Twenty Years of ITS in the Czech Republic – Standards and Practice

https://standardland.cz/wrc23-en

XXVII[TH] WORLD ROAD CONGRESS PRAGUE 2023

wrc2023prague.org

Introduction by the Minister of Transport

The name of the *Transport Telematics* field often remains less than comprehensible to ordinary users. Even the currently used term *Intelligent Transport Systems* (ITS) does not evoke particular ideas due to its generality. However, upon closer acquaintance with individual applications, users will be surprised to discover the variety and breadth of this field. Every driver is familiar with the highway's visible electronic toll system gates. However, it's only the professionals behind the wheels of trucks who know and utilize the specialized "boxes" (On-Board Units), enabling both communication and functionality of the entire payment system. In financial terms, this system currently generates 15 billion CZK annually for the operation, maintenance, and development of transportation infrastructure in the Czech Republic. It also enables economic efficiency by using one of the ITS applications. The same applies to the *Electronic Highway Vignette* project, which has been functioning in the Czech Republic since the end of 2020. Many other systems and applications are presented in this publication, covering a range of topics from traffic control to the functionality of emergency eCall buttons in automobiles and motorcycles.

The strength of all economic prosperity stems from education and the highest level of schooling. I am pleased that Professor Ondřej Přibyl, Dean of the *Faculty of Transportation Sciences* at the Czech Technical University, continues in his father's legacy, Professor Pavel Přibyl, the doyen of Czech transport telematics. The Faculty of Transportation is a strong player both in education and in several top projects developed based on European cooperation, as evidenced by profiles of several faculty members in this publication.

This publication commemorating the 20th anniversary of the *National Mirror Committee 136 – Transport Telematics* (NMC 136) showcases, through the personal profiles of its members, the true wealth of any economy – both top experts and professionals. Over twenty years, thanks to the longstanding involvement of most NMC 136 members in European and international standardization, a solid foundational generation has been formed for the field. Their overview of professional activities is impressive and results in positioning the Czech Republic among advanced European states. The significant focus on safety and tunnel management through telematics applications, found in the likes of the Blanka Tunnel and the entire Prague Ring Road, underscores a high level of advancement in the field, even compared with European leaders.

I am delighted to present an exceptional project, carried out by NMC 136, contributing to European and international standardization, the StandardLand. Within the StandardLand project, a unique information system regarding standards has been developed, embodying EU Regulation No. 1025/2012 on European standardization. A format called Extract provides information in a precise structure and scope of around 4 pages that detail the content of each standard. Extracts are publicly available and, through a search system, allow users to gain necessary insights into existing standards in the field. These Extracts comprehensibly convey the content of the standard from English originals to Czech, intending to reach a broad audience. While the database of 450 processed ITS standard extracts in Czech may be unintelligible to foreign specialists, the central idea of the Extract, which we wish to share with the world in this way, is straightforward. Imagine that every processor of European or international standards EN, ISO is tasked with submitting an extract alongside the standard, a tightly structured synopsis of its content. This can be accomplished without incurring any additional costs. Gradually, a system will emerge whose informational value, freely accessible to users on the web, will be far greater than what is currently available. Let us not forget that technical standards are still covered by copyright, and their use and purchase entail fees. An information system about standards used within CEN and ISO, based on standard extracts, would comply with EU Regulation No. 1025/2012 and be free. This is one of the significant contributions of the work of *NMC 136 – Transport Telematics*, which we offer to Europe and the world as hosts of the *27th World Road Congress*.

The work of *NMC 136 – Transport Telematics*, evidenced by its representatives, has been awarded the highest honors in technical standardization on home soil. The 2017 *Vladimír List Award* for significant lifelong contributions to the development of technical standardization in the field of Transport Telematics was awarded to the aforementioned founder of the field, Professor Ing. Pavel Přibyl, CSc. The 2007 *Vladimír List Certificate of Merit* was awarded to Ing. Karel Urban, an employee of the Ministry of Transport of the Czech Republic. I am, therefore, genuinely pleased that the long-standing support of *NMC 136*'s work and projects by the Ministry of Transport are bearing fruit in this professional symbiosis of *NMC 136* members and their exemplary teamwork.

I wish you many successes in the years to come.

Mgr. Martin Kupka
Minister of Transport, Czech Republic

Foreword by the Dean of Faculty of Transportation Sciences, Czech Technical University in Prague

National Mirror Committee 136 – Transport Telematics is an integral part of the standardization process, focused on adopting international standards into the context of the Czech Republic.

Experts from this committee actively participate in creating and reviewing standards within this field in international working groups of the ISO/TC 204 and CEN/TC 278 technical committees.

They represent the Czech Republic in providing input on proposed versions of standards. The high degree of expertise of these professionals from the Czech Republic thus reflects in quality outputs incorporated into Czech legislation and, in some cases, translated into the Czech language.

The work of this expert team also includes the development of encyclopedic tools for public education in the field of ITS (Intelligent Transportation Systems), tools for systematic work with the content of norms, as well as maintenance of up-to-date technical terminology in relation to standards, as it continuously evolves due to new technologies.

This approach is unique even within Europe. Over the past 20 years, there has been a significant shift in the advancement of techniques and technologies, which becomes evident in the demands of transport telematics. The focus now emphasizes defining functions, open interfaces, and practical applicability. This progress is even captured at the level of standardization by the corresponding development of normative documents.

NMC 136 also reflects this ongoing evolution, directing its approaches and ideas toward innovative methods such as the introduction of the ITS Czech terminology dictionary, utilization of ontologies for term and standard organization, as well as the application of standard extracts. This allows an even broader Czech audience to navigate complex standards that may not always be available in the Czech language.

Last, but not least, I am pleased that among the experts contributing to this vital work are colleagues from the Faculty of Transportation Sciences at the Czech Technical University. In collaboration with other ITS specialists and experts, they take part in creating regulations aimed at significantly advancing transport telematics, not only in the Czech Republic but throughout the European Union, leading to greater prosperity and the sustainability of transportation.

This collaboration among experts from various organizations and diverse backgrounds is also crucial from the perspective of the Czech Republic, enhancing its overall competitiveness. Only through such efforts can we truly move forward in such a significant field as transport telematics.

Prof. Ing. Ondřej Přibyl, Ph.D.
Dean of the Faculty of Transportation Sciences, Czech Technical University in Prague

Uses of Standardization in Research and Education

The general benefit of standardization is evident—it serves as a critical element in the preparation, design, solution, implementation, and evaluation of technical and technological activities. New approaches are being introduced within the *National Mirror Committee NMC 136 – Transport Telematics*. This work extends beyond the mere adaptation of standards, their revision, or translation. Instead, it is an ongoing procedural activity encompassing crucial elements that can be further leveraged in education and applied in both higher education and research. Experts and specialists within the committee are dedicated to standardization issues and are employed at universities or other research institutions. In the case of the private sector, they frequently contribute to developmental activities within companies.

ITS standardization extends across the entire spectrum of the field, from administrative tasks, through project design and approval, to implementation, administration, as well as inspectors and controllers of investors who require the norms. For swift and effective familiarity with ITS matters, the public is not only provided with the standards themselves but, thanks to the efforts of *NMC 136*, the standards are supplemented with reference information called extracts. These extracts significantly aid orientation within this field, serving contracting authorities, educating the broader public audience, as well as students working on academic papers. In fact, these outputs are even usable at high schools, given their comprehensible format.

Any expert or student will also appreciate the opportunity to make use of another output of *NMC 136's* work, the freely available ITS Terminology dictionary at https://itsterminology.org, along with an interactive web search that is considerably more user-friendly thanks to the StandardLand project at https://www.standardland.cz. Standards created within the ISO/TC 204 and CEN/TC 278 committees are occasionally challenging to understand, even for some experts in the ITS field. The form of Extracts, along with the ITS Terminology dictionary, present standards in the Czech language, making their use and application apparent and thus supporting development in transport telematics within the Czech Republic. This approach is also exemplary within the EU and globally, considerably contributing to clarity and applicability within legislation.

These experiences and knowledge are reflected in teaching various subjects at the Faculty of Transportation Sciences, Czech Technical University in Prague. Some experts from *NMC 136* are faculty staff members directly engaged in both scientific and pedagogical roles. With respect to the individual ISO, as well as CEN working groups in the ITS field, this knowledge echoes in subjects such as Safety and Reliability of ITS Systems, Localization and Navigation, Telematic Systems and their Design, Vehicles in ITS, Interactive Simulation and Simulators, as well as Electronic Systems of Modern Vehicles and other specialized subjects taught in both Czech and English languages.

Naturally, insights from research, verification, and experiences gained at the Faculty of Transportation Sciences at the Czech Technical University also flow back into standardization efforts, ensuring that proposed versions of standards align with practical use. Feedback from students, as well as their understanding of specific nuances in transport telematics, lead to further refinement while motivating students to accurately apply technical standards. The knowledge from *NMC 136*, and especially the supplementary contributions facilitated by the committee under the guidance of the Ministry of Transport of the Czech Republic and the Czech Standardization Agency ČAS, significantly aid in the promotion and advancement of transport telematics within the Czech Republic. Certain outputs, such as the dictionary, extracts, and other innovative approaches delivered by this group of professionals, inspire not only other technical standardization committees but also attract the attention of emerging young experts completing studies in universities that focus on ITS.

One of the first 'large simulators' with panoramic image projection

Traveller information systems (ISO/TC 204/WG 10)
Traffic and traveller information (CEN/TC 278/WG 4)

Petr Bureš

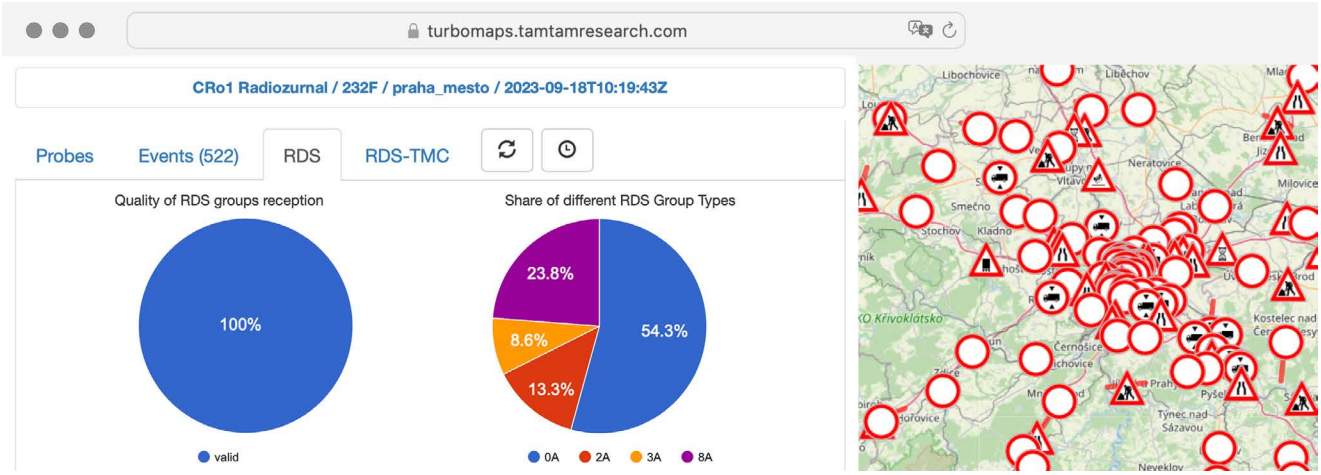
Ing. Petr Bureš, Ph.D., is the Chair of the *National Mirror Committee NMC 136 – Transport Telematics*.

An expert in the field of information systems focused on road transport, data and information quality, and ITS architecture, he has a long-standing presence at the Faculty of Transportation Sciences at the Czech Technical University in Prague, where he serves as an assistant professor. He is the co-founder of TamTam Research company, is also leading commercial, research, and student projects, as well as serving as an expert and consultant on various projects.

His involvement in standardization began during his doctoral studies at the Faculty of Transportation Sciences, Czech Technical University in Prague. He initially focused on identification systems (CEN/TC 278/WG 12) and later extended his interests to traffic and traveller information (CEN/TC 278/WG 4). He also focuses on geographic information systems and their intersection with transportation (CEN/TC 278/WG 7). The author of numerous extracts, translated standards, and coauthor of the methodology for extract creation. His long-term commitment to transport telematics standardization culminated in the chairmanship of *NMC 136*, the mirror committee to CEN/TC 278 and ISO/TC 204, which he continues to lead.

His primary areas of professional interest lie in transport information systems.

- As a project manager at CEDA, he oversaw the implementation of the RDS-TMC system (as per CSN EN ISO 14819) in the Czech Republic. He further contributed to standardizing, developing, monitoring, and enhancing the quality of this system. He authored studies for implementing and maintaining the RDS-TMC system and co-authored the first localization tables for this system. Engaging in research projects (MONITOR, CG944051120; TurboTMC TA03031386), he participated in designing a system for monitoring and evaluating the quality of the RDS-TMC system, as well as the design of a system enhancing transmission efficiency and capacity.
- He collaborates on the standardization of the TPEG system (per CSN EN ISO 21219) and its research (DAB&TPEG, CG741139120) in the Czech Republic. He is the author of articles and studies exploring the possibilities of this system and is a co-operator of a short-term pilot broadcast.
- Over the past decade, he has ventured into the DATEX II system, specifically its implementation within the National Transport Information Center. He has authored numerous studies and methodologies (BEDA, TB0500MD014) for introducing this standard (CSN EN 16157 series) and co-authored documentation and profiles of traffic information sources in the National Transport Information Center. He serves as an expert in this field concerning the implementation of the European Directive 2010/40/EU on intelligent transport systems in road transport.
- He is a co-creator of the national access point NAP https://registr.dopravniinfo.cz.
- He focuses on the research and implementation of the provision of traffic and travel information through linked and open data within the Lod-Roadtran18, 2018-EU-IA-0088 project https://lod.tamtamresearch.com/sparql.
- His second-most significant area of professional interest is system architecture. He teaches it at the faculty and, with a focus on ITS, engages in scientific and research projects both locally (ARCHITECT, CG941-011-120) and on the European level (E-FRAME, FP7-ICT-2007-2; FRAME-NEXT, MOVE/C3/2016-405/CEF/Transport).
- He applies experiences gained from both research projects and practical work to multinational implementation projects such as CONNECT, CROCODILE1-3, and NAP-CORE, where he serves as a technical advisor and expert in transport telematics, as well as the co-author of the TP172 technical conditions for traffic information centers.



Monitoring of live RDS-TMC broadcast content

Vehicle/roadway warning and control systems (ISO/TC 204/WG 14)
Ergonomics – Symbols (ISO/TC 22/SC 39/WG 5)
Ergonomics – TICS on-board-MMI (ISO/TC 22/SC 39/WG 8)

Petr Bouchner

Doc. Ing. Petr Bouchner, Ph.D., has long been engaged in the interface between humans and machines, as well as vehicle construction and safety, including their electronic systems. He particularly focuses on the perspective of functions and user interaction, resulting in the development and construction of complex interactive simulators.

At the Czech Technical University in Prague, Faculty of Transportation Sciences, he is the head of the Department of Vehicle Technology, which provides education in the areas of modern vehicle systems, mobility means, construction and safety, as well as human factors in transportation, HMI, and interactive simulations.

Aside from teaching, the department conducts projects ranging from basic research focused on understanding and describing driver/operator behavior to applied research projects in collaboration with industrial partners. The department has produced numerous interactive simulators for means of transport, ranging from single-track vehicles, personal automobiles and trucks, to rail vehicles and metros.

Another of his key competences lies in sustainable urban and individual mobility, reflected in the development and construction of lightweight emission-free means of transport, such as the developmental and research platform for a small urban electric automobile. A student development and racing team has been formed and is active in this department, regularly participating in the Moto Student international competition, in recent years with a purely electric motorcycle.

Petr Bouchner is one of the founders and heads of the Automotive Lab R&D 4.0: Joint Laboratory among CTU CIIRC, CTU FTS and Škoda Auto a. s. This lab conducts applied and commercial research in the automotive industry, contributing both to future vehicle development and the education of future professionals and leaders in the industry.

The HMI laboratories with vehicle simulators are equipped with tools for psycho-physiological measurements of drivers, including eye-tracking and biosensor systems. The primary research areas and developmental tools are the measurement and analysis of driver workload, distraction, fatigue, and performance. User requirements are verified, including the acceptance of technical solutions and the design of physical and digital components of interfaces. Innovative vehicle systems are developed here, especially concerning their comprehensive user interfaces.

Projects and Scientific Activities

Petr Bouchner has led or collaborated on various research and development projects:

- Within the framework of the Technology Agency of the Czech Republic and in the field of ITS, e.g.:
  - Project VG20122014085 – *Enhancing Vehicle Safety during the Transportation of Passengers and Goods at Critical Points of Infrastructure*, which led to the development a device for C2X communication between a train, a level crossing, and an approaching vehicle.
  - Project TA01030574 – *Laboratory for Training and Education of Professional Truck Drivers*, able to measure and analyze psycho-physiological, psychological and performance parameters. It resulted in the development of, at the time, the most advanced truck simulator in the Czech Republic. It served many years to train truck drivers for critical situations and was operated by Dekra under the name DekTruck.
- As part of the *National Centers of Competence* project, he collaborated on the Automotive Lab R&D 4.0: Joint Laboratory among CTU CIIRC, CTU FTS and Škoda Auto a. s.
- For the Faculty of Transportation Sciences of Czech Technical University he is responsible for the pan-European consortium Urban Mobility EIT KIC (European Institute of Innovation and Technology, Knowledge and Innovation Communities) established and supported by the European Commission. Here, Bouchner has a long-standing involvement in various programs and urban mobility projects, such as UrbanSmartPark, MaaS together, e-Ultimate (electric and green buses for cities) and Nimbee (mobile charging stations for electric vehicles), among others.
- In the safety domain, projects such as the *Technological Platform for Road Transport* (TPSD) are crucial, mapping and predicting the development of road traffic and technologies from a safety perspective, e.g., the *Travel Map of Road Transport Modernization*. Here, Bouchner particularly focused on the effects of ITS, smart infrastructure and intelligent assistance systems (including their interfaces) on safety.

