Recommendations on parameters to be stored in on-board equipment designed for use with the European Electronic Toll Service

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Expert Group 2: Vehicle Classification

working to support the European Commission DG TREN

on the work on Directive 2004/52/EC

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1. SCOPE

1.1 THE TASK OF EXPERT GROUP 2

European Directive 2004/52/EC deals with the interoperability of electronic road toll systems in the Community. The Directive sets a target date of July 2006 for international agreement on the definition of the European Electronic Toll Service (EETS).

It is expected that OBUs will be provided to users requiring the EETS service by any authorised Issuer for use with all eligible charging schemes across Europe. Each Issuer of OBUs intended for use with the EETS (which we refer to as EOBUs) will be expected to enter the required vehicle parameters for use with any scheme which needs them.

Expert Group 2 on Vehicle Classification was established by the European Commission to provide recommendations on the vehicle parameters to be stored in EOBUs. This paper provides the recommendations which will be presented and discussed at the EFC Expert Group to be held in January 2005.

Expert Group 2 comprises seven experts[1], selected by the European Commission on the basis of their experience and on the basis of comments provided by members of the EFC Expert Group early in 2004.

The report of Expert Group 2 was presented to a meeting of the full Expert Group on 27th January 2005. Comments received at that meeting and subsequently in writing have been incorporated. A record of the comments received and response is available separately.

1.2 SCOPE OF THE TASK

The Group has sought to define the **minimum set of vehicle characteristics which are required to be stored in the EOBUs**, for use with those charging schemes which need them.

The work of the Group:-

- Has no impact on the choice of tarification schemes by operators and Member States
- Is independent of the technology used for the EOBU
- Is restricted to vehicle characteristics. The work does not cover any parameters required for variations in tariff which are not related to the vehicle, such as:-
  - The use being made of the vehicle (e.g. emergency vehicles)
  - The load carried by the vehicle (e.g. local industry)
  - Characteristics of the driver (e.g. disabled person)
  - Characteristics of the journey (e.g. origin/destination)
- Recognises the right of each operator to verify the accuracy or feasibility of declared parameters by an appropriate method.

The Group has been very conscious that most schemes currently use measured characteristics and that a cost-effective solution must be found which is acceptable to all operators.

[1] Details of the group are given in Annex A.

2. BACKGROUND

2.1 THE SITUATION TODAY

By the principle of subsidiarity, countries and operators are responsible for the definition of appropriate tariffs for tolling. Local classification systems show a wide variation, reflecting the local charging policies and systems.

There are two main methods that may be used to derive the vehicle tariff class in EFC systems - by measurement and by declaration.

Measurement can be by observation or done automatically. Staff situated at the toll station may observe the vehicle and allocate it to one of the tariff classes. Alternatively, roadside equipment (RSE) may measure certain vehicle physical characteristics, such as the number of axles.

Declaration involves the OBU in communicating certain parameters relating to the required vehicle characteristics, or the preassigned tariff class. In some cases, the OBU provides a unique identification which is used to access tariff information in a database, either stored in the Roadside Equipment at the charging point, e.g. a toll station, or in the central system.

Most current toll systems in operation across Europe involve the direct measurement of vehicle characteristics.

Whatever the method, there is a two step process involved in vehicle classification. The first step is to derive the vehicle characteristics. The second step is to assign the vehicle to a tariff class.

2.2 THE SITUATION IN THE FUTURE

Existing classification systems are not static, but are evolving. There are many factors which may lead existing operators to change their tariff scheme. For example, changes in vehicle design have made the widely used characteristic of "height above first axle" to be less reliable in identifying a passenger car. There has been a tendency to replace this characteristic with one based on vehicle height.

Operators may wish to "automate" systems based on classification by observation, perhaps to provide a free-flow[2] payment service. The tariff classes defined for application by observation may not be readily automated. For example, a tariff class might be a small bus. This is difficult to determine by measurement. Operators may issue users with a pre-configured OBU which contains the relevant vehicle class.

Some operators with toll plazas are considering the provision of some multi-lane charging points, and some of the vehicle characteristics being measured in a mono-lane environment may not be feasible to measure in multi-lane operation.

Interest in national interoperability may result in some harmonisation between local tariff schemes within a country.

New national charging systems are being proposed. The national charging scheme introduced in Switzerland and that soon to begin operation in Germany are based on new charging concepts. The tariffs are based on vehicle characteristics such as maximum permissible gross laden weight, which are legal limits and not physical characteristics amenable to measurement.

[2] In this paper, free-flow refers to both mono-lane and multi-lane operation.

New charging policies are being encouraged by the European Commission which are based on environmental parameters. The draft Eurovignette directive refers to vehicles with "Road Friendly Suspension[3]" and proposes different tariffs for such vehicles. There is no currently satisfactory method of measuring such vehicle characteristics.

In many toll schemes, the OBU is used primarily as a payment means, the classification and assignment of the vehicle to a tariff class is done through measurement. In future, the vehicle classification parameters may be included in the OBU, thus avoiding the need for the measurement equipment. However, the need to enter information on the characteristics of the vehicle creates problems for some countries where the OBU is considered purely as a payment means and is therefore issued by financial institutions. They would prefer to leave the calculation of the tariff to the toll operator and do not wish to accept the responsibility for data entry, integrity and maintenance.

All of these issues are national issues. Further problems are introduced if OBU is intended to be used in other countries

2.3 THE WAY FORWARD

It is widely accepted that it is not politically feasible to attempt to harmonise the tariff classes used across Europe, particularly within the timescale set by the Directive.

However, it does appear feasible to agree on a common set of vehicle characteristics which all operators can use to define their own tariff classes. ISO/EN 14906 provides a comprehensive set of vehicle characteristics which might be used. The Expert Group has taken this as the starting point.

The aim of Expert Group 2 is to recommend a minimum set of vehicle classification parameters which would provide European Interoperability and to propose a cost effective way to implement the solution.

Vehicle characteristics may be derived by any of the methods previously described. The methods may also be mixed, with some being measured and others being declared. The operator uses the values of the characteristics to assign the vehicle to an appropriate tariff class.

A given vehicle may be assigned to a different tariff class in each charging scheme.

However, for any given scheme, it is a requirement of European law that the same vehicle, whatever its country of origin, must always be classified as the same tariff class - there must be no discrimination between users on the basis of nationality.

[3] More precisely, the directive refers to "air suspension or recognised equivalent"

3. GUIDING PRINCIPLES

The Expert Group adopted the following guiding principles:-

(a) Each Member State and/or operator remains free to define tariff and vehicle classes. This is the principle of subsidiarity.

(b) The European Electronic Toll Service (EETS) will be an additional service to those offered locally.

Local and national charging schemes are permitted to continue alongside the EETS. We appreciate that some countries may wish to adopt a single solution which will provide interoperability at both the national and international level. This is not assumed to be the case in all countries.

(c) All users must be treated equally within a Member State. This is an essential requirement contained in the European Treaty.

(d) Users are free to take advantage of the local and/or European service.

(e) The vehicle characteristics need to be stable. The characteristics will be stored in the EOBU and declared to charging schemes when requested. It is a relatively expensive process to collect, maintain and verify these data. Toll operators need to have confidence in the stored data. It is not considered feasible to include characteristics which may vary over the life of the EOBU.

(f) The vehicle characteristics must be cost-effective to collect, maintain and certify. The parameters describing the relevant vehicle characteristics will need to be entered into the EOBU **by all the issuers** of the EOBUs. Most current issuers of OBUs support systems which are based on measured characteristics and therefore do not require the parameters. They will be asked to undertake this task on behalf of operators of schemes which need the parameters. It is therefore vital that the solution must be cost-effective to all those involved.

4. A COST EFFECTIVE SOLUTION FOR OPERATORS AND USERS

4.1 DIFFERENT MARKET SEGMENTS

Figure 2 shows the total numbers of vehicles registered in the fifteen European Member States in 2001 by vehicle type. Given that 97.5% of all vehicles are small passenger cars or light goods vehicles, we have searched for a low-cost solution for these vehicles.

Vehicle type		
Cars	184 million	87.5%
Commercial Vehicles ≤ 3.5 tonnes	21 million	10.0%
Commercial Vehicles >3.5 tonnes	4.8 million	2.3%
Buses	0.5 million	0.2%
Total	210 million	100%

Figure 1: Total registered vehicles in the 15 European Member States in 2001

4.1.1 Charging of light vehicles

OBUs issued for light vehicles are mainly used as an easier and possibly faster means of payment of tolls for frequent users. Most tariffs for light vehicles are based on physical characteristics of the vehicle, which means that, in systems which are based on measured characteristics, users could be allowed to move the OBU between vehicles.

These OBUs are issued in large numbers and therefore issuers of the OBU seek to minimise the cost of the OBU and associated administrative costs, thereby by avoiding or minimising the need for personalisation.

