LECTURE

10 Electronic Toll Collection Systems

Zuzana Bělinová, Jakub Rajnoch
Faculty of Transportation Sciences, Czech Technical University in Prague

Toll

Toll – a charge for the usage of the road infrastructure subject to the charge

- **Classifications**
  - Charge events: Discrete (Open / Closed) / Continuous (TDP)
  - Charging: Manual (non-free flow) / Automatic (free-flow)
  - Objective: RoI / O&M budget / Tax / Traffic regulations
  - Geo-characteristics: Urban / Inter-urban areas (congestion pricing / tolling)
  - Technology: DSRC / Tachograph / GNSS / CN
  - Legal nature: Levy / Tax

Charging objectives

- To finance infrastructure: Electronic Toll Collection
- To manage demand: Congestion Charging
- To reduce local emissions: Emissions-related charging
- To contribute to roads maintenance: Truck Tolling
- To encourage sharing: High Occupancy & Toll Lanes (HOT)
- To introduce usage-based taxation: National Road Pricing
- To commercialise road management: Shadow tolls

Congestion Charging

- Urban environment – different traffic characteristics than in the inter-urban environment
- Same technologies used as for the regular tolling (or the combinations)
- Usual objective is to reduce the pollution and traffic
- Peak time and off-peak time tariffs
- An alternative option for travelling is usually offered when congestion charging is introduced

Discrete vs. Continuous

- **Discrete**
  - Road-side infrastructure
  - Might be considered unfair
  - Effects on spatial planning
- **Continuous**
  - Fairer
  - Need for the RSE is reduced significantly

EFC system architecture

- **Road-side**
  - Tolling (DSRC only)
    - Fixed gantries
  - Enforcement
    - Fixed / Mobile / Portable / Manual (Handheld)
  - Other (LAC / CCC)
- **Back-office**
  - Tolling
  - Enforcement
  - Operation & Maintenance
- **OBU**

Roles

- **Toll Charger**
  - Tolling system operator
  - Enforcement operator
  - Scheme owner
- **Service Provider**
- **User**

Stakeholders

- Public authorities
- Suppliers
- Manufacturers
- Providers
- Users
- Users associations
- Politicians

System aspects of EFC design

- **conceptual aspects** (links to other systems, modularity, scalability, interoperability, authors‘ rights, goals, etc)
- **political aspects** (choice of charged infrastructure, additional services)
- **organizational and process** (different implementation models, definition of processes, supervision models)
- **legal** (agreements, exceptions, data access, payment methods)
- **technical** (unified traffic infrastructure description, vehicle identification, data models, system parameters, certification)

Legal aspects

- obligatory / dual EFC system (having or not having OBU)
- full area EFC (distance) / only chosen communications (entry/exit)
- inverse EFC (full-area system with reduced price for highway communications)
- time payment
- city EFC systems
- various combinations of EFC systems

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Economic aspects

- **toll rates** (emergency vehicles, buses, day/night, particular days during week/year)
- **vehicle classes** (based on maximal weight, number of axes, emission class, trailer)
- toll is/is not subject of value added tax (VAT)
- ecological and safety component of EFC

EFC processes and their organization

- **OBU** processes (OBU loss, intentional/unintentional damaging of OBU, OBU logistics, OBU repair / replacement, OBU lending at borders, connection to neighbouring countries)
- **monitoring** processes (access to OBU data, equipping of supervision authorities with appropriate devices, data archiving, life-cycle of data, etc.)
- **information processing** (payment definitions: pre/ post payment, payment media definition: credit card, bank account, checking credibility, list of non-payers “white and black list“)

EFC monitoring, statistics

- invoice for EFC
- remote control of payments via internet (by drivers, operators – different access rights)
- different types of loyalty programs and benefits
- statistics of payments for the infrastructure operator, investors
- control of payment success rate via third party (usually part of the contract)


Zdroj: Autobusové noviny

Legal frame definition

- contracts between EFC operator and state (owner of the traffic infrastructure)
- contracts between EFC operator and users of OBU units
- definitions of rules and exceptions – which vehicles are not subject of tolling
- operator‘s access to private data
- means of supervision – if EFC operator can stop and check vehicle, role of police
- enforcement processes for foreign vehicles – how to check registration data of foreign vehicles, how to ensure cross-border enforcement, etc.

