Transport Regulatory Uses of Telematics in Europe //

Volume 1

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Transport Regulatory Uses of Telematics in Europe Volume 1

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List of abbreviations

Abbreviations	Meaning
ACC	Adaptive Cruise Control
ACE	Alpine Crossing Exchange
ADAS	Advanced Driver Assistance Systems
ADR	Agreement concerning the International Carriage of Dangerous Goods by Roads
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CEN TC 278	CEN Technical Committee 278 on Road Transport and Traffic Telematics
CHF	Swiss franc
DSRC	Dedicated Short Range Communications
E112	Location enhanced emergency call
EC	European Community or European Commission
EEA	European Economic Area
EFC	Electronic Fee Collection
EETS	European Electronic Toll Service
FCD	Floating Car Data
GIS	Geographic Information System
GPS	Global Positioning System
GPRS	General Packet Radio Service (Data communications service based on GSM)
GSM	Global System for Mobile Communications (European standard for cellular communications)
GST	Global System for Telematics
HV	Heavy Vehicle (HGV, Coaches and other vehicles over 3.5 tonnes MPVW)
HGV	Heavy Goods Vehicle
IEEE	Institute of Electrical and Electronics Engineers
LSVA	Leistungsabhängige Schwerverkehrsabgabe , Heavy Goods Vehicle Fee in Switzerland
MoU	Memorandum of Understanding
MPVW	Maximum Permissible Gross Vehicle Weight
MPTW	Maximum Permissible Gross Vehicle Train Weight
OBU	On-Board Unit
RDS-TMC	Radio Data System - Traffic Message Channel
PSAP	Public Service Answering Point
PYAD	Pay As You Drive
RTTT	Road Transport and Traffic Telematics
SMS	Short message service
TERN	Trans European Road Network
TDG	Transport of Dangerous Goods
TTDG	Tracking and Tracing of Dangerous Goods
UN	United Nations
UNECE	United Nations Economic Commission for Europe

Foreword

Transport Certification Australia Limited (TCA) was established by its Members, the road transport authorities of the State, Territory and Commonwealth governments, to implement and administer the Intelligent Access Program **(**IAP).

The IAP is a vehicle telematics solution, which provides a nationally agreed vehicular telematics technical platform and legal framework. A platform and framework that caters for both government (regulatory) and non-government (commercial) vehicular telematics solutions.

An important function of TCA, as described in its constitution, is to monitor technological developments. In this capacity, TCA commissioned Rapp Trans AG, one of Switzerland's leading independent engineering and design consultancies, to undertake a study of the use of transport regulatory applications in Europe. This document, *Transport Regulatory Uses of Telematics in Europe*, is the result of that study.

Transport Regulatory Uses of Telematics in Europe provides a comprehensive view of the regulatory use of vehicle telematics in Europe and should prove to be a valuable resource for anyone seeking to increase their level of understanding regarding the possibilities and effectiveness of such applications. In particular the report details six regulatory telematics applications selected as being representative and relevant to assessing the current state of the art:

- Charging of heavy goods vehicles in Europe
- Digital Tachograph
- e-Call / Emergency Call
- Tracking and Tracing of Dangerous Goods
- European Electronic Toll Service
- Alpine Crossing Exchange

The report also contains important information on emerging technologies that might have an impact on future regulatory telematics applications.

The report clearly identifies that vehicle telematics is a tool and not an end in itself. The report highlights the importance of proper application definition, that is, 'what is the problem to which vehicle telematics provides a possible solution', of setting standards, and of driving the development of regulatory traffic telematics applications though a process-oriented approach dealing holistically and iteratively with policy, regulatory, institutional, technical and business case issues. The six regulatory telematics applications case - studied provide valuable lessons regarding the above issues.

To the authors, Bernhard Oehry, Markus Schüller, Andrea Felix and Ken Perrett, all of the Rapp Group, I would like to offer my congratulations on their excellent work in producing such an informative and insightful report. I especially want to thank them for their candour in critiquing the European applications and their assessment going forward. I would also like to acknowledge the valuable contribution of Dr Charles Karl, TCA Major Projects Manager, in guiding this project to its successful conclusion.

As the authors state: "while the European approach to regulatory traffic telematics has not been ideal in many respects, some noteworthy examples have also emerged. There is good reason to remain convinced that traffic telematics is the best available tool for tackling the traffic problems that this century will bring. We are convinced that managing traffic will be one of the key issues that will shape our future. We therefore expect a continued growth of traffic telematics, especially for regulatory applications."

Australia is at a critical time in the area of transport regulatory telematics applications.

In considering what is possible in regulatory uses of telematics in Australia, it is beneficial for all interested parties to familiarise themselves with the potential uses and applications of this technology, such as those discussed in this report. Even more importantly though, it is vital that interested parties take note of the lessons learnt in problem definition, evaluation of options and institutional effects, implementation and operational issues.

