A kilometre tax for heavy goods vehicles in Sweden – A conceptual systems design.

Part 1: Requirements and preconditions

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The ARENA project

ARENA is a national project that aims to build competence for a future introduction of a road user charging system for Heavy Goods Vehicles (HGVs) in Sweden. The project has been developed in accordance with EU Directives and the Swedish public authority plans to introduce a kilometre tax for HGVs. ARENA started in 2006 and is financed by the Swedish Road Administration and the Swedish Governmental Agency for Innovation Systems. NetPort.Karlshamn is the project coordinator.

The approach of ARENA is to take a wide view and not only focus on technology. Innovation potential, consequences and possibilities related to an implementation of road user charging is also important as well as respecting that different stakeholders have different needs and requirements. This requires interaction between relevant stakeholders at an early stage. The role of the ARENA project includes the following elements:

- acting as broker both between groups of stakeholders who normally do not meet and between competitors within the same group
- develop and support knowledge both within the project but also as a coordinator between other projects

A concept for a kilometre tax system in Sweden is developed with a functional approach, which does not prescribe any technical solutions. The concept is generic rather than specific, in the sense that it should be possible to implement the result in several ways. Hence, we are trying to define the system independently from its final technical design. The motivation for this is that the time horizon for realisation is far ahead, maybe 3-6 years, and we can expect considerably changes in technical preconditions over this period. The concept includes a number of characteristics that differs from existing systems, which will reduce cost, promote innovative solutions and enable European interoperability.

The work of ARENA will continue in ARENA 2.0, where the concept will be further developed in close cooperation with the industry and relevant authorities and administrations. A full-scale demonstration will be developed for the ITS World Congress in Stockholm 2009.

Swedish Road Administration

The Swedish Road Administration (SRA) is the national authority assigned the overall responsibility for the entire road transport system in Sweden. SRAs task is to co-operate with others to develop an efficient road transport network in the direction stipulated by the Swedish Government and Parliament. SRA has been commissioned to create a safe, environmentally sound and gender-equal road transport system that contributed to regional development and offers individuals and the business community easy accessibility and high transport quality.

VINNOVA

VINNOVA (Swedish Governmental Agency for Innovation Systems) is a State authority that aims to promote growth and prosperity throughout Sweden. VINNOVAs particular area of responsibility comprises innovations linked to research and development. The tasks are to fund the needs-driven research required by a competitive business and industrial sector, and to strengthen the networks that are such a necessary part of this work.

Preface

This report has been developed within the ARENA project[1]. It provides an approach to a systems design for the foreseen Swedish kilometre tax for heavy goods vehicles, providing a platform for a continued analysis within the project concerning feasibility and viability, security etc.

The report has been developed by Ulrik Janusson, Thomas Sjöström and Jonas Sundberg at SWECO VBB, and is based on and represents the authors own judgements. It has been thoroughly discussed with various stakeholders inside and outside the project, but does not represent a formal common standing for the project partners of ARENA.

[1] *www.arena-ruc.se*

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Introduction

The objective of the ARENA project is to develop a possible solution for a Swedish kilometre tax system for heavy goods vehicles. The development will follow several stages, where the first step is to develop a conceptual systems design.

We have decided to use the term *conceptual* in order to underline that the solution shall be generic rather than specific, in the sense that it should be possible to implement the result in several ways. Hence, we are trying to define the system independently from its final technical design. The motivation for this is that the time horizon for realisation is far ahead, 4-6 years, and we can expect considerably changes in technical preconditions over this period.

The structure of the conceptual design

The Conceptual design is divided into two documents with annexes:

Part 1: Requirements and preconditions (this document)

Part 2: Proposal for systems design

Special comment to this document

This report, Part 1, provides a background to the second part. The expectations from the policymakers and expected legal, technical and interoperability requirements form a platform to the system design. Hence this document provides the motivation to the defined functionality provided in part 2.

As this is the case, this document is also in itself an important input to the discussion on how to design and implement a kilometre tax for heavy goods vehicles in Sweden.

Methodology – Description model

We expect the final results from this work to be a part of the documentation used for the procurement process required for putting the kilometre tax in operation.

