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ITS system, TEAM project

Miroslav SVÍTEK[1]

ARCHITECTURE OF INTELLIGENT TRANSPORT SYSTEMS AND SERVICES

The goal of the paper is to present the current state of the ITS architecture which is developed in framework of the national TEAM project[2]. The work is fully supported by the Ministry of Transport of the Czech Republic and the achieved results could be applicable in a lot of CEEC countries.

ARCHITEKTURA I USŁUGI W SYSTEMIE INTELIGENTNEGO TRANSPORTU

Celem referatu jest przedstawienie aktualnego stanu architektury ITS, która jest opracowywana w ramach krajowego projektu TEAM. Prace są całkowicie sponsorowane przez Ministerstwo Transportu Republiki Czech a uzyskane wyniki mogłyby zostać zastosowane w wielu krajach CEEC.

1. INTRODUCTION

The presented results were created within the "TEAM project", the goal of which is to develop the national ITS architecture and support the strategy for ITS development in the Czech Republic (organizational and legislative analysis of ITS applications, etc.) with respect to current and future transport-telecommunication environment of the Czech Republic.

The architecture reflects several different views of the examined system and can be divided into:

- Reference architecture - defines the main terminators of ITS system (the reference architecture yields to definition of boundary between ITS system and environment of ITS system),
- Functional architecture - defines the structure and hierarchy of ITS functions (the functional architecture yields to the definition of functionality of whole ITS system),
- Information architecture - defines information links between functions and terminators (the goal of information architecture is to provide the cohesion between different functions),

[1] Faculty of Transportation Sciences, Czech Technical University in Prague, Konviktská 20, 110 00 Prague 1 Czech Republic, svitek@fd.cvut.cz
Dr. Svítek is responsible manager of the TEAM project ("ITS in the transport telecommunication environment of the Czech Republic").

- Physical architecture - defines the physical subsystems and modules (the physical architecture could be adopted according to the user requirements, e.g. legislative rules, organisation structure, etc.),
- Communication architecture - defines the telecommunication links between physical devices (correctly selected communication architecture optimises telecommunication tools),
- Organisation architecture - specifies competencies of single management levels (correctly selected organisation architecture optimises management and competencies at all management levels).

The ITS architecture of the Czech Republic is conformable with the KAREN methodology, with ACTIF results and partly with COMETA recommendations. The main afford is put into the promotion of ITS architecture in real ITS practise and using it for solving the different ITS optimisation tasks.

2. PERFORMANCE PARAMETERS DEFINITION

First step in addressing the ITS architecture requirements should be the analysis and establishment of performance parameters in telematics applications, in co-operation with the end-users or with organisations like Railways Authority, Road and Motorways Directorates, etc.

The methodology for the definition and measurement of following individual system parameters is being developed in frame of the ITS architecture:

- Safety - risk analysis, risk classification, risk tolerability matrix, etc.
- Reliability - the ability to perform required function under given conditions for a given time interval.
- Availability - the ability to perform required function at the initialisation of the intended operation.
- Integrity - the ability to provide timely and valid alerts to the user when a system must not be used for the intended operation.
- Continuity - the ability to perform required function without non-scheduled interruption during the intended operation.
- Accuracy - the degree of conformance between a platform's true parameter and its estimated value, etc.

Substantial part of the system parameters analysis is represented by a decomposition of system parameters into individual sub-systems of the telematic chain. Part of the analysis is the establishment of requirements on individual functions and information linkage so that the whole telematic chain should comply with the above defined system parameters.

The completed decomposition of system parameters will enable the development of a methodology for a follow-up analysis of telematic chains according to the various criteria (optimisation of the information transfer between a mobile unit and processing centre, maximum use of the existing information and telecommunication infrastructure, etc.).

3. PROCESS ANALYSIS OF ITS SYSTEMS

The instrument for creating ITS architecture is the process analysis shown on Fig.1. The processes are defined by chaining system components through the information links. The system component carries the implicit system function (F1, F2, F3, G1, G2, G3, etc.). The terminator (e.g. driver, consignee, emergency vehicle) is often the initiator and also the terminator of the selected process.

The chains of functions (processes) are mapped on physical subsystems or modules (first process is defined with help of functions F1, F2 and F3 on Fig.1, second process is defined by chaining the functions G1, G2 and G3) and the information flows between functions that specify the communication links between subsystems or modules. If the time, performance, etc. constrains are assigned to different functions and information links, the result of the presented analysis is the table of different, often contradictory, system requirements assigned to each physical subsystem (module) and physical communication link between subsystems.