Most current OBUs contain little information other than is necessary to achieve the payment. This means that pre-configured OBUs are readily available to users at points of sale.

4.1.2 Charging of heavy vehicles

OBUs for charging heavy vehicles are mainly designed to collect correct charge data, rather than for payment. Payment of charges is not the responsibility of the HGV driver, but rather of the company.

Vehicle classification is vitally important as heavy vehicles pay higher charges and at many different rates according to vehicle configuration (e.g. towing trailers). The distances travelled are much greater than for light vehicles and the opportunity for organised fraud are significant.

The charging schemes for HGVs which are being implemented use vehicle characteristics which cannot easily be verified by operators without stopping the vehicle. Issuers will need to assure operators that any classification data declared by the vehicle is correct.

These requirements all tend to lead to a more complex OBU, with built-in compliance features, a man-machine interface, additional data and a requirement to fix the OBU securely in the vehicle. This solution leads to greater costs for the OBU, more elaborate installation costs and lost production time for the vehicle owner.

Expert Group 2 Recommendation(s):

Recommendations from Expert Group 2 are shown in blue type and numbered sequentially throughout the report.

[R 1] There might be two different sets of requirements for classification parameters, one for "light" vehicles and one for "heavy" vehicles. The first aim of the Directive being to introduce a system designed for heavy goods vehicles and long distance coaches, the present document will focus essentially on this type of vehicles.

The EOBU will use multiple technologies to achieve interoperability with all eligible toll schemes across Europe. It is expected that progress with interoperability between existing schemes will continue to be made in advance of the full EOBU solution. The achievement of interoperability will be made easier if the existing systems adopt the same approach to classification during the migration process.

[R 2] Any strategies which are proposed to migrate current EFC systems towards the EETS should adopt the approach to classification proposed in this report.

4.2 SELECTION OF PARAMETERS

The starting point for the list of parameters to be stored in the EOBUs was that given in ISO 14906. We had also received comments from seven Member States and have taken these into account (See Annex C). The group defined the following criteria as the basis for inclusion in the list:-

- The parameters need to be already in use (as declared parameters) by some operators
- Stability - in terms of the value of the parameter during the operation of the vehicle
- Feasible to collect and verify the parameter in a cost-effective way

We then went through all the ISO 14906 parameters and applied the criteria. We came to a provisional conclusion on each parameter. In some cases there were reservations from some members of the group about the decision on the inclusion or exclusion of a particular parameter. We allowed those members with reservations to undertake some investigation and analysis of the issue and to report back to the group which then made a final decision. The list of ISO 14906 parameters and reasoning for the non-inclusion of parameters are given in Annex B.

The next step was to apply the parameters to the appropriate vehicles, i.e. the vehicles defined as "light" and "heavy".

5. APPLYING THE PARAMETERS TO APPROPRIATE VEHICLES

5.1 DEFINING LIGHT AND HEAVY VEHICLES

Having considered each of the parameters and decided which should be recommended for inclusion in the EOBUs, we turned to the question of applying the parameters to appropriate vehicles.

The group made an analysis of different types of vehicles, bearing in mind the number of each type and the way in which these are generally classified for toll schemes across Europe.

We looked for a way to define "light" and "heavy" vehicles. The reasoning was that, if we could define the concept of light vehicles which could be accepted by all operators as chargeable without the need for a set of personalised vehicle parameters, then these vehicles could be issued with one of a small set of "standard" pre-configured EOBUs which could potentially be moved between vehicles and could be used as a payment means.

Having dealt with the majority of vehicles, the remaining vehicles are defined as "heavy". These would contain the full set of recommended parameters. The parameters would be unique to the vehicle and thus require that the EOBU would be securely attached to the vehicle. The parameters would need to be certified to assure all operators that they are correct.

We found that the distinction between passenger and goods vehicles is quite important to a number of schemes. We also observed that vehicle weight is significant, particularly for goods vehicles.

So, we looked for a consistent way to define the various groups in such a way that we provide operators with an efficient method to determine whether the EOBU contains stored vehicle classification parameters.

We found that the international UNECE resolution[4] regarding vehicle categories provides a very useful set of definitions of vehicle groups. The vehicle category is contained in many European vehicle Registration Documents. It is defined as an (optional) parameter (j) in Directive 2003/127/EC on electronic vehicle registration documents.

We therefore used this as a basis for defining six groups of vehicles. The proposed grouping is shown in Figure 2.

There are six proposed groups. These are as follows:-

Group 0 Motorcycles

This group is UNECE vehicle category L. Toll schemes treat motorcycles in different ways (including no charge).

[4] ECONOMIC COMMISSION FOR EUROPE, INLAND TRANSPORT COMMITTEE, Working Party on the Construction of Vehicles, CONSOLIDATED RESOLUTION ON THE CONSTRUCTION OF VEHICLES (R.E.3), Revision 1 - Amendment 2 - April 1999

Group 1 Small Passenger Vehicles

This group is UNECE vehicle category M_1. It is defined as a passenger vehicle with not more than 8 passenger seats, plus the driver. It covers all passenger cars. Although the definition of M_1 does not mention weight, these vehicles are in practice all less than 3.5 tonnes[5].

Group	Description	Characteristics	UNECE class
0	Motorcycles	2 or 3 wheels	L
1	Small passenger vehicles	Seats ≤ 8 + driver	M_1 (See note 1)
2	Light goods vehicles	Weight ≤ 3.5 t	N_1 (See note 2)
3	Large passenger vehicles	Seats > 8 + driver	M_2, M_3 (See note 3)
4	Heavy goods vehicles (up to 12 t)	Weight > 3.5 t and ≤12 t	N_2
5	Heavy goods vehicles (over 12 t)	Weight > 12 t	N_3
6	Not used		
7	Other vehicles		

Figure 2: Proposed vehicle groups

Group 2 Light Goods Vehicles

This group is UNECE vehicle category N_1. These are goods vehicles less than 3.5 tonnes. The Group has assumed that all such vehicles have only two axles.

Group 3 Large Passenger Vehicles

This group comprises UNECE vehicle categories M_2 and M_3. They are both passenger vehicles with more than 8 passenger seats, plus the driver. M_2 vehicles weigh up to 5 tonnes. M_3 vehicles weigh more than 5 tonnes.

Group 4 Heavy Goods Vehicles (up to 12 tonnes)

This group comprises UNECE vehicle category N_2. These are goods vehicles weighing more than 3.5 tonnes and up to 12 tonnes.

Group 5 Heavy Goods Vehicles (over 12 tonnes)

This group comprises UNECE vehicle category N_3. These are goods vehicles weighing more than 12 tonnes.

Group 6

Not yet used (unless the Comité Télépéage decides that it would be useful to identify goods vehicles over 12 tonnes, in which case Group 5 would be used.

[5] The Group found one vehicle of category M1 which is more than 3.5 tonnes. This is the Hummer and would be assigned to Group 7.

Group 7

Any vehicle not falling in Groups 0-4

[R 3] The proposed European Vehicle Groups are defined as follows, with the criteria of the figure 3 above :
Group 0 - Motorcycles
Group 1 - Small passenger vehicles
Group 2 - Light Goods Vehicles
Group 3 - Large passenger vehicles
Group 4 - Heavy Goods Vehicles (up to 12 tonnes)
Group 5 – Heavy Goods Vehicles (over 12 tonnes)
Group 7 - Other vehicles

5.2 THE VEHICLE CLASS ATTRIBUTE

Each operator will decide how to use any vehicle parameters which are stored within the EOBU. We searched for a method to provide operators with an efficient mechanism to determine whether the EOBU contains the relevant parameters.

We decided to make use of the *Vehicle Class* attribute as defined by ISO 14906. The standard does not provide an implementation of the vehicle class attribute. However, the CARDME final report made recommendations on the way in which this attribute might be used and the Expert Group recommends that the CARDME proposal is adopted for the EETS. The CARDME proposal is illustrated in Figure 3. The name of this attribute was defined in ISO 14906. **It is not intended to be a common tariff class for local toll schemes.**

The attribute is divided into three component parts:-

- Trailer switch
- European Vehicle Group
- Local Vehicle Group

This is shown in Figure 3

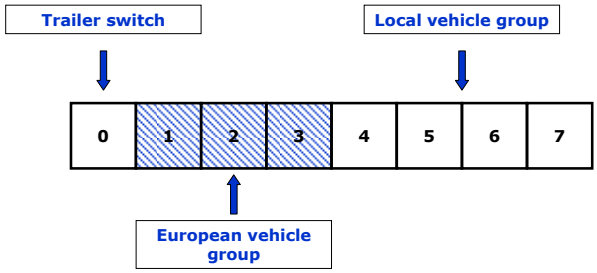


Figure 3: CARDME proposal for the use of the Vehicle Class attribute

The Trailer Switch is used to indicate whether the vehicle is towing a trailer. Most vehicles never tow a trailer, and so any EOBU for these vehicles could have this parameter set to 0. Where there is the possibility of a trailer, then the EOBU will require some form of switch which will be operated by the driver to indicate that a trailer is fitted. In these cases the switch would be set to 1.

