data to draw insights from, share with other relevant stakeholders, and even monetize by selling appropriate data to private companies.

LOCAL KNOWLEDGE

Local PTOs have an advantage in their local knowledge of market and customers. This can be further enhanced by using **crowd movement data** to gain deeper understanding of customers' needs, enable **route optimization** and identify new route opportunities. However, this is a double-edged sword, as it also enables multinational operators to instantly access current and historical data and gain local knowledge.

Today, the market for crowd movement data is somewhat immature and stakeholders in public transport have limited knowledge. Local market relevance also differs. Compared to the Baltics, decision makers in the Nordics can gain greater advantage from these solutions due to higher relative costs of wages and fuel.



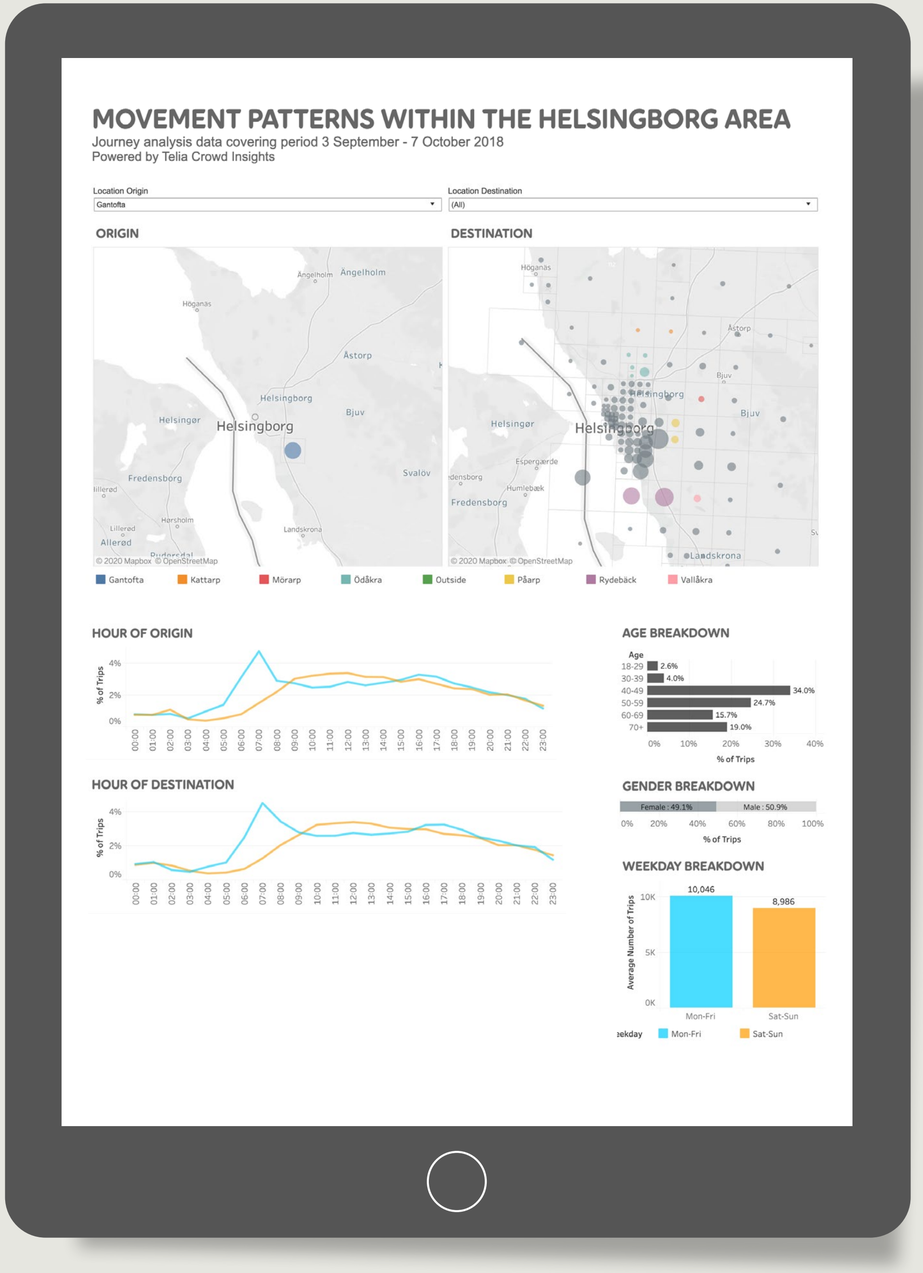
Using crowd movement data to improve traffic planning