Other aspects

- complaints processes and proving
  - conclusive data of tolling (compressed data about position, list of detected gateways, charged fee in correspondence with vehicle category, etc.)
  - life-cycle of data with respect to complaints processes and authentication
- system misuse protection
  - internal security (concerning the employees)
  - external security against outside invaders
- authors‘ rights
  - intangible industrial rights for EFC technologies (there are worldwide several thousand patents concerning the EFC)
  - SW ownership rights

Other aspects

- Traffic infrastructure description
  - data model independent on chosen EFC technology
  - unified description of zones – information connectivity with other IS
  - same data model in central control, monitoring system and OBU
  - connection to other ITS systems (RDS-TMC, traffic control centres, etc.)
- Identification and registration of OBUs
  - standard EN ISO 14816 Automatic vehicle and equipment identification -- Numbering and data structure
  - unique relation vehicle-OBU
  - in case of owner change – new registration to the EFC system

Generic EFC system

- Tolling Sub-system
- Enforcement Sub-system
- Operation&Maintenance Sub-system
- User

Tolling sub-system

- Processes covered:
  - Charge objects definitions
  - Tariffs definitions
  - Charge records collection
  - Charge calculation
  - Payment & clearing
- Payment means types:
  - OBU (DSRC / GNSS-CN)
  - Non-OBU (mobile / cash / card / etc)

Enforcement sub-system I.

- Important to distinguish between:
  - Compliance checking
  - Enforcement
- Processes covered:
  - Check of users‘ compliancy
  - Collection and storage of the evidence
  - Penalties processing
- Enforcement strategy
  - Combination of system enforcement means
  - Public awareness

Enforcement sub-system II.

- System must be able to provide court-proof evidence
- System must be able to detect anomalies, which may indicate an offence or offences committed by the user
  - Swapped OBU
  - No OBU
  - Incorrect declaration of the attribute used in the tariff identification process
- All information collected shall be kept for the penalties management process and potential hearings at the court

Operation & Maintenance Sub-system

- Processes covered
  - Regular maintenance of the back-office & road-side facilities
    - Support levels
  - Customer service
  - Performance monitoring & reporting
- Some of the processes might be outsourced

Operators

- Tolling sub-system
  - Supplier / Scheme owner
- Enforcement Subsystem
  - Public authority (Customs)
  - Legal processes are usually not within the responsibility of the private company
- Maintenance & Operation sub-system
  - Supplier / Scheme owner
  - Third party

Technologies used in the EFC systems

- **Technologies used for the purpose of charging**
  - DSRC
  - GNSS-CN
  - Tachograph
  - Cameras (ANPR)
  - Combination of the above
- **Technologies used for the purpose of the enforcement**
  - Laser detectors & scanners (vehicle class detections)
  - Overview & ANPR Cameras (LPN recognition)
  - DSRC

EFC situation in Europe

- App. 15 European states uses DSRC system
- Germany and Slovakia use GPS system
- introducing GPS systems has the EU support

EU interoperability

- Ability of two or more independent EFC systems operate in cooperation / conjunction
  - An OBU of one system could be used in other systems as well
- Foundations of the interoperability of the European EFC systems laid down in the EC „Interoperability Directive“ 2004/52/EC via definition of the EETS service (European Electronic Toll Service):
  - Definition of EETS
  - List of technologies to be used in the future EFC systems implementations
  - Schemes out of the scope
- EU-funded projects: CESARE, PISTA, MEDIA, MOVE-IT

EU interoperability

- after 4 years of preparation work and negotiation European Commission came to the requirements for introducing EFC in EU countries
- COMMISSION DECISION from the 6 October 2009 **on the definition of the European Electronic Toll Service and its technical elements**
- These requirements can be summarized as
  - one OBU
  - one contract
  - one invoice

EETS - history

- European Electronic Toll Service
- April 2004: Directive 2004/52/EC: Directive provides for the Setting-up of a European Electronic Toll Service (EETS) – this document enables the EETS
- October 2009: Decision 2009/750/EC of the Commission on the definition of the EETS and its technical elements (approved by Member States in the Toll Committee) – this document defines the EETS
- October 2012: EETS to be available for vehicles exceeding 3,5 tonnes and coaches (Obligation of Member States according to Art 3 (4) Directive 2004/52/EC – Interoperability Directive)

Eurovignette Directive (1999/62/EC)

- toll' means payment of a specified amount for a vehicle travelling the distance between two points on the infrastructures referred to in Article 7(2); the amount shall be based on the distance travelled and the type of the vehicle;
- 'user charge' means payment of a specified amount conferring the right for a vehicle to use for a given period the infrastructures referred to in Article 7(2);
- Possibility of imposing tolls / user charges on motorways, higher class roads, bridges, tunnels
- Tolls and user charges may not be imposed at the same time for the use of single section of the road
- Tolls and charges shall not discriminate
- Setting up limits for the tolls and user charges

Interoperability Directive (2004/52/EC) I.