As the time to implementation is rather long, is it important to avoid tying up the conceptual design to specific technical solutions. We can for sure expect new and better solutions to be made available a few years ahead from now. This is why the description of the system is at first hand functional, with a certain focus on identification of the key interfaces in the system.

Together with the functional description an analysis of possible technical implementations is also made (in part 2). The aim is to develop a functional solution which with certainty can be technically realised and operated with high efficiency and reliability.

Reference documents

SRA Guidelines for ITS Systems Architectures[i]

Since 2002 SRA together with ITS Sweden is aiming at the development a national strategy for ITS Systems Architecture development. One result from this work is a handbook in ITS systems architecture development. The Conceptual Design model is developed in accordance with the guidelines given in this handbook.

Amendments to SRA Guidelines for ITS Systems Architecture[ii]

Modifications and amendments to the SRA Systems Architecture Guidelines were made to take into account specific requirements from the definition of an architecture for HGV RUC.

A Generic RUC Architecture[iii]

The Conceptual Design model is developed in accordance with (and starting from) a Generic RUC Architecture developed by SRA. This generic architecture describes a global model with fundamental actors, functions and information flows in a RUC system independent from technology, vehicles and scope.

The Road Tax Investigation[iv]

The Conceptual Design is based on information from the final report of the governmental Road tax Investigation, where the implementation of a kilometre tax was investigated.

Norits[v]

The results from the NORITS project provides the backbone for RUC interoperability between Sweden, Norway and Denmark. This reference provides an overview to the legal framework of Norits, and describes the technical solution and architecture applied for key processes.

CESARE III[vi]

The report provides the knowledge on establishment and design of the EETS service that has been developed in the CESARE III project.

Technical Overview[vii]

This report provides an analysis on technical preconditions for future RUC systems, and on the probable technical development in some key areas.

Fundamental prerequisites and requirements

Prerequisites for a Swedish kilometre tax system

This conceptual design is based on certain assumptions concerning the legal prerequisites for a kilometre tax. These assumptions are based on the Commission on Road Transport Taxations final recommendations for a kilometre tax[2], the investigation on alternative financing of the extension of motorway E6[3], the legal framework developed for the congestion tax in the Stockholm trial[4] and the proposed tax for the Svinesund Bridge and other related legislation (e.g. video surveillance).

To facilitate the readers understanding of the conceptual description some fundamental terms are presented below:

Tax duty

Tax duty occurs when a vehicle liable to pay kilometre tax runs on a section of the road network[5] where the kilometre tax is due. Which vehicles and what part of the road network that is applicable to the kilometre tax will be defined in the forthcoming legislation. The vehicle owner is responsible to pay the kilometre tax but can sign a contract with a proxy (e.g. EETS provider) acting as intermediate in the payment process.

Tax rate

The tax rate defines the size of the tax and depends on vehicle characteristics and which road is run. Some roads may have tax rate 0 SEK[6]. The tax rate will be defined in the forthcoming legislation.

Declaration duty

When tax duty occurs, declaration duty also occurs, meaning that a vehicle liable to pay kilometre tax submits a route declaration to the toll charger according to specified procedures and requirements. The requirements will be defined in the forthcoming legislation and are further developed in the conceptual design model. The subject responsible for the tax duty is also responsible for the declaration to be performed.

Proxy

A proxy may stand in place for the subject liable to pay the kilometre tax and be responsible for the tax payment through a negotiated payment guarantee. The proxy will collect the data from the vehicle and process it to form a Route Declaration which is then forwarded to the Toll Charger. The presence of a proxy is most likely in the case when a foreign vehicle (associated with an EETS provider) is liable to pay kilometre tax[7].

[2] Skatt på väg (SOU 2004:63)
[3] Andra vägar att finansiera nya vägar SOU 2006:33
[4] SFS 2004:629
[5] Differentiating in time and place on the road network may come in a second system generation
[6] The utilisation of the tax level 0 SEK is discussed in a separate memorandum on legal issues (only in Swedish)
[7] The main lead for the CESARE III definition of EETS and also used in NORITS

Tax decision

Toll charger establishes the tax decision based on the route declarations received.