Crowd movement data helps the city to make more informed decisions and prioritize infrastructure investments.

The City of Helsingborg in Sweden has traditionally used surveys to map local commuters' travel patterns and habits. The city did, however, see gaps in what the surveys could cover and so wanted to find a more accurate way to understand travel patterns.

"How do people actually travel to and from different parts of the commuter lines today? We wanted to describe the conditions required for sustainable travel by bicycle, bus or train. A six-year-old survey was not reliable enough to successfully plan future investments in infrastructure. The commuter towns are not very large, and we previously had little data to use," says Linda Bermin, a traffic planner at the Urban Planning Department in Helsingborg.

Crowd movement data help the city to make more informed decisions and to prioritize infrastructure investments in order to maximize benefits for citizens. Data is created continuously and shows people's actual behavior – representing the entire population as a basis for decision-making.



THE ROAD AHEAD

In the public transport sector, the direction and speed of digital transformation is often dictated by the technology and sustainability requirements in tenders. Public transport authorities therefore play a crucial role in driving the adoption of new technology.

How the tenders and requirements are structured varies significantly between PTAs. But the formal requirements in a tender are typically the main reason for PTOs to invest in connected vehicles and other solutions.

In the Nordic and Baltic rail and metro sector, PTAs generally own the trains and decide which solutions should be installed, whereas the PTOs are tasked with operating and maintaining them. In the bus sector on the other hand, PTOs generally own the buses. In both cases, digital solutions are included as part of tender requirements, but exactly where the line is drawn between PTA and PTO responsibilities is not always clear. In some cases, information technology needs are only partially specified by the PTA, opening up for alternative solutions. In other cases, across-the-line consistency is strictly enforced, meaning all vehicles must follow the same solution standards. Skånetrafiken in Southern Sweden, for example, has adhered to the latter model and developed a new ticketing system in its entire city bus fleet.

Because contract periods often have a long duration and the tendering window is short, this limits the window of opportunity to implement new initiatives. In particular, this is a risk to the development of smart solutions for trains where contracts are longer and regulations related to installations are extensive. To realize future ambitions, PTAs should be proactive in the requirements they set and PTOs should be proactive in preparing for them.

	1. BUILD THE RIGHT MINDSET	2. TAKE THE FIRST STEPS	3. MAINTAIN SPEED	4. MAXIMISE VALUE
PUBLIC TRANSPORT AUTHORITIES	Set long-term ambitions and concrete targets	Develop a clear but flexible digital solution roadmap	Collaborate with other PTAs	Examine how smart solutions can be used to meet internal needs
PUBLIC TRANSPORT OPERATORS	Disrupt or be disrupted	Select initial use cases and get started	Have the right competence in place	Ensure compliance with relevant standards and track progress

In the following section we address these recommendations in detail.

PUBLIC TRANSPORT AUTHORITIES

SETTING EXPECTATIONS

If the public transport industry is to capture the full potential of digitalization; learning from successful implementations and understanding common challenges and pitfalls is the starting point. As successful use cases emerge, the adoption rate will accelerate.

For PTAs to succeed in attracting more passengers and reducing costs through digitalization, they should:

1. Set long-term ambitions and concrete targets

To achieve their public transport ambitions, PTAs should be clear and concrete about their expectations and strategy. For example, clarify PTA versus PTO responsibilities and what competencies, capabilities and collaborations are necessary to succeed, and which standards should apply. Incentives clearly linked to well-defined KPIs are a good way of measuring and encouraging this.

