



DIRECTIVE 2004/52/CE on the Interoperability of Electronic Fee Collection Systems in Europe

INTEGRATION OF ON-BOARD UNITS INTO VEHICLES

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Table of Contents

	Page
1. <u>Scope</u>	
1.1 Mandate and task of Expert Working Group 6	4
1.2 Scope of the task	4
2. <u>Background</u>	5
2.1 The Needs of Stakeholders	5
2.2 The situation today	6
2.3 The situation in the future	8
3. <u>Guiding Principles</u>	9
4. <u>Solutions for 2009 and 2011</u>	10
4.1 Physical incorporation	11
4.2 Integration with other existing functions	20
5. <u>Future Solutions</u>	
5.1 Integration of other devices in the future	21
6. <u>Recommendations</u>	21
7. <u>Annexes</u>	22
Glossary	23
Membership of Working Group 6	24
Users needs according to IRU	25

DRAFT REPORT

1. Scope

1.1 Mandate and task of Expert Working group 6

European Directive 2004/52/EC provides for the interoperability of toll collection systems within the European Union. The Directive sets a target date of July 2006 for an agreement on the definition of the European Electronic Toll Service (EETS). The EETS is expected to enter into service in 2009 for trucks and 2011 for other vehicles.

It is expected that on-board units (OBUs) will be provided to users requiring the service by authorised issuers for use with all eligible tolling schemes across Europe. These OBUs will need to be fitted to vehicles.

Working Group 6 on the Integration of OBUs in vehicles was established by the European Commission to provide recommendations on the way in which OBUs are fitted into vehicles. This report provides recommendations which will be presented at an EFC Expert Group meeting for discussion.

Working Group 6 is comprised of seven experts¹, selected by the European Commission.

1.2 Scope of the task

The group has sought to analyse the needs of stakeholders and the OBU integration situation both today and in the future within certain guiding principles. The work of the group is to make recommendations which deal with:

- the physical incorporation of the OBU into the vehicle;
- the integration of the OBU with other functionalities both existing and future;
- fitment-related OBU ownership issues including, configuration, maintenance and software updating and;
- other issues such as user constraints and human machine interface.

These recommendations need to be independent of the technology used in the OBUs and should comply with other relevant legislation.

By vehicles, the working group members have identified their scope as trucks², buses and coaches³, light commercial vehicles⁴ and passenger cars. Motorcycles have not been included within the scope of consideration for a number of reasons including: security of equipment, physical limitations on space available and power usage. While systems do exist in some countries for motorcycles, group members consider none of these fully acceptable. However, if a DSRC only interoperable system can be envisaged, then under certain circumstances like free flow, a portable motorcycle

¹ Details of the group are given in Annex 2

² Commercial vehicles over 3.5 tonnes

³ Passenger vehicles with more than 9 seats excluding the driver

⁴ Commercial vehicles less than 3.5 tonnes

EFC unit could be considered. If charging systems were to be extended to roads other than motorways then other vehicles could also be included like agricultural vehicles.

2. Background

At present, electronic fee collection relies mainly on the usage of domestic on-board units for local, regional or national charging schemes⁵. One of the tasks of working group 6 is to design a consistent solution for the fitment of OBUs instead of one for each country, region or locality. This means that the needs of a wider group of stakeholders have to be taken into account.

Imagine a household with two vehicles which move regularly between a number of European Union Member States where tolls are collected using different technologies. To be able to take advantage of electronic toll collection, equipment needs to be fitted to the cars. This involves cabling and the need to locate the equipment. Each vehicle would need workshop time for the necessary installation to fit the devices, even if the OBUs can be moved from car to car.

Imagine a haulage company with operations in a number of Member States running 180 vehicles of which 120 need to be equipped with OBUs. These may cost €200 to 300 each and take around half a day to fit. There is a risk that safety could be adversely affected when the OBU cannot be placed optimally. All of this poses a considerable cost to the company.

2.1 The Needs of Stakeholders

Operators

- Toll operators need an easy, cost effective and efficient system. This means minimising the costs of collecting the toll.
- They also need a system that encourages customers to use it by being convenient to use.
- Data needs to be secure, reliable, verifiable and possible personalisable, which requires a proper interface on the OBU.
- Instructions need to be of the utmost simplicity possibly through pictograms.
- Certified or approved procedures are needed for the secure fitment of OBUs to vehicles.
- Issuers can be different organisations from operators but may share some of the needs of operators including the need to know that the personalised data are, secure and not subject to fraud.

Users

Users need to maintain a good environment for the driver which means that the HMI

⁵ Although the Swiss on-board unit can be used in the Austrian tolling system

- principles are respected for new and retrofitted vehicles. Multiple equipment needs to be avoided and driver interaction minimised.
- Long term planning is necessary so that the correct equipment can be fitted to vehicles that does not have to be changed during the vehicle life which could be four to ten years, increasing costs.
 - EFC systems need to be stable and avoid frequent up-dating and consequent disruption.
 - Hauliers believe that if on-board equipment is fitted for the benefit of authorities rather than users then the authorities should be prepared to pay for it and take responsibility for HMI.
 - In the longer run, users want integral technical equipment fitted before the vehicle is brought into service.
 - Hauliers cannot accept that their vehicles are off the road frequently or for long periods for whatever reason eg updating or downloading.

