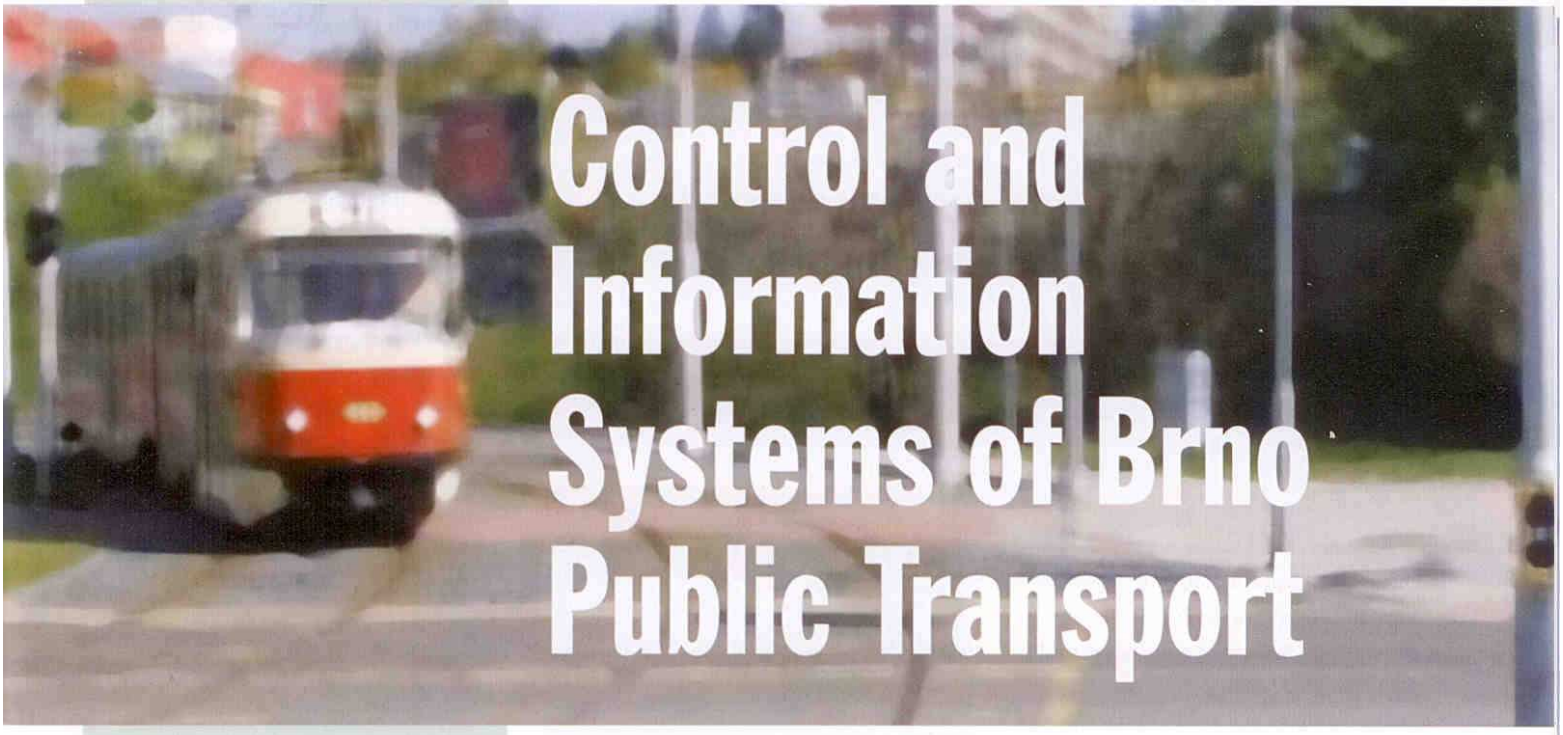

Control and Information Systems of Brno Public Transport

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The origin of public transport in Brno dates back to 1869 when the operation of the first horse-drawn carriage from the city of Brno to Kralovo Pole commenced. A long evolution of Brno public transport began in 1884 with the introduction of a street steam tram, electrification of the tram in 1900, the bus in 1930, and the trolley bus in 1949.

The current network of Brno public transport includes more than 800km of lines. During the working day, about 560 vehicles transport almost one million passengers. The Brno PT is prepared for the continuous operation of almost 400,000 citizens of the city of Brno and its large surroundings.

