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Helsinki Intelligent Transport System Development Programme 2030

Developing traffic information, new mobility services and automation

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Preface

The purpose of this work was to update the Helsinki Intelligent Transport System Development Programme prepared in 2013 and determine the required development actions in specific focus areas. The determined focus areas were collection and utilisation of traffic data, digital transport management, the role of Helsinki in the new services and transport automation. Before starting preparation of the operational programme, the development outlook of the operating environment and technology were assessed, and key possibilities and risks to which the city must react were identified. The final result of the work is an operational programme on intelligent transport for 2020–2024. The programme has been divided into seven packages of measures and strongly prioritised based on the city's goals and the estimated impact of the measures. The programme is ambitious in its scope and will require strong commitment, efficient organisation and sufficient resources from the city. In addition to the Helsinki City Urban Environment Division (Kymp), Forum Virium Helsinki, parties responsible for the development of digitisation, HSL and other regional authorities, as well as companies providing intelligent transport services will participate in the implementation of the operational programme. The intelligent transport operational programme is also dependent on broader digitisation of the city's services and infrastructure, and the programme must be synchronised with a broader whole in this respect.

The preparation of the development programme has been guided by a steering group consisting of Reetta Putkonen (chair), Mikko Lehtonen, Marko Mäenpää and Heikki Hälvä from the Helsinki City Urban Environment Division; Pekka Koponen and Roope Ritvos from Forum Virium Helsinki; Karoliina Rajakallio from HKL; Ulla Tapaninen, Kalle Toivonen, Suvi Hänninen and Kari Pudas from the City Executive Office; and Reetta Koskela from HSL. Two broader workshops and discussion events for intelligent transport companies were also arranged during the course of the work. While the development programme was being prepared, Gunnar Heipp from Strategic Urban Mobility Consulting prepared a separate review of case cities all over the world. He also participated in the steering group's work and workshops, providing valuable input on successful global implementation projects.

The plan was prepared between the autumn of 2018 and the spring of 2019. A team of consultants consisting of Tomi Laine (project manager), Inna Berg and Tuuli Salonen from Strafica Ltd; Matti Huju and Risto Kulmala from Traficon Ltd; and Sakari Lindholm from WSP Finland Ltd. was in charge of its preparation.

Helsinki, 24 June 2019

Reetta Putkonen
Director, Traffic and Street Planning
Helsinki City Urban Environment Division

1 Changing intelligent transport operating environment

1.1 City grows and becomes more compact along the railways

Helsinki's population has been forecast to increase quickly: the population is expected to be more than 700,000 by 2027. The new local master plan bases growth on a rail transport network with several strong city centres. Infrastructure investments aim to retain the public transport system as the trunk of the regional transport system. Railways can transport large passenger volumes efficiently and in an environmentally friendly manner. Boosting land use close to the railway network is part of the regional land use, housing and transport policy (MAL).

The investments in intelligent transport methods, the development of transport services, pilot projects related to self-driving vehicles and the development of the operating environments required by automatic vehicles aim to support the development of the networked city mentioned in the local master plan. However, the development of market-based services will not be limited to, for example, rail transport feeder services. Instead, the development of services will be allowed in any areas where there is a market for them. As the city grows and the volume of traffic increases, the transport system is subject to a great deal of development pressure. More comprehensive information on the status of the transport system and the development of the transport system indicators must be collected by the means available to intelligent transport, to be utilised in daily management and long-term development of the transport system.

1.2 Traffic flows can be managed by means of intelligent services and cooperation

Vehicles with a continuous network connection, C-ITS and automation hugely increase the amount of traffic data. Except for specific applications based on data transfer between the infrastructure and a vehicle, most of the data is created by refining relevant information from the data provided by the various sensors in vehicles. Gradually, the monitoring of traffic will be based on measuring instruments installed in the infrastructure and vehicle sensor devices. Road operators will be able to purchase the data they require from service providers active in the market through competitive bidding procedures. This development also includes the fact that unlike solutions based on the infrastructure, the new data sources do not follow the administrative borders between road operators. Procurement cooperation between all road operators in the region will become a key development driver.

As the volume of traffic data increases, automation and analytics will be needed to turn the data into relevant information for users. Traffic data users may include the city's own or a regional traffic management centre as well as other service providers that can reach consumers through their own services. The city's role as a producer and provider of refined traffic data involves both risks and opportunities. As stated above, as the technology develops, traffic information, the control of traffic and guidance will first transfer from the side of the road to a vehicle device, and will be automated later. The risk with this development is that the road operator's role as the traffic controller may diminish or disappear unless the city can find itself a role in the future information value chain. In such an event, the road operator will naturally have fewer opportunities to influence the traffic flows that use its network. Cooperation models and tools are already being prepared, and the city of Helsinki should participate in this development. Such extensive cooperation concepts will provide brand new opportunities to manage, for example, traffic during street repairs and public events, which often hamper people's movement in Helsinki.

1.3 From owning vehicles to using services

Transport servitization is breaking down the mobility culture based on owning or leasing a vehicle. Instead of owning, people use a variety of mobility services and select the best service, mode of transport or a combination of both for each situation. The service portfolio of a MaaS (Mobility as a Service) provider is often a combination of a variety of modes of transport from vehicle rental services to public transport, city bikes and taxi services. The goal of MaaS operators is to provide such an attractive combination of high-quality services that the service level and price are a competitive alternative to owning your own car. Furthermore, new modes of transport are being created all the time. Such services are connected to servitization development, and rented electric scooters are an example. Interviews with MaaS providers emphasise the fact that although the connecting of digital services requires work, it is still easier to achieve than a functional and competitive trip chain in the physical urban environment. What is slightly surprising is that the expectations of the MaaS operators involve quite traditional issues, such as year-round maintenance of pavements and cycleways, minimisation of disadvantages caused by street maintenance and high-quality planning of terminals and transit points.

MaaS can also change the traditional operating models involving company cars and commuting. Many companies are already offering their employees several alternatives, such as company bicycles, public transport tickets and a benefit from the use of a company car and parking space. In future, the benefit could consist of a mobility service package combining a variety of services. The taxation of employee benefits will play a key role in this development.

Servitization will not stop at the integration of mobility services into one service package; instead, mobility services will also be linked to housing and housing services. Lessors or developers are interested in the integration because of the need to reduce the number of car owners and increase the opportunity to realise housing projects with a smaller number of parking spaces, which will reduce costs. Helsinki approved the principles of a market-based parking experiment in the spring of 2019.

If successful in achieving sufficient market penetration, transport servitization can decrease the number of car owners and the volume of vehicle mileage, boost a quick renewal of the vehicle stock and significantly contribute to the achievement of traffic emission reduction targets. MaaS can also be seen as a method of digital mobility management. If skilfully used, MaaS combining a variety of mobility options can efficiently guide the choices made by a large number of people in the desired direction. Mobility management can consist of rewarding customers for making sustainable choices or utilise a variety of gamification tools.

As a general rule, servitization progresses on market terms, with cities and the public sector acting as enablers of the development. The city of Helsinki is an experiment platform for new services in connection with the Jätkäsaari Mobility Lab project, for example, and realises pilot projects as part of the Forum Virium Helsinki project portfolio. Forum Virium Helsinki specialises in screening the extensive selection of projects and service providers to find candidates whose services support the achievement of the city's goals and are scalable to the entire city.

1.4 E-commerce fragments product flows

Fragmented product flows increase the demand for new types of distribution services. E-commerce for both consumer goods and perishables is growing by some 10% per year (Nenonen 2018). In today's Finland, online stores offer both direct deliveries to your home and pick-up services from a Posti or Matkahuolto service point, a parcel point or a pick-up point of a service provider. As the order volume grows, the current "final mile" distribution services will increase the traffic volume, especially in residential areas, although the dense network of pick-up points will support the pick-up of parcels on foot or by bicycle.

Large-scale global enterprises, in particular, are actively developing new kinds of distribution services to boost the transport chain and produce savings for both sellers and buyers. Amazon has been testing the delivery of parcels with drones in different countries for several years now. It has been estimated that drones could decrease final mile transport costs by up to 80%. Benefits for the city include reduced emissions and reduced vehicle traffic volume if vehicle deliveries are replaced with drones. Finnish logistics companies have also realised pilot drone transport projects. Thus far, there are some technical limitations to transport with drones.

Land transport robots are also becoming more common globally. Starship Technologies has developed a robot for final mile transport, which has already been used in 16 countries (Nenonen 2018). The robot has been used to transport orders from restaurants and grocery stores, for example. At present, the use of robots or drones requires the recipient to be present at the destination to accept the parcel.

The volume of vehicle distribution traffic is also increasing. For example, Amazon has introduced the Amazon Flex transport service, through which any vehicle owner can deliver parcels (Nenonen 2018).

1.5 Self-driving interactive vehicles will soon be here

Automation is increasing in all areas of society, including transport. Changes are expected to be fastest in road traffic and public transport where the first applications – self-driving lorries and their queue driving applications, autopilots for the motorway environment, as well as robot buses and taxes – are expected to enter the market in the early 2020s. However, the views of experts are somewhat contradictory, which is why an exact estimate cannot be given. The safety potential of such automation level 4 applications is significant, as they are expected to eliminate up to half of road fatalities once the penetration is sufficiently high. Applications at the lower automation levels also provide traffic safety benefits.

At first, the automation applications will only work in operating environments specifically built for them, which are expected to expand fairly quickly, however, partly through investments made by road operators. Automation is a major factor of change especially in terms of the production costs and service level of public transport services, as it will eliminate drivers and related costs. Automation therefore offers interesting opportunities for the development of regional public transport. It has been estimated that the role of minibuses and robot taxis in feeder services to support rail transport may be significant, at first in suburban areas where the operating environment requirements can be more easily reached than in the inner city, which is a challenging operating environment for self-driving vehicles due to the high volume of cyclists and pedestrians, for example.