It is proposed to store the vehicle group as defined in section 5.1 in the *European Vehicle Group*. This is a code in the range 0-7.

The *Local Vehicle Group* is left for use by individual operators or for national use where there is an agreement on this. This is a code in the range 0-15. It could be used as a tariff class. More details of this are given in Section 5.5.

The V*ehicle Class* attribute is defined in ISO 14906 as a single byte of information, i.e. the data element VehicleClass. In order to provide each operator with information on the vehicle group and storage of characteristics within the vehicle, we propose that the *Vehicle Class* attribute is included in the BST/VST exchange where communications

follows the CEN TC278 standards for charging by 5.8GHz microwave communications. Systems using other technologies will need to implement a similar feature.

[R 4] The data component "European Vehicle Group" (being part of the VehicleClass data element) will be used as a cost-effective means of determining the type of vehicle which has an OBU installed for use with the European Electronic Toll Service.

[R 5] The data element TypeOfContract for the EETS shall be coded in a way to provide for inclusion of the European vehicle Group.

5.3 CLASSIFICATION PARAMETERS FOR "LIGHT VEHICLES"

Expert Group 2 has defined "light" vehicles as those in vehicle groups 0, 1 and 2. This mainly consists of small passenger vehicles (up to 8 passengers seats in addition to the driver) and light goods vehicles (up to 3.5 tonnes).

As shown in **Figure 4**, we propose that, for light vehicles, just the V*ehicle Class* attribute is stored in EOBUs for these vehicles and declared to roadside equipment as part of the normal communication exchange. On receiving the V*ehicle Class*, the operator will be able to determine that the vehicle is either a small passenger vehicle or a light goods vehicle. The number of axles is known to be 2. The weight is known to be less than or equal to 3.5 tonnes. Any other vehicle characteristic that may be required for the purpose of tariff class determination must be determined by roadside equipment.

Light vehicle attributes
Vehicle Class
Trailer switch (first bit in the data element VehicleClass
European vehicle group (second to fourth bit in VehicleClass)
Local vehicle group (last four bits in VehicleClass)

Figure 4: Classification parameters for light vehicles

[R 6] Small passenger vehicles (with up to 8 passenger seats in addition to the driver) and small goods vehicles (up to 3.5 tonnes in weight) will be provided with a pre-configured EOBU which defines the vehicle group.

Other projects raised in the frame of the Directive 2004/52/CE, like CESARE III, will define whether or not he EOBU may be passed form one vehicle to another of the same class.

Some tolling schemes in operation have separate tariffs for light vehicles towing trailers. Light vehicles which may tow trailers can be issued with EOBUs with a mechanism to enable the driver to declare that a trailer is fitted. When the vehicle is towing a trailer, the trailer switch bit will be set in the V*ehicle Class* attribute.

Given that setting the trailer switch is the responsibility of the driver, operators may decide to apply measures to verify that the correct declaration is being made. For some existing systems which do not have a trailer switch on the OBU, this will be an improvement in terms of revenue assurance.

[R 7] Light vehicles should be provided with an EOBU which includes a trailer declaration, e.g. by means of a switch or a pushbutton.

5.4 CLASSIFICATION PARAMETERS FOR "HEAVY VEHICLES"

"Heavy vehicles" are mainly those in vehicle groups 3, 4 and 5. These are large passenger vehicles (with more than 8 passengers in addition to the driver) and goods vehicles over 3.5 tonnes.

Given the importance of assuring the correctness of the vehicle characteristics, we assume that the EOBU for heavy vehicles will be securely attached to a specific vehicle and will not be moved between vehicles during normal use, unless previous notice to the issuer takes place and relevant changes of the EOBU data is performed by the issuer.

[R 8] EOBUs for heavy vehicles shall be required to be securely attached to a specific vehicle and not moved between vehicles during normal use. EOBU shall contain an extended set of parameters defined in ISO 14906, as shown in Figure 5 below.

Heavy vehicle attributes
Vehicle class attribute
Trailer switch (0-1)
European vehicle group (1-7)
Local vehicle group (1-15)
Vehicle axles
VehicleAxlesNumber
Vehicle Licence Plate Number
Vehicle Weight Limits
VehicleMaxLadenWeight (Maximum laden weight of the drive unit)
VehicleTrainMaximumWeight (Maximum laden weight of the vehicle train)
Vehicle Specific Characteristics
VehicleSpecificCharacteristics
EnvironmentalCharacteristics euroValue
Vehicle suspension type (not provided for by ISO 14906)

Figure 5: Vehicle Characteristics for Heavy Vehicles

Each of these is described below:-

Vehicle Class

This attribute is the same as that already described for light vehicles. EOBUS for HGVs would normally have a trailer switch. Operation of this would be indicated in the flag (first bit) within the *Vehicle Class data element*.

Number of axles

This characteristic is used in many schemes for deriving the tariff class. However, it is used in various ways across Europe. Most tolling schemes base the tariff on the number

of axles on the complete vehicle. At least one scheme expects to base the tariff on the number of axles on the tractor, or towing unit.

The Expert Group has considered various ways to ensure that the total number of axles is correctly stored in the EOBU. We have already proposed that there is a trailer switch on the EOBU. We have investigated whether this can be used to declare the correct number of axles in all cases.

There are considerable variations in the configuration and thus numbers of axles of HGVs. The tractor unit of the vehicle is registered by all member states. (Optional) parameter L in the registration document provides the number of axles on the vehicle and this is usually (but not always) the tractor unit.

There are two main situations to consider. Firstly, there is the situation of rigid vehicles. These may pull a "draw-bar" trailer. Trailers may have 1, 2 or 3 axles.

Secondly, there are articulated vehicles. The tractor unit may draw a semi-trailer with 1, 2, 3 or 4 axles. In some case, the articulated vehicle may be registered as a single vehicle.

We consider that there are three potential options:-

Option (a) - Store the number of axles of the tractor unit. Provide a trailer switch and assume trailers have two additional axles.

Option (b) - Store the number of axles of the tractor unit. Provide a declaration of the total number of axles on the vehicle.

Option (c) - Store the number of axles as indicated in the registration documents. Provide a declaration of the total number of axles on the vehicle.

Option (a) would be relatively straightforward for the driver to operate and thus probably lead to fewer errors in trailer declaration. It would also be straightforward to enforce. However, there would be situations where the wrong number of axles would be declared. It would be necessary for the driver to be aware of the axles declared and the implications on the tariff class, and to make a manual declaration to the toll operator in the case of a wrong tariff class being applied. This might prove difficult in practice and lead to some undercharging. Even if there was no difference in the tariff, it is not a good situation to allow a vehicle to be declaring the wrong number of axles.

Option (b) would provide the driver with the opportunity to ensure that the correct number of axles is being declared. However, it places more responsibility on the driver and may lead to errors in operation, whether intentional or accidental. The EOBU would probably need to have built-in compliance checks, for example, to ensure that the number of axles was not changed during a journey.

Option (c) would be straightforward for the Issuer to verify the information recorded in the registration documents. However, it would lead to the situation where similar vehicles are declaring different information depending on how they were registered. This is caused by the fact that a "vehicle" is defined (and registered) in different ways by countries. This might lead to problems in the enforcement process.

The Expert Group have considered the advantages and disadvantages and recommend option (b).

Some vehicles have axles which can be raised for more economic operation when the vehicle is travelling at less than the full load. We have investigated this situation and find that such axles are normally counted by operators in assessing the tariff class. The number of axles would therefore include drop axles.

[R 9] EOBUs designed for use with Heavy Vehicles should contain the number of axles on the tractor unit.

[R 10] EOBUs designed for use with Heavy Vehicles should provide the driver with the facility to enter the total number of axles of the complete vehicle.

[R 11] EOBUs designed for use with Heavy Vehicle should monitor the operation of the trailer declaration and assist the driver in minimising errors in declaring the number of axles on the vehicle.

If Option b is accepted, then the number of axles would comprise two parts:-

- Number of axles on the tractor unit
- Number of additional axles (i.e. the number of axles on the trailer)

There are 6 bits allowed for the number of axles in the ISO 14906 standard. We propose that this field is used to store these two values, each in the range 0-7.

Number of Axles					
Number of axles on tractor unit			Number of axles on trailer		
0/1	0/1	0/1	0/1	0/1	0/1

Figure 6: Coding of the number of axles

Vehicle Licence Plate Number

This is a mandatory parameter (A) in all registration documents across Europe. The coding of this attribute in the EOBU is already defined in the standards and straightforward. The country of registration of the vehicle would already be available on the EOBU.

