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*Intelligent Transport System (ITS), KAREN*

Kornel B. WYDRO[1]

# INFORMATION FLOWS IN INTELLIGENT TRANSPORT SYSTEM

The paper presents problems of transport system information transmission, storing and distribution for Intelligent Transport System applications. Questions of the information sources, characteristics of information flows in the system are discussed.

# STRUMIENIE PRZEPŁYWU INFORMACJI W SYSTEMIE INTELIGENTNEGO TRANSPORTU

Artykuł zawiera określenie źródeł informacji i ich charakterystyk, jej przepływów, przetwarzania, gromadzenia i udostępniania dla potrzeb aplikacji stosowanych w systemach inteligentnego transportu, z odpowiednim uwzględnieniem sytuacji w Polsce.

## 1. INTRODUCTION

The worlds gathered experience shows, that implementation of Intelligent Transport Systems (ITS) and its development brings valuable profits to all the parties involved in the enhancement and building of the modern transport systems and transport infrastructure. It also favours a common sustainable development of the country [3,15].

Telematic solutions applied in this area ensures:

- More intensive exploitation of the existing infrastructure and fleet,
- Higher economic effectiveness and higher competition in transport sector,
- Higher traffic security,
- Decreasing of the environment degradation,
- More effective co-operation between all the parties involved in transport business,
- Easier accession to the globalisation and integration processes, especially in transport systems and structures.

[1] National Institute of Telecommunications, Szachowa Str., 04-894 Warsaw, K.Wydro@itl.waw.pl

Deployment of the telematic solutions which builds ITS is conditioned by possibility of gaining and utilising of the information about state of transport hiper-stucture[2]. It allows more economic and safe transport tasks realisation. One estimates [1] that savings being possible in effect of transport structural information support reaches tens of percents of expenses in traditional transport systems. Therefore information gathering, exchange and usage methods elaboration for ITS implementation seems to be a key problem.

## 2. TRANSPORT SYSTEM

In the ITS systems an information sharing have to occurs between following transport hiper-structure's elements [18]:

- Direct transport infrastructure users: drivers, pilots, travellers, pedestrians;
- Transport means: road vehicles, trains, aeroplanes, vessels;
- Roads and theirs direct environmental surroundings;
- Institutions and organisations: t.ex. road infrastructure's administration, firms – infrastructure's users, infrastructure's builders and maintenance and complementary services providers (motels, car services etc.)
- The management and security institutions: (t.ex. polices, border guard, emergency services, public administration.

The efficiency and quality of such complex systems as composed with the listed elements, at the contemporary technology state depends strongly on properly developed information support. For having possibility to exchange an utilise state system information, it is necessary to equip the system with variety of sensors (vehicle's counters, meteorological stations, video cameras, satellite observations and others), information transmission networks, computer systems and information distribution and presentation means (variable message signs, digital radio and so on). Moreover each system have to be equipped with proper potential of possibilities and abilities of information exploitation. Evidently all mentioned elements as well as intellectual potential creates above mentioned transport hiper-structure.

Telematic applications supports various informative and automatic functions. Often those are defined in advance for defined classes of operations and such can be seen as a telematic services. Those services are numerous and deployed according to needs and possibilities. Very often new ones are emerging with the ITS development and arise from actual transport needs or are inspired by new information technology possibilities.

[2] By transport hiperstructure herein we understand an roads infrastructure, vehicles, users, surrounding environment elements and related control and information systems.

## 3. INFORMATION FLOWS IN ITS

From the system control and management point of view a telematic system's basic characteristic of given kind of transport is its information characteristic, describing information by this system generated (i.e. data describing the actual state of the system) and information collected from environment. Both kinds of information are necessary for proper end effective work of the system, as those information completely describe manner and conditions of the system work. It is even important how often those information have to be refreshed and which or in what part it have to be real time information. Information characteristic depends on dynamic features of the system and quantity of its elements. For example, in a case of road transport, there are millions of moving objects with considerable high dynamics (moving speed) and with random behaviour of a particular traffic objects and traffic streams. Changes become quick, what generates big amounts of information. Information concerning related environment, i.e. road sides, meteorological situation and like that has dynamics lower, necessary refreshing must not be made so often. Both kinds of information must be very often delivered to moving objects in real time. Transport systems needs also various information about actively interacting surrounding, t.ex. about entities delivering services for passengers, cargo services and transport means itself. Those information is relatively constant and can be collected in advance, for example before journey, in stationary conditions. It is worth to mention, that various types of traffic of the same kind has different dynamic parameters. For example urban traffic characteristics differs deeply from highway traffic. It relates also to variations in environment state.

