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Intelligent Transport System (ITS), transport telematics solution, ITS architecture of the Czech Republic (CR), ITS package, ITS macro-package, benefit (effectiveness) of ITS package

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ASSESSMENT OF TRANSPORT TELEMATICS SOLUTIONS BENEFITS IN THE CZECH REPUBLIC

The paper will be deal with assessment of effectiveness (efficiency) of different and/or heterogeneous transport telematics solutions (ITS packages, ITS functions, ITS services, ITS subsystems, more robust ITS functional wholes of ITS packages, etc.) in a scope of open global ITS architecture of the Czech Republic (CR).

OCENA EFEKTYWNOŚCI SYSTEMÓW TELEMATYKI TRANSPORTU W REPUBLICE CZECH

Referat dotyczy oceny sprawności (skuteczności) różnych i /lub heterogenicznych rozwiązań telematyki transportu (pakiety ITS, funkcje ITS, usługi ITS, podsystemy ITS, trwalsze całości funkcjonalne ITS z pakietów ITS itp.) w zakresie otwartej globalnej architektury ITS w Republice Czech (CR).

1. INTRODUCTION

Starting points of research of assessment benefit (efectiveness) of various ITS solutions in the Czech Republic (CR) were formulated by the first results of grant of the Czech Ministry of Transport, No. 1F41E/093/120 „Research of effectiveness of telematics systems in transport" [6], [9] with conceptional assistance by [1], [2], [3], [4], [5], [7], [8], [10], [11], [12].

We present czech concept of construction of more robust ITS (macro-) solutions (ITS functional wholes) from basic ITS packages [6]. Each of these basic (for the present about) 90 ITS packages is connected with so called characteristic „indicators" (financial, time, etc). These indicators describe various (quantitative and/or qualitative) important attributes of contributions of each ITS package (e.g. cost, price, function, etc.).

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Benefit of each of these more robust ITS solutions (ITS services, ITS subsystems, ITS macro-packages, etc.) is given as non-sum (synergy) cooperation with another parts (ITS packages) in each more robust ITS functional whole. These contributions are described by typical indicators of each ITS functional whole (ITS macro-solution).

2. CONNECTING ITS PACKAGES, BENEFITS AND ITS GOALS SCHEME

At first, we present a summary scheme of our evaluation of transport telematics solutions of the ITS architecture of the CR as it impacts the overall goals of ITS. This scheme connects the ITS packages, the benefits metrics (indicators), and ITS goals (see simple benefits flow diagram in Fig.1). The argument is made regarding the ability of the architecture to support these goals. The ITS architecture of the CR supports a regional, and state deployment.

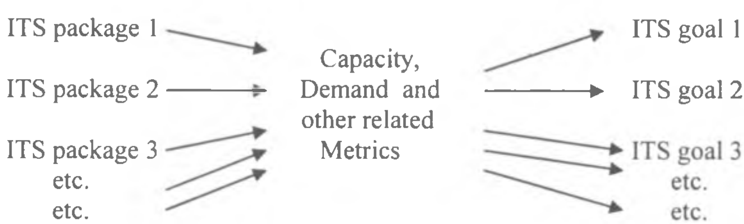

Fig.1. Benefits flow diagram scheme

2.1. INCREASE TRANSPORTATION SYSTEM EFFICIENCY AND CAPACITY

The analysis of benefits has explicitly considered improvements in the effective capacity and improvements in traffic flow over the existing transportation system infrastructure of the CR. The ITS macro-packages from the ITS architecture potentially will be provide the highest level of benefits, at least in the short term, include:

- Broadcast Based ATIS
- Interactive Traveler Information
- Autonomous Route Guidance
- Dynamic Route Guidance
- ISP Based Route Guidance
- Integrated Transportation Management/Route Guidance
- Surface Street Control
- Freeway Control
- Traffic Information Dissemination
- Regional Traffic Control
- Incident Management System.