2. Develop a clear but flexible digital solution roadmap

Providing visibility of future needs, including upcoming tenders, enables PTOs to start exploring specific use cases to be ready to meet needs. In the process, both the PTA's and PTO's competence will grow. Roadmaps must, however, be kept flexible. PTAs that stay updated will be able to include the right solution requirements in tenders and maintain a realistic ambition level for implementation.

"We are looking at data use high and low. Now we are doing different proof-of-concepts to understand what data we need, the cost and what decisions to take […] Suddenly we can see how bus and train stops are placed in the wrong location."

– Technical Manager, Swedish PTA

3. Collaborate with other PTAs

To stay informed and maintain momentum, PTAs should ensure collaboration with each other nationally and internationally, as well as with suppliers, disruptors, and operators. This will enable them to leverage existing expertise and experiences to evaluate use case relevance and feasibility. Collaboration can also enable pooling of data and integrated services, which many ecosystem players are already doing.

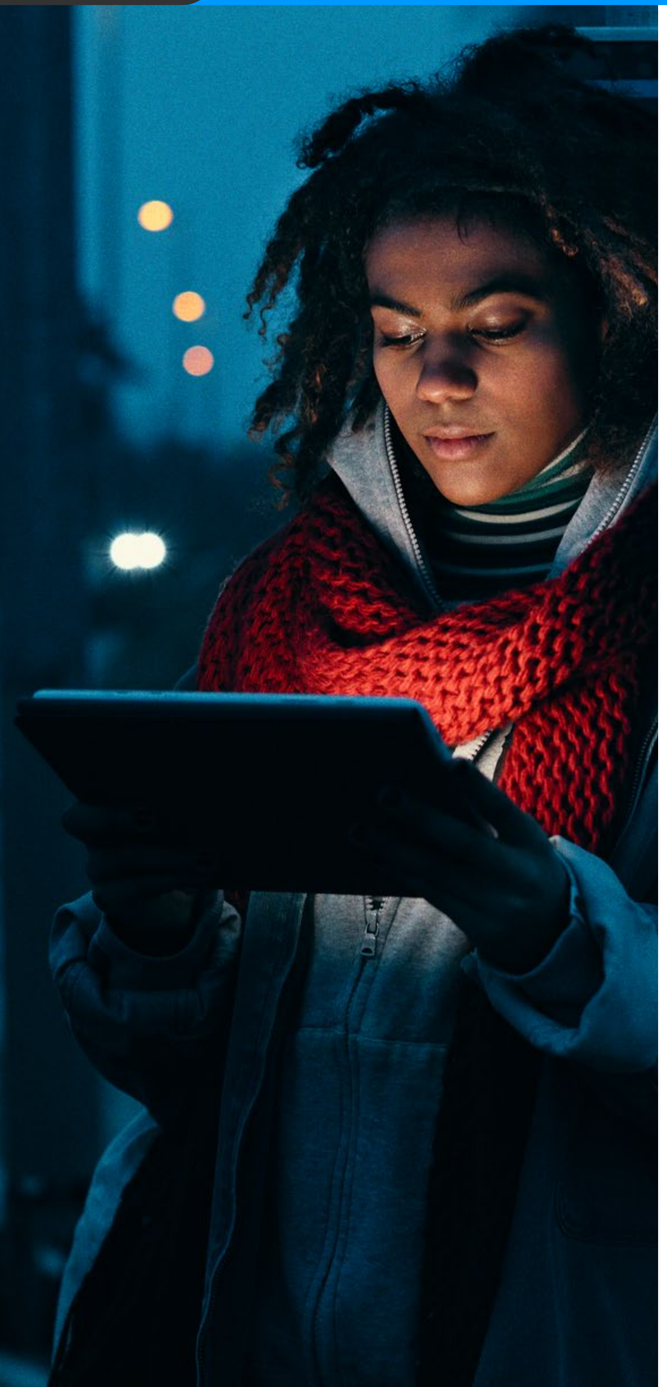
In Sweden, Samtrafiken is a partnership of mostly PTAs and PTOs, offering a set of traffic-related services and open data APIs as well as developing standards for interoperability. In Norway, the state-owned company Entur has a similar role, as has the PTA-co-owned Rejseplanet in Denmark. There are also intra-Nordic collaborations. Partnerships do not have to be formal – opening up communication channels between PTAs as well as with other ecosystem actors is enough to spur the exchange of ideas.