He also serves as the editor-in-chief of the scientific journal *Neural Network World*, focusing on the theory and applications of informatics and artificial intelligence, advanced data processing methods and artificial neural networks.

Educational activities at the CTU

The Faculty of Transportation Sciences at the Czech Technical University in Prague has approximately 1,300 students, producing nearly 300 graduates yearly. The domain of *Intelligent Transportation Systems* (ITS) is among the cornerstones and an essential competence both in the realm of education and in the professional and scientific development of the faculty. The faculty offers an entire Intelligent Transportation Systems study program at all three degrees of study: bachelor's, master's, and doctoral. Bouchner serves as the guarantor and chairman of the specialized board for the doctoral program in ITS. These programs focus on teaching modern information and communication systems that are perceived as a superstructure for transportation infrastructure, assisting in solving transportation issues such as traffic congestion, traffic flow, environmental impacts, and transport safety. The education covers fundamental topics related to the architecture and operation of telematics systems, along with practical applications, particularly in the field of road and rail traffic management, vehicle systems and cooperative systems. These ITS application foundations formed a significant part of the *Smart Cities* (SC) concept that gradually led to distinct educational programs accredited at the Czech Technical University's Faculty of Transportation Sciences. Numerous other study programs build upon and utilize the expertise from the domains covered by *NMC 136*.

The curriculum is designed in a project-based manner and, particularly in its second part, focuses on practical aspects, with a significant segment conducted within specialized laboratories. Laboratories that extensively delve into ITS include:

- The Smart City Telematics Laboratory,
- The Joint Laboratory for System Reliability of Czech Technical University's Faculty of Transportation Sciences and the Institute of Computer Science of the Czech Academy of Sciences,
- Automotive Lab R&D 4.0: Joint Laboratory among CTU CIIRC, CTU FTS and Škoda Auto a. s.
- The Driving Simulation Research Group,
- The Laboratory for Traffic Management and Modelling,
- The Specialized Center for Applied Simulation and Visualization in Děčín (activities linked to U-smart-zone),
- Joint Laboratory of Tunnel Systems of the Faculty of Transportation Sciences, University of Žilina and Eltodo a. s., and
- The Mobile Laboratory for Transport Analysis.

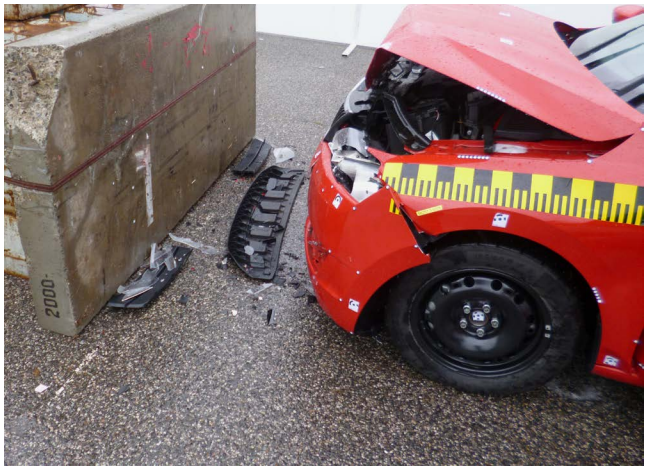
Student work on projects conducted within these laboratories aims to prepare competent and experienced graduates. Nonetheless, substantial emphasis is also placed on providing a comprehensive overview of related issues and theoretical knowledge. Typically, final student theses stem from their activities within the institute or laboratory. For students aspiring to enrich their studies with international experience, the faculty provides the opportunity for two master's 'joint degrees' programs: the *Intelligent Transport Systems* program in collaboration with Linköping University (Sweden) and the *Smart Cities* program in partnership with The University of Texas at El Paso (USA). Moreover, the faculty participates in the Erasmus student exchange program and EIT Urban Mobility Doctoral Training.

Standards, Legislation and Implementation

In the scope of his activities within *NMC 136*, Bouchner is an active member of the working groups ISO/TC 204/WG 14, ISO/TC 22/SC 39/WG 8, and ISO/TC 22/SC 39/WG 5. These groups work annually on several standards and convene regularly, typically twice a year.

The areas addressed by ISO/TC 204/WG 14 *Vehicle/Roadway Warning and Control Systems* are particularly focused on:

- Advanced driver assistance systems (e.g., dangerous lane departure assistance, pedestrian and cyclist recognition…),
- Systems for partial automation of driving (highway autopilot, low-speed automated driving, convoy driving…),
- Vehicle subsystem automation (automated parking in parking structures, remote-controlled driving in specific areas),
- Autonomous vehicles.



The first CRASHTEST trial deployment of the eCall system (HeERO project for the Ministry of the Interior conducted by the Faculty of Transportation Sciences of the Czech Technical University, Department of Vehicle Technology)

Vehicle control and Warning systems (source: iStock.com/supergenijalac)

ISO/TC 22/SC 39 *Ergonomics* deals with various aspects of the human-machine interface. Typical topics covered include:

- Ergonomic aspects of intelligent transportation systems,
- Measurement of driver's visual behavior in relation to transportation information and control systems in vehicles,
- Interactive simulation and measurement methods,
- Ergonomic aspects of transportation information and control systems,
- Human performance and condition in the context of automated driving.

ISO/TC 22/SC 39/WG 5 group focuses exclusively on graphic symbols for control, informational, and warning elements/systems in vehicles.

The topics addressed are essential in the process of designing, conceptualizing, and evaluating vehicle interfaces, particularly concerning safety, ergonomics and reliability, as well as comfort and perceived quality. All three working groups cover topics that are highly relevant to the advancement of know-how in research and development activities, as well as the applications of ITS and advanced systems, particularly in road traffic and the automotive industry in general. This facilitates strong collaboration not only with public administration and transportation service providers but also with developers and manufacturers in the automotive field (such as Škoda-Auto, Valeo, Bosch, Porsche Engineering, Kaipan, and others).

Among the most highly relevant and notable standards being addressed by these groups, in terms of current relevance and usability in our field, are:

- The series of ISO/CD 23374-x Intelligent Transport Systems standards — Automated Valet Parking Systems,
- The series of ISO 23792-x Intelligent Transport Systems standards — Motorway Chauffeur Systems,
- The joint ISO/SAE PAS 22736 Taxonomy and Definitions standard for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,
- The ISO 15007 Road Vehicles standard — Measurement and Analysis of Driver Visual Behavior with Respect to Transport Information and Control Systems.

Training and research truck simulator integrated into a trailer with a classroom (with Dekra Automobil)

Architecture (ISO/TC 204/WG 1)

Vladimír Faltus

Ing. Vladimír Faltus, Ph.D., is an expert in traffic control, data processing, traffic strategy and ITS, system architecture, efficiency and risk assessment, terminology, and standardization. He processes and reviews projects, provides transport and technical consulting and engages in educational activities.

He graduated from the Czech Technical University, Faculty of Transportation Sciences, in 2005, specializing in Transportation Engineering and Telecommunications – Automation in Transportation and Telecommunications. In 2003, during his studies, he was awarded the *Josef Hlávka Prize* for successful students of Czech universities. He completed his doctoral studies in the field of Engineering Informatics in 2012 with a dissertation on the topic of Modeling and Control of Traffic.

From 2005 to now, he worked as a lecturer and assistant professor at the Department of Transport Telematics and the Department of Transportation Systems at CTU Faculty of Transportation Sciences. He also works on scientific/technical projects, frequently in collaboration with various external entities in both the private and public sectors. He intensively cooperates with the ITS&S (Association for Transport Telematics), the Road and Motorway Directorate of the Czech Republic, and city administrations of major Czech cities. He manages the *Laboratory for Traffic Management and Modelling*, guiding students in their bachelor's and master's studies toward their final projects through project-oriented teaching.

Since 2019, Faltus has been a member of the *National Mirror Committee 136 – Transport Telematics* at The Office for Technical Standardization, Metrology and State Testing, where he serves as the delegated expert in the area of ITS architecture. His membership in NMC 136 reflects in his pedagogical activities at the faculty – educating future specialists in the field of transportation and ITS.

His field of practice is quite extensive, yet organized into specific domains from D1 to D8 (as outlined below), which partially overlap. The common denominator in all domains is transport, ITS, and systems engineering. This practice aligns with the Convener role in the National Mirror Committee.

D1: Traffic Control

During his studies, Faltus developed methods and algorithms for traffic control in both his master's and doctoral theses. He designed the logical core and algorithms for ensuring and controlling railway traffic as well as traffic in congested road networks. He later focused on optimizing traffic light devices, using vehicle-infrastructure communication, including testing in Prague Zličín. He explored the potential for using intelligent units for traffic management in saturated urban networks.

He devised a methodology for incorporating traffic light systems into public transport preferences in České Budějovice. This included algorithmic requirements (the basis for programming and testing) for both traffic lights and vehicle onboard computers, enabling the system's expansion throughout the city.

From 2019 to 2022, he defined requirements for lane control, entrance control, and traffic control in adverse weather conditions, in three studies for the Road and Motorway Directorate in the Brno area. The aim of these studies was to gradually establish a comprehensive telematics system on major roads in the area. Traffic control design is always closely related to ITS architecture**.**

He is currently finalizing a national concept of traffic lane control within the authority of the Road and Motorway Directorate, which involves designing the fundamental management of several traffic control functions, including entrance control, opening the shoulder to traffic, as well as dynamic turning or merging.

He also participates in a research and development project for a HW/SW prototype for traffic control, designed as a superstructure to sensors and traffic lights, to be pilot-tested under actual traffic conditions in Brno. Additionally, he is currently preparing a collaboration with České Budějovice regarding supporting the implementation of traffic-dependent control in urban areas, now enabled by the newly established City Traffic Control Center.

Installation of testing equipment on traffic lights

D2: Data Processing and Model Creation for Transportation/ITS Needs

In this domain, Faltus deals with spatio-temporal models of transportation quality and its development, as well as algorithms for processing and evaluating various traffic data, including error identification and correction. His work with data and data registries is closely linked to his role as a delegated expert in the National Mirror Committee.

Beginning in 2006, he worked on a hybrid model for estimating travel times from detectors and floating vehicles. He also focused on the estimation of queue lengths, using information from floating vehicles and contributed to identifying problematic points in selected noise barriers based on measurements and data evaluation. He continuously processes and evaluates

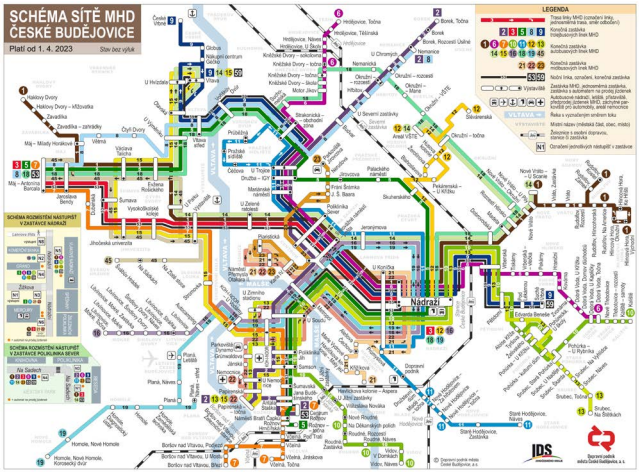


Diagram of the complete public transportation network in České Budějovice

data for public transport plans and Sustainable Urban Mobility Plans, with demonstrative graphic outputs, presenting data from sensors and surveys. These projects involve both Czech and foreign cities.

Since 2016, Faltus focused more on processing traffic data from Prague. Based on processed data, he helped analyze the impact of the construction of the Blanka Tunnel complex on Prague's traffic. He also developed a global urban traffic model for the city's control interventions planning and transport investment efficiency evaluation. This work involved processing a large volume of data, creating a historical traffic model, modeling traffic quality over detector networks, analyzing externalities, and assessing the impact on the sustainability of major urban transport projects on traffic and the environment. He intends to contribute to further data processing and utilization projects concerning traffic quality and externalities.

D3: Transport and ITS Development Strategy, Risk Analysis, Efficiency Evaluation

In this domain, Faltus's expertise since 2010 involves strategic projects to design effective and safe transport and ITS development measures for road, railway, and public transport. These projects typically encompass defining key stakeholders, analyzing and outlining issues as well as their solutions, ITS architecture, elaborating specific measures, and consulting with those stakeholders defined.

These include the creation or revision of concepts and strategies for the development of telematics development, public transport master plans, traffic control projects, and *Sustainable Urban Mobility Plans* for multiple cities in the Czech Republic, including those where he analyzed and graphically processed input data, as covered by Domain 2. Some examples of telematics strategies for cities include Prague, Brno, and České Budějovice.

Since 2017, he has been systematically involved in creating strategic plans and technical studies for the Road and Motorway Directorate, proposing further development measures, typically over 10 years, particularly for the *Unified Traffic Information System / National Transport Information Center*. This included information regarding charging stations for alternative energy sources for the National Transport Information Center, as well as a Road Database, ITS for the D1 motorway near Brno, ITS for the Brno area, dynamic vehicle weighing, and the aforementioned traffic lane controls.

One of his successful strategic projects was the Public Transport Master Plan in České Budějovice, which led to the launch of the *'new public transport system'* in mid-2011, as well as the follow-on project of development strategy for public transport. This optimization of public transport operations enhanced both efficiency and attractiveness. Additionally, he created a clear diagram of the entire public transport network, still in use after 12 years and practically unchanged.

From 2008 to 2011, he was responsible for a project analyzing technical and metrological requirements for the *Global Navigation Satellite System* receivers and their operations. The goal of this project, conducted by Czech Technical University for The Office for Technical Standardization, Metrology and State Testing, was to establish a methodology for certifying (confirming functionality) of transport applications using GNSS systems – closely related to his activity in the *NMC 136*. The essence of this project was measuring specific values and calculating evaluation indicators as a basis for certification, including pilot testing the methodology.

Faltus dealt with risk analysis and related measures in multiple projects. One focused on optimizing the technological equipment of road tunnels, where he prepared a fuzzy expert model (SAFECALC) to assess tunnel safety. Another was a safety study for the Railway Administration, creating a method for risk analysis and assisting in finding solutions in collaboration with many key players.

In recent years, beginning in 2021, he was systematically engaged in studies for the development of electromobility in public transport. This involves analyzing various types of traction, including costs and risk estimates. The goal is to find optimal strategies for gradually replacing transport company fleets with modern propulsion types. His first study covered Brandýs nad Labem and Kostelec nad Labem in the Central Bohemian Re-

gion, followed by studies in North Bohemia for Děčín and Most. Currently, Teplice is in line, with other locations in preparation.

Since 2022, he has also been a member of the NAPCORE European project, which aims to support the development and interoperability of National Access Points (NAP) for transport information. He has implemented automated calculations within the methodology for evaluating the current status of NAP in individual EU countries and identifying weaknesses.

D4: Creation of ITS System Architecture

In this domain, Faltus specializes in creating system architectures for Intelligent Transport Systems (ITS) from various perspectives to ensure the efficient implementation and optimization of these systems. The creation of ITS architecture is often an integral part of ITS development (Domains D1 and D3) and frequently serves as a foundation for technical consultancy (Domain D5), which is why its creation is almost always linked to related projects.

An expert, he holds extensive professional experience in ITS architecture at both national and local (urban) levels, as evidenced by his involvement in numerous projects over the past years. Among the projects in which he created ITS architecture on a national level are the aforementioned conceptual documents for the Road and Motorway Directorate, covering topics such as the *Unified Traffic Information System / National Transport Information Center*, information regarding charging stations for *National Transport Information Center*, the *Road Database*, as well as traffic lane control. At the local level, he developed ITS architecture for the Brno area, as well as cities such as České Budějovice, Hradec Králové, and Ostrava.

Faltus also has experience with the European FRAME architecture, gained through the *Program Support Action* for maintenance, adaptation, and further development of the European framework architecture for ITS. In the near future, his participation is expected in the aforementioned NAPCORE European project, involving system architecture for national and European access points for traffic information.

D5: Transport and Technical Consultancy, Analyses, and Expert Opinions

For over a decade, Faltus has dedicated himself to supporting the implementation of ITS in Czech cities by collaborating with local municipalities. This cooperation involves feasibility studies and project specifications for ITS systems implementation. His activities encompass development strategies, assessment of strategic documents, system inventory (passportization), feasibility studies, ITS funding issues, preparation of technical conditions for public procurement, supervision of tendering processes, as well as expert supervision of ITS implementation. These efforts also reference ITS standards.

His collaboration with the city of České Budějovice over more than 10 years has led to the establishment or modernization of numerous ITS systems. This includes integrating traffic signal controllers and public transport vehicles into the preference system, establishing strategic detectors, parking systems, parking guidance systems, as well as traffic information and control centers, expanding CCTV coverage, weather stations, and cable routes. From 2016 to 2023, he participated in supporting the procurement and expert supervision of a comprehensive ITS system in Hradec Králové. This unique project was awarded by the *Association for Transport Telematics* in the nationwide 2023 *Czech Transport Construction, Technology, and Innovation of the Year* competition.

Faltus also collaborates with the city of Ostrava to create a public procurement regarding the expansion of ITS, including traffic lights, dispatching, C-ITS, and preference systems. He provides expert opinions on procurement documentation for other Czech cities and expert opinions for police investigations (serving the needs of the Czech Police or the Office for the Protection of Competition). He supports expert assessments in collaboration with the Department of Forensic Experts in Transportation at the Faculty of Transportation Sciences of the Czech Technical University.