Vehicle Manufacturers

- Vehicle manufacturers need a fitment system that is easy to factory fit or to prefit ready for fitment at the request of the vehicle purchaser.
- Equipment ownership issues need to be clarified so that vehicle purchasers can own OBUs.
- Equipment needs to be fitted in a way that is electromagnetically compatible, complies with all other safety requirements and within defined type approval procedures.
- To minimise cost vehicle manufacturers need an interface to access functionalities like localisation and communication, present in the EFC OBU that can be utilised for other purposes.

Equipment Suppliers

- Equipment suppliers need standardisation to achieve lowest cost;
- Specifications need to be stable;
- Test procedures need to be harmonised;
- Equipment volumes need to be high;
- There should be room for innovation;
- There should be clarity on personalisation and security application.

This report aims to reconcile these different needs from stakeholders

2.2The situation today

In general three different EFC-Systems using an On-Board-Unit exist in Europe.⁶

⁶ Video-based systems without using an On-Board-Unit are also in operation but are not in the scope of this report (cf. London Congestion Charging, Austrian toll stations with video tolls for season tickets and pre-booked single trips).

The three different types of systems are:

- GNSS/CN based systems

Such a system is in operation in Germany. This is a sophisticated On-Board-Unit, which has to be installed in the vehicle. The installation has to be done by an authorized workshop and needs some hours. . The system needs the fitting of a GNSS/CN-antenna. Due to the high installation effort, a second option for not equipped users (occasional users) is necessary, since this type of user cannot use the On-Board-Unit due to the high installation costs.

- Mileage counting based system

This type of system is in use in Switzerland. The whole distance driven in a designated area (e.g. within Switzerland) is counted by an On-Board-Unit which is mandatory for domestic vehicles covered by the scheme. This On-Board-Unit needs a connection to the tachograph to account for the mileage⁷. Therefore integration by an authorized workshop is also necessary. For this reason a system for occasional users is also necessary.

- DSRC based systems (Dedicated Short Range Communication)

The majority of European EFC-systems work on this basis. The DSRC technology uses microwave communication at 5.8 GHz. The DSRC technology performs a short-range communication between an antenna mounted above the road and a DSRC On-Board-Unit. The DSRC On-Board-Unit can be mounted on the windscreen by the driver without any assistance. The on board units are quite simple and cheap (compared to both types of on-board unit described above). Therefore it is possible to make the system mandatory, as in Austria or to use the On-Board-Unit voluntarily and offer manual toll lanes for occasional users.

Since DSRC technology is also used in tolling stations, it is possible to measure the category of the vehicle in the tolling lane and to calculate the tariffs by these measured categories. This makes the OBU even simpler, since (nearly) no user interface is necessary. By all the other systems, which are tolling in the free traffic flow, the category has to be declared by the driver.

At present most OBUs are utilised by single toll operators⁸. This means that the component supplier includes transaction/anti-fraud security during manufacture or during the personalisation process. In future, with multiple toll operators using a single OBU a suitable security application will still be needed but it may not be possible to include it during manufacture.

Recommendation 1. A transaction/anti-fraud security scheme needs to be introduced that does not hinder the efficient fitment of OBUs.

⁷ This may be a problem with the introduction of digital tachographs, as tachograph security should not allow direct access. Indirect access to data may be possible through a download interface.

⁸ However, this is not universally the case for example in Spain the “viaT” system a subset of the PISTA project, uses almost 400,000 interoperable OBUs (increasing at 7% per month since October 2004) which financial and non-financial companies issued like credit cards as a means of payment.

2.3 The situation in the future

A number of technologies are likely to change considerably in the time it takes for the European ETS system to become available to all vehicles.

- Mobile Communications Links

This market is likely to change in future as new possibilities for data communication come on stream. In particular additional security functions may open up the possibility for communication sharing for EEFC and other uses.

- New Mobile Phones

The trend to combine more and more functions into mobile phones to enable them to do much more than make phone calls. SMS, MMS, push-to-talk, e-mail, internet, calendar and wake up functions, play console, mobile banking and payment systems, navigation, digital camera and mobile television are all being incorporated into modern phones. This may convert the mobile phone amongst other things into being more like a “wallet”.

- Positioning systems

Before EEFC availability, extended positioning systems may come into existence. Galileo is planned to come into service around 2010. Upgraded GPS may also be available.

- New HMI possibilities may exist

Touch screens are more in use now than even two years ago. Speech control is also becoming a more realistic option. Single vehicle control panels, perhaps involving joysticks may also be introduced. Smartcards and micro SIM cards may also become even more widely used for identification and payment which would have implications for HMI.

- Existing installations

between now and 2010 a number of different installations in vehicles can be expected. More systems using positioning sensors and communications systems will exist and there would be no benefit to change systems that still function satisfactorily so less need for pre-installation may be necessary.

- New and more reliable “wireless” data communication in vehicles.

Current vehicles tend not to use wireless data communication because of the poor security and reliability. This could improve over the next 5 or 6 years opening up the possibility of more in-vehicle wireless data communication.

- Commercial vehicle manufacturers may make more use of metal laminated glass in trucks and buses to help reduce interior temperatures. This could impact on DSRC OBU module functionality.

- The expansion of fleet and freight managements systems and the deployment of terminals are expected to continue for commercial vehicles. These require location and

communications functionalities and therefore may reduce the need for stand alone tolling OBUs

These changes may open up possibilities which could be taken advantage of.

Although at the beginning of the deployment of the European Electronic Fee Collection system it will be necessary to retrofit the majority of the on-board units, in time it may be possible for the functionalities to be fully integrated into the vehicle. This facility may be available to those vehicle purchasers who require it and may be demanded especially by long distance truck users⁹. Many more vehicles may never require to use an interoperable toll collection system since the vehicle never or seldom leaves the country in which it is registered. In that case there will be no requirement for fully integrated interoperable toll collection functionality.

