Machine Translated by Google




# Intelligent Transport Systems (ITS)

**PhDr., Mgr., Martin Janda, DBA, DiS., DiS., OLJ.**

2026

Institute-of-Education

Machine Translated by Google

Intelligent transport systems (ITS) represent one of the most important directions of modern transport planning and management, because they allow the connection of technologies, data, processes and strategies to achieve more efficient, safer, more sustainable and more adaptive transport. The principles of ITS are based on the use of advanced information and communication technologies. technologies that allow monitoring the traffic situation in real time, analyzing behavior of traffic participants, predict the occurrence of traffic jams, accidents and crisis situations and optimize the use of transport infrastructure. ITS is a multidisciplinary field that combines transportation, informatics, electronics, telecommunications, data science, safety engineering and environmental aspects, creating a comprehensive system able to respond to dynamic changes in the transport environment and changing needs users.

The heart of intelligent transport systems is data collection and processing. Modern ITS use a wide range of data sources, including sensors located on roads, camera systems, traffic detectors, traffic lights with intelligent logic, GPS-equipped vehicles, mobile applications and other IoT devices. This data provides information on traffic density, vehicle speed, frequency of traffic incidents, behavior of road users, environmental parameters such as air quality and noise, as well as about the capacity and condition of the infrastructure. The collected data is then analyzed using advanced algorithms, machine learning and predictive models, which allows optimize transport processes and prevent problems before they occur.

One of the main principles of ITS is the management and optimization of traffic. Based on data in real time, intelligent systems can dynamically adjust traffic lights, redirect traffic based on current road load, recommend alternative routes to drivers and provide traffic information to the public via information panels, mobile applications or navigation systems. In this way there is an increase in traffic flow, a reduction in the risk of accidents, a reduction in emissions and an improvement overall quality of mobility.

Another key aspect of ITS is transport safety and crisis management. Systems they can monitor risky areas, detect potentially dangerous situations, for example, sudden traffic slowdowns, traffic jams or accidents, and actively react by warning road users, activating safety measures or

Machine Translated by Google

coordination of rescue services. ITS also allows for simulations of crisis situations scenarios, test measures before their implementation and evaluate the effectiveness of individual interventions.

The integration of ITS into urban, regional and national transport enables the interconnection of various modes of transport and supports multimodal mobility. This includes the coordination of road, railway, urban public transport, cycling infrastructure, pedestrian routes and shared mobility. Intelligent systems ensure that individual modes of transport work harmoniously, enable smooth transfers, optimize interchange capacities and increase comfort passengers. This not only improves transport efficiency, but also supports sustainable mobility and reduces environmental impacts.

Digitalization and the use of data platforms is another major trend in ITS. Cloud solutions, interoperable databases, advanced analytical tools and visualization platforms enable comprehensive monitoring of the transport system, scenario modeling, prediction of traffic flows and assessment of the economic, social and environmental impacts of individual measures. These tools enable not only operational traffic management, but also strategic planning, optimizing infrastructure investments and implementing new technologies, including autonomous vehicles and electric mobility.

Future ITS trends include the development of autonomous vehicles, intelligent fleets, adaptive transport infrastructure, use of big data and artificial intelligence for predictive modeling, integration of mobility as a service (MaaS) and the interconnection of transport systems with environmental and energy goals. ITS is also increasingly focused on sustainability, reducing emissions, supporting active mobility, recycling and optimizing energy efficiency transportation systems.

Overall, it can be said that intelligent transport systems represent complex, adaptive and a data-driven approach to transportation that enables efficient, safe, sustainable and flexible mobility. By combining modern technologies, sophisticated data collection and analysis, integration of multimodal transport, environmental and social aspects, predictive management and strategic planning, ITS creates modern transport systems that are capable of respond to changing conditions, minimize risks, optimize resource utilization, and increase the quality of life of residents and the efficiency of goods transport.

Machine Translated by Google

The history and development of intelligent transportation systems represents a gradual transformation transport from simple mechanical and manual control systems to modern, digitalized and data-oriented solutions that today enable efficient, safe and sustainable mobility. The origins of ITS can be traced back to the mid-20th century, when the first electric and automated traffic control systems began to be implemented, such as traffic lights with time cycle, signaling panels and simple traffic detectors operation. These elements represented the first step towards systematic monitoring and traffic regulation, with the main emphasis placed on increasing traffic flow and reducing risk of traffic accidents.

With the advent of computer technology in the 1960s and 1970s, the first computer-based controlled systems for traffic light control and a centralized traffic center, which enabled the coordination of individual intersections and the monitoring of traffic flows on a larger level. The 1980s saw the integration of data networks, telecommunications, and more advanced sensors, which allowed the introduction of dynamic information systems, the first forms of automated traffic management on highways and experimental use of predictive algorithms for traffic optimization.

In the 1990s and early 21st century, the development of ITS accelerated significantly with the advent of the Internet, GPS technology and mobile communication devices. The first integrated traffic systems were created information systems, navigation applications and central platforms for collection and analysis traffic data. ITS have begun to gain ground not only in road traffic management, but also in railway transport, urban public transport, logistics and multimodal transport systems. At this stage, there is an emphasis on the interoperability of systems, the interconnection of different modes of transport, predictive monitoring and adaptive traffic management.

The current development of ITS is characterized by massive digitalization, the use of big data, artificial intelligence, intelligence, Internet of Things (IoT) and autonomous technologies. Intelligent transport systems today they include sophisticated sensors, cameras, road signs with integrated sensors, intelligent traffic lights, vehicle tracking systems, interactive information panels and cloud platforms for real-time traffic data analysis. These technologies enable traffic load prediction, route optimization, capacity management, traffic jam prevention accidents, effective crisis management and support for multimodal transport.

Machine Translated by Google

The development of ITS is also closely linked to environmental and sustainable goals. Modern systems strives to minimize emissions, noise, energy consumption and promote active and environmentally friendly forms of transport, including walking, cycling and shared mobility. Future trends include autonomous and electric vehicles, integration of mobility as a service (MaaS), digital transport infrastructure twins, adaptive infrastructure, predictive modeling and smart integration of urban and regional transport networks.

Overall, it can be said that the history and development of ITS represents a continuous transformation of transport from simple mechanical devices to integrated, data-driven and adaptive systems that combine technological, environmental and social aspects of transport. This development enables more efficient, safer, more sustainable and more flexible operation transport systems and provides decision-makers and infrastructure managers with tools for strategic planning, operation optimization and long-term mobility development.