Although the traffic safety and service level development potential is huge, the development of automation also involves plenty of questions and even some clear risks from the perspective of the goals set by the city of Helsinki. The most major question in terms of the impact is how self-driving passenger vehicles will enter the consumer market – as a service or to be privately purchased. If the price level of self-driving passenger vehicles is low enough for the average consumer to be able to purchase one on their own, the development may damage – through the lowering of the value of travel time – the competitive ability of rail transport and cause congestion in the road network, regardless of the potential additional capacity provided by the self-driving vehicles. Another clear uncertainty is related to the arrangement of automatic transport services. It is almost certain that commercial automatic transport services will be created on the market, and the affordability of such services will depend on the above-mentioned mechanisms. Such services can excellently supplement the public transport feeder services, in which case the fully market-based services can have a positive impact. However, if such services do not operate as part of the regional rail-based system but offer an affordable and attractive alternative to the system, the development may be a threat to the competitive ability and financing base of the regional public transport system. The current driver-based commercial transport services have already reduced public transport passenger volumes in New York, for example (New York Times 2018).

Automation of the transport system is a major factor of change. After the testing phase – and already during this phase – transport policy control and regulation, as well as other methods to prevent the realisation of the above-mentioned threats will be necessary. Cooperation between the city of Helsinki, HSL, the state and other municipalities in the region in the generation of a policy on self-driving vehicles will also be necessary. Different types of pricing models based on utilisation of the street space must be reviewed at the latest in this connection.

It is likely that self-driving vehicles will become more common quite slowly in the 2020s, because the renewal of the vehicle stock is a slow process. It has been estimated that in 2030, only a couple of per cent of the vehicle stock will consist of self-driving vehicles (level 4), and self-driving vehicles will not become more common until the 2030s. The transition period will be long, and during this time the transport system must serve vehicles of a low automation level and vehicles of a higher automation level. It is likely that road management costs will increase and the benefits from automation will not be realised at the transport system level during the first stages of the transition period. Furthermore, providing/constructing infrastructure dedicated to self-driving vehicles in the densely built urban environment is not considered realistic. It is likely that the need for traffic control will increase during the transition period, because different types of disturbances will become more common, for example. The possible disturbances during the transition period must be accepted and active measures to mitigate them must be taken. Means to accelerate the renewal of the vehicle stock will be integral to the transport policy. On the other hand, servitization of transport is a trend that will accelerate the renewal of the vehicle stock and thus the implementation of new technologies.

Cooperative Intelligent Transport Systems (C-ITS), or interactive vehicles that can communicate with other vehicles and the infrastructure, are part of the development of transport automation. Implementation of C-ITS applications will start sooner than the implementation of level 4 automation due to control by the European Commission, for example, and the applications will become more common quite quickly in the 2020s due to retrofit and mobile solutions. It has been estimated that C-ITS applications will reduce accidents by up to 10%, as they offer drivers exact real-time situational awareness and integrate warnings into lower automation level applications (such as automatic emergency brakes). C-ITS also offers advanced information and navigation services in vehicle devices, which is a key step towards the transfer of traffic information and control from the roadside to the vehicle. In addition, the road operator's role is significant in the case of C-ITS services, as the road operator maintains the traffic light system, for example.

2 Review of cities abroad

2.1 Background

The future of mobility in large cities abroad was investigated with a horizon of around ten years or until 2030. Mainly European cities with a clear transport digitalisation strategy were selected. A survey for the cities was created, focusing on aspects related to future mobility: vision, administration, strategy and key projects.

Eight cities replied to the survey by providing detailed information on their intelligent transport focus areas. Six other cities were investigated by studying publicly available materials and by means of telephone interviews.

Table 1. Reviewed intelligent transport cities.

Intelligent transport focus areas	Case data
• Hamburg • Lisbon • Munich • Stuttgart • Toronto • Stockholm • Vienna • Zurich	• Amsterdam • London • Lyon • Oslo • Osnabrück • Paris

2.2 City-specific intelligent transport focus areas in trailblazing cities

The intelligent transport focus areas of eight cities were determined by means of a survey form and supplementary telephone interviews.

Table 2. City-specific intelligent transport focus areas

Hamburg	Lisbon
Strong investments in intelligent and public transport An intelligent transport vision approved by the city council An open cooperation network to boost operations of the private sector Multimodal mobility stations to connect public transport with other means of transport A private company, Moia, is conducting an extensive experiment of an on-demand ridesharing service	The city is a strong leader in the promotion of intelligent transport innovations Interested in exchange of information on problem-oriented data processing Participates in the EU's C-Roads project An integrated ticket system Promotes mobility based on demand Extensive stakeholder participation

Munich	Stuttgart
A large testing site for self-driving vehicles with public and private participants in 2019–2021 The city controls all new modes of transport, such as micro mobility (electric scooters, etc.), self-driving vehicles and on-demand traffic control Comprehensive car sharing and city bike services with a high utilisation rate Multimodal mobile app of the Munich Transport Corporation (MVG), which provides information about public transport, ridesharing and city bikes Traffic safety policy: using data for assessment and control	Strong investments in intelligent transport and the multimodal traffic control centre over the course of several years One smart card for all services The best example of a car sharing service with the city's main public transport operator (SSB) as the operator The city has a strong role in transport planning, traffic control, parking and emissions
Toronto	**Stockholm**
Major investments in rail transport as the trunk network The public transport organisation is testing an integration of ridesharing and the transport system All final mile services will be combined with the standard public transport service Aware of the risks caused by privately owned self-driving vehicles if their share increases in relation to public transport	The best example of a successful congestion charge system that has reduced emissions and travel times, as well as increased the use of public transport when compared to other modes of transport A strong policy that favours an environmentally friendly vehicle stock The city supports the implementation of new transport innovations An experimentation area for self-driving buses and commercial vehicles, realised in cooperation with businesses A city data platform in use
Vienna	**Zurich**
Due to extreme investments, the public transport system is a passenger transport trunk line to which intelligent transport solutions are connected Focused on developing a smart city where the key goal is the reduction of emissions Involved in digitalisation of public transport, aiming for optimisation of functions The city owns a multimodal transport platform that is open to all services. A strong basis for the use of intelligent transport	The best example of the integration of regional and local public transport and related services The best example of a city traffic management centre which is responsible for the generation of benefits to public transport The city requires that new service providers hand over open data to the city Data-based parking management in private car parks, such as shopping centres Self-driving vehicles do not play a key role in the resolution of traffic problems

2.3 Conclusions on the foreign case cities

Ridesharing, combining people and vehicles, and optimisation of the street and road network are the key measures to achieve private, individual and communal mobility. In rapidly growing Helsinki, the most major challenge is the fact that there is no room for more private vehicles. Increasing the utilisation ratio of private vehicles and the use of other modes of transport is therefore key in all strategic, tactical and operational measures in the planning of intelligent transport and traditional mobility.

In Helsinki, more trips connected with leisure and shopping are taken than commuting trips. Helsinki should develop its mobility management in cooperation with residents, employers, commercial centres and freight traffic operators. The goals should be boosting of trips connected to shopping and distribution traffic, as well as promotion of walking, cycling and the use of public transport. Furthermore, emission-free driving power during motor vehicle trips should be promoted.

The traffic management centre must be modernised in the same way as in the case cities. Stuttgart is an example of using integrated traffic management strategies and sensors for different modes of transport, London of comprehensive utilisation of traffic monitoring data and Zurich of optimisation of the existing road and street network and securing the quality of urban life and the environment.

3 Vision, goals and packages of measures

3.1 Intelligent transport vision 2030

The intelligent transport vision clarifies the target state and the key areas in which mobility and the transport system will be developed by means of intelligent transport in Helsinki in the 2020s.

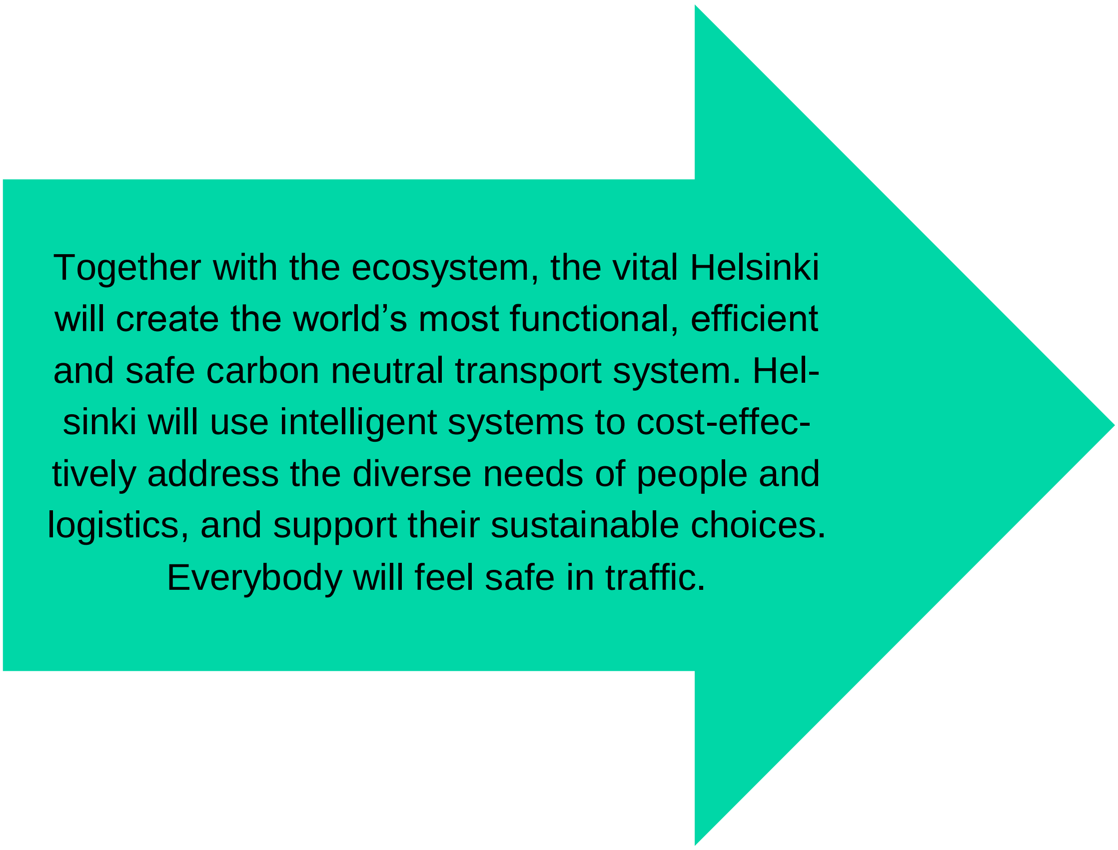

Figure 1. Helsinki intelligent transport vision 2030 from the perspective of people and the transport system

In the vision, Helsinki is a vital city, and its vitality is supported by the development of intelligent transport and new services. Helsinki aims to become the world's most functional and safe city, and intelligent transport measures play a key role in this ambition. The vision emphasises the importance of cooperation with the entire intelligent transport and new service ecosystem – this promise cannot be redeemed with the city's own resources alone. Extensive cooperation is important in both the piloting of new solutions and in the implementation of new cooperation concepts. Cooperation also involves real-time sharing of situational awareness between the parties.

