Telematics fundamentals, architecture, applications and benefits

Prof. Dr. Ing. Miroslav Svítek
Head of Laboratory of Telematics
Vice-Dean for external and foreign relations
svitek@fd.cvut.cz
Content

• **Introduction**
• **ITS model**
  • ITS architecture
  • ITS data register
  • ITS standards
  • New services of with ITS models
  • Economical analyze of ITS model
• **Application/projects of ITS models**
  • Dangerous Goods Transport Monitoring
  • Universal On-Board Unit
  • Development of new in-vehicle services
  • ITS effectiveness
• **Certification laboratory for ITS**
• **Conclusion**
ITS models
Project supported by Ministry of Transport of the Czech Republic

ITS architecture of the Czech Republic

- is solved within the project „ITS in transport-telecommunication conditions of the Czech Republic (802-210-108) supported by Ministry of Transport
- comes from KAREN, FRAME, ACTIF projects
- time schedule 2001 - 2005
ITS architecture – process analysis

The architecture defines the basic arrangement in (abstract) space:

- **Reference architecture** – defines main subsystems, basic actors, relation with system environment
- **Functional architecture** – defines main subsystem functions and applications
- **Information architecture** – defines requirements on collection, transfer and processing of information
- **Physical architecture** – defines requirements on physical subsystems (equipments)
- **Communication architecture** – describes subsystems for transfer of information with respect to physical architecture
- **Organisational architecture** – allocates the human function into system components
ITS architecture – process analysis

**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)
Management of ITS systems - model and reality

MODEL OF ITS SYSTEM
- ITS architecture
- ITS standards
- ITS data register

REAL ITS SYSTEM
- ITS aplikacations
- ITS interface
- ITS databases
ITS architecture – Information data flow

- **Input data flows to functional area 5 from terminators**
- **Data flows between functional areas**
- **Outputs data flows from functional area 5 to Terminators**
ITS architecture – Information data flow

Input data flows from other functions

Input data flows from terminators

Output data flows to other functions

Output data flows to terminators
ITS architecture – physical architecture

**Centre subsystems**
- Maintenance Management System
- Parking Management System
- Public Transport Management System
- Tool Administration System
- Traffic Management System
- Travel Coordination System
- Archived Data Management System
- Commercial Vehicle Administration System
- Emergency Management System
- Feet Management System
- Freight Management System
- Information Service Provider System
- Law Enforcement System

**Travellers subsystems**
- Kiosk Systems
- Personal Device system

**Vehicles subsystems**
- Commercial Vehicle System
- Emergency Vehicle System
- Freight Equipment System
- Maintenance Vehicle System
- Public Transport Vehicle System
- Personal Vehicle System

**Infrastructure subsystems**
- Commercial Vehicle Check System
- Tool Collection System
- Parking Facilities System
- Roadway System

Czech Technical University in Prague - Faculty of Transportation Sciences
Department of Control Engineering and Telematics
ITS Data Register

The definition of data registry (ISO/IEC 11179)

- An information resource kept by a registration authority that describes the meaning form of data elements, including registration identifiers, definitions, names, value domains, metadata and administrative attributes.

The data registry should manage two types of information

- Data and information standards at micro and macro information levels to be used in data management.
- Information about current (legacy) data elements.

<table>
<thead>
<tr>
<th>Name of element</th>
<th>Definition</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID Airport</td>
<td>unique kode assigned to Airport</td>
<td>char (4)</td>
</tr>
</tbody>
</table>

Value

LKPR
Benefit of data registry:

- **Data quality and access** – reducing the ambiguity about similar data defined differently across systems
- **Interoperability** – today, system interfaces are customized between pairs of systems (expensive to build and maintain, inflexible) – solution is data structure definition
- **Cost effectiveness** – constrained budget can be used when data services can serve multiple systems rather than when each system develops its own data services locally
- **Flexibility** – common data services developed with automated tools allows system-wide access to metadata and the data behind them more easily and efficiently
ITS Standards

ITS standards (CEN, ISO) could be linked with

- ITS architecture: functions, interfaces, physical subsystems, communication links
- ITS data registry: data model, transmission messages

The role of ITS standards could be summarized:

- instrument for time, parameter and protocol synchronization
- added value for ITS architecture and ITS data registry
Tools for ITS design
## Tools for ITS design

### Informační architektura pro poskytování aktuálních dopravních informací

<table>
<thead>
<tr>
<th>Realizační funkce</th>
<th>Datové toky vstupu</th>
<th>Datové toky systému</th>
<th>Datové toky výstupu</th>
<th>Terminátoru</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.2.1. Identifikace a klasifikace náměstí</td>
<td>za vstupem aj.</td>
<td>za vstupem aj.</td>
<td>za vstupem aj.</td>
<td>za vstupem aj.</td>
</tr>
<tr>
<td>3.1. Doporučené řešení</td>
<td>osvět.</td>
<td>osvět.</td>
<td>osvět.</td>
<td>osvět.</td>
</tr>
</tbody>
</table>