Sensors and data collection technologies in transportation represent a fundamental pillar modern intelligent transport systems and are a key tool for effective management, optimization, safety and sustainability of transport. Their importance lies primarily in in the ability to provide accurate, detailed and up-to-date information on traffic flows, behavior of transport participants, infrastructure capacity, environmental parameters and other relevant factors that enable the creation of predictive models, planning infrastructure and strategic decision-making. Sensors are now being used across the entire transport networks – from urban roads, highways, railways, ports and airports to intermodal hubs, combining various technologies for maximum coverage, accuracy and speed of acquisition give.

Basic types of sensors include induction loops and detectors placed directly in the surface. roadways that allow the detection of vehicle passage, measurement of their speed, direction of movement and traffic intensity in real time. Another group consists of radar and laser detectors movement, which provide detailed information about vehicle speed, distance, density traffic and enable the detection of accidents or other incidents. Camera systems, often equipped with artificial intelligence and computer image processing, they allow not only to monitor traffic flow, but also to analyze the behavior of traffic participants, identify violations, detect free parking spaces or monitor infrastructure usage. Environmental sensors are able to monitor air quality, noise levels, temperature, humidity and precipitation, which is important for

Machine Translated by Google

assessment of the environmental impact of transport, planning of sustainable measures and protection health of the population.

Mobile and vehicle sensors represent another key layer of data collection. Vehicles equipped GPS, telematics devices, accelerometers, gyroscopes and other sensors provide detailed information about the position, speed, acceleration, trajectory and behavior of drivers. Data from These devices allow you to analyze traffic flows on both a macroscopic and microscopic level. level, monitor the use of infrastructure and the efficiency of transport routes. Data from mobile applications and smartphones that provide information about pedestrian movements, cyclists and public transport users, travel preferences and mobility time patterns.

The Internet of Things (IoT) and the interconnection of sensors into large networks enable the emergence of complex intelligent transport platforms, where data is not only collected but also analyzed, visualized and used for predictive decision-making in real time. This connected architecture enables dynamic traffic light control, route optimization, redirection traffic during load, capacity monitoring, identification of critical sections and rapid response to traffic incidents. Data from individual sensors is integrated into central platforms and cloud solutions, where they are combined with historical records, meteorological data, public transport information and other relevant inputs, creating a robust a tool for simulations, scenario analyses and transport infrastructure planning.

Sensors and data technologies are essential for increasing traffic safety. They can detect accidents, crisis situations, capacity overflows, unusual slowdowns traffic or dangerous behavior of participants, thus enabling early warning, activation security measures and coordination of rescue services. Intelligent systems based on sensors, they also enable testing of crisis scenarios, predictive modeling risks and evaluating the effectiveness of preventive measures, which significantly contributes to prevention accidents, minimizing damage and protecting human lives.

Environmental and sustainable aspects of ITS are another key dimension of sensor usage. Monitoring of emissions, noise, energy consumption, road surface temperature and more ecological parameters allows to evaluate the impact of transport activities on the environment and implement measures that promote environmentally friendly forms of transport, such as electromobility, shared mobility, cycling or pedestrian transport. Sensors therefore not only contribute

Machine Translated by Google

to efficiency and safety, but also to the sustainable development of transport systems and strategic fulfillment of environmental goals.

Last but not least, sensors and collection technologies enable the support of predictive and adaptive traffic management. Based on continuous monitoring, it is possible to predict the emergence of traffic jams, plan preventive interventions, optimize capacities and flexibly respond to changes in the transport environment, for example, increased demand within seasonal fluctuations, crisis situations, accidents, closures or exceptional events. Sensors allow you to connect traffic models with real-world data, which provides more accurate, faster and more effective decision-making tools for infrastructure managers, transport planners and municipal governments.

Overall, sensors and data collection technologies form the basis of modern smart homes. transport systems and are essential for effective management, optimization, prediction and adaptation transport processes. They allow the integration of technological, environmental, safety and social aspects of transport, support multimodal connections, increase the quality of mobility, minimize risks, reduce environmental impacts and ensure long-term sustainability; and flexibility of transport systems. Thanks to them, ITS become complex, adaptive and data-driven controlled systems that allow planning, optimizing and safely managing traffic in in real time and prepare infrastructure for future challenges, including urbanization, technological progress, increasing mobility and climate change.

Communication technology and the Internet of Things (IoT) in intelligent transportation systems they represent the basic infrastructure that enables the interconnection of all elements of transport, sensors, vehicles, transport nodes and control centers into an integrated and dynamic system. These technologies ensure that information about traffic, infrastructure status, behavior traffic participants and environmental parameters are collected, transmitted, analyzed and used in real time, which enables adaptive management of traffic flows, route optimization, predictive monitoring and decision support. IoT in transportation includes a wide range of devices, from smart sensors, cameras, traffic lights and road signs, to vehicles equipped with GPS, telematics and communication modules, to mobile applications and shared mobility platforms.

Machine Translated by Google

Communication technologies include a wide range of options, from traditional wired and wireless networks, through fourth and fifth generation mobile networks (4G, 5G), to specialized transport communication protocols such as Dedicated Short Range Communication (DSRC), C-V2X (Cellular Vehicle-to-Everything) or Vehicle-to-Infrastructure (V2I) protocols and Vehicle-to-Vehicle (V2V) communication. These technologies allow vehicles, infrastructure and control centers communicated with each other, sharing data on location, speed, traffic congestion, accidents, closures and other important information. Thanks to this transport systems can be flexible, respond quickly to changes, prevent congestion, optimize traffic flow and increase the safety of road users.

IoT and communication technologies also enable the creation of smart transport hubs, where various modes of transport are connected, such as road, rail, urban public transport transport, cycling and walking routes. Data from these nodes is collected and analysed to ensure smooth connection and coordination between individual transport systems, minimized waiting times during transfers, optimized the capacity of transfer stations and improved the comfort and efficiency of transport.

Another key aspect is the use of IoT for predictive monitoring and crisis management. Sensors and communication devices enable the detection of accidents, capacity overruns, unusual slowdowns or infrastructure failures and provide early warning data, automated system responses and coordination of rescue services. Intelligent algorithms using data from IoT devices can perform simulations, traffic predictions loads, optimize operations and plan preventive measures, thereby increasing safety and smooth traffic flow.

