

## QUO VADIS ELECTRONIC FEE COLLECTION

*Electronics Fee Collection (EFC) is among priority elements of transport telematics. According to categorization of basic services of ITS (Intelligent Transport Systems) defined by European project KAREN, EFC is the part of financial services and transport control groups, emergency, and demand which is one of the main services in wide portfolio of IDS users needs. Fee collection is a typical transport service highly dependent on identification of vehicle type and position. In our contribution we would like to concentrate on transport performance payments.*

**Keywords:** *Electronic Fee Collection, GPS, On Board Unit, GNSS, Galileo*

Transport forms inevitable condition for management and effective working of the economics and the society as a whole. Its wide range of use and quick extension are often considered to be the main reasons of undesirable side effects on environment. Growing number of cars on roads and highways contributes much to the air pollution. Therefore the international and national organizations are trying to find ways and mechanisms how to improve the environment together with the extension of traffic network.

The accumulative problems need to solve the unfriendly impacts of transport to environment. The problems are solving with active approach, which is oriented on prevention or early elimination. The solving of this problem exact of Resort of Transport and Environment. It is necessary to focus on this way before the solving after-effects [1].

The challenge of the EU in this area is to reduce the emissions and the energy consumption due to transport activities, in order to avoid or to reduce the related environmental impacts (mainly the air pollution in urban areas, with the consequent effects on human health and on local and regional environment, and the production of greenhouse gases), without affecting the economic growth. In other terms the challenge is a sustainable growth of transport [2].

### **Influences and impacts of transport on the environment**

The environmental impact of increased road traffic can be seen in local, regional and even global merit. Basic negative factors are the production of harmful smokes from internal combustion engines, pollution of the air, water and soil, the noise and vibrations from traffic operation, always increasing number of accidents, and among the others also the taking up of valuable soil for transport connected buildings.

One of the most significant factors affecting increase in road transport safety is reduction of external costs. External costs are described as follows.

When consumers decide to purchase an item or take a trip, they examine the price of a given option and compare it to the gain or satisfaction they expect to derive from the item or trip. For instance, an individual wishing to get from A to B will consider the price (of using public transport or his/her private car) and quality of the service provided before opting for a given transport mode. Users are willing to accommodate a whole array of parameters (speed, frequent/regular service, quality, flexibility, etc.) in the transport price they pay.

Conversely, consumers of goods or services do not generally foot the full bill for the costs their decision imposes on society and the environment. Such costs are defined as external because they are not reflected in the price paid by users and are not factors in the market. The main sources of external cost in the transport sector are accidents, congestion, air pollution, noise and climate change. Individuals using a given form of transport are not generally aware of the external cost generated and indeed it is possible that some of these costs have never been defined.

Nonetheless, external costs do exist and since they are not met by the parties responsible, they must be borne by society as a whole.

Significant external costs are: [1]

- accidents, when transport systems are used, accidents occur, generating a whole range of costs which are only partly covered by mutual risk insurance schemes (loss of life, medical care and disabilities sustained by victims, loss of production, etc.),
- air pollution, emission of particulate matter, carbon monoxide, lead, volatile organic compounds, nitrogen oxides and sculpture dioxide, damaging health, the environment and buildings,

- climate change, greenhouse gases (mainly carbon dioxide – CO<sub>2</sub>) have an enduring impact on the earth's climate, resulting in increased desertification, raised sea levels, serious harm to agriculture and other destructive environmental and health-related side-effect,
- noise, transport generates noise, which adversely affects humans in a variety of ways, causing disturbances, stress and more serious health problems,
- congestion, more vehicles are being added to already dense traffic flows, particularly car traffic flows, paralysing the system and leading to substantial wastage for all users. Congestion makes the entire transport system inefficient.

The Environment problems in countries of EU caused by transport recall the need of political measures, e. g. fee collection for usage of the transport road. Its quick and effective implementation is necessary. Electronic Fee Collection (EFC) is not only the source of fair incomes, where performance is paid, but it is also an efficient regulator because it enables the use of progressive payments, which can be raised multiply if driver goes to the town centre and does not use means of public transport. It is also supposed that transits through certain road sections (e.g. tunnels) will be paid.

That way can to consider external costs caused by operation vehicles (air pollution, accidents, climatic changer, noise and vibrations, influence on environment, ect.). That is to say that users pays precisely for what they cause. Modern transport system must be stabilized not only from economical an social, but also from environmental point view.

#### Main advantages of electronic pricing systems

- possibility of differentiated fees according to different vehicle characteristics and wide range of transport and environmental criteria,
- possibility of quick money transaction and the fee collection without stopping of the car,
- greater effectively in lowering the external costs.