Identification of the discussed characteristics and determination of information communication directions and features of information flows, are the most important part of ITS construction. Accordingly to that, methods of information gathering, transmission and distribution (what means also choice of sensors and specialised electronic communication systems) have to be elaborated.

### 3.1. INFORMATION EXCHANGE SUBJECTS

In broad ITS meaning, among information sources and consumers (informatically active elements) are:

- Roads network
  - Vehicle's roads (conditions and technical parameters of the roads sectors, bridges, tunnels, traffic exclusions and limitations etc.)
  - Railways (conditions and technical parameters of the roads sectors, bridges, tunnels, exclusions, tracks works etc.)
  - Inland water roads (conditions and technical parameters of the water roads, traffic exclusions and limitations etc.)

- Transport structure's and surrounding operators
  - Transport operators (fleets of transport firms and enterprises, delivered services etc.)
  - Infrastructure operators (firms and enterprises providing access to infrastructure, enterprises for infrastructure maintenance, renovation etc.)

  - Machines service providers (firms and enterprises operated service vehicles, road building machines etc.)
  - Travellers services providers (firms and enterprises such as: travel offices, information points, call-centres, motels, inns, restaurants, etc.)

- Travellers
  - Drivers (drivers of individual cars, of public transport vehicles, trucks, cyclists)
  - Passengers (passengers of the individual cars, public transport, railways, vessels and so on)
- Vehicles
  - Goods transport vehicles, carriages, water transport means, etc.)
  - Public transport vehicles (buses, trams, trolley buses, personal carriages, ships, etc.)
  - Individual transport vehicles (cars, boats, ferries, etc.)

- Operation systems
  - Emergency systems (rescue of accidents victims, rescue in natural disasters etc.)
  - Road technical help (after-collision services, haul etc.)

- Information systems
  - Road information systems (information about road condition, by-passes, parking, road help, etc.)
  - Meteorological information systems (information about meteorological conditions on particular roads sectors, road surfaces and railway trails, water trails, etc.)
  - Travellers information systems (time schedules, connections, weather conditions, services points localisation etc.)
  - Traffic measurement systems (measurements for urban and country traffic control systems, planning systems, road building and re-constructions etc.)
  - Vehicle positioning systems (surface and satellite positioning systems (GPS), on-board anti-collision warning systems etc.)

- Organisations
  - Country administration (Ministry of Infrastructure (MI), General Directorate of Country Roads and Highways (GDDKiA), Meteorology and Water Management Institute (IMiGW)
  - Local administrations (road and transport involved voyevodship and local government institutions)
  - Police
  - Border guards and services
  - Health services
  - Environment protection services
  - Crisis management services
  - Research and planning institutions (specialised research entities, universities design offices etc.)
  - Training and education institutions
  - Financial institutions
  - Legislation and law institutions.

- Inner-system connections structures
  - Inter-modal connections (electronic communications systems between road railway, inland water and maritime navigation and air communication systems)
  - Data flows control systems (information exchange management systems controlling data flows between transport hiper-structure elements, data bases systems, internet usage etc.)
  - ITS co-ordination and control centres (data processing systems, transport management systems, infrastructure management and maintenance, transport hiper-structure elements co-ordination, co-operation with foreign partners)

Above mentioned shows the informative complexity of ITS itself as well as complexity and broadness of the necessary information exchange network.

### 3.2. INFORMATION FLOWS FEATURES

Particular kinds of informatively active system elements differs in quantity and space location; some of them are mobile, some stationary, and have various information features. The last concerns generated information types, their quantity and distribution in time and also how this information is exchanged with other system elements. In some cases it is regular exchange, in other – the exchange is accomplished on demand. There appears demand for information broadcasted, dedicated, and often confidential, distributed between authorised parties. Some information need to be permanently or timely stored, some is important only temporarily.