Recommendation 2. In time EETS OBU architecture should facilitate the full integration into vehicles

3. Guiding Principles

The Expert Working Group adopted the following guiding principles:

- all users of vehicles must be treated equally. This is an essential requirement of the European Treaty.
- the fitment and removal of OBUs should be done in a cost-effective way. Integration should minimise the time taken for fitment and also minimise the downtime of the vehicle and other costs so as not to contribute to any loss of competitiveness. The same principle should also apply to any configuration and calibration or up-dating and maintenance of the OBU.
- OBUs should be integrated in a safe and secure way and should comply with other legislation in these matters such as vehicle type approval and recycling.
- The integration of OBUs should also comply with the “Commission’s recommendation on safe and efficient in-vehicle information and communication systems: a European statement of principles on human machine interface” (2000/53/EC).
- The fitment of OBUs into vehicles should allow for future developments both of the OBUs themselves and other integration of functionalities that might take place, insofar as these are predictable and avoid disruption to users.
- Fitment of OBUs should allow for different solutions in different circumstances. Given the wide variety of vehicles for which the European electronic toll collection system is to be made available, it may be necessary to provide different solutions that take into account the size and functions of the OBUs.

⁹ Trucks used for long distance or international transportation are often replaced quite frequently which may speed up the possibilities for factory fitting and full integration into the vehicle systems.

Recommendation 3. Each step in the deployment and fitment of OBUs needs to fulfil an approval procedure, which should be proposed by the certification centres entitled to work on the EETS on-board units.

Recommendation 4. OBUs for the EETS should comply with a type approval system and recycling legislation.

4. Solutions for 2009 and 2011

In the context of interoperable EFC, and especially when including mandatory systems, the adoption of a reference architecture for on-board equipment is considered as an important success factor. The basic principle of interoperable fee-collection scheme is to integrate a single OBU per vehicle, attached to a single contract.

This is also an attempt to define a common platform, serving as a basis for EFC and also allowing future integration of services (such as hazardous goods monitoring, and also for building new applications). The aim is to reduce costs for manufacturing, deployment, maintenance, as well as additional costs for adjusting the system for each project, and therefore to lower the toll collection costs.

Since the full specification of any OBU is not yet fully defined, the working group is operating without a full picture, so the aim of this architecture is also to provide guidelines to all parties wishing to acquire or develop on-board systems as well as OEM components for interoperable EFC. To develop the relevant architecture, the starting point was the different technologies considered by the EFC Directive. It therefore implements the following technologies: satellite positioning, mobile communications using the GSM-GPRS standard and 5.8 GHz microwave technology.

Conforming to the mandate of Working Group 6, this architecture covers both OBU top-level design and physical integration issues.

Within the architecture, the exchange of data between the roadside entities and the vehicles are based upon satellite positioning, mobile communication using GSM-GPRS standard (reference GSM TS 03.60/23.060) and 5.8 GHz microwave technology, CEN and Telepass, according to UNI standards. In turn, it may provide some core services for general-purpose information exchange between the roadside and in-vehicle systems.

The architecture of the on-board unit is defined to have a minimum impact on already implemented applications on the ground.

Recommendation 5: The physical architecture of the OBU should allow the fitment or replacement of modules issued from several manufacturers, without changing the interfaces between the replaced entity or other in-car devices.

Recommendation 6: The architecture should be flexible and extendable in terms of data storage, to include additional EFC data elements or new software, without changing the hardware interfaces or the main processing unit.

Recommendation 7: The architecture should be open to include multiple service providers and operators, thus contributing to the development of inter-operable services.

Recommendation 8: The architecture should allow, as far as possible, the re-use of some existing interfaces (such as GSM/GPS antennas already installed in approximately half million heavy trucks at mid-2005).

4.1 Physical incorporation

The architecture proposes a modular approach, multi-functional, and implementing the generic technologies prescribed by the EFC Directive. It enables in-vehicle integration by different parties, such as vehicle makers and EFC operators.

The OBU physical architecture is designed with serviceability in mind through the use of several modules. The on-board system architecture is composed of two major elements:

- the OBU transmission elements and radio DIN slot rack, which can be pre-installed,
- the OBU central unit, which holds the processing unit, the operating and application software, as well as, in some cases, the human-machine interface.

The OBU physical architecture is illustrated by Figure 1 below.