Payment duty

Payment duty occurs after the tax decision. Details (such as time to payment etc) will be regulated in the forthcoming legislation.

Compliance and fine

A vehicle applicable to tax duty and not submitting a route declaration will be subject to an enhanced charge. Delayed route declarations will trigger a compliance charge and if none is submitted a fine is applied.

The amount for compliance charges and fines will be regulated in the forthcoming legislation.

The main difference to the Stockholm congestion tax trial is the use of route declaration. The toll charger will not keep track of who is subject to the tax duty (outside the control function), but the task is solely on the subject itself to submit the route declaration to the toll charger, possibly via a proxy.

Requirements on a Swedish kilometre tax system

During the conceptual development, requirements and prerequisites that we know or expect have been taken into account in the design of the Swedish kilometre tax system. These requirements are divided as follows:

- System requirements set by the legislator
- User requirements
- Requirements regarding security and reliability
- Requirements on manufacturers of components
- Requirements on added value services
- Interoperability requirements

System requirements set by the legislator

These requirements are described by the Commission on Road Transport Taxation, the transport policy proposition[8] and their following government decisions, and other relevant policy related documents. The requirements define the encompassed vehicle fleet, the geographical spread and which relevant vehicle characteristics that should be managed.

The requirements are direct, defined in ruling documents, or indirect, i.e. we have translated formulations in ruling documents into system requirements.

[8] Modern transports, Governmental proposition 2006/06:160

1. The kilometre tax system shall encompass all heavy goods vehicles with a maximum laden weight of 3,5 tonnes or more.
2. The vehicle owner is responsible for kilometre tax payments.
3. The kilometre tax system shall encompass all public roads.
4. The kilometre tax system shall manage to differentiate the tax rate depending on geographical areas. In this case, one road segment is considered as an area.
5. The kilometre tax system shall manage that a geographical area may overlap another. It shall be possible to manage a regional charge/tax in parallel with a kilometre tax.[9]
6. The kilometre tax system shall manage that different vehicles have different tax rate.
7. The kilometre tax system shall manage different tax rates depending on time (time differentiation)

Thus, the resulting kilometre tax for a performed run is a product of vehicles characteristics, driven distance, classification of road segments used and time of day.

Legislation requirements interpreted into system requirements

8. The kilometre tax system shall identify passage of national (and other) borders
9. It shall be possible to pay kilometre tax for a performed route described in non vehicle based equipment, a fallback solution if the vehicles equipment suddenly is out of order.
10. Tax decision is always taken by the Toll Charger based on a route declaration provided by the vehicle owner.
11. The vehicle owner is responsible to provide a route declaration as tax duty occurs.
12. The vehicle owner is responsible to know when tax duty has occurred.
13. Payment duty occurs for a vehicles presence on a road segment where kilometre tax is applicable. This will be defined in a separate properties layer in the National Road Data Base (NVDB).
14. One or more kilometre tax segments in the properties layer in NVDB may be represented by one road link in NVDB or vice versa.
15. The charge for a kilometre tax segment is directly related to its length and potentially other parameters (such as population centre classification) defined in applying legislation.
16. The kilometre tax system shall not discriminate different payments methods.
17. There will be exceptions for military vehicles, agriculture machines etc.

Special comment

The conceptual system design for the kilometre tax is to some extent based on commonalities with the congestion tax in the Stockholm trial, primarily in order to avoid unforeseen legal and practical obstacles. Still there are some fundamental differences between these two systems: A vehicle owner in the Stockholm trial is not responsible to provide toll passage information, e.g. there is no route declaration submitted by the vehicle owner. Instead the tax authority is responsible for registration as input to tax decision. Hence, if a toll passage is not registered there will be no tax decision and the vehicle owner has no obligation to pay the congestion charge.

[9] Andra vägar att finansiera nya vägar SOU 2006:33

Another principle is required for the occurrence of tax duty in the kilometre tax system due to the simple fact that the enforcement system has no possibility to cover the complete national road network. So, for that reason the basic principle is that tax duty occurs when a vehicle liable to pay kilometre tax runs on a road where kilometre tax is due. The vehicle owner must be responsible, by his own initiative (and supported by the system), to provide information on performed routes regardless whether the use of the routes has been observed by the tax authority or not.