D6: Terminology, Ontology, Notation

The subject of standardized terminology, in which Faltus has been involved since 2019, is listed below in Domain D8, but is currently significantly developed, both in ISO/TC 204 WG 1 and in the Czech STANDARD project. However, his involvement in terminology-related work began even before he entered into TSC.

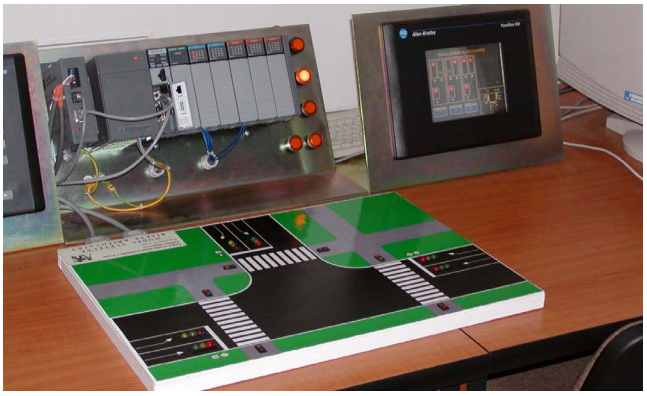
Between 2013 and 2015, in collaboration with Prof. Pavel Přibyl, he focused on knowledge systems for road tunnels, including terminology, domain-oriented ontology and semantics, as well as the analyses of content and relevance of standards. This work was closely related to efforts by Japanese colleagues supporting Prof. Kawashima. Since 2021, he has been engaged in two projects concerning tunnel ontology for the *Road and Motorway Directorate*, aiming to unify the then diverse forms of project documentation on several levels.

The issues of ontology and terminology are also closely connected to notation. Due to his active interest in music, since 2015he has been involved in notations related to medieval Eastern liturgical music. These significantly differ from contemporary ones. He collaborated with Dr. Haig Utidjian (a descendant of Armenian ancestors living in the Czech Republic) and Dr. Jacob Olley (University of Münster, later at the Music Faculty in Cambridge) to create digital graphic support for notation.

His work involves Limōnčean symbols, a musical notation system and medieval Armenian neumes, which encompass not only those characteristics typical for early sources but also sources drawn from Ottoman secular music. The outcome contributes to Armenian neumatology, used in universities in the Czech Republic and abroad. Further collaboration is anticipated in 2023 to update and expand additional symbols.

D7: Educational and Academic Activities

Faltus has dedicated himself to teaching at the Czech Technical University since 2005, both in Czech and English, in Prague as well as at the Děčín branch. He lectures in bachelor's and



A glance into the Control Systems Application laboratory

master's programs, focusing on transport systems and ITS, covering topics such as traffic flow theory, traffic control, and ITS. His teaching naturally incorporates his standardization experiences and the aforementioned practical domains, including ITS architecture, systems analysis, risk analysis and management, as well as control and regulation methods. Approximately a hundred graduates emerge annually from these programs.

Since 2005, he has led the student *Control Systems Application* project within project-oriented education, generating graduates in bachelor's/master's programs specializing in control algorithms for various traffic and ITS purposes. Since 2008, he has also been involved in the accreditation processes of traffic engineering and ITS study programs. This involvement allows him to influence program innovations according to the latest needs of the transportation and ITS industry. Currently, he is participating in the preparation of a lifelong learning course focused on ITS and urban engineering, aimed at participants from government authorities, local administrations, and related professional communities.

Since 2022, he has striven to apply modern teaching methods in collaboration with the University of Stavanger in a project sharing experiences regarding challenge-based learning. He has experience in managing academic institutions, gained through years of work in academic senates at both faculty and university levels. He participates in conference organization (e.g., European Transport Congress) and occasionally reviews articles and contributions in various journals and conferences.

D8: Standardization and Other Activities in NMC 136

Faltus became a member of *National Mirror Committee 136 – Transport Telematics* in 2019, immediately taking on the role of a delegated expert in the field of ITS architecture. With rich experience in ITS architecture (domains D1, D3, D4, and D5), data models (domain D2), and a favorable relationship with ontology and terminology work (domain D6), he could not have been assigned to a more suitable delegation area.

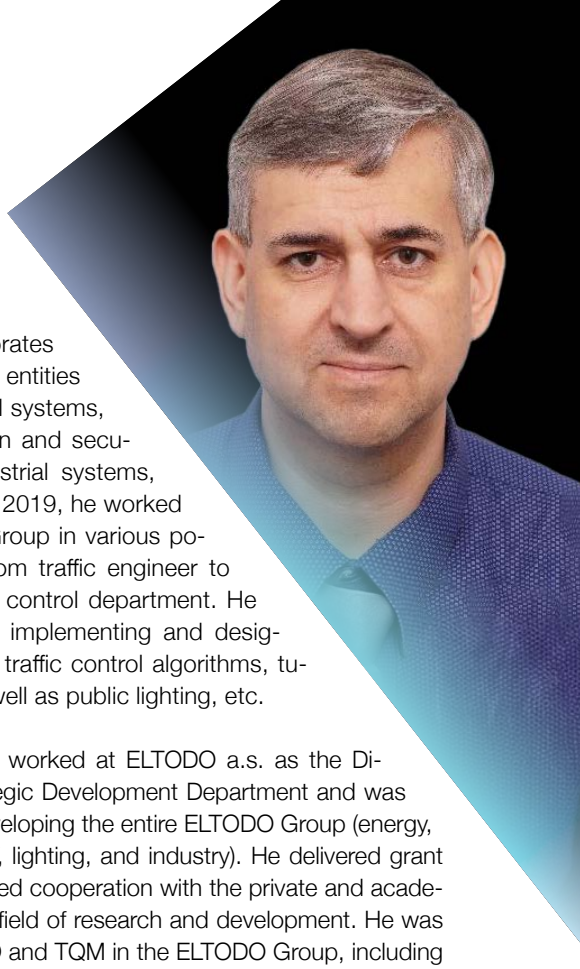
The work of the delegated expert for ITS Architecture is closely related to the activities of the ISO/TC 204 WG 1 Architecture work group, chaired by Ken Vaughn from the USA. The European level of this field is a part of the ISO activity. Among the significant areas of activities pertaining to this work group are efforts regarding definitions of ITS architecture, data registry, ITS services, ontological approaches and, particularly in recent years, regarding the ITS terminology dictionary (standard ISO 14812).

The role of a delegated expert for ITS Architecture in *NMC 136* typically involves the following:

- Active participation in ISO/TC 204 WG 1 meetings, approximately 1–2 times per month. Here, the primary focus is on the development (specifically, supervision over the entire life cycle) of standards in the above-mentioned areas:
  - Engaging in WG 1 activities, including document revision preparation, drafting opinions and comments, active participation in discussions and editing proposals, and more. This direct involvement ensures that the Czech Republic's input is included in the final versions of international standards;
  - Devoting time to WG 1 presentations of current topics to other WGs or the broader professional community. In 2021, the expert actively lectured on the subject of ontology use in standards and extracts from the Czech standards (see below), which seemed to be an unachievable dream, even for many developed countries worldwide;
  - WG 1 discussions are usually held online or in hybrid format, facilitating near-100% attendance;
  - Providing feedback and voting on various stages of the process of introducing standards related to ISO/TC 204 WG 1 in the international context, which amounts to approximately 2–3 standards per year.
- Creating extracts and terminology entries from international standards in the Czech language, significantly simplifying access to relevant terminology and the content of standards through the *StandardLand* web site. This allows Czech experts or students to preview standard content before acquiring the standards.
- Developing a national plan for adopting standards into the Czech language, specifically the updating of these standards.
- Preparing quarterly reports on the working group's activities and annual reports on the activities within his expertise.

In 2022, the delegated expert was also invited to join the StandardTeam group, which is developing the methodology of the StandardLand project. This group works under the umbrella of the *SILMOS s.r.o., Technical Standardization Center* in Brno and generally meets quarterly or more frequently as needed. The group focuses on translating and systematically organizing technical terms from standards, particularly those related to adopting the aforementioned ITS Terminology Dictionary (ISO 14812) into the Czech context. This effort provides both Czech experts and lay audiences with a clear and practical overview of ITS standardization and the field as a whole.

Insights gained from activities in TSC positively impact all other mentioned professional activities of the delegated expert, including education, thereby preparing promising future experts in the field of ITS.



Tomáš Tichý

Doc. Ing. Tomáš Tichý, Ph.D., MBA, was born in Prague in 1974 and graduated from the Czech Technical University in Prague, Faculty of Transportation Sciences, in 2000. He completed his Ph.D. studies in 2004 in the field of Engineering Informatics and was appointed as an associate professor in Engineering Informatics of Transportation and Communication in 2009.

He completed his MBA studies in 2017 at the University of Economics in Prague. He has been an authorized engineer of the *Czech Chamber of Authorized Engineers and Technicians* in the field of Transportation Systems and Telecommunication Systems since 2007. He holds several certifications, such as PRINCE2, ITIL, and FIDIC. He is a member of PIARC (World Road Association) committees, *NMC 136*, TSC 146, and a member of the scientific board of the Czech Technical University in Prague, Faculty of Transportation Sciences.

Currently, Tichý works at the Czech Technical University in Prague, Faculty of Transportation Sciences, as a scientific and pedagogical staff member – associate professor and deputy head of the Department of Transport Telematics. He is also the head of the Laboratory for Traffic Management and Modelling and the Urban Engineering and Lighting Technology Laboratory. In these roles, he is involved in scientific and research projects, with a particular focus on ITS, traffic control, tunnel systems, mobility, safety and reliability in transportation, including cyber security, predictive diagnostics, and the application of telematics in urban engineering and Cooperative Intelligent Transport Systems.

He also collaborates with commercial entities dealing with tunnel systems, control, information and security systems, industrial systems, etc. From 2000 to 2019, he worked for the ELTODO Group in various positions, ranging from traffic engineer to head of the traffic control department. He has experience in implementing and designing ITS systems, traffic control algorithms, tunnel systems, as well as public lighting, etc.

Since 2014, Tichý worked at ELTODO a.s. as the Director of the Strategic Development Department and was responsible for developing the entire ELTODO Group (energy, transportation, ICT, lighting, and industry). He delivered grant projects and handled cooperation with the private and academic sectors in the field of research and development. He was responsible for ISO and TQM in the ELTODO Group, including project management and engineering. He managed a team of more than 50 people with an annual turnover exceeding CZK 50 million.

He uses his long-term membership in *NMC 136* both to provide comments on selected standards in the field of traffic control, C-ITS, and other professional areas and, particularly, to promote standardization outcomes in education and selected conference contributions.

"Full Simulator" based on a Škoda Superb within the Joint Automotive R&D 4.0 Laboratory with Škoda Auto

Václav Krumphanzl

Ing. Václav Krumphanzl is a transportation engineer with more than 17 years of experience in transport telematics. He spent the first 15 years of his career in the state administration, specifically at the Ministry of Transport. He began as a Telematics and Road Network Toll Department specialist, then led the department and eventually became Director of the Ground Transportation Division. Throughout these 15 years, he focused on transport telematics, particularly in the area of performance-based tolling (Electronic Toll Systems) and the implementation of the interoperability of toll systems in the Czech Republic and European Union. He worked at both the European and regional levels (for instance, within the framework of the Stockholm Group).

As part of his work in transport telematics, he contributed to creating the *Unified Traffic Information System* for the Czech Republic. This included its legal establishment through relevant regulations, the preparation and execution of various investment projects related to providing traffic data for the system, as well as its technological infrastructure. He was also involved in establishing the *National Transport Information Center* of the Road and Motorway Directorate of the Czech Republic. This included the preparation and execution of individual investment projects to establish all areas of this center.

In the context of performance-based tolling, he participated at the international level in developing legal regulations, as a member of the European Commission's Electronic Toll Committee, as well as the expert group. It should be noted that the enforcement of relevant technical standards depended on the existence of corresponding legal regulations. Within these groups, interoperability of electronic toll systems was both formed and defined, leading to the concept of the European Electronic Toll Service, which aimed to unite multiple systems under a single contract, onboard unit, and invoice. He also played a role in the preparation and execution of the tender for the extension of the operation of the *Electronic Toll System*, which used microwave technology from 2007 to 2019 and included the subsequent tender for the new Electronic Toll System.

Standardization was another significant area of his work during his 15 years at the Ministry of Transport. This included the ministerial level in the context of ground transport network quality policy (technical regulations under the Ministry of Transport's authority, such as technical conditions, technical quality conditions, example data sheets, etc.). At the national level, he was a member of the *National Mirror Committee 136 – Transport Telematics*.

His membership in the *NMC 136* was not focused on delegated-expert activities for any specific areas within CEN/TC 278 or ISO/TC 204. Instead, it provided support and stability to the functioning of this standardization committee and involved coordination with the Czech Office for Standards, Metrology, and Testing and, from 2018, the Czech Agency for Standardization.

Thus, his work at the Ministry of Transport had a dual character. On one hand, it involved standardization, and on the other, it was in the application area (specifically user-oriented). This was particularly evident in the implementation of the European Electronic Toll Service in the Czech Republic, as well as

Toll gate at the point of lane narrowing

On-board unit for a satellite toll system

the Electronic Toll System operated from December 1, 2019, where various technical standards from this field were utilized.

Aside from his involvement in performance-based tolling, he acted as the expert guarantor or liaison for numerous research projects, primarily funded by the Ministry of Transport and the Technology Agency of the Czech Republic, as well as the Ministry of the Interior in the field of transport telematics. These projects were conducted in collaboration with both scientific research institutions and commercial entities.

For the past two years, his work has been associated with the Technical Road Administration of the Capital City of Prague, a.s., where he serves as the Director of the Telematics Division. This entity is a joint-stock company founded and solely owned by the City of Prague. The company was established primarily to manage, maintain, repair, and further develop those immovable assets that include second- and third-class roads, local roads, and certain purpose-built roads within the territory of the City of Prague.

Additionally, the company provides services related to managing these assets, as well as design, transportation, and civil engineering activities. The company mainly focuses on continuous maintenance of roadways and related assets, such as traffic signs, traffic lights, sidewalks, bridges, tunnels, greenery, and various other structures. It also handles repairs and reconstructions of local roads when needed. Furthermore, the company is engaged in initiatives to reduce traffic accidents, optimize traffic organization and control, monitor and evaluate traffic trends, as well as systematically plan further development of the entire transportation system of the City of Prague by the extensive use of transport telematics.

The Telematics Division manages all traffic light systems owned by the City of Prague, as well as equipment for operational information, variable traffic signs, weather stations, camera systems, traffic detectors, systems for measuring instant and segmental speed, journey time systems, dynamic weighing systems, vehicle height control systems, systems for detecting vehicles in dedicated lanes, and systems for detecting driving on red lights, among others. Considering that we cannot live without technical standards, as they are an integral part of our everyday lives even if we don't consciously realize it, the same applies to transport telematics used within the territory of the City of Prague. Thus, technical standards are an everyday matter in the activities carried out by the Telematics Division of the Technical Road Administration of the Capital City of Prague, a.s., positioning the division as a significant user of technical standards in the field of transport telematics.

In his role as the Director of this division, Krumphanzl primarily participated in the preparation and execution opening of the Control System architecture for the Main Traffic Control Headquarters, as well as the Traffic Information Center. Among other responsibilities, he also ensured service for traffic light systems and managed service for Unicam systems. At the same time, he played a crucial role in forming several projects, including the innovative *Management of Telematics Assets Partnership*.

Main Traffic Control Center and the Traffic Information Center

Introduction of the ElectronicToll System in the Czech Republic

The introduction of electronic toll system in the Czech Republic can be divided into three fundamental phases:

1. Electronic toll system from 2007 to 2016,
2. Electronic toll system from 2017 to 2019, and
3. Electronic toll system from 2019 (12/2019)

1. Electronic Toll System from 2007 to 2016

The years 2004 and 2005, during the preparation of specifications for the Electronic Toll System, lacked a sufficient understanding of this field due to the absence of crucial technical norms. This led to a sparse regulatory foundation in the procurement documentation. Specifically, references were made to the following legal and technical regulations:

Legal Regulations:

- Act No. 101/2000 Coll.,
  on the Protection of Personal Data
- Act No. 365/2000 Coll.,
  on Information Systems in Public Administration

Technical Regulations:

Specific technical regulations:

"The On-Board Units (OBUs) must meet the following requirements for non-discriminatory access to the System:

Interoperability of the unit is required in line with the process of adopting relevant EU standards. Each of the offered OBUs must technically comply with at least one of the requirements of Directive EC 52/2004

- *Satellite positioning with mobile communication using GSM-GPRS standards (reference GSM TS 03.60/23.060);*
- *Microwave technology at 5.8 GHz.*

Regardless of the employed localization technology, each OBU must have a DSRC interface meeting the conditions set by CEN/TC 278 for enforcement."

2. Electronic Toll System from 2017 to 2019

The Electronic Toll System from 2017 to 2019 represented a three-year extension of the preceding system, operational from 2007 to 2016. This extension included the delivery of the *European Electronic Toll Service* module as a part of the supply.

3. Electronic Toll System operational since 2019 (December 2019)

During 2017 – 2019, the preparation, execution, and implementation of the procurement process took place for the new Electronic Toll System implementing satellite technology. The below list of legal and technical regulations makes it evident that these regulations already adequately covered the area of performance-based tolling. It should be noted that without proper standardization, it would not have been possible to precisely specify the detailed technical requirements for the Electronic Toll System, thus ensuring its openness and modularity.

