



Faculty of Transportation Sciences

Department of Control Engineering
and Telematics



T.E.A.M.



telematics
economy
architecture
management

Telematics fundamentals, architecture, applications and benefits

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 - ITS architecture
 - ITS data register
 - ITS standards
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 - Universal On-Board Unit
 - Development of new in-vehicle services
 - ITS effectiveness
- **Certification laboratory for ITS**
- **Conclusion**





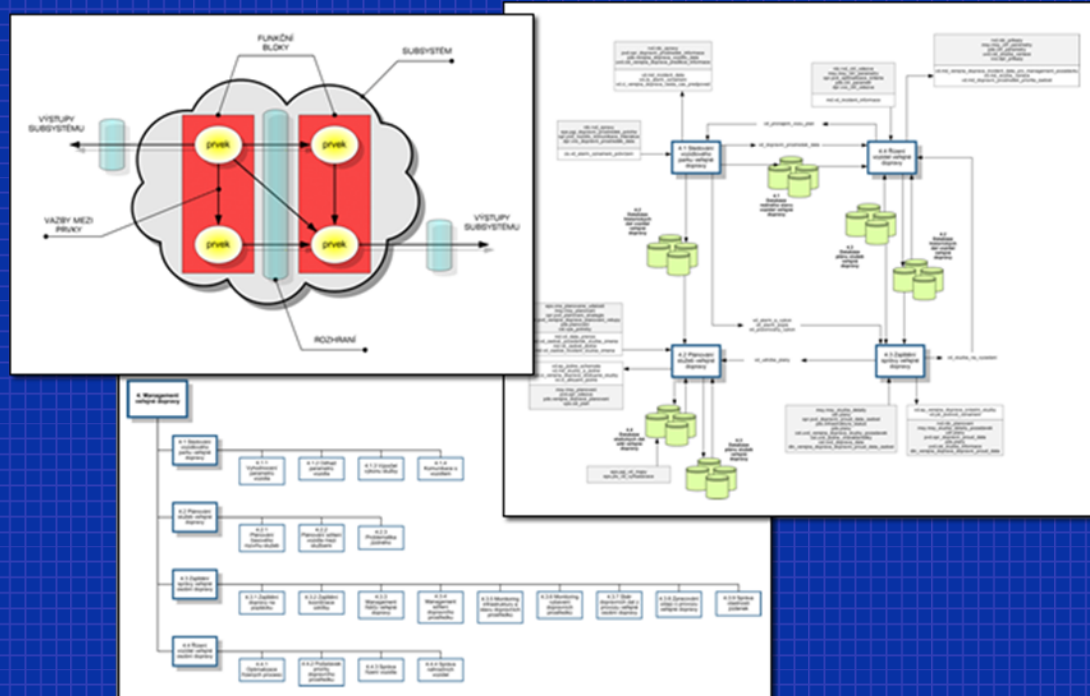
ITS models



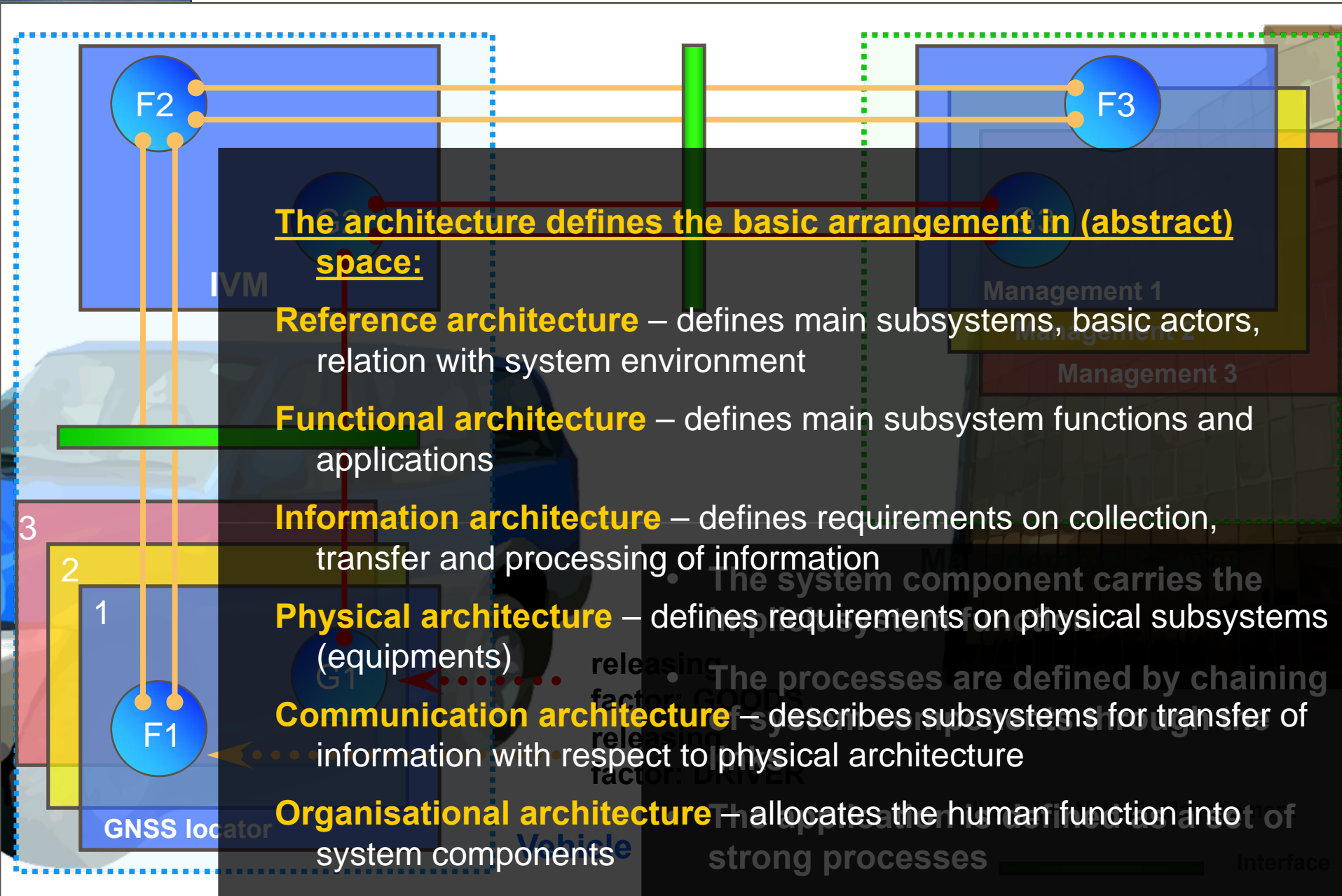
Project supported by Ministry of Transport of the Czech Republic