From the viewpoint of the construction of the selected subsystem it is possible to consider a single universal subsystem fulfilling the most exacting system parameters, the creation of several subsystem classes according to a set of system parameters, creation of a modular subsystem where the addition of another module entails the increase of system parameters, etc.

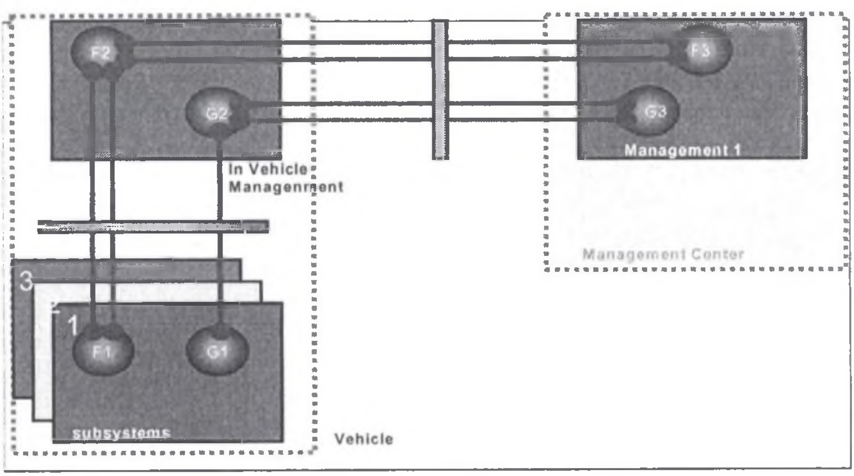

Fig.1. The principle of process analysis

The same principle may be applied while designing the telecommunication environment between selected subsystems (unified radio band frequency for all transport telematic applications, combination of individual transmission systems, combination of fixed and radio networks, etc.). In analogy with the subsystem design, the design of the telecommunication environment may be divided into several classes or, as the case may be, the transmission environment may be designed in a modular way when higher system parameters on the information transmission may be achieved by adding additional modules.

Similar situation applies to the other part of ITS system, or between ITS systems of different transport modes, e.g. road and railway transport. It is necessary to consider whether each transport mode has to have the selected subsystem alone available or whether there is an opportunity for sharing such subsystems, etc.

Following summary presents the basic strong ITS processes:

Processes related to transport infrastructure:

- Monitoring of technical conditions in transport infrastructure (transport roads and terminals)
- Monitoring of climatic and weather conditions in transport infrastructure (transport roads and terminals)
- Traffic control in transport infrastructure (transport roads and terminals)
- Operation and maintenance control in transport infrastructure (transport roads and terminals)
- Planning and development of transport infrastructure (transport roads and terminals)

Processes related to in-vehicle management:

- Traffic monitoring through vehicle
- Monitoring of driver's physical conditions during vehicle driving
- Monitoring of vehicle's technical conditions
- Information services inside the vehicle
- Navigation services inside the vehicle
- Automated cruise control of vehicles

Transport related processes:

- Control of traffic in transport infrastructure (transport terminals)
  - Traffic flow control
  - The fleet management (freight and public transport management)
  - The interventions of emergency vehicles
- Support for transport processes
  - Enforcement systems
  - Systems for electronic information exchange
  - Electronic fee collection systems

Travel and forwarding related processes:

- Monitoring and control of passengers mobility
  - Transport information kiosks for passengers
  - Integrated time-tables and booking systems
  - Payments by unified smart cards and by mobile phones
- Monitoring and control of carriage of goods
  - Monitoring of dangerous freight transport
  - Electronic identification of freight
  - Electronic bill of loading, custom declaration
  - Electronic paymentIn case all the processes are mapped by the physical subsystems or modules the following results of process analysis could be achieved:

- **The functional specification assigned to each selected subsystem or module:**
  - o Allocation of functions into subsystems or modules,
  - o Performance parameters assigned to functions (reliability, safety, availability, etc.),

    - Sharing of data or functions within ITS databases or ITS subsystems,
- **The interface specification:**
    - Definition of exchanged information between subsystems or modules (parameter synchronisation),
    - Timing of exchanged information (time synchronisation)
    - Performance parameters assigned to different information flows in selected interface - reliability, safety, availability, etc. (interface protocol optimisation)
- **The performance specifications of processes:**
    - Optimisation of telecommunication transmission within ITS system,
    - Omitting the process triggering by errors,
    - Avoiding the parallel processes within ITS system,
    - Specification of information lifetime within each process (lifetime of data stored in databases, etc.)