Legal Regulations:

- Act No. 13/1997 Coll., on Roads, as amended
- Act No. 365/2000 Coll., on Information Systems in Public Administration and on Amendment of Some Other Acts, as amended
- Act No. 181/2014 Coll., on Cyber Security and on Amendment of Related Acts, as amended
- Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
- Act No. 101/2000 Coll., on the Protection of Personal Data, as amended
- Directive 1999/62/EC of the European Parliament and of the Council of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures
- Directive 2004/52/EC of the European Parliament and of the Council of 29 April 2004 on the interoperability of electronic road toll systems within the Community
- Commission Decision 2009/750/EC of 6 October 2009 on the definition of the European Electronic Toll Service and its technical elements
- Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC
- Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC

Technical Regulations:

- CSN ISO/IEC 31000:2009
  CSN ISO/IEC 27005:2011
  ISO/IEC 27035-1:2016
  ISO/IEC 27035-2:2016
- CSN ISO/IEC 27000:2016
  CSN ISO/IEC 27001:2013
  CSN ISO/IEC 27002:2013
  CSN ISO/IEC 27003:2010
  CSN ISO/IEC 27004:2016
  ISO/IEC 27035-1:2016
  ISO/IEC 27035-2:2016

- CSN P CEN ISO/TS 174441:2013 Electronic Fee Collection (EFC) – Performance metrics – Part 1: Metrics and CSN P CEN ISO/TS 174442:2014 Electronic Fee Collection (EFC) – Functional characteristics of toll collection – Part 2: Test framework
- CSN EN ISO 12855:2012
- CSN EN 15509:2014
- CSN ISO 27000:2016
- EN ISO 14906 (DSRC profile according to EN 13372 composed of DSRC application layer 7 ISO OSI model according to EN 12834, DSRC data link layer 2 according to EN 12795, DSRC physical layer 1 according to EN 12253)

Overview of Tolling Assessments from 2007 to 2022

Year	Toll Assessment [in billions of CZK]
2007	5,558
2008	6,135
2009	5,536
2010	6,565
2011	8,112
2012	8,666
2013	8,545
2014	8,703
2015	9,720
2016	9,876
2017	10,389
2018	10,805
2019	10,936
2020	11,512
2021	14,198
2022	14,850
Total	**150,106**

Toll gate (source: czechtoll.cz)

Brief Overview of Performance Tolling Development

Date	Change
March 29, 2006	Completion of the tender for the Electronic Toll System – contract signing.
January 12, 2007	Commencement of performance tolling for vehicles with a maximum authorized weight of at least 12 tons on highways and expressways (968 km). Vehicles were divided into two emission groups: EURO 0-II and EURO III.
January 1, 2008	Commencement of performance tolling for vehicles with a maximum authorized weight of at least 12 tons on Class I roads (178 km).
January 1, 2010	Expansion of performance tolling to vehicles with a maximum authorized weight of at least 3.5 tons.
February 1, 2010	Introduction of increased toll rates on Fridays from 3:00 PM to 9:00 PM, including an offset by rate reductions (by 50%), during other times of the day and week.
January 1, 2011	Change in toll structure to three emission groups (EURO 0-II, EURO III-IV, and separate emission class EURO V+).
	25% increase in toll rates for emission classes EURO 0-II and EURO III-IV. No increase in rates for emission class EURO V+ (rate of emission class EURO V+ set at the level of emission class EURO III-IV as of December 31, 2010).
	Reduction of the increased toll rate in selected Friday hours to 40% to compensate carriers.
September 1, 2011	Introduction of separate reduced toll rates for buses. Toll rates for buses are differentiated solely based on emission classes and are not increased on Fridays.
January 1, 2012	Approximately 25% increase in toll rates for emission classes EURO 0-II and EURO III-IV. This toll rate increase does not apply to emission class EURO V+ and buses.
January 1, 2015	Change in toll structure to four emission groups (EURO 0-II, EURO III-IV, EURO V, and EURO VI + EEV).
	8.2% increase in toll rates for emission class EURO III-IV, 9.8% increase in toll rates for emission class EURO V. Toll rates for emission class EURO VI + EEV set at the emission class EURO V+ level as of December 31, 2014.
	Change in time range (3:00 PM–8:00 PM) for applying increased toll rates during Friday afternoon peaks.
September 20, 2018	Completion of the tender for the new Electronic Toll System – contract signing.
September 22, 2018	Commencement of the implementation of the new Electronic Toll System.
September 23, 2018	Commencement of pilot operation. Commencement of pre-registration followed by the distribution of onboard units.
November 21, 2018	Completion of pilot operation and handover of the new Electronic Toll System.
December 1, 2019	Commencement of operation on the existing scope of tolled roads. Commencement of regular toll collection on the existing scope of tolled roads.
January 1, 2020	Expansion of tolling scope on Class I roads by approximately 870 km to 1,102.3 km.
February 28, 2020	Completion of the Electronic Toll System trial operation on the overall scope of tolled roads.
January 1, 2021	Introduction of a three-component toll structure (road usage fee, noise fee, and pollution fee).

Fee and toll collection (ISO/TC 204/WG 5)
Electronic fee collection and access control (CEN/TC 278/WG 1)

Jaroslav Altmann

Ing. Jaroslav Altmann is an expert focused on telematics and electronic tolling. He has worked for many years with a team of developers and analysts within Princip a.s., a company that is part of the Eurowag Group. Telematic units developed by this team are installed in 130,000 vehicles in Europe. Eurowag is the first European Electronic Toll Service (EETS) provider in the Czech Republic.

- He participated in developing and certifying the toll unit for autonomous electronic tolling, which combines microwave and satellite systems. It is certified in eleven European countries, including the Czech Republic.
- He has long been engaged in telematics, primarily in obtaining, processing, and transmitting vehicle information. For example:
  - Development of models for assessing driving styles of both passenger and freight vehicles, processing data from vehicle data buses and measurements from inertia sensors. These models also reflect the complexity of the given route,
  - Reading data from electric and hybrid vehicles, evaluating speed and charging progress,
  - A system for vehicle sharing, authorization, and unlocking through a mobile phone.
  - Reading warning icons from the vehicle dashboard,
  - Connection to tachographs and reading data from tachographs. Remote reading of data stored in them,
  - Identification of connected semi-trailers through wireless beacons,
  - Creation of an automated design for vehicle electrification based on operational assessment,
  - Monitoring the development of CO2 intensity per ton-kilometer for large fleets of freight vehicles, analyzing those factors influencing emissions,
  - Collection of vehicle data for transport research and real-time traffic modeling.

Performance-Based Toll in the Czech Republic

Performance-based electronic tolling for vehicles over 3.5 tons was introduced in the Czech Republic on January 1, 2007. The toll system was delivered by a consortium of companies led by Kapsch A.G. and based on toll stations using DSRC microwave communication technology. At that time, tolls were collected for 970 kilometers of highways and roads using 178 toll stations. Toll-paying vehicles were equipped with an onboard unit with a DSRC interface for communication with transmitters located at toll stations.

On December 1, 2019, the microwave toll system was replaced by a satellite toll system delivered by the CzechToll and SkyToll consortium. This toll system calculates tolls

The EVA on-board unit from Eurowag

using position evaluation through an onboard unit containing a GNSS receiver and GSM communication module. While this system also uses microwave communication with toll stations (DSRC), it is primarily for checking the functionality of onboard units. Transmitters placed on Customs Service vehicles, and a small number of original toll stations are used for checking.

From the beginning, this toll system was designed to be compatible with the European Electronic Toll Service (EETS), allowing toll payment in the Czech Republic based on contracts with EETS service providers (other than the one operating the toll system in the respective country). EETS service providers equip vehicles with their own certified toll units, which, thanks to certification, behave the same way as national operator's toll units. In this case, the national toll operator acts only as an EETS collector. In 2022, the toll system operator in the Czech Republic began certifying EETS providers, and in 2023, the Eurowag group received the first such certification.

Standards, EU Legislation and Certification

Standards and certification play a crucial role in electronic toll systems. Standards define physical parameters, technical requirements, communication protocols, minimum standards for quality, safety and system reliability, ensuring compatibility of systems provided by various manufacturers. Certification ensures that specific components and systems comply with applicable standards and are capable of communicating with other systems within the EU. They also meet minimum requirements for safety, technical quality, and reliability.

Some of the most important standards for electronic toll systems include CSN EN 15509, CSN EN ISO 14906, and CSN EN 12813, which comprehensively define the DSRC communication interface, including application layers and data used for toll and control transactions. The CSN EN 15509 standard is a profile standard that lists parts of other relevant standards for the certification of microwave communication devices in the EETS environment. Standards CSN EN ISO 12855 and CSN EN ISO 17575-1 define the protocol for data exchange between the collector and EETS service provider. Manufacturers of EETS components commonly use all these standards, and their regular updates are treated with great care, as any change can affect the usability of millions of onboard units and other components installed throughout Europe.

EETS is defined by the Directive (EU) 2019/520 of the European Parliament and of the Council of 19 March 2019, was well as the Commission Implementing Regulation (EU) 2020/204 of November 28 2019, which establishes the toll component certification system. This document lists harmonized standards and defines the European Electronic Toll Service interface.

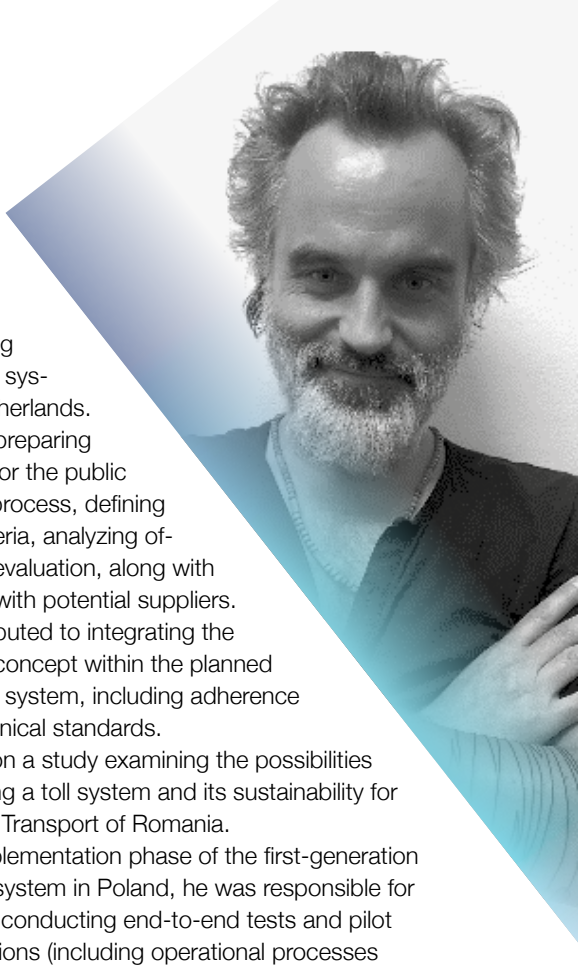
Operational Entities for Toll Collection in the Czech Republic

- Ministry of Transport of the Czech Republic
- Road and Motorway Directorate
- CzechToll and SkyToll Consortium
- Eurowag Group
- Kapsch Czech Republic

EETS-certified toll box

Fee and toll collection (ISO/TC 204/WG 5)
Electronic fee collection and access control (CEN/TC 278/WG 1)

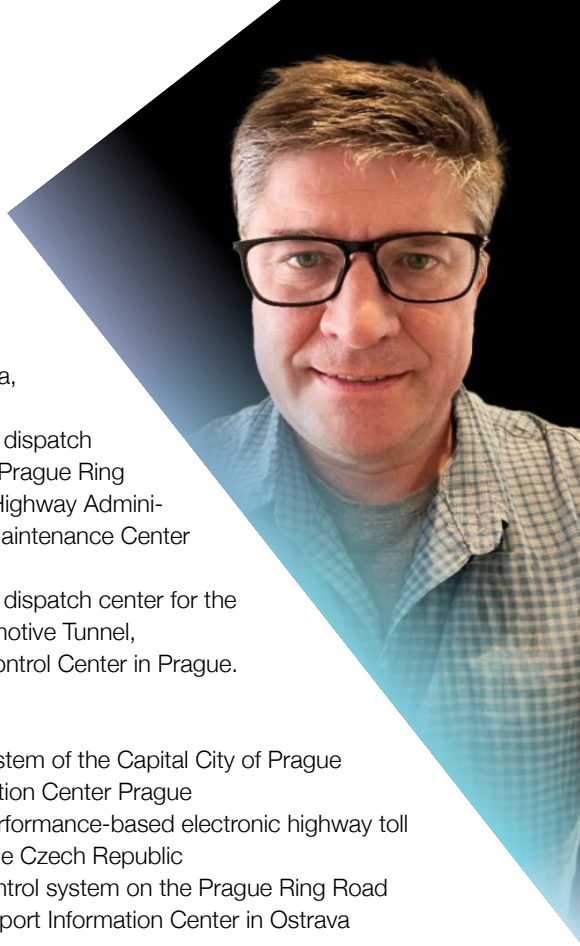
Jakub Rajnoch



Mgr. Jakub Rajnoch is an independent consultant specializing in electronic tolling. He has extensive experience in both private and public sectors in a wide range of areas and phases within electronic tolling systems, spanning from design to implementation. This includes system architecture design, sub-system or functional module design and specifications within public tenders, as well as defining the acceptance and evaluation criteria for offers and their assessment. During the implementation phase, he consults on the design and management of test concepts and trial operation management. Currently, he consults for one of the current EETS service providers as a system architect and business analyst, involved in integrating the individual toll domains of member states within one system.

- Collaborated on a cost and benefit analysis, including variations of scenarios for the introduction of universal onboard units under the Mobile Location Unit project, funded by the European Commission's Directorate-General for Mobility and Transport (DG TREN).
- Contributed to the impact analysis of DSRC technology in an urban tolling system during a pilot operation under the Transport for London (TfL) Technology Trials Programme. The analysis resulted in the effectiveness assessment of using DSRC technology in conjunction with existing automatic license plate recognition technology for vehicle and toll system user identification. This included detecting urban-specific situations and evaluating them as part of toll calculation and invoicing.
- Participated in testing electronic toll system solutions within the Department for Transport (DfT) Demonstration Programme, aimed at a detailed analysis of available market technological solutions.
- Was a member of a team responsible for designing an enforcement and compliance checking service within the forthcoming nationwide toll system in the Netherlands. This included preparing requirements for the public procurement process, defining evaluation criteria, analyzing offers and their evaluation, along with consultations with potential suppliers. He also contributed to integrating the EETS service concept within the planned nationwide toll system, including adherence to related technical standards.
- Collaborated on a study examining the possibilities of implementing a toll system and its sustainability for the Ministry of Transport of Romania.
- During the implementation phase of the first-generation electronic toll system in Poland, he was responsible for preparing and conducting end-to-end tests and pilot system operations (including operational processes and acceptance procedures of potential EETS service providers).
- For the first generation of the Czech Republic's electronic toll system, he contributed to the renewal of the central system's server component. He was responsible for designing test and pilot operational concepts and overseeing their execution.
- Designed business processes for Bulgaria's nationwide toll system, both from the toll collector's perspective and as one of the service providers for toll declarations.

Toll gate



Jiří Řehák

Ing. Jiří Řehák is, among other things:

- The Executive Director of ALMAPRO, s.r.o. (www.almapro.cz). The company specializes in project preparation and coordination of significant transportation infrastructure projects, particularly in the area of electric engineering and telematics systems;
- The Head Designer of transport systems, telematics and ITS Systems;
- The national delegated expert of *NMC 136 ISO/TC 204 WG 16 – Communications;*
- A specialist in road tunnels and transport telematics, and an authorized inspector of road tunnels according to the methodology guidelines of the Ministry of Transport of the Czech Republic;
- An authorized engineer with the *Czech Chamber of Authorized Engineers and Technicians* in the field of construction technology.

Areas of ALMAPRO's Project Activities:

- Technological equipment for road tunnels within urban and suburban areas,
- Telematics systems in cities and on highways,
- Construction of traffic signaling systems in major cities,
- Construction of urban and highway cable infrastructures, high-speed rail projects,
- Cybersecurity issues in road infrastructure construction.

Selected Reference Projects in the Role of the Delegated Expert:

Tunnels:

- Prague: Strahov Tunnel, Mrázovka Tunnel, Blanka Tunnel, Těšnov Tunnel, Letná Tunnel, Zlíchov-Radlická Tunnel,
- Brno: Pisárecký Tunnel, Husovice Tunnel,
- Highway D0: Lochkov Tunnel, Cholupice Tunnel,
- Highway D1: Klimkovice Tunnel,
- Highway D35: Dětřichov Tunnel, Maletín Tunnel,
- Highway D11: Opevnění Tunnel, Poříčí Tunnel, Kamenný Vrch Tunnel,
- Class I road tunnels: Jihlava, Hřebeč,
- Tunnel control dispatch center for the Prague Ring Road for the Highway Administration and Maintenance Center Rudná,
- Tunnel control dispatch center for the Strahov Automotive Tunnel,
- Main Traffic Control Center in Prague.

Telematics:

- Telematics System of the Capital City of Prague
- Traffic Information Center Prague
- System for performance-based electronic highway toll collection in the Czech Republic
- Traffic lane control system on the Prague Ring Road
- National Transport Information Center in Ostrava

Traffic Signaling Systems:
Prague, Pilsen, Brno, Ostrava

As the delegated expert in *NMC 136,* Řehák focused on communication-related subjects. ISO/TC 204/WG 16 – Communications currently manages 53 standards, of which one standard was adopted into the Czech Technical Standards system through translation and nine standards were adopted in their original form. These standards address communication within the ITS field, introducing a platform that unifies various communication technologies (LTE, DSRC, InfraRed, Bluetooth, etc.). It creates a communication framework that is fully transparent to other ITS technologies, simplifying the optimal selection of suitable communication media.

Among the most significant standards within ISO/TC 204/WG 16 is the CSN ISO 21217 Intelligent Transport Systems – Station and Communication Architecture, which introduces the concept of ITS stations, the fundamental building block of all cooperative C-ITS systems (C-ITS standards reference standard).