Vehicle Weight Limits

Maximum laden weight of the drive unit

This is (optional) parameter F2, which is defined in Directive 2003/127/EC on electronic registration documents as "maximum permissible laden mass of the vehicle in service in the member state of registration". Where the vehicle is an articulated vehicle, this will be the maximum permissible weight of the tractor unit.

Maximum laden weight of the vehicle train

This is (optional) parameter F3, which is defined in Directive 2003/127/EC on electronic registration documents as "maximum permissible laden mass of the whole vehicle in service in the member state of registration".

Vehicle Specific Characteristics

Environmental characteristics

Expert Group 2 recommends that the vehicle Euro value (data element euroValue) is stored in the EOBU, recognising the importance of emission levels for future charging schemes.

Vehicle suspension type

The draft Eurovignette directive proposes a differentiation based on "Road-Friendly Suspension". However, this parameter cannot easily be verified without access to the vehicle documentation. The Group has consulted Member States on the need for this

parameter; opinion is divided. Moreover, there is no provision for this attribute in the ISO 14906 standard. The Regulatory Committee is asked to decide whether a parameter on vehicle suspension type is required.

[R 12] The Regulatory Committee is asked to decide whether there is a requirement for the vehicle suspension type to be included in the EOBU, particularly in the light of the draft Eurovignette directive which proposes differentiation on the basis of "Road Friendly Suspension".

5.5 PROVISION FOR OPTIONAL AND LOCAL VEHICLE CLASSES

It is recognised that the choice of vehicle classification parameters may not meet the requirements of every scheme across Europe. We have proved two additional features to assist local schemes.

5.5.1 Local Vehicle Group

Expert Group 2 proposes that the field "Local Vehicle Group" is used by operators and possibly by countries where further refinement of the declared parameters is required, but cannot be justified at the European level.

This field may take the value 0-15 for each of the European vehicle groups. This field may be used by particular operators, or if a country so decides for a national classification scheme. This would provide for some refinement of the vehicle groups to support local needs. Of course, EOBUs which are issued in other countries may have a different set of codes for the local vehicle groups. The country code will be required to determine the set of local codes being used.

[R 13] The Local Vehicle Group may be used within each country as decided by the national tolling authority.

5.5.2 Optional parameters for light vehicles

The group recognises that some Member States would like to use one or more of the following parameters for light vehicles:-

- Vehicle Licence Plate
- Euro emission value (i.e. EURO 0 - 6)
- Type of fuel (data element EngineCharacteristics in Vehicle Specific Characteristics)
- Height above the first axle

We did not recommend their inclusion as this would imply that the EOBU for light vehicle would need to be personalised to the vehicle.

[R 14] The following parameters should be available in EOBUs designed for light vehicles for use by those operators that wish to use them for local schemes.
- Vehicle Licence Plate
- Euro emission value (i.e. EURO 0 - 6)
- Type of fuel (data element EngineCharacteristics in Vehicle Specific Characteristics)
- Height above the first axle

However, we propose that all EOBUs are designed to be capable of storing these parameters, and to declare their values on receipt of an authorised request.

The parameters may be used in two ways. Where groups of toll operators (or national toll authorities) consider that the addition of these parameters will provide additional benefit, then they may wish to incur the additional cost of personalisation. For example, the vehicle licence plate may offer toll operators more assurance.

Where users may derive additional benefit from having these parameters stored in their EOBU, and the Issuer is willing to offer the service (maybe at an additional price) then these parameters may be added to their EOBUS. For example, gas-fuelled, bio-fuelled or electric vehicles may attract a discount.

5.5.3 Issue of non-discrimination

A significant issue has arisen in the discussion on the use of the local vehicle group and optional parameters.

Suppose a Member State decided to introduce an **electronic** charging scheme where the tariff was based on **declared** parameters and these parameters are not expected to be available in EOBUs issued in other countries, for example fuel type.

The operator of that charging system will be obliged to accept EOBUs fitted to foreign vehicles. If the required parameters are not available, then the operator would be forced to make one of the following choices:-

1. Users with EOBUs not having the required parameters would be required to stop to make a declaration of the information required. They could then be charged as local users.
2. Users with EOBUs would be required to upgrade their EOBU with the relevant information before using the particular charging scheme.
3. Users with "foreign" EOBUs would be charged at a different tariff from local users.

None of these options are political acceptable.

It appears inevitable therefore that the classification parameters for all charging schemes which fall within the scope of the European directive must either be stored in all EOBUs, or must be measured by the operator at the point of use.

The use of the Local Vehicle Group and optional parameters are thus limited to either local schemes which are outside the scope of the directive, or the migration of national systems towards the EETS.

The essential principle is that **Member States must avoid any discrimination between users from different countries when considering the use of the Local Vehicle Group or the optional parameters.**

5.6 POTENTIAL NEED FOR ADDITIONAL PARAMETERS IN THE FUTURE

It is recognised that the EETS will evolve and that there may be a need for additional parameters in the future. Furthermore, these may not be defined within the ISO 14906. For example, there is no data element defined for "Type of suspension".

We therefore propose that the Regulatory Committee should have the authority to approve the definition and use of additional parameters. The process would be as follows:-

- A proposal would be made to the EFC Expert Group for one or more additional parameters
- The EFC Expert Group would analyse the need for such parameters and assess the impact on the EETS.
- The EFC Expert Group would prepare a formal definition of the required parameter(s) and submit a request for approval to the Regulatory Committee.

- Once approved, all operators would be given a reasonable time to implement the changes.

[R 15] Additional classification parameters (EETS1 – EETSn) will be subject to approval by the Regulatory Committee following a submission on the need for, and impact of, such parameters.

5.7 RELATED DEVELOPMENTS WITH SECURE STORAGE OF IN-VEHICLE DATA

It is envisaged that development with such applications as Automatic Vehicle Identification may lead to some vehicle parameters being available in the future in some form of secure in-vehicle storage device.

When such data is available, it might be more appropriate for EOBUs to be connected directly to these in-vehicle devices. This would provide a higher level of assurance of the data and eliminate the need for EOBU issuers to certify and enter the data into the EOBU.

Given that it will take many years for secure vehicle data to be available in all vehicles, there will continue to be a requirement for Issuers to enter the data into some EOBUs.

6. COLLECTION, MAINTENANCE AND VERIFICATION OF THE VEHICLE PARAMETERS

6.1 LIFE CYCLE OF CLASSIFICATION PARAMETERS

The minimum set of vehicle parameters for the European EFC Service will be stored as data elements in the memory of the On-Board Unit (OBU). Each of the data elements will have a lifecycle as shown in Figure 7.

A vehicle parameter is always *generated* by someone, e.g. the authority issuing the vehicle registration document, an entity measuring certain vehicle characteristics or the driver. The vehicle parameter will be *stored* in the OBU by someone, e.g. the issuer of the OBU or an entity acting on behalf of the issuer. Later the data will be *maintained*, i.e. they may be changed which requires new data to be generated and stored in the OBU. An important part of the maintenance will be the *protection* of the vehicle parameters stored in the OBU, i.e. preventing an unauthorised change of the parameters. The vehicle parameters will be *used* by the EFC operators for a classification of the vehicle which is further used for the calculation of the fee. The EFC operator may want to *certify* the vehicle parameters that he collected from the OBU during the communication between the OBU and the Roadside Equipment. By certification is meant confirming that the vehicle data are true, accurate and genuine. Finally the data will be *deleted* whenever the OBU is renovated or not to be used any longer.

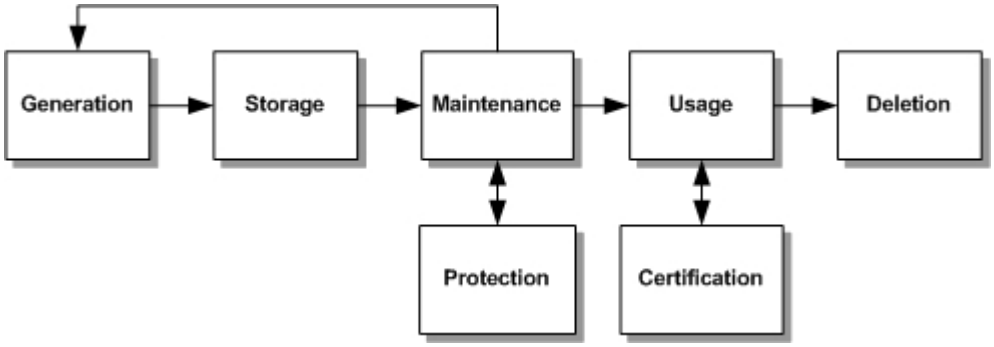


Figure 7: Lifecycle of the data elements for the vehicle parameters

6.2 RESPONSIBILITY FOR THE CLASSIFICATION PARAMETERS

Currently this report envisages one entity that may write data on the OBU: the OBU-Issuer. In addition the OBU-Holder is also mentioned as responsible for dynamic user data (e.g. trailers).