By the second half of the twentieth century, the transport was still controlled directly on the tracks. The attendants, equipped with pocket watches, knew a simple timetable by heart, as did all drivers and conductors. It was only in the 1960s that a new central control centre started to be developed. So far, existing connections by means of railroad telephones were complemented with a radio network that has been connecting all PT vehicles since 1969.

At the turn of the last century, Brno Public Transport Company decided – with the approval of its owner, the City of Brno – to invest in a system bringing substantial profits for the operator, passengers and other citizens of the city.

The inspection of operation runs automatically and in real time. The control is based on objective real data, and a secure inspection of the measures is taken.

The on-board computer is used for a variety of tasks

Brno:

Brno, the Czech Republic's second largest city, has a population of nearly 370,000 people.

The data is archived and used for quality evaluation for handling complaints and optimising timetables.

Increased safety

The system provides a multi-way communication of the vehicle with the control centre and easy emergency calls. The communication infrastructure can also be used to deliver important information to the passengers and citizens.

Improving working conditions for the drivers

The system eliminates routine activities not directly related to the driving of the vehicle. Most information and communication functions run automatically. In case of a breakdown, the driver has tools telling him how to report it and how to inform the passengers. Furthermore, there is a reduction in the demand of manpower as the system automatically provides recovery of on-board data.

Optimising the operation of light-controlled crossroads

The vehicle transfers all the data that is required by the transport solution for an effective control of the operation at the crossroad. The amendment in the transport solution will appear only on the data without any requirements regarding physical modifications of the crossroad's infrastructure.

The benefits mentioned are enabled by the Control and Information System of Brno PT; in short, RIS. The system has a timeless concept and uses contemporary technology. Only in Brno is it possible to see the integration of functions, elements and technologies that are used somewhat sparingly by other PT operators. The RIS system fitted in all PT vehicles is identical, no matter what type of vehicle it is. As of October 2007, this system is in 274 trams, 143 trolley-buses, and 295 conventional buses.

Determining the position of a vehicle

To monitor the position of a vehicle, Brno Public Transport Company uses a GPS satellite navigation system. The level of accuracy means that the exact geographical co-ordinates of a vehicle can be determined to within five to ten metres.

Data communication between the vehicle and control centre

To obtain a reliable bi-directional data transfer between the vehicle and control centre, a private cell data radio network (MORSE) was built in the frequency band of 430 MHz. Some 26 base radio modems are connected via terrestrial (wired) or radio WAN with the RIS server in the

The modem on-board each public transport vehicle transmits data to the traffic light controller

control centre. On a regular basis (every 25 seconds), the vehicle's information is automatically logged. It transfers the following data:

- Identification (vehicle number and route number)
- Immediate GPS position
- Time of arrival and departure from the last stop
- On-board informatics codes
- Strength of signal of the voice-radio network
- Other additional data

The data network is also used for sending short text information to the display of the on-board computer, script for the voice announcer, or text to the visual information equipment in the vehicle. It is also possible to send a coded message in the opposite direction that can be used as an alternative to the voice message.

The architecture of the data network is open. In the future it can be used for communication with other equipment of the operator, such as ticket vending machines or information systems.

Voice-radio network

The voice-radio network within the band of 460 MHz of Motorola technology operates on the principle of analogue trunking. The stations can be individually selected on the basis of different criteria; for example, in accordance with the vehicle number, route number, or location. There are six pairs of frequencies for trunking and one simple frequency for open direct connection of radio stations. A shifting converter on the hillock in Brno-Kohoutovice provides a signal for the coverage of the entire operating area. From the driver's point of view, the operation of the voice connection is simplified. To protect the drivers, an SOS button can be activated with a function for automatic transmission of sound from the cabin, as well as the location and identification of the vehicle. This is all sent to the control centre.

Vehicles on a traffic light controlled crossroad

The vehicle is equipped with another data radio modem within the frequency of 0.9 GHz for fast data communication. From a few hundreds metres up to a distance of many kilometres, the modem, in due time, sends the data and details needed for the sophisticated decision making process to the traffic lights controller. This includes:

- Identification of the vehicle
- Deviations from the timetable
- Report of successful thoroughfare of a crossroad

The vehicle radio modem is multipurpose and enables a relatively fast data transfer at a short distance, even for other purposes.