D1 Highway Klimkovice Tunnel – tunnel technological equipment

Jan Vlčinský

Ing. Jan Vlčinský has been involved in the processing and provision of traffic information since the time when most messages were sent via fax, when usable digital map data for road networks only existed in bold visions and progressive mobile operators used Wireless Application Protocol (WAP) to disseminate traffic information. In his company, he developed a range of solutions, such as for the call center ABA a.s. – Autoklub Bohemia Assistance.

He is a Managing Director of TamTam Research s.r.o. Collaborating with Petr Bureš, they initiated pilot testing of RDS-TMC in the Czech Republic, which later led to the establishment of TamTam Research s.r.o., where they jointly focus on distributing traffic information, monitoring its quality, and supporting its effective provision.

He worked with various entities through project engagements, including the Transport Research Center, the Technical University of Ostrava, and the Faculty of Transportation Sciences at the Czech Technical University.

Since 2009, he has been a *NMC 136 – Transport Telematics* member and serves as the delegated expert of the CEN/TC278 WG8 work group, which deals with traffic information DATEX II.

In designing data formats, APIs, information systems, and their integration, he values open interoperability, usable documentation, and both technical and content quality.

Overview of Selected Projects and Implementations

Editorial and presentation systems for transport information:

- Call center ABA a.s. – Autoklub Bohemia Assistance,
- National Transport Information Center: Editorial system for the *Methodology for Influencing Behavior of Traffic Participants through Media for the Ministry of Transport of the Czech Republic*, for ABA (circa 2003),
- Traffic Info: Display of traffic information for Czech Radio editors,
- CDI2/3: Traffic Information Center for the Police of the Czech Republic.

RDS-TMC:

- Pilot operation of RDS-TMC in the Czech Republic, verification of the usability of the system,
- Nationwide RDS-TMC broadcasting with Czech Radio and TELEASIST (2005),
- RDS-TMC broadcasting by the Technical Road Administration of the Capital City of Prague, in the Prague region,
- TurboTMC: Upgrade design of RDS-TMC for higher transmission capacity (research project),
- RDS-TMC Maps (https://rdstmcmaps.tamtamresearch.com): Reception of RDS data, decoding of RDS-TMC content, visualization of current and historical content,
- RDS-TMC-cz: Nationwide RDS-TMC broadcasting for Road and Motorway Directorate (2022) and subsequent supervision.

TPEG:

- DABaTPEG: Research project with Czech Technical University, Faculty of Transportation Sciences: Broadcasting TPEG via DAB.

Back office, distribution systems, system integration, and API designs:

- CE-Traffic a.s.: System for receiving primary data and providing resulting data,
- SUPERHUB (https://www.superhub-project.eu): Integration tests of the planner,
- Kamelot, research project: Distribution of traffic information, its documentation, and quality monitoring,
- C-ROADS (https://c-roads.cz): Research project developing C-ITS usage in the Czech Republic. Role: Subcontracted back-office and integration with other systems,
- C-ZONE (https://c-zone.cz): Research project: Optimization of road closure approval process and subsequent traffic information distribution. API design and DENM message distribution.

Documentation of traffic information and quality monitoring:

- Monitor: Research project: Monitoring the quality of traffic information. Role: analyst,
- InQMS (https://inqms.tamtamresearch.com/): Research project: Monitoring the quality of traffic information,
- Traffic Information Registry (https://registr.dopravniinfo.cz): National access point with documentation of National Transport Information Center data sources, their formats, and retrieval methods,
- IS Nominated Person: Implementation of a system (for the Transport Research Center) to support the functioning of a nominated person monitoring the compliance and quality of traffic information provision.

DATEX II

- DATEX II Browser (https://datexbrowser.tamtamresearch.com): Model browsing,
- 3rd DATEX II User Forum Prague 2014: Regular (biennial) conference of the DATEX II community in Europe. Role: Initiator of the event in Prague, member of the core organizing team,
- Location Referencing for Dummies: Presentation of various ways of describing locations to convince traffic information providers in the Crocodile project to also support OpenLR,

- Implementation of the European DATEX II Standard for Traffic Information Exchange: Beta project to support the Ministry of Transport in implementing DATEX II in the Czech Republic,
- RODOS (http://www.centrum-rodos.cz): Research project with the Technical University of Ostrava on the topic of the Development Centers for Traffic Systems. Role: DATEX II consultant,
- LOD-RoadTran18 (https://cef.uv.es/lodroadtran18): European research project (Connecting Europe Facility – CEF): Providing traffic information (Safety-Related Traffic Information) as Linked Open Data.
- NAPCORE (https://napcore.eu): European research project (CEF) focused on developing DATEX II usage. Role: Analyst, Consultant.

A Brief History of Providing Traffic Information in the Czech Republic

In 2004, a project named the *Unified Traffic Information System for the Czech Republic* was established, coordinated by Jaroslav Zvára. In 2005, the National Transport Information Center was officially established and, in the following years, individual modules of the system began operation. These modules already used digital map localization, and the Czech Standard format known as DDR became established.

In subsequent years, integration with traffic information providers took place, including firefighters, medical emergency services and especially the Czech Police, which integrated its CDI2 system. In 2005, the TELEASIST company, in cooperation with Czech Radio, launched nationwide RDS-TMC broadcasting on the Czech Radio station, Radiožurnál, followed by the National Transport Information Center on the Vltava station in 2008.

In 2016, the Ministry of Transport, as part of the project Implementation of the European DATEX II Standard for Traffic Information Exchange, created a methodology for implementing DATEX II in the Czech Republic. The National Transport Information Center subsequently implemented data sources in the DATEX II format.

The European Commission issued a regulation requiring the establishment of a National Access Point (NAP) to improve data source accessibility. In 2016, the *National Traffic Information Registry* (https://registr.dopravniinfo.cz) was established in the Czech Republic.

At the end of 2022, the upgrade of nationwide RDS-TMC broadcasting with National Transport Information Center data was completed.

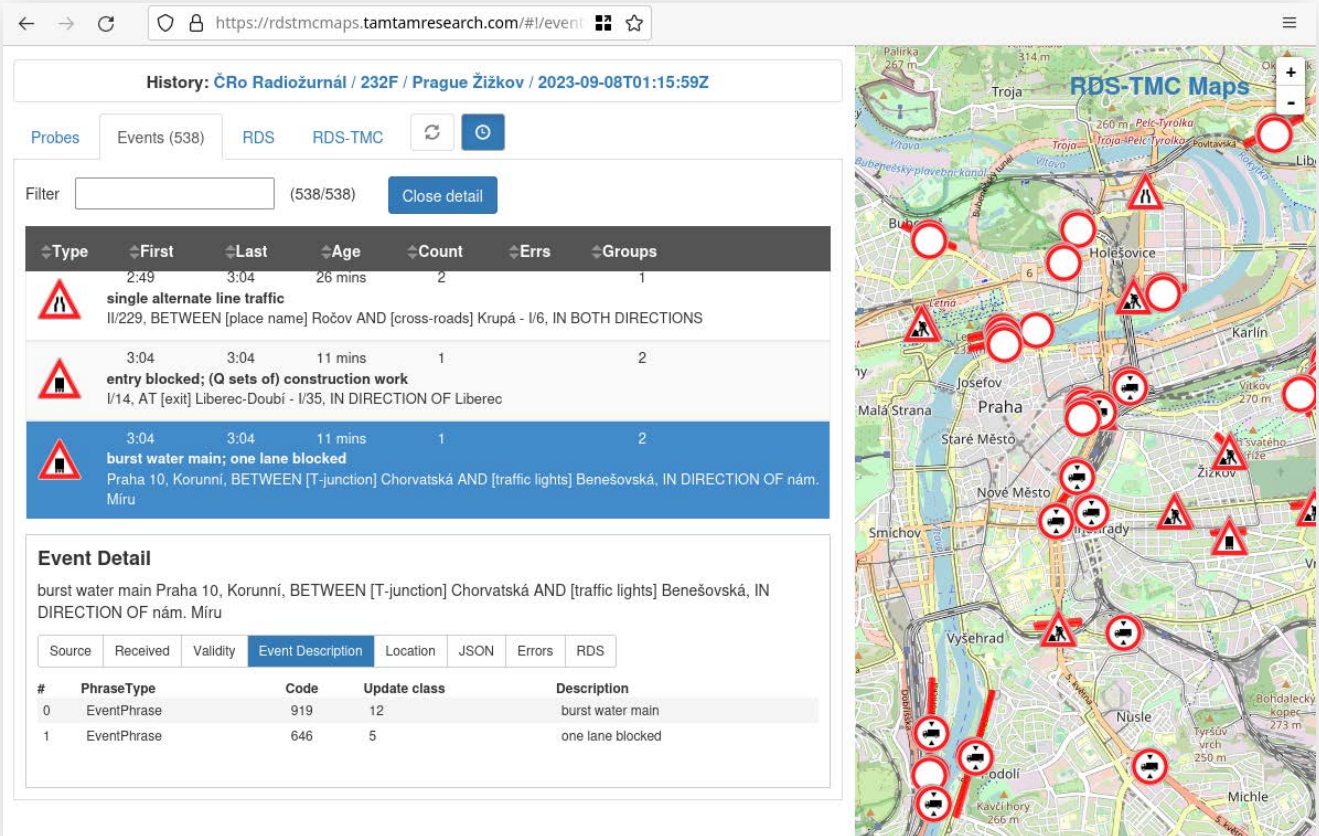
DATEX II in Europe

DATEX II solves road traffic information and, in terms of the number of supported application areas, implementation rates, and continuity, is a very successful project. DATEX was established in the 1990s, and the design of DATEX II (with the first implementation of v1.0) followed in 2006, shortly after the turn of the millennium. It is now in operation in v2.x and v3.x, with a concept for version 4.x being prepared.

The initial set of standards for v1.x had three parts and only dealt with providing general traffic information. The current v3.x version has 12 parts, with more being added. The planned integration of TN-ITS into DATEX II will add the attribute of updating map sources.

The European Commission supports DATEX II through two types of projects: pan-European projects that develop DATEX II as a tool and regional projects that support both implementation and exchange in the project corridors. The Czech Republic falls within the *Crocodile Project Corridor*, which includes Poland, Slovakia, Hungary, Austria, Germany, Slovenia, Croatia, Greece, Romania, Bulgaria, Cyprus, and Italy.

RDS-TMC Maps: Monitoring of current and historical broadcast content



Integrated transport information, management and control (ISO/TC 204/WG 9)
Traffic control (CEN/TC 278/WG 5)

Zdeněk Pliška

Ing. Zdeněk Pliška is the Executive Director of ALMAPRO, s.r.o. (www.almapro.cz). He has been professionally involved in telematics systems since 2002 and is a co-founder of an elite design office primarily focused on the project preparation of telematics systems in the Czech Republic and Europe. He is authorized as an engineer for Transportation Structures by the Czech Chamber of Authorized Engineers and Technicians, a long-standing member of *NMC 136*, and the delegated expert of CEN/TC 278/WG 5 a ISO/TC 204/WG 9.

Pliška has contributed to conducting the following significant ITS projects:

- A research project of the Ministry of Transport named the *Implementation of the Toll System in the Czech Republic,*
- Member of the implementation team for toll system construction in the Czech Republic,
- Author of the Telematics Architecture in the area of Prague,
- Member of the implementation team for the construction of a driver information system based on traffic information devices installed in Prague,
- Deputy Chief Designer for the preparation of Signalized Intersection Control Systems in Prague,
- Co-solver of Telematics projects on the D10, D6, D7 and D4 highways,
- Co-solver of projects for the construction of traffic lane control on the D0, D1 and D5 highways,
- Co-solver of the study and project for the construction of a Traffic Control Center in České Budějovice,
- Co-solver of Traffic Lights Audit in the area of Prague,
- Co-solver of the study of traffic lane control development in the Czech Republic (member of the ITS&S team),
- He has been extensively focused on ITS in cities, highways and in tunnels,
- He is an author/processor of project proposals for the construction of ITS systems in the Czech Republic.

Pliška has served as the national delegated expert of ISO/TC 204/WG 9 and CEN/TC 278/WG 5 for several years. The mission of this work group is to address the issues of traffic control systems and traffic centers.

Significant standards include documents such as ISO/TS 19468, addressing data interfaces between traffic centers on an independent data model platform, and ISO 148274, focusing on data interfaces between traffic centers using an XML-based protocol (Profile B).

Traffic Information and Control Center in České Budějovice

Mobility integration (ISO/TC 204/WG 19, CEN/TC 278/WG 17)
Nomadic devices in ITS systems (ISO/TC 204/WG 17)

David Bárta

Mgr. David Bárta is an expert focused on smart cities and the utilization of sensor networks of the *Internet of Things* (IoT) for integrated territorial investments. He worked extensively with IoT sensor and network hardware and software developers, data analysts, and experts from various fields.

After 6 years in transport research, he founded his own consulting company, *CityOne*, which focuses on creating development strategies and planning investments for cities or companies, as well as data-driven decision-making. He is the author of the *National Methodology for Smart Cities* (2015), European specifications for intelligent urban access management based on air quality (CEN TS 17378), designer and operator of sensor networks for cities or companies, as well as the publisher of the educational magazine *CITY:ONE* for sharing best practices among cities in Central Europe.

Bárta has been deeply involved in urbanism and its impact on city transportation, including related fields such as energy/electromobility, traffic flow detection, zone regulation and parking, pedestrian safety at crossings, smart public transport stops, and climate sensor networks.

Some of his main activities and work results include:

- Architect and operator of IoT systems for ŠKODA AUTO, Kvasiny plant (2017, traffic load in municipalities and parking navigation system for employees), Mladá Boleslav plant (2019, traffic safety in the facility, climate network, and frost predictor). The systems collect data from hundreds of IoT devices of various types, and it was the first IoT traffic geofencing in Central Europe,
- Architect of the CityLab in Žilina, Slovakia (https://www.clevernet.sk/cs/citylab/, 2021), the first IoT traffic geofencing center of the city,
- Architect of the first municipal IoT climate sensor network in the Czech Republic for the city of Orlová (2023),
- Publisher of the CITY:ONE magazine (since 2017).

Standardization

Bárta served as a long-term secretary of the Center for Technical Standardization SILMOS s.r.o. for *NMC 136 – Transport Telematics* (2003–2011) and was a regular participant in meetings of the European CEN/TC 278 committee. In 2011, he was one of the main organizers of the first ISO/TC 204 meeting in Prague. He has translated dozens of CEN and ISO standards. In 2008, as part of the Ministry of Transport's STANDARD Project, he contributed to creating a new presentation format for standard content, called *Extract*, which aims to briefly explain both content and usability standards in practice before their purchase. He has processed dozens of extracts, particularly for urban ITS and portable devices. He is also a co-author of the dictionary of transport telematics (1,500 entries) and the dictionary of transport (9,500 entries).

Science and Research Projects

- From 2011 to 2016, Bárta worked at the *Transport Research Center* in the Transport Telematics Department. He was the author and co-researcher of many research projects, both national and European.
- In the *POSSE* project, he was recognized with an award by the Interreg IVC program for designing the parking policy of the city of Karlovy Vary, supported by an IoT sensor network (2013).
- In the *Smart Slovak and Czech Cities* project (2013–2014), he created the first Smart City interpretation concept with a pilot implementation of a smart parking system in Žilina.
- In 2015, he became the principal author of the national methodology for the *Concept of Smart Cities* for the Ministry of Local Development. This methodology was followed by two national projects: the *SmartNet Project*, which deals with a sensor network for traffic flow and air quality, and the *SmartMap Project*, which explores the availability of open data for spatial planning and the use of business

Components of a sensory network deployed as a traffic-climatic network

LoRa network *Traffic sensor* *Microclimate unit* *Frost sensor* *Parking sensors* *Facade sensor*

intelligence for data analytics. The results of the SmartNet project, which, for example, analyzed available low-cost air quality sensors and subsequently assessed the quality and reliability of measurements, later influenced the content of the CEN TS 17378 standard on traffic control in cities based on air quality.

- After establishing his own consulting practice, he joined the *CleverNet* project. Here, he developed a conceptual approach to deploying sensor networks for various use cases, as well as designed and co-implemented a city laboratory in the form of a sensor network for traffic and climate. He deployed the first low-cost IoT traffic geofencing in the city center, as well as a sensor map of heat islands. This data is now used for designing public space modifications in response to climate change and for parking policy. The data is designed as open-source and is available at https://dashboards.clevernet.sk.
- He is currently involved in the Interreg Central Europe *NXTLVLparking* project (2023–2026), which aims to offer parking policy as part of the Sustainable Urban Mobility Planning (SUMP), including green aspects. In this project, CityOne is responsible for applying these findings to parking policies in the cities of Olomouc and Žilina.

Implementation and Operation of IoT Systems

One of his most significant activities is the long-term operation of a sensor network for ŠKODA AUTO's Kvasiny plant. As the architect of the entire solution, he connected the client's needs with those of neighboring municipalities. The system provides permanent parking occupancy monitoring for plant employees (2,000 places) using several IoT traffic magnetometers of Czech production. It is supplemented by a navigation system in municipalities using variable traffic signs.

The system further covers all access roads and, in 2017, it became the first traffic geofencing in Central Europe, performed by a network of up to two hundred sensors and devices and built on three different IoT connectivity technologies. This created a unique laboratory, identifying the limits of detection and connectivity in actual practice. The system has been gradually upgraded, and the current third version is built on second-generation classification magnetometers with LoRaWAN connectivity. In another ŠKODA AUTO plant in Mladá Boleslav, he implemented his own robust LoRaWAN network at a height of 60m to provide connectivity not only for internal needs but also as a natural data interface between ŠKODA AUTO and the city. He also deployed the first IoT Frost Predictor service, which provided a warning of frost occurrence to maintenance workers up to three hours before the event, based on data from various sensors and data inputs. For example, using the transport network, it provides statistics on traffic safety evaluation.