Intelligent transport must boost the efficiency of the transport system and guide the development towards the carbon neutrality target of 2035. Intelligent information services and MaaS will play a key role in this respect. They will be actively used to guide the mobility and consumption choices of residents and businesses in a more sustainable direction. Perceived safety is a key requirement in terms of the equality of mobility. It involves not only the current modes of transport but also the upcoming automated transport services. Striving to become the best in the world means that Helsinki will be the benchmark, the most advanced city in the world, in each of the subareas.

3.2 Transport goals and indicators

Intelligent transport refers to a wide range of ways to promote the strategic mobility and transport system goals in Helsinki. Such goals were already specified in the Helsinki City Strategy 2017–2021, the Carbon-neutral Helsinki 2035 operational programme and other development programmes for traffic and digitalisation, among other themes. As Helsinki is developing intelligent transport and transport services in cooperation with businesses, the development programme is also linked to the city's industrial policy goals. The transport-related goals of the intelligent transport development programme can be divided into four target areas, as illustrated by Fig. 2 below.

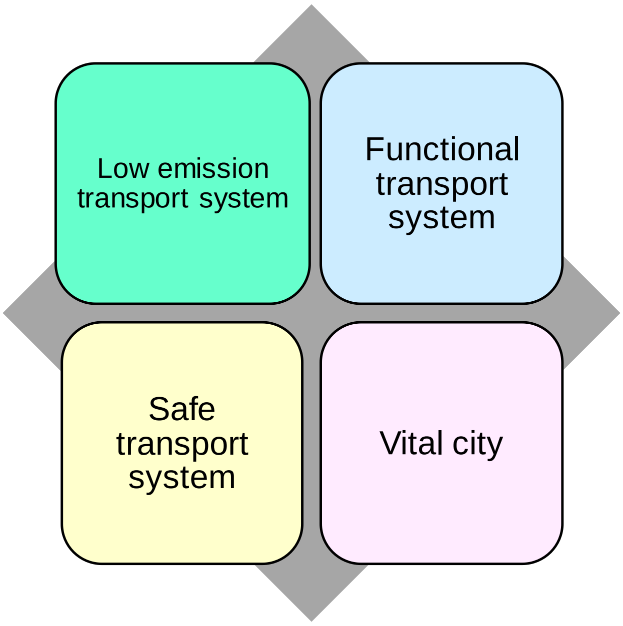

Figure 2. Target areas of the intelligent transport development programme.

Key goals for each target area were specified based on processed policy documents and interactive events arranged during the work. The intelligent transport development programme is to promote the achievement of these goals. Each target area also includes a note as to whether the goal was included as such in any previous strategy or whether it was raised when preparing this plan. In addition, the table includes preliminary indicators that can be used to monitor the achievement of each goal. The development monitoring processes, launch of the indicators and the data to be used in the indicators must be separately planned in more detail. The plan is to utilise existing data and data that will be collected in any case as effectively as possible.

Table 3. Concrete goals and indicators of the intelligent transport development programme.

No.	Goal	Reference	Potential indicators (**KPIs highlighted in red**)
1	CO2 emissions from traffic and transport will be reduced by 60% by 2030 (compared to the level of 2005)	City Strategy 2017–2021	**CO_2 emissions from traffic and transport**
2	Health hazards caused by traffic noise and emissions will be reduced	City Strategy 2017–2021	Development of the annual mean nitric oxide (NO2) concentration and particle (PM2.5) concentration at the air quality measuring network's traffic stations Number of times the daily limit value for inhalable particles (PM10) is exceeded at the air quality measuring network's traffic stations Number of people living in the zone where the daytime equivalent continuous sound level (LAeq 7-22) exceeds 55 dB
3	The transport system supports functional everyday life, and is predictable and resilient	Helsinki Mobility Development Programme (2014)	Number of severe disturbances in different modes of transport Duration and impact of the disturbances Comparison of travel times
4	Rail transport and cycling connections between city centres make sustainable mobility a competitive option	New Helsinki local master plan	**Travel time when using public transport, cycling and driving a passenger vehicle between the ten most important urban centres in Helsinki.**
5	Mobility is arranged as efficiently as possible, considering the use of the urban space and the city's financial resources	Helsinki Mobility Development Programme (2014)	A calculated index that is based on utilisation of the different modes of transport, their degree of utilisation and the space they require, considering the development of land use. Financial resources used to maintain and develop the transport system per resident
6	Freight transport is efficient and affordable, and has minimal externalities	City Logistics Development Programme (2015)	Fluency and punctuality of freight transport Number of parking spaces reserved for delivery vehicles in the inner city

No.	Goal	Reference	Potential indicators (**KPIs highlighted in red**)
7	The transport system is so safe for all user groups that nobody has to die or sustain a severe injury in traffic	Helsinki Traffic Safety Development Programme (2015)	**Number of accidents leading to bodily injury**
8	Mobility and the use of mobility services are considered safe	A workshop during planning	Perceived traffic safety (survey) Perceived social safety (survey)
9	The city, mobile service users and businesses generate, share and utilise information	A workshop during planning	Number of information services Number of information service users Volume of traffic data produced by the city for the open interface
10	Helsinki will be used as a testing platform for the commercialisation of new intelligent mobility services and the promotion of future technologies	City Strategy 2017–2021	**Number of intelligent transport experiments carried out in Helsinki (where the city is involved)**
11	The Helsinki intelligent transport ecosystem generates growth companies and attracts international parties	New Helsinki local master plan	Number of service providers utilising the HSL ticket interface Number of companies with a contractual relationship with the city for mobility services

In addition to the intelligent transport measures, the achievement of the goals depends on a variety of other factors, such as traffic route investments, parking policy, taxation and economic growth. The share of the impact of intelligent transport on the measured development is difficult and partly impossible to reliably separate from the impact of the other factors. From the city's perspective, the essential point is that all the available methods and other social factors guide the development in the desired direction.

Prioritisation of the means available and the selections made must be based on which means will influence the achievement of the goals. For more information on the impact assessment, please see Chapter 5.

3.3 Structure of the development programme

The measures required for the Helsinki Intelligent Transport System Development Programme have been investigated in four focus areas: traffic information, traffic management, transport services and transport automation. During the work, the focus areas were analysed from the perspective of traffic policy and regulation (requirements), projects and investments and the roles and operating models of the different parties involved. Monitoring and research needs were also considered. A more detailed analysis of the different focus areas is available in a separate background report.

The analysis framework is presented in the figure below.

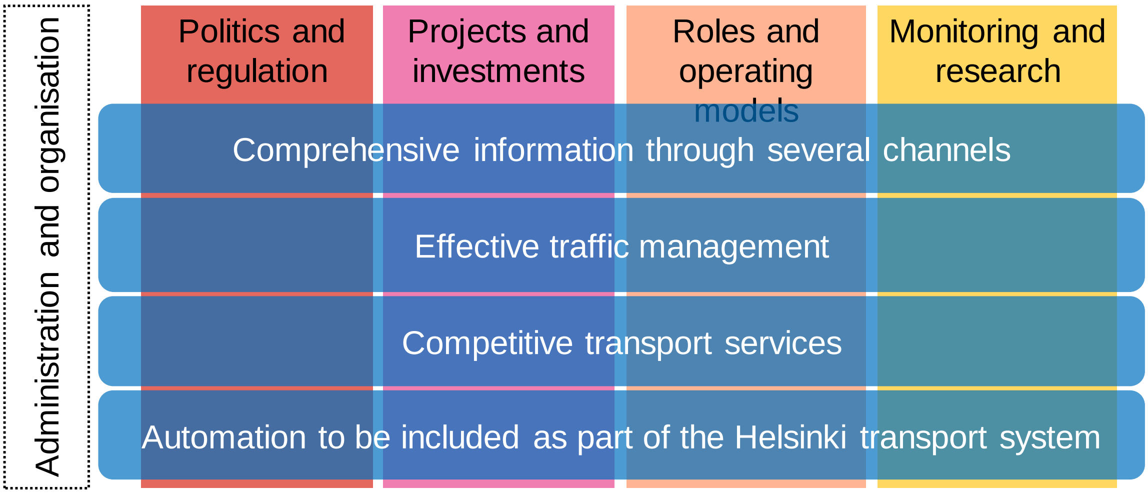

Figure 3. Structure of the intelligent transport development programme

In workshops, a description of a target state for 2030 concretising the intelligent transport vision was created for each focus area.

3.4 Target state 2030

3.4.1 Comprehensive information through several channels

In this target state, the city monitors the development of the transport system and plans its operations based on high-quality traffic information. The city ensures, for its part, that people using the mobility services can make decisions regarding their trip with the help of situational awareness based on high-quality data using a variety of communications channels. Companies providing transport and mobility services can plan their operations and operate more efficiently.