ITS architecture of the Czech Republic

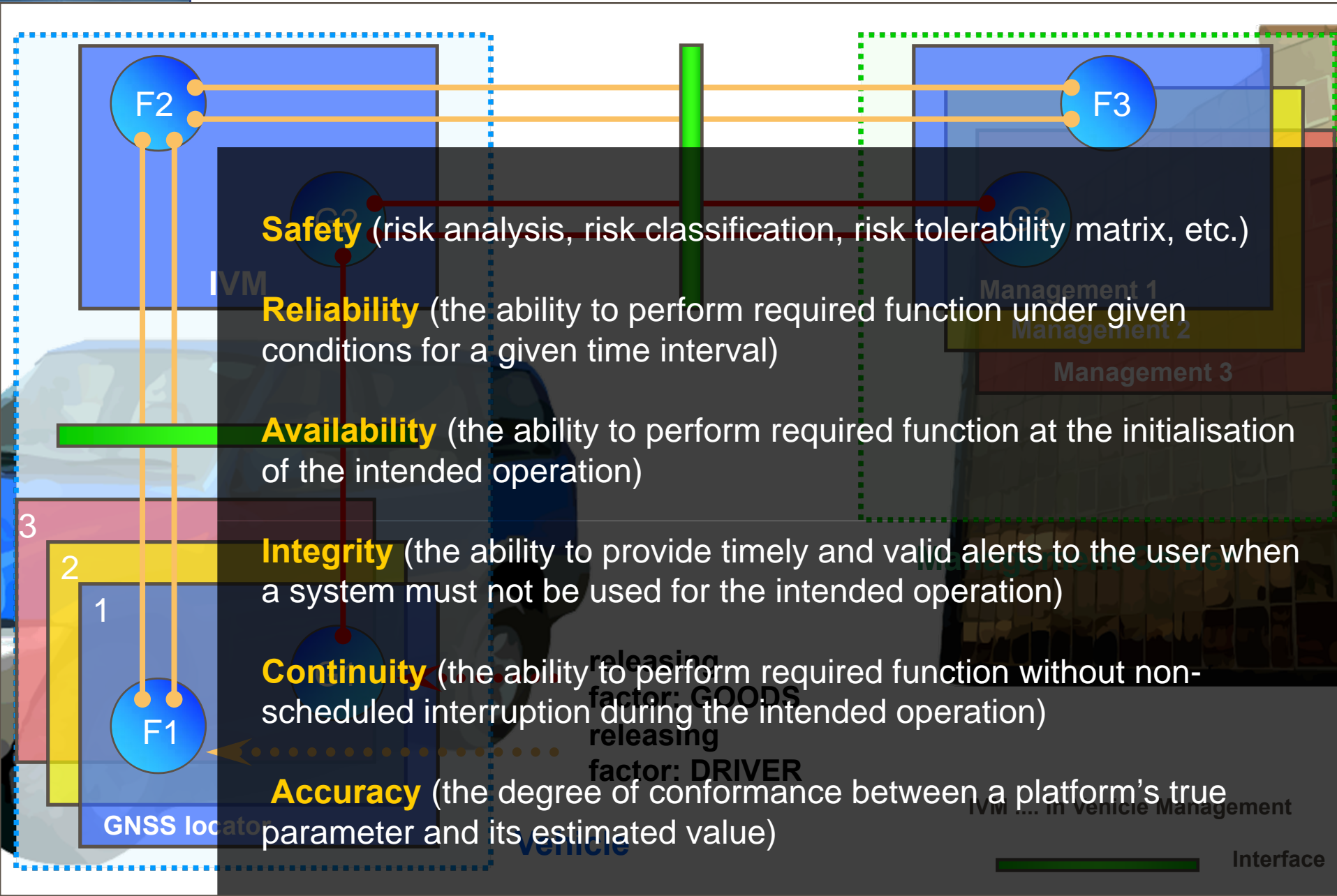
- is solved within the project „ITS in transport-telecommunication conditions of the Czech Republic (802-210-108) supported by Ministry of Transport
- comes from KAREN, FRAME, ACTIF projects
- time schedule 2001 - 2005