Automatic maintenance of on-board data

Radio modems at 0.9 GHz are also used for data connection with the vehicle in the depot. In case of any changes – from the amendment of names of stops, to extensive amendments of timetables or routes – it must allow data amendment for on-board computers, voice announcements and visual display units inside all vehicles. So far, this has meant that the technology needs to be set-up in each vehicle.

Today, a stationary radio modem is able to wake up the on-board information system of vehicles, transfer the data, and put the vehicle to sleep again. The function offers so far unknown operational comfort. After the transfer of planned amendments and handover of the instruction via network application the following morning, the vehicles depart with fresh data; and all without human interaction.

Improving information for passengers

Within the RIS project, all vehicles were equipped with a standard on-board computer enabling valuable control of information peripheries. This is a basis for a provision of automatically generated, strictly addressed information. The new voice-radio network enables the operator in the control centre to speak directly to the passengers, and the data-radio network enables this text to be displayed in the vehicle.

A standard part of the acoustic system of the vehicle, which is otherwise used for announcement of stops and as a vehicle radio, is a responder for blind people. As per the command of a pocket transmitter, information regarding the route and direction of the journey is transmitted outside by a loudspeaker on the vehicle.

The position of each vehicle can be seen on a map at the control centre

Support of the controller's work

The controller working in the control centre has exact data on traffic, which helps him in his decision making process. The data on the position of each of the 560 monitored mobile units during working days peak hours are no more than 30 seconds old. The controller sees the position of the vehicle on a map, or in another understandable form. The system is continuously evaluating timetables and notifies the controller about deviations. The controller is able to transfer his instructions via two independent communication channels (voice and data), and most importantly, he can check his decisions at any time.

The primary controller's tool is a personal computer with an interface for control of voice and data communication, with visualisation of the vehicle position in accordance with the timetable, and other purpose-based and common user software. The controller's client has personal profiles, data filters and inter-connection among collaborating modules and sub-systems. To promote team work, there is a large-scale display of data on the Barco equipment at the front of the control centre.

Barco equipment at the front of the control centre

Switches on the railtrack

The control of railtrack switches of the trams and trolley wire switches of the trolley-buses are undergoing a fundamental change. The traditional contact systems for transmission of 1bit information that require changing the position of the switch are disappearing. The RIS uses induction data transmission that is error-proof, precisely localised and enables the transfer of a sufficient amount

of information at a usual access speed. The following data is continuously transmitted from the vehicle to the switch receiving coil above the trolley wire, or under the ground between the rails:

- Vehicle identification
- IT address of the switch (data recipient)
- Required direction of the thoroughfare through the switch; in case of multiple switches, the resultant direction of travel

The data transferred to the switches are part of the vehicle's route data. It also includes information regarding the stops and crossroads. An automatic selection of the driving direction through the switch is displayed on the on-board computer. During the journey, the driver does not operate the switch; he only monitors a signal switch indicator.

A manual option when going on an unknown route (from the point of view of the on-board computer) is simplified to intuitive commands. Left, straight ahead, or right can be entered with three keys of the on-board computer. A permanent induction transfer of vehicle identification data can also be used to prevent movement of trams in an opposite direction on single rail tracks, thus avoiding an accident.

Data utilisation

The system generates a huge amount of data on traffic. All data, from the moment the RIS launches, is archived and transformed to the format appropriate for further processing. Thus, background information for analysis of a real journey of any vehicle is generated. For instance, handling of complaints, negotiations regarding changes in public transport, and its optimisation are conducted on the basis of exact, precise and evident information.

Conclusion

The architecture of the RIS system is a result of a decade of collecting information on the methods of inspection and control of public transport, on communication technologies, and in relation to passengers in Europe and worldwide. It is a result of a continual creative team discussion on the subject of Brno Public Transport Company, the Association of Public Transport Operators, Association for Transport Telematics and between potential producers and suppliers. The system produced by Buse Blansko Ltd gives a true picture of timeless needs of a modern PT operator. The system has brought improvements for passengers, drivers and controllers in the control centre within the entire transportation process. ■

biography

Zdenek Schimmer

Zdenek Schimmer has worked for Brno Public Transport Company since 1971. He started as a tram-driver before working as a supervisor of radio networks. He was soon promoted to Head of Public Transport Information Department, and then the Head of the Marketing Department until becoming Administrator of Public Transport Telematics and Information Systems.