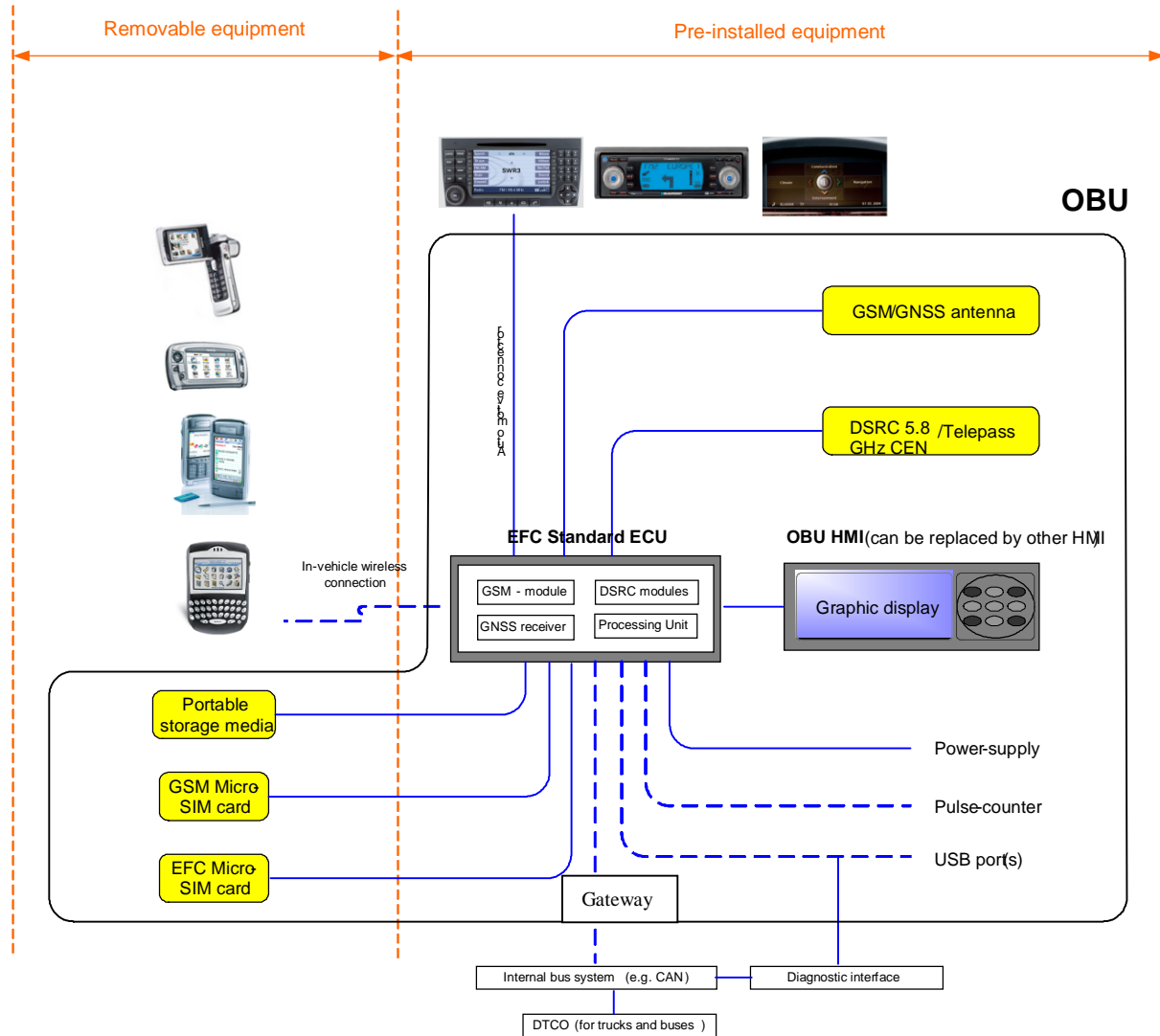


Figure 1: Contribution of the Architecture

- *dashboard:*

The OBU could fit in a DIN car radio slot, bearing in mind that this solution takes advantage of the vehicle dashboard design (as many commercial vehicles and cars have a radio-slot available) but many different dashboard types exist (passenger cars, light trucks, heavy trucks, buses and coaches)

The OBU front panel could be removable, in order to provide flexibility for deployment, maintenance, rebates, personalisation and software update. It could also be used for different applications since it is to some extent a “sensor platform” with communications applications. The OBUs can also be produced in different types for example as a retro-fit unit or as a factory-fitted unit.

During installation, it is necessary to obtain a tight connection of all cables and a strong bond between the connectors, wires, and mechanical elements. This part of the OBU requires an appropriate mechanical structure, and permanent assembly that shall not get weak over the lifetime of the unit.

Recommendation 9: *The OBU shall be automotive compatible regarding power supply, mechanical resistance, operating temperature range, and EMC.*

Recommendation 10: *The European Commission should request the European Standards Organisation to develop physical and electrical standards (including standby) for OBU layout and connection. These standards should also take into account requirements for fast and easy installation of equipment. European projects related to Directive 2004/52/CE should make proposals for these standards.*

This would lead to lower costs and ease of fitment.

- Type of fitment

Different OBU systems require different treatment. Simple stand-alone tags require little or not installation. More sophisticated tags may have to be retro-fitted. Their requirements could be pre-installed or full installation could be possible in the factory, especially if the functionalities are integrated into the vehicle electronics.

It has been assumed that all EEFC OBUs should have all functionalities within them and so be able to work within either DSRC systems or with GNSS/GPRS systems. It seems that it might also be possible to have a parallel DSRC only interoperable service. This gives rise to the following matrix of potential fitment arrangements.

Figure 2: OBU functionality and installation requirements

	DSRC and GNSS/GPRS	DSRC and GNSS/GPRS	DSCR only	DSRC only
	Passenger Cars	Trucks and Buses	Passenger Cars	Trucks and Buses
No Installation	Not possible	Not possible	Possible	Not likely
Retro-fit	Possible	Possible	Possible	Not likely
Pre-installation	Possible	Possible	Possible	Not likely
Full Installation	Possible	Possible	Possible	Not likely

The cells in red do not appear possible, or likely, combinations. All combined DSRC and GNSS/GPRS systems will require some kind of installation¹⁰. Similarly a DSRC only system might be less attractive to commercial vehicle operators since GNSS/GPRS systems are already in operation for trucks and buses in some countries.