I am pleased to recommend this two volume report for your consideration and information.

Chris Koniditsiotis
Chief Executive Officer
Transport Certification Australia Limited

July 2008

Executive summary

Telecommunications and informatics have changed our lives significantly during the last ten or twenty years. Personal computers, mobile phones and the Internet have become major parts of our lives and have changed society as a whole. Notably, however, one major area has been ignored by these developments: vehicular traffic. Cars increasingly use electronics for operations and control, but not for telecommunications or informatics. Essentially, the “car” concept has remained unchanged, not experiencing the revolutionary changes that have affected other parts of our lives.

Vehicular traffic is a pillar of our society and of the modern economy. It is also ever-increasing, with traffic problems becoming severe, threatening economic growth and causing environmental damage.

The application of telecommunications and informatics in an integrated way is called telematics. In the traffic and transport environment, telematics is the discipline concerned with the transfer of data and services to vehicles. Telematics can lead to more efficient use of the road infrastructure, relieving congestion, saving lives by avoiding accidents and altogether making travel a new experience.

It had been hoped that as traffic telematics applications became widespread, traffic would be revolutionised in the same way as technology has revolutionised other parts of our lives. However these hopes have not been realised and vehicle telematics is still an emerging technology. This report gives an overview of the current situation, discussing why certain expectations have not come to fruition, and where the future might lead us.

Transport Certification Australia Limited (TCA) administers a traffic telematics application, the Intelligent Access Program (IAP). TCA’s vision is to be the national leader in the provision of certification, accreditation and related services to transport authorities, thus supporting the development and operational implementation of national transport reforms. Part of TCA’s Statement of Corporate Intent is to ‘monitor technological developments’. Aligned with this, TCA engaged Rapp Trans to undertake this report on the European perspective regarding regulatory, mostly governmental, applications of telematics, especially with regard to heavy vehicles.

The private telematics market in Europe is characterised by low-volume, bespoke solutions for small segments of the transport market. Most devices and applications are specialised “island” or “silo” solutions, tailored according to the needs and requirements of individual fleet operators or transport modes. The equipment market is mostly served by small and medium sized enterprises that are able to develop specialised low-volume products and applications at acceptable costs.

More activity can be seen in the public sector. Numerous national initiatives, and even more activities on a European level, are driving the development. It can be argued there are two motives behind these policies. On the one hand there is a genuine interest in developing telematics into a powerful instrument for managing and controlling traffic, particularly since there are few other options available that could help tackle the ever growing traffic problem. On the other hand there are also industrial interests, namely giving Europe a lead in what may become the next industrial revolution.

This report, *Transport Regulatory Uses of Telematics in Europe*, is made up of two volumes.

Volume one presents six regulatory telematics applications selected as being representative and relevant to assessing the current state of the art. The six applications are:

- Charging of heavy goods vehicles in Europe
- Digital Tachograph
- e-Call / Emergency Call
- Tracking and Tracing of Dangerous Goods
- European Electronic Toll Service
- Alpine Crossing Exchange

Each regulatory application is described briefly and its status and prospects are assessed.

Volume two contains a more detailed description of each application (including background, development, implementation, and impacts).

Volume one also contains a chapter on emerging technologies that might have an impact on future regulatory telematics applications. Five systems or technologies are considered as being the most relevant ongoing telematics developments in Europe:

- Galileo – the European satellite navigation system
- Open telematics vehicle networks
- Car-to-Car Communications
- Advanced Driver Assistance System
- Pay As You Drive

A general conclusion when reviewing the material collected in the report is that in the European developments, new technologies were the focus, with applications standing in their shadow. People were looking for new technology, or were trying to sell advanced technologies such as Global Positioning System (GPS) and Galileo. The focus was rarely on developing an innovative application. The failure to put the service in front of all other considerations, to think about business processes rather than about hardware has led to a remarkable number of failures, and inefficiencies.

While the European approach to regulatory traffic telematics has not been ideal in many respects, some noteworthy examples have also emerged. There is good reason to remain convinced that traffic telematics is the best available tool for tackling the traffic problems that this century will bring. We are convinced that managing traffic will be one of the key issues that will shape our future. We therefore expect a continued growth of traffic telematics, especially for regulatory applications.

This report highlights the importance of proper application definition, of setting standards, and of driving the development of regulatory traffic telematics applications though a strictly process-oriented approach instead of rushing into or after technology. In Australia, and especially in regard to the IAP, the approach has been better focused on creating applications for clearly defined regulatory needs. The IAP constitutes an excellent organisational basis on which to build other telematics applications. Some of the regulatory traffic and transport telematics applications in Europe presented here might well serve as a stimulus for developments in the Australia context.