For example, the analysis of the communication between roadside an a emergency services vehicle shows that features of exchanged information calls for special telecommunications techniques, which can be applied to communicate vehicle and road signals controller. Connection have to be established during seconds, with preserved high security of vehicle identification, for avoiding eventual influencing on signal system by others non-authorised vehicles.

At such a conditions the most proper system is the short range radio communication system (to 20 m). But for such a system does not exist any standard. Alternatively can be analysed possibility of applying one of other standardised systems as GSM, TETRA or DECT. GSM and DECT are not proper ones, as the time of connection establishing is relatively high and there is a danger of congestion in the network. TETRA offers very short time of connection, even with priority attribute, but gives no possibility of the vehicle positioning. It means that some positioning system with possibility of driving direction identification have to be added, as for example GPS. But It makes a solution to complicated. Even majority of the satellite-based communications solutions are not proper for such an applications for necessity of installation of special antennas. Such installation on the roadsides are difficult and communication in towns is not sure, especially with moving vehicles.

### 3.3. TRANSMISSION PROBLEMS

It easy to see, that for ITS needs have to be used several transmission means often allowing supply of great amounts information for telematic applications and other goals. Indeed, there are applied copper and optic fibre cables, wireless systems working on various bands of electromagnetic waves for radio transmission of long and short range. Also there obviously can used existing telecommunications network and systems, among them broadcasting systems (analogue radio, and especially in the case useful digital radio) or radar and satellite transmission systems. Dedicated or specialised transmission systems are applied for example in automatic identification of vehicles, loads, drivers etc. Consequently the concept of information exchange network for ITS have to take into consideration possibility of information delivering to optional points in whole area of transport system taking into account that mostly it will be mobile points.

## 4. STRUCTURAL ATTEMPT TO INFORMATION EXCHANGE PROBLEM

Obviously taking as the basis above discussed circumstances, founders of the integrated solutions of ITS proposes some frames of structural attempt even to information exchange solutions in ITS. Those frames have to quarantee comprehensiveness, completeness, compatibility and scalability of the system. Such an attempt is applied in national ITS architectures constructions in many countries [8]. Here it will be illustrated on the example of European ITS Frame Architecture KAREN [6].

Communication Architecture, a part of KAREN Architecture, describes mechanisms supporting information exchange between various parts of ITS. The information exchange have to fulfil two basic conditions:

- have to enable data transmission between interested points of the system and be balanced as regards costs, accuracy and transmission delay;
- have to secure correctness of the interpretation of received information transmitted by the sender.

Both conditions requires:

- to complete detailed analysis of definitions and descriptions of the communication links in main subsystems of transport physical structure interfaces;
- to define necessary communications protocols.

In KAREN are identified five main kinds of points described in Physical Architecture:

- Centre: a place where are collected and comparatively authenticated traffic data, payments (fares) and trucking orders, and where are generated traffic measurements and fleet management instructions (t.ex.. traffic control centres, traffic data bases, fleet management centres);
- Kiosk: installation located mainly in public place, providing information convenience for travellers (t.ex. tourist information points);
  Roadside: a place where appears vehicles and pedestrians, are made payments and/or are made measurements for traffic management for traffic control purposes or are provided information for drivers or pedestrians
- Vehicle: a device which can move on roads network and transport one or more persons (t.ex. bicycle, motor cycle, car, public transport vehicle) or goods (any goods transporting vehicle);
- Traveller.

There are also defined needs of information exchange between the above listed. Such a links, called interfaces, stands for basic structural description for information network system. Each of interface is described according to:

- Kind of connection;
- Kind of technology which can be used;
- Frequency of information exchange;
- Typical information transmission time;
- Range of idle communication time;
- Kind of transmitted information and necessary security level.

A structure of information transmission relationship in the system is presented on Fig.1.

