A New Approach to Control in the ARENA concept for HGV kilometre tax in Sweden

Jonas Sundberg, SWECO VBB

arena

ARENA REPORT 2008:4

2008-02-29

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.

Table of contents

Preface – Instruction to readers

This report has been developed within the ARENA project[1]. It presents an approach to the control function within 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 Jonas Sundberg with support from Ulrik Janusson and Thomas Sjöström at SWECO, and is based on and represents the authors own judgements. It has been discussed with various stakeholders inside and outside the project, but does not in its present form represent a common standing for the project partners of ARENA.

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

Background

The approach to control is a key to successful implementation of an EFC system for HGV kilometre tax in Sweden. A well designed control system will bring reasonable costs and ensure user confidence and acceptance.

The control system approach presented in the draft concept[2] for the Swedish kilometre tax did not meet these requirements. The approach taken, with physical installations in the road network as the main real time control component, has been found to bring too high costs in relation to the foreseen revenue from the system. In addition, the approach taken did not really solve the problems associated with road transport on the secondary road network – the road network is too large to be covered by installations and physical observations for real time control.

To overcome these problems, a new approach to the real time control function has been developed. This new approach could best be described accordingly:

- Much more focus on control mechanisms related to business processes – more intelligence and less hardware
- The line of control should follow contractual relations – more responsibility to the Toll Service Provider in his relation to the user
- The scope of the Toll Charger has been focused
- Adaptation to the existing legal base for road side control and enforcement authority – as tax authorities are not allowed to stop vehicles at the road side

The basis of this new approach is presented in this document. The conclusions have been used for a revision of the Swedish Concept for a HGV kilometre tax.

The concept remains a functional approach

The ARENA concept for a kilometre tax in Sweden is first of all a functional approach. This means that the concept in itself does not prescribe or even recommend any technical solutions. In order to visualise "what an implementation of the concept could look like", and thereby facilitate discussion and hence increase the credibility of the concept, the concept gives examples of technical solutions that meet the ideas of the concept.

In a recent national investigation for a kilometre tax[3], the prevailing example of a physical implementation of the concept has been used to provide a cost estimate for the kilometre tax system in order to enable a cost/benefit calculation. This analysis has shown that the cost associated with the design, which is implied by the concept, is too high, and has called for a revision of the concept. In particular the control system needs to be revisited since it is the major cost driver.

We can already now see that this fairly thorough revision of the underlying ideas on the control system design will not have a very big impact on the functional composition of the

[2] Up to and including version 0.931
[3] The first SIKA investigation, January 2007

system – the actual concept. This means that the changes in the concept will not really reflect the order of magnitude of the change in the control system approach.

The Actor model

The approach to control is very much related to the business model, with actor roles, relations and responsibilities. As the description of the control concept will use abbreviations and references to the actor architecture, this section below is repeated from the concept document.