4. THE RESULTS OF ITS ARCHITECTURE

Fig.2 describes the principle of context diagram. The current state of functional and informational architecture of the Czech Republic is shown on Fig.3 and Fig.4 where the Fig.3 presents the macro-functions (9 basic macro-functions) and information links between them and Fig.4 presents the detail view on macro-function 5 (Provide Advance Driver Assistant System).

The information links in white box represents the linkage between functions and the information links in shadow box represents the information linkage between functions and terminators.

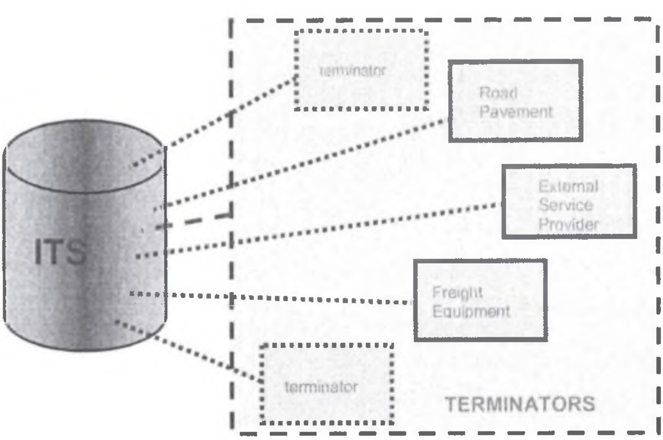

Fig.2. Principle of Context Diagram

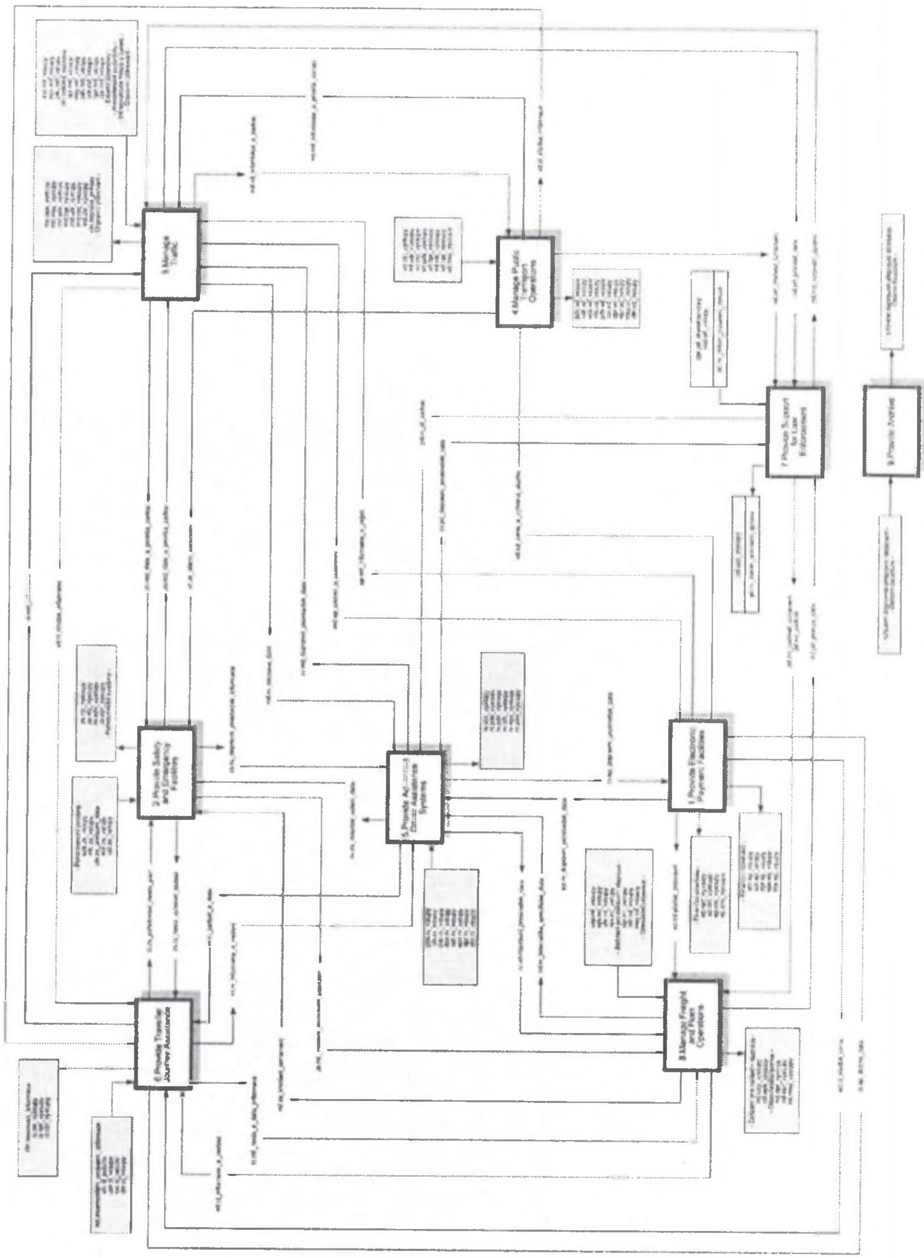

Fig.3. Functional and informational ITS architecture

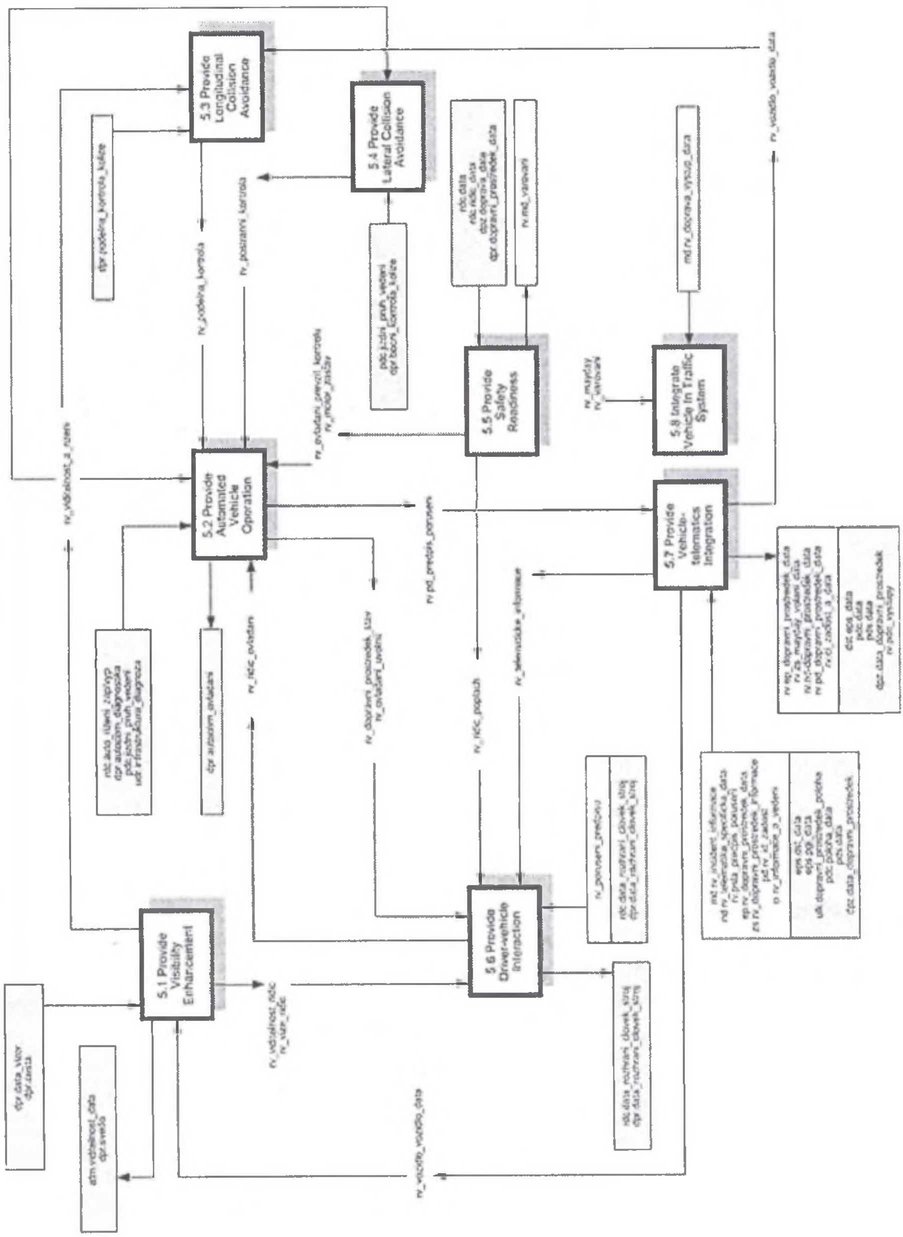

Fig.4. Functional and informational ITS architecture of Macrofunction 5
(Provide Advance Driver Assistant System)

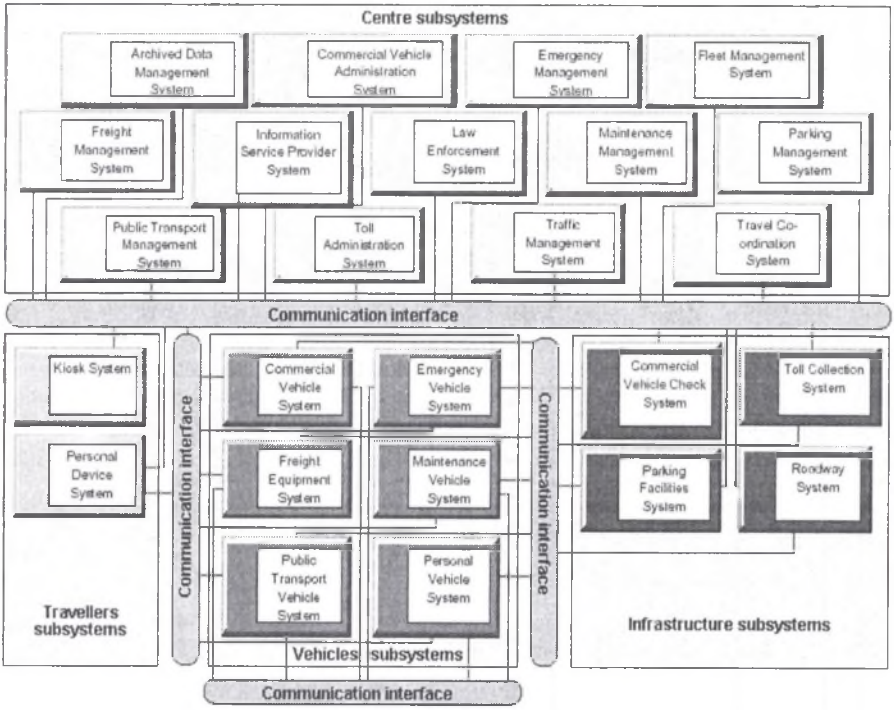

Fig.5. The example of physical ITS architecture [1]

5. CONCLUSION