IoT and communication technologies are also essential for the implementation of autonomous and electric vehicles, digital twins of transport infrastructure and modern systems Mobility as a Service (MaaS). These systems require the interconnection of vehicles, infrastructure and control platforms to operate efficiently, safely and sustainably. Thanks to IoT, they can vehicles are informed about the traffic situation, available parking spaces, options transfers or optimal routes, while the infrastructure can dynamically manage traffic lights, signaling, traffic junctions and capacity of roads or interchanges.

Machine Translated by Google

Overall, communication technologies and IoT form the backbone of modern intelligent transport systems. systems. They enable real-time data collection and analysis, support predictive and adaptive traffic management, integrate different modes of transport, increase safety, efficiency and comfort users and enable the implementation of sustainable, flexible and technologically advanced transport solutions that respond to current and future challenges of mobility, urbanization and environmental policies.

Traffic management and optimization is a key part of modern transport systems and intelligent transport systems (ITS), as it allows for increased traffic flow, minimize the risk of accidents, reduce emissions and improve comfort passenger and freight transport efficiency. This process involves a combination of technologies, algorithms, data collection, simulations and strategic decision-making to ensure that the transport network operated as efficiently as possible, both at the macroscopic level of entire cities and regions, as well as at the microscopic level of individual intersections, road sections or railway lines tracks.

Traffic management includes monitoring and analyzing traffic flows, identifying critical sections, detection of accidents and traffic incidents, prediction of traffic jams and evaluation capacity utilization of the infrastructure. Data for these processes are obtained through sensors, cameras, detectors, GPS devices, telematics systems and other IoT devices. Data analysis allows you to identify weak points, overloaded sections, peak times, problematic transfers between different modes of transport and other factors that negatively affect the smoothness and safety of traffic.

Traffic optimization includes the implementation of adaptive and dynamic control systems, such as intelligent traffic light control, traffic redirection on based on the current load, coordination of signaling systems between individual intersections, optimizing routes for public transport and trucks, and ensuring smoothness of transfers in multimodal transport hubs. An important part is also predictive control, where systems based on historical data, current measurements and models traffic flows predict the occurrence of traffic jams or crisis situations and automatically adjust the management traffic to prevent them.

Machine Translated by Google

Traffic management also includes safety aspects, where systems detect accidents, dangerous situations, capacity overflows and other incidents, and inform in real time traffic participants, coordinate rescue operations, activate warning signals and enable a quick response to problems that arise. Part of the optimization is also the integration environmental parameters, such as managing traffic to minimize emissions, noise and energy consumption, while also promoting environmentally friendly forms of transport, such as is electromobility, shared mobility, cycling and walking.

Advanced optimization methods include the use of machine learning algorithms, predictive models, traffic flow simulations and digital twins of transport infrastructure. These The tools enable not only operational transport management, but also strategic investment planning, evaluation of transport measures and simulation of the impacts of various scenarios, including crisis scenarios situations, closures, exceptional events or seasonal fluctuations. The result is a system able to respond adaptively to changing conditions, optimize the use of the transport network and increase the satisfaction of passengers and transport participants.

Overall, traffic management and optimization represents a comprehensive, data-driven and an adaptive approach to transportation that combines technology, data collection and analysis, predictive models, safety measures, environmental aspects and strategic planning. Thanks these principles make it possible to achieve efficient, safe, sustainable and flexible transport, which responds to the current and future needs of residents, companies and society as a whole. This access is essential for modern urban and regional transport systems, where it ensures coordination, optimization and predictive management of traffic flows across various modes of transport and multimodal nodes.

Predictive monitoring and analysis of traffic flows represents an advanced methodology in within the framework of intelligent transport systems (ITS), the aim of which is not only to monitor the current status transport, but also to predict its development, identify potential problems and optimize real-time traffic network management. This approach combines data collection, modeling, simulation and analytical tools to predict congestion, traffic incidents, capacity restrictions, impacts of lockdowns or crisis situations and enable timely decisions by transport planners, infrastructure managers and drivers.

Machine Translated by Google

Data for predictive monitoring is obtained from a wide range of sources, including sensors, cameras, motion detectors, GPS devices, vehicle telematics, mobile applications and IoT devices deployed in infrastructure and vehicles. These sources provide information on traffic intensity, vehicle speed, their routes, traffic density, frequency of stops, the behavior of traffic participants, the capacity of intersections and sections of roads or railway lines. Furthermore environmental data, such as air quality, noise, temperature and weather conditions that affect traffic and its safety.

Traffic flow analysis uses statistical methods, modeling, predictive algorithms and machine learning, which allows you to identify movement patterns, time peaks, problematic sections, traffic "bottlenecks" and risky locations. Based on these analyses traffic load predictions, traffic scenario simulations can be generated, evaluation of the impacts of planned infrastructure changes, closures or the introduction of new transport measures. Such predictions enable effective planning and optimization traffic flows, coordination between different modes of transport and adaptation of capacities and traffic management to current and future conditions.

Predictive monitoring is closely linked to adaptive traffic management. Intelligent traffic lights, dynamic traffic signs, navigation systems and central control platforms use predictive data to redirect traffic, optimize public transport routes, reducing waiting times at interchanges and minimizing supply delays, and logistics operations. In case of emergency situations such as accidents, closures, extreme weather weather or other crisis events, the system can predict the impact on the transport network and provides recommendations for crisis management, informs traffic participants and coordinates interventions rescue services.

Predictive analysis of traffic flows also contributes to environmental sustainability. Based on predictions, speed profiles can be optimized, traffic intensity can be controlled, and congestion and congestion, thereby reducing COÿ emissions, noise and fuel consumption. Integrating this data into transport policy planning and infrastructure development enables long-term sustainable transport development, supports multimodal connections and the efficient use of existing capacities.

Overall, predictive monitoring and analysis of traffic flows represents a combination of technology, data analytics, modeling and strategic management, which enables

Machine Translated by Google

anticipate traffic problems, optimize operations, increase safety and efficiency, minimize environmental impacts and promote sustainable and flexible mobility. This approach allows transport infrastructure managers, urban and regional transport planners and transport users to respond not only to the current situation, but also to future scenarios, thereby significantly increasing the ability of transport systems to adapt growing demand, urbanization and technological development.

Traffic safety and crisis management supported by intelligent traffic systems systems (ITS) is a key area that ensures the protection of lives, the minimization of infrastructure damage and optimizing response to transport emergencies. ITS provide tools for monitoring, prediction, early warning and coordination of interventions, which enables a quick and effective response to accidents, malfunctions, natural disasters or other crises situations, while also supporting the prevention of traffic incidents.