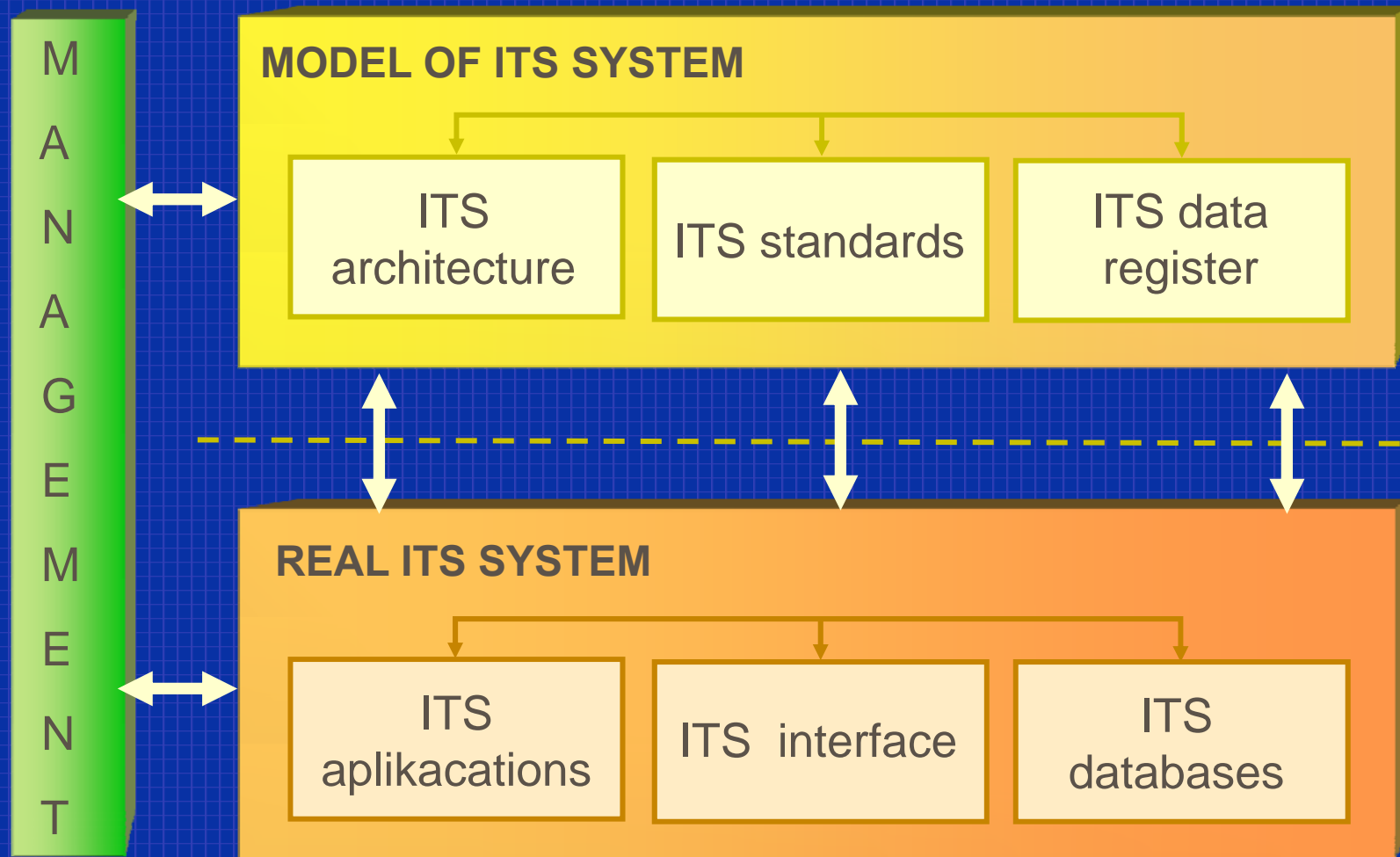
ITS architecture – process analysis



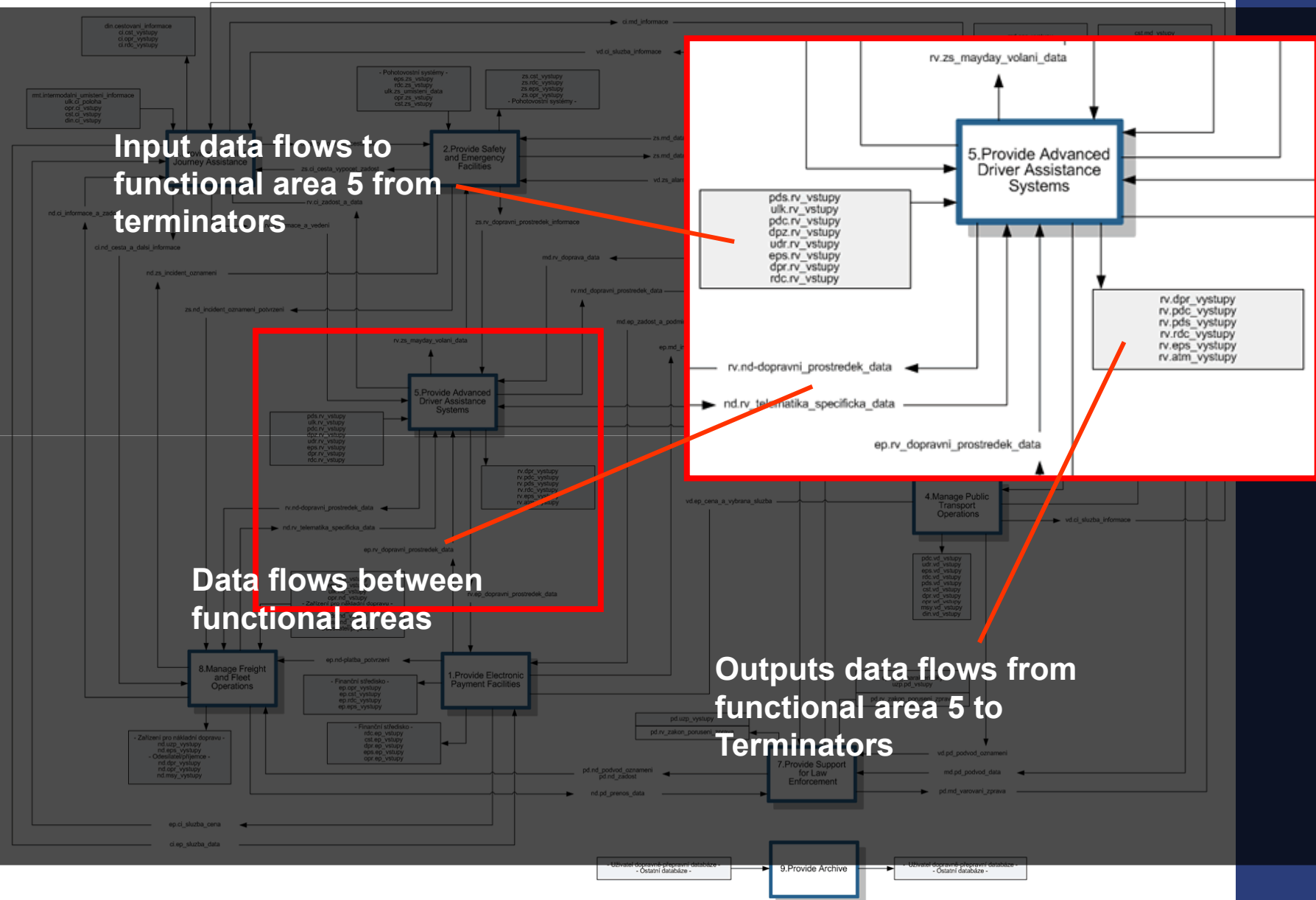
ITS architecture – process analysis



Management of ITS systems - model and reality



ITS architecture – Information data flow



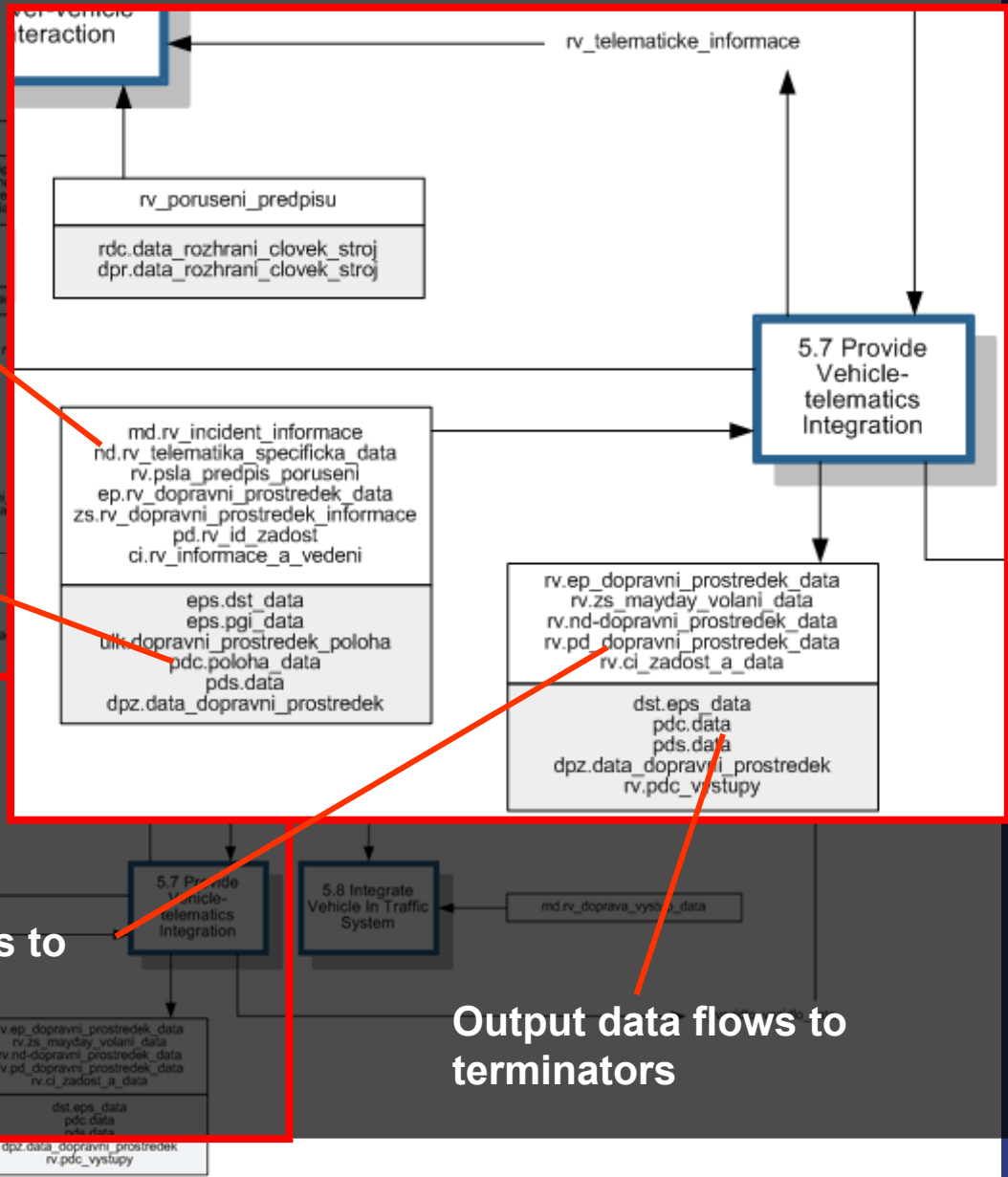
ITS architecture – Information data flow

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

Communication interface

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



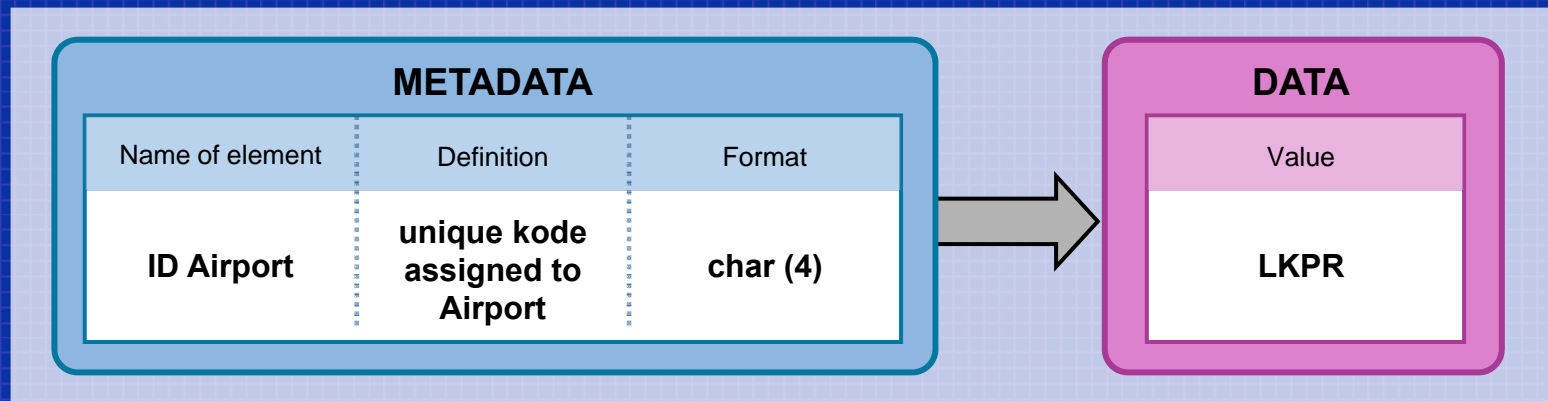
ITS Data Register

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

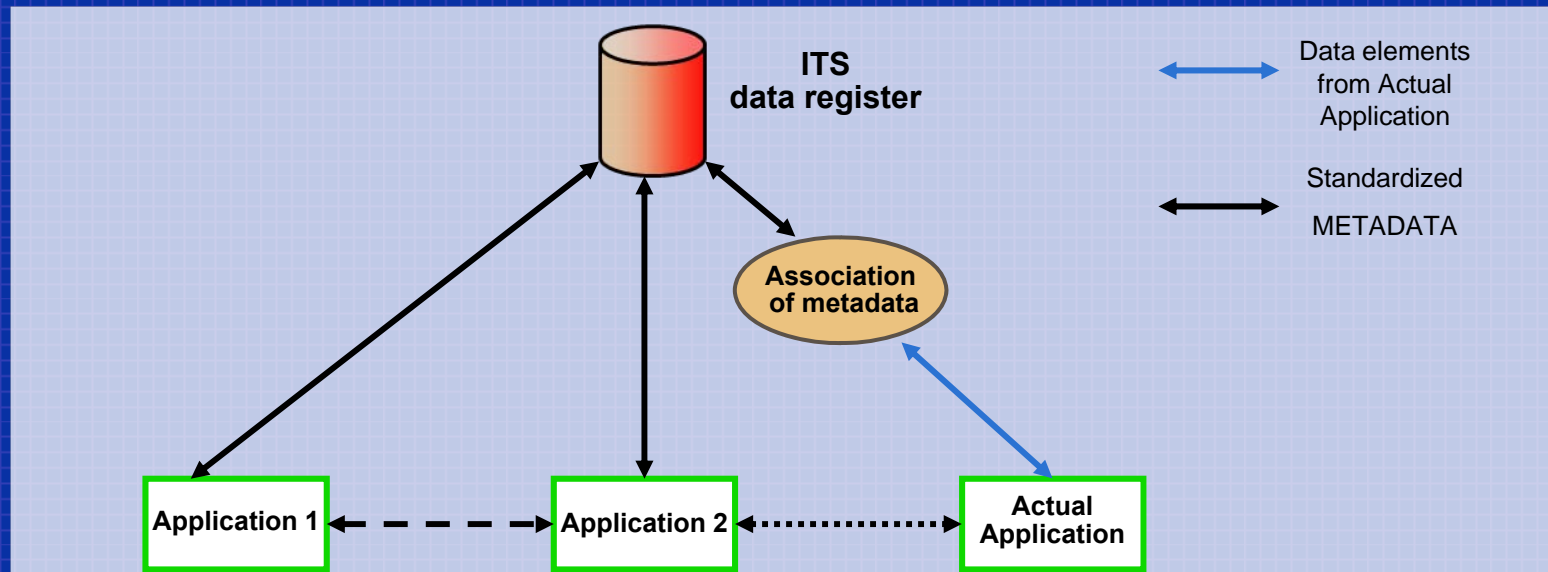
- Data and information standards at micro and macro information levels to be used in data management
- Information about current (legacy) data elements