Different data types and data type combinations create ***"situational awareness"*** and ***"monitoring and statistical awareness".*** **Situational awareness** consists of data provided in nearly real time (although the data generation algorithms may utilise data that is updated less often). Situational awareness serves the information services and operations of a variety of parties. **Monitoring and statistical awareness** serve transport planning with the aid of related measures and broader monitoring of the development of the transport system using history data.

In the target state:

- Helsinki collects real-time data that covers all means of transport for planning and monitoring needs. Key data includes volumes of the different modes of transport, speed as required, information on the reservation status of the different services (such as car parks and kerbside parking, as well as city bikes) and data on traffic infrastructure conditions (such as the weather, winter maintenance, roadworks and public events).

- The collected data is compiled and refined on a modern information service platform, where monitoring and statistical awareness for the city's internal use and situational awareness of the traffic for application developers, service providers and other partners (such as HSL and the Helsinki Region Traffic Management Centre) are created.

Data requirements, data collection and acquisition and technical solutions must be specified in detail before procurement and the solution's implementation. Requirements of businesses and different stakeholders must also be taken into account in the development work. Opportunities to utilise each data type in the city's own operations and in the operations of the stakeholders, as well as commercial utilisation opportunities, will be assessed, and the results will be compared with the data collection costs. It should be noted that some data types may not be usable as such, but data fusion may be required.

Data collection should cover the entire city, but if it is necessary to erect equipment at the kerbside (to collect status data on kerbside parking, for example), the data collection area may need to be strictly limited. Attempts will be made to commit commercial mobility services operating in Helsinki in the work to generate data for the requirements of situational awareness and monitoring and statistical awareness.

As a general rule, data collection will consist of the city's own data collection and data obtained from the continuously developing traffic data market. Data collection experiments may have to be conducted when developing the data collection to ensure that the city has modern and efficient data collection methods at its disposal. The Jätkäsaari Mobility Lab project is a key data collection experimentation platform. The practical data collection solution must be linked to the broader Helsinki city digitalisation programme.

When acquiring data for situational awareness, monitoring and statistical awareness, data collection, analytics and distribution platforms available on the market should be used. They can be customised for the city. Most platforms have been designed for modular implementation. Their continuous development is therefore possible. Another benefit of ready-made products is faster implementation.

Figure 4 illustrates the data collection and the situational awareness and monitoring and statistical awareness to be generated based on the data. High-class real-time data will be collected using a data collection platform, from which it can be shared via an open interface after validation. The collected data will be further refined by combining data from different sources using the required algorithms. The refined data will generate real-time situational awareness and monitoring and statistical awareness. These wholes can be shared with the different parties and information services through interfaces.

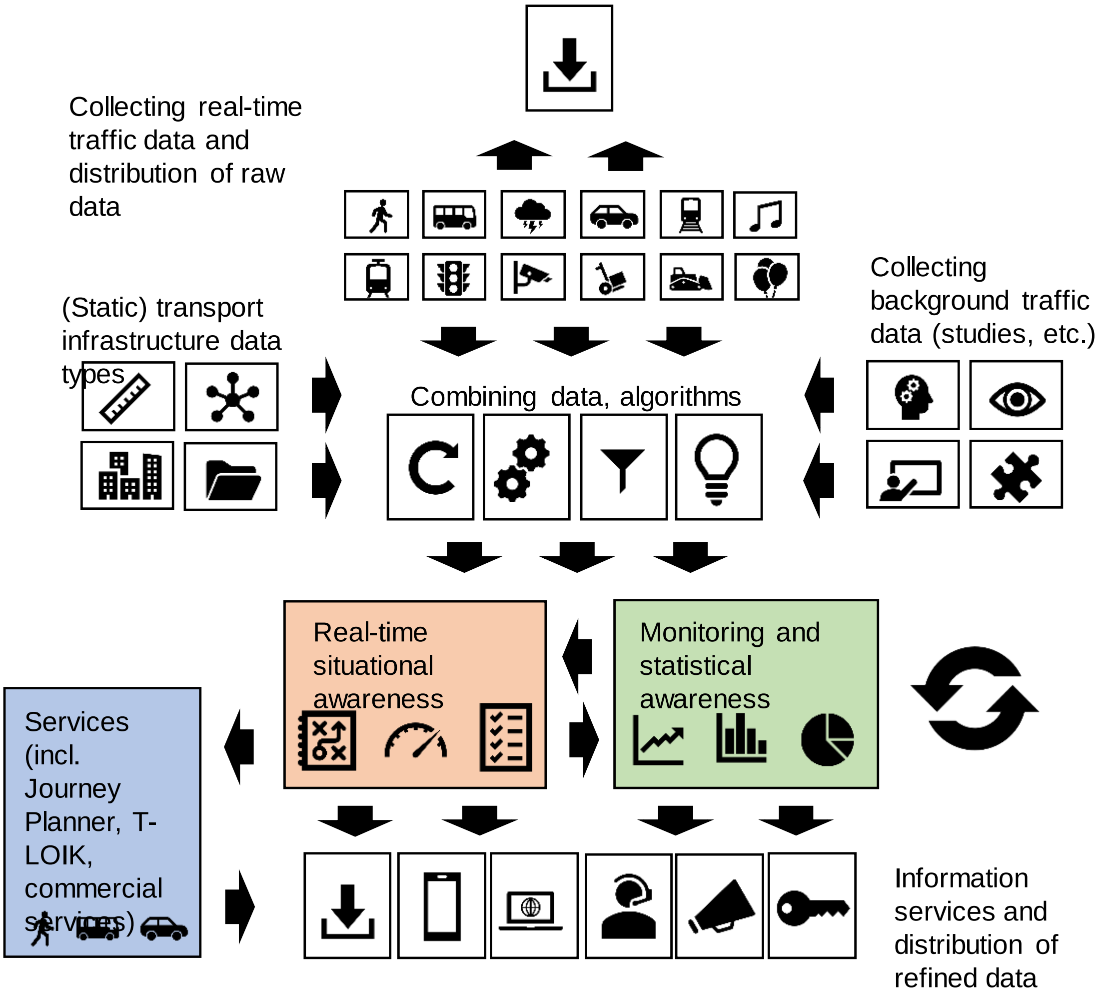

Figure 4. An illustration of the collection of traffic data, the utilisation of data and the generation of the situational awareness and monitoring and statistical awareness.

3.4.2 Effective traffic management

The development work aims to base traffic management on exact status data, advance planning, new control systems and cooperation with commercial information service providers. In the target state, the network control of vehicle traffic is based on agreed cooperation models with commercial information service providers. Roadworks are managed to ensure that they will not cause any significant disadvantage for pedestrian, cycling, public transport, distribution or vehicle traffic routes. Traffic control can safely manage malfunctions of self-driving vehicles. To prevent traffic congestion and other negative externalities, the Helsinki region will proceed with the launch of intelligent road tolls in compliance with the land use, housing and transport plan in cooperation with other parties active in the region and the Government.

The target state in terms of traffic lights is that all traffic lights are connected to the control and monitoring systems and there is a CCTV camera connection at all the key intersections to ensure that the Helsinki Region Traffic Management Centre will be able to dynamically change the programming of traffic lights in case of exceptional traffic situations. Traffic light malfunctions should be detected by remote monitoring, which will accelerate repair times and significantly improve traffic safety, especially at intersections that are problematic in terms of traffic or located close to special sites.

The development of technology will allow the transfer of traffic control and the mediation of traffic information from the roadside to vehicles. By developing the new cooperation concept with commercial service providers, the authorities will be able to expand traffic management operations to a broader network which utilises vehicle drivers' terminal devices and the information they contain on the driver's current position and destination. The vehicle routing service will also take into account a route hierarchy determined by the street or road operator to ensure that the services avoid steering traffic to routes of a lower level or to residential areas. At its most refined, the hierarchy is dynamic, i.e. it takes into account public events, state visits, public transport and exceptional public transport routes, peak hours of commercial operations and schools' starting and ending times. Such interactive cooperation has been outlined in international cooperation under the working title Traffic Management 2.0.

The transfer of guidance to vehicles also supports a variety of methods for the management of demand that can be introduced to reach climate targets, for example. Such methods include environmental zones in city centres to which access is only allowed with an electric or low-emission vehicle, as well as road tolls for the city region.

The Helsinki Region Traffic Management Centre's target state is a situation where the authority acts as the traffic management coordinator. In collaborative traffic management, policy decisions (control policy and traffic management principles) must be created in cooperation by the authority (the Government or city) and the service provider to ensure that the solutions serve all the parties involved. In this concept, the combination of data sources and the related analyses are undertaken by a situational awareness service, and the analysis results are used to determine, among other issues, the control of variable message signs and an analysis of the availability of the route network for service providers.

Interactive and collaborative traffic management elements and their interconnections are illustrated in Fig. 5.