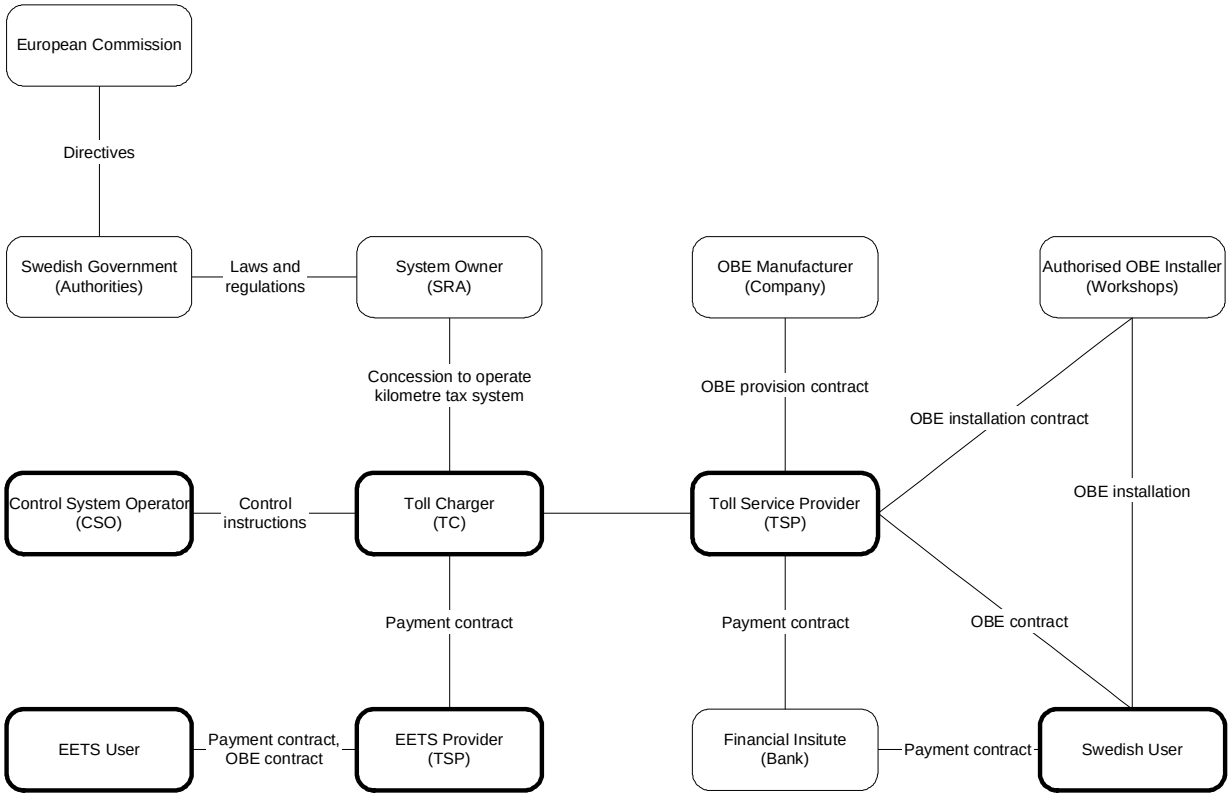

Figure 1 Actors model: Swedish road charging actors [i]

The system concept presents two parallel services to perform a Swedish kilometre tax payment. One is the national service only functioning within Sweden's borders[4]. The second is the European interoperable road charging service EETS which is required through European legislation according to the road charging directive[ii]. 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 schemes 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 (TC), Toll Service Provider (TSP), Control System Operator (CSO) and EETS Provider. The EETS Provider and the TSP are sometimes both referred to as TSP.

[4] There are however no technical limitations to the scope of the service

The Business Model – Roles and responsibilities

The traditional control model

The “traditional control model” reflects a relation between actors in EFC operation where the Toll Charger controls each and every user of the transport service individually to verify that they have carried out proper payment.

In DSRC based systems, the most prevalent EFC technology in Europe, control functions are integrated with the debiting functions and carried out in real-time. In autonomous charging (based on distance, area etc) the control functions are performed with spot checks but the traditional Toll Charger to User control relationship is maintained.

The key point reflected in the traditional approach is the effort to detect users that are not equipped with accepted equipment for the EFC service – the unknown user. This focus is clearly relevant if the primary threat seen is about unequipped and unknown users. As the Toll Charger in traditional tolling also often is issuer (TSP) of EFC equipment for his service, this is a rational approach.

In the first control system approach developed for the Swedish kilometre tax, this traditional approach was applied. However, it was done in spite of the fact that in distance based charging systems using positioning mechanisms, the debiting and control functions do not have to be simultaneous and can be separated also in geography. Also, the first approach did not make use of existing strong relations between actors. In particular in the national situation where association to the service is mandatory for all vehicles of the categories concerned and follow automatically from the vehicle registration process, many (all national) users are known from the beginning. **All in all, it is not adapted to the situation where the TSP is separated from the TC.**