1. Introduction

1.1 Telematics in traffic and transport

Telematics is a term that has been created to describe technologies and applications which make integrated use of *tele*communications and infor*matics*. More specifically, telematics is the discipline concerned with the transfer of data and services to mobile locations such as vehicles, containers, or people. The underlying technologies are often referred to as Information and Communications Technologies or ICT.

Telematics has its origins in military localisation applications, but the term is now mostly used as a synonym for vehicle telematics (also known as *Road Transport and Traffic Telematics* or RTTT in Europe, and *Intelligent Transport Systems* or ITS in the United Kingdom and United States).

Vehicle telematics applications are delivered through in-vehicle devices that as core technologies typically contain satellite localisation such as Global Positioning System (GPS) and cellular communications such as General Packet Radio Service (GPRS).

1.2 Background and scope

Transport Certification Australia Limited (TCA) commissioned Rapp Trans to provide this report on the transport regulatory uses of telematics in Europe. The objective is to give an overview of the "state of the art" concerning regulatory, i.e. governmental, uses of road transport and traffic telematics in Europe, including an expert assessment on conclusions that can be drawn regarding lessons learnt and the future potential of regulatory telematics applications.

The report is written from a European perspective, and attempts to highlight aspects of potential relevance to similar developments in Australia. The expected audience for the report is senior decision-makers who have some technical expertise.

1.3 Report structure

The report is made up of two volumes. Volume one provides:

- a brief overview of the traffic telematics applications currently in use in Europe as well as the policy basis for them
- a detailed description and analysis of each of the six selected regulatory applications
- an appraisal of emerging technologies under research or development in Europe including a detailed analysis of systems considered to be potential market drivers
- an assessment by the authors which seeks to help decision-makers assess the potential of the applications and to identify critical factors for success.

Volume two provides a detailed examination for each of the selected regulatory applications, including:

- application background
- a description of the application
- a listing of associated regulatory documents.

2. Traffic Telematics in Europe

2.1 History and expectations

The term ‘telematics’ has officially been in use since 1979, when the European Commission launched a programme to help European telematics, that is the high-growth industries of telecommunications, computers, microchips and databases. At that time vehicle telematics in particular was considered as the area for the next “industrial revolution”.

The ever-growing capabilities of electronics have led to several major industrial (and one could say even societal) revolutions in the last decades, starting with the mass deployment of consumer electronics (TV, CD, DVD), through the growth in telecoms (especially with cell phones), the informatics revolutions (particularly those involving the PC) and probably the most influential - the explosive growth of the Internet. Daily life has changed considerably in these years, with telecommunications and informatics devices becoming an omnipresent part of our lives.

One area of life has notably not been revolutionised in the same way, namely vehicular traffic. As the CEO of car manufacturer Opel / General Motors said at the ITS Congress in Sydney in 2001, the car concept is a hundred years old and has not changed a lot – four wheels, a body with some seats, and an explosion motor. Electronics are used to improve basic operations, but are not core to the concept. Telecommunications and informatics are today still not part of the car concept.

In industrial nations, the volume of traffic is growing at around 1-2% per annum and road transport by at least 5%, with much higher figures in developing countries. Road infrastructure cannot be built at a comparable pace. If this growth remains unchanged, and there are no indications to the contrary, increasing congestion and even a complete breakdown of the system must occur at some point in time.

This situation of traffic not being in the mainstream of the revolutions associated with electronics, together with the foreseeable massive traffic problems on a global scale, has led to the expectation that the next industrial and market revolution will be where telecommunications and informatics enter the vehicle. Vehicle telematics will then revolutionise traffic as it has other parts of our lives. In particular it will lead to more efficient use of the road infrastructure, relieve congestion, save lives through accident avoidance, and generally make travel a new experience.

It is obvious this vision has not yet been realised and that vehicle telematics is still an emerging technology. This report gives an overview of the current situation, discussing why certain expectations have not come to fruition, and where the future might lead us.

2.2 Nature of the vehicle telematics market

There are various different perspectives on telematics applications. One perspective presumes that vehicle telematics are part of the “information on the move experience”, while others view telematics as an enhancement of the driving experience. However, vehicle telematics applications are not limited to private sector commercial products but are also deployed for regulatory purposes such as tolling and vehicle monitoring, as well as for several safety related purposes.

This report essentially addresses telematics in the commercial transport sector, not the private car sector. For private cars we see one successful mass-deployed application: vehicle navigation based on GPS localisation and digital maps. We are not aware of any deployment of a truly telematics application, i.e. an application that also includes communications. A particular reason industry is trying to develop and push telematics technologies in the private car sector is to overcome the saturation seen in the mobile phone market. Saturation means the mobile computing market is growing rather slowly, so why not equip every car with a telematics unit that creates air-traffic via GSM? Despite intensive efforts, industry has not yet found the “killer application” that would lead to significant demand in the private car sector.