Alone, each of these ITS macro-packages hold out the benefits in the form of reduced network travel and delay times, reductions in the number of stops, and only small increases in VMT. These ITS packages provide what seem to be the largest possible gains in transportation system efficiency in the short run from early deployment (in the 5- to10-year time frame).

These gains in system-wide traffic flow may have considerable implications for induced demand in the travel network. For this reason, we believe that the ITS architecture must be deployed in a manner that is consistent with local transportation planning and policy objectives. Moreover, we believe that the architecture can be used to support management of demand, including effects on air quality and the environment (see part 2.3).

2.2. ENHANCE MOBILITY

Individual, corporate, and system-wide mobility embodies enhancements in terms of traveler information and service enhancements to affect travel-related choices. The quantitative benefits of mobility, both from the perspective of individual and system-wide mobility. That analysis suggested that many of the ITS macro-packages can provide individual travel time benefits.

Such mobility enhancements suggest a final set of ITS packages that provide better information on travel alternatives and enhancing the utility of non-SOV travel. This more expansive view of mobility leads to the following possible list of ITS macro-packages as providing a high level of mobility benefits:

- Broadcast Based ATIS
- Interactive Traveler Information
- Autonomous Route Guidance
- Dynamic Route Guidance
- ISP Based Route Guidance
- Integrated Transportation Management/Route Guidance
- Surface Street Control
- Traffic Information Dissemination
- Regional Traffic Control
- Incident Management System
- HOV and Reversible Lane Management
- Transit Vehicle Tracking
- Transit Fixed-Route Operations
- Transit Demand-Responsive Operations.

This set includes not only the ITS packages that suggest more significant benefits, but also includes ITS packages that enhance mobility through higher-occupancy travel modes, including HOV and transit use. Still, most of these ITS macro-packages have quantifiable benefits to the traveler, primarily in terms of potential time savings and the resulting improvements in accessibility.

2.3. REDUCE ENERGY CONSUMPTION AND ENVIRONMENTAL COSTS

There is yet little empirical evidence of the ability of ITS user services to reduce energy use and enhance the environment, there are several proxy variables that suggest that many of the ITS packages will enhance system-wide performance in these areas as well.

Most directly, the ITS architecture of The CR includes ITS packages for area-wide traffic management and for emissions and environmental monitoring. Even just by knowing the magnitude and geographic scale of air quality problems, traffic may be better managed (through routing and traffic control measures) to reduce emissions in certain areas. Thus, the emissions and environmental sensing ITS package may be implemented most directly to monitor and influence environmental conditions, depending on the types of system control measures that may used in response.

In addition, those ITS macro-packages that were seen to provide quantifiable benefits to traffic flow, and thus to fuel consumption and air quality, include:

- Broadcast Based ATIS
- Interactive Traveler Information
- Autonomous Route Guidance
- Dynamic Route Guidance
- ISP Based Route Guidance
- Integrated Transportation Management/Route Guidance
- Surface Street Control
- Freeway Control
- Traffic Information Dissemination
- Regional Traffic Control
- Incident Management System.

By routing traffic around congested parts of the network, and through better management of existing travel patterns and incidents, travel times in the network can be reduced. Each of the factors of higher speeds and a reduction in accelerations and stops suggests that vehicle emissions and fuel consumption would be reduced. While there is little quantitative research to date that confirms the magnitude or even direction of these impacts, there is at least a growing body of researchers that support this conclusion on qualitative grounds.

2.4. IMPROVE SAFETY

The preliminary qualitative and quantitative analysis of safety benefits of the ITS Architecture of the CR and its corresponding ITS packages suggest that there are significant safety benefits that can be addressed through ITS. Possible ITS macro-packages that could be early and likely big winners from the point of view of safety benefits include:

- Roadside CVO Safety
- On-board CVO Safety
- Mayday Support
- Transit Security
- Emergency Response

- Emergency Routing
- Incident Management System
- Vehicle Safety Monitoring.