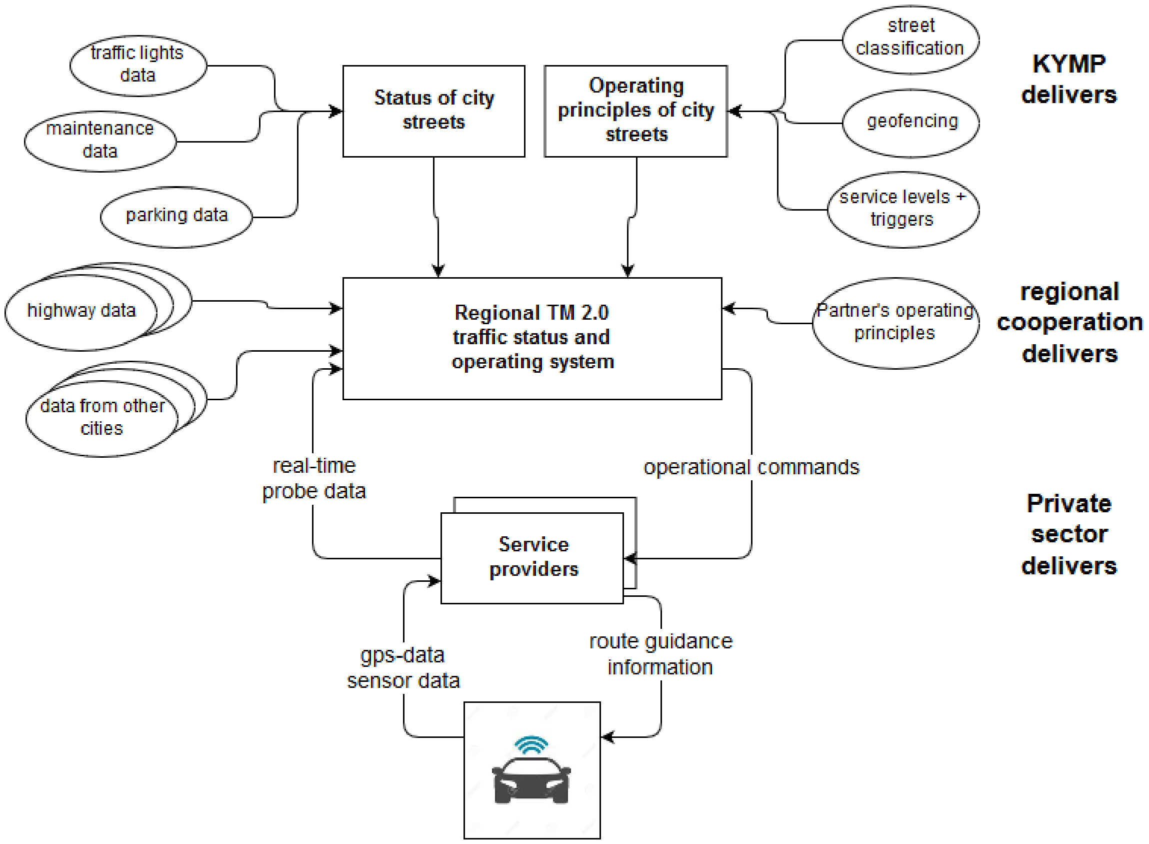

Figure 5. Development of the regional traffic management (Traffic Management 2.0) situational awareness and control system.

The regional TM 2.0 situational awareness and control system will be connected through interfaces to the city's situational awareness and the city's own datasets, some of which are also required to develop regional situational awareness.

The development will allow the Helsinki City Urban Environment Division's traffic light planning to identify traffic lights' functional defects via the control and monitoring system, and thus to react to them. Appropriately functioning traffic lights will make public transport more punctual, improve the flow of traffic in general, reduce emissions and make people respect traffic lights more. Priority for public transport and enforced priority for rescue vehicles can be realised cost-effectively via interfaces between the traffic light control and monitoring systems and the priority systems.

In this target state, the city has a strong grasp of traffic light C-ITS applications and their future development. Compatibility of traffic light equipment and control centre systems with current and future C-ITS services will be taken into account in procurement. The city will pilot traffic light C-ITS applications in areas with a high impact potential, such as close to the ports in Jätkäsaari as part of the Jätkäsaari Mobility Lab project.

3.4.3 Competitive transport services

The aim of the development of transport services is to provide residents with versatile mobility services and intelligent service combinations, enabling fluent everyday life without the need to own a car or regularly use one. In this target state, trip chains based on public transport trunk connections and versatile feeder services are competitive and affordable compared to using one's own car, all resident groups commonly use the new transport services and the services have clearly reduced the number of cars owned and the mileage of privately owned cars. Due to the increased user potential caused by the popularity of the services and denser land use, mobility services are profitable in market terms. In 2030, transport services based on self-driving vehicles are easy and safe to use, and the services increase the independent mobility of children and the elderly.

It is justified for the city of Helsinki to support transport services and servitization of the mobility culture with its transport policy and its actions, because the support will make sustainable modes of transport equal to the owning and use of a private car. The starting point is for new transport services to be created on the market in cooperation with the city. The support for transport services must be consistent, and the supported services must promote the achievement of the city's transport system development goals. The city of Helsinki must assess all services that wish to enter the market, and compare their potential impact with the intelligent transport development goals and the city's values. Aspects to be taken into account in this assessment, in addition to the goals, include social equality, public health issues and the right to use the travel data collected by the service.

Key issues in cooperation with service providers include equal treatment of the parties involved and fair competition. If a service requires a permit from the city to reserve city space for parking spaces, charging points or docks, for example, the city may allocate the space needed by the service and assist in the building of the required infrastructure. In such a situation, the city must strive to avoid one service provider being able to achieve an unnecessary monopoly in a specific market. Fair competition will improve the quality of services and reduce prices, which is in line with the city's goals. If the impact of a service wishing to enter the market contradicts the city's goals and values, entry of the service into the Helsinki market will not be supported and may even be prevented in some cases.

The city will also promote the servitization of mobility through land use planning. Demand potential can be created and transport services operating on market terms can be enabled by making land use denser. This is the most important tool to be used by the city of Helsinki in the promotion of servitization. The city can also promote servitization by combining transport services with land use planning for residential properties and the design of parking spaces. The Urban Environment Division approved the principles of a market-based parking experiment in the spring of 2019. These principles will be applied at least to the land use planning of Hakaniemenranta, Nihti (the southernmost tip of Kalasatama) and Hernesaari.

Other potential regulatory means include environmental zones (in the inner city, for example) to limit the ownership or use of specific vehicles within a specific zone. The limitation will create an opportunity for car sharing to be allowed in the zone by those who need a car in the inner city. Kymp is preparing a separate survey on the introduction of environmental zones.

The development of situational traffic awareness (see Chapter 3.4.1) will also boost the creation of advanced high-quality transport services.

3.4.4 Automation to be included as part of the Helsinki transport system

The goal of this focus area is to promote an efficient, functional, safe and emission-free transport system by means of automation. Automation will be realised in ways that improve the transport and traffic service portfolio and service level, but will not compete with public transport or clearly increase decentralisation of the urban structure. In this target state, automation of the metro system in 2028 has improved efficiency and competitive ability of the transport system.

Responsibility for the safety and functionality of all automatic applications lies with the vehicle supplier or company operating the service. A prerequisite is the vehicle being able to operate safely in the realised operating environment. The company must be able to present an operating model that will efficiently manage disadvantages caused by any malfunctions to traffic, such as remote control. Special requirements for the remote monitoring and control of vehicles may be specified, particularly to verify traffic safety. This is an essential issue for the development of services, because remote monitoring is an absolute necessity for self-driving bus and taxi services to ensure the safety and functionality of the transport service provided to customers. The party in charge of regulation is the Finnish Transport and Communications Agency (Traficom), and close cooperation with Traficom in this respect will be necessary.

Experiments involving self-driving buses will be continued and robot taxi experiment(s) will be launched to create a public transport system where self-driving buses and robot taxis act as efficient feeder services for the rail-based public transport system. The city’s duty will be the implementation and maintenance of the physical and digital infrastructure required by the self-driving vehicles, such as passenger pick-up and drop-off areas.

Vehicle designers and manufacturers will be responsible for the requirements involving their self-driving vehicles to the operating environment and thus to the infrastructure. At least for the time being, there are no regulations on compliance with operating environment requirements, which means that self-driving vehicles will create no additional regulatory requirements in the street environment. It is in the best interest of industrial companies to provide as extensive an operating environment as possible for their self-driving vehicles within the limits set by technology and its costs. The operating environment of self-driving vehicles is expected to strongly expand in the next twenty years as vehicle sensors, software and AI are developed, and solutions become more affordable, which means that the infrastructure requirements will become lighter and some of the requirements will be eliminated during this period. It is possible that industrial companies, road operators and authorities will agree on the implementation of operating environments and related primary targets and schedules at the EU level by, for example, 2025.

3.5 **Packages of measures**

By strongly prioritising the extensive selection of available methods, seven packages of measures were created during the course of the work based on the description of the target state. These packages of measures will be implemented in the next five years. These packages of measures will create the basis for services and traffic management based on comprehensive high-quality data and situational awareness and the prerequisites for the dynamic operation of traffic lights, and transform other operational traffic management actions from traditional systems based on roadside equipment into operating models that efficiently combine digital systems created by public and commercial parties. Meanwhile, the prerequisites for the regional commissioning of new economic policy instruments will be created and traffic automation to support the public transport system will be developed. The strongest development phase is not expected to occur until after the next five-year period.

The packages of measures included in the development programme, divided into the focus areas, are as follows:

- **Comprehensive information through several channels**

  1. Developing the collection of traffic data
  2. Developing situational awareness and monitoring and statistical awareness

- **Effective traffic management**

  3. Interactive and collaborative Traffic Management 2.0
  4. Developing traffic light control
  5. Economic instruments

- **Automation to be included as part of the Helsinki transport system**

  6. Public transport system that utilises automation
  7. Physical and digital infrastructure for self-driving vehicles

In the case of competitive transport services, the development will mainly occur in companies operating on the market, and the city of Helsinki will not be expected to perform any actual measures in terms of the service portfolio. However, the city will support servitization and entry into the market by collaborating with businesses in the Jätkäsaari Mobility Lab Project, for example. The city may also realise measures and create data systems to support services, such as distribution traffic parking IDs and related digital services, which will not be created on market terms. Development of situational traffic awareness will also promote servitization and boost the availability of the services through exact information on traffic and conditions, for example.

The Jätkäsaari Mobility Lab project is considered a key party in the implementation of the pilot projects in the operational programme, although it has not been included in the operational programme's projects because it is already an ongoing project. The urban logistics development programme 2.0, which will be completed in 2020, will also include new transport sector measures.

4 Operational programme 2020–2024

4.1 General

This chapter presents the concrete measures that will be used to promote the implementation of the selected seven packages of measures in compliance with the goals. The measures of the operational programme cover the years 2020–2024, or the next five-year period. The operational programme will be updated in 2024 to continue the development work.