For telematics in the commercial transport sector the situation is different. The market in Europe is characterised by low-volume, bespoke solutions for small segments of the transport market. Most devices and applications are specialised “island” or “silo” solutions tailored according to the needs and requirements of individual fleet operators or transport modes. The equipment market is mostly served by small-and-medium-sized enterprises that are able to develop specialised low-volume products and applications at acceptable costs.

The following sections give an overview of the status of traffic telematics in Europe from the perspectives of policy, consumer and industry.

2.3 Overview of traffic telematics applications in use

Geographically, European countries are comparatively small, and the commercial and legal environments change every few hundred kilometres. The transport market in general is a strongly diversified and colourful one, with several different transport solutions competing for each market segment.

The often announced killer application in telematics has not yet been found and none of the specialised solutions have reached a market penetration such that they could be considered as mass market. However, despite the small scale of individual solutions, the use of telematics devices is widespread in transport.

Applications can be grouped in terms of their intended use:

- telematics for individual car traffic
- telematics for commercial freight traffic
- telematics for transport infrastructure
- telematics for public transport.

Within these operative ranges many different applications exist, such as:

- vehicle tracking and tracing
- navigation services
- fleet management
- remote diagnostics for maintenance purposes
- monitoring of vehicle / trailer properties (temperatures, door open/closed, etc.)
- livestock management
- anti-theft measures
- Floating Car Data (FCD)
- computer aided operations control systems.

The only application which can be considered as mass market in the individual car traffic group is the navigation service. This application is mainly hardware-based (device plus map) provided either directly by the vehicle manufacturer or by dedicated electronic hardware suppliers in the follow-up after market. Figure 1 shows such a device.

Figure 1: Satellite navigation device

[Source: http://www.zdnet.de/i/et/peripherie/2005/11/viamichelin.jpg]

According to a recent market study[1], the total sales of portable satellite navigation units amounted to around 7.6 million in Western Europe in 2006 and is anticipated to rise to 11.8 million in 2007. In Germany alone sales quadrupled in 2006. Strongly decreasing prices have stimulated the demand for such units.

Tracking and tracing systems for trucks and containers can presently be seen as the most noteworthy telematics application used in commercial freight traffic. In these systems the truck or container is equipped with an on-board device capable of receiving signals from a satellite positioning system (for example GPS) and then communicating this position data to a central operator by using cellular networks (for example GSM). In this way the fleet operator is always informed about the current position of his trucks or goods. Figure 2 shows such a tracking device used for vehicle fleets.

Figure 2: Tracking device

[Source: http://www.cabtronix.ch/files/images/products/emu3null1sm2.jpg]

A combination of GPS tracking and wireless communication with an appropriate human-machine interface in the vehicle and in the corresponding central equipment allows these tracking and tracing systems to be upgraded to full fleet management systems. These systems make additional features possible, such as bidirectional messaging, route management, remote diagnostics etc. The majority of users of tracking and tracing systems utilise such additional features.

The main aim of using telematics for traffic infrastructure is to reach an optimal traffic flow through effective traffic management based on real-time traffic information. The most relevant application for

1 Source: http://www.gfk.com/imperia/md/content/presse/pd_navigationsystem_deutschland_efin.pdf

obtaining real-time traffic information is Floating-Car-Data (FCD). FCD is characterised by monitoring individual vehicles in the traffic flow in order to construct a picture of the overall traffic situation. Three kinds of FCD can be identified:

- Passive Floating Car Data where traffic information is collected by beacons or cameras from passing vehicles.
- Active Floating Car Data where the vehicle is equipped with a device able to localise and to communicate by wireless.
- Extended Floating Car Data where the vehicle is provided with a sophisticated device which is linked to dedicated vehicle sensors, detecting the status of the ABS[2], the ESP[3], activated lights or windscreen wipers. The device can transmit additional road or weather conditions besides position data.

Figure 3 shows an Extended FCD arrangement.