CITY:ONE Magazine

Bárta is well aware of the difficulty of implementing innovations into practice, mainly due to a lack of information and knowledge on the side of the state and local governments. He followed up on previous experiences by publishing the Smart Cities magazine (2013–2016) and began publishing a CITY:ONE magazine in print form, with the aim of mediating innovations from various cities in Central Europe. The magazine is not sector-specific. Its purpose is to overcome this *tunnel thinking* and offer more cross-sector and integrated territorial investments. The latest issue of the magazine (January 2023) focuses on the decentralization of energy supply in a specific area. This includes the required productions from renewable sources, accumulation, stabilization of the transmission network, electromobility, as well as digitization of spatial planning, inspired by the UK government's strategy and activities of the *Connected Places Catapult*.

Other Conceptual and Methodological Activities

- Methodological guidance of the *Smart Stop* study (Transport Research Center, 2013)
- Co-author of the Methodology for the Ministry of Transport for the certification of ITS devices and compliance with European directives (Technology Agency of the Czech Republic, Beta, 2016)
- Co-author of the methodology for the implementation of DATEX II for the Ministry of Transport (Technology Agency of the Czech Republic, Beta, 2016)
- USER FORUM, Prague, May 2014, award for best presentation in the section
- Translator of the first versions of DATEX II standards into the Czech language (2012)

City:One,
a magazine about innovations in Central European cities

Public transport/emergency (ISO/TC 204/WG 8)
Public transport (CEN/TC 278/WG 3)

Zuzana Švédová

Ing. Zuzana Švédová, Ph.D., is a qualified transportation engineer with over 17 years of experience. Her expertise is focused on sustainable urban mobility planning, development and implementation of transportation systems, and standards for multimodal data exchange.

As a research scientist, she has been working at the Transport Research Center since 2006, engaging in research projects aimed at developing central public transportation information systems, and creating methodological and strategic documents to support ITS development. She also has international experience, collaborating with local and regional transportation organizations within interregional projects focusing on sustainable urban mobility planning and implementation.

Since 2020, she has been a member of the international team of DATA4PT and NAPCORE implementation projects. These projects aim to accelerate the adoption of EU standards for multimodal data exchange throughout the EU and to assist EU stakeholders in responding to the European Commission's requirements regarding open data. Her work contributes to providing more efficient, sustainable, and user-friendly urban mobility for all citizens. She is also involved in the professional preparation of the ITS Library web platform, which focuses on informing about the state of ITS system development and implementation in the Czech Republic.

She has been involved as a project leader in various projects, such as:

- System for predicting traffic flow dynamics based on deep neural networks (2020–2023)
- Development of an integration platform for Mobility as a Service (MaaS) in the field of parking systems (2021–2023)
- New technologies utilizing Big Data and IoT systems for continuous road network performance monitoring (2021–2023)
- Development of the ITS Library web platform and related software tools (2021–2023)
- Smart solutions supporting low-emission zones and other low-carbon mobility policies in EU cities (Interreg Central Europe 2016–2019)
- Opportunities for mitigating adverse impacts of transportation on the environment through innovative sensor networks integrated into transportation information and control systems (2015–2017)
- Public transportation stabilization in relation to state conceptual documents (2015–2016)
- ITS component and application conformity assessment (2015–2016)
- Technical support and methods for verifying interoperability of dispatching and information systems in public transportation (2012–2015)
- Promoting open specification and standards for the EU (Interreg 2012–2014)
- Youth education regarding sustainable transportation (2014–2015)
- Unified data system in public transportation with consideration for standard-format application with the possibility of connecting existing systems into a unified software platform (2011–2013)
- Sustainable transportation – a chance for the future (2004–2008)
- Proposals of information technology standards in public personal transportation with respect to their mutual compatibility (2009–2010)

Public transportation services in the Czech Republic

In the Czech Republic, public transportation services and information systems are at a high level, but they are continually evolving and improving in response to increasing demands for service quality. Here are some ways in which these services are evolving in the Czech Republic:

Modernization of Information Systems

Public transportation service providers and transportation companies are investing in modernizing their information systems, including updating hardware and software to ensure reliable operation and high service availability. For example, this includes modernizing websites, mobile applications, information panels at stops, and traffic information centers.

Expansion of Coverage and Availability

Efforts are being made to expand the coverage of information systems in public transportation to a greater number of regions and cities in the Czech Republic. The goal is to provide intelligent mobility services not only in large cities but also in smaller towns and regions, in order to improve information availability for passengers to equal levels.

Integration of Multimodal Services

A current trend is the integration of different modes of transportation into a single system. This includes linking buses, trains, trams, shared mobility services, and other transportation options into one integrated system. This allows passengers to plan and pay for their journey across different

modes of transportation. For example, the Oneticket service enables convenient travel anywhere and anytime with a single advantageous ticket across all participating carriers and train connections in the Czech Republic. Regional integrated transportation systems succeeded in the integration of check-in and information systems among participating carriers.

Innovation and New Technologies

Transportation companies are interested in utilizing modern technologies, such as artificial intelligence, big data, the Internet of Things (IoT), and more, to enhance public transportation services. This includes, among other aspects, using predictive analytics to forecast delays, implementing smart stops, or employing mobile payment solutions.

Collaboration and Standardization

Transportation companies collaborate and share their experiences and expertise in developing information systems. Collaboration with other partners, including municipalities, regions, technology companies, and universities, also plays a significant role. All of these activities are united under the common denominator of standardization and adherence to European and international norms.

The field of standardization and adherence to European and international standards plays a crucial role in unifying information systems in public transportation. Regulation (EU) 2017/1926, following Directive 2010/40/EU, provides clear guidance on meeting the necessary requirements to ensure that multimodal travel information services across the EU are accurate and accessible to ITS users across borders. This is specifically based on the accessibility and exchange of travel and transportation operations data and their respective updating.

It defines requirements, emphasizing that the state's internal access point should use the CEN standards for data exchange, such as NeTEx CEN/TS 16614, based on the Transmodel EN 12896: 2006 reference model, to exchange static data regarding regular transportation (e.g., public transport, long-distance coach transport, and maritime transport, including ferry transport). The SIRI CEN/TS 15531 standard is defined for dynamic data exchange.

In the Czech Republic, the *National Public Transport Information System* (CIS) has been gradually implemented since 1998–1999. The system covers intercity bus lines, urban bus transportation, and railway transportation. The Ministry of Transport is responsible for operating the system. CIS provides timetables in both human-readable and machine-readable formats, but some associated services, such as journey planners, are not part of CIS. The information contained in CIS is published as open data in the *National Catalog of Open Data* (NKOD), which is managed by the Ministry of the Interior. Thus, this catalog can be considered as a national access point to open data in the sense of Article 3 of the Delegated ITS Regulation (1926/2017).

Further assesments is expected in the future, aiming to evaluate which functions a public transportation timetable information system should have, and to reconsider the roles of government administration and commercial entities in providing these services. Furthermore, support for creating this system and other systems that promote the development of intelligent mobility will be important.

Passenger processing system (source: iStock.com/Anna_Anikina)

General fleet management and commercial/freight (ISO/TC 204/WG 7)

Eva Gelová

Ing. Eva Gelová has worked with the Transport Research Center since 2003 as a research scientist specializing in transport telematics and project management. Soon after, she became involved in the field of standardization within *NMC 136*.

Over these twenty years, she has been involved in numerous national and international projects, as well as commercial contracts. As a project manager, she led both small and large projects in the fields of science, research, and education.

Her original profession in civil engineering provides her with a beneficial perspective for addressing broader urban issues and mobility solutions. Her experience as an educator contributes to activities focused on both education and training.

Professional and Scientific Activities

Strategic Documents:
- Conceptual documents for ITS, including the Strategic Plan for ITS in the Czech Republic
- Updates to the Implementation Plan for ITS in the Czech Republic
- Progress reports on ITS implementation in the Czech Republic for the European Commission

Research Projects in Areas of:
- ITS for traffic control
- ITS and freight transportation
- ITS and public transportation
- ITS and psychology for traffic safety
- ITS and cycling
- ITS and parking
- Sustainable mobility
- Smart City and Smart Region

Support of the Professional Community:
- Organization of conferences, workshops, and seminars
- Long-term maintenance of the ITS Library website (available online)

Education Preparation:

- Coordination of methodology and teaching materials for sustainable mobility education at primary and secondary schools

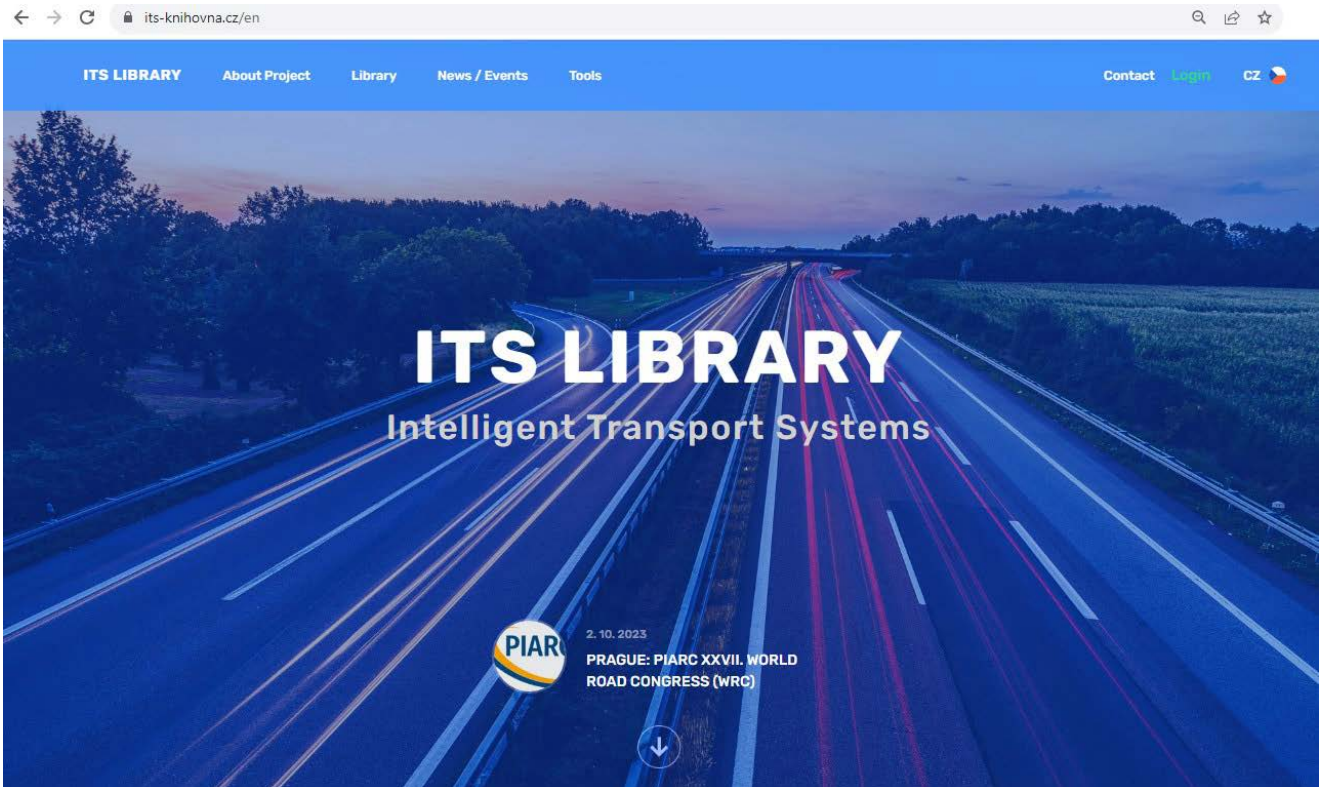
Recent Publishing Activities

Ongoing updates to the ITS Library as a Czech knowledge database in the field, in collaboration with colleagues from the Transport Research Center, Available online at: https://www.its-knihovna.cz.

Eva GELOVÁ, Jan MYNAŘÍK, Jan VLČINSKÝ et al. CZECH NATIONAL STRATEGY OF DEVELOPMENT OF INTELLIGENT TRANSPORT SYSTEMS AND LINKED ACTIVITIES. Perner's Contacts [online]. 2021, vol. 16, no. 2 [cited 2021-12-30]. Available online: https://pernerscontacts.upce.cz/index.php/perner/article/view/1723. ISSN 1801-674X.

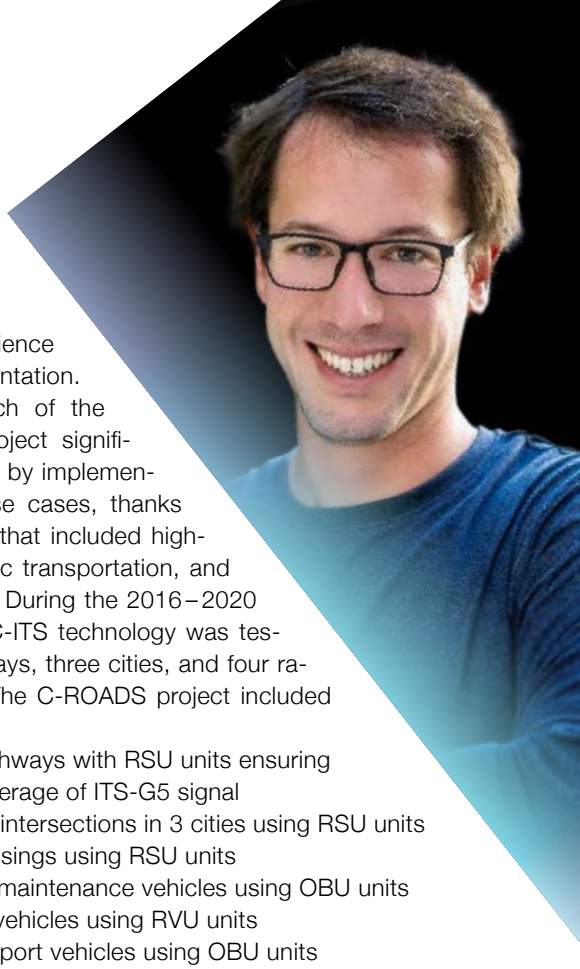
Martin PÍPA, Martin BAMBUŠEK, and Eva GELOVÁ. Solutions to the Problems of Intensive and Burst Traffic in Municipalities. For SMART REGION 2020. Brno, January 23, 2020.

ITS Library website (by the CDV, v.v.i.)



Cooperative systems (ISO/TC 204/WG 18)
Cooperative ITS (CEN/TC 278/WG 16)

Jiří Beneš



Ing. Jiří Beneš is an expert with extensive experience in intelligent transportation systems, primarily on roadways, including highways, and urban telematic systems.

He worked in the research and development department of a leading Czech telematics company, focusing on the operation and evaluation of tunnel and highway control systems (traffic lane control). He contributed to developing a mobile telematics system warning about highway convoys, and other telematics projects. Here, he also engaged with cooperative systems, both in developing the actual cooperative units and implementing pilot projects for cooperative systems in the Czech Republic.

Currently, he serves as a project manager and analyst for transportation systems at INTENS Corporation s.r.o., a technological company and a key supplier to the C-ROADS CZ project. In this role, Beneš was involved in equipping selected highways with infrastructure RSUs, delivering OBU units, their SW application equipment and implementing the central C-ITS back-office server solution.

Cooperative Intelligent Transportation Systems in the Czech Republic

The implementation of C-ITS in the Czech Republic began in 2016 as part of the European C-ROADS Platform project, in which the Czech Republic was a founding member due to prior experience in C-ITS implementation. The Czech branch of the C-ROADS CZ project significantly contributed by implementing numerous use cases, thanks to a broad focus that included highways, cities, public transportation, and railway crossings. During the 2016–2020 implementation, C-ITS technology was tested on two highways, three cities, and four railway crossings. The C-ROADS project included equipping:

- 230 km of highways with RSU units ensuring complete coverage of ITS-G5 signal
- 25 signalized intersections in 3 cities using RSU units
- 4 railway crossings using RSU units
- 109 highway maintenance vehicles using OBU units
- 124 warning vehicles using RVU units
- 7 public transport vehicles using OBU units
- 1 fire rescue vehicle using an OBU unit

These C-ITS units were integrated into the central C-ITS Back Office element used for system management. It enables hybrid communication between the units using mobile operator networks and facilitates information sharing via an Integration platform. This platform connects multiple central elements and enables third-party information retrieval. The

Alerts drivers to an approaching vehicle of the Integrated Rescue System or rescue locations

RSU unit

C-ITS Back Office also enables connecting units to the public key infrastructure, functioning as a certification authority, assuring communication reliability by signing C-ITS messages exchanged between the individual units with digital certificates, preventing message forgery.

Significant use cases on highways include warnings about ongoing roadwork, adverse weather conditions, traffic congestion, and the transfer of information and traffic signs from infrastructure to vehicles. Additional use cases were tested during pilot operations, such as the passage of an integrated emergency system vehicle, warnings about stationary and slow-moving vehicles, and more.

Among the “urban” use cases are requests for priority at signal-controlled intersections, both for urban public transport and emergency vehicles, as well as warnings about public transport vehicles leaving a bus stop. A unique use case in the pilot operations was the broadcasting of C-ITS messages warning about a passing train at a dangerous railroad crossing.

Overview of state and corporate entities providing this service in the Czech Republic:

- Road and Motorway Directorate
- Brno Roads
- Brno City Transport Company
- Statutory City of Mladá Boleslav
- Ostrava City Transport Company
- Hradec Králové City Transport Company
- Pilsen City IT Administration

Key Standards CEN/TC 278/WG 16 and ISO/TC 204/WG 18

The most significant standards, introduced by the ISO/TC 204 WG 18 working group, currently used within implementation projects of cooperative systems in the Czech Republic, are ISO/TS 19321, containing a data dictionary for In-Vehicle Information (IVI) provision, and ISO/TS 19091 defining the use of cooperative ITS in applications related to signal-controlled intersections. The WG18 is currently focused on developing standards for data communication security (EN ISO 21177, CEN/TS 17429).

