

**COMMON APPROACH TO VEHICLE CLASSIFICATION
IN SUPPORT OF THE
EUROPEAN ELECTRONIC TOLL SERVICE**

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ABSTRACT

European Directive 2004/52/EC(1) on the interoperability of electronic road toll systems in the Community was formally adopted in April 2004. The Directive sets a target date of July 2006 for international agreement on the definition of the European Electronic Toll Service (EETS). It is intended that on-board units (OBUs) will be provided to those users that require the service for use with all eligible charging schemes across Europe. Each Issuer of OBUs intended for use with the EETS (which are referred to in this paper as EOBU) will be expected to enter the required vehicle parameters for use with any scheme which needs them. The European Commission has established a set of Expert Groups to provide recommendations on all aspects of the EETS. Expert Group 2 on Vehicle Classification was established by the European Commission to provide recommendations on the vehicle parameters to be stored in EOBU. This paper provides a summary of the Group recommendations as set out in the report to the European Commission(2). The report was accepted by the Commission and will be submitted for approval by the Regulatory Committee in Autumn 2005. The latest news will be given in the presentation.

KEYWORDS

EFC, Vehicle classification, interoperability, European, Directive

BACKGROUND

Creation of EFC Expert Groups by the European Commission

The European Commission has established a set of Expert Groups to provide recommendations on all aspects of the EETS.

Expert Group 2 on Vehicle Classification was established by the European Commission to provide recommendations on the vehicle parameters to be stored in EOBU. These recommendations will be discussed by the EFC Expert Group, which comprises representatives from all 25 Member States, some additional invited countries and some European Institutions. Formal Decisions will be taken by qualified majority at the Comité Télépage, which consists of 25 Member State representatives.

Expert Group 2 comprised seven experts 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 author gratefully acknowledges the contribution of all the members of the group to the work reported in this paper.

Methods of Vehicle Classification

By the principle of subsidiarity, European 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 are 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.

Evolution of Classification Schemes

Existing European 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 payment service. (In this paper, the term free-flow refers to non-stop charging in both mono-lane and multi-lane operation). 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. To overcome this difficulty, some 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; 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 just started 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.

New charging policies are being encouraged by the European Commission which are based on environmental parameters. The draft Eurovignette directive refers to vehicles with air suspension (or recognised equivalent) 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

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 was 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.

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.

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.
- (b) The EETS will be an additional service to those offered locally.
- (c) Local and national charging schemes are permitted to continue alongside the EETS.
- (d) Users are free to take advantage of the local and/or European service.
- (e) All users must be treated equally within a Member State.
- (f) The vehicle characteristics to be declared need to be stable.
- (g) The vehicle characteristics must be cost-effective to collect, maintain and certify.
- (h) The solution must be cost-effective to all those involved

COST EFFECTIVE SOLUTION FOR OPERATORS AND USERS

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, the Group 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

OBUs for 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.

OBUs for of heavy vehicles

OBUs for charging heavy vehicles are mainly designed to collect correct charge data, rather than for payment. Payment of accumulated charges is not normally 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 possibly lost production time for the vehicle.

DEFINITION OF COMMON VEHICLE GROUPS

Defining light and heavy vehicles

The Group looked for a way to define “light” and “heavy” vehicles. The aim was to 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. These vehicles could then be issued with one of a small set of “standard” pre-configured EOBU 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.

The Group 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, the Group 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.

The Group found that the international UNECE resolution 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.

The Group 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	Description	Characteristics	UNECE class
0	Motorcycles	2 or 3 wheels	L
1	Small passenger vehicles	Seats \leq 8 + driver	M1
2	Light goods vehicles	Weight \leq 3.5 t	N1
3	Large passenger vehicles	Seats $>$ 8 + driver	M2, M3
4	Heavy goods vehicles	Weight $>$ 3.5 t	N2, N3
5	Not used		
6	Not used		
7	Other vehicles		

Figure 2: Proposed European Vehicle Groups

Group 0 Motorcycles

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

Group 1 Small Passenger Vehicles

This group is UNECE vehicle category M₁. 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 M₁ does not mention weight, these vehicles are in practice all less than 3.5 tonnes.

Group 2 Light Goods Vehicles

This group is UNECE vehicle category N₁. 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 M₂ and M₃. They are both passenger vehicles with more than 8 passenger seats, plus the driver. M₂ vehicles weigh up to 5 tonnes. M₃ vehicles weigh more than 5 tonnes.

Group 4 Heavy Goods Vehicles

This group comprises UNECE vehicle categories N₂ and N₃. They are both goods vehicles weighing more than 3.5 tonnes. N₂ vehicles weigh up to 12 tonnes. N₃ vehicles weigh more than 12 tonnes.

Group 5 and 6

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

Group 7

Any vehicle not falling in Groups 0-4

CLASSIFICATION PARAMETERS FOR LIGHT VEHICLES

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 passenger seats in addition to the driver) and light goods vehicles (up to 3.5 tonnes).

As shown in Figure 3, the Group proposed that, for light vehicle, just the *Vehicle Class* attribute is stored in EOBU for these vehicles and declared to roadside equipment as part of the normal communication exchange. On receiving the *Vehicle 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 3: Classification parameters for light vehicles

CLASSIFICATION PARAMETERS FOR HEAVY VEHICLES
classification parameters for “heavy vehicles”

“Heavy vehicles” are mainly those in vehicle groups 3 and 4. 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 assumed 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.

Heavy vehicle attributes
Vehicle class attribute
Trailer switch
European vehicle group
Local vehicle group
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 4: Vehicle Characteristics for Heavy Vehicles

A MECHANISM FOR OPERATORS TO DETERMINE VEHICLE GROUP

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.

The Group 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 5. 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

The Trailer Switch is used to indicate whether the vehicle is towing a trailer. Most vehicles

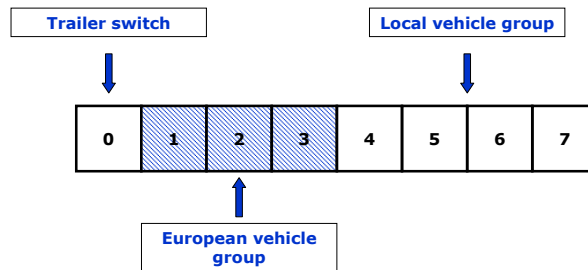


Figure 5: CARDME proposal for the use of the Vehicle Class attribute

never tow a trailer, and so any EOBUs for these vehicles could have this parameter set to 0. Where there is the possibility of a trailer, then the EOBUs 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.

The *European Vehicle Group* 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.

The *Vehicle 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.

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 provided two additional features to assist local schemes.

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, EOBU's 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.

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

If these parameters are used, then the OBU will need to be personalised. This adds to the cost of the administration and maintenance of the OBUs and means that they cannot be transferred between vehicles.

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