The green cells are possible and appear to require little unfamiliar treatment. Trucks are already retro-fitted with DSRC /GNSS/GPRS systems and pre-installation is following. Full installation of systems would become the responsibility of vehicle manufacturers, at the request of customers, if this were to become reality. DSRC only OBUs are already widely fitted to passenger cars in many EU Member States.

Fitment may be somewhat more complex for retro-fitting or pre-installation for passenger cars (marked in orange) since in addition to power connection, GNSS/GPS antenna and DSRC antenna/module connection would be needed.

- *(pre) installation requirements*

On-board units will need to be type approved for installation and they will need to fulfil the requirements for ECUs (electronic control units) in vehicles which are quite similar in trucks, buses, coaches and passenger cars. Such requirements deal for example with:

- Power
- Temperature
- Electromagnetic Compatibility
- Mechanical resistance

For example some truck manufacturers specify:

- § operating voltage: 16V – 32 V
- § nominal voltage: 24 V DC
- § test voltage : 27,6 V (+- 0,4)
- § overvoltage : 36V (40°C) 1 hour
- § operating temperature : -40°C - +80°C
- § storage temperature : -40°C - +90°C
- § EOL programming (e.g. switchable resistors)
- § ASAM support
- § Diagnostic interface

For a fleet of several million units, installation and cabling can be a very long process. Where possible, existing installations (antennae, cables, etc.) should be used. The proposed architecture allows cabling works and final installation of active equipment to be performed independently.

For retro-fit units such requirements will also be needed and guidelines should be developed for the performance of these units.

¹⁰ Even self installation of such systems has not proved possible so far

- **Windscreens**

It has become increasingly widespread for passenger cars to have a windscreen laminated with a metal layer. These have the advantage of reducing radiation into the vehicle thus lowering the inside temperature. Problems arose on the introduction of DSRC toll collection systems because the metal layer interfered with the communication between the OBU inside the windscreen and the roadside equipment. A specification for a non-metal section to be included when the windscreen is manufactured to allow the DSRC to work has been developed. This has become a de facto standard although it has so far not been adopted by any of the standardisation bodies.

Though they are not in use at present, in future, the use of metalised windscreens is likely to spread to trucks and buses¹¹. If this is the case then it will be necessary to specify a similar arrangement for truck and bus windscreens to allow a DSRC module to operate effectively from within the truck or bus. This will need to be at a height that allows communication with roadside equipment but does not interfere with the forward vision of the driver.

- **Standby**

Existing multi-functional OBUs have a standby facility which has a power requirement of between 1 and 4 mA. The upper end of this range appears quite high even for trucks. There may be good safety reasons why the OBU should be switched off when the vehicle is not operating. This is already a requirement for vehicles carrying dangerous goods. At the very least any standby facility must not require a current that will adversely affect the vehicle battery and thus interfere with the starting and running of the vehicle.

- **Antennae**

Most of the elements need be installed in the driving cab, except the GPS/GSM dual antenna, which must be fixed on the roof of the vehicle in a weatherproof enclosure. To minimise disruption, combined antenna should be used for location and communication for example. This could be done in a number of ways as illustrated in figure 3.

¹¹ Some manufacturers are investigating the but it is not possible to say at this stage what proportion of new commercial vehicle will have metalised windscreens by 2010.


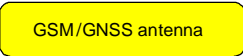
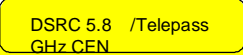
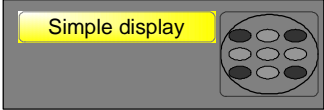

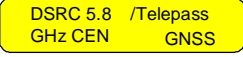

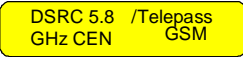

Possible variants for OBU HMI	Possible variants for TRANSMISSION EQUIPMENT
 <p data-bbox="597 302 732 369">Graphic display Function keys Buzzer</p>	 
 <p data-bbox="597 567 724 634">Simple display Function keys Buzzer</p>	 
 <p data-bbox="597 827 816 894">LED(s) Buzzer Trailer declaration switch</p>	 

Figure 3: Possible variants for transmission Equipment and HMI

The DSRC unit could be either an antenna or, given their current small size, a complete transmission and processing unit which is installed in the driving cab of the vehicle, in a central position behind the windshield but without compromising forward vision¹². It may be wired or combined with an in-vehicle wireless connection device such as Blue Tooth which would enable integration of future on-board devices (such as audio announcement, satellite command, body computer of the vehicle, navigation system and so on). The DSRC unit could also be combined with either the GSM/GPRS antenna or with the GNSS antenna.

The general scheme of the device can be given as an example on the following figure 4.

¹² Other positioning solutions may be possible in the longer term or with full integration with vehicle systems.