A rough cost estimate for services, equipment and systems to be acquired from outside the city organisation in connection with each measure has been specified. Experts have prepared the cost estimates based on the best available information. Rough estimates of the city's own personnel resources required to implement the measures (as person-months/person-years) and the required competencies have also been made. In starting the implementation, the city must assess the extent to which the required competencies can be found and allocated from within the city's own organisation and the extent to which external experts will be required to complete the projects.

A party responsible for each measure has been determined in cooperation with the steering group whenever possible. In cases where no agreement on the responsible party could be made, the forum in which an agreement on the division of responsibility must be made has been determined.

A broad range of potential measures were identified and prioritised by the steering group into classes 1 and 2. To clarify the focus of the development programme and ensure that resources will be effectively utilised, only priority class 1 measures were accepted in the final development programme presented here. The prioritisation was based on the estimated impact of the measures in relation to the goals set for the development of intelligent transport, for example. The impact assessment and further potential development measures are presented in the separate background report.

4.2 Comprehensive information through several channels

1. Developing the collection of traffic data

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
1.1	Specifying traffic data collection development requirements	Plan	Specifying the traffic data requirements and the market situation, as well as resolving technical issues in cooperation by the city and the stakeholder groups. **Reconciling the specified requirements with the situational awareness, monitoring and statistical awareness, as well as the information service specifications of the mobility service users** to ensure comprehensive progress of the development. Continuous development of data collection will be taken into account when specifying the requirements.	Kymp will be the co-ordinator, and participating parties will include, in particular, the city's data administration and digitalisation departments, Elo Mutual Pension Insurance Company (Helsinki), Forum Virium, HKL, HSL, ITM Finland, Uusimaa Centre for Economic Development, Transport and the Environment and the Finnish Transport Infrastructure Agency
1.2	Carrying out data collection pilot projects	Experiment	Experimenting with the collection of the specified data in the Jätkäsaari Mobility Lab project and assessing the experiments. Carrying out pilot projects as part of the	Forum Virium, organisations responsible for the collection of the data to be piloted

Schedule

Measure	*19*	2020	2021	2022	2023	2024
1.1 Specifying traffic data collection development requirements						
1.2 Implementing and assessing the required pilot projects						
1.3 Developing the data collection platform and collecting data						

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
1.1	Specification expert services EUR 100,000 by 2020. Thereafter, EUR 20,000 per year.	4 person-months	Traffic technology and logistics, IT, data science, procurement expertise
1.2	EUR 100,000 by 2020. Thereinafter, EUR 25,000 per year.	2 person-months (by 2020)	General intelligent transport expertise, procurement expertise
1.3	EUR 2–3 million by 2024. The data collection platform will also serve the development of situational awareness (measure 2.2).	4 person-months per year	General intelligent transport expertise, IT expertise, procurement expertise

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service (plans).*

2. Developing situational awareness and monitoring and statistical

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
2.1	Specifying development needs related to situational awareness, monitoring and statistical awareness	Plan	Specifying, based on the data to be collected, the required analytics and reporting tools and the further use of the refined data (operations and monitoring). **The specification will be reconciled with the collection of traffic data and the information service specifications of the mobility service users**. The development of "Traffic Management 2.0" will be taken into account for vehicle traffic. Continuous development will be taken into account in the specification work.	Kymp will be the coordinator, and participating parties will include, in particular, the city's data administration and digitalisation departments, Elo Mutual Pension Insurance Company (Helsinki), Forum Virium, HKL, HSL, ITM Finland, Uusimaa Centre for Economic Development, Transport and the Environment and the Finnish Transport Infrastructure Agency
2.2	Developing situational awareness tools	Developing information	Realising a real-time (and predictive) traffic data service that will serve operations.	Responsible parties will be determined during the specification work.

Schedule

Measure	*19*	2020	2021	2022	2023	2024
2.1 Determining information service development needs						
2.2 Developing situational awareness tools						
2.3 Developing monitoring and statistical awareness tools						

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
2.1	Specification expert services EUR 100,000 by 2020. Thereafter, EUR 20,000 per year.	4 person-months	Traffic technology and logistics, IT, data science, procurement expertise
2.2 2.3	EUR 2 million by 2024. If the "Traffic Management 2.0" measures are a goal in the development of situational awareness, the cost estimate will be higher. Meanwhile, the number of responsible parties will also increase (the role of the parties in the road network will increase).	2 person-months per year	Traffic technology, IT, data science, procurement expertise

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service (plans)*

4.3 Effective traffic management

3. Interactive and collaborative traffic management (2.0)

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
3.1	Feasibility study on the management of collaborative and interactive traffic management	Plan	Further specifying the target state, international practices, assessing technical feasibility and further specifying the development projects, as well as further specifying the cost estimate.	HSL, ITM Finland, the cities, Traficom, Uusimaa Centre for Economic Development, Transport and the Environment, the Finnish Transport Infrastructure Agency, Helsinki Region Traffic Management Centre. In Helsinki, Kymp will participate as one of the clients in a project managed by the Centre for Economic Development, Transport and the Environment.
3.2	More detailed planning and agreements	Plan	Specifying earnings models and agreements of commercial parties, technical and functional architecture, specifying the	HSL, ITM Finland, the commercial parties, the cities, Traficom, Uusimaa Centre for Economic Development, Transport and

Schedule

Measure	19	2020	2021	2022	2023	2024
3.1 Regional feasibility study						
3.2 More detailed planning and agreements						
3.3 Acquisition, implementation and commissioning of development projects						

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
3.1	Participation in procurement of a regional feasibility study (unit price EUR 150,000), approximate share EUR 23,000	1 person-month	Operational traffic management and related systems.
3.2	Participation in the more specific planning and preparation of agreements (unit price EUR 650,000) in regional cooperation, approximate share EUR 100,000	3 person-months	Operational traffic management and related systems. Contract law and system procurement.
3.3	Participation in procurement, implementation and commissioning of development projects (unit price EUR 10 million), approximate share EUR 1.5 million	6 person-months	Operational traffic management and related systems. Contract law and system procurement.

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service*

4. Developing traffic light control

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
4.1	Including all traffic lights in the scope of remote monitoring	Procurement of equipment/services	Implementing the control and monitoring system interface and the required data connection for traffic lights yet to be included in the scope of remote monitoring.	Kymp, ITM Finland, Helsinki Region Traffic Management Centre
4.2	Using traffic lights to collect traffic data	Technical survey, procurement of equipment/services	Developing the utilisation of traffic light data acquired through the control and monitoring systems and open sharing of data, procuring traffic monitoring cameras for intersections significant for traffic.	Kymp, Helsinki Region Traffic Management Centre
4.3	Monitoring the devel-	Market	Actively monitoring development of	Kymp, ITM

Schedule

Measure	*19*	2020	2021	2022	2023	2024
4.1 Including all traffic lights in the scope of remote monitoring *)						
4.2 Using traffic lights to collect traffic data **)						
4.3 Monitoring the development of traffic light C-ITS and carrying out a pilot project ***)						

**) Action plan and preparation of the project/competitive bidding in 2019–2020; implementation in 2021–2022.*

Traffic lights to be renovated in street renovation projects in 2023–2024 can be connected to the central system in connection with the project.

***) Technical study and action plan by the summer of 2020; implementation by 2022.*

****) Implementation of pilot projects in 2023–2024.*

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
4.1	The city's estimated share of the costs (some of the traffic lights are owned by ITM Finland or jointly owned) of the connecting of 180 control devices to the central system is EUR 350,000. If a new central system is to be procured, the costs will be higher, estimated at EUR 500,000. Preparation of the action plan will require approximately 2 person-months.	2–3 person-months	Operational traffic management and related systems. Contract law and system procurement.
4.2	Determining technical prerequisites and options, EUR 30,000. Realising data distribution interface and data storage in the control and monitoring system, EUR 100,000–200,000. Procuring CCTV cameras for 50 traffic light intersections, EUR 350,000.	2–3 person-months	Operational traffic management and related systems. Contract law and system procurement.
4.3	Carrying out pilot projects and impact assessment, EUR 100,000.	2 person-months	Operational traffic management and related systems. Contract law and system procurement.

**) An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service (plans).*

5. Economic instruments

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
5.1	Planning intelligent road tolls	Plans and surveys	Participating in the preparation of the regional plan and surveys on intelligent road tolls in the Helsinki region.	Regionally HSL Kymp in Helsinki Other regional authorities
5.2	Extensive commissioning and pricing of distribution traffic parking ID	Traffic control, IT services	Based on a separate requirement analysis, expanding dedicated loading spaces and parking rights in kerbside parking spaces subject to a charge for distribution traffic vehicles (incl. passenger vehicles). Introducing a payment system in compliance with a separate plan.	Kymp
5.3	Planning and commissioning of progressive and dynamic kerbside parking	Implementation project	Planning and implementing progressive pricing of kerbside parking in compliance with the Helsinki Parking Policy (2013). At the planning stage, investigating the opportunity to dynamically change the tariff level based on a variety of factors.	Kymp

Schedule

Measure	*19*	2020	2021	2022	2023	2024
5.1 Planning intelligent road tolls		x	x	x		
5.2 Expanding distribution traffic parking ID	x	x	x			
5.3 Progressive pricing of kerbside parking		x				

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
5.1	An assessment of the costs of the planning of intelligent road tolls was not carried out in this connection.	Significant	Road toll systems, transport economics
5.2	Costs/profits were not assessed in this connection.	Moderate	Parking, data systems
5.3	Costs/profits were not assessed in this connection.	Moderate	Parking, payment systems

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service*

4.5 Automation to be included as part of the Helsinki transport system

6. Public transport system that utilises automation

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
6.1	Continuing with self-driving bus experiments	Pilot project	Monitoring previously started pilot projects and selecting new ones based on the goals and business feasibility, supporting the pilot projects by means of campaigns, physical and digital infrastructure and assessment studies.	Kymp, HSL, Forum Virium, Traficom

Schedule

Measure	*19*	2020	2021	2022	2023	2024
6.1 Continuing with self-driving bus experiments	···	▬	▬	▬		