In the above description of benefits, there are clear advantages to these ITS macro-packages. Generally, as one might expect, safety benefits are likely to be realized through prevention or early detection of hazardous situations, speedier notification of incidents and emergency situations, and faster response to incidents and other travel-related emergencies. In such cases, significant improvements in vehicle safety seem possible, and are likely to be technically feasible in the short term (5-10 years).

The benefits of more vehicle-based safety systems are still uncertain at this time; however, further investigation of these technologies and their capabilities may give additional insight into the timing and likely benefits of these ITS macro-packages.

In any case, we hope the more advanced vehicle safety ITS packages are not likely to be implemented in any significant way before at least the 10-year time frame (2012).

The ITS architecture of the CR incorporates reasonable mitigation approaches to these issues. In response to the first point, our preliminary architecture definition emphasizes vehicle-based functionality, and thus minimizes the need for critical external interfaces.

As for the second point, the critical systems design issues are based on potential deployments of the architecture. To this end, we have included important design criteria in our development of the architecture's performance requirements. Finally, the our team's approach to information integrity and security address the criticality of communications links.

2.5. INCREASE ECONOMIC PRODUCTIVITY

One of the stated goals of the ITS program of the czech transport telematics is to improve economic productivity. Certainly one perspective on improving economic productivity involves providing individual users as well as public and private agencies with a more effective and cost-efficient means of doing business.

The ITS architecture of the CR supports a broad range of ITS packages that contain this feature, primarily through automating processes that are now conducted manually, or also by improving the flow of information within the transportation system.

2.5.1. ITS PACKAGES INCREASING ECONOMIC PRODUCTIVITY

There are many ITS packages within the ITS architecture to improve personal and corporate productivity. First, in terms of financial transactions, the ITS architecture supports several ITS packages to enhance and automate financial transactions for transportation services.

This may take the form of a debit or smart card to pay for services electronically, or setting up an account with a service provider that is debited (or credited) whenever the system is used. As such, the architecture reduces the cost of manual collection and cash handling. We believe there are substantial financial savings that may be realized here, as evidenced by the development of billing support services, smart cards, and debit cards in other (non-transportation) industries.

Within the ITS architecture of the CR, the ITS packages that support this function include:

- Dynamic Toll/Parking Fee Management
- Passenger and Fare Management

Other ITS packages seek to automate service delivery, or simply reduce the administrative costs of various transportation functions. For emergency management systems, the emergency response and mayday support ITS packages reduces the level of manual handling of emergency calls by providing geographic referencing for incoming calls and forwarding of messages automatically to appropriate personnel.

The CVO safety ITS packages allows the vehicle driver to monitor vehicle and cargo condition, thus allowing prevention of CVO incidents and faster response to vehicle and cargo hazards.

Perhaps the highest level of benefit for the vehicle, it allows electronic verification of credentials at designated airports of entry, thereby reducing or eliminating the delays that occur when this process is done manually. Delays associated with vehicle weighing may also be reduced by weigh-in-motion capabilities of the weigh-in-motion ITS package.

This ITS package also will be support electronic filing of credentials with governmental agencies, again saving manual effort and costs associated with performing these tasks manually.

Similar cost and personal productivity improvements may be realized within the transit industry through the APTS ITS macro-packages:

- Transit Vehicle Tracking
- Fixed-Route Operations
- Demand-Responsive Operations
- Passenger and Fare Management
- Transit Maintenance.

The passenger and fare management and transit vehicle tracking ITS packages provide real-time information to improve transit service. By collecting passenger load and vehicle location information automatically, this reduces the need for manual data collection and increases the accuracy of this data. Moreover, the availability of this data allows for improved service planning, thereby enhancing the job of making transit service more cost-effective and efficient.

Costs associated with service planning and maintenance planning may be reduced by automating the routing and scheduling of services. In addition, electronic vehicle tracking and vehicle condition monitoring (in the transit vehicle maintenance ITS package) allow for reduced manual collection of such information in the field, thereby reducing labor costs.