User requirements

Despite a relative limited number of vehicles directly influenced by the kilometre tax (estimated 90-100 000 vehicles) a larger number of people will have a direct connection to the system. These also represent different groups: From a Russian truck driver passing through the country, to a gravel truck running a local commission, and to their administrative back office systems and employer. In addition, the tax authority and legislation must be regarded as important user groups and manufacturers of equipment and vehicles, and installation workshops.

All these different groups have legitimate requirements that the kilometre tax system shall be well designed and satisfy their requirements concerning reliability, privacy and cost.

We foresee different categories of users:

Drivers driving vehicles applicable to the kilometre tax system are directly affected by the system. They will be responsible for the functioning of the vehicle equipment in their daily work and have to take action in any situation where malfunction occurs.

The vehicle owner is responsible to make sure the vehicles are correctly equipped and that the drivers have the essential knowledge to maintain the equipment functionality. The vehicle owner will also be responsible to establish the necessary contracts in order to fulfil the payment duty which occur after the tax decision.

A proxy[10] will play a key role, especially in relation to kilometre taxation of foreign vehicles. The proxy has a business relation with the driver, the vehicle owner and the tax authority.

Common for all categories of users is they put high demands on information accessibility of the kilometre tax system and especially on the different technical parts of the system.

The vehicle equipment shall fulfil requirements with respect to interfaces corresponding to…

- Information shall be traceable and tamper proof
- The system shall be user friendly and allow a high level of automation
- The equipment shall be easy to procure, install and replace
- The payment transactions shall be adapted to normal business processes
- Privacy and business secrets shall well protected

T.b.c.

Privacy, security and reliability requirements

T.b.c.

[10] The EETS Provider is a typical example of a Proxy

Requirements from components manufacturers

Components manufacturers provide equipment to be used in the kilometre tax system. The manufacturers requirements are mainly focused on the accessibility to specifications and standards which safeguards the provided equipments initial purpose and functionality.

ADDED VALUE SERVICES REQUIREMENTS

The vehicle equipment used in the kilometre tax system provides possibilities for added value services. The services of interest that might be introduced will probably be specified by the system owner and thus becoming decisive for the requirements on system components.

The conceptual design for kilometre tax system does not comprise choice or design concerning integration of added value services. If such services will be defined within the kilometre tax system framework is an issue not yet resolved.

However, to enable future integrations requirements should be placed on the system since a great interest for added value services (especially from the governments) exist.

18. The kilometre tax system shall be based on open specifications
19. The kilometre tax system shall be based on general and publicly available interfaces

Interoperability requirements

This section comprises requirements to comply with the adaptation to EETS and the requirement that the system shall serve within a national EFC-solution. The EETS requirements are not yet permanent and we face a situation where we must "guess" the future solution. This insecurity is the root cause to why we have separated these requirements from the others and the necessary adjustments will be obvious if the international preconditions changes.

The kilometre tax system is one of many road charge systems in Sweden[11]. Other examples are the congestion charge in Stockholm and charges on the Öresund and Svinesund bridges.

It is fundamental the kilometre tax system is interoperable with the other national road charging systems. This enables vehicles applicable to the kilometre tax to pay other road charges needing only set of vehicle equipment. Furthermore, Öresund and Svindesund bridges are affiliated with the NORITS-cooperation meaning full interoperability between EFC- facilities in the Nordic countries. Thus, the OBU used in the Swedish kilometre tax system should be embraced by NORITS.

It is important to stress the dependence to the European EFC-service EETS[12]. A Swedish or foreign vehicle conveying goods in Sweden shall be able to pay the road tax in Sweden by using an OBU provided by an EETS-provider.

20. The kilometre tax system shall be able to encompass EETS
21. The kilometre tax system shall be interoperable with other road charges applied in Sweden.
22. The kilometre tax system shall be able to be embraced by NORITS
23. EETS users shall be able to establish contracts with an arbitrary EETS provider and to acquire or replace an EETS OBU as the users see fit.