The basic component is a data collection system from transport infrastructure and vehicles, which includes sensors, cameras, radar and laser detectors, GPS tracking, vehicle telematics and IoT equipment. This data provides information on traffic flow, speed and density, location of incidents, capacity of roads and intersections, weather and environmental conditions conditions. Analysis of this data allows identifying risk areas, patterns accident rates, peak times, capacity overruns and other critical situations that may endanger the safety of road users.

ITS enables the implementation of adaptive and predictive control systems, for example dynamic traffic light regulation, automatic traffic rerouting, warning signals and informing road users about the risks involved. In the event of traffic accidents or In crisis situations, the system actively informs rescue services, control centers and participants traffic, optimizes emergency vehicle access, coordinates closures and diversions, and this minimizes response time and damage.

ITS-supported crisis management also includes predictive modeling of traffic flows and simulation of possible scenarios. Based on historical data, current measurements and traffic models can predict the impact of closures, outages, extreme weather or increased demand and prepare measures to ensure smooth and safe transport. This

Machine Translated by Google

includes evacuation planning, emergency route management, optimization of public transport use and coordination between different modes of transport.

Another dimension is the integration of environmental aspects and sustainability. ITS enable monitor the impact of transport on air, noise, energy consumption and emissions, and in managing crisis situations situation to optimize operations so as to minimize negative impacts on the environment environment. This is particularly important in transport planning in densely urbanized areas and in the long-term management of sustainable transport systems.

Overall, ITS-supported traffic safety and crisis management represents comprehensive, data-driven and adaptive approach to road user protection, prevention incidents and effective response to crisis situations. Thanks to the connection of technologies, data collection, With analytical tools and intelligent control, transportation systems can respond quickly, predictively and coordinated, increase safety, optimize operations and contribute to sustainable development of modern transport networks.

Integration of Intelligent Transport Systems (ITS) into urban and regional transport represents a fundamental step towards increasing the efficiency, safety and sustainability of transport networks and to improve the mobility of people and the logistics of goods. This process consists of connecting various modes of transport, including road, rail, urban public transport, cycling and walking transport, through technological solutions, data platforms and communication network so that traffic is coordinated, smooth, predictively controlled and adaptive to current conditions.

A key part of ITS integration is the collection and analysis of data from various sources, including sensors in infrastructure, cameras, GPS devices, vehicle telematics, mobile applications and IoT devices. This data provides information on traffic intensity, speed and vehicle routes, use of public transport, behaviour of pedestrians and cyclists, capacity of transport infrastructure, traffic incidents and environmental parameters. Based on this information traffic flows can be optimized, predictions of traffic jams and risks can be made more precise, and Real-time traffic management is effectively implemented.

ITS enables interconnection and coordination between different transport systems. For example traffic lights, dynamic traffic signs, intelligent interchanges, shared parking systems mobility and passenger information portals communicate with each other to optimize people's movement

Machine Translated by Google

and goods. Public transport can be prioritized in critical sections, which increases its reliability and attractiveness for passengers. Truck traffic can be directed to minimize traffic congestion in urban areas and ensure efficient connections to ports, railways or distribution centers.

Another aspect is the integration of predictive control and crisis management. ITS can detect accidents, capacity overruns, infrastructure failures or unusual traffic situation and, based on predictive models, propose measures to minimize impacts. This includes rerouting traffic, informing road users, activating security measures, coordination of rescue services and optimization of capacities in case of emergencies.

Environmental and sustainable aspects are also an important part of the integration of ITS into urban and regional transport. Thanks to the collection of data on emissions, noise, energy consumption and other environmental parameters, transport systems can be managed to minimize negative impacts on the environment. This supports the introduction of environmentally friendly forms transport, such as electromobility, cycling, walking and shared transport, while enables planning of a sustainable transport development strategy.

Overall, the integration of ITS into urban and regional transport allows for the creation of a connected, a data-driven and adaptive transportation system that increases safety, efficiency and comfort travel, minimizes environmental impacts, optimizes infrastructure use and supports multimodal transport connectivity. This approach is essential for modern cities and regions where there is a need to respond to increasing mobility, urbanization, technological progress and the need for sustainable development of transport systems.

Multimodal transport and intelligent transport systems (ITS) represent a modern approach to optimizing the mobility of people and goods, which connects various modes of transport - road, rail, urban public transport, air, sea, cycling and pedestrian – into an integrated, efficient and adaptive system. The goal of multimodal transport is to maximize transport efficiency, minimize the time and costs of both passengers and goods transport, reduce environmental impacts and increase user safety and comfort. ITS plays a key role here role, because they allow the connection of individual transport modes through

Machine Translated by Google

advanced communication technologies, data collection, predictive analytics and intelligent traffic flow management.

The basis of multimodal transport supported by ITS is the collection and analysis of data in real time. Sensors, cameras, in-vehicle telematics devices, GPS, mobile applications and IoT devices allow you to monitor the location, speed, occupancy and capacity of individual transport vehicles resources and interchanges. The data is then analyzed using predictive algorithms and traffic flow models, which allows not only current traffic optimization, but also long-term capacity planning, traffic load forecasting, identification critical nodes and potential risks.

ITS enable the coordination of individual transport modes in such a way as to minimize waiting time during transfers, the capacity of transfer stations has been optimized and ensured the smooth movement of passengers and goods across the transport network. For example, public transport can be synchronized with railway timetables, parks and shared micromobility systems, while ITS provide information to passengers about the fastest routes, availability parking spaces, arrival and departure times, alternative connections and any delays. In logistics, ITS allows for optimizing truck routing, coordinate multimodal transport between ports, rail and road and minimize time delivery and operating costs.

Predictive monitoring and modeling of traffic flows in a multimodal network not only allows operational management, but also strategic decision-making. ITS uses historical and current data, simulation tools, machine learning algorithms and digital twins of transport infrastructure to predict traffic jams, closures, crisis situations, seasonal fluctuations in demand or emergencies. This allows transport infrastructure managers and operators to transport to prepare measures in time for the smooth running of journeys, optimize capacities and minimize negative impacts on passengers and logistics operations.

Safety is another key element of ITS-supported multimodal transport. Systems detect accidents, overloads, critical situations, environmental risks and provide real-time timely warning to passengers and transport centers. At the same time, they coordinate the interventions of rescue services components, activate emergency signals, redirect traffic and optimize capacity individual nodes in order to minimize the risk of secondary accidents and delays.