ITS Data Register

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



Web portal: www.its-portal.cz

The screenshot displays the ITS portal interface. At the top, there is a navigation bar with the ITS logo and a menu: Home | Functional Areas | Dataflows - logical | Functions | Datastores | Terminators | Dataflows - physical | Subsystems | Standards | User needs | Slovník | Prohlázení ITS. Below this is a sidebar menu with options like 'Přihlášen jako: Galik Ondřej (multigroup)', 'Logical part', 'Functional Areas', 'Dataflows - logical', 'Functions', 'Datastores', 'Terminators', 'User needs', 'Physical part', 'Dataflows - physical', 'Subsystems', 'Standards', 'Standards', 'Prohlázení', 'ITS architektura', 'Projekt Slovník', 'Editace slovníku', 'Uživatel', 'Odhlásit se', 'Změna hesla', 'Přehled uživatelů', 'Nápoje', and 'Zobrazit nápovědu'. The main content area features a 'Novink' section with text: 'Byla přidána rozhraní pro proch. Najdete jej pod odkazem "ITS...', 'Byly vytvořeny zkratky terminátů na adresu:', and 'Byla přidána funkce rozlišení stránek. Položky jsou barevně odlišeny...'. There are two login forms with fields for 'uživatel' and 'heslo', and a 'Přihlásit' button. The 'ITS portál' header includes the text: 'portál inteligentních dopravních systémů a telematiky - vytvořeno v rámci projektu 802-210/108 MČR (ZDE) - odpovědný řešitel Doc.Dr.Ing. Miroslav Světek, laborator telematiky FD ČVUT (ZDE)'. Below the header, there are sections for 'Projekty' (National and European), 'Světové' (TransGuide, Houston TranStar, DalTrans, TransVISION, Detroit traffic), and 'Architektura ITS ČR' (Subsystems, Functions, Terminators, Logical, Physical). A 'Webmaster' link is also present. At the bottom, there is a diagram titled 'Komunikační rozhraní' showing three interconnected systems: 'Systémy Uživatelů' (Informační kiosek, Systém způsobů komunikace), 'Vozidlové systémy' (Systém komerčního vozidla, Systém záchranného vozidla, Systém nákladního zařízení, Systém vozidel pro údržbu silničních komunikací, Systém vozidla veřejné dopravy, Osobní dopravní prostředek), and 'Systémy na dopravní infrastrukturu' (Systém kontroly komerčního vozidla, Systém placení mýta, Systém parkovacích ploch, Silniční komunikace).



Tools for ITS design

The screenshot displays the ITS design tool interface, which is divided into several main sections:

- Top Bar:** Includes the ITS logo, a login/logout area with the username "ITS user", and language options for "česky" and "english".
- Left Navigation Panel:** Contains menu items such as "PROJEKTY", "ODKAZY", "HOME", "PROHLÍŽENÍ ARCHITEKTURY", and "NÁPOVĚDA".
- Main Content Area:**
 - PROJECT - NÁVRH:** Shows the project name "MANAGEMENT VEŘEJNÉ DOPRAVY - Odbavovací systém a placení jízdného". It lists "Vybrané uživatelské potřeby" (Selected user requirements) and "Nevybrané uživatelské potřeby" (Unselected user requirements). Two items in the unselected list are circled in red: "4.2.4-A - Systém by měl sloužit autoritě odpovědné za smlouvu" and "2.1.0.1 - Systém umožní přizpůsobit dopravu a...".
 - PROJECT - SPRÁVA:** Shows the same project name and a description of the project's goals, such as increasing safety and efficiency.
 - VAŠE PROJEKTY:** A table listing various project tasks and their status.
 - VEŘEJNÉ PROJEKTY:** A table listing public projects and their status.
- Bottom Bar:** Includes a legend for project status (green for approved, orange for in progress, red for rejected) and a copyright notice for 2004.