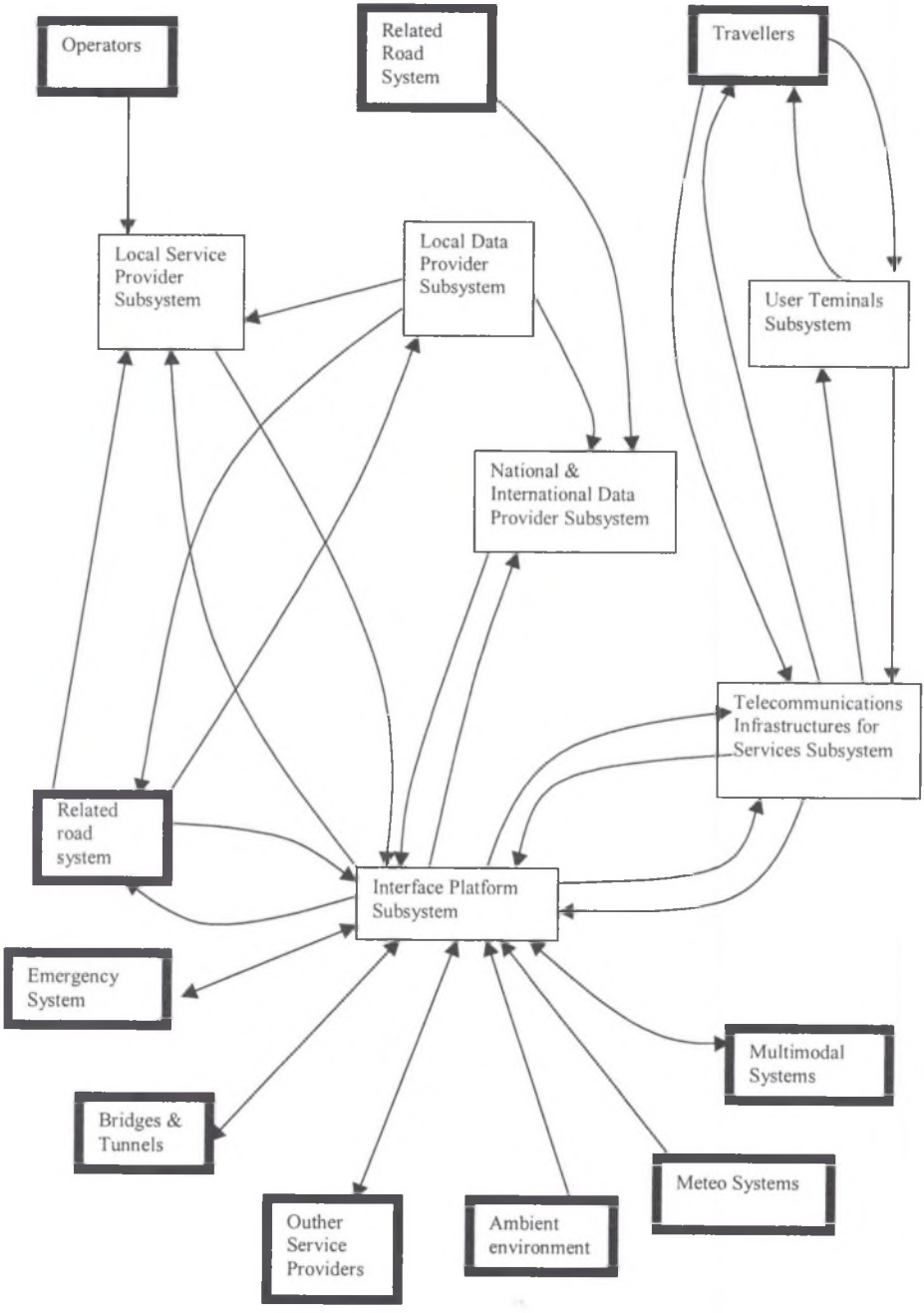


Fig.1. A example of information exchange links according to KAREN

## 5. CONCLUSION

Rational strategy of ITS building calls for careful consideration electronic communications problems and determining of information network building principles as along with local information exchange means, taking into account actual and predictable foreseen needs. A the same, considering the scale of the build system, it have to be solution with maximal economy. It is even important to take to account problems of standardisation, mainly related to applied communications systems and equipment, which are actually deeply considered by European and world standardisation institutions [15].
Elaboration in Poland, on the manner of other countries, a proper national architecture of ITS, and at the same related information (communication) architecture on the basis of KAREN frame architecture with accounting other countries experience is the non-avoidable task and need to be started as soon as possible.

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Reviewer: Prof. Barbara Kos