Basic objective of the creation of the transport-telematic architecture is the achievement of the interoperability between individual telematic applications, including maximum use of available infrastructure by all telematic applications while keeping system requirements in individual telematic applications (technical requirements: safety, reliability, availability, integrity, etc.; transport related requirements: transport comfort, minimisation of external requirements of the transport related process, maintaining transport policy objectives at national and European level, etc.).

The result of the ITS architecture should be a design of individual subsystems and functional blocks, including the definition of their system parameters for OBU (On-Board Unit), telecommunication environment and processing centres for all kinds of transport telematic applications - Fig.5.

However, in the case of various alternatives of the OBU design, transmission environment or processing centres, the system parameters of individual transport telematic applications have to be guaranteed. Correctly conceived architectures of transport telematic systems in transport organisations of the Czech Republic will have a direct impact on the following factors:

- Efficient building of telecommunication environment and corporal networks will reduce their expenditures;
- Considerable reduction of transmitted information will reduce expenditures of transmission;
- Definition of requirements from the part of organisations will force the existing operators to offer services with these over-standard requirements, which will result in reduction of expenditures when building special telecommunication environments;
- Economical convenience of new solutions of transmission information will lead to the increase of demand for new technologies of telecommunication networks particularly in the field of access networks;
- It will be possible to secure modular development of telematic systems in single branches and organisations using the existing systems.

The above factors have an immense impact on economy of building telematic systems. A correctly conceived architecture, which utilises advanced information processing system, also logically leads to the reduction of information collection and transmission expenditures.

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