However, the authors accept that there may be many other different entities that may write data on the OBU, thus having to claim a responsibility for that data. Those may be: Payment Means Data (from the Payment means issuer), OBU-Issuer data (from the OBU Issuer), OBU equipment data (from the OBU manufacturer), Vehicle Data (from e.g. a vehicle register), Receipt data (from an EFC-Operator) or dynamic user specific data (from the OBU Holder).

The proposed solution does not provide for such a division of data responsibilities, but assumes that there is one entity, the OBU-Issuer that takes an overall responsibility for all data in the OBU. This may not be a feasible solution for some operators or countries

(there may have a clear distinction between the payment-means-role (e.g. banks) and transport specific roles (e.g. a transport authority). If not spelled out, the report thus makes an EFC architecture choice that affects the flexibility of implementation of the EFC service.

Furthermore, this may also be a problem with the use of ISO 14906, as this standard does not provide more than one data element for data responsibilities (the *ContractProvider*).

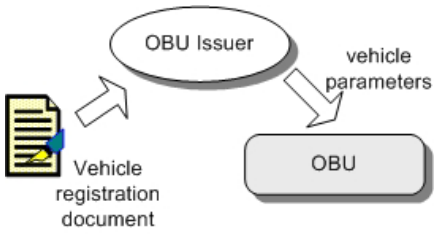
We suggest that the project CESARE analyses these problems and outlines some possible solutions, and clearly spells out any architecture assumptions being made. The project should also make suggestions for the use (and definition) of additional data elements signifying responsibility; e.g. *VehicleDataProvider* or *EquipmentProvider*. This may be an additional input to the revision of ISO 14906.

For simplicity, this paper refers only to the issuer of the EOBU as the custodian of all the classification data.

[R 16] CESARE should consider the proper entity to be responsible for the collection, maintenance and verification of the vehicle parameters to be stored within the EOBUs

Collection of vehicle parameters

The vehicle registration documents will contain sufficient information to be used as the primary source of reliable information on vehicle parameters. Hence, as long as the Issuer of the OBU uses the original registration documents the vehicle parameters collected for storage should be true.



[R 17] The issuer of the EOBU shall be required to keep copies of the vehicle registration documents.

Storage of vehicle parameters

Two entities are usually able to store data in the OBU. The first one is the Issuer of the OBU, i.e. the entity that initialises the OBU by a machine-machine interface. The type of vehicle parameters will be of a more *permanent* type, i.e. parameters that usually do not change during the lifetime of the vehicle. The other entity is the OBU holder (usually this means the driver) who may use a human machine interface, e.g. a switch, pushbuttons or a keypad, to store data in the OBU. Typical data stored by a driver could be whether the vehicle having the OBU installed is pulling a trailer. Another example is whether the vehicle is loaded with dangerous goods. These types of data will usually not be permanent during the lifetime of the vehicle and are referred to as *dynamic* vehicle parameters.

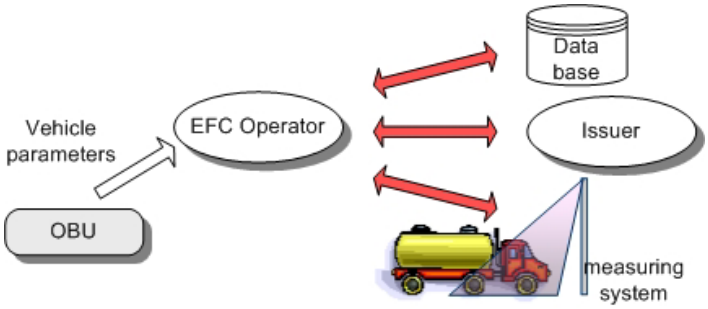
Based on the assumption that the Issuer can be trusted it remains to see how the OBU holder should be able to store data in the OBU. *As a principle the possibilities should be limited as much as possible due to traffic safety, security, fraud possibilities and human errors.*

Protection of vehicle parameters in the OBU

Concerning the protection of data there are several ways of preventing unauthorised changes of vehicle parameters stored in the OBU, e.g. access control and data authenticators (signatures). It is outside the scope of this report to go into further details but it could be assumed that the detailed specification of the EOBUs for the European EFC Service will include measures to meet the data protection requirements.

Usage and Certification of vehicle data

EFC operators will use the vehicle parameters for classification but may not trust the parameters read from the OBU, e.g. the dynamic data given by a driver. Hence, there will be an EFC operator requirement to be able to certify the vehicle parameters.



The EFC operator may certify the data stored by the Issuer by access to the national vehicle register, by adding the vehicle parameters to the claim to the Issuer requesting a certification (true or false vehicle parameters) or by measurements. The only way to certify vehicle parameters given by the driver is by measurements which is a strong argument for limiting the possibilities of the driver to just declaring trailer or no trailer.

[R 18] Vehicle parameters that are not possible to certify either by access to the vehicle registration document, access to the national vehicle data base or by measurement (either by personnel or measuring equipment) should not be used for classification.

[R 19] All permanent vehicle parameters stored in the OBU and used for the European EFC Service shall be retrieved from the vehicle registration document.

[R 20] The Issuer (or entities authorised and acting on behalf of the Issuer) shall be responsible for storing the correct vehicle parameters in the OBU.

[R 21] The permanent vehicle parameters shall be protected against unauthorised changes.

[R 22] The dynamic vehicle parameters that are stored in the OBU by the OBU holder, e.g. the driver, shall be limited to declaring the number of axles on a trailer for heavy vehicles and to declaring whether the vehicle is pulling a trailer for light vehicles.

ANNEX A EXPERT GROUP MEMBERS

The members of the Expert Group were appointed by the European Commission.

Name	**Company/Organisation**
Ken Perrett (Lead)	Rapp UK (UK)
Bernhard Oehry	Rapp Trans (Switzerland)
Trond Foss	SINTEF (Norway)
Mike Hollingsworth	ACEA (European/UK)
Joao Pecegueiro	Brisa (Portugal)
Joel Bomier	ASF (France)
Paolo Giorgi	AISCAT (Italy)

ANNEX B REASONS FOR NON-SELECTION OF ISO 14906 DATA ELEMENTS

The full list of ISO 14906 parameters is given in **Figure 8**.

Attribute [EN ISO 14906]	**Data Element**	**Description**
Vehicle Class	VehicleClass	The vehicle class field as defined by CARDME
Vehicle Dimensions	VehicleLengthOverall	Nominal maximum overall length, in dm.
	VehicleHeightOverall	Nominal overall unladen height, in dm.
	VehicleWidthOverall	Nominal overall width, in dm
Vehicle Axles	VehicleFirstAxleHeight	Bonnet height, measured over the front axle, in dm.
	VehicleAxlesNumber	Number of axles (including drop axles) plus presence of dual tyres
Vehicle Licence Plate Number	VehicleLicencePlateNumber	Declared licence plate of the vehicle
Vehicle Weight Limits	VehicleMaxLadenWeight	Maximum permissible total weight including payload in 100kg units.
	VehicleTrainMaximumWeight	Maximum permissible weight of the complete vehicle train.
	VehicleWeightUnladen	Nominal unladen weight.
Vehicle Specific Characteristics	VehicleSpecificCharacteristics	EnvironmentalCharacteristics: EuroClass (Euro Emission Class) CopValue (COP-Emission Code) EngineCharacteristics (leaded/unleaded Petrol, Diesel, LPG, ..) DescriptiveCharacteristics (Vehicle shape).

Figure 8: Vehicle Classification parameters defined in ISO 14906

The Group has summarised the group discussion and the reason for the decision to exclude some of the data element available in ISO 14906 in the following table.

Data element	Reasoning against criteria	
Vehicle dimensions VehicleLengthOverall VehicleHeightOverall VehicleWidthOverall	In use:	(a) These parameters are currently measured by systems which use them. (b)The measurements are sometimes used as part of the enforcement process to verify the plausibility of tariff class already declared. In this case the characteristics will continue to be measured and not declared. (c) The length characteristics are used as part of the tariff class for ferry charges in Scandinavian countries. Enquires indicate that these parameters will continue to be measured and so are not required to be declared.
	Stability:	Height is not stable over the life of the vehicle for many vehicles, the height varying according to the load and trailer configuration.
	Cost effective:	Instability of this parameter increases the cost of verification.
	Conclusion:	The group decided that this is mainly used for the verification of tariff classes, rather than being part of the tariff calculation. We therefore consider that these parameters are not required.
Vehicle Axles VehicleFirstAxleHeight	In use:	This characteristic is used as part of the tariff class calculation by many operators. It has been used to identify cars. However, it is a measured characteristic in all current systems.
	Stability:	This characteristic is becoming less effective for the identification of cars due to the design of modern cars. There is also an element of variability in this characteristic.
	Cost effective:	Requires verification
	Conclusion:	The group decided that this characteristic should not be mandatory as a declared parameter.