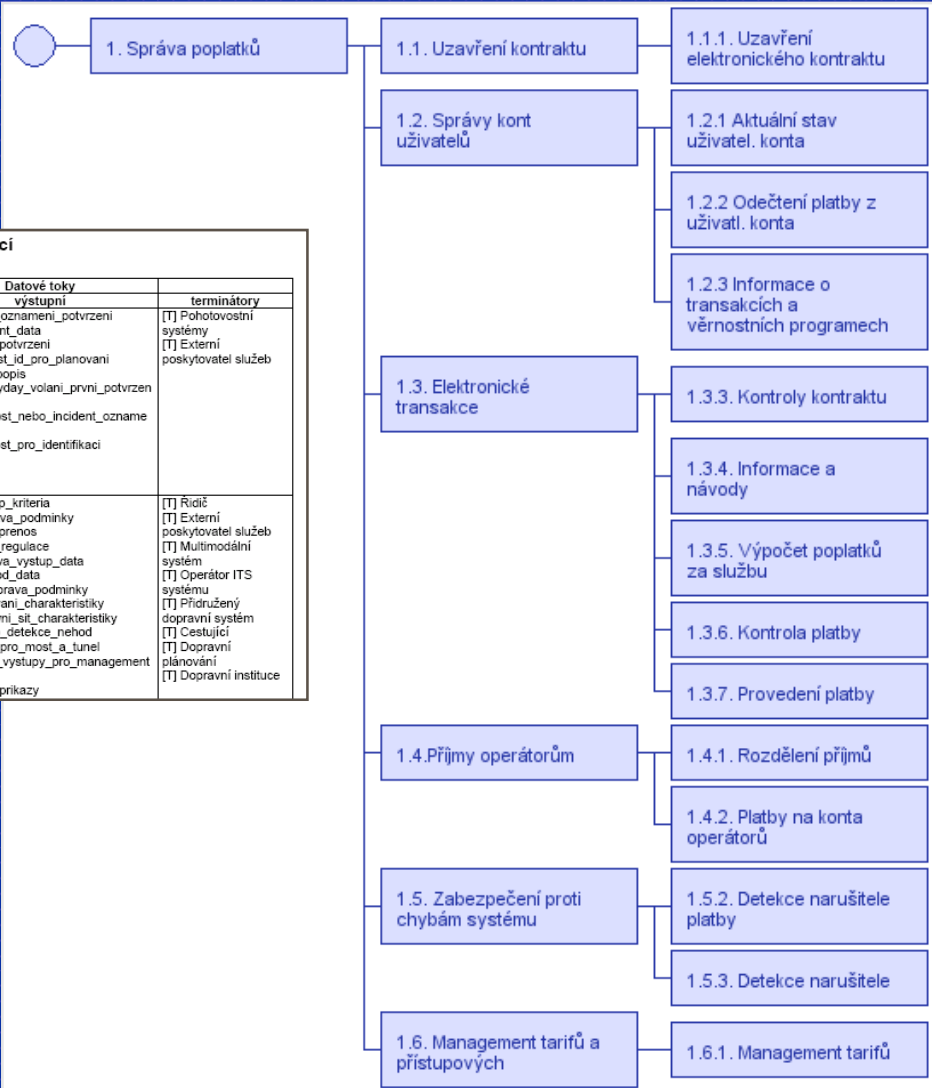


Tools for ITS design



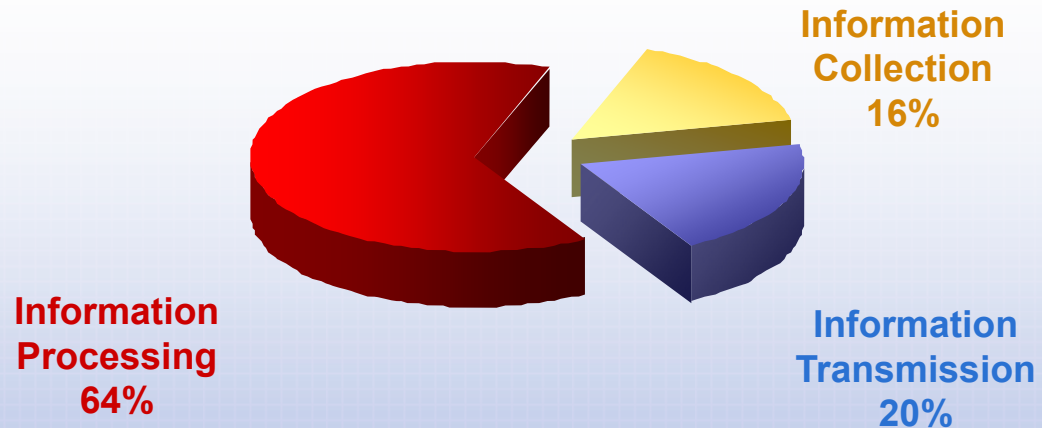
Informační architektura pro poskytování aktuálních dopravních informací

Realizující funkce	Datové toky		Datové toky	
	vstupní	terminátory	výstupní	terminátory
2.1.2.1. Identifikace a klasifikace nehod	pos.pohotovost_nebo_incident_ozn ameni eps.pgi_identifikace_odezva md.zs_incident_oznameni md.zs_incident_oznameni rv.zs_mayday_volani_data zs_obecna_pohotovostni_data_ zs_pohotovost_popis zs_pohotovost_id_pro_preklasifikov ani zs_okraj_mayday_volani rv.zs_dopravni_prostredok_data rv.zs_dopravni_prostredok_pozice	[T] Pohotovostní systémy [T] Externí poskytovatel služeb	zs.vd_alam_oznameni_potvrzeni zs.md_incident_data zs.rv_volani_potvrzeni zs_pohotovost_id_pro_planovani zs_incident_popis zs_okraj_mayday_volani_prvni_potvrzen i pos.pohotovost_nebo_incident_ozname ni pgi.eps_zadost_pro_identifikaci	[T] Pohotovostní systémy [T] Externí poskytovatel služeb
3.1. Dopravní řízení	zs.md_pohotovost_zadost msy.msr_krizovka_zadost opr.ods_doprava_prikazy pds.doprava_management_data cst.vyskyt_chodce dpl.strategie_a_predpoved_prikazy dpz.doprava_data_vstupy dpr.vvo_lokalni_priorita_zadost vd.md_dopravni_prostredok_priorit a_zadost md_vstupy_most_a_tunel md_vstupy_management_pozadav ku md_doprava_prostredi_vstupy	[T] Multimodální systém [T] Operátor ITS systému [T] Přidružený dopravní systém [T] Cestující [T] Dopravní plánování [T] Dopravní provoz [T] Dopravní prostředek	md.ep_pristup_kriteria md.ep_doprava_podminky md.vd_data_prenos md.rv_rizeni_regulace md.rv_doprava_vystup_data md.pd_podvod_data md.ci_sit_doprava_podminky md.ci_parkovani_charakteristiky md.ci_dopravni_sit_charakteristiky md_data_pro_detekce_nehod md_vystupy_pro_most_a_tunel md_doprava_vystupy_pro_management _pozadavku rdc.doprava_prikazy	[T] Řidič [T] Externí poskytovatel služeb [T] Multimodální systém [T] Operátor ITS systému [T] Přidružený dopravní systém [T] Cestující [T] Dopravní plánování [T] Dopravní instituce

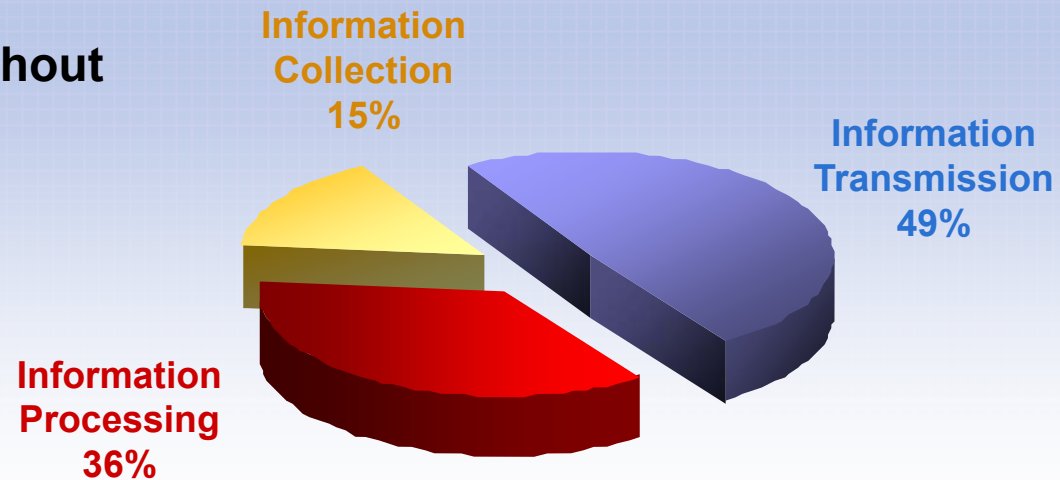


Economical Analysis of ITS Architecture

Telematics system with designed architecture



Telematics system without designed architecture





Application of ITS models



Project supported by Ministry of Transport of the Czech Republic

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

telematics means (OBU of rescue vehicles, etc.)

IS Rescue Services

IS Public Authority

IS Custom Authority

other companies
e.g. insurance

I
N
F
O
R
M
A
T
I
O
N

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 management

ITS Forwarding Companies

ITS Transport Operators

other companies
e.g. meteo

telematics means (detectors, actors, OBU, ID, etc.)