[11] Road taxation is included in the term road charge system
[12] Reference to EETS/Cesare IV WP1

Starting point for systems design

Based on experiences achieved by national and international research projects, analysis of existing road charging systems and associations of such, we assume the following system characteristics:

24. Compliance control is based on knowledge of all vehicles liable to provide route declarations. This means that all vehicles entering and leaving the country will be registered.
25. The controls on the road network will primarily be done by registering the vehicles number plate by mobile and fixed video cameras (e.g. speed cameras) and (complementary) by real time DSRC communication with OBU´s.
26. The kilometre tax system shall require a minimum of stationary installations in the road network. When possible, synergies with other installations (e.g. speed cameras) shall be sought for.
27. The vehicle equipment used in the payment system shall securely register a performed route applicable to road tax and submit route data through a proxy (Toll Service Provider/EETS provider) or directly to the Toll Charger.
28. The kilometre tax system calculates, collects and claims road user charge payments.
29. The kilometre tax shall be part of an integrated national solution which comprises all road charging services. The payment system shall also be part of future road charging services designed for infrastructure ventures and public road charging systems for personal vehicles.

The above requirements and assumptions can be summarized to the following fundamental starting points for system design.

30. An extensive kilometre tax network
31. Low traffic intensity on major parts of the taxation road network
32. Vehicles with a maximum laden weight of also less than 12 tonnes are applicable to road charge (a distinction to the German system)
33. Foreign vehicles are applicable to kilometre tax (a distinction to the congestion charging in Stockholm)
34. Integration with existing DSRC-systems is a requirement

System boundaries

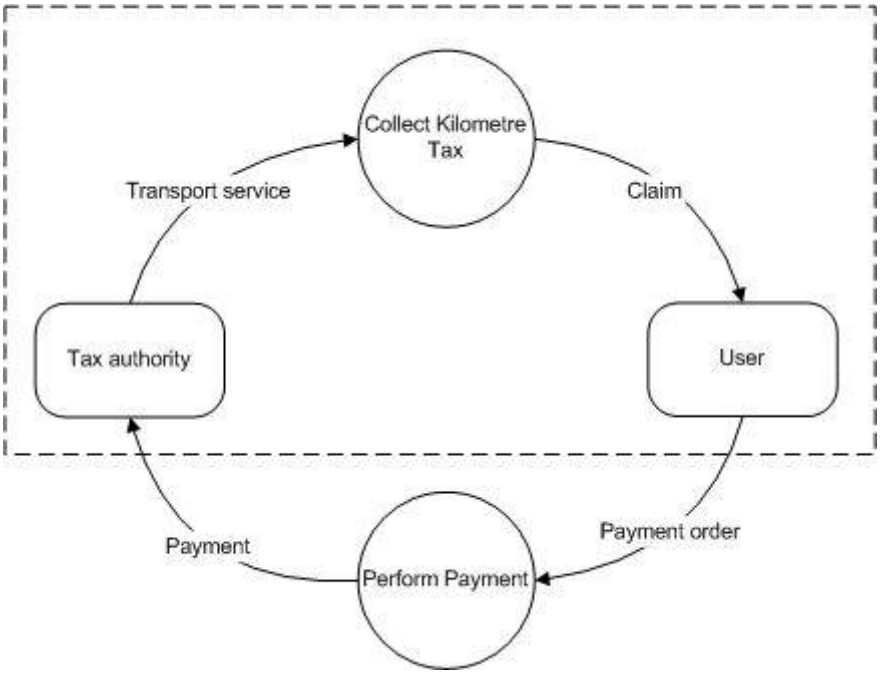

Figure 1 Context diagram: system limitations and superior architecture

Figure 1 displays the kilometre tax system in its context and defined as one function. The system manages the processes needed in order for a user (customer) to perform a correct tax payment.

The two main functions “Collect Kilometre Tax” and “Perform Payment” are separated. The first function is performed by the kilometre tax system and requires technical development and implementation while the latter function mostly uses established processes in bank and financial systems.

The conceptual development is focused on the function ”Collect Kilometre Tax” which measure, calculates and manages all information needed in order to pay a correct road tax, and performs the required processes to guarantee tax is correctly paid.