Vehicle Weight Limits VehicleWeightUnladen	In use: Stability: Cost effective: Conclusion:	Not used in any current European system Requires verification Not required by any operator.
Vehicle Specific Characteristics VehicleSpecificCharacteristics CopValue	In use: Stability: Cost effective: Conclusion:	Not used in any current European system Requires verification. Not required by any operator.
Vehicle Specific Characteristics VehicleSpecificCharacteristics DescriptiveCharacteristics	In use: Stability: Cost effective: Conclusion:	This parameter identifies the vehicle shape. It is not used by any European charging system Requires verification. Not required by any toll operator.
Vehicle Identification Number (VIN) This was suggested by ACEA.	In use: Stability: Cost effective: Conclusion:	This is a unique identification number for the vehicle. It is not used by any European charging system. Requires verification. No required by any toll operator
Vehicle Suspension Type	Use: Stability: Cost-effective: Conclusion:	The Eurovignette Directives (existing and proposed) propose that vehicles with air suspensions are charged differently. Characteristics is stable Requires verification The Comité Télépéage should be asked whether suspension type should be differentiated.

ANNEX C RESPONSES TO COMMENTS RECEIVED FROM MEMBER STATES

Comments were received from eight countries. These were Finland, Germany, Netherlands, Norway, Portugal, Spain, Switzerland, and UK. Comments were also received from ACEA.

C.1 Finland

Request	Response
Fuel type to be included for private cars.	Fuel type included as "optional" parameter available for national use and by agreement between groups of operators.
Local differentiation	Provided as Local Vehicle Group.
Consideration of directives - 70/156/EU, 2001/116/EU, 96/53/EU, 2002/7/EU on type approval.	Done - UNECE vehicle categories used.
Shorter subset of parameters for private cars	Done.

C.2 Germany

Request	Response
Flexibility for the user of HGVs in relation to parameters	Accepted. The number of axles on the trailer will be entered by the driver.
Inclusion of maximum trailer weight	The Group considered this point at length, but decided not to recommend this parameter within the set of minimum requirements.
Parameter for obliged to pay	This varies from scheme to scheme. We have provided a mechanism to identify vehicle groups and these are based on general obligation to pay principles.
Restrictions on access to parameters	Agreed and included in the text.

C.3 Netherlands

Request	Response
Contract details	These are outside the scope of vehicle classification. The various proposals for airlink transaction (e.g. CARDME, PISTA) for microwave include these details. Expert group 2 is not addressing the overall transaction - this is the work of Expert Group 1.
Use of 99/37 recommended	Done
Request for "Type of fuel"	Optional for light vehicles. Almost all heavy vehicles are diesel so not considered necessary.
Request for "Eurosclass"	Done. Mandatory for heavy vehicles. Optional of light vehicles.
Request for Number of axles	Done
Request for type of suspension	Offered as a possibility
Request for unladen vehicle weight	Not accepted - did not fall within criteria as it appears not to be used for tariffing at present
Request for maximum laden weight of the vehicle and maximum laden weight of the vehicle train	Done for heavy vehicles.

Request for trailer switch	Done, plus declaration on the number of axles on trailers for Heavy vehicles.
Request for number of passengers	Done - differentiation between small and large passenger vehicles included.
Request for type of vehicle	Done - 6 vehicle groups defined

C.4 Norway

Request	Response
Ability to move OBU for light vehicles	Done
Use of European vehicle group to identify small passenger cars	Done
Requirement for a trailer switch	Done
Vehicle length	This was discussed by the group but not recommended for the minimum set of characteristics as the length is always to be measured in Norway. The operators can therefore already derive the length of all vehicles.
Maximum vehicle laden weight	Done
Mechanism for fast reading of characteristics	Done through the vehicle class attribute.

C.5 Portugal

Request	Response
Height above first axle	Done. This characteristic is important in Portugal. Although the OBU declares the tariff class, the vehicle characteristics used for the tariff class are measured by an automatic vehicle classification system. There appears to be no problem in classifying foreign vehicles and no requirement for this parameter to be declared. In the event that multilane systems are deployed, the non-declaration of this parameter will have to be taken into account.
Inclusion of parameters relating to the Eurovignette	Done - road friendly suspension offered as an additional parameter.

C.6 Spain

Request	Response
Twin wheel	This was discussed at length. It is understood that this is a measured characteristic in Spain. There appears to be no requirement for this parameter to be declared by the EOBU.
Problems faced by Issuers in Spain	The Group discussed the issues for Spain as a result of having financial institutions as Issuers. We appreciate the problems and offer a part solution. Light vehicles would continue to be issued with an OBU which acts purely as a payment means. These could be transferred between vehicles. We believe that this is in line with the Spanish model.

	For HGVs, the EOBU will be much more sophisticated and the Issuer will be involved in the personalisation process. It is accepted that financial institutions may not wish to be involved in the issue of EOBUs for HGVs.
Different solution for light and heavy vehicles	Done

C.7 Switzerland

Request	Response
Request for vehicle class, vehicle licence plate, vehicle weight limits, euroclass for heavy vehicles	Done.
Different solution for light vehicle	Done.
Efficient mechanism for informing the roadside that the EOBU contains vehicle classification parameters	Done.
Use of up to seven harmonised vehicle groups	Done.
Use of optional parameters for light vehicles	Done. Vehicle licence plate, Euroclass and type of fuel included.
Recommendation for a task force.	Done.

C.8 UK

Request	Response
Number of seats in passenger vehicles	The group discussed this proposal at length. It is accepted that several toll schemes in the UK use the number of passenger seats as a tariff parameter. However, this was not a requirement elsewhere in Europe. The group settled on vehicle categories are the most helpful in this respect. We define small passenger vehicles (≤ 8 seats in addition to the driver) and large passenger vehicles (> 8 passenger seats in addition to the driver). We also provide the weight of the vehicle. Category M_2 is ≤ 5 tonnes and M_3 is over 5 tonnes. The UK is the only Member State which allows a minibus to be driven as a private vehicle and this accounts for the UK population of such vehicles. These are considered as PSVs abroad and charged as buses.
DfT provided a list of classes in use in the UK.	Noted.
The issue of plated weight.	This has been investigated. The UK practice of allowing a vehicle to be registered at a lower maximum gross laden weight is unusual. Vehicles which have been approved to operate at a lower weight are "plated" by attaching a metal plate to the vehicle. We understand that the "plated weight" is recorded as the

	maximum gross laden weight. We have assumed that the vehicle would operate at the lower weight both within the UK and abroad.
Reference made to UK legislation on vehicle classification for charging schemes authorised under the Transport Act	The proposals have been checked against the UK legislation and a conformance table created.
Conformance with UK Open Minimum Interoperability Specifications Suite (OMISS)	The proposals have been checked against the OMISS specification and a conformance table created.

C.9 ACEA

Request	**Response**
Consideration of European vehicle database for storing classification parameters for all vehicles using the EETS.	Discussed at length in the Group, but recommended as not considered feasible. The main reasons were:- • the need for real-time information at the charging point • the lack of an appropriate organisational framework
Issue of source of the vehicle data	All data will be collected by Issuers of EOBUS from the vehicle registration documents.
Type of suspension	Proposal included.
VIN	This was discussed, but not considered as required by any current charging scheme.

C.10 Italy

Request	**Response**
Ability to move OBU for light vehicles	Done
Requirement for a total number of axles (trailer included)	Done
Height above first axle	Done.

ANNEX D EXAMPLES OF THE APPLICATION OF THE SOLUTION TO MEMBER STATES

D.1 Requirements:

When a vehicle approaches a tolling station, the road-side must be able to obtain the following information in order to charge the vehicle correctly:

1. Does the vehicle have a valid contract?

This can by standard be deduced from information contained in the EFC-ContextMark contained in the VST.

2. Is it subject to the fee?

In some tolling system only some vehicle classes are subject to the toll or fee, e.g. only heavy vehicles, or only heavy goods vehicles. The road-side must be able to decide whether the vehicle is subject from information contained in the Harmonised Vehicle Classification Set, (HECS). Regarding exempt vehicles (ambulances, military, etc.) it is assumed that there is information in the EFC-ContextMark.

3. What tariff applies to the vehicle?

The data contained in the HECS must be sufficient to allow the road-side to calculate the applicable tariff.