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
6.1	Supporting self-driving bus experiments with campaigns, infrastructure measures and assessmen studies; campaigns and assessment studies total EUR 100,000, infrastructure measures EUR 100,000, pilot project support EUR 80,000.	2 person-months per year	Public transport, intelligent transport, data communications, infrastructure, communication, assessment study

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service.*

7. Physical and digital infrastructure for self-driving vehicles

Measures 2020–2024

No.	Measure	Type	Description of content	Responsible parties
7.1	Planning the physical and digital infrastructure required by self-driving vehicles	Plans and surveys	Investigating requirements set by the piloting parties and industry for the infrastructure and current status in the experiment areas, as well as preparing a detailed infrastructure and infrastructure implementation plan.	Kymp, HSL, Traficom, the Finnish Transport Infrastructure Agency, Uusimaa Centre for Economic Development, Transport and the Environment
7.2	Creating the physical infrastructure required for self-driving bus and taxi experiments	Implementation project	Implementing the physical infrastructure in the experiment areas (at least passenger waiting, pick-up and drop-off areas and safe places to stop).	Kymp, Stara, Uusimaa Centre for Economic Development, Transport and the Environment, HSL

Schedule

Measure	*19*	2020	2021	2022	2023	2024
7.1 Infrastructure required by self-driving vehicles: planning						
7.2 Physical infrastructure for self-driving bus/taxi experiments						

Cost estimate and required resources

No.	Investments/ operating costs [EUR]	Personnel resources *	Required competence
7.1	Infrastructure requirement analysis, surveying the existing infrastructure, basic planning of solutions and planning of the pilot project areas, EUR 100,000	2 person-months	Intelligent transport, public transport, data communications, infrastructure, planning
7.2	Implementing stops and safe stopping areas for self-driving buses/taxis in the pilot project areas; EUR 0.2–0.7 million per area, depending on the current status of the experiment area	3 person-months	Public transport, infrastructure, construction, maintenance, procurement

** An assessment of the city's own personnel resources required to prepare the plan and realise the procurement. These personnel resources are not related to the actual provision of the service.*

4.6 Summary of the operational programme

In this summary, the operational programme's costs have been divided into investment costs and operating costs. The latter include costs arising from surveys, plans, pilot projects and impact assessments. During the five years, the investment costs of the measures will be EUR 7.4 million, and costs counted as operating costs will be approximately EUR 1.2 million, i.e. the total costs will be EUR 8.6 million. The measures will require personnel resources of almost 1.5 person-years per year from the organisation of the city of Helsinki, but these personnel resources will be divided into several competence areas. Some of the personnel resources can be acquired as expert services. In addition, personnel resources for coordination of the implementation of the operational programme will be required. These resources are not included in the resources mentioned above.

The clear focus areas of the operational programme are the development of information (43% of costs) and the development of traffic management (35% of costs). Automation development projects account for approximately one-fifth of the operational programme's total costs. The table below provides a more detailed summary of the division of costs and personnel resources in the packages of measures. The table on the next page presents the annual cost estimates of the single measures (18 measures in total).

Table 4. Division of costs and personnel resources into the packages of measures in 2019–2024.

Package of measures	Investments (tEUR)	Operating costs (tEUR)	Total costs (tEUR)	Personnel resources (as person-months)
1. Developing the collection of traffic data	1,250	380	1,630	22
2. Developing situational awareness, monitoring and statistical awareness	2,000	180	2,180	12
3. Interactive and collaborative Traffic Management 2.0	1,500	123	1,623	10
4. Developing traffic light control	1,050	130	1,180	8
5. Economic instruments		150	150	16
6. Public transport system that utilises automation	100	180	280	10
7. Physical and digital infrastructure for self-driving vehicles	1,500	100	1,600	5
Total	**7,400**	**1,243**	**8,643**	**83**

Table 5. Summary of the annual costs of the measures.

	Investments (€ 1,000)					operating costs (€ 1,000)				
Contents	**19-20**	**21**	**22**	**23**	**24**	**19-20**	**21**	**22**	**23**	**24**
Specifying traffic data collection development requirements						100	20	20	20	20
Carrying out data collection pilot projects						100	25	25	25	25
Implementation and continuous development of data collection [1]	250	250	250	250	250					
Specifying development needs related to situational awareness, monitoring and statistical awareness						100	20	20	20	20
Developing tools		500	500	500	500					
Information costs total	**250**	**750**	**750**	**750**	**750**	**300**	**65**	**65**	**65**	**65**
Feasibility study on the management of collaborative and interactive traffic management						23				
More detailed planning and agreements							40	30	30	
Acquisition, implementation and commissioning of development projects					1500					
Including all traffic lights in the scope of remote monitoring		250	250							
Using traffic lights to collect traffic data [1]		275	275			30				
Monitoring the development of traffic light C-ITS and carrying out a pilot project									50	50
Planning intelligent road tolls [2]								50	50	50
Expanding the use of distribution traffic parking ID [2]										
Progressive pricing of kerbside parking										
Traffic management costs total	**0**	**525**	**525**	**0**	**1500**	**53**	**40**	**80**	**130**	**100**
Continuing with self-driving bus experiments	50	50				80	50	50		
Planning the physical and digital infrastructure required by self-driving vehicles						100				
Creating the physical infrastructure required for self-driving bus and taxi experiments	500	500	500							
Automation costs total	**550**	**550**	**500**	**0**	**0**	**180**	**50**	**50**	**0**	**0**
Measures programme total	**800**	**1825**	**1775**	**750**	**2250**	**533**	**155**	**195**	**195**	**165**

1 Maximum estimate of the cost range

2 Excluding implementation costs

It should be noted that some of the costs of the self-driving bus pilot projects are not included in the calculation above, because it only includes the estimated share of Kymp of the pilot project costs. Costs or profit from the implementation of the system have not been assessed at all in the case of the economic instruments.

Annually, costs included in the operating costs will be at their highest during the first years (2019–2020), when the planning stage of the packages of measures will be carried out. The estimated operating costs in 2019–2020 are some EUR 530,000. Correspondingly, most of the investment costs will be incurred in 2021–2024. Most of the city’s personnel resources will be required during the first years of the operational programme, when the plans are being prepared.

Table 6. Summary of the personnel resources required for the measures.

required own personnel resources (as person-months/person-years)					
Contents	**19-20**	**21**	**22**	**23**	**24**
Specifying traffic data collection development requirements	4				
Carrying out data collection pilot projects	2				
Implementation and continuous development of data collection [1]		4	4	4	4
Specifying development needs related to situational awareness, monitoring and statistical awareness	4				
Developing tools		2	2	2	2
Information costs total	**10**	**6**	**6**	**6**	**6**
Feasibility study on the management of collaborative and interactive traffic management	1				
More detailed planning and agreements		1	1	1	
Acquisition, implementation and commissioning of development projects					6
Including all traffic lights in the scope of remote monitoring	1	1	1		
Using traffic lights to collect traffic data [1]	1	1	1		
Monitoring the development of traffic light C-ITS and carrying out a pilot project				1	1
Planning intelligent road tolls [2]	2	2	2		
Expanding the use of distribution traffic parking ID [2]	4	2			
Progressive pricing of kerbside parking	4				
Traffic management costs total	**13**	**7**	**5**	**2**	**7**
Continuing with self-driving bus experiments	2	2	2	2	2
Planning the physical and digital infrastructure required by self-driving vehicles	2				
Creating the physical infrastructure required for self-driving bus and taxi experiments	1	1	1		
Automation costs total	**5**	**3**	**3**	**2**	**2**
Measures programme total	**28**	**16**	**14**	**10**	**15**

5 Impact assessment

In this work, the effects of the priority projects that support the intelligent transport vision are assessed based on their **impact mechanisms** and **impact potential**. The impact mechanisms are used to describe how the priority project is expected to influence the transport goals. The impact potential is used to describe the magnitude of the impact or the group being affected whenever possible. The traditional qualitative impact assessment methods of intelligent transport projects are thus supplemented by quantitative assessments where possible.

The impact assessment emphasises factors considered to have a key position in the achievement of positive effects.

The impact of the 2030 vision's four target areas are assessed:

- **Low-emission transport system:** Reduction of CO_2 emissions and health hazards
- **Functional transport system:** Mobility in everyday life, accessibility of centres, street space, efficient transport
- **Safe transport system:** No severe accidents, perceived safety
- **Vital city:** Generation and utilisation of data, transport services, intelligent transport ecosystem

Based on the mechanisms and the impact potential descriptions, the packages of measures are assessed in terms of the impact of each of the four target areas using the following scale:

Table 6. Impact potential assessment scale.

+++	Significantly promotes (almost) all the target area's concrete goals	**- - -**	Significant negative impact on (almost) all the goals
++	Significantly promotes some of the goals OR Somewhat promotes (almost) all the goals	**- -**	Significant negative impact on some goals OR Some negative impact on (almost) all the goals
+	Impact mostly in line with the goals, but minor	**-**	Impact mostly negative, but minor
0	No noteworthy impact/impact cannot be assessed		

It has been noted during the work that some of the packages of measures are **enabling** in nature. The enabling measures themselves have no direct impact on the vision's target areas (or the impact is fairly minor), but expecting positive development of intelligent transport without these measures is unrealistic. Such enabling measures have been assessed on the basis of what the measures are expected to achieve in the long run when the high-quality traffic data or real-time situational awareness is being utilised in the services of the different parties, for example.

The enabling measures include the following:

- Developing the collection of traffic data
- Developing situational awareness and monitoring and statistical awareness of traffic
- Planning of economic instruments
- Automation experiments

The positive impact of traffic automation assessed in this work can be achieved through the automation of public transport if the monetary savings achieved with automation are allocated to the development of the public transport system.

Table 7. Summary of the effectiveness of the packages of measures in the target areas.