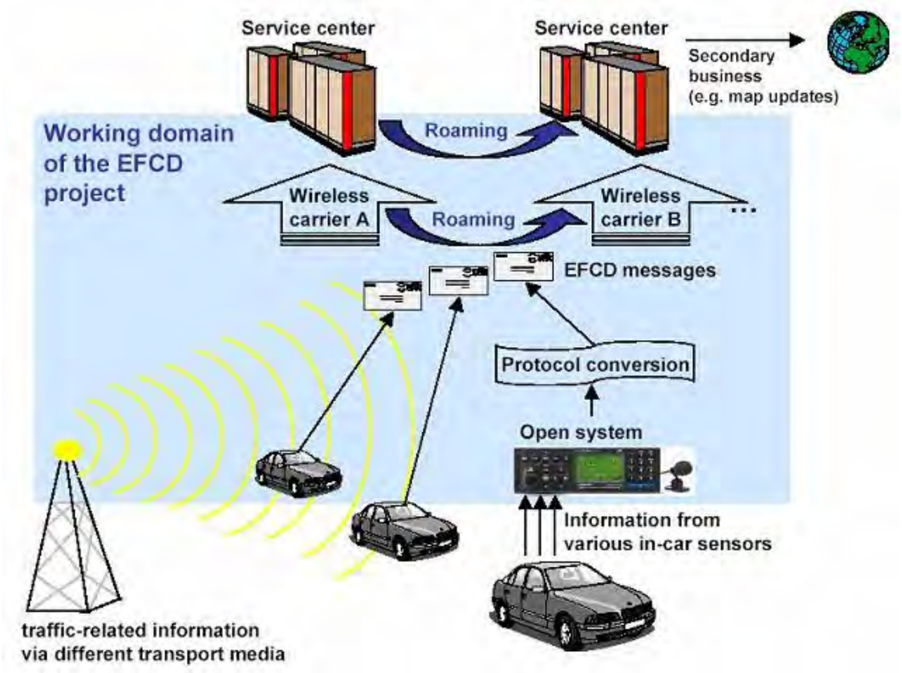

Figure 3: Extended Floating-Car-Data arrangement

[Source: http://www.gstforum.org/images/aachen/Enhanced_Floating_Car_Data_kleiner1.JPG)]

2 ABS: Anti-lock Braking System,

3 ESP: Electronic Stability Program

Most of the telematics systems deployed in public transport in Europe are computer-aided operational control systems aimed at managing and optimising fleets of buses and trams. Dispatchers use the current locations of the vehicles as the basis for the calculation of schedule compliance and for deciding whether they need to intervene in order to guarantee a smooth service. These systems typically consist of:

- control centre with a communications network
- in-vehicle on-board computer
- touch-screen display for driver
- in-vehicle displays for dynamic passenger information
- information displays at stops.

The communication and transmission of data between the central and mobile components can be achieved through a variety of means including private mobile radio, trunk radio, or public cellular networks (GSM, GPRS).

Figure 4 shows a Mobile touch-terminal for operating the on-board computer in public transport buses and trams.

Figure 4: Mobile touch-terminal for driver

[Source: http://www.siemensvdo.com/NR/rdonlyres/D21384A3-259F-4B8C-82AC-A46D68821298/0/IBISplus_Touch_3D_180x140mm_300_dpi_RGB.jpg]

2.4 Policy regarding traffic telematics in Europe

Increasingly, the continued growth of both private and commercial vehicular transport is leading to significant traffic and environmental problems in Europe. Capacity limits of transport infrastructure, especially in conurbations and on main interurban or interstate routes, are reached quite regularly. Problems are growing with the enlargement of the European Union which increases markets both in terms of geography and volume. Free trade and free travel in Europe, together with just-in-time methods of production and outsourcing of services to low-wage countries, are significant drivers of traffic demand.

Limits in infrastructure capacity could begin to endanger industrial growth. As an instrument for achieving more efficient use of the existing transport infrastructure, the deployment of traffic telematics applications are viewed as part of effective overall traffic management. As early as the 1990s, the European Commission, based on a Council Resolution adopted on the 28 September 1995, set up a working party of high level representatives of the Member States. This working party, called the Road Transport Telematics High Level Group, is responsible for the deployment of telematics in the road transport sector.

The main outcome of these activities was the Commission's "Communication on a Community strategy and framework for the deployment of road transport telematics in Europe" (COM (97) 223 final of 20.05.97). Here the Commission clearly identified that technical harmonisation, including standardisation, publicly available specifications, protocols, reference position documents etc., and the development of a Memoranda of Understanding by involved parties, are vital to ensure an appropriate level of interoperability between infrastructures and services to provide an optimum service to users.

The Commission identified five priority areas needing specific action to be taken in order to facilitate the implementation of Road Transport and Traffic Telematics (RTTT) in Europe. These are:

- RDS-TMC (Radio Data System - Traffic Message Channel)
- Electronic Fee Collection (EFC)
- Traffic Data Exchange
- Human-Machine Interface
- System Architecture.

In the past few years special attention has been given to the standardisation and harmonisation of Electronic Fee Collection systems as an essential part of traffic telematics applications in Europe. It is expected the European Commission Directive 2004/52 will have an especially high impact on the introduction of a European Electronic Toll Service (EETS) (see Section 3.6).

The German policy regarding traffic telematics is noteworthy for a national point of view. The Federal Transport Infrastructure Plan 2003[4] clearly states the national need for promoting modern transport technologies. For this reason the (then) German Federal Ministry of Transport, Building and Housing initiated the Economic Forum on Transport Telematics to bring together policymakers, industry, service providers, and the transport sector.

4 http://www.bmvbs.de/Anlage/original_17121/Federal-Transport-Infrastructure-Plan-2003.pdf

2.5 Drivers for traffic telematics applications in Europe

Electronic Fee Collection (EFC) remains a potential driver for the deployment of standardised wide-spread telematics solutions in Europe. The European Commission Directive 2004/52 on the introduction of a European Electronic Toll Service (EETS) requires the tolling systems in the Member States of the European Union to become interoperable by prescribing the use of GPS, GSM and Dedicated Short Range Communications (DSRC) technologies.