The function “Perform Payment” is currently of limited interest to the development of the kilometre tax system and will not be further covered in this report.

Furthermore, the conceptual development is limited only to discuss the collection of road charges in Sweden. How Swedish vehicles pay road charges in foreign countries is currently out of the documents scope. This limitation is justified since the issue must be resolved within the European interoperable service EETS (please see below).

Actors

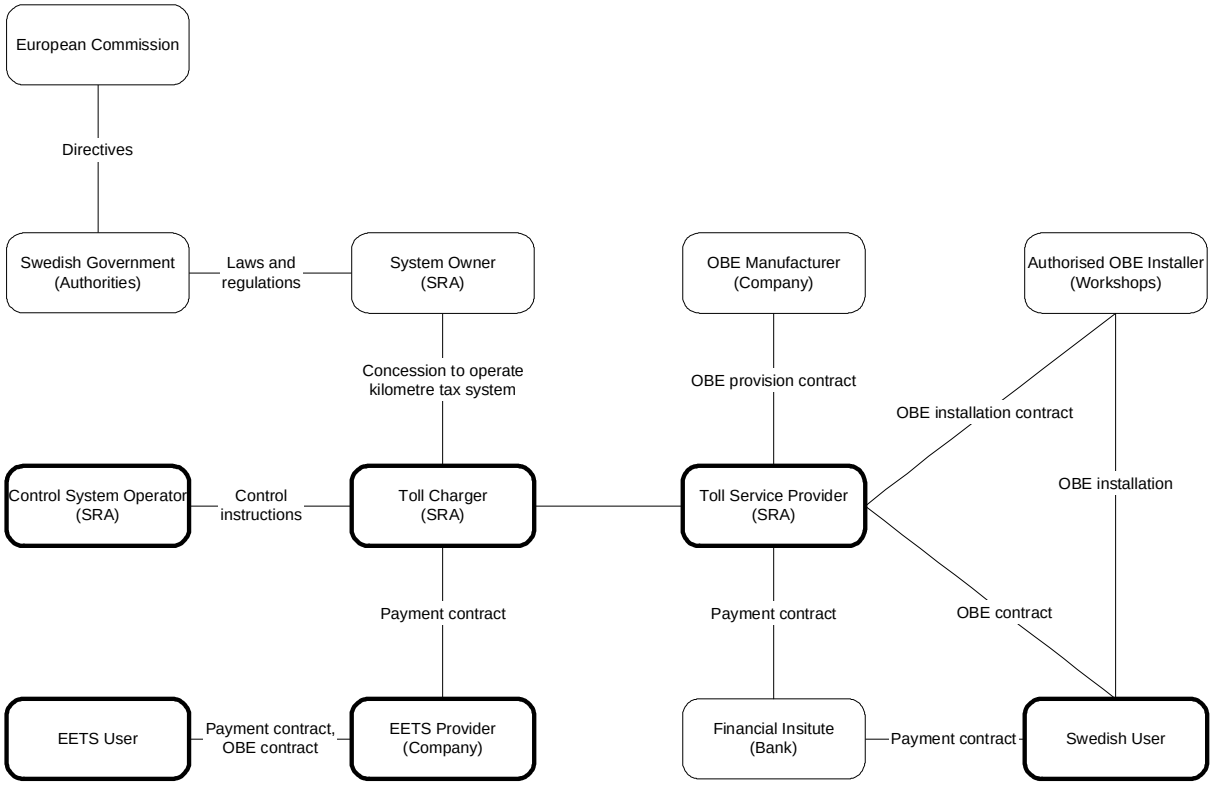

Figure 2 Actors model: Swedish road charging actors [viii]

The system concept documents presents two different services to perform a Swedish kilometre tax payment. One is the national service only functioning within Sweden's borders[13]. The second is the European interoperable road charging service EETS which is required through European legislation according to the road charging directive[ix]. The latter is neither entirely specified nor implemented. Furthermore, it is likely that EETS will be shaped differently in different countries since it must adapt to local charging systems and procedures. The conceptual design includes and takes into account current requirements and procedures agreed on European level.

Furthermore, the conceptual design excludes actors responsible for processes that currently must be regarded as details, such as installation of vehicle equipment. This does not mean that these processes can be neglected and are easy to solve, far from.