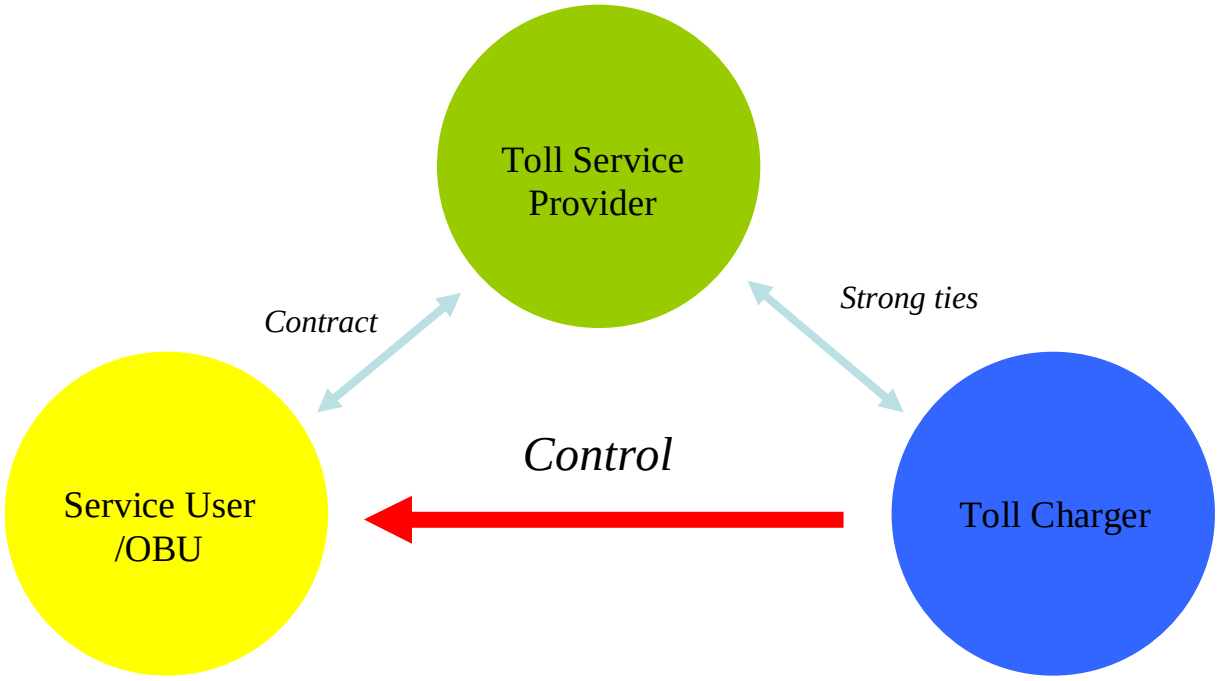

Figure 1 Control and information flows in "traditional approach"

The revised control model

The revised control model reflects other relations between the entities. Instead of exercising direct control of the users, the TC will build a control mechanism that follows contractual relations. Hence, the Toll Charger will exercise his primary control towards the TSP, and the TC furthermore expects the TSP to exercise thorough control on his associated user/OBU.

There is also a mechanism maintained that include the TCs direct monitoring of vehicles. This control has however a scope that differs from the traditional model: The responsibility of the TC is to measure the level of fraud/anomalies rather than to catch violators and execute enforcement.

Observations from the fraud measurement will also be fed into the non real-time control part of the system, which remain the responsibility of the Toll Charger as this control is mainly directed towards the TSP.

In this model, there is of course no evident solution to the case of "unequipped users", i.e. vehicles that do not carry an OBU / have no contract with a TSP. The role of enforcing authority is outside the scope of the Toll Charger, and shifted to other public authorities that are in command of the necessary tools: The right to stop vehicles at roadside, the right to issue fines etc.

A clear advantage of this model is that it fits better with the roles and responsibilities that are established in Sweden in relation to e.g. tax evasion and fraud related to the use of the tachograph.