D.2 Heavy Vehicles Fee Switzerland

Title	Distance-dependent heavy-vehicles fee for HGVs on all roads
System type:	Tachograph-based distance charging
Subject vehicles:	Heavy goods vehicles with maximum laden weight exceeding 3.5 tonnes. Busses pay a time dependent fee, i.e. a fixed amount per day. Heavy trailers (>3.5t) pulled by light vehicles are subject.
Tariff Classes:	Tariff is proportional to the maximum permissible weight of the vehicle combination, in 100kg-steps. In addition, tariff depends on emission class (Euro-classes). Classification relies on declared characteristics residing in the central system and available as a copy on the OBU. Driver must declare trailer presence and maximum trailer weight at the OBU.
Application of the proposed HECS:	
Subject to the fee:	Whether the vehicle is subject to the fee follows from the vehicle group (HGVs are N2/N3), except for the special case of heavy trailers, which cannot be deduced from the HECS. The trailer maximum weight is not offered by HECS. For vehicles pulling a trailer (as evident from the Vehicle Axles attribute) it can be assumed in international traffic that the vehicle combination reaches the vehicle train limit (usually 40t). This is an assumption that might fail in exceptional cases. Emission class follows from "Vehicle Specific Characteristics" attributes.
Tariff class:	Based on maximum tractor weight, plus maximum trailer weight. Also based on Euro classes.

Conclusion:	Minor issues. Most vehicles can be correctly classified using the HECS. Some truck/trailer combinations will overpay when pulling a light trailer. Liability to the system follows from the vehicle group, except for light vehicles pulling heavy trailers. This is a Swiss national peculiarity that does not affect international traffic.
Confirmed by the operator	No

D.3 LKW-Maut Austria

Title	Heavy-vehicles toll on Austrian motorways
System type:	Multi-lane free-flow DSRC system with mandatory OBU
Subject vehicles:	Heavy vehicles (busses and trucks) with maximum laden weight exceeding 3.5t. Heavy trailers (>3.5t) pulled by light vehicles are exempt.
Tariff Classes:	According to total number of axles of vehicle train: 2-axles, 3-axles, 4 and more axles. Trailers of busses are not taken into account
Application of the proposed HECS:	
Subject to the fee:	Whether the vehicle is subject to the fee follows from the vehicle group (HGVs - N2/N3, Busses - M2/M3).
Tariff class:	Vehicle class can be deduced from "Vehicle Axles" attribute, by adding the number of axles for tractor and trailer (if any) Trailer handling for busses follows from the Vehicle Group (HGVs are N2/N3, Busses are M2/M3)
Conclusion:	No issues. Liability to the system follows from the vehicle group. All vehicles can be correctly classified through the HECS.
Confirmed by the operator	No

D.4 France

Title	"TIS" "télépéage intersociétés" "is the name of ETC system and the commercial name is "Liber't".
System type:	Toll plaza system with manual lanes and automatic lanes for cards-money and ETC. Classification in manual lane is derived by observation (toll collectors gives the right class). In automatic lanes we have dedicated lanes for cars (small passenger vehicles) class 1 and for heavy goods vehicles class 4 where the maximum tariff is fixed. There are also automatic lanes accepted all mean of payments and all vehicles class with an automatic classification by sensors to determine the right

	class. Finally there are dedicated lanes for cars ETC payment only (dedicated class 1). Next time in 2006 ETC service will be extended to large passenger vehicles and heavy goods vehicles (class 3 : height more than 3,00meters and 2 axles; class 4 height more than 3,00meters and 3 or more axles). Class 4 will have dedicated lanes for ETC and credit cards payments. All others vehicles class 2-3-5 must go through the manual lanes with ETC antenna.
Subject vehicles:	At this moment ETC OBUs are for class 1 (cars), class 2 (Light Goods vehicles) , and class 5 (two or three wheeled vehicles) The dedicated electronic lane is only used by class 1 vehicles equipped with an OBU. Electronic and manual lane is used by class 1-2-5 vehicles equipped with OBU and all others customers (all means of payments and class vehicles). At this moment there are around 6 millions transactions per week and around 1.5 millions OBUs. The dedicated electronic lane for heavy goods vehicles will exist from the 1 January 2006. Therefore at this date ETC service in France will be an all classes ETC system and a full European service for heavy goods and large passenger vehicles. In each situation operators does measures in all single lane to derive the vehicle class (even are their payment mean
Tariff Classes:	Are determined by toll side equipment in each toll lanes
Application of the proposed HECS: for Heavy goods and large passengers vehicles	
Subject to the fee:	All vehicles
Tariff class:	The tariff class is derived entirely from measuring vehicle characteristics (height and axles) or observations by toll collectors in manual lanes
Conclusion:	At the moment France EFC system will be able to classify all vehicles either by reading vehicle class attribute and control by sensors measuring beside toll lanes. For heavy vehicles by reading vehicles attributes (ISO 14906) mainly "vehicle axles number" and "vehicle licence plate", and so the EFC context mark. All vehicles can be classified with OBUs filled with attributes recommended by the expert group 2: vehicle classification directive 2004/52/EC. For a multilane free flow application it will be necessary to fill tags with optional information like weight height and axles number.
Confirmed by the operator	No

D.5 Italy

Title	Telepass (as an EFC means of payment in the Italian interconnected network among 23 Motorway Concessionaires; other forms accepted are cash, credit cards, debit cards)
System type:	Monolane DSRC with dynamic measurement of vehicle's class, respecting the other means' logics: axles-shape.
Subject vehicles:	All vehicles
Tariff Classes:	Class1: cars with height at first axle < m1.3; Class B: passenger cars with height at first axle not < m 1.3; Class 3: 3 axle vehicles; Class 4: 4 axle vehicles; Class 5: 5 or more axle vehicles.
Application of the proposed HECS:	
Subject to the fee:	All classes
Tariff class:	In the monolane system, no problem due to measured characteristics; for future multilane schemes, partial possibility to detect the current vehicle's class as a reinterpretation of the scheme (ok for classes 0 or 1 or 2).
Conclusion:	Acceptable, but subject to a change of national scheme proposal.
Confirmed by the operator	No

D.6 Germany

Title	Heavy goods vehicles toll on German motorways
System type:	Multi-lane free-flow GPS/GSM system
Subject vehicles:	Heavy goods vehicles with a maximum laden weight of 12t or more.
Tariff Classes:	According to total number of axles of vehicle train: 2 classes: up to 3 axles, 4 and more axles; Tariff further differentiated according to EURO-emission classification (3 classes)
Application of the proposed HECS:	
Subject to the fee:	From the vehicle group (N2/N3) and the maximum laden weight of the drive unit (in case of no trailer) or the maximum laden weight of the vehicle train (in case of a trailer)
Tariff class:	Vehicle class can be deduced from "Vehicle Axles" attribute, by adding the number of axles for tractor and trailer (if any), plus from the EURO value parameter.
Conclusion:	No issues. Liability to the system follows from the vehicle group and the weight limits attribute, plus the trailer status. All vehicles can be

	correctly classified through the HECS.
Confirmed by the operator	No

D.7 UK - Severn Bridge, M6(Toll)

There are four current tolling schemes in the UK which operate on the TERN, so expected to come within the scope of the Directive. These are the Severn Bridge, Dartford Crossing, M6 (Toll), Forth Road Bridge. These are described in the following tables.

The London Congestion charging Scheme is not currently within the scope of the Directive as it does not involve electronic charging.

The Lorry Road-User Charging Scheme would come within the scope of the Directive, but no details have been announced on the tariff classes.

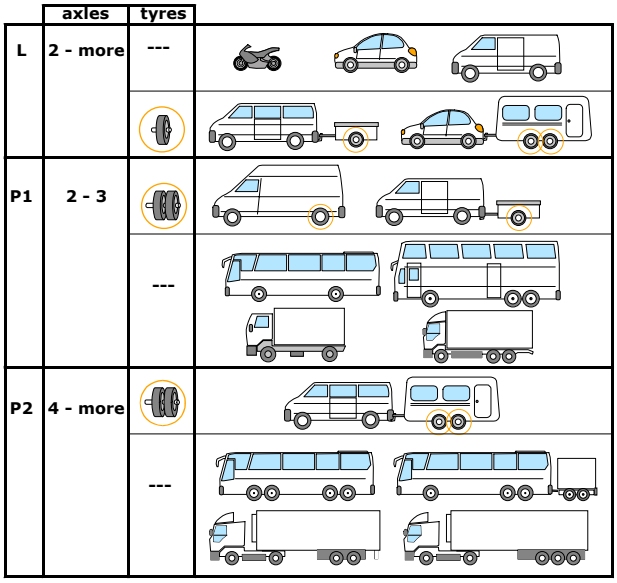
Title	**Severn Bridge**
System type:	Toll plaza with manual lane in which the tariff Class is derived by observation. Non-stop lanes available for vehicles equipped with pre-configured OBU according to tariff class.
Subject vehicles:	All except 2 wheeled vehicles
Tariff Classes:	Class 1: Motor cars and caravans Class 2: Goods vehicles up to 3.5 tonnes. Buses with up to 16 passenger seats Class 3: Goods vehicles more than 3.5 tonnes. Buses with more than 16 passenger seats.
Application of the proposed HECS:	
Subject to the fee:	Vehicles not subject to the fee are required to go through manual lane. All vehicles with EOBUs will be subject to the fee.
Tariff class:	Class 1: European Vehicle Group 1 Class 2: HGVs under 3.5 tonnes = European Vehicle Group 2. Buses with up to 16 passenger seats are mostly European Vehicle Group 3 with maximum weight up to 5 tonnes. Class 3: HGVs over 3.5 tonnes = European Vehicle Group 4. Buses with more than 16 passenger seats are mostly European Vehicle Group 3 with maximum weight more than 5 tonnes.
Conclusion:	Minor issue. Using the weight limit of 5 tonnes for buses would be in line with UK legislation on tariff classes, but may lead to slight differences compared with using the number of passenger seats.
Confirmed by the operator	No