Project supported by Ministry of Trade and Industry of the Czech Republic

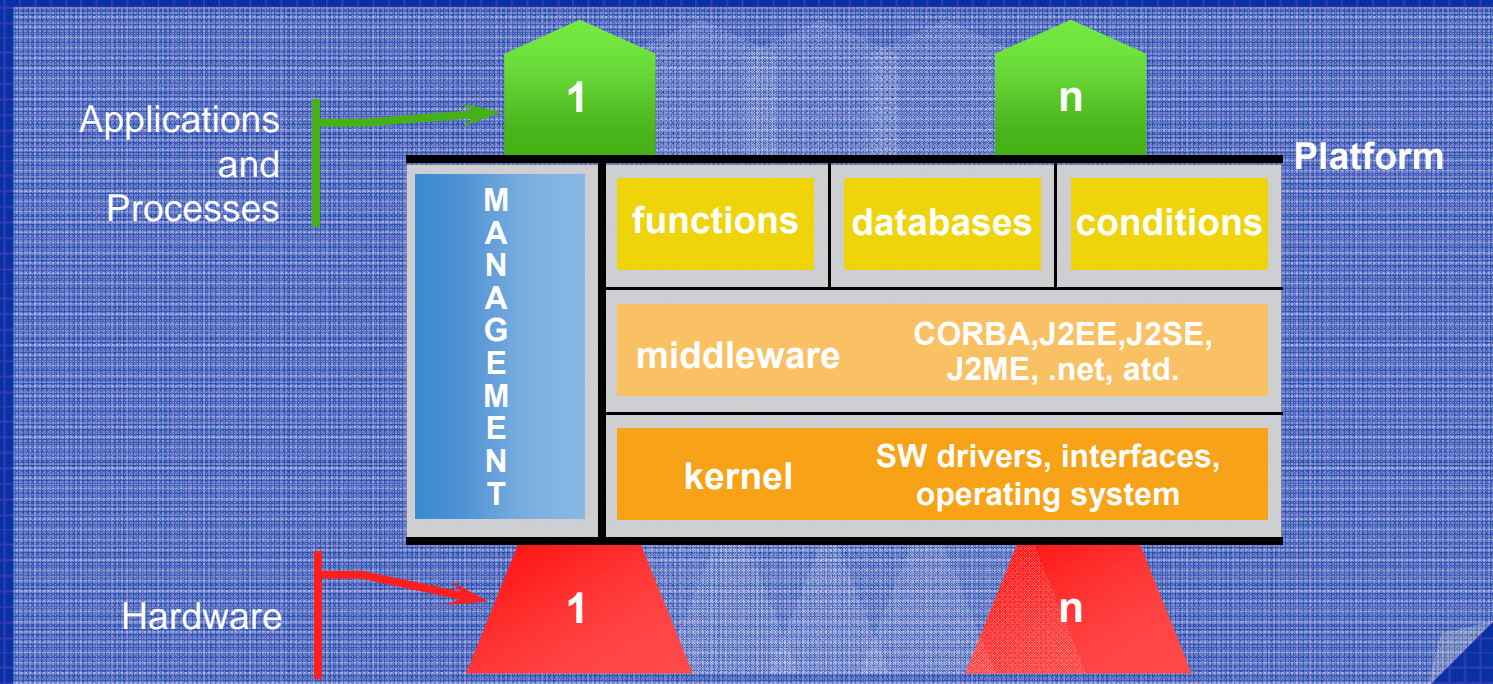
Universal On-Board Unit for ITS

- 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

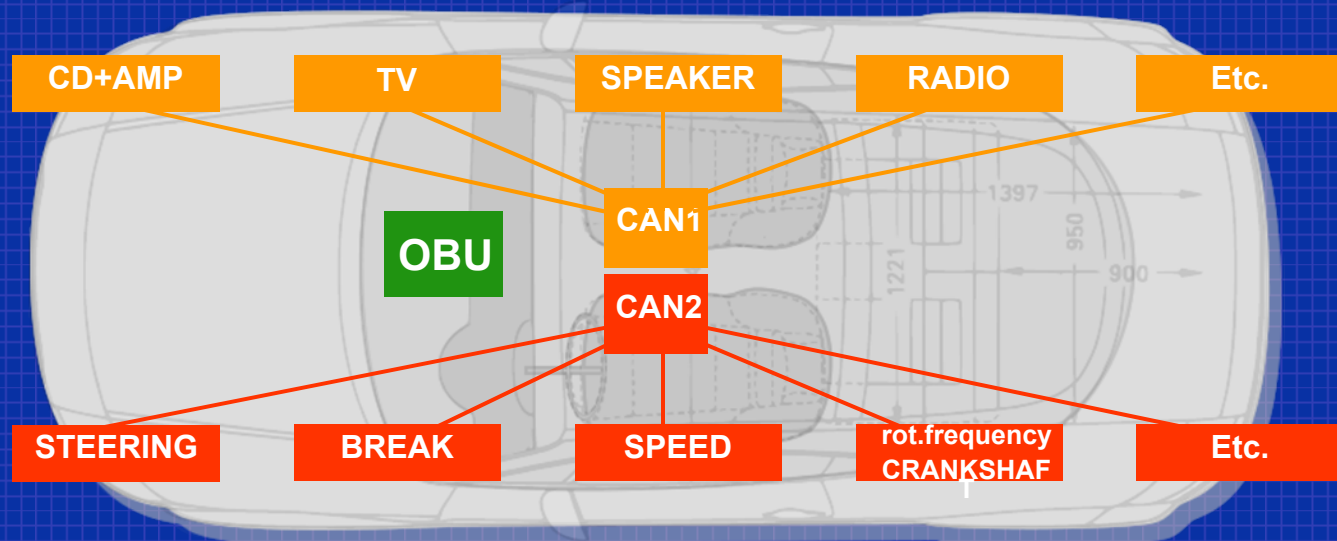
- Definition of all parameters used in OBU together with its attributes (sample frequency, accuracy, representation, etc.)
- Definition of unified SW modules available for all OBU processes (functions, databases and conditions)
- Definition of OBU management taking into account all system parameters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



Project supported by Ministry of Transport of the Czech Republic

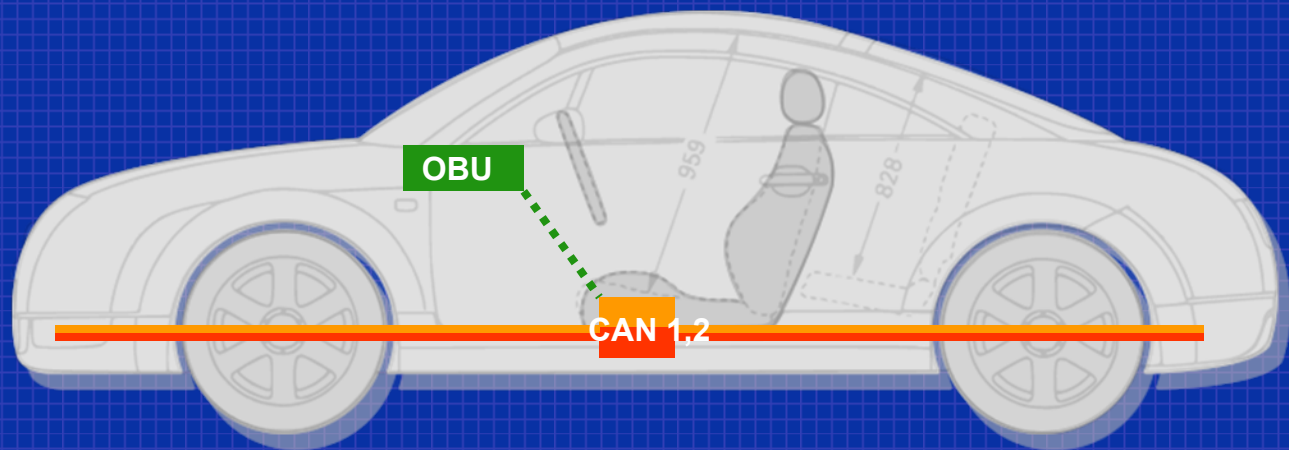
Economical, Ecological and Safety Electronic Fee Collection

- 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

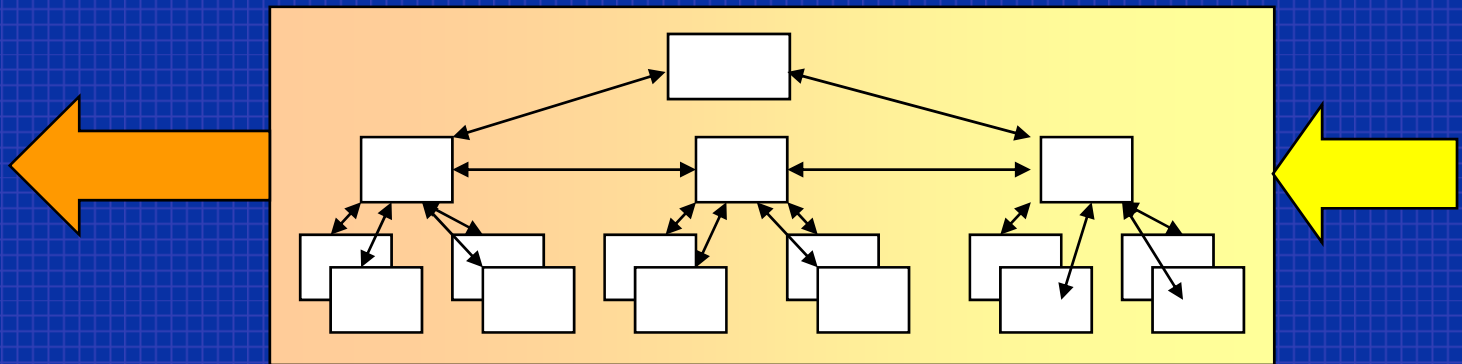
$$m_i := \frac{\frac{ip \cdot up}{Ra} \cdot M(n_i) - a_i \cdot \left(\frac{ip^2 \cdot Im}{up \cdot Ra^2} + \frac{Ia + Ib}{Ra^2} \right) - \frac{0.5 \cdot \rho \cdot cw \cdot SP}{3.6^2} \cdot (v_i - vx_i)^2}{a_i + \left(ka + \frac{v_i}{3.6} \cdot kb \right) + 9.807 \cdot \sin \left(\text{atan} \left(\frac{\alpha_i}{100} \right) \right)}$$