C-ITS unit

Jan Votoupal

Ing. Jan Votoupal is an expert specializing in telematics, smart mobility, and the processing of signaling data from mobile phones. He works at INTENS Corporation s.r.o., which is owned by O2 Czech Republic a.s. Besides methodological and project management leadership in projects focused on requirements analysis, system design, and delivery, he also engages in conceptual document processing, strategies, and technical specification documents. He also works on research and development projects in the field of transportation and telematics through the Technology Agency of the Czech Republic, as well as collaborating on public sector projects under the *Innovation Partnership Procedure*. Some of the projects he's been involved in include:

- Purchase of geolocation data from mobile operators for the implementation of the project Improving Conditions for Decentralization and Accessibility of Public Administration in a Territory (2021–2023)
- Development of the C-ITS system in the Brno metropolitan area (2021)
- Operation of the eCall simulator (2017–2020)
- Feasibility study of a predictive mathematical traffic model (2019)
- eCall Conformance Testing (2017)
- Transport telematics to enhance the safety of cyclists and pedestrians in road traffic for the Technology Agency of the Czech Republic (2014–2015)
- Revision of the Strategic Plan for Transport Infrastructure Development of the Slovak Republic by 2030 (2015)
- Implementation of applications and services using the Galileo and EGNOS satellite navigation systems in the Czech Republic for the Technology Agency of the Czech Republic (2014)

eCall button in a passenger car

In the context of the eCall system, Votoupal leveraged INTENS's know-how gained during the European research *HeERO Project* (Involvement of the Czech Republic in the European pilot project for automatic emergency calling from an eCall vehicle), which was executed in cooperation with the Ministry of Transport of the Czech Republic in 2011–2013. This project laid the foundation for the successful implementation of the eCall system in the Czech Republic in accordance with the EU decision and related regulatory framework.

The eCall System

The official introduction of the eCall system in the European Union took place on April 1, 2018, after which all new vehicles of category N1 and M1 must be equipped with an eCall unit in accordance with European specifications. The Czech Republic fulfilled its infrastructure obligations and prepared the E112 system to receive eCalls by October 31, 2017. Preparedness was ensured both by mobile operators and the 112 Emergency Call Center.

As the penetration of vehicles equipped with eCall increases on European roads, handling eCalls is becoming a common duty of emergency call center dispatchers. That said, in the Czech Republic, it is still a small part of the overall volume of emergency calls. A current standardization topic is the preparation and revision of standards regarding system operations in packet-switching networks, specifically the hybrid environment, which relates to the risk of future discontinuation of 2G networks by mobile operators. There is also consideration of mandatory eCall extension to other vehicle categories.

Standards, EU Legislation

Compliance with eCall deliverables plays a crucial role in the proper functioning of the eCall system across Europe. The system is interoperable, meaning individual national Emergency Call Centers accept emergency calls from vehicles within their state's territory. While specific technical implementation methods may differ, both in-vehicle eCall units and Emergency Call Centers must adhere to norms.

eCall in-vehicle unit

The family of eCall standards constantly expands, reflecting the preparation for eCall implementation in other vehicle categories and the development of mobile networks through which emergency calls are primarily transmitted. The basic framework of eCall was established by standards of application and operational requirements CSN EN 16062, CSN EN 16072, the standard defining the eCall data message CSN EN 15722, and CSN EN 16454 (eCall system conformity testing). The conformity of the eCall application for emergency call handling at Emergency Call Centers in the Czech Republic was tested according to the latter standard (see the overview of selected projects above).

Standards are subject to ongoing revisions, with the WG 15 working group responding to operational experiences on the European scale, as well as technological development. The operation of the eCall system was mandatorily introduced by European Parliament and Council Decision No. 585/2014/EU of May 15, 2014, for the infrastructure side (Emergency Call Centers and mobile operators) and European Parliament and Council Regulation (EU) 2015/758 of April 29, 2015, for the vehicle side.

Entities Handling eCall in the Czech Republic

- Ministry of Transport of the Czech Republic
- Ministry of the Interior of the Czech Republic (operation of Emergency Call Centers through the Fire Rescue Service of the Czech Republic)
- Road and Motorway Directorate (National Transport Information Center)
- Automotive sector – M1, N1 vehicle manufacturers (Škoda Auto, Toyota Motor Manufacturing, Hyundai)
- Private sector providing SW solutions – O2 ITS Services s.r.o., Vítkovice IT Solutions a.s., and others.

eCall on a motorcycle

NMC 136 – Transport Telematics and CTN SILMOS s.r.o.

NMC 136 – Transport Telematics was established in 2003 and has been working continuously in collaboration with the Czech Standardization Agency. The commission's Secretary, Ing. Jan Křivka, has held the position since 2011. The scope of *NMC 136* is primarily focused on thematically related commissions such as CEN/TC 278 Intelligent Transport Systems and ISO/TC 204 Intelligent Transport Systems, with overlaps into areas such as ISO/TC 22/39 Ergonomics. The field's dynamism is evident in technical standardization, where ISO/TC 204 has been ranked within the top tEN ISO commissions based on activity over the past five years. The primary mission of *NMC 136* is to ensure international cooperation, as well as to provide comments and adopt new standards and normative documents, but also to advocate for Czech Republic positions. The productivity of the standardization work is illustrated in the graph *Creation of Standards and Their Extracts in NMC 136* (see below), which shows that by the end of 2022, 558 titles have been processed. The specific nature of the new field is evident from its emphasis on the swift development of standardization documents. Due to faster processing and review procedures, these documents may not always have the full standard status but are often at the lower level as Technical Specifications (TS) or Technical Reports (TR). However, regular revision processes ensure an overview of the uses of these documents and facilitate their transition into full standards. This is exemplified in the area of DATEX II (WG 8). Lower-level deliverables necessitate careful expert assessment regarding which documents to incorporate into the CSN structure. This is a qualified process undertaken by the delegated experts. The novel nature of the field and the narrow segment of standards' users influence the number of standards designated for translation into Czech. The fact that, during *NMC 136*'s two decades of existence, 83 standards have been translated and integrated into the CSN system, is a result of exceptional cooperation on the part of the Czech Standardization Agency and the support of the Czech Ministry of Transport for this endeavor.

To ensure professional participation in the creation and review of normative documents, the role of a delegated expert was established with the support of the Czech Ministry of Transport, representing the Czech Republic within individual Working Groups (WG). The COVID-19 crisis accelerated the transition to online meetings, simplifying the continuous participation of delegated experts in WG (TC) meetings. The competence and respectability of *NMC 136* members within the WGs are demonstrated by the fact that a Czech representative, Mgr. D. Bárta, was the main processor of a European standard, CEN/TS 17378 Urban ITS – Air Quality Management in Urban Areas. Within the countries of Eastern Europe, the Czech Republic is a stable base for collaboration on the technical standardization of ITS, as is evident from the fact that in 2011, Prague hosted a large meeting of ISO/TC 204 and, in 2017, the session of CEN/TC 278.

The creative activity in the ITS technical standardization produced a total of more than 20,000 pages of normative documents. The need for quick orientation within this extensive body of standardization and the necessity of an efficient search system led to the creation of the STANDARD/StandardLand project. The outputs of this project, which are unique within the European scale, align with the intentions of EU Regulation 1025/2012 on European standardization. Table 1 shows that practically all approved standards have corresponding extracts, enabling users to gain detailed insight into the standards and the necessity of obtaining the original documents for further work.

Since its inception, *NMC 136 – Transport Telematics* has been actively supported by the Center for Technical Standardization (CTN) SILMOS s.r.o., which became the first institution in the Czech Republic to obtain CTN status in 2000. In addition to the STANDARD project, systematic efforts were primarily dedicated to creating national terminology for ITS in the Czech language. This terminology incorporates new standards into the CSN system and serves educational

SILMOS s.r.o.,
Technical Standardization Center and NMC 136 secretariat

Ing. Igor Večerka

Ing. Věra Vrtěnová

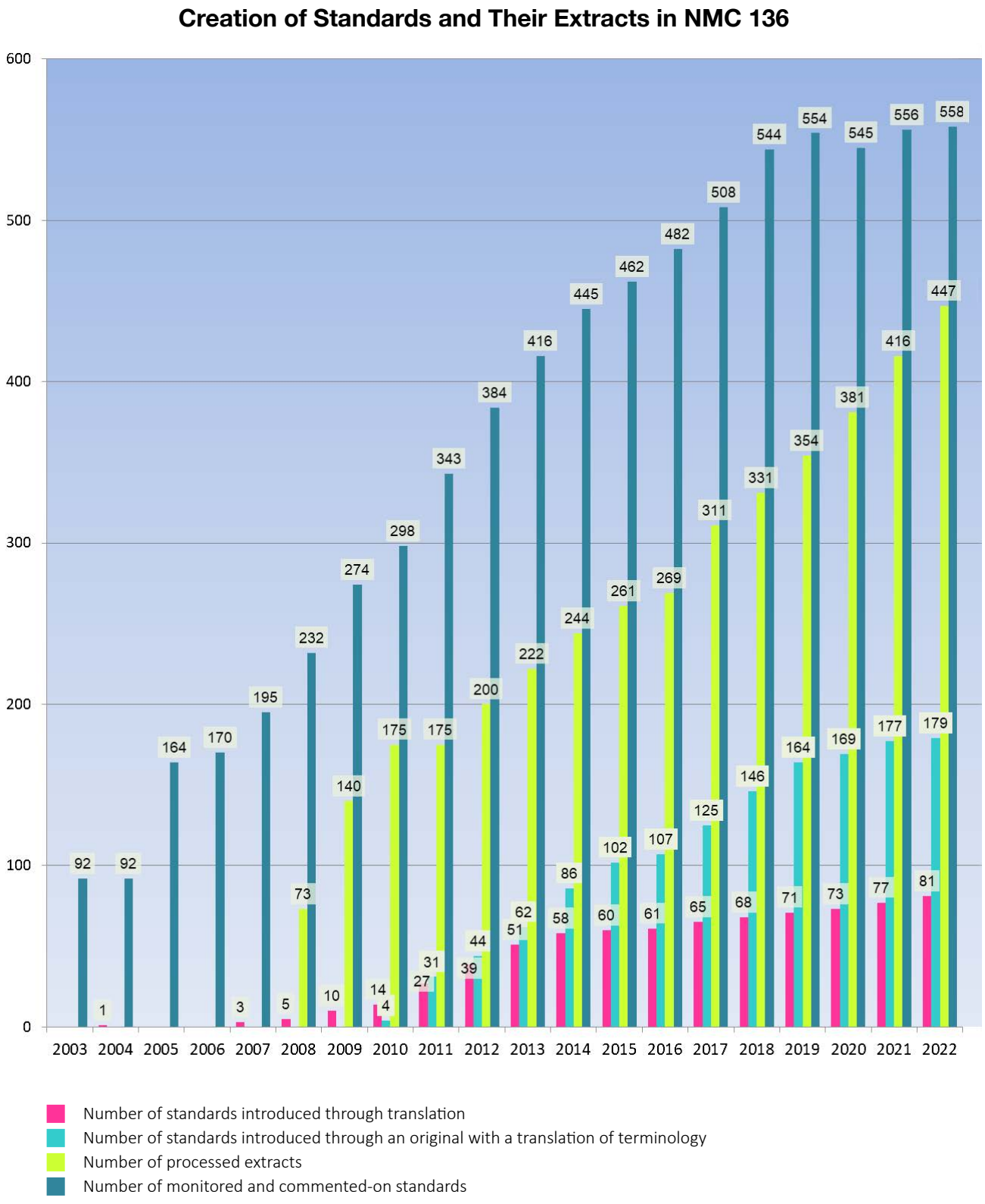
Mgr. Lenka Svorová

ČAS Agency
secretary for NMC 136

Ing. Jan Křivka

purposes in universities as well as practical applications for professional users. The result of this terminological work was codified Czech terminology in CSN 73 6100-5 Nomenclature of Road Transport – Part 5: Transport Telematics. Published in 2014, this standard is undergoing a complete revision in 2023 due to the field's rapid development and extensive expansion.

The results of the ongoing work of *NMC 136 – Transport Telematics* and SILMOS s.r.o. demonstrate our ability to collaborate at a cutting-edge level, not only in creating technical standards but also in their broad practical application. This is evidenced by the growing strength of Czech companies operating in the ITS domain. The exceptional founding role of Professor Pavel Přibyl, CSc., the long-standing chair of *NMC 136*, has influenced an entire generation of students and successors who actively contribute to ITS activities. Also, the unusual and steadfast support from the Czech Ministry of Transport ensured the stability of *NMC 136*'s long-term activities, facilitating the professional growth of its members within both European and international contexts, including research and technical standardization projects. The unique STANDARD/StandardLand project stands as a testament to this collaborative effort.



StandardLand: EXTRACT

Regulation (EU) No 1025/2012 of the European Parliament and of the Council on European Standardization imposes the *"making available free of charge on their website abstracts of standards"* on national standardization bodies in Article 6, paragraph 1e. Given the insufficient amount of information about the content of standards in traditional formal provisions of the 'scope' type, a new format called '*EXTRACT FROM THE STANDARD*' was developed in collaboration with *The Office for Technical Standardization, Metrology and State Testing*. This format provides detailed information about the content of the standard and enables users to make informed decisions about purchasing the entire standard.

Disadvantages of standards and advantages of extracts

STANDARDS	EXTRACTS
Extensive	**Concise (about 5 pages)**
Complex	**Easy to understand**
In English	**In the national language**
Expensive	**Free**
Inaccessible	**Available on the web**

EXTENSIVE – CONCISE
- Standards are becoming longer, often several dozen pages each.
- An extract is consistently limited to about 5 pages of text.

COMPLEX – EASY TO UNDERSTAND
- Standards describe increasingly complex subjects, processes, procedures, and multiple interconnected parts, volumes, etc.
- An extract is clear, based on a unified structure and compression of the standard's text.

IN ENGLISH – IN THE NATIONAL LANGUAGE
- European and international standards are universally processed in English.
- An extract is translated into the national language.

EXPENSIVE – FREE
- Standards are protected by copyright and their use (purchase) incurs costs.
- Extracts are provided for free as informational texts about the content of standards with a marketing effect.

INACCESSIBLE – ON THE WEB
- Standards are made accessible to users through payment mechanisms, printing, etc., and are protected from unauthorized access.
- Extracts will be freely accessible to users on the web of European and National Standards Organizations, TCs, or other interest groups.

The real-world application of extracts in the field of ITS standards demonstrated these advantages in practice. Out of a set of over 550 standards and deliverables comprising extensive standards totaling about 20,000 pages in English, extracts were produced for over 450 standards (i.e., practically all approved items). With the standard range of an extract being 4–5 pages, a 'summary of the content of standards' in Czech translation is thus available to the extent of about 1,700 pages (1:10 of the original). This system of extracts, accessible on the web, provides a complete informational foundation for the field, meeting the needs of practical usage, education, project management, contracting and procurement.

The methodology for producing extracts is generally applicable to all fields and types of standards. Its adoption, for instance, into the EN system and the simultaneous creation of extracts by the standard's processor would solve, without additional costs, the provisions of Regulation No. 1025/2012 at both the EN and CEN levels.

StandardLand: ITS TERMINOLOGY

ITSTerminoology is an online hypertext terminology database containing codified terms and abbreviations from standards, organized by subject area.

Creating and establishing accurate terminology for the field of Intelligent Transport Systems (ITS) has been a goal pursued by the technical standardization committee since its inception. When this field emerged twenty years ago, all normative and legislative documents were, and to a large extent still are, available only in English. Therefore, it was necessary to gradually create a terminological foundation through translations and then monitor and adjust the terminology as it stabilized in practicality as the ITS field developed.

Terminological work for the ITS field, carried out within the *NMC 136* committee, culminated in the form of book publications, Czech standards (CSN), and web dictionaries in the years 2006, 2010, 2014, 2015, and 2023.

The initial compilation of ITS terminology was in the form of the book *Terminological Dictionary of Transport Telematics,* published in 2006. The second edition went much further. The *Dictionary of Transport Terminology* already included four types of transport terminology: transport telematics, railway, road, and water transport. With the support of the Czech Ministry of Transport and other organizations, it was published in 2010 as a comprehensive publication exceeding 1,000 pages, with a Czech-English dictionary and an English-Czech index. Simultaneously, this four-group dictionary was transposed to the web format of the *Dictionary of Transport* (slovnikdopravy.cz), which is still functional and used by the public.

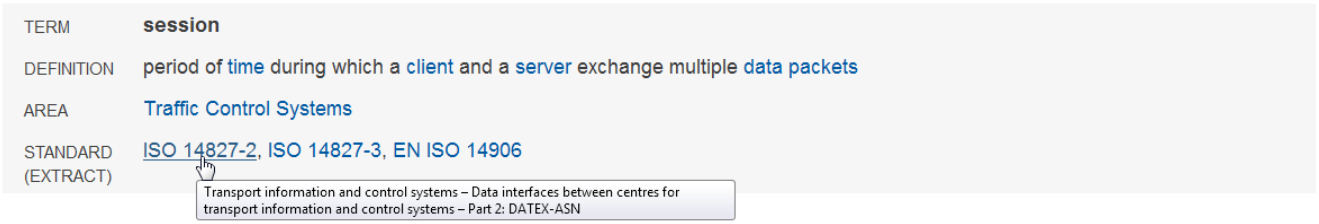
Just a few years later, in 2013, the rapid development of the ITS field and a significant increase in the number of European and international standards for this field necessitated the supplementation and updating of the terminology. The output was the standard CSN 73 6100-5 Terminology of Road Traffic – Part 5: Transport Telematics (2014).