Title	**M6(Toll)**
System type:	Private tolled motorway. Toll plaza offering manual and non-stop payment. OBU is used for payment, classification being

	measured.
Subject vehicles:	All vehicles
Tariff Classes:	Class 1: Fewer than 4 wheels Class 2: 2 axles. Height above first axle < 1.3 metres Class 3: More than 2 axles. Height above first axle < 1.3 metres Class 4: 2 axles. Height above first axle ≥ 1.3 metres Class 5: More than 2 and less than 7 axles. Height above first axle ≥ 1.3 metres. Class 6: more than 7 axles. Height above first axle ≥ 1.3 metres
Application of the proposed HECS:	
Subject to the fee:	Vehicles not subject to the fee are required to go through manual lane. All vehicles with EOBUs will be subject to the fee.
Tariff class:	The tariff is derived entirely from measuring the vehicle characteristics.
Conclusion:	No issue.
Confirmed by the operator	No

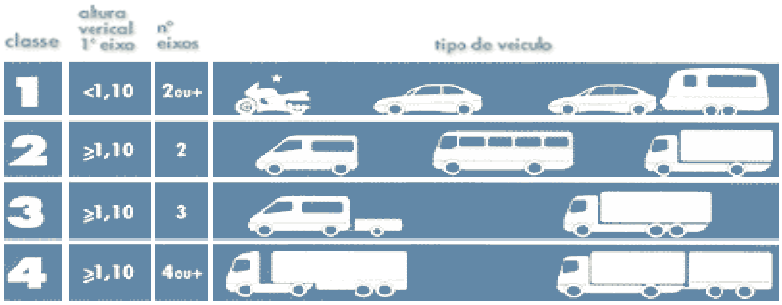
D.8 Spain

Title	**Electronic Toll Collection for all type of vehicles on Spanish toll motorways**
System type:	• Dedicated Monolane with barrier DSRC System; • Mixed Monolane DSRC and Toll collector; • Mixed Monolane with barrier: DSRC and automatic machine (self operation of magnetic cards and/or tickets) • Dedicated Monolane free flow DSRC System for light vehicles.
Subject vehicles:	All type of vehicles equipped with a valid DSRC OBU.
Tariff Classes:	3 tariff classes based on the number of axles (maximum 5 axles) plus presence of **dual tyres**. Fee dependent on tariff class, travelled distance, date and time. For statistics purpose most operators use different sensors to get up to 10 vehicle classes.

	
Application of the proposed HECS:	
Subject to the fee:	All vehicles will be subject to the fee, in accordance with measured vehicle parameters. Number of axles and dual tyres shall be measured (at least until multilane systems are authorized and deployed). The video enforcement is still under a govern decision.
Tariff class:	Current tariff classes shall be maintained (see above). These tariff classes are defined in the Concession Contract.
Conclusion:	Software modifications are required on RSE and in personalization equipments in order to use class declared by the OBU. None of the 225.000 new OBUs viaT issued has the class stored.
Confirmed by the operator	Abertis, CINTRA

D.9 Portugal

Title	Electronic Toll Collection for all type of vehicles on Portuguese toll motorways
System type:	Dedicated Monolane free flow DSRC System (Low Data Rate and Medium Data Rate)
Subject vehicles:	All type of vehicles, including motorcycles, equipped with a valid DSRC OBU.
Tariff Classes:	5 tariff classes based on height over the 1st axle and the number of axles (maximum of 4 axles). Fee dependent on tariff class and travelled distance. Motorcycles equipped with OBU are considered tariff Class 5.

	
Application of the proposed HECS:	
Subject to the fee:	All vehicles will be subject to the fee, in accordance with declared and measured vehicle parameters. Height over first axle shall be measured (at least until multilane systems are deployed) and number of axles shall be read from the OBU and measured if required for enforcement purpose.
Tariff class:	Actual tariff classes shall be maintained (see above). These tariff classes are defined in the Concession Contract.
Conclusion:	No major implications are foreseen. Software modifications are required on RSE in order to use measured height over 1st axle and number of axles for first instance vehicle classification, in opposition to vehicles with OBU's issued in Portugal, where the tariff class is declared by the OBU. Declared number of axles may be used for enforcement purpose.
Confirmed by the operator	BRISA, AEA

D.10 Norway

Title	AutoPASS
System type:	Single lane DSRC, - open systems and toll rings. In the future it will cover multilane free-flow and other transport services like ferries and parking.
Subject vehicles:	All vehicles benefiting from the transport service, e.g. the use of a sub-sea tunnel or the road network inside a toll ring.
Tariff Classes:	Three different principles: 1. *Maximum permissible total weight* - Small/Large vehicle (Less or equal to 3,5 tons and above 3,5 tons) 2. *Length* – Small, Medium and Large (less than 6.0 m, between 6.0 and 12.4 m and above 12.4 m) 3. Combinations of 1. and 2.
Application of the proposed HECS:	
Subject to the fee:	Not relevant as all vehicles are subject to the fee

Tariff class:	EFC systems using Principle 1 will read the Vehicle Group data and decide whether it is a Small or Large vehicle (Group 0-2 or Group 3 – 4). EFC systems using Principle 2 measures the length and may use the Vehicle Group data to verify or control. EFC systems using Principle 3 reads the Vehicle Group data from the OBU and measures the length and decides the class (usually three different classes)
Conclusion:	Norwegian EFC systems will be able to classify all vehicles either by reading the *VehicleClass* data element including the Vehicle Group data and/or the EFC systems will measure the length.
Confirmed by the operator	tbd

ANNEX E: GLOSSARY OF TERMS

Term	Meaning
Complete Vehicle	Entire unit as driven on the road, including articulated semi-trailers or draw-bar trailers.
Declared vehicle parameter (or characteristic)	Value of the specified characteristic as stored in the parameter within the OBU and offered in response to a request from the charging equipment.
EETS	European Electronic Toll Service
EOBU	European On-Board Unit - OBU designed to support the EETS.
Freeflow	Charging system which enables the traffic to pass freely without stopping, whether channelled into single lanes, or under normal traffic conditions.
Full trailer	A towed vehicle having at least two axles, and equipped with a towing device which can move vertically (in relation to the trailer) and controls the direction of the front axle(s), but which transmits no significant static load to the towing vehicle. (Source: UNECE)
HECS	Harmonised European Classification Set. This comprises the classification parameters proposed in this report.
Monolane	Charging system which channels vehicles into single lanes, each on which is fully equipped for charging and enforcement.
Multilane	Charging system which does not channel traffic. Charging and enforcement are undertaken across all lanes of the road.
Personalised EOBU	An EOBU in which parameters relating to a particular vehicle are stored, thus uniquely assigning the EOBU to the vehicle.
Pre-configured EOBU	An EOBU in which certain common parameters have been already set, removing the need to personalise the EOBU at the time of issue.
Semi-trailer	A towed vehicle, in which the axle(s) is (are) positioned behind the centre of gravity of the vehicle (when uniformly loaded), and which is equipped with a connecting device permitting horizontal and vertical forces to be transmitted to the towing vehicle. (Source: UNECE definition)
Tariff Class	Group of vehicles attracting the same tariff

Tractor Unit	That part of the vehicle which is powered and contains the driver.
Value	True value of the specific vehicle characteristic
Vehicle	Generic term which does not imply any particular configuration.
Vehicle Characteristic	Quantifiable attribute of the vehicle, such as height, weight, number of axles, fuel type.
Vehicle Group	Grouping of vehicles based on vehicle type and weight allowing operators to efficiently identify those having stored characteristics on the OBU.
Vehicle Parameter	Value of the characteristic as stored within the OBU. It should, but may not be the (correct) Value.