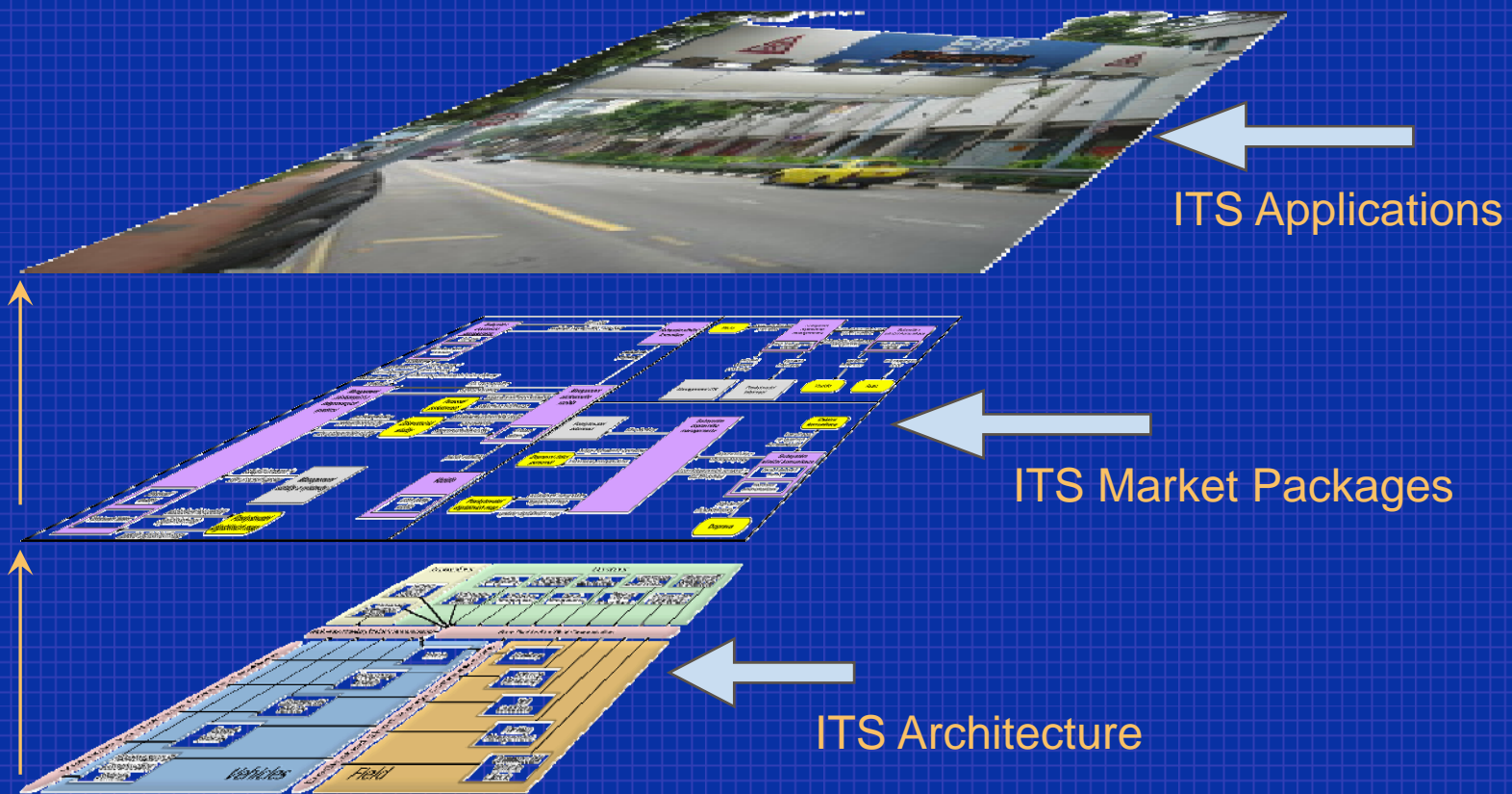
Project supported by Ministry of Transport of the Czech Republic

ITS effectiveness

- Is supported by Ministry of Transport of the Czech Republic
- Project consortium:
 - Telematix Services, a.s.
 - Babcie, s.r.o.
 - Telefonica O2, a.s.
- time schedule 2004 - 2008