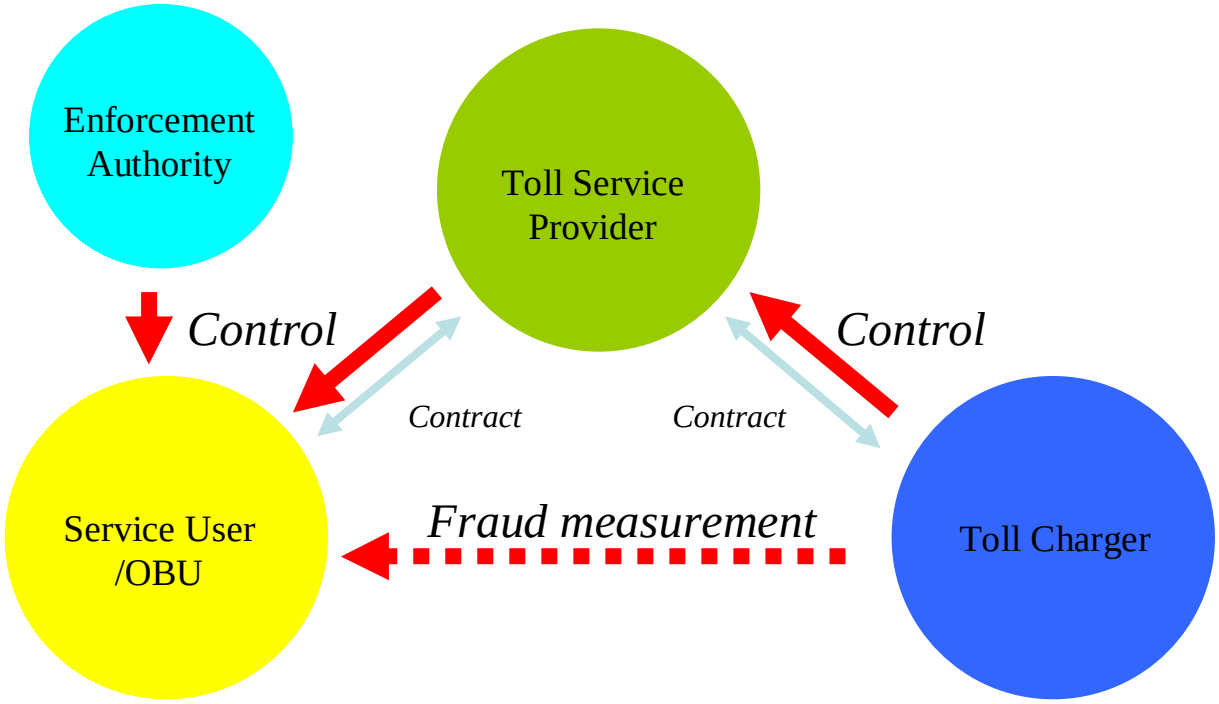

Figure 2 Control and information flows in "new approach"

As long as the detected (measured) level of fraud is below a certain threshold (let's say 2%) there is no need to upgrade the enforcement system. If a tendency to a raising level of fraud in general is observed, or if the level of fraud is found to be unacceptably high amongst a certain category of users, the Toll Charger will call for increased enforcement (more road side control, higher fines etc.).

Fraud related to manipulated information from vehicle OBU´s is not expected to be a major problem. It will clearly be in the interest of the TSP to ensure correct and timely declarations from associated vehicles, as this is regulated in the contract between the TC and the TSP concerned.

Don't work harder, work smarter!

The system will provide a lot of data that can be analysed to find behaviours that indicate cheating users. Usually this will not be enough to actually put some kind of sanction on the user; behaviour in a specific case can nearly always be explained with some more or less exceptional circumstance. Instead the analysis is geared towards the development of countermeasures in the system, and tracking the performance of the TSP´s as regards his associated users compliance with the system.

New actors in the revised model

As the traditional control model reflects a traditional EFC system organisation, the revised model opens up for new actors. The relation between the TSP and the User becomes more like relations found in telecom between subscribers and operators, in the way that the role of the TSP is to monitor his associated users, to provide a service to them and manage the billing process.

We can also see that when the responsibility for control and enforcement is removed from the Toll Charger, this also opens up for new actors to carry out the Toll Charger functions. There are interesting parallels in e.g. the Swedish custom and the Swedish vehicle registry where responsibilities have been shifted to private actors in competition.

Control Philosophies in EFC

Traditional case: the unknown user

Road Toll systems are in general operated by a Toll Charger with dedicated responsibility for a specific implementation. Clients are those that select to use the tolled infrastructure provided by the Toll Charger, be it a bridge, a motorway or an urban tolling scheme. A portion of the clients may enter into a contract for the use of an EFC payment facility, while others may consider themselves occasional users with little benefit from an EFC contract. For those, the Toll Charger offers alternative payment options (manual etc.).

This means that there are numerous vehicles using the tolled infrastructure that are not known beforehand by the Toll Charger, and where absence of registration means for ever lost revenue. No other sources of information can be used for the purpose of cross-checking. It should be noticed that there are several transport services offered where there are no physical barriers hindering use of the transport service even if payment is not made. Good examples are Norwegian toll systems which use EFC in open lanes, the Toll Collect system in Germany and numerous public transport ticketing systems.

For this reason, the Toll Charger installs and operates control systems to register unauthorised use of the transport service. The control system is normally fully integrated with the debiting system and in simultaneous operation.

This control philosophy – “obtain complete control” – is for obvious reasons dominating in the world of RUC.

There are examples of other control philosophies. The London RUC scheme is a good example, where registrations are made at certain checkpoints, but where the Toll Charger does not know which vehicles that actually use the transport service. All users are expected to pay voluntarily within a certain time period if they have used the transport service concerned (i.e. driving in London centre). If a vehicle is registered and payment is not made within a certain time, a heavy penalty fine is issued. This is a good example of a solution where the debiting function has no real time connection with the control function.

Alternative case: the (mostly) known user

Now consider what control philosophy to apply if users are known to the Toll Charger also prior to the use of the service, and the service is a monopoly. Furthermore, consider the situation where there is no integration between the debiting and the control functions.

Simply, this means that a vehicle with certain characteristics that has been driven during a certain period within the area concerned (Sweden), is eligible to pay tax. In this case we can use a whole series of methods to verify whether driving has taken place; the tachograph, the trip meter, fuel consumption etc. give all indications of vehicle usage in non-real time. Key point is that this verification can not take place at the same time and place as when the service is acquired except at specific control points.

Thus, the key question is how to apply control of a (fairly) known fleet of vehicles on a nationwide road network, where the debiting function (tax collection) only to a limited extent can be integrated with the control function.