Machine Translated by Google

Predictive algorithms enable not only response to current incidents, but also preventive traffic management, leading to increased safety and reduced costs associated with accidents and traffic disruptions.

Environmental sustainability is an integral part of multimodal transport supported by ITS. Route optimization, coordination between different transport modes and predictive control allow you to reduce energy consumption, COÿ emissions, noise and other negative impacts on the environment environment. ITS supports environmentally friendly forms of transport, for example electromobility, cycling, shared transport and walking mobility, and ensure that multimodal the network was sustainable in the long term.

Overall, the integration of ITS into multimodal transport creates a connected, adaptive and data-driven a controlled system that ensures smoothness, safety, efficiency, sustainability and comfort passengers and goods transport. This system enables not only operational management of transport in real-time, but also strategic planning, infrastructure optimization and prediction future development of traffic flows. Thanks to multimodal transport supported by ITS, it is possible effectively connect different modes of transport, maximize capacity utilization, minimize environmental impacts and respond to increasing mobility, urbanization and technological progress, creating a modern, sustainable and flexible transport network.

The digitalization of projects and the use of data platforms in the field of transport represent a fundamental a transformational step that enables effective planning, management and optimization of transport projects from the design phase to the operation and maintenance of the infrastructure. This approach combines modern information technologies, digital tools, analytical platforms and intelligent data collection systems to increase transparency, accuracy, speed of decision-making and resource efficiency. Project digitization involves the integration of different types of data, their analysis, visualization and sharing between individual stakeholders so that possible to respond predictively to risks, optimize schedules, minimize costs and increase the quality and safety of transport infrastructure.

Data forms the backbone of digital projects. In transport, it is collected from various sources, such as traffic sensors, GPS devices, cameras, vehicle telematics systems, IoT devices, drones, mobile applications and historical databases. This information covers the intensity traffic, vehicle speed and trajectory, public transport use, interchange capacity,

Machine Translated by Google

environmental parameters, safety incidents, quality of building materials, logistic flows and financial indicators of projects. Data collection is continuous and allows monitoring the current state of infrastructure, traffic and construction activities in real time.

Data platforms provide tools for integrating and analyzing these large and diverse data. They enable the connection of historical data, operational measurements and predictive models into one coherent system that supports decision-making. Advanced analytical tools, including machine learning algorithms, traffic flow simulations, infrastructure digital twins and predictive models, allow not only to detect patterns and weaknesses, but also simulate the impact of different scenarios, plan capacities, predict risks and optimize construction and logistics operation schedules.

Digitalization of projects also enables effective coordination between individual participants projects, including transport planners, construction companies, subcontractors, logistics, municipal authorities, investors and the public. Through centralized data platforms, it is possible to share current information about the status of projects, schedules, capacity utilization, costs, performance and safety indicators, which significantly improves transparency, predictive planning and communication between stakeholders.

Digitalization also supports effective risk management. Based on predictive analytics, identify potential technical, financial, legislative and environmental risks, prepare mitigation scenarios, optimize resources and minimize negative impacts. For crisis situations and emergencies can be simulated and used in real time provide recommendations for response, traffic redirection, activation of security measures measures or interventions by rescue services.

Furthermore, digitalization enables optimization of project costs and efficiency. Data analysis provides an accurate overview of material consumption, labor, machinery and transportation utilization resources, enabling efficient planning, waste minimization and predictive maintenance infrastructure. The digital twin of a project enables the visualization of the entire transportation system, simulation of traffic, construction activities and logistics, leading to faster decision-making, better quality of outputs and reduced risk of errors.

Machine Translated by Google

In the field of transport projects, digitalization also supports sustainability and environmental aspects. Predictive models and data analytics allow you to optimize transport routes, reduce emissions, noise and energy consumption, promote multimodal and environmentally friendly modes of transport such as electromobility, shared transport, cycling and walking mobility. Digitalization enables long-term monitoring and evaluation of environmental parameters and sustainable operation of transport infrastructure.

Overall, the digitalization of projects and the use of data platforms creates a comprehensive, integrated and adaptive approach to transport project management. It enables efficient collection, integration and data analysis, predictive planning, resource optimization, risk management, coordination stakeholders, ensuring safety, sustainability and high quality of outputs. This approach is essential for modern transport systems, where there is a need to respond to growing demand, urbanization, technological progress and the requirements of sustainable development. Digitalization is thus transforming the way transport projects are planned, implemented, monitored and evaluated, thus enabling the creation of effective, safe, predictive and sustainable transport environment.

Simulation tools and software for intelligent transportation systems (ITS) represent an essential part of modern transport planning, management and optimization, because they enable model, analyze and predict the behavior of transport networks in various scenarios and conditions. These tools allow not only to visualize the current traffic situation, but also perform experiments and simulations that would be costly, time-consuming in real operation challenging or dangerous. The use of simulation software includes the area of road, rail, urban and multimodal transport, while enabling the integration of data from different resources, predictive analysis, crisis scenarios, capacity planning and decision support in implementation of intelligent transport measures.

Simulation tools use different types of modeling that match the scope and purpose project. Macroscopic models focus on overall traffic flows, traffic density and capacity load of roads or railways. Mesoscopic models combine detailed and overall view, they analyze the behavior of vehicle groups and interactions between individual sections of the network. Microscopic models track individual traffic participants, their speed, acceleration, deceleration and interaction with the surroundings, which allows for very accurate predictions of traffic situations, accidents and delays. Simulations can also include agent models, where individual participants

Machine Translated by Google

transport have their own behavior, goals and reactions, which allows for realistic modeling
complex transport systems.

ITS software enables the integration of large amounts of data from various sources – traffic
sensors, cameras, GPS devices, vehicle telematics, IoT devices, mobile applications,
historical data and meteorological information. These data inputs are processed
analytical algorithms, machine learning and predictive models that allow you to detect
traffic patterns, identify critical nodes, predict traffic jams, analyze impacts
transport measures and evaluate the effectiveness of planned investments and interventions.

Simulation tools allow testing of different scenarios and traffic management strategies,
for example, optimizing public transport routes, adapting traffic lights to current traffic conditions
conditions, priority management for emergency vehicles, implementation of emission reduction measures and
noise, multimodal transport coordination and predictive capacity planning. In crisis situations
situations such as accidents, closures, extreme weather or excessive traffic congestion
networks, simulation models can provide real-time recommendations for minimizing
impact, optimizing evacuation, rerouting traffic and coordinating interventions.