"You should work together, not on your own. Public transport in the Nordics is not very complicated. The challenges are the same, the needs are the same. I am hoping for stronger Nordic cooperation."

– Nordic PTA

4. Examine how smart solutions can be used to meet internal needs

Not all digital use cases need PTO involvement and the tendering challenges that entails. In particular, ensure all available data is leveraged – see, for example, the crowd movement data use cases introduced in earlier chapters, where movement data is used to support PTAs in planning routes and bus stops. By evaluating and developing use cases internally, PTAs can develop understanding, skills, and insights that will be valuable in their interaction with PTOs as well.



PUBLIC TRANSPORT OPERATORS

LAYING THE FOUNDATIONS

In order to continue to support PTAs in the future, PTOs are putting the technology foundations in place. In many cases, the digital solutions they are implementing enable immediate efficiency gains. Moreover, they are seen as an investment in fulfilling future needs.

1. Disrupt or be disrupted

As technology requirements in tenders become increasingly sophisticated, PTOs need to ensure they have the capabilities in place and that they test them to be able to compete in cost and quality. Top-level management buy-in is a key enabler here, both for the required investment and to facilitate internal engagement.

2. Select initial use cases and get started

The ideal use case has a solid business case, appeals to the end-user and can be implemented without interrupting the daily business. While this may seem demanding, all solutions presented in this report are already in operation.

"It is important that you have a vision and that the entire organization works to find solutions that support the vision in different ways."

– Product Manager, Nordic PTO

3. Have the right competence in place

Interviews with key players in the Nordic and Baltic markets highlight a lack of knowledge both in the selection, implementation and usage of digital solutions, as well as the need to build individual competence and organizational capabilities in both PTAs and PTOs. Because the competition for talent in digitalization, IoT and data insights is very high, it is important to balance talent acquisition with internal development. This starts with assigning responsibilities and investing in people to develop the required skill sets and increasing knowledge of industry standards, available solutions and PTA goals and ambitions. Where competence gaps are identified, external recruitment or partnering should be considered.

"Our expertise is not the development of smart solutions, instead we know how to provide good public transport. [...] When implementing a new smart solution, we try to work with the suppliers with the best expertise and leverage their know-how, while we can evaluate what will be useful or not."

– CIO, Swedish PTA

4. Ensure compliance with relevant standards and offer adequate flexibility

While it is important to comply with current standards, the evolving nature of technology means that flexibility should always be an important consideration. Otherwise, if future requirements change and existing systems and data cannot be integrated to meet them, technical and organizational complexity increase.

Proprietary systems should be implemented with caution and appropriate standards should be investigated for any solution. Active participation in standards development is recommended to fully understand and take part in future development.