The conceptual design is focused on the interaction between the following actors: Swedish user, EETS user, Toll Charger (SRA), Toll Service Provider (eventually SRA), Control System Operator (SRA) and EETS Provider. The actors architecture reflects the three roles of the decisive authorities (SRA): one role as Toll Charger[14], one role acting as intermediary of payment information by providing payment system functionality and equipment[15] and one role as operator of control system functions. Also, the EETS Provider makes a complex service available comprising means of payment

[13] There are however no technical limitations to the scope of the service
[14] *Toll Charger* according to CESARE III
[15] This role is best represented by *EETS Provider* according to CESARE III

(OBU) and replaces the vehicle owners payment duty towards the Toll Charger through an expected payment obligation (as implemented in Norits and expected in EETS).

We would like to stress that the identification of SRA as the actor in the role of the Toll Service Provider, is not at all written in stone. This role can be maintained by as well a contractor to SRA, by other authorities and through one or several independent bodies. In its most advanced form, we can even allow for competing Toll Service Providers to be operating within the Swedish kilometre tax system. This may sound strange, but it is a natural extension of the appearance of multiple EETS providers (which is indeed foreseen).

Different user contracts

Vehicles driving on the Swedish road network may choose to install a Swedish or an EETS on board unit [16]. A contractual relationship starts when the OBU provider (EETS Provider or Toll Service Provider) is chosen according to the principle one vehicle-one contract-one OBU[17].

We consider it less likely that a foreign vehicle is affiliated to the Swedish service. This is due to the increased administration that will be laid upon the user, who most likely runs through several countries often and for sure would benefit from being an EETS user instead. However, we consider it most likely that a Swedish vehicle that often drive in foreign countries will be affiliated with an EETS Provider and use that vehicle equipment also for transports carried out in Sweden.

[16] The concept is based upon mandatory use of an OBU. However, there may be vehicles driving with a not functional OBU e.g. OBU malfunctions or user tampering.
[17] This is a fundamental principle in CESARE III and in the EU-directive 2004/52

Issues yet to resolve

Thin or heavy client

The conceptual development recommends a thin client solution. This means that the OBU has no or little information of current tariff regulations etc. applying to the kilometre tax. This is associated with the following advantages: less complexity, increased flexibility, less downloads from central system to OBU, better possibilities to introduce added value services and high reliability. For vehicles affiliated to the Swedish service this implies that the Toll Service Provider and the Toll Charger has maximum control over data and data processing. It is also compliant with one of the cornerstones of the Swedish systems design: the Toll Charger always makes tax decisions. Tax calculation in the vehicle is against the praxis applied in Sweden[18].

However, the thin client is associated with some disadvantages such as: more uploads (information from the OBU is probably sent more often) and *no access* to real time information (such as current road rate and accumulated road tax).

The secure module

What costs and problems are really associated with a device using tamper proof hardware and controlled boot-processes? Will international harmonisation efforts provide an EETS OBU with an interoperable security mechanism?

Virtual On Board Unit

The concept design suggests a virtual OBU, i.e. it shall be able to implement all necessary functionality into a vehicles existing technical platform. This is however complicated by the need of the secure module which has parts protected from tampering. This is an important issue to research but the conceptual development team expect that the kilometre tax system can be introduced without the virtual OBU made available. The virtual OBU may be introduced in connection with a future system upgrade.

Only report positions on road tax network?

A prerequisite for the Swedish kilometre tax system is that some parts of the road network will be liberated from tax. But, it is not obvious the thin client has the “knowledge” to separate a tax-liberated road from a road where tax is applicable. A possible solution is for the OBU to send information of all performed transports needed to calculate the road tax to the Toll Charger who then consider transports liberated from road tax. A functional approach solving would then be to define all roads liberated from tax as road tax areas but with tax rate 0 SEK. This would require a mandatory route declaration to be continuously submitted within national borders.

The alternative is to define areas liberated from road tax, so-called bounding boxes, in the OBU. Furthermore, this is probably an essential functionality in order to control reporting of vehicles entering or exiting national borders. The technical approach would be to define borders (“geo-fencing”) in the OBU software controlling other functions.