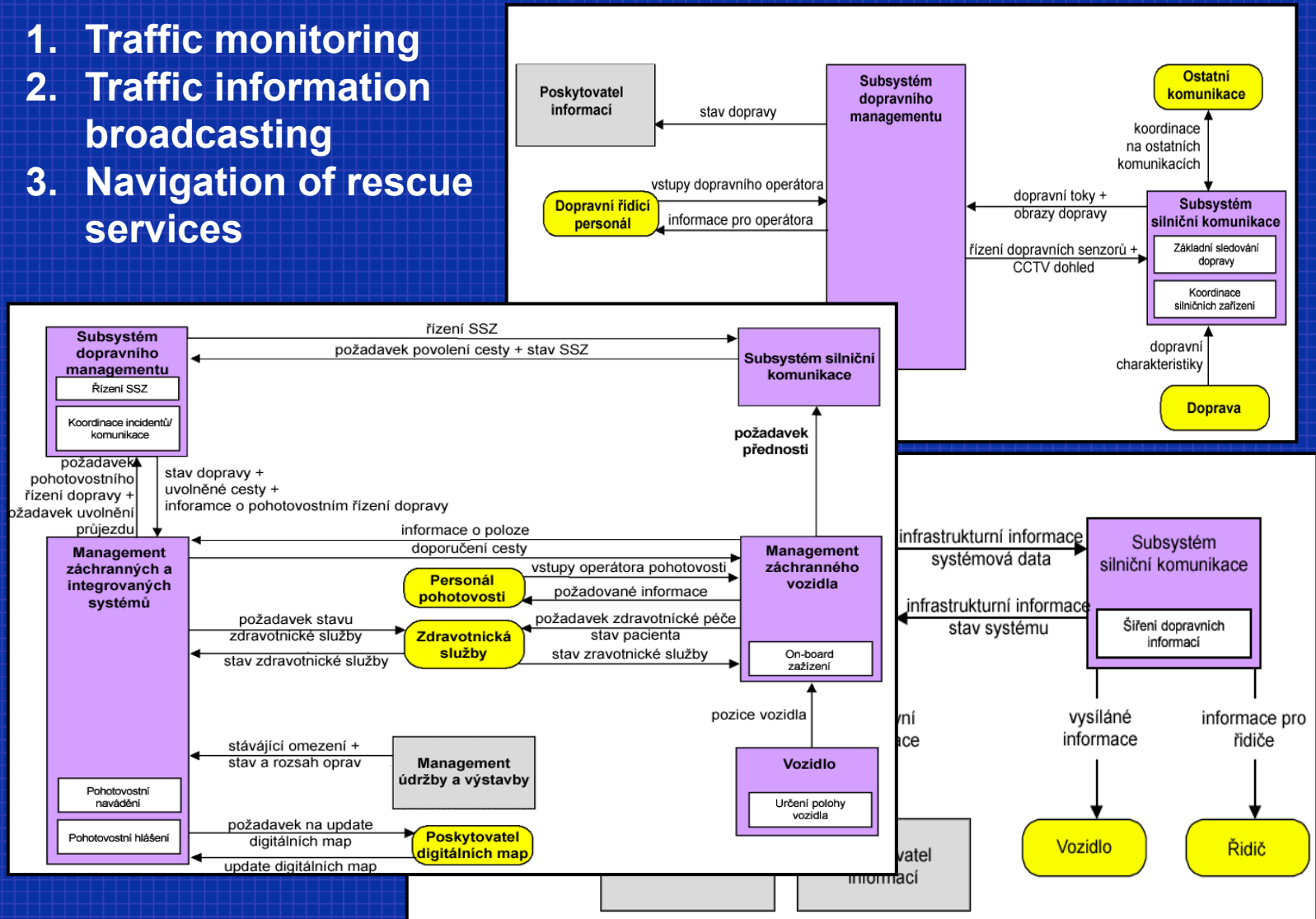


ITS market packages

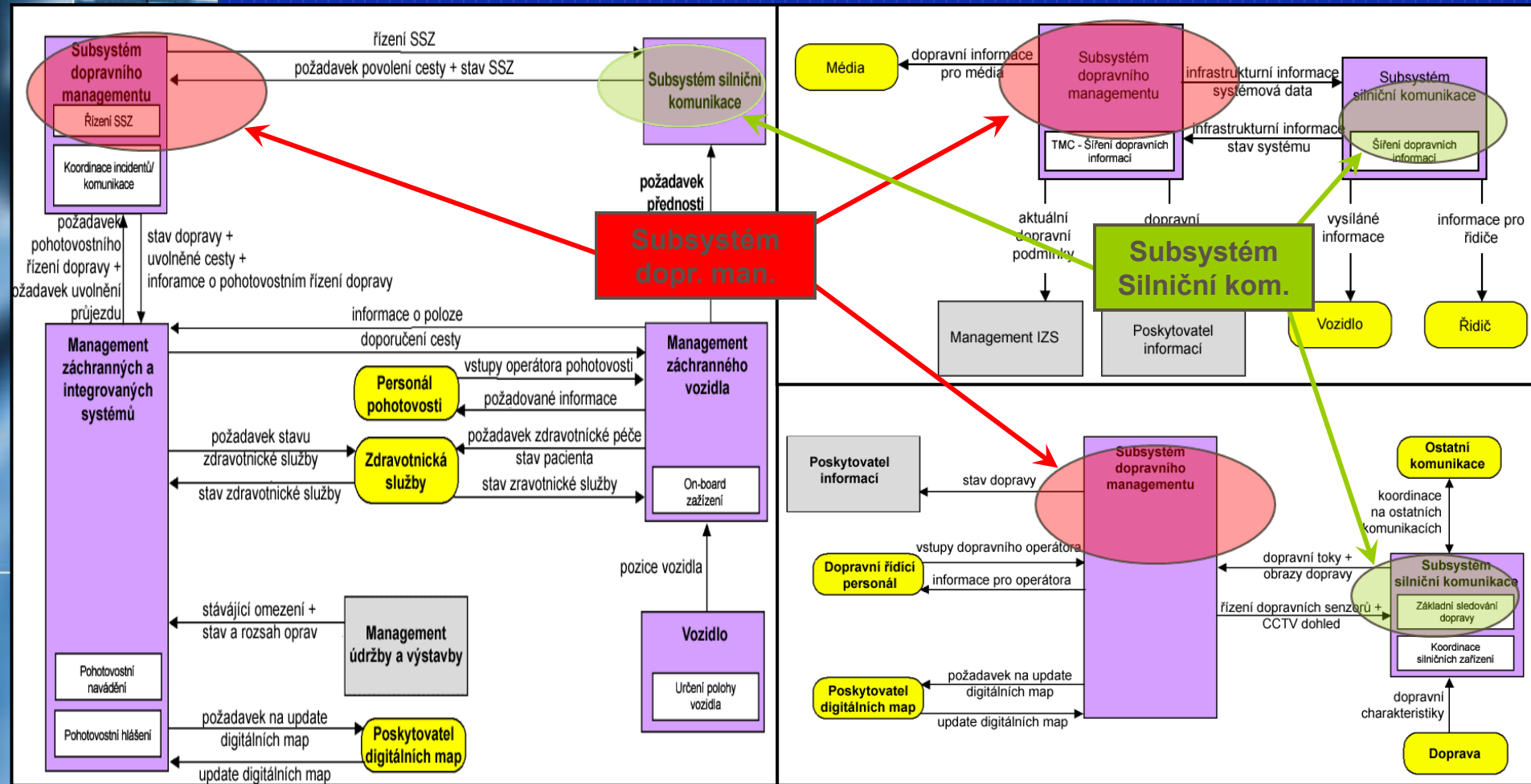


Example – 3 ITS market packages

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

The screenshot shows the LFLC 2000 software interface. The main window is titled "C:\Program Files\LFLC 2000\snizeni provoznich nakladu p2.rb" and contains a table of rules. The table has columns for "délka doprav.", "počet křížení", " hustota inform.", " hustota dopravní", and "snížení provozních". The rules are numbered 1 through 29. A 3D surface plot is overlaid on the table, showing a complex surface with a red vertical line and a blue horizontal line. To the right of the table, there are several graphs for input variables: "délka dopravní" (Value: 36.60), "počet křížení" (Value: 9.33), " hustota informa" (Value: 7.11), and " hustota doprav" (Value: 6.95). Each graph shows a scale from 0 to 100 and a typical expression. On the far right, there is a section for "Inference method" (Fuzzy Approximation with Implications) and "Defuzzification method" (Defuzzification of Linguistic Expressions). Below this, there is a graph for "Output variables" showing a value of 3.42. At the bottom right, there is a "Projection variable" graph showing a step function with a value of 2.5. The Windows taskbar at the bottom shows the Start button, several icons, and the system tray with the time 12:00.

	délka doprav.	počet křížení	hustota inform.	hustota dopravní	snížení provozních	Group	Inconsistency	Redundant suc
1.	sm	sm	me	me	bi			
2.	sm	sm	sm	me	ro bi			
3.	sm	sm	me	sm	ro bi			
4.	sm	me	me	me	ex bi			
5.	sm	me	sm	me	me			
6.	sm	me	me	sm	me			
7.	bi	bi	bi	bi	ex bi			
8.	me	me	me	me	ex bi			
9.	sm	bi	sm	me	sm			
10.	sm	bi	me	sm	sm			
11.	sm	bi	bi	sm	sm			
12.	sm	bi	sm	bi	sm			
13.	sm	bi	me	bi	sm			
14.	sm	bi	bi	me	me			
15.	bi	sm	me	me	bi			
16.	bi	sm	bi	me	bi			
17.	bi	sm	me	bi	bi			
18.	bi	sm	sm	me	sm			
19.	bi	sm	me	sm	sm			
20.	bi	me	me	me	sm			
21.	bi	me	sm	me	sm			
22.	bi	me	me	sm	sm			
23.	bi	me	bi	bi	ex bi			
24.	me	sm	me	me	bi			
25.	me	sm	sm	me	me			
26.	me	sm	me	sm	me			
27.	me	sm	sm	sm	sm			
28.	me	bi	bi	bi	bi			
29.	me	bi	sm	me	sm			

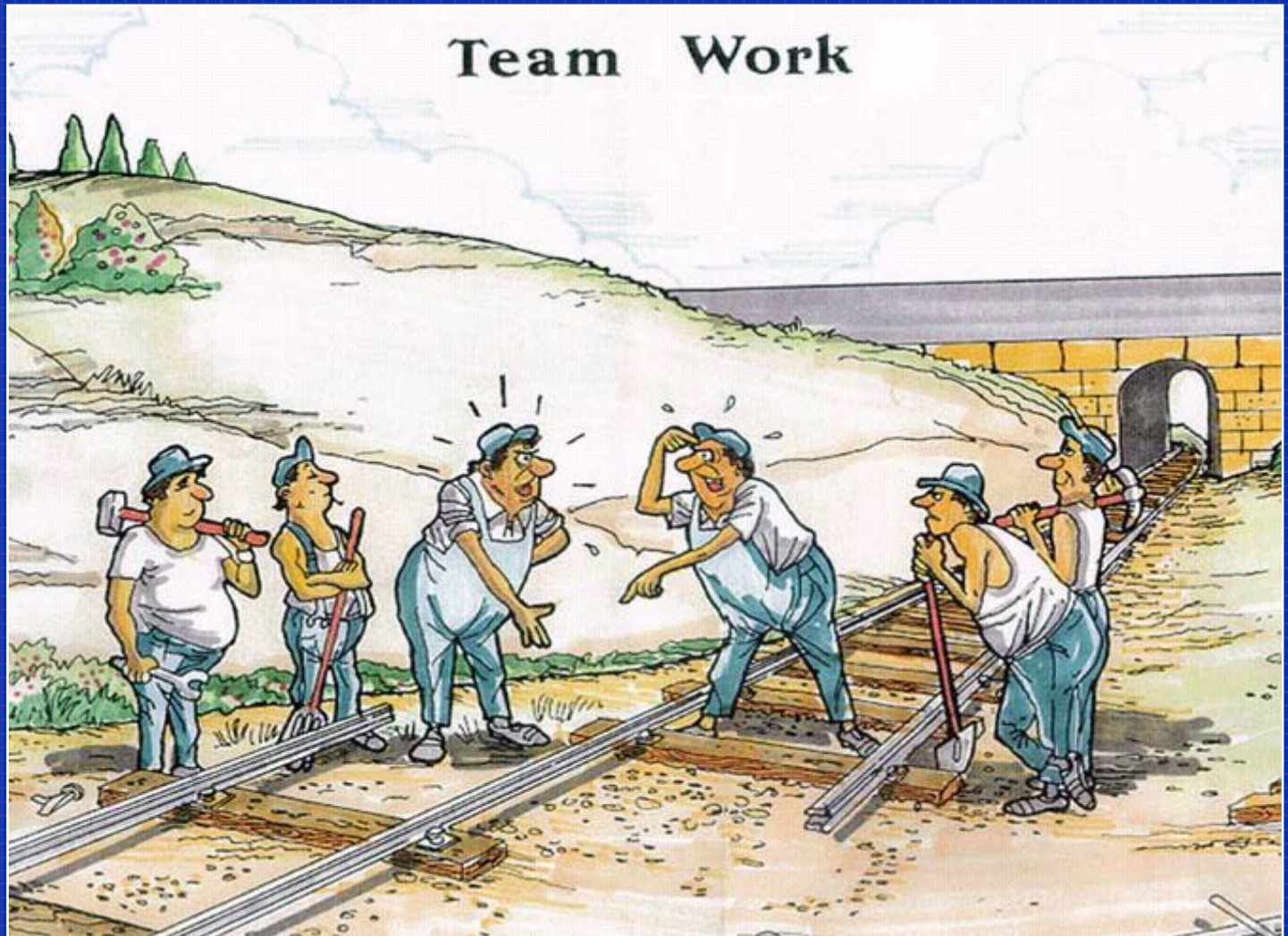


ITS Certification Laboratory

- **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



More information: WWW.LT.FD.CVUT.CZ