5. Track deployed solutions

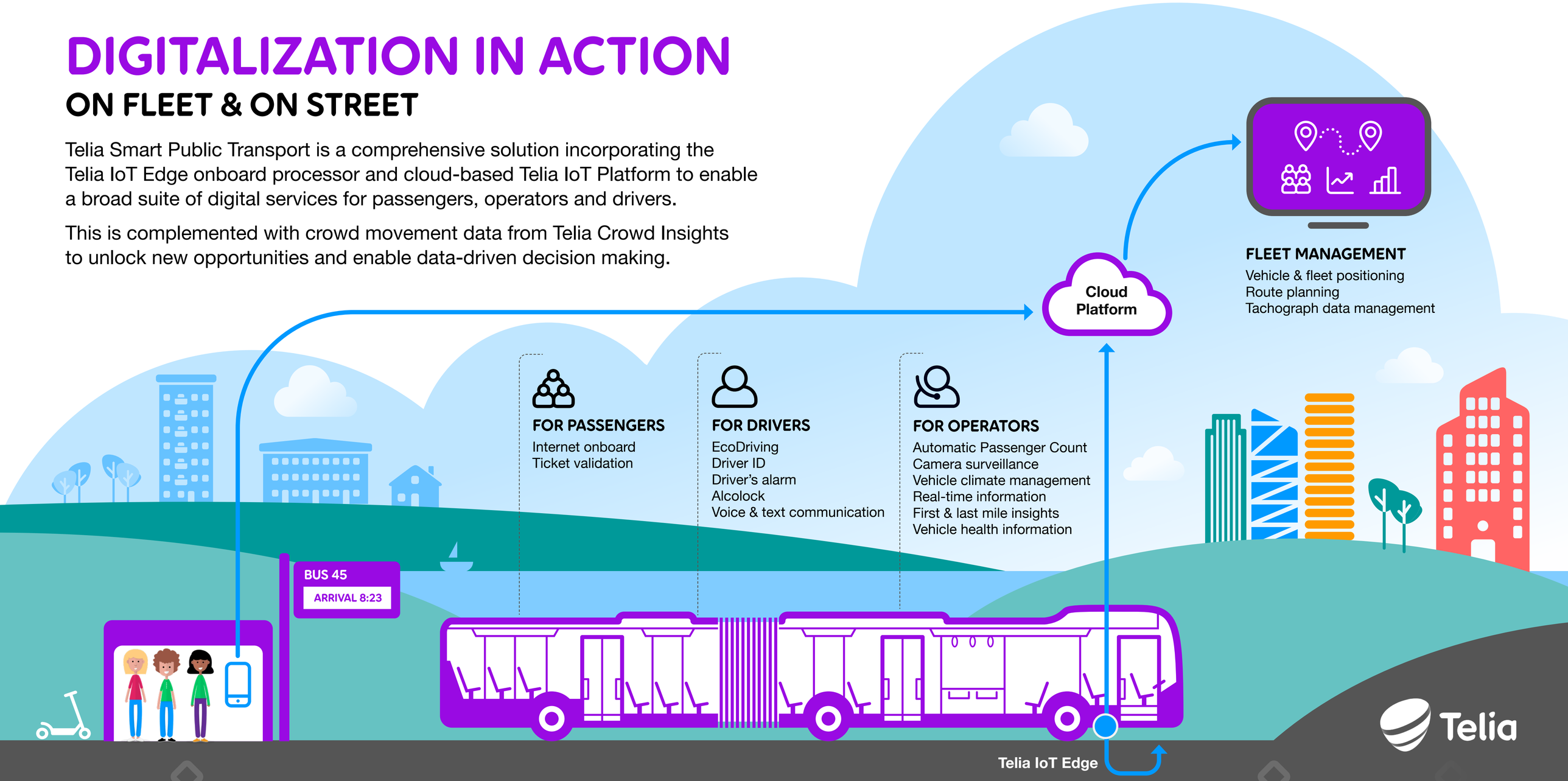
To maximize the benefits, deployed solutions should be followed up to ensure they are used to their full potential. For example, a Nordic PTO noted it has had compliance issues with its eco-driving as drivers did not turn the solution on at the start of their shift. Both PTOs and PTAs should commit to seeing the implementation of their solutions through all the way, ensuring they have the intended effect on the public transport key goals.

DIGITALIZATION IN ACTION

ON FLEET & ON STREET

Telia Smart Public Transport is a comprehensive solution incorporating the Telia IoT Edge onboard processor and cloud-based Telia IoT Platform to enable a broad suite of digital services for passengers, operators and drivers.

This is complemented with crowd movement data from Telia Crowd Insights to unlock new opportunities and enable data-driven decision making.



Learn more about IoT and Data Insights at business.teliacompany.com

Or ask us a question iot-sales@teliacompany.com