[18] Referens till Trängselskatten i Stockholm och förarbeten till Broskatt för Svinesund

The need to report position information (track log) for areas not applicable to road tax is not obvious, and less obvious to perform compliance controls within these areas. But, it is essential if the control system functionality should perform a match between the distance registered in the digital tachograph (or other distance measure device like the trip meter) compared to the reported track log. It is also essential to enable control of “uninterrupted” track logs: If all routes are declared, then the authorities (or Toll Service Provider) may require complete declarations without “loop-holes” like missing sections.

Another aspect concerning this issue is that the road signs exposure may become expensive and thus hinder the control function. If certain road areas are defined as tax liberated, a consequence may be the requirement to place road signs on each and every border. It would become rather expensive to guarantee a correct roadside exposure with several tax liberated road segments.

Appendix A. Terms and Definitions

In this section both Swedish and English terms are explained below.

Kilometre tax system: All systems needed in order to collect road charges (but not to perform payment, according to Figure 1)

Central system – Collection of terms including all technical systems not included in the OBU or on road side.

DSRC – Direct Short Range Communication[x]

Driver – A person actually driving the vehicle.

EETS – European Electronic Toll Service. An interoperable ETS-service defined by the European Commission.

EETS Provider – An actor providing equipment and contracts enabling a user to pay a road charge. CESARE III project has defined the terms as "The EETS Providers are offering EETS by issuing OBE, contracts and payment means to the Service Users. They guarantee the payment of the services consumed by their customers the proved by genuine claims from the Toll Chargers. They will claim payment from the Service Users."

GNSS – Global Navigation Satellite System. Generell term for satellite positioning.

PKI – Public Key Infrastructure[xi], a structure of asymmetric cryptographic keys allowing binding of private/public identities with pairs of keys by a Certificate Authority.

MAC – Message Authentication Code[xii], a cryptographic one-way function used to prevent tampering of message contents. Mac supports a secret symmetric key as input and the message integrity can not be verified without access to this key.

Transaction – Continuously messages follows after one another according to the communication protocol, e.g. a report.

Appendix B. Requirements justification and discussion

Below is an extensive justification and discussion touching some of the requirements currently demanded on the kilometre tax system.

2. The vehicle owner is responsible for kilometre tax payments.
According to the Commission on Road Transport Taxations final recommendations for a kilometre tax the vehicle owner is responsible for payment duty. Probably the police are in charge to manage controls and have the courtly right to stop vehicles. It would be positive if money could be directly enforced at the control site, but the issue does not affect the conceptual development and is currently beyond the scope and aim of this report.

3. The kilometre tax system shall encompass all public roads.
Urban streets are applicable to road tax except private roads. This issue is thoroughly described in the Commission on Road Transport Taxations final recommendations for a kilometre tax.

8. The kilometre tax system shall identify passage of national (and other) border
The conceptual team considers this requirement as necessary in order to: avoid unnecessary communication, to complete transactions before vehicles leaves the Swedish jurisdiction and to enable controls using the information stored in the digital tachograph and the vehicle trip meter function. The requirement will also enable requirement on route declarations without missing segments.

35. 9. It shall be possible to pay kilometre tax for a performed route described in non vehicle based equipment, a fallback solution if the vehicles equipment suddenly is out of order.

There will always be vehicles driving without an installed OBU, there will always be OBUs suddenly ceasing to function and users in these situations must have a possibility to pay the road charge. A solution managing the situation is most likely cumbersome. This is the reason why the conceptual development team foresees very simple OBUs, running on batteries, store position information on a memory card (instead of using mobile communication) will be available to temporary users.

13. Payment duty occurs for a vehicles presence on a road segment where kilometre tax is applicable. This will be defined in a separate properties layer in the National Road Data Base (NVDB).

36. 14. One or more kilometre tax segments in the properties layer in NVDB may be represented by one road link in NVDB or vice versa.

37. 15. The charge for a kilometre tax segment is directly related to its length and potentially other parameters (such as population centre classification) defined in applying legislation.

This implies a road charge for one road segment will be unambiguous.

Reference list

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