In the revised Swedish approach, we have looked for similarities in other systems, and found that a key principle to apply is the principle of trust: If we can assume that the vehicle owners and drivers are trying to comply with the regulations, then a very different situation occurs. This assumption can be made if we have trust in the management of the transport company, and we can see that they have applied the various mechanisms that are required to ensure that kilometre tax is paid.

Instead of controlling the performance of OBU´s in real time, focus is laid on control of business processes and quality systems in non-real time. The key point is that a transport company that is found to not comply with the regulations (i.e. perform tax evasion), will suffer from this in many ways.

Here we face a situation where all users are not equally well known by the Swedish tax authority. In particular EETS users are in fact not very well known. The mechanisms we have to apply to know them better are in short: Register their entrance on the road network and require that the associated EETS provider has good control (good knowledge).

Summary on Control Philosophy

The traditional control philosophy applied in RUC (and the previous ARENA concept) is characterised by:

- Control everything yourself
- Do it in real time – integrate the debiting and control functions
- Users are unknown until registration at control point
- Do not trust anyone
- Toll Charger is in command of enforcement

The Alternative Control Philosophy developed for the ARENA Concept is characterised by:

- Trust until security is under threat
- Toll Charger keeps track on level of fraud and violations - use random check to measure violations
- Focus Toll Charger control on business processes and quality systems of transport operators
- Delegate to the TSP to have control of associated subscribers
- Synchronize and use parallel control mechanisms
- Focus on non-real time control measures, separate the debiting and control functions
- Other authority than the Toll Charger is in command of enforcement
- Keep track on all vehicles that are expected to pay

Changes in the control system

The Control system included in the Swedish kilometre tax concept[5] was designed to use parallel and supplementary control methods. These have been adjusted and extended as described below:

	Previous control system	**Revised control system**
a)	The OBU is equipped with a real-time communication unit (e.g. DSRC) to enable identification and response to control requests at Control Sites, border crossings etc. Exceptions will trigger video registration of license plates, and a post-observation request to provide proof of a performed Track Log registration or reference to a provided declaration.	The use of the real time communication unit will be restricted to border crossings, where there is a remaining need to register vehicles entering and exiting the country. For this purpose, also video registration can be used.
b)	Control Sites (normally a gantry equipped with DSRC transceivers, equipment for vehicle classification and video registration) are established at every 50 km on all major roads, and then with reduced density at secondary and smaller roads. Also, fixed installations are required at national borders. In all, approximately 750 fixed installations have been included. The secondary road network will be equipped with video-registration units only (possibly shared with the speed camera infrastructure	No dedicated control stations. Video registration spot-checks will be made at random. We expect the automatic speed enforcement system cameras to be developed for this purpose into an integrated system.
c)	Mobile Control and Enforcement units operate on smaller roads. They establish mobile control points with a limited functionality, e.g. hand-held DSRC and video-registration	Mobile Units will be retained, but they will only be used for providing statistical knowledge of the fraud level. The mobile Units will not collect full evidence of fraud, and will not pursue found anomalies. Measurements from other parts of the system can, while not being strong enough to provide evidence of fraud, give directions on which times and locations that are suitable for spot checks
d)	In the post-observation part of the control procedure , the Toll Service Provider will be requested by the Toll Charger to display the specific Track log	Same

[5] Up to and including version 0.931

	corresponding to a certain declaration or a specific observation of the vehicle at the road network. Exceptions (failure to prove declaration) will trigger a contact with the vehicle owner / Toll Service Provider. As the User through his OBU (IC-card) can provide a reception receipt on submitted Track Logs, the position of the vehicle owner versus the Toll Service (EETS) Provider can be secured.	
e)	Verification of declared trips against other registrations, e.g. the vehicle trip meter, requested tax deductions for fuel costs etc.	Same
f)		The TSP will monitor the function of the OBU, and randomly collect data from the OBU, without knowledge of the driver, for verification against received track logs
g)		The TSP will ensure that trip declaration from a vehicle are consistent (no holes etc)
h)		Police authorities will conduct road side control following the directive 2006/22/EG where also the kilometre tax OBU will be included in the control procedure
i)		The Toll Charger (tax authority) will audit business processes and quality systems of transport operators, and require sound procedures to provide transport permits. It shall be in the interest of the transport operator to comply with the kilometre tax.

Control mechanisms in the new approach

Control characteristics

A mandatory OBU makes the vehicles "known" to the Toll Charger

Vehicles included in the Swedish vehicle registry and with appropriate vehicle characteristics will be automatically associated to the kilometre tax system with a mandatory use of OBU. This means that the tax authority will know about these vehicles. Also foreign vehicles entering Sweden will be mandated to use OBU. All together, this means that the Toll Charger at every occasion will "know" the fleet of vehicles that are eligible to pay tax.