If we want to solve the problems of environmental impacts of road transport with a pricing, it is inevitable, that all external costs must be taken into account. However, their rating is very problematic. Most of foreign researches had considered the road transport to be the main source of negative environmental impacts. It is necessary to determine the so-called Zero point, from which up we can speak of damage. Under the limits of tolerance we understand admissible norms, which undergo a continuous change due to the technical progress and increasing environmental awareness of the society [5].

The external costs as such demand their rating into financial categories. Two ways of rating are known:

- rating of external costs on the basis of the resources used, i.e. external costs are understood as the effective expenses arisen,
- rating of external costs on the basis of the decreasing value of capital, i.e. external costs cause the decrease of resources.

This can be seen in relation to individual preferences, e.g. the benefit from the silence as an absence of noise. It relates also to human capital, which, due to the loss in car accident can not take part in the reproductive process of the population

#### Baseline components

Electronic fee collection systems are composed of three basic system components: the collection of information, a monitoring system, and the processing of information:

1. *Collection* of information is the first component about the movement of vehicles along the toll-charged transport infrastructure. This infrastructure is a selected network of roads and motorways, historical parts of towns, bridges, tunnels, etc. The basic task is to identify and localize vehicles. Positioning is either monitored continuously, e.g. via a GPS system, or is detected only at certain points,
2. *Monitoring* (enforcement) systems, which are used for the oversight of EFC activities. By means of fixed monitoring gateways or by means of mobile monitoring stations, the registration plate is scanned or information is read from the vehicle unit remotely. The monitoring system makes sure that the information obtained by the vehicle unit matches the current situation in the traffic infrastructure,
3. *The processing of information* includes the initial registration of vehicles, their technical specifications, contact information about their owners and users (address, bank account, etc.), the processing of information about vehicle movements over the toll-charged infrastructure, and the transfer of this information to specific payments, payment settlement, and any claims.

#### Technology

Nowadays we know possibilities of EFC systems as follows: [3, 4, 5]

**DSRC** (Dedicated Short Range Communication) technology transmits identification information from the vehicle unit located in the vehicle to the check point. The check point is also fitted with a monitoring system, which can identify the registration numbers

of vehicles. If the registration number does not tally with the electronic information, the data are sent to the processing centre.

DSRC technology is nowadays profiled in Europe like this: (existing system based on DSRC or system in construction): Austria, Denmark, Sweden, France, Norway, Italy, Slovenia, Spain, Portugal, Greece, Great Britain.

Such a toll system only makes sense for defined road routes and is not at all suitable for complicated networks.

**GNSS-CN** (Global Navigation Satellite System – Cellular Network) - this technology identifies a paid section of transport infrastructure by means of satellite localization. The number of kilometers traveled on the toll-charged infrastructure is measured in the vehicle unit. After a certain number of kilometers are reached, the information on the number of kilometers traveled (or information on the corresponding amount to be paid) is sent to the centre via a mobile network (GSM, GPRS). Because the vehicle unit is fixed to the vehicle and has its own intelligence (for example, it can recognize attempts at tempering), there is no need for a large number of monitoring point.

The German toll system has been in use since January 1, 2005, and is compulsory for trucks weighing over 12 tones. It is the first toll system to use satellite technology to such a high degree. The On-Board Unit (OBU) receives satellite signals, matches them up with stored geo-data, acquires the driven segments and transfers them to a control centre by means of SMS.

**LSVA** (Swiss system), technology is based on intelligent OBU, which reads distance from electronic tachometer and can use distance correction from GPS.

**London system** – this system is based on manual time payments, e.g. at kiosks, where the registration number of the paying vehicles is also entered. Camer-

as are installed at the entrance and exits of the parts of the city subject to the fee. These cameras record the registration numbers of vehicles and if a payment is not made by certain time (usually midnight) the vehicle is identified as a defaulter.

### Intelligent On Board Unit (OBU)

As every electronic system has to have its own OBU, the future is one intelligent OBU that could monitor driving properties and emission parameters of the vehicles. It is possible to process related data real-time and evaluate them individually in OBU. So we obtain exact them information of vehicle environment impacts (production of external costs). This information could be a base for assessment of toll (electronically) with all related facts as: achievement of demanded level of reliability and demonstrability of specified emission parameters.

The information channel between OBU and vehicle electronics allows operation of telematic services that can have relation to vehicle driving parameters. By delivering those services engine and vehicle emission and dynamic characteristics are made full use of. In this way we can model ecological and safety impacts of vehicle drive. In this case it is sufficient to measure just the parameters as: speed, acceleration, rpm etc., which can be measured from vehicle CAN bus [6, 7].

### The outlook in Europe

For Europe and all the other participating nation (e.g. the People's Republic of China, South Korea, Australia, Brazil), the introduction of the Galileo satellite system from 2008 onwards will open up new possibilities. In EU directive 2004/52 EC, the satellite-based toll technology was named as an important application for the system to be created.

