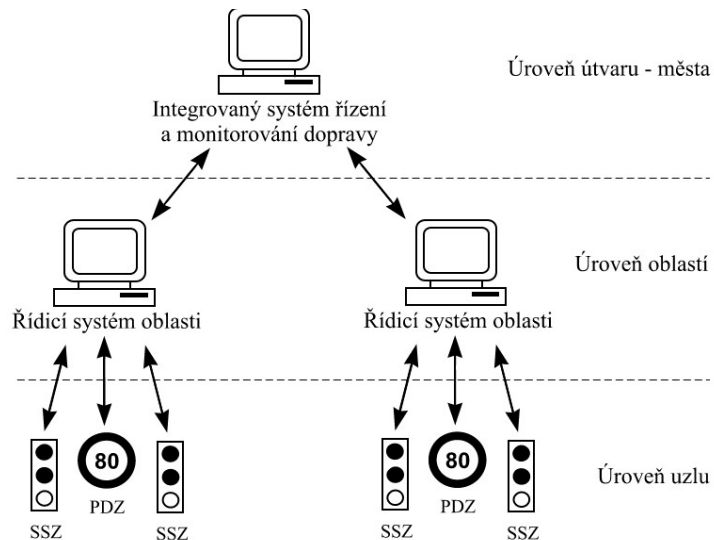


Urban Telematic System Architecture

Legend: Úroveň útvaru – města – Segment – City Level; Úroveň oblasti – Zone Level; Úroveň uzlu – Node Level; Integrovaný systém řízení a monitorování dopravy – Integrated system of controlling and monitoring traffic; Řídicí systém oblasti – Zone control system; SSZ – LSD; PDZ - VTS



Urban Telematic System Architecture

The architecture of an urban control system usually consists of a three-level structure, as shown in the figure above. On the lowest level, there is the traffic controller of the luminous signal device, parking system, tunnel traffic control etc. that directly interfere with general traffic control. One step higher is the level of areas that should be as much as possible closed entities with the minimum of links to the ambient environment, and containing the control system that manages that specific entity. On the highest level, there is the city/town level that integrates control systems of single closed entities and monitors urban traffic.

The most important functions of the telematic system include optimising and controlling the traffic network, informing and navigating, preferred urban mass transportation, and ensuring links and relations to other systems and subsystems, such as tunnel technologies, providing information prior to the journey and others.

Urban Traffic Control

Two real-time techniques are used for urban traffic control:

- 1) With centralized intelligence
- 2) With decentralized intelligence

The **centralized** control intelligence consists in evaluating all detectors in the controlled area and in the optimising calculations of vehicles dispersion. Based on the calculations, the controlled parameters change in real time. This technique is very demanding technologically and economically.

The **decentralized** control intelligence consists in the fact that a traffic node reacts immediately on traffic conditions and the higher-level computer functioning as the coordinator of single traffic network nodes. The decentralised control intelligence collects data from all detectors and modifies cycle lengths, phase structure, and possibly lengths of red signals according to the actual traffic situation.

More signal devices are associated into zones arranged in lines or areas, and adaptively controlled in a certain time roster varying in the range from 10 to 30 minutes. Recently, this kind of systems application is in progress in the Short Smichov Circle. Today, the very circle represents 21 signal devices to be controlled through the MOTION algorithm. Entrances into the zone (altogether 9 additional signal devices) will be regulated through the TASS algorithm.

TASS

TASS – Traffic Actuated Signal Plan Selection

This software tool selects control signalisation programs based on the actual traffic situation detected by detectors, and responds accordingly. In the Smichov zone, the TASS system will control entry into the controlled zone on major approach communications to prevent traffic jams. The actual traffic situation is evaluated from the data collected and measured, and stored in the control system based on a list of conditions, and the corresponding program is selected through decision-making tables.

Basically, the TASS system works on two levels:

1. **Strategy level** – Detecting traffic situations in the controlled zone and its vicinity
2. **Tactics level** – Selecting a signalisation plan for a group of controllers at a sufficient distance before the zone.

On the strategy level, various traffic situations are detected. For every situation, there is at least one (basic) signalisation plan for every crossing that corresponds to the nature of traffic conditions in the given situation (standard cycle time, coordination, and others).