To achieve this, we will need an "entry and exit registration" of all domestic and foreign vehicles entering and exiting Sweden[6]. Those vehicles that are considered to be inside the country are eligible to pay kilometre tax when used. The Toll Charger is responsible for this "list of vehicles".

Border Crossing registration

The Toll Charger will execute a video registration of all vehicles entering and leaving the country. This means that the TC at all times will know which vehicles that are currently expected to provide trip declarations. We expect registration to be made by video, and this process can be coordinated by registration practises carried out by the customs. E.g. the Finnish customs already perform video registration of vehicles on the Swedish/Finnish border. This can be synchronized with the Swedish needs for the kilometre tax.

The TC can call for a trip declaration

When a vehicle leaves/is about to leave the country the TC will be able to require a concluding trip declaration in connection with the border crossing. If the OBU/vehicle do not provide this (within a certain time frame) the vehicle will be put on the black list. At next entrance (at least) Swedish authorities will be alerted on a tax evader entering Sweden.

Toll Charger will monitor TSP's

The Toll Charger will focus its control on the TSP's that operate in Sweden. This include as well national TSP's as EETS providers. It shall be understood that in order to qualify as a TSP in Sweden certain requirements have to be met[7]. One shall expect a TSP to provide thorough information on its systems and services before being accepted as a TSP for the Swedish kilometre tax.

TSP's will have to submit reasonable trip declarations

Trip declarations (from as well native as foreign/EETS vehicles) are routed through a TSP (national or EETS) which translates data received from the vehicle into a trip declaration, which is sent to the TC. The TSP will be reasonable for a consistency check of all trip declarations, making sure that there are no "holes" in the accumulated journey etc. If such inconsistency is found, the TSP will have verify the reason for this with the driver/OBU and/or inform the TC about this anomaly.

[6] This means that all border crossings have to be equipped for automatic registration of vehicles that enter or leave the country

[7] Likely this set of requirements is not unique for Sweden

TSP's will have to monitor associated OBU's

The requirement on the TSP to provide "reasonable trip declarations" calls for the TSP to have a fairly well developed solution for monitoring OBU status. This OBU status check may include as well a status indication as a position indication ("where is the OBU, and how does it feel?"). This control could be carried out either as continuous monitoring, or as random spot checks.

In order to be accepted as a TSP in Sweden, the TSP will have to demonstrate its solution for and capability of monitoring OBU's, ensuring that it is trustworthy. This and the previous point makes clear that the TSP will have to establish a contract with the user that grants the TSP a quite considerable influence on the operation of the OBU.

TC will carry out random spot checks

The TC will have a considerable amount of staff allocated to measurement of fraud/lack of registration in the system. Spot checks are carried out (including simple vehicle observations: Identity, characteristics, time and place[8]) and compared to submitted trip declarations. The objective with the spot checks is to ensure that the level of fraud is kept at a reasonably low level in all kinds of environments and situations (small roads, rural areas, night time).

If the level of fraud is found to be unacceptably high in a certain environment, the TC will call for an increase in the road side control and/or increase in the level of penalty.

Road side control is carried out by police authorities

The primary tool for enforcement of violating vehicles is road side control carried out by police (and similar) authorities. This control function should be co-ordinated with the control on tachograph functionality and contents etc. The expected level of control that must be carried out according to the directive 2006/22/EG[9] also satisfies the needs for control that arise from road charging.

This directive, in force since 1'st of April 2007, decides the control level of driving and rest times as well as if a tachograf is installed. In the first step 1% of the working days are to be controlled. In 2010 the number shall be 3% and a minimum of 30% of the controls shall be done on the road side

TC will carry out audits on transport companies

Operation of road transport services are subject to public licensing. In order to be accepted as a freight operator, the company has to comply with certain requirements. The public authorities carry out audits on transport operators to validate that their operation is sound and adhere to requirements set. Such audits will include control of how the company manages the kilometre tax: Equipment and status of OBU's, performed declarations etc.

[8] Automatic Speed Cameras could eventually be used for this purpose as no enforcement is involved

[9] This directive that has been in force since 1 st of April 2007 decides the control level of driving and rest times as well as if a tachograf is installed. In the first step 1% of the working days are to be controlled. In 2010 the number shall be 3% and a minimum of 30% of the controls shall be done on the road side

Comparative checks

There will be opportunities to compare information retrieved from different systems: data from the tachograph can be validated against data from the OBU, data from the trip-meter can be validated against trip declarations e.g. at the annual vehicle inspection etc. Such checks may not bring enough evidence of fraud, but may cause an intensified control to be executed on a particular vehicle by its TSP or public authorities.