2.5.2. ITS ARCHITECTURE FEATURES ENHANCING ECONOMIC PRODUCTIVITY

There are several features of the ITS system architecture of the CR that enhance the level of economic productivity.

First of all, the ITS architecture provides *inter-operability*. Thus, for most of the ITS packages described above, there will be standard interfaces across the Czech Republic so that individuals and firms that use ITS products and services can use them across the country (electronic payment services for commercial vehicles, etc.).

One other aspect of inter-operability that also appears in the ITS architecture is a *commonality of communications systems*, allowing a seamless communications system that may perform any number of tasks. The wide-area communications system may be used for both data and voice messages, and accommodates a broad range of ITS packages. This ensures that many different functions can be accommodated within a single wide-area communications system and interface. Also, the communications systems proposed for the vehicle-to-roadsid communication in the ITS architecture may use a common communications infrastructure for many different functions.

The other advantage of the ITS architecture is that it provides a *modular system with multiple levels of ITS package functionality*. The advantage of this capability for economic productivity is two-fold: (1) benefits may be realized from a small investment, and (2) the capabilities of a package or set of packages may grow incrementally as an individual or organization is likewise able to grow in their means, but with *compatibility with existing systems.*

This means that the ITS packages are accessible to a the broadest possible range of potential users. The market size is thus larger, with a corresponding large set of ITS system beneficiaries.

3. CREATE AN ENVIRONMENT FOR AN ITS MARKET

One of the goals for the development of an ITS system architecture is that it provide the proper stimulus to encourage the initiation of new (ITS-related) industries. The ITS architecture of the CR has several features to enhance the growth of an ITS industry.

First, *the ITS architecture* of the CR *emphasizes flexibility and openness*. These words have specific meaning for the development of new ITS products. First, all components of the ITS architecture are non-proprietary. This means that the number of potential firms that may enter the ITS market is not limited by the definition of the architecture. Thus, any number of firms may enter the market for devices, for communications systems, for hardware and software, etc.

Second, the ITS architecture is also flexible, which in this context means that we expect devices to be compatible to an interface, but what goes on behind the interface is not touched. A firm may have a special product or service it is willing to offer, and the only restriction placed on that firm is that it has the appropriate interfaces to other subsystems in the architecture. This specification of interfaces, but not the internal workings of each architecture subsystem, means that there is ample opportunity for innovation in product and service design.

Third, *the ITS architecture is modular and expandable*. The equipment packages and ITS packages described in the architecture may be implemented in a modular and expandable fashion. The specification of key interfaces guarantees that any product or service that is developed is 100% compatible with other systems and technologies in the ITS architecture. Again, the ITS architecture does not specify technologies or the detailed design of functions; rather, it simply assures that any technologies that are so developed are compatible with other parts of the architecture. To a device or service supplier, this ensures that their end product will work with other systems.

In a similar light, *the ITS architecture supports multiple levels of functionality* and *multiple levels of technical sophistication*. In terms of functionality, a firm interested in providing a device or service has several options for the level of functionality of that device or service. For example, in the realm of traveler information services, a firm may market a simple paging device that allows the user to access broadcast traffic information.

Another firm could market a device that not only receives that information, but allows the user to query for particular pieces of information, allowing greater user interaction. Both levels of functionality are covered in the architecture. Thus, a firm entering the ITS industry has a wide variety of possible ways to enter the market, depending on the chosen level of function and technical sophistication.

Finally, as has been mentioned previously, *the ITS architecture will specify interfaces between ITS subsystems*; indeed, this specification of interfaces is one of the main purposes of a physical ITS architecture. The level of detail to which these interfaces are specified is also an important piece of the ITS architecture. If an interface is overspecified, it may restrict the development of the market for products and services designed to that interface.

On the other hand, if an interface is not specified, then particular hardware and software may not be compatible with other systems.

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