Standardisation for this purpose is ongoing, and mainly involves the application protocols for GSM and DSRC communications. Developments towards EETS have triggered new developments in on-board units (OBU) and communications standardisation and may also lead to developments in integrated telematics services.

Another driver may be that the European Commission will pay increased attention to tracking and tracing of animal transport (livestock management) in Europe. This is in accordance with Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport[5]. The animal transport tracking and tracing issue is strongly connected with the localisation of vehicles involved in the transportation of animals. European research projects have been conducted to investigate and demonstrate the technical possibilities for tracking and tracing these vehicles.

A feasibility study by the European Commission is currently in progress to investigate technical and procedural options for tracking and tracing transport involved in the movement of persons, animals and dangerous goods. The study is also investigating potential synergies with OBUs developed for the purpose of the EETS.

The combination of these initiatives in the mid-term may lead to a larger market for prime movers and trailer devices and put more pressure on standardised solutions.

In the context of this report it is a noteworthy conclusion that European policy does not necessarily trust market forces to introduce telematics services, but drives the sector through regulatory applications, such as electronic fee collection.

5 see also amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97

3. Transport Regulatory Uses of Telematics in Europe

3.1 Introduction

The following sections describe telematics applications that are representative of the use of telematics for transport regulatory uses. Each section contains a short description of the application and an assessment of its relevant features in the context of the application. A more detailed description of each application, including its background, development, implementation, and results, can be found in Volume 2.

The six applications considered in this report as transport regulatory uses of telematics in Europe are:

- Charging of heavy goods vehicles in Europe
- Digital Tachograph
- e-Call / Emergency Call
- Tracking and Tracing of Dangerous Goods
- European Electronic Toll Service
- Alpine Crossing Exchange

3.2 Charging of heavy goods vehicles in Europe

EFC has been a focus of European policy development over the last decade, with several guidelines and a number of binding regulations (Directives) issued on the subject. The most influential has been the Eurovignette Directive for heavy vehicles which sets limits for the value of lump sum temporal fees such as Vignettes, i.e. stickers that permit use of certain infrastructure for a given time period (for example a month or a year).

Several European countries have found the revenue generated by temporal fees insufficient and have developed plans to move towards distance-dependent fees, an area in which the Eurovignette Directive allows for considerably higher tariffs. In addition to this, policy-makers have adopted the ideas put forward in the policy documents of the European Commission that call for fees which better reflect actual road usage.

For these reasons, Austria (2004), the Czech Republic (2007), and Germany (2005) have introduced charging systems for heavy goods vehicles on motorways. Switzerland, although not a member of the European Union, also introduced a distance-dependent fee in 2001.

Although the four systems share some common features, they also differ in many respects. All can be considered relevant examples or even prototypes for different approaches to charging.

This report presents the four charging systems and compares them in terms of their background, policy, objectives, legal aspects, project aspects, procurement, implementation and the results obtained.

3.2.1 EFC Schemes: Description of applications

Considerable differences in charging principles, liable vehicles and charging parameters can be observed across the four nationwide EFC schemes implemented in Europe for heavy goods vehicles. The charging principle is mainly driven by policy decisions developed during the political discussion phase of the implementation of a nationwide scheme.

Table 1 gives an overview of the core policy-related aspects of the four charges. Table 2 compares the system implementation, especially the main aspects of the technical solution. Figure 5, Figure 6, Figure 7 and Figure 8 depict the relevant on-board units (OBU).

Table 1: Comparison of four HGV charging systems

	Austria	Czech Republic	Germany	Switzerland
TITLE OF SCHEME	GO Mautsystem für LKW und Bus (GO bus and truck tolling system)	Premid / MYTO CZ (Czech Truck Tolling System)	Toll Collect LKW-Maut Deutschland (Toll Collect Heavy Goods Vehicle Toll on German Motorways)	Leistungsabhängige Schwerverkehrs-abgabe (LSVA) (Distance-related heavy vehicle fee)
START OF OPERATION	1 January 2004	1 January 2007	1 January 2005	1 January 2001
CHARGED ROADS	All motorways and selected expressways	Phase 1: All motorways and expressways Phase 2: (from 1 January 2008): Selected ordinary roads	All motorways (with the exception of some sections) Since 1 January 2007 also three sections of ordinary roads	All roads in Switzerland
LIABLE VEHICLES MPVW: Maximum Permissible gross Vehicle Weight MPTW: Maximum Permissible gross Vehicle Train Weight	All Heavy Vehicles with a MPVW over 3.5 tonnes	All vehicles with MPVW of 12 tonnes or above and vehicle combinations with MPTW of v2 tonnes or above	Heavy goods vehicles with MPVW of 12 tonnes or above and HGV combinations with MPTW of 12 tonnes or above	All heavy goods vehicles with a MPVW over 3.5 tonnes
CHARGING PRINCIPLE	Distance and number of axles	Distance, number of axles and emission values	Distance, number of axles and emission values	Distance, weight limit and emission values
OBJECTIVES OF CHARGING	The LKW-Maut aims to: Guarantee the financing of the extension, operation and maintenance of the Austrian motor- and expressway network	The Czech Truck Toll aims to: Guarantee the financing of the extension, operation and maintenance of the Czech motorway and expressway network	The LKW-Maut aims to: Establish the 'user pays' principle. Additional revenue for finan-cing the motorway and expressway network. Fair competition for rail and waterways modes for goods transport. Improve the efficient use of HGV. Promote innovative technology.	The LSVA aims to: Create incentives for the transfer of goods traffic from road to rail. Internalise the external costs of transport. Finance new railway infrastructure, in particular the new rail tunnels through the Alps.