On the tactics level, signalisation plans are selected for all the TASS group controllers depending on actual traffic conditions. The purpose of this is to respond quickly to fluctuations of the traffic stream in a segment of the controlled zone. The so-called **alternate signalisation plan**, whose basic characteristics (cycle time, coordination, and others) should correspond to the current active signalisation plan ensure this. This will prevent artificially generated disturbances in the traffic stream caused by signal switching from occurring.

MOTION

MOTION – Method for the Optimisation of Traffic Signals In On-line Controlled Networks

The **MOTION system** is a macroscopic modular control system for optimising control of traffic streams in urban road networks to be used for the Smichov zone control. The basic concept of the MOTION method is the ability of combining perquisites of an efficient traffic network model for the most important traffic streams with the possibility of almost instant response to a change in the traffic stream through local crossing control. To allow this flexible way of control, data on traffic is collected, completed, and analysed.

Based on this analysis, all the parameters of signalisation programs (cycle time, phase sequence, green signal lengths) are optimised for all the crossings in the network, and create new signalisation programs.

MOTION works in three levels:

1. **Strategy level** where the followings are determined every 10 – 15 minutes:
 - Cycle time
 - Green signal distribution
 - Basic sequence of phases
 - Coordination parameters (offset).
2. **Tactics level** where it is possible to effect on the basic sequence of phases through the local control method for the calculated cycle time, e.g. by inserting a special phase; this occurs ca. every 60 to 90 seconds:
 - Local sequence of phases, e.g. for preferring the urban mass transportation.
3. **Operation level** where it is possible to respond through the local control method for single vehicles ca. in 1 second:
 - Length of green signal (responded to single devices, UMT (Urban Mass Transportation) preference, and others).

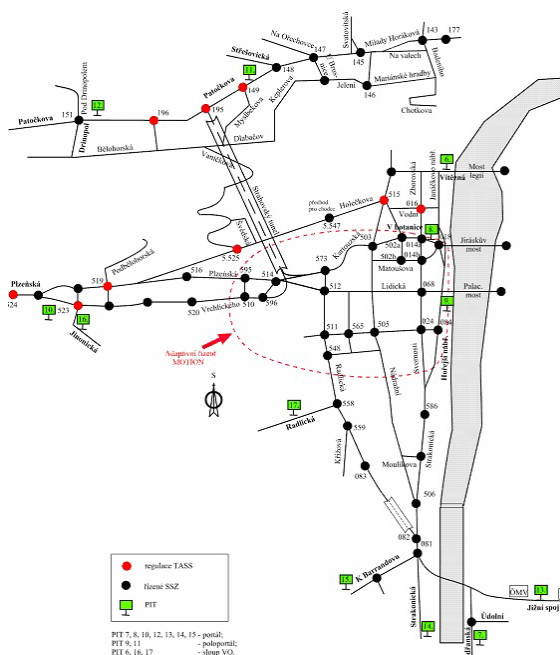
On the strategy level, there is the possibility of assigning the UMT higher priority than that assigned to individual car transportation. In the local control, controllers are given and keep a high level of independence in reacting to traffic situations: The central control sets up the permissible limits.

The activation of the CIM module will represent additional improvement in traffic control in the Smichov zone controlled by the MOTION system in critical situations; the CIM module will allow performing the traffic control management in situations of accidents, traffic jams, and disasters with different control strategies.

The **CIM module** (Congestion and Incident Management) allows selecting responses to accidents or traffic jams on the network level, depending on the traffic situation.

MOTION and TASS Systems Controlled Zones

MOTION takes strategic decisions in the network whereas tactical and operational decisions are materialized in crossing controllers according to control logic. The general control strategy is based on optimising the dispersion of vehicles in the network. The network control limits local control only in the extent needed for ensuring good coordination in the whole network.



Informing and Navigating Drivers

The purpose of the information system is to prevent dangerous situations from occurring, and allowing drivers to make respective decisions comfortably and in time based on information on the traffic condition on the communication. Major information should focus on traffic closures, traffic jams, ice, and recommended detour routes.

The purpose of the navigation system is to ban using certain communications, and command using offered routes by changing traffic signs.