Advanced software platforms often include digital twin capabilities that
represent a virtual replica of a transport network or infrastructure and allow testing of changes and
measures without risk to real traffic. The digital twin allows you to monitor traffic flows,
predict delays, evaluate the impact of new investments, optimize traffic management and
evaluate the effectiveness of implemented ITS solutions. This method increases the accuracy
decision-making, reduces the risk of errors and enables long-term planning and optimization
transportation systems.

The benefits of using simulation tools and software for ITS include increased efficiency,
safety and sustainability of transport, reduction of operating costs, minimization
environmental impacts, predictive traffic flow management and rapid response to crises
situation. They also support the integration of different modes of transport, coordination between urban and
regional transport, optimization of logistics operations and strategic development planning
infrastructure.

Overall, simulation tools and software for ITS represent a key tool
modern traffic planning and management, enable the use of complex data inputs,

Machine Translated by Google

predictive analysis, operation optimization, increased safety and efficiency, support sustainable transport and provide a robust platform for strategic and operational decision-making. Their implementation is essential for modern cities, regions and transport networks that face growing demand for mobility, urbanization and requirements for smart, safe and sustainable transport.

Sustainability, environmental impacts and intelligent transport systems (ITS) represent a complex and multidimensional area of modern transport that deals with the optimization movement of people and goods, minimizing negative impacts on the environment and maximizing efficiency of transport infrastructure. In the context of ITS, sustainability is not limited to ecological dimension, but also includes economic efficiency, social benefits and the long-term viability of transport systems, which is key to the development of modern cities, regions and national transport networks.

ITS enables the collection, integration and analysis of large data sets that provide detailed information on traffic flows, use of individual modes of transport, consumption energy, emissions from motor vehicles, noise and other environmental indicators. Sensors, cameras, telematics systems, IoT devices, GPS and mobile applications provide real-time data that can be used for monitoring and managing transport networks in such a way as to minimize environmental impacts. These technologies allow the identification of critical sections where there is an accumulation of emissions, noise or infrastructure congestion, and apply measures to reduce negative impacts on the environment and the health of residents.

Predictive models and simulations of traffic flows play a key role in assessing impacts individual transport measures from a sustainability perspective. Using historical data, sensor measurements and machine learning algorithms can simulate various transport scenarios, for example, introducing low-emission zones, optimizing public transport routes, rerouting freight transport outside urban centers or the implementation of multimodal systems including pedestrian and bicycle traffic. This allows transport planners and managers infrastructure to predict the impacts of decisions on air quality, energy intensity, noise and emission balance.

Energy efficiency is another key aspect of sustainability in ITS. Intelligent transport systems allow for the optimization of traffic flows so as to minimize

Machine Translated by Google

fuel consumption, reducing COÿ and other greenhouse gas emissions and increasing efficiency utilization of transport infrastructure. Adaptive traffic light control, dynamic rerouting transport, predictive capacity management and an intelligent shared mobility system contribute to smoother operation and thus lower energy consumption.

The integration of multimodal transport systems promotes sustainability through a combination of public transport, cycling, walking and shared transport. ITS enable coordinate transfers, optimize capacity and synchronize schedules between individual transport modes, which reduces the need for individual car transport and thus the overall environmental burden. In logistics, ITS support efficient route planning trucks, use of rail, shipping and multimodal storage and distribution centers to minimize empty shipments, reduce emissions and reduced operating costs.

ITS also enable effective monitoring and evaluation of environmental impacts transport measures. Thanks to data platforms and analytical tools, the quality of air quality, noise, energy consumption, emissions and other indicators in real time and create dynamic reports and visualizations. This allows transport managers and city authorities make informed decisions, evaluate the effectiveness of measures, identify risk areas and optimize long-term strategies for sustainable transport development.

The predictive and adaptive nature of ITS allows it to respond not only to current traffic situation, but also to climate and environmental challenges such as extreme weather, air pollution or the burden on urban centers due to population growth and urbanization. Intelligent monitoring systems can actively regulate traffic, recommend alternative routes, activate low-emission zones and predict the impact of seasonal or impact of traffic peaks on environmental parameters.

Long-term sustainability is supported by the integration of ITS into transport planning and operation infrastructure. Predictive maintenance of bridges, roads and rail systems, optimization energy consumption of lighting, signaling and communication devices, and effective management transport capacities extend the life of the infrastructure, reduce repair costs and at the same time minimize environmental impacts associated with construction activities and operations transport networks.

Machine Translated by Google

The social dimension of sustainability is also crucial. ITS allows for increased comfort and passenger safety, minimize delays, inform about alternative routes, capacities and availability of transport means, thereby promoting inclusive and accessible transport. Transparent reporting and visualization of environmental and operational data strengthens public trust, supports citizen participation in decision-making and enables better integration of transport and urban strategies.

Overall, the connection of ITS with sustainability and environmental aspects brings a comprehensive, data-driven and adaptive approach to traffic management. It allows to minimize negative environmental impacts, optimize infrastructure use, increase safety and passenger comfort, promote multimodal and environmentally friendly modes of transport and to create a long-term sustainable and intelligent transport network. ITS implementation in the context sustainability is becoming a key part of modern transport policy, a strategic planning and development of urban and regional transport systems, which allows responding to increasing mobility, urbanization, technological progress and environmental challenges of the contemporary world.

Autonomous and electric vehicles represent a fundamental innovation in the field of intelligent transport systems (ITS) and their integration into modern mobility brings a wide range of technological, environmental, economic and social impacts. These vehicles are not just a new form of transportation, but function as an active part of interconnected digital transport networks that use real-time data, communication between vehicles and infrastructure (V2I), between vehicles and each other (V2V), and advanced algorithms for predictive traffic management and route optimization. Autonomous vehicles, equipped with sensors, cameras, LiDAR, radars and artificial intelligence, are capable of real-time analyze the traffic situation, evaluate risks, predict the behavior of other participants traffic and make decisions that increase safety, traffic flow and efficiency transport infrastructure.

Electric vehicles represent an environmentally friendly alternative to traditional combustion engines, because they significantly reduce emissions of COÿ, NOx and other harmful substances, noise and fossil fuel consumption. The integration of electric vehicles into ITS allows their optimized coordination, such as predictive planning of charging cycles, optimization of routes in terms of availability of charging infrastructure and efficient use of batteries,

Machine Translated by Google

thereby maximizing their operational efficiency and minimizing environmental impact. ITS
It also allows you to monitor battery status, predict maintenance needs and optimize
lifespan of electric vehicles, contributing to long-term sustainability and reducing
operating costs.