Table 2: Implementation aspects of the HGV charging systems

	Austria	Czech Republic	Germany	Switzerland
				
OBU TECHNOLOGIES	DSRC	DSRC	GPS and GSM (plus DSRC for interoperability and infrared for enforcement)	Tachograph and DSRC (GPS as redundancy)
OCCASIONAL USER SOLUTION	Mandatory OBU for all	Mandatory OBU for all	Manual trip booking at self-service terminals or via the Internet	Self-service terminals
OBU COSTS (MAGNITUDE)	€ 40 (AUD 65)	€ 40 (AUD 65)	€ 500 (AUD 800)	€ 500 (AUD 800)
INSTALLATION	Self installed (stick to windscreen)	Self installed (stick to windscreen)	2-4 hours in an authorised garage	2-4 hours in an authorised garage
ENFORCEMENT	Fixed gantries, some mobile units	Fixed gantries, some mobile units	Fixed gantries and a fleet of mobile units	Redundant information in OBU, some fixed gantries

Figure 5: Austrian OBU "GO-Box"

Figure 6: Czech OBU "Premid"

Figure 7: German radio-slot sized Toll Collect OBU

Figure 8: SWISS OBU "Tripon"

3.2.2 Operations and Costs

The European EFC schemes are operated by different institutions. In this report, regulatory solutions in Germany, the Czech Republic, Austria and Switzerland are discussed (see Table 3).

The split of roles and responsibilities are country and scheme specific. In schemes with a private operator, such as in Germany and the Czech Republic enforcement tasks are allocated with the authority. The private charging operator is in charge of the operation and maintenance of the physical enforcement infrastructure and is responsible for the manual verification of evidence records taken by automatically operated enforcement sites.

The same model applied at the launch of Austria's EFC scheme. Private company EUROPPASS was in charge of the enforcement scheme initially, but only until hand-over of verified and confirmed evidence records ready to issue a penalty notice. The operation of the Mobile Enforcement Units and the billing of penalties were under full control of the road operator ASFINAG. Since ASFINAG took over EUROPPASS in 2005, the entire operation, including enforcement, is the responsibility of ASFINAG. In Switzerland the entire HGV scheme is operated by the Swiss Customs Authority.

Costs of implementation and operation of the various schemes vary widely and depend to a large extent on the organisational, procedural and technical approach taken. In particular, the business and organisational model has an impact on implementation costs. If a new charging scheme can be implemented by an existing (public or private) organisation, the investments are much lower than when starting up a completely new 'green fields' company

Only limited information is available about the operation costs for privately operated schemes, as the service supplier receives a contractually fixed remuneration for the provided service, which is often composed of a flat annual rate plus a service level based variable component.

In regard to the operational costs of a charging scheme, the following general cost-drivers can be identified:

- business model and organisation of the operator (established organisation vs start-up)
- extent of outsourcing of tasks and responsibilities to third parties
- political or legal constraints to unify the equipment and infrastructure for frequent and occasional users
- procedural and technical complexity of the charging scheme
- model of remuneration of the operator (in particular if based on service level agreement or bonus/penalty schemes in context with the traffic volume).