- Lays down the condition necessary to ensure the interoperability of electronic road toll systems in the Community.
- Considers all types of road fees and entire Community road network (urban, inter-urban, motorways, major, minor roads, tunnels, bridges and ferries)
- Possibility of imposing tolls / user charges on motorways, higher class roads, bridges, tunnels
- Interoperability shall be achieved via introduction of European Electronic Toll Service
  - As complementary to the national electronic toll services
- Defines a set of technologies to be used 2007 onwards:
  - DSRC
  - GNSS & CN

Interoperability Directive (2004/52/EC) II.

- Provides for the usage of an On-Board Unit (OBU) through all the electronic toll systems in the MS (based on previously listed technologies)
- GNSS-based technology is of a preference
- Possible migration of the DSRC-based systems
  - Study on possible migration to toll systems using satellite positioning and mobile communications technologies by systems using other technologies launched in 2009
  - Outcome – technically feasible, but expensive
- Possibility of usage of OBU for other services – i.e. single contract with the Provider of the EETS service
- OBU / Contract shall entitle the user to use the whole network of road infrastructure

Interoperability Directive (2004/52/EC) III.

- EETS shall be independent of the fundamental decisions taken by the MS (vehicle types, purpose, etc.)
- EETS service shall be provided irrespective of the place of registration of the vehicle or nationality of the parties to the contract (i.e. road user can register the contract with any provider)
- The work of the standardisation bodies shall be used as much as possible (i.e. provide for the standards applicable to the electronic toll systems)

EETS Decision (2009/750/EC) I.

- Defines EETS – roughly speaking, a service allowing a user to use only one OBU for all EFC systems in EU
- Sets out the necessary technical specifications and requirements, and contractual rules relating to EETS provision
- Defines the roles and their obligations and rights
  - EETS Provider
  - Toll Charger
  - EETS User
- Contains definitions (e.g.):
  - EETS domain / EETS domain statement
  - Suitability for use
  - Interoperability constituent
- Defines relationships between the roles

EETS Decision (2009/750/EC) II.

- Defines the evaluation phases towards the equipment of the EETS Provider (i.e. EETS OBU) whether it complies with the requirements of the Toll Charger
  - Conformity to specifications
  - Suitability for Use

EETS – Toll Charger

- Toll Charger - means a public or private organisation which levies tolls for the circulation of vehicles in an EETS domain (e.g. RSD or MD)
  - Shall accept on a non-discriminatory basis any EETS Provider
  - Shall maintain EETS domain statement
  - The toll charged to EETS users shall not exceed the corresponding national / local toll
  - Shall accept any EETS OBU of any EETS Provider with whom the TC has a contractual relationship and which has been evaluated for its conformity and suitability
  - Shall provide for the “degraded mode of service”

EETS – EETS Provider

- EETS Provider - means a legal entity fulfilling the requirements of Article 3 and registered in a Member State where it is established, which grants access to EETS to an EETS User
  - Shall conclude contracts covering all EETS domains
  - Shall inform EETS users of his EETS domain coverage
  - Shall provide EETS users with EETS OBUs (within contract)
  - Shall provide customer services and support to the EETS User
  - Shall collaborate with the Toll Charger in the enforcement efforts

EETS – EETS User

- EETS User- means a (natural or legal) person who subscribes a contract with an EETS Provider in order to have access to EETS
  - May subscribe to the EETS service through any EETS Provider
  - Shall ensure that all user and vehicle data provided to the EETS Provider is correct
  - Shall operate the EETS OBU according to the EETS Provider's instructions
  - Shall pay for the usage of the service to the EETS Provider

Thank you for your attention

References

- Rajnoch J. Electronic toll collection systems. TSJ lecture 2014.
- Andrew T.W. Pickford . Road User Charging & Electronic Toll Collection. *Semiinario Tarificación Por Congestión. 2008.*
- Andrew T.W. Pickford, Philip T. Blythe. Road User Charging and Electronic Toll Collection
- www.premid.cz
- http://www.eurowag.com/en/toll/toll-cz/
- http://www.rapp-trans.ch/en/presentationsandarticles/2004.php
- http://www.tolltickets.com/
- http://www.calccit.org/itsdecision/serv_and_tech/Electronic_toll_collection/electron_toll_collection_report.html
- http://telematik.niedersachsen.de/fileadmin/user_upload/pdf/Stockholm_Cebit2008__Schreibgeschuetzt_.pdf