The ITSTerminology.org website was created in 2015 based on this CSN and included the addition of about 1,000 new and revised terms. It represented a significant breakthrough, as it linked Module III: ITS Terminology with the other three modules of the StandardLand project. It was, and still is, an exceptional terminological hypertext dictionary, precisely thanks to the classified ITS terminology, as well as the interlinking of terms and definitions with source term references and extracts from source standards. This involves processing terminology in the context of standards, which had not been done before. During the CEN/TC 278 meeting in Prague in 2017, the work of the *NMC 136* gained admiration and appreciation from the then chairman of TC 278 and other conveners, as it not only met but exceeded the longstanding efforts of ISO and CEN TCs to unify the terminology of the field. The complete integration of all four modules was made possible by the new StandardLand.cz website (2019).

The above-mentioned CSN 73 6100-5 and, subsequently, the ITS Terminology web dictionary brought another novelty in addition to the categorized and unified terminology from CEN and ISO standards that had insufficiently respected unified nomenclature. This unique feature was the arrangement of terms. Instead of the usual alphabetic arrangement of unrelated terms, they were sorted thematically and hierarchically with respect to the division of ISO and CEN working groups (WGs). This allowed readers to view related terms from one area in a logical order within one chapter.

The many years of efforts within CEN/TC 278 and ISO/TC 204 to unify terminology in standards finally materialized in 2022 with the first issued international terminological standard for ITS, ISO/TS 14812 Intelligent transport systems – Vocabulary. This technical specification does not cover the entire field of ITS, containing over 300 terms and definitions, which is less than a tenth of the terms contained in ITS Terminology. However, it covers terms where consensus was reached at the international level.

Along with the need for continuous terminology updates, this technical specification provided a significant impetus for the update and revision of CSN 73 6100-5 and, subsequently, the web dictionaries. Therefore, new work on updating ITS terminology has been ongoing within the *NMC 136* committee since 2022, originating from two sources: one being the additions from adopted standards from 2015–2022, and the other the translation of terms from ISO/TS 14812, with the goal of completing and issuing a revised CSN by the end of 2023.



Example of the ITSTerminology.org website:
Each term displays its source document (standard). Hovering over a link with the mouse displays the standard's name. Clicking on the standard number redirects the user to the Extract of the standard.

StandardLand: ITSPEDIA

ITSPedia aims to create an “ITS Wikipedia” based on uniformly structured ITSpedia entries. While a definition suffices for the use of a term in a standard, an ITSpedia entry pertains to content-rich terms that describe specific processes, events, schemes, and solutions.

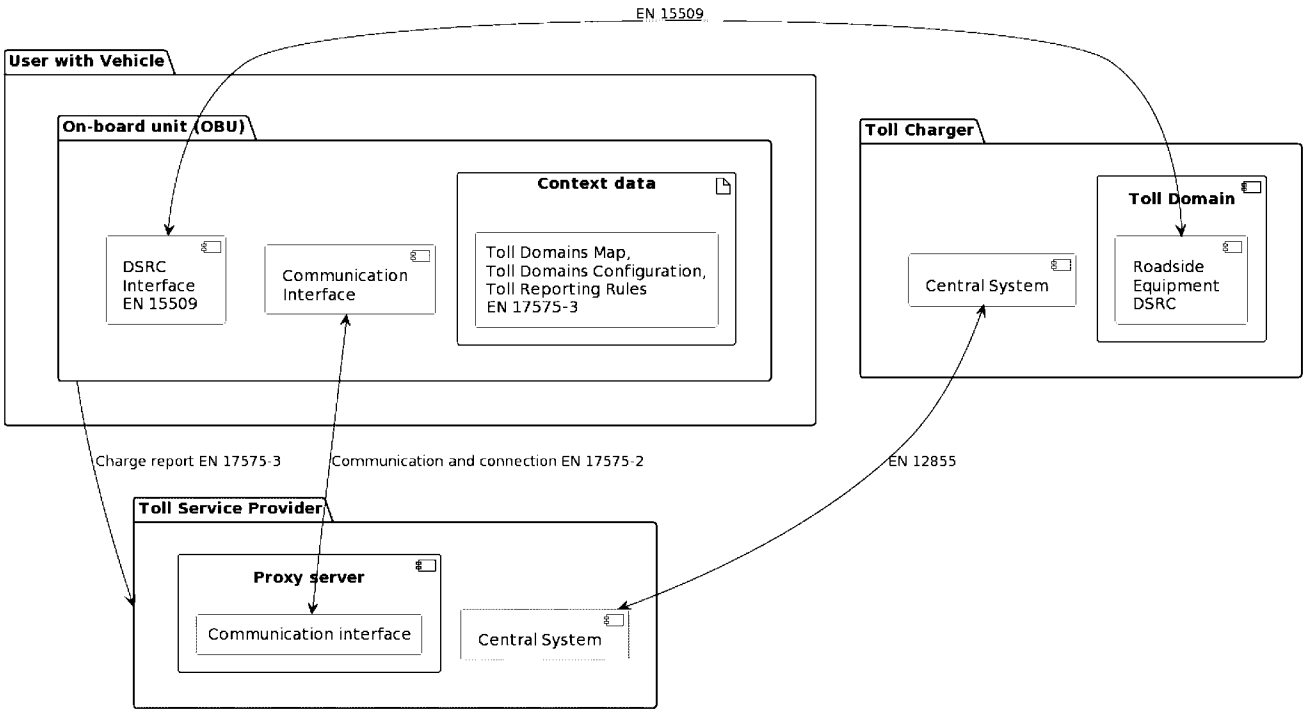
The outcome of five years of work on ITSpedia is the creation of 79 ITSPedia entries. These entries on various ITS applications are freely available to the professional and general public on the standardland.cz website. In 2021, this “ITS Wikipedia” was also published as a book totaling 432 pages. This corresponds to an average length of one ITSpedia entry spanning 5–6 pages.

The structure of an ITSpedia entry consists of nine points, all of which are fulfilled in a specific sequence for all entries.

I.	**Entry DESCRIPTION (textual)**	**1. Title** *(= term, concept)*
		2. Characterization *(= definition, sentence)*
		3. Description of the addressed issue at a high level *(= paragraph, summarizing introduction)*
II.	**Entry SCHEME**	**6. Terms and concise definitions** *(primarily related to an image/diagram)*
		7. Architecture of the described solution *(= core of the entry, image, diagram, structure)*
		8. Overview of functions *(= how the system works)*
III.	**REFERENCES (evaluation)**	**4. Applicability** *(= detailed evaluation of practical use)*
		5. Placement in the hierarchy of topics *(currently inactive, superior and subordinate relationships are not the only possible ones; a comprehensive system of entries is missing)*
		9. Links, references, standards *(= supplementary information for a more detailed understanding)*

The core of an ITSPEDIA entry is point 7 – the *Architecture of the described solution*, which, for clarity, is explicitly derived from the presented diagram.

Example diagram of a toll charging principle



StandardLand: STANDARD Search System

The search system for standards categorizes standards, allowing users to quickly find relevant extracts/standards.

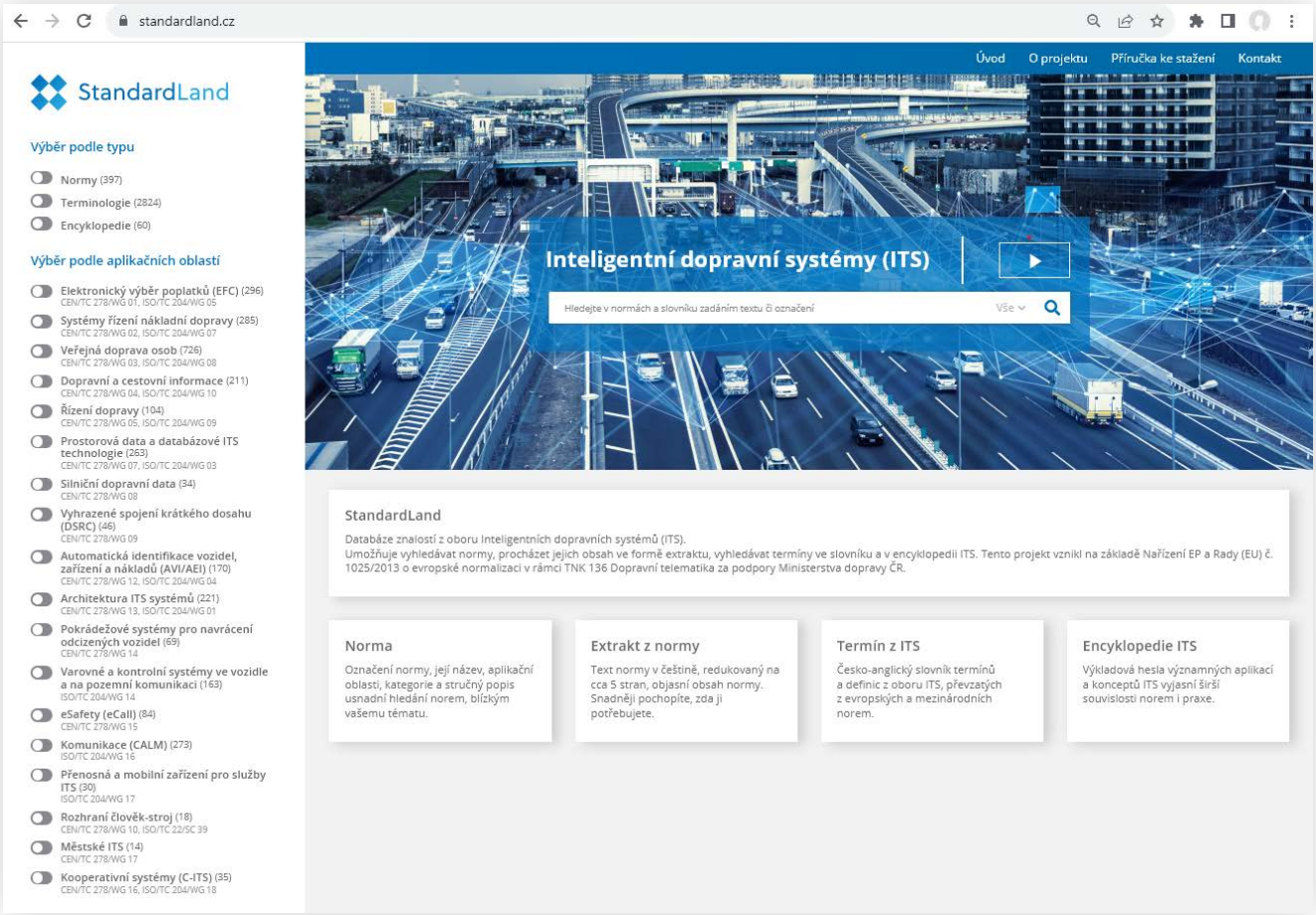
The original search system allowed users to filter and find relevant standards in extracts based on pre-defined categories.

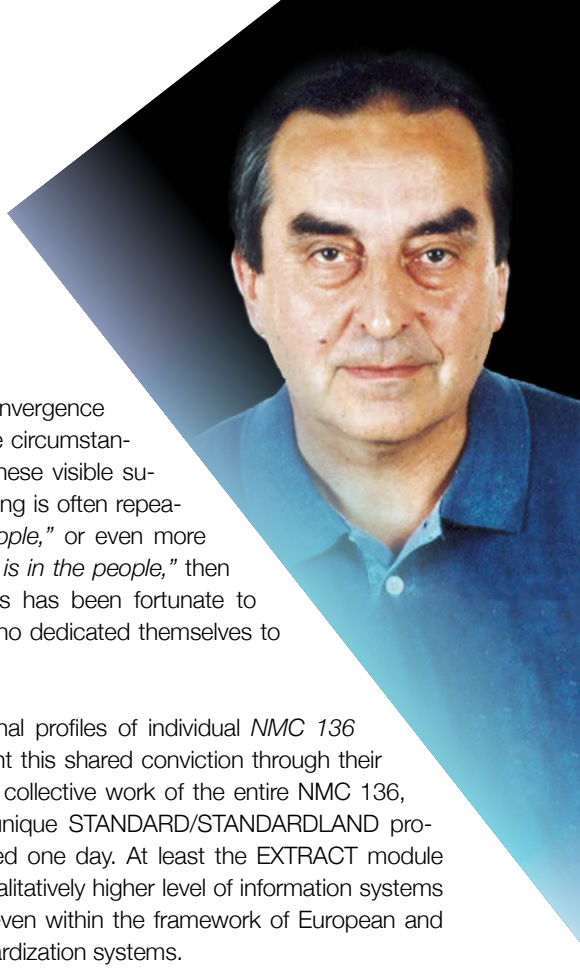
Later, a comprehensive Czech-English base of ITS terms, definitions, and abbreviations was created and linked to ITS standards (extracts) called ITS Terminology.

After creating the final ITSpedia module, Extracts from standards were linked with ITS terminology and structured ITS entries (ITSpedia) into one interconnected search system, StandardLand.cz (www.standardland.cz).

Both the text formats of StandardLand, Module 4 Extract, and Module 4 ITSpedia, complement each other in content. While Extract is strictly structured information about the content of ONE STANDARD, an ITSpedia entry aims to describe a specific ITS subject with references to used or cited standards. Integrating both modules, including their terminological foundation and the ability to search for terms with definitions in Module 3 ITS Terminology, within the StandardLand search system enables seamless communication between modules. A term can be traced from its definition (Module 3), through the respective standards in which it is used (Module 1), to its thematic integration into the explanation of an ITSpedia entry (Module 4).

StandardLand homepage (https://www.standardland.cz)





Reflection, Not Just Over Twenty Years...

Looking back over the twenty years of the existence of *NMC 136 – Transport Telematics* means returning to the very beginning, to the year 1996, well before 2003. At that time, the emerging ITS community first came together in the working section TSC 51 Road Transportation and began its work as a modern dynamic field, not only in technical standards but also in entirely practical applications in transportation.

As a longtime educator at the Faculty of Transportation Sciences of the Czech Technical University in Prague, this reflection brings me joy through personal profiles of genuine experts, many of whom I consider my students, and naturally take pleasure in their professional achievements. In many respects, what was perceived as a fantasy vision twenty-five or thirty years ago has become a real-world solution operating in practice.

A new social demand required by European legislation emerged, so did new teams and projects, both in research and application, new specialized companies were founded, and telematics became an integral part of transportation. If the annual revenue from the electronic toll system on Czech highways and Class I roads is around 15 billion CZK, then we have a clear economic indicator of the contribution of one of the applications in the field of transport telematics.

The significant point I would like to emphasize is the dynamism of this new field, which practically emerged from scratch. Thanks to enthusiasm, interest, and tangible business opportunities, it became a real business in the best sense. The electronic toll system operator belongs to the PPF Group, while, on the other side of the user chain, EUROWAG is among the significant service providers for transportation. I mention Mr. Martin Vohánka, the owner of EUROWAG, as a representative of the local entrepreneurial class that has a constructive interest in contributing to the effective development of the Czech Republic. This is evidenced by the establishment of the initiative named *The Second Economic Transformation – Czech reVision*, where Mr. Petr Fiala, the Prime Minister of the Czech Republic, participated in the discussion forum on June 5, 2023.

The CEBIA company is based on experts from *NMC 136*, focusing on the area of vehicle anti-theft systems (CEN/TC 278/WG 14). It has become a respected partner for insurance companies in identifying vehicles, their parts and technical condition data. If it was traded by a strategic partner at around 500 million CZK, it shows a visible economic success resulting from the long-term work of one professional field. I could continue symmetrically with examples for each working group (WG) in standardization, showcasing their successful corporate representations in practice.

In this assessment of a quarter-century of transport telematics in the Czech Republic, I would also like to mention an essential moment of the convergence of several favorable circumstances that enabled these visible successes. If the saying is often repeated: *"It's in the people,"* or even more clearly: *"Everything is in the people,"* then transport telematics has been fortunate to have the people who dedicated themselves to it as a field.

Personal professional profiles of individual *NMC 136* members document this shared conviction through their work. I believe the collective work of the entire NMC 136, embodied in the unique STANDARD/STANDARDLAND project, will be adopted one day. At least the EXTRACT module should be, as a qualitatively higher level of information systems about standards, even within the framework of European and international standardization systems.

It would be a worthy continuation of the tradition of Czech technical standardization, represented during the interwar period by Professor Vladimír List (1877–1971), who was elected in 1937 as the president of the *International Standardization Federation ISA* (now ISO). It would also become a fulfilled lifelong dream.

Prof. Ing. Pavel Přibyl, CSc.
Founding Chairman of *NMC 136*

Highest Awards for Technical Standardization Work for the Founder and Honorary Members of NMC 136 – Transport Telematics

The Vladimír List Award and Certificate of Merit

The *Professor Dr. Ing. Vladimír List Award and Certificate of Merit* were ceremoniously presented for the first time in 2002, on the occasion of the 80th anniversary of the establishment of organized Czechoslovak standardization. These prestigious awards express gratitude for the recipient's significant contribution to developing and popularizing technical standardization.

Professor Dr. Ing. Vladimír List, Dr. h.c. (1877–1971) was a leading European personality whose foundational role in the field of standardization was acknowledged, among other achievements, by his election as the president of the *International Federation of Standards Associations ISA* (now ISO) in 1932.

The Vladimír List Award 2017

This award was presented to Prof. Ing. Pavel Přibyl, CSc., for his significant lifelong contribution to advancing technical standardization in the field of transport telematics.

The Vladimír List Award

Prof. Ing. Pavel Přibyl, CSc., founder and long-time chairman of NMC 136 Transport Telematics (2003–2017)

The Vladimír List Certificate of Merit 2007

The certificate was presented to Ing. Karel Urban, an employee of the Ministry of Transport of the Czech Republic.

The Vladimír List Award Diploma

Ing. Karel Urban, Ministry of Transport

Content

The StandardLand Award