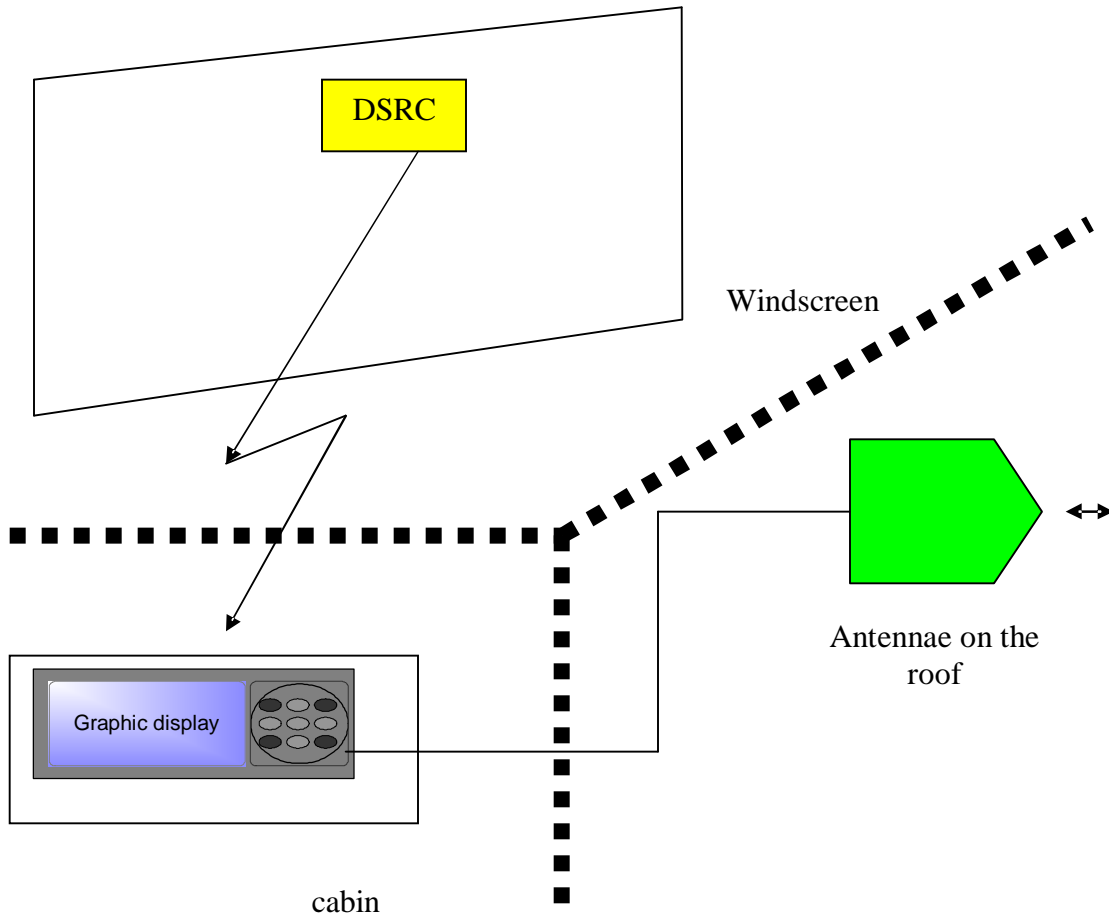


Figure 4 : general overview of the EETS onboard device

- ***External interfaces***

The external interface shall provide, as a minimum, the following connections:

- power supply, including ignition sense,
- CAN-bus,
- one portable storage media such as USB or flash card,
- pulse counter.

Such external interfaces may be used to capture the status of the various vehicle parameters including odometer and other devices which will indicate the conditions the vehicle is experiencing.

Tachograph CAN connection only applies to trucks and buses but may use existing CAN messages from DTCO on the internal bus (acc ISO 16844) by which distance travelled information is available for factory fitted solutions or through a manufacturer provided gateway.

A portable storage media interface, would allow future extension, and the possibility for offloading data, as well as in-vehicle detailed examination using test equipment.

- **HMI**

A large number of HMI possibilities exist as illustrated in Figure 3.

a) For retro-fitted systems the HMI could be connected with the OBU and could be:

- a simple LED, trailer declaration switch and buzzer
- a simple display, function keys and buzzer
- a graphic display, function keys and buzzer

b) In addition wireless connection could link to portable HMI as illustrated in Figure 1

c) Integrated systems could be connected to existing vehicle HMI, again illustrated in Figure 1.

The keyboard/display can be used for different purposes:

- It could display messages, pictograms, currency units, and menus.
- As different languages are required for pan-European use, the keyboard/display will allow the selection of alternative available languages.
- Enabling display of financial figures and transaction related data such as name of EFC transport service provider, time and place of transaction.
- Some EFC context requires selection of vehicle class according to number of axles and trailer presence. This may vary from 2 to up to 8 axles, and therefore requires an appropriate menu.
- Some EFC context may require calibration of parameters, depending on the vehicle characteristics.
- Existing HMI in dashboards should be used where available though the responsibilities and modalities will need to be defined.

Whatever HMI solution is utilised, it must conform to the Commission recommendations on HMI (2000/53/EC) or its successor documents.

- **Ownership**

At present in many cases the ownership of the OBU remains with the toll operator or OBU issuer. With a multi-functional OBU such an arrangement can, and has, lead to significant difficulties for fitment and removal. In future the ownership of this module may remain with the vehicle owner or EFC subscriber. This does not necessarily mean that the full cost of the unit,

installation and vehicle downtime would be the responsibility of the vehicle user. Fitment and removal of antennae and cabling for example must be within the control of the vehicle owner and thereby, the transmission part fixed to the vehicle is the responsibility of the vehicle owner¹³. In the near future, some of the transmission elements may be directly installed by the vehicle manufacturers and if the OBU is not the property of the truck owner problems will emerge when the vehicle is sold. In addition ownership of the SIM cards may also need clarification. These ownership issues need to be resolved and this could perhaps be done within the CESARE III project.

- *Up-dating*

Up-dating of hardware and software, though necessary, is disruptive, time consuming and expensive. It may be necessary when, for example, new countries join the EEFC tolling system during the lifetime of a vehicle but should be done as infrequently as possible to avoid vehicle downtime and loss of revenue. When it is essential cheap, secure downloadable software should be available. Hardware changes should be avoided within the lifetime of a vehicle wherever possible.