Autonomous vehicles in conjunction with ITS significantly affect traffic safety. Advanced
algorithms can detect and prevent potential collisions, analyze behavior
other traffic participants and coordinate driving with other autonomous and conventional vehicles
vehicles. Thanks to V2V and V2I communication, autonomous vehicles can respond to traffic jams,
accidents, closures and emergency situations much faster than a human driver, reducing the risk
secondary accidents, minimize traffic delays and increase the smoothness of traffic flows.

The integration of autonomous and electric vehicles into ITS also supports multimodality
transport and shared mobility. Vehicles can be part of shared transport systems,
autonomous taxis, shuttle services or connected to public transport, which allows
optimize transfers, minimize individual car traffic and support
sustainable forms of mobility. Thanks to data platforms, users can
obtain information about vehicle availability, estimated time of arrival, capacity and
route efficiency, thereby increasing comfort, safety and environmental benefits of the entire
system.

Electric and autonomous vehicles also enable predictive traffic planning
infrastructure. Analysis of traffic flows, energy needs, charging station capacities
and frequency of vehicle use allows you to optimize infrastructure investments, predict
loads on roads, parking spaces and interchanges, and ensure long-term sustainability and
efficiency of the transport system. Digital twins of transport networks and simulation tools
allow testing the introduction of autonomous and electric vehicles in different scenarios,
analyze their impacts on traffic flow, environmental parameters, safety and
economy without having to interfere with real operations.

The social and economic impacts of autonomous and electric vehicles are also significant.
ITS enable optimization of transport costs, reduce the need for human driving,
minimize traffic congestion and improve mobility accessibility for different population groups,
including seniors, people with reduced mobility or residents of peripheral areas. Effective management

Machine Translated by Google

electric and autonomous vehicles contributes to lower operating costs, smaller environmental burden, higher passenger satisfaction and improved quality of life in cities and regions.

Overall, the connection of autonomous and electric vehicles with intelligent transport systems systems create a data-driven, predictive and adaptive transportation ecosystem that optimizes the use of infrastructure, increases the safety and smoothness of traffic, minimizes environmental impacts, supports multimodal and sustainable mobility and enables effective strategic and operational traffic management. The implementation of these technologies is crucial for future cities, regions and national transport networks that must respond to growing demand for mobility, urbanization, technological development, environmental challenges and the need for sustainable, safe and intelligent transport. The integration of autonomous and electric vehicles into ITS not only transforms the way people travel and goods are transported transports, but also redefines strategic planning, infrastructure management, security protocols and environmental policies of modern transport systems, thereby creating the basis for the intelligent, sustainable and adaptive mobility of the future.

The evaluation of the effectiveness of intelligent transport systems (ITS) projects represents a key part of planning, implementing and optimizing transport networks, as allows you to quantify the benefits achieved, identify weaknesses, optimize use resources and support decisions about future investments. Effective evaluation requires a comprehensive approach that includes a combination of quantitative and qualitative methods, use of key performance indicators (KPIs), economic and social analysis (including Cost-Benefit Analysis – CBA), environmental indicators and monitoring of user experiences.

KPIs represent a basic tool for measuring the performance of ITS projects and allow you to monitor: whether the project objectives are met in terms of transport efficiency, safety, sustainability, user satisfaction and economic return. Typical KPIs include, for example, reduction traffic congestion and delays, shortening travel times, reducing the number of accidents and their severity, saving energy and emissions, using multimodal transport, adhering to schedules and budgets, and the level of satisfaction of passengers and logistics operators. KPIs are defined on based on the strategic objectives of the project and their evaluation is ongoing even after completion

Machine Translated by Google

implementing ITS to enable predictive and adaptive optimizations
system.

Economic evaluation of ITS projects often includes Cost-Benefit Analysis (CBA), which
allows to calculate the ratio between the costs of implementing and operating the system and the benefits that
the project brings. The benefits can be direct, such as reduced operating costs,
more efficient use of infrastructure and means of transport, or indirect, for example
reduction of emissions, increase in population productivity, improvement in quality of life, reduction of economic
losses caused by congestion and accidents or supporting the sustainable development of cities and regions.
CBA also includes sensitivity analysis and scenario studies that allow for the assessment of
impacts of different ITS implementation options and identify risks associated with deviations from
expected results.

For a comprehensive assessment of the effectiveness of ITS projects, it is necessary to include environmental and
sustainable aspects. Indicators such as reduction of COÿ and NOx emissions, energy efficiency, etc. are monitored.
consumption, noise, use of renewable resources and impact on air quality and the environment
around the transport network. Predictive models and simulations allow analyzing the impact of ITS
measures on environmental parameters before their implementation and at the same time monitor
their real impact after the system is implemented, thus ensuring long-term sustainability
transportation projects.

Social aspects of the evaluation include measuring user satisfaction, safety and
transport accessibility. ITS projects often contribute to better coordination of public transport,
shorten waiting times, increase travel comfort and support affordable mobility for various
population groups, including seniors and people with reduced mobility. Satisfaction surveys,
Feedback analysis and user behavior monitoring are therefore an integral part
evaluation and provide valuable information for the optimization and further development of ITS.

Advanced data platforms and analytical tools allow you to collect and evaluate
huge amounts of data from the transport network, vehicles, sensors, cameras, mobile applications and
other sources, allowing you to measure KPIs in real time and perform dynamic CBAs. Thanks to
This makes it possible to identify weak points, predict problems, optimize traffic
flows, plan investments and respond adaptively to changes in demand, weather or crisis situations
situations. Digital twins of transport systems then allow for the simulation of various scenarios

Machine Translated by Google

and evaluate their impact on efficiency, costs, safety and environmental parameters, which brings accurate and predictive decision-making tools.

Another critical aspect of evaluating ITS effectiveness is the ability to integrate projects into broader transport policy and urban planning strategies. ITS projects are not isolated interventions, but part of a complex mobility system that includes multimodal transport, logistics, energy and environmental policy. Evaluation efficiency therefore also includes an assessment of synergistic effects, interoperability of systems, integration with urban and regional plans and the ability to respond to future challenges, such as are autonomous and electric vehicles, smart mobility, demographic changes or climate impacts.