IMPACT ON THE VISION 2030 GOALS:			
LOW-EMISSION TRANSPORT SYSTEM	**FUNCTIONAL TRANSPORT SYSTEM**	**SAFE TRANSPORT SYSTEM**	**VITAL CITY**
PACKAGE OF MEASURES: Comprehensive information through several channels 1) Developing the collection of traffic data 2) Developing situational awareness and monitoring and statistical awareness of traffic			
+ +	+ + +	+ +	+ + +
PACKAGE OF MEASURES: Effective traffic management 3) Interactive and collaborative Traffic Management 2.0			
+	+ + +	+ + +	+ + +
PACKAGE OF MEASURES: Effective traffic management 4) Developing traffic light control			
0	+ +	+ + +	+ +
PACKAGE OF MEASURES: Economic instruments Measure: Planning of intelligent road tolls. Preparation of the plan has no direct impact on the vision's goals. The impact of road tolls will be comprehensively assessed in connection with planning. Below is a rough estimate of the impact of a potential road toll implementation option on the target areas.			
+ + +	+ + +	+ +	+ +
PACKAGE OF MEASURES: Automation to be included as part of the Helsinki transport system 6) Public transport system that utilises automation (experiments) 7) Physical and digital infrastructure for self-driving vehicles (experiments) Based on the assessments made, an automated public transport system will have an especially significant positive impact on the achievement of a functional low-emission transport system and a lively city, provided that the savings achieved with automation are allocated to improving the service level of the public transport system and the related infrastructure. The impact on safety is also considered positive.			
+ + +	+ +	+ + +	+ + +

6 Conclusions

6.1 Organisation of the operational programme's implementation

The updated Helsinki Intelligent Transport System Development Programme has been prepared in cooperation with the parties participating in the implementation of the packages of measures, such as HSL and Forum Virium Helsinki. During the process, the most important and most effective goals were prioritised for the next five-year period based on a selection of methods prepared by a consultant. The estimated speed of change of the different development paths was also taken into account in the prioritisation.

For the operational programme to be implemented on schedule, the participants – the Helsinki City Urban Environment Division (Kymp) in particular – must commit themselves to the above-mentioned investments and the planning stage preceding the investments. Several packages of measures must be simultaneously launched. Although responsibility for implementation should be divided within Kymp among parties responsible for the different competence areas, focus on coordination of the operational programme as a whole is key to the programme's implementation. In practice, Kymp will require a full-time development programme coordinator who will be responsible for the organisation of the measures, monitor their implementation and report to the management.

The coordinator will need fairly extensive competencies to manage the packages of measures. Using experts from Forum Virium, for example, and expert support purchased from outside Kymp when launching the packages of measures may therefore be necessary. An assessment of the 2013 intelligent transport development programme that was prepared as part of this work stated that a key reason for the slowing down or failure of the measures presented in the development programme was insufficient resource allocation within the city organisation. The packages of measures in the updated programme are at least as extensive as those in the previous programme version, which means that sufficient planning and implementation resources, as well as personnel resources, must be allocated to the programme in the autumn of 2019 when creating the budget for the next year.

Thus far, the city of Helsinki has implemented intelligent transport projects as processes completed alongside other work duties. To ensure completion of the complex whole, Kymp should launch a project-type collaboration model in the development of intelligent transport. Such a model is already in use in the Jätkäsaari Mobility Lab project. In addition to the coordinator and possible support services, experts with the competencies required by the different projects must be allocated. They can be from different parts of the city organisation or from subsidiaries. At least the following special experts will be necessary:

- An expert in traffic monitoring and situational awareness (Kymp/external), 6 person-months per year

- An expert in traffic lights and traffic management (Kymp/external), 2 person-months per year

- An expert in transport automation (Kymp), 3 person-months per year (to monitor development in the market and prepare the pilot projects)

The operating model should be for those named for the above-mentioned competence areas to work one or two days per week promoting the packages of measures in accordance with the plan.

The implementation of the operational programme will be monitored and guided by an intelligent transport coordination team and a transport project steering group.

Three of the packages of measures include a variety of technical pilot projects, which must be implemented before the actual implementation stage. The following measures include such pilot projects:

- 1.2 Carrying out data collection pilot projects
- 4.3 Monitoring the development of traffic light C-ITS and carrying out a pilot project
- 6.1 Continuing with self-driving bus experiments

The pilot projects mentioned above will serve broader implementation of the packages of measures where the city's own role is significant or for which the city is responsible. The pilot projects are first and foremost technological tests to be carried out in an actual traffic environment and application tests with actual customers. They do not involve a direct question of commercial scalability. Commercial scalability does not therefore need to be separately assessed when preparing the pilot projects. Where applicable, solutions will be scaled by means of investments and procurement made by the city and other public sector parties (HSL). The pilot project implementation sites will be primarily selected from the intelligent transport development sites of the city of Helsinki, the Jätkäsaari Mobility Lab and Intelligent Kalasatama.

Of the identified pilot project needs, both the implementation of the data collection pilot projects and the traffic light C-ITS application pilot project are directly linked to Kymp's future system and equipment procurement, which means that the pilot projects will serve the technological choices to be made. Kymp will be responsible for these pilot projects. However, Forum Virium's expertise will be required in the preparation of the pilot projects. The pilot projects on continuing with the self-driving bus experiments must be carried out in close cooperation with businesses. Forum Virium Helsinki should be responsible for these pilot projects.

6.2 Monitoring and research

Chapter 3.2 of this report presents the transport system level indicators guiding the development of intelligent transport and the related indicators. The indicators will serve the monitoring of the transport system status and the monitoring of the development of intelligent transport and communications, which is why launching of the indicators is absolutely necessary to control the development of intelligent transport during the operational programme's implementation stage as well. The Helsinki intelligent transport coordinator is responsible for the organisation of the launch of the indicators. The indicator system is fairly extensive, and its implementation will require a more detailed plan on where to obtain the data required by the indicators and which unit of the city of Helsinki should calculate the results. A decentralised approach is probably best: one party should collect the results provided by the different units in an annual report and verify the continuity of time series.

The recommended approach to communication is for the city of Helsinki to start publishing an intelligent transport development review similar to the cycling review, which should include the following:

- Development of indicators linked to the intelligent transport goals

- Research data on service users and effects
- Positive user stories and examples
- Reviews of future pilot projects and new services
- Reviews of the progress of the development programme's priority projects

The intelligent transport review must be edited, and it must be a high-quality publication with a clear layout.

The servitization of transport is one of the key ongoing changes in the transport sector, and its potential impact on mobility habits and transport is significant. The development is mostly market-based. However, monitoring the development and generating data on the impact of servitization are absolutely necessary for the city of Helsinki to ensure that it can quickly react to the development in the appropriate manner whenever necessary. Key questions for the monitoring of the servitization of transport are:

- How does the number of registered users in different transport services develop?
- What are the users of the different transport services like and for what kind of trips do they use the services?
- What effects will the transport services have in relation to the concrete goals (environment, functionality, safety, vitality)?
- What obstacles to servitization have been detected?

A further measure is launching a servitization monitoring process for the city of Helsinki to collect data on selected major transport services in cooperation with the parties operating the services. The collection of impact study data can be realised in cooperation with academic institutions and research establishments, for example.

In addition to the development of services, the development of traffic automation is very fast at present, and its monitoring requires a fair amount of resources. Experts in different fields should monitor the progress of automation in their fields and the development of data communication technology, map data technology, positioning technology and related infrastructure that are requirements for all forms of automation. This will also require selective participation in international workgroups and forums.

To fully utilise the potential of the automatic bus experiments, investments in related assessment studies must be made. Here, the key research questions are:

- Does the automation application meet the users' expectations and needs?
- How does the service influence mobility habits, the use of mobility services and the selection of mode of transport? Does the service increase mobility? Does the service reduce the use of public transport? How does the service influence cycling and walking?
- How willing are the users to pay for the automation application or service?
- How do automation applications and services influence the users' traffic safety, occupational health and safety as well as perceived safety?

- How do automation applications influence the fluency of traffic and greenhouse gas emissions, and does the impact differ in different parts of the city (e.g. the city centre versus suburbs)?
- How does automation influence equality and accessibility?
- How economically effective for society are the services and applications – are investments in digital infrastructure and automation equipment worthwhile?

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Summary:

The goal was to create a new intelligent transport system (ITS) development programme for the city of Helsinki. The programme identified and defined ITS development trends and goals as well as their indicators. In addition, the program defined development projects and measures as well as the role of the City of Helsinki in the development of smart mobility. The development programme was extend until 2030, but the measures for 2020–2024 were planned and prioritised in more detail. Intelligent transport is the part of the transport system that connects transport system users to the system and its services.

The background to the development of the action plan was an assessment of the operating environment and technological development perspectives and the identification of key opportunities and risks to which the city should respond. It is essential to support the development of the rail network city.

The intelligent transport vision 2030 clarifies the target state and the key areas in which mobility and the transport system will be developed by means of intelligent transport in Helsinki in the 2020s. The measures required for the Helsinki ITS Development Programme have been investigated in four focus areas: traffic information, traffic management, transport services and transport automation. During the work, the focus areas were analysed from the perspective of traffic policy and regulation (requirements), projects and investments and the roles and operating models of the different parties involved. Monitoring and research needs were also considered. Seven sets of measures were selected from the range of measures outlined on the basis of the target status, to be implemented between 2020 and 2024.

During the five years, the investment costs of the measures will be EUR 7.4 million, and costs counted as operating costs will be approximately EUR 1.2 million, i.e. the total costs will be EUR 8.6 million. Personnel resources for coordination of the implementation of the operational programme will be required. The measures will require personnel resources of 7.5 person-years from the organisation of the city of Helsinki.

The effects of the priority projects that support the intelligent transport vision are assessed based on their impact mechanisms and impact potential. The impact mechanisms are used to describe how the priority project is expected to influence the transport goals. The impact potential is used to describe the magnitude of the impact or the group being affected whenever possible.

For the operational programme to be implemented, the participants – the Helsinki City Urban Environment Division (Kymp) in particular – must commit themselves to the investments and the planning stage preceding the investments. The programme must have a full-time coordinator responsible for organizing, monitoring and reporting on activities.

Keywords: intelligent transport system, vision 2030, transport system, real time data, traffic management, services, automation