- *Legal requirements*

OBUs and their fitment will need to comply with a number of legal requirements including:

- Electromagnetic Compatibility - 95/54/EC
- Forward vision - 90/649/EC
- Interior Fitment - 94/60/EC

Recommendation 11: To simplify fitment, ownership of the OBU (but not necessarily the full cost) should rest with the vehicle owner.

Recommendation 12: To minimise the number of transmission modules, antennae and related electronics should be combined as much as possible between different onboard applications, as illustrated in Figures 1 and 3.

Recommendation 13. OBUs must comply with vehicle manufacturer requirements for example those listed page 14 in the section of this report dealing with (pre) installation requirements.

Recommendation 14. Existing HMI should be used for OBUs that are integrated versions fitted when the vehicle is built.

Recommendation 15. For retro-fit OBUs, European requirements suitable for vehicle use need to be defined by an appropriate mechanism. The project RCI should provide inputs for this definition.

Recommendation 16. Design, fitment and interfaces need to comply with EU legislation and HMI recommendations.

¹³ Although adequate anti-fraud security must be provided.

Recommendation 17. An informal standard for metalised windows exists for passenger cars, a similar arrangement for other vehicles should be developed by an appropriate mechanism.

This appropriate mechanism should be defined between the toll operators, the truck manufacturers and the glass manufacturers, with the help of the electronic suppliers. The location of the onboard unit on the windscreen and of the corresponding non-metal section will have to be defined in accordance with the transmission zone of the roadside antenna. Due to the difference in height between cars and trucks, this location might be slightly different.

Recommendation 18. The preferred fitment area should be a DIN radio slot.

Recommendation 19. To avoid the need for re-fitment and the concomitant disruption, the EETS and its OBUs should be as stable as possible over time.

Recommendation 20. To promote flexibility and ease of fitment, a modular approach should be adopted.

Recommendation 21. Software and definition file downloading needs to be made in a cost effective way including through portable storage media, a USB port or the GPRS link.

4.2 Integration with other existing functions

A suitable interface¹⁴ should be provided to access functionalities in the OBU which could be used for other solutions, for example navigation.

A Micro SIM card module provides authentication services for data transmission based upon GSM. The Micro SIM card is the Subscriber Identification Module used in all GSM mobile phones. The Micro SIM main purpose is to provide a security domain to the GSM operator, in particular to maintain the code which encrypts and decrypts the GSM/GPRS digital signals.

The EEFC OBU will need two micro SIM cards. One will be issued by the mobile communications provider and enable the GSM communications necessary. The second will be issued by the toll contract issuer and will provide authentication for the toll collection.

Exclusion zones are being insisted upon for some existing devices fitted on vehicles whereby no other device should be fitted within a given distance. Such exclusion zones make installation of EFC OBUs problematic. Exclusion zones should not be necessary if EMC requirements are fully met. The fitment of OBUs will require that some procedure is adopted to avoid or reconcile demands for exclusion zones.

Recommendation 22. To facilitate fitment of OBUs, “exclusion zones” should be avoided between electronic equipment fitted in the same vehicle.

¹⁴ Read-only may be suitable for some functionalities but bidirectionality may be necessary for example for mobile communications.

5. Future Solutions

5.1 Integration of other devices in the future

In the initial phase of the introduction of a European electronic toll collection system, many OBUs will need to be fitted to existing vehicles. In future, standardised OBU equipment could be fitted at the factory in new vehicles intended for use on roads covered by the toll system, at the request of the owner and prior to being put into service by motorists and transport companies. The more widespread application of freight and fleet management systems might facilitate this and could avoid incomplete technical solutions but this is not easy and many issues are believed to still need resolution. Such integrated devices could be standard and thoroughly tested, provided the related authorities or transport purchasers planned properly so that vehicle manufacturers could deliver a greater number of complete or prepared vehicles directly from the factory.

Since the modular OBU proposed can act as a “sensor platform” other devices can be connected via the defined interfaces. For example navigation systems or emergency call systems, freight and fleet management systems, telephones, security alarms and tracking systems could be provided via this route.

6. Recommendations

- 1) A transaction/anti-fraud security scheme needs to be introduced that does not hinder the efficient fitment of OBUs.
- 2) In time EETS OBU architecture should facilitate the full integration into vehicles.
- 3) Each step in the deployment and fitment of OBUs needs to fulfil an approval procedure, which should be proposed by the certification centres entitled to work on the EETS on-board units.
- 4) OBUs for the EETS should comply with a type approval system.
- 5) The physical architecture of the OBU should allow the integration or replacement of modules issued from several manufacturers, without changing the interfaces between the replaced entity or other in-car devices.
- 6) The architecture should be flexible and extendable in terms of data storage, to include additional EFC data elements or new software, without changing the hardware interfaces or the main processing unit.
- 7) The architecture should be open to include multiple service providers and operators, thus contributing to the development of inter-operable services.
- 8) The architecture should allow, as far as possible, the re-use of some existing interfaces (such as GSM/GPS antennas already installed in approximately half million heavy

trucks at mid-2005).