Incentives

The absence of penalties is of course an incentive to comply with the kilometre tax regulation. However, it should be further investigated what other incentives to compliance that can be implemented in the kilometre tax scheme.

Possible penalties

The new approach includes control mechanisms in several relations. This means that there also have to be penalties associated with detected anomalies. In addition to fines that follows from not complying with the kilometre tax regulation, other kinds of penalties will be executed:

Toll Charger vs. TSP

The most evident penalty that the TC can execute versus the TSP is to terminate the TSP contract. This would cause the OBU's associated to the TSP to not function in Sweden.

TSP versus OBU / User

The most evident penalty is the black-listing of the OBU. As soon as the OBU is put on the black-list it cannot be used for the kilometre tax. The TSP will signal this by a status indicator on the OBU.

Police versus OBU / User

The Police authority (or similar) will have the right to stop vehicles for road side control. In case of found non-compliance (e.g. no OBU is in operation) the police may issue fines and take other actions as found appropriate (e.g. stop from driving).

Toll Charger versus OBU/User

In the revised control model, the Toll Charger will not issue penalties versus the driver/OBU carrier. This is outside the scope so the Toll Charger.

Toll Charger versus transport company

The Toll Charger will audit the business processes of the transport company to ensure its sound operation and compliance with the kilometre tax system. If the Toll Charger finds that a transport company cannot be trusted, its transport license may be withdrawn.

Other authorities versus the OBU/user

It is evident that a hauler / transport company which does not fulfil legal requirements as regards kilometre tax payment, and cannot prove its sound processes, will be "punished" by the market in any procurement. Buyers of transport services are increasingly interested in the fair competition between providers of the services.

The need for a mandatory OBU in the revised approach

In the concept for the Swedish kilometre tax, we have assumed that mandatory use of an OBU is required. This requirement follows partly from the control system, which was designed for continuous registration of vehicles in real-time control mode. To allow for a mandatory OBU, we concluded that there is a need for a "temporary OBU" solution in parallel to fixed installation OBU's.

Now, if we change the control system and remove the real-time control from the main parts of the road network, will that make any difference?

Our conclusion is that the secure track log, the centre part of the OBU, becomes even more important in the situation where the element of real time control is reduced. The only viable alternative to the secure track log is pre-registered (pre-paid) trip plans, which could include as well a daily pass as a planned declared route. These shall be seen as fallbacks for the OBU, but not alternatives. One of our key concerns has been the efficient control of the transport services carried out on minor roads "far from civilization". It is evident that the control mechanisms now put in place benefit very much from the presence of an OBU: E.g. all control based on comparisons between systems (e.g. declarations vs. trip meter data) will be dependant on such information.

However, the change in control philosophy will eventually reduce the need for OBU functionality: As the real-time control component is heavily reduced, we can more easily accept an OBU with a limited communication capability. The need for continuous reporting of travel logs is not required if the OBU can be expected to be subject to a manual "return and read out the OBU procedure" within a couple of days when leaving the country. Such "temporary OBU exchange points" can be provided also spread over the country, to allow for e.g. replacement every week to prevent from memory overflow etc.

There are additional fallback options and solutions, and our general feeling is that the degrading of the real time control, rather makes these fallback solutions more easy to design and manage than in the previous control approach.

The need for a mandatory OBU shall also be seen in the light of border registration and declaration of all travel in Sweden. In practise, each vehicle entering and leaving Sweden will have to declare an undisturbed travel path between the entry and exit points. Those vehicles not leaving Sweden, will have to declare a travelled distance complying with the trip meter registration e.g. at vehicle inspection.

Technical opportunities

The Conceptual Design is basically functional, but in order to verify its feasibility a potential technical solution is provided with the concept. The changed approach to control adds a few new possible technical features to the system:

TSP monitoring of OBU

A TSP can use A-GPS (already today) to monitor the movement of associated OBU´s. This means that the TSP can implement a control function where he very soon will detect if the OBU provide trip declarations from other positions than where the OBU actually is. This monitoring can be made without the driver knowing it.

We can in general see that the higher requirement that we put on the TSP will call for a more advanced contract between the TSP and the user, as well as between the TSP and the Toll Charger. Also, the TSP will require a fairly thorough service agreement with a telecom operator in Sweden.

The secure module as a SIM-card

An obvious option is that the secure module that has been defined is a SIM-card issued by telecom operators in association with the Swedish authorities. SIM cards already today exists with integrated A-GPS on the chip.