Overall, the evaluation of the effectiveness of ITS projects represents a combination of quantitative and qualitative approaches, predictive and scenario analyses, KPI measurement, CBA, environmental and social indicators and the use of modern data platforms and simulation tools. This comprehensive approach allows not only to objectively assess achieved benefits, but also identify areas for improvement, optimize the use of resources, minimize risks, promote sustainability and ensure that ITS projects deliver long-term value for users, infrastructure managers, cities and regions. Evaluation efficiency thus becomes an integral part of the entire life cycle of ITS projects – from planning, through implementation and operation, to review, adaptation and optimization of systems, thus enabling the creation of intelligent, safe, efficient and sustainable transport networks future.

Future trends and innovations in the field of intelligent transport systems (ITS) represent a key factor in the transformation of mobility in cities, regions and at national levels, because they allow us to combine technological progress, sustainability, safety, efficiency and user comfort. With the rapid development of digitalization, the Internet of Things (IoT), artificial intelligence, machine learning, big data, autonomous vehicles, electric mobility, smart infrastructure and cloud data platforms, ITS is becoming increasingly sophisticated, an interconnected and adaptive ecosystem that responds to the complex demands of modern transport and mobility.

Machine Translated by Google

One of the main trends is the full integration of autonomous and electric vehicles into transport infrastructure. These vehicles communicate with each other and with the transport infrastructure, which enables predictive traffic flow management, congestion minimization, optimization energy consumption and emission reduction. In combination with digital twins of the transport network, simulate different transport scenarios, evaluate the impacts of new technologies and optimize operation without the need to intervene in real traffic. Autonomous vehicles bring also significant safety benefits, because they reduce human errors, predict risky situations and coordinate movement between individual transport participants.

Another significant trend is the development of predictive and adaptive traffic management based on big data analysis. Modern ITS platforms collect huge amounts of data from traffic sensors, cameras, telematics, mobile applications, GPS devices, IoT sensors and meteorological stations. This information allows us to create predictive models traffic flows, optimize signaling, reroute vehicles, identify critical sections and minimize the impacts of accidents, closures or extreme weather. Big data analytics and artificial intelligence allows not only to react to the current situation, but also to plan long-term infrastructure, increasing network capacity and efficiency and supporting sustainable and multimodal transport.

Digitalization and data platforms are becoming the basis for interoperability of transport systems. systems. Smart applications, mobile platforms, cloud solutions and open data interfaces enable the integration of various modes of transport – urban, regional, rail, road, cycling and walking. This integration supports multimodal mobility, efficient transfers, shared transportation and optimized logistics operations. Users get information in real-time information about the availability of transport means, capacity, estimated time range and environmental impact, which increases comfort and supports a sustainable way of transport.

In the area of infrastructure, significant innovations are taking place in the form of smart roads, bridges, tunnels and signaling devices equipped with sensors and communication technologies. These elements enable predictive maintenance, load monitoring, and material condition monitoring. and adaptive traffic management. For example, smart traffic lights and dynamic traffic signs can automatically adjust timing based on current traffic, reducing traffic

Machine Translated by Google

congestion and emissions, reduce travel times and increase safety. In combination with autonomous vehicles and with electric mobility, infrastructure becomes an active part of the transport ecosystem.

Another trend is the development of digital twins of urban and regional transport systems. networks that allow you to simulate traffic flow, predict the impacts of construction interventions, introduction of new routes, change of public transport modes, or implementation of new ITS measures. The digital twin allows for experimentation with scenarios such as the introduction of low-emission zones, logistics optimization, integration of shared mobility, or the introduction of new autonomous lines without disrupting real traffic, thereby reducing costs and risk of ineffective decisions.

The intensive development of artificial intelligence and machine learning enables autonomous adaptation transport systems. ITS systems can analyze the behavior of traffic participants, identify load patterns, predict peak traffic times, optimize multimodal transport layout and provide recommendations for strategic and operational Intelligent algorithms also enable adaptive management of supply and logistics routes, optimization of public transport capacity, prediction of demand for shared vehicles and reducing the impacts of extreme events on transport.

Sustainability and environmental impacts remain at the forefront of ITS innovation. Intelligent systems contribute to reducing COÿ, NOx and PM2.5 emissions, optimize energy consumption, support the use of electric and low-emission vehicles, support multimodal transport and minimize the burden on city centers. Predictive traffic management, adaptive traffic lights, intelligent logistics and route optimization allow to reduce travel times, reduce traffic congestion and increase the energy efficiency of the entire transport network.

Last but not least, future trends focus on connecting ITS with other technologies smart cities, such as smart energy, environmental monitoring, mobile services, healthcare and urban planning. An integrated approach enables comprehensive management mobility, increases the quality of life of residents, improves the availability of services, supports public participation and enables long-term sustainable development of cities and regions.

Overall, future trends and innovations in ITS represent a combination of autonomous mobility, electric vehicles, digitalization, big data, artificial intelligence, multimodal integration, smart infrastructure, predictive and adaptive traffic management, digital

Machine Translated by Google

twinning and sustainability. These trends enable the creation of smart, safe, efficient and sustainable transport systems that are able to respond to growing mobility, urbanization, technological progress and environmental challenges of the 21st century, while at the same time ensure the optimization of infrastructure, reduction of negative impacts on the environment and improving the quality of life of residents of cities and regions.

The course Intelligent Transport Systems (ITS) provides a comprehensive view of current and future technologies, processes and strategies that transform mobility in cities, regions and at the national level. Students were introduced to the principles of ITS, the history of their development, modern communication technologies, sensors, digitalization and data platforms, predictive traffic management, traffic safety, multimodal integration and environmental aspects. Emphasis was placed on connecting theory with practice, using simulation tools, project effectiveness assessment through KPI and CBA, and identifying future trends and innovations, including autonomous and electric vehicles, smart infrastructure and artificial intelligence.

Graduates of this course have gained the ability to understand complex transport ecosystems, analyze traffic flows, plan and optimize transport networks, evaluate economic, social and environmental impacts of ITS projects, and effectively integrate new technologies into real transport systems. The subject also supports strategic thinking, the ability to adapt to technological changes and orientation towards sustainable mobility, which enables graduates to actively contribute to the development of intelligent, safe, efficient and environmentally responsible transport.

Overall, the course creates a solid foundation for understanding current and future developments transport, prepares students for strategic and operational decision-making in the field of ITS and provides the tools and knowledge needed to implement innovative transport solutions, which reflect modern technological, economic and environmental requirements. Students leave with comprehensive knowledge of ITS, the ability to analyze traffic problems comprehensively and competently manage projects that support safe, efficient and sustainable mobility for 21st century societies.