Galileo will offer the users a range of new services – “value-added services”. There is no reason why it should not be possible to provide these services by means of an OBU installed in the vehicle. Galileo will therefore not only ensure greater availability, increased accuracy and higher integrity, it will also be able to supply additional services for:

- haulage companies, Galileo means automatic toll charging, more information, the possibility of fleet tracking (transport of hazardous goods) and real-time statistics,
- road operators, one of the great benefits is that real-time information can be gathered regarding the condition of the roads and the degree of utilization. It will also be possible for them to make forecasts,

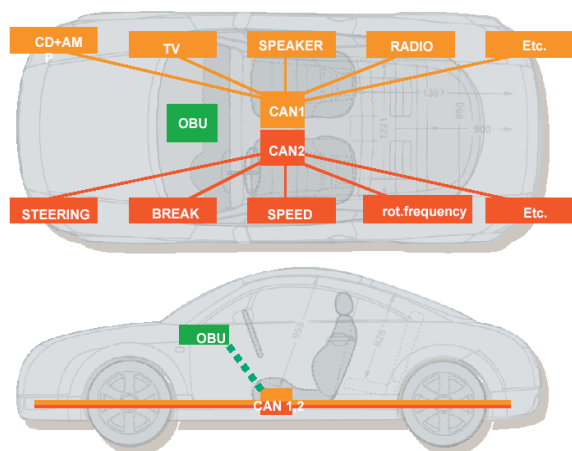


Fig. 1. Information connection between OBU and electronic equipment of vehicle

- the automotive industry, it will be possible to diagnose and service vehicles remotely as well as to provide specific assistance for specific problems that drivers are faced with,

In 2003 with the Resolution of SR 523/2003 the legislative preparation for the establishment of supervisory body for routes and highways was brought forward. This state independent association should provide the management, maintenance and development of highways and routes, also the manufacturing and distribution of highway vignettes. Its role should be also to monitor the system and transparency of future EFC incomes.

Before deciding for a particular technology, our politicians and experts intending to introduce a toll collection system should analyze precisely the experience from other countries and realize which targets the system of heavy truck fees should be aimed at.

Besides choosing EFC technology the high number of road owners complicates the situation in Slovakia. The table shows that up to 3000 subjects participate in road administration and that local self-governments administrate over 90% of the roads.

#### Slovakia

The European Commission had decided to stimulate member states to develop and put into usage the universal strategy of EFC system. According to the integration of SR into European structures, it is necessary to develop systems of such type and quality, that would be possible to interconnect with the systems of other member states. EFC systems offer the best possibility for greater fee differentiation, what contributes to the effectivity of transport operation. In comparison to highway vignettes, this system will price the vehicles according to the real distance traveled.

Currently the usage of insulated highway and transport route sections is in SR possible after paying the flat-rate fee in the form of a highway vignette

for one year. The way of marking the sections, usage of which is paid, as well as the vignette model and its placement on the vehicle are determined by the Ordinance of MDPT SR 185/1996. There are three international categories of vehicles and motor sets. (to 3.5 t, 3.5t - 12 t, over 12 t). When considering the negative environmental impacts of transport and the problems of externalities, the system of flat-rate fee hardly seem to be the best solution. It does not price vehicles for their real distance traveled, and the type differentiation is too little to consider all real environmental influences of different types of vehicles.

#### Conclusion

In The first phase in the time horizon to 2005 there is an assumption to prepare the pricing for load vehicles over 3,5 t. This is currently in use in Germany, Austria and Czech Republic. After 2008 there is an expectation to widen the EFC to other motor vehicles [5].

The introduction of an electronic toll system will not give rise merely to an instrument for the Collection of fees for use of the transport infrastructure, but will also give us a tool that can be used for the creation of an active transport policy by the government, regions, and municipalities. The amount of the toll will affect vehicle movements and the price of the product price. Data from the EFC system can be used to model transport networks, estimate journey times, provide navigation services, prevent and eliminate the effects of traffic accidents, and monitor the transportation of hazardous cargoes, and can be used automatic emergency call systems.

The implementation of EFC is a complicated technical/organizational/legislative process where efforts could be impaired if any of the above-mentioned components are underestimated. As has been said many times in the past, you cannot buy EFC, you have to build it up long term and systematically.

| Administrator                                     | number of subjects | network length (km)* | share (%) |
|---|--------------------|----------------------|-----------|
| Supervisory body for roads and highways           | 1                  | 318                  | 0.73      |
| Road administration office of the Slovak Republic | 1                  | 3335                 | 7.76      |
| Regional authority                                | 8                  | 14124                | 32.85     |
| Municipalities and towns                          | 2928               | 25220                | 58.66     |

\* source: SSC position as per January 1<sup>st</sup>, 2004

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