- 9) The OBU shall be automotive compatible regarding power supply, mechanical resistance, operating temperature range, and EMC.
- 10) The European Commission should request the European Standards Organisation to develop physical and electrical standards (including standby) for OBU layout and connection. These standards should also take into account requirements for fast and easy installation of equipment. European projects related to Directive 2004/52/CE should make proposals for these standards.
- 11) To simplify fitment, ownership of the OBU (but not necessarily the full cost) should rest with the vehicle owner.
- 12) To minimise the number of transmission modules, antennae and related electronics should be combined as much as possible between different onboard applications, as illustrated in Figures 1 and 3.
- 13) OBUs must comply with vehicle manufacturer requirements for example those listed page 14 in the section of this report dealing with (pre) installation requirements.
- 14) Existing HMI should be used for OBUs that are integrated versions fitted when the vehicle is built.
- 15) For retro-fit OBUs, European requirements suitable for vehicle use need to be defined by an appropriate mechanism. The project RCI should provide inputs for this definition.
- 16) Design, fitment and interfaces need to comply with EU legislation and HMI recommendations.
- 17) An informal standard for metalised windows exists for passenger cars; a similar arrangement for other vehicles should be developed by an appropriate mechanism.
- 18) The preferred fitment area should be a DIN radio slot.
- 19) To avoid the need for re-fitment and the concomitant disruption, the EETS and its OBUs should be as stable as possible over time.
- 20) To promote flexibility and ease of fitment, a modular approach should be adopted.
- 21) Software and definition file downloading needs to be made in a cost effective way including through portable storage media, a USB port or the GPRS link.
- 22) To facilitate fitment of OBUs, “exclusion zones” should be avoided between electronic equipment fitted in the same vehicle.

7. Annexes

Annex 1

Glossary

CAN BUS	Controller Area Network
CEN	European Committee for Standardisation
DIN	Deutsches Institut für Normung
DSRC	Dedicated Short Range Communication
DTCO	Digital tachograph
ECU	Electronic Control Unit
EEFC	European Electronic Fee Collection service
EFC	Electronic Fee Collection
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute
GNSS	Any global satellite positioning system
GPRS	Global Packet Radio Services
GPS	Global Positioning System (US)
GSM	Global System for Mobile Communications
HMI	Human Machine Interface
ISO	International Standards Organisation
MMS	Multimedia Message Service
OBU	On-board Unit
SIM	Subscriber Identity Module
SMS	Short Message Service
Tachograph	ECU recording vehicle speed, distance, usage time, driver details etc

Annex 2**Composition of Working Group 6**

Name	Position	Organisation	Sector	Country
Jean-Marc Gautier	Domain Expert in Electronics	ISIS	Equipment Supply	France
Mike Hollingsworth (Chairman)	Director	ACEA	Vehicle Manufacture	UK
Marten Johansson	Head of Technical Affairs	Sveriges Akeriforetag	Haulage	Sweden
Armin Keller	Director	Logicom	Vehicle Manufacture	Germany
Lars Olsson	Director – Business Development	Kapsch	Equipment Supply	Sweden
Mario Rueda	Head of IT	Iberpistas	Motorway Operation	Spain
Anton Sieber	Head of Group Strategy	Asfinag	Motorway Operation	Austria

User Needs according to IRU

NOTE : The following annex is an input from the representative of the haulage association to the Expert Group 6.

Users are a key constituent for the success of the EETS. Road hauliers in particular now have extensive experience of using EFC systems. Their needs are summarised in section 2 but more explanation is given below.

Working environment -HMI (2000/53/EC).

The vehicle owners want to maintain a good working environment in the driver's cab. This means that the principles of the HMI recommendation must apply to all new vehicles, as well as to any retro-fitted technical equipment necessary for the vehicle to be used. In the view of hauliers the cost of HMI adaptation should be payable by those demanding the equipment to be fitted. Nowadays, the fact that different countries and different towns/ cities choose different technical equipment solutions for road tolls causes spatial problems in the driver's cab and additional costs, and has a negative effect on the working environment while the principles of the HMI recommendation are ignored.

Improved long-term planning

The economic life of vehicles used for the commercial transport of goods varies from 4 years to around 10 years, depending on the type of goods and the type of vehicle involved. Freight costs are affected by the vehicles' economic life -a shorter life increases freight charges, with a consequent rise in the price of goods in the shops. If the prerequisites for being allowed to use the vehicles change retrospectively, with requirements for new technical solutions, the cost of freight increases and goods become more expensive. The consumer has to foot the bill. If rules are adopted for a longer period of time, e.g. 10 years without retrospective changes, this particular reason for an increase in prices is removed. But even so, the cost of freight will increase as a result of wage demands, increased energy costs, rising road tolls etc. Retrospective requirements for technical equipment without which vehicles may not be used involve unnecessary costs which could have been minimised with better long-term planning which would have ensured that the vehicles had been fitted with the right equipment before they were taken into service,

Retrospective problems

The vehicle owners want to minimise the rules which retrospectively prevent the use of vehicles which have already been brought into service in goods transport operations, In the view of hauliers this would be partly achieved by the liability for payment resting with the authorities who require the new equipment to be fitted.

Integrated technical solutions

The vehicle owners want future vehicles to have integrated technical solutions which minimise downtime and the cost of fitting, maintaining, operating and dismantling equipment for road tolls, as well as optimum integration with other technical

28 July 2005

equipment such as GPS, navigation systems etc. aimed at ensuring a high level of compliance with HMI and minimising costs. A single OBU should be able to cope with all types of road toll systems.

Liability for payment

The vehicle owners want the authorities who require the retro-fitting of equipment in vehicles, both hardware and software, also to be responsible for paying for the installation, operation, maintenance, repair, dismantling and replacement of such equipment, as well as for the cost of vehicle downtime resulting from such requirements for equipment.