Table 3: Regulatory organisation and costs of EFC Schemes across Europe

	Austria	Czech Republic	Germany	Switzerland
				
SCHEME OPERATOR (STATUS 2007)	ASFINAG Maut Service GmbH (MSG) on behalf of ASFINAG, the Austrian motorway and expressway operator. At start of operation EUROPPASS LKW Mautsystem GmbH was the charging operator. This company was a 100 % subsidiary of Autostrade S.p.A., Italy.	Kapsch Telematic Services - Czech Republic (KTS-CZ) on behalf of Road and Motorway Directorate of the Czech Republic (RSD). KTS-CZ is a private company and has a 10 year contract	Toll Collect GmbH was commissioned by the German Federal Government to set up the country's first EFC System. The contract was awarded by the Federal Ministry of Transport, Building & Urban Affairs (BMVBS; Bundes-ministerium für Verkehr-, Bau und Stadtentwicklung) TollCollect GmbH is a consortium of DaimlerChrysler (45%), Deutsche Telekom (45%) and French-owned Cofiroute S.A. (10%).	Eidgenössische Oberzolldirektion (OZD) / Federal Customs Administration (FCA), which operates the system, was put in charge of collecting the fee by the Federal Council.
ENFORCEMENT OPERATOR	Enforcement is covered by the scheme operator as well.	Generálni ředitelství cel CR / General Customs Directorate of the Czech Republic	BAG (Bundesanstalt fuer Gueterverkehr) [Federal Office of Goods Transport].	Enforcement is covered by the scheme operator as well.
COST OF SCHEME IMPLEMENTATION (ESTIMATION)	About € 350 million (AUD 586 million) for the complete commissioning of the system.	About € 827 million (AUD 1385). This figure includes the operation costs for ten years.	No official figures available. Investments estimated to be much more than € 1 billion (>AUD 1675 million).	The total investments into infrastructure and OBU up to date are about 300 million CHF (AUD 300 million). The procurement of the second generation of OBU (emotach®) a contract value of 50 million CHF (ca. AUD 51 million) has been awarded in 2006.
REVENUES (FOR 2007)	About € 900 million (AUD 1500 million) expected.	During first year of operation 5.57 Mrd. Czech Crowns (about 211 Mio. Euro) have been collected.	About € 3.4 billion (AUD 5.7 billion) expected.	About CHF 1500 million (AUD 1530 million) expected.
COST OF OPERATION (IN % OF REVENUES) (ESTIMATIONS ONLY)	About 8–10 % of total revenues. About € 90 million (€ 150 million) per year.	No figures available yet.	About 20 % of total revenues (contractual agreement). About € 700 million (£420 million) per year	About 6-8 % of total revenues in 2001 – 2004, as of 2005 less than 5% due same operation costs but higher revenues (see above). About 50-60 million CHF (AUD 51-20 million) per year.
OBU COSTS (MAGNITUDE)	First/second generation: € 40 (AUD 65) Third generation: € 20 (AUD 33)	€ 40 (AUD 65)	€ 500 (AUD 800)	TRIPON® [2000]: CHF 1500 (AUD 1500) emotach® [2006]: CHF 500 (AUD 500)

3.2.3 EFC Schemes: Assessment

Although the EFC applications described follow different technical approaches, they all aim to achieve the same result – a move towards more effective road infrastructure generating (the 'user pays' approach), additional revenues for investments in transport infrastructure and a more balanced modal split of transport modes (for example shift from road to rail). In general the four schemes have been meeting expectations but show some differences. In this report each of the four schemes has been assessed in terms of:

- technology
- acceptance issues
- procurement issues
- policy and economical issues.

Austria

In Austria, the official motivation for introducing a distance-based charging system for heavy vehicles was the desire to attribute costs more fairly based on use. However, there was also the urgent need for income to service the huge debts that ASFINAG accumulated during the period when Austria's major road network was built. Since the European Commission's Eurovignette Directive severely limits time-dependent charges, Austria decided to move to distance-dependent tolling of its motorway network to raise more revenue.

<u>Technology</u>

Austria's is the first free-flow tolling system in the world to employ mandatory OBUs. The Microwave DSRC technology again proved its maturity and reliability, without any delays in implementation or other technical/operational issues. In what could be considered somewhat of a surprise, the concept of offering no manual alternative to the OBUs worked well. Austria made sure that users could obtain OBUs close to every motorway entry in the country, without any administrative hassle. OBUs are free, except for a handling fee of € 5 (AUD 8). Users simply attach the OBU to the windscreen by means of a Velcro strip.

<u>Acceptance Issues</u>

The scheme was accepted from the beginning because of a smooth introduction, and a professional information and implementation phase. Transport operators also understood the need to raise additional revenue for the high-level road network.

<u>Procurement Issues</u>

An important part of ASFINAG's procurement strategy was to contract a turn-key supplier for the entire tolling scheme, with ASFINAG mainly fulfilling a strong review and steering function. The procurement process itself was split into three phases - capability assessment, tender phase and negotiation phase. The procurement and implementation was guided in a particularly professional and strict way. This was one of the main reasons for the successful and punctual operational start of the complete nation-wide system.

<u>Policy and economical issues</u>

Due to the well-managed preparation and implementation phase (which included a stable legal basis from the outset) there were no major policy or acceptance issues. The system is operating efficiently, consuming only about 10 percent of the total toll revenues for operations.

Conclusion

Austria's move from time-dependent stickers to a truly distance-dependent and, therefore, use-related charge went exceptionally smoothly. It would appear two factors have