The use of a suitable way of informing combined with navigating and, thus, easing actual situations in a certain zone in the city is an integral part of improving the passage through the city. The information systems can also be suitable for using in the UMT systems where information improves the well-being of passengers.

The operation of such a transportation information system contributes significantly to improving traffic safety and traffic fast-moving in heavily loaded transportation networks in large cities and on approach communications.

For an information system that is to effect the traffic stream more effectively, **variable information signboards** (VIS – Refer to Fig. 4). The VIS use electromagnetic flip-flop elements highlighted with LED diodes. The VIS form an integral part of higher control methods; information on them are manually supplied from the dispatching centre by the operator based on evaluation of the traffic situations in respective transportation segments by the system, from the camera surveillance system, or/and automatically from other city control subsystems, such as traffic centres or tunnel control systems. Other benefits of the VIS consist in the possibility of feedback reporting to the control centre on the device condition, and low electricity consumption.

In cities, the traffic stream speed change and redirecting the traffic if there is a traffic jam or an accident are primarily accentuated. The system for navigating vehicles to a parking site may be used as an example of the navigation system.

A system of this kind provides current, complete, and precise information on sites, vacancy in the nearest park-and-rides (P+R), and on optimal routes; at the same time, the system should stay operational even when one or several park-and-rides are full. Any suggested system must be uniform in the specific area, clear to drivers, and open for additional development.

Variable Information Signboard in the Smichov Zone



Tunnel Safety Systems

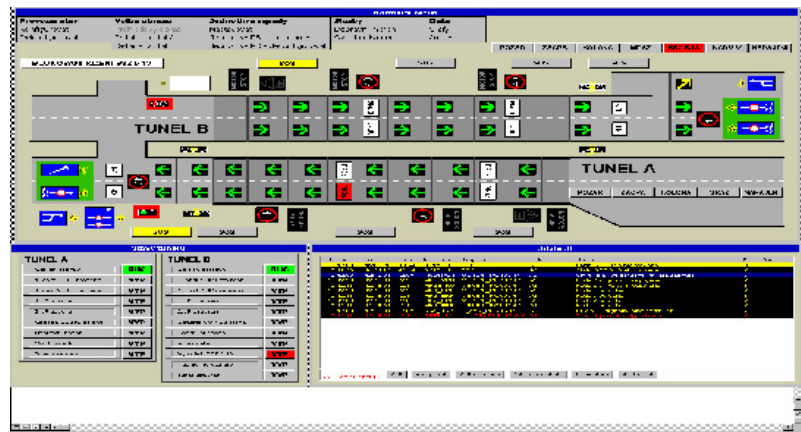
Any tunnel is a specific segment of a communication where specific traffic rules apply.

The traffic inside is not only controlled depending on the traffic stream but it also must respect the condition of air-conditioning and safety systems.

Any tunnel represents a system of technology devices interconnected and forming one single entity consisting of devices for traffic control and devices for equipment control. From the traffic control point of view, it is an autonomous system where the traffic control is limited just to changing the speed of vehicles or redirecting the traffic. For that purpose, variable signboards controlled automatically or manually by the traffic operator from the control centre are used.

The suitable incorporation of relatively independent tunnel technology into other city systems so that single systems behave as entities is a very important requirement especially in the cities. This primarily comprises timely informing on and redirecting of the traffic when tunnels are closed, or changing or modifying interlinked systems in the tunnel's vicinity. For this, the devices described above in connection with the smooth UMT and IBT (Integrated Bus Transportation) may be used with an ecological load that is as low as possible.

Tunnel Measuring System Example



Epilogue

Using the combination of these technologies for improving thoroughfare, smoothness and safety of the traffic, along with reducing the ecological load, is a suitable solution of the urban traffic control.

The method of urban traffic control by means of the real-time control with the decentralized intelligence is used in Prague's Smichov zone. As already mentioned, the Smichov zone will be controlled by the MOTION system, which pertains to 21 crossings in the zone. The CIM module resolves problems in non-standard situations, such as accidents and traffic jams; this module is part of the MOTION system.

These systems correspond to the urban telematic system architecture. They incorporate passive and active forms of preferring the UMT. These systems also interconnect to the systems of informing and navigating drivers by means of information signboards, and suitably respond even to the tunnel technology, which interferes in a significant extent with the Smichov zone traffic control.

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