### 1. Správa poplatků

#### 1.1. Uzavření contraktu

1.2. Správa konta uživatelů

1.2.1. Aktuální stav uživatů konta

1.2.2. Odečtení poplatky z účtu kl. konta

1.2.3. Informace o transakcích a výrobních programech

1.3. Elektronické transakce

1.3.1. Kontrole contraktu

1.3.2. Informace a návody

1.3.5. Výpočet poplatků za službu

1.3.6. Kontrola platby

1.3.7. Provedení platby

1.4. Příjezdní operátorů

1.4.1. Rozdělení příjmu

1.4.2. Platby na konta operátorů

1.5. Obecné věci

1.5.2. Detekce narušení systému

1.5.3. Detekce narušení

1.6. Management tarifů a přístupových
Economical Analysis of ITS Architecture

Telematics system with designed architecture
- Information Processing: 64%
- Information Transmission: 20%
- Information Collection: 16%

Telematics system without designed architecture
- Information Processing: 36%
- Information Transmission: 49%
- Information Collection: 15%
Application of ITS models
Information system for monitoring and control of dangerous goods

- is one of the pilot applications prepared within project „Involvement of the Czech Republic into Galileo Project“ (802-210-112) supported by Ministry of Transport
- is pilot application of using the ITS architecture for practical design of selected telematics application
- time schedule 2001 - 2006
System architecture

**Management subsystem**
- Route selections and dangerous transports tracks monitoring
- Emergency call in case of accidents, accident location
- Processing of available information (models of contamination, traffic information, etc.)
- Instruction for intervention
- Re-routing of traffic, warning the public, etc.
- Accident impact evaluations

**ITS Infrastructure**
- ITS Rescue Services
- ITS Public Authority
- ITS Custom Authority
- other companies e.g. insurance
- IS Rescue Services
- IS Public Authority
- IS Custom Authority
- other companies e.g. insurance

**External Information**

**ITS Infrastructure management**
- ITS Forwarding Companies
- ITS Transport Operators
- other companies e.g. meteo

**Telematics means**
- (OBU of rescue vehicles, etc.)
- (detectors, actors, OBU, ID, etc.)
Project supported by Ministry of Trade and Industry of the Czech Republic

**Universal On-Board Unit for ITS**

- is the industry realization of universal ITS on-board unit in conformance with Czech patent
- Project consortium:
  - Honeywell,
  - Telematix Services, Telematix Software,
  - Faculty of Transportation Sciences, Czech Technical University
- time schedule
  2006 - 2009
System architecture

• Definition of all parameters used in OBU together with its attributes (sample frequency, accuracy, representation, etc.)
• Definition of unified SW modules available for all OBU processes (functions, databases and conditions)
• Definition of OBU management taking into account all system parameters (safety, priority, etc.)
• Definition of OBU processes/ applications using unified functions, databases and conditions (development kit)
Economical, Ecological and Safety Electronic Fee Collection

- is supported by Ministry of Transport of the Czech Republic
- the project consortium is:
  - Czech Technical University of Prague, Faculty of Transportation Sciences
  - Czech University of Agriculture in Prague, Technical Faculty
  - Telematix Services, a.s.
- time schedule is 2004 – 2007
Using of in-vehicle data in transport telematics applications

- The connection between OBU and in-vehicle data (CAN) can yield to providing the new telematics services:
  - In-vehicle weight in motion
  - On-line assessment of vehicle emission
  - On-line measurement of externalities
  - Safety assessment of vehicle driving
  - Ecological assessment of vehicle driving,
  - Etc.
Illustrative example - In-vehicle weight in motion system

- The basic principle comes from Newton’s Law of Inertia:
  \[ F = m \cdot a \]
  - \( F \) – vector of vehicle force,
  - \( m \) – vehicle weight,
  - \( a \) – vector of vehicle acceleration
- The acceleration \( a \) is measured by accelerometer or GPS/GALILEO locator inside OBU
- The vehicle force \( F \) is measured by processing of CAN bus data
- Novak M., Svitek M., Votruba Z.: The patent application CZ PV 2003-3337

\[
m_i := \frac{ip \cdot up}{Ra} \cdot M(n_i) - a_i \cdot \left( \frac{ip^2 \cdot Im}{up \cdot Ra^2} + \frac{Ia + Ib}{Ra^2} \right) - \frac{0.5 \cdot \rho \cdot cw \cdot SP}{3.6^2} \cdot (v_i - vx_i)^2
\]

\[
a_i + \left( ka + \frac{v_i}{3.6} \cdot kb \right) + 9.807 \cdot \sin \left( \text{atan} \left( \frac{\alpha_i}{100} \right) \right)
\]
Project supported by Ministry of Transport of the Czech Republic

**ITS effectiveness**

- Is supported by Ministry of Transport of the Czech Republic
- Project consortium:
  - Telematix Services, a.s.
  - Babtie, s.r.o.
  - Telefonica O2, a.s.
- time schedule 2004 - 2008
ITS market packages
Example – 3 ITS market packages

1. Traffic monitoring
2. Traffic information broadcasting
3. Navigation of rescue services
Example – synergy models of ITS packages
Fuzzy-linguistic approximation

- Processing of different knowledge representations (experts knowledge, equations, statistical knowledge)
- Synergy models of cost/benefit indicators
ITS Certification Laboratory

- **2005 - 2007** – a lot of lessons learned through EFC system implementation
- **2007** – expert team of Minister created basic EFC architecture with recommend opened interfaces
- **2007** – first contract signed between Ministry of Transport and Faculty of Transportation Sciences to launch ITS certification laboratory
- **2007** – first ideas how to legally create the laboratory were discussed:
  - ITS architecture and standards are main support documents for certification
  - Certification is in reality the compliance evaluation between predefined architecture/standards and real product of supplier
- **2008** – certification laboratory starts to work
Thank you for attention