Effect on control system costs

The cost estimate of the previous control system approach indicated initial investment costs in the order of 1,7 bn SEK, and operational costs in the order of 0,35 bn SEK/year.

Part of system	**Initial investment**	**Annual operational cost**
Vehicle equipment	387	-
Fixed road side installations	950	100
Mobile control units	80	160
Information and user service, service points and other staff	25	42
Control- and operations centre	300	15
Control operation	-	35
Total	**1742 MSEK**	**352 MSEK**

As can be seen, the fixed roadside installations alone corresponded to approximately 55% of the investment costs, and together with mobile control units to approximately 70% of the operational costs.

Part of system	**Initial investment**	**Annual operational cost**
Vehicle equipment	387	-
Fixed road side installations	150	30
Mobile control units	80	160
Information and user service, service points and other staff	25	30
Control- and operations centre	150	15
Control operation	-	35
Total	**792 MSEK**	**270 MSEK**

The new approach means a reduction of fixed installations with approximately 90%, and a reduced need for staff and systems dedicated to the management of control transactions. It

will also bring down the investment costs with at least 50%, and also bring a considerable reduction of the operational cost.

Taking into account an estimated annual depreciation during the first years, it is reasonable to estimate that the new approach will reduce the system cost to half during the initial years.

One must however understand that costs will increase in other sectors (e.g. the police carrying the responsibility for road side control), and that the level of fraud most likely will increase slightly which will bring down the revenue from the system.

Terms and Abbreviations

EFC	Electronic Fee Collection (generic term)
EETS	The European Electronic Toll Service
EETS Provider	An actor providing contract and equipment (EFC OBU) for EETS
HGV	Heavy Goods vehicle
OBU	On Board Unit – Vehicle equipment for EFC
RUC	Road User Charges
TC	Toll Charger
TSP	Toll Service Provider. A generic denomination of an actor providing contract and equipment for EFC. An EETS provider is always a TSP, while a TSP is not always an EETS provider...

References

[i] Sjöström, Ulrik Karlsson, Vägverkets FUD-projekt Kilometerskatt i Sverige, Rapport från etapp 1, Generisk arkitektur, Jonas Sundberg, Thomas

[ii] Directive 2004/52/EC of the European Parliament and of the Council of 29 April 2004, on the interoperability of electronic road toll systems in the Community (2004)

List of ARENA reports

ARENA REPORT 2008:1. “Road User Charging of Heavy Goods Vehicles in Sweden”. Final report ARENA 1., NetPort.Karlshamn

ARENA REPORT 2008:2. Sundberg, J., Janusson, U., and Sjöström., “A kilometre tax for heavy goods vehicles in Sweden – A conceptual systems design. Part 1: Requirements and preconditions”., SWECO VBB

ARENA REPORT 2008:3. Sundberg, J., Janusson, U., and Sjöström., “A kilometre tax for heavy goods vehicles in Sweden – A conceptual systems design. Part 2: Proposals for systems design”., SWECO VBB

ARENA REPORT 2008:4. Sundberg, J., “A New Approach to Control in the ARENA concept for HGV kilometre tax in Sweden”., SWECO VBB

ARENA REPORT 2008:5. Hamilton, C J. “A market based approach to achieve EFC interoperability in Europe”., Policy Technology

ARENA REPORT 2008:6. Eliasson, C and Fiedler, M., “Dimensioning study for road user charging”. Blekinge Institute of Technology.

ARENA REPORT 2008:7. Boldt, M and Carlsson, B,. “Hotanalys för positionsangivelsekedjan”. Blekinge Institute of Technology.

ARENA REPORT 2008:8. Davidsson, P and Persson, J., “A Criteria-Based Approach to Evaluating Road User Charging Systems”.,Blekinge Institute of Technology

ARENA REPORT 2008:9. Sundberg, J., “PM kring legala frågeställningar”., SWECO VBB

ARENA REPORT 2008:10. Janusson, U., Berg, P and Udin, C., “ARENA DEMO”., SWECO VBB

ARENA REPORT 2008:11. Sundberg, J., PM kring kostnadsberäkning”., SWECO VBB

ARENA REPORT 2008:12. Forss, M., Gustafsson, I., and Källström, L., “ARENA RUC Seminar 1 & 2 – Summary of the seminars”., NetPort.Karlshamn

ARENA REPORT 2008:13
Published papers produced within the project

ARENA
NetPort.Karlshamn
Biblioteksgatan 4 • 37435 Karlshamn • Sweden

Project partners:
Swedish Road Administration • SWECO • BMT Transport Solutions • Blekinge Institute of Technology • NetPort.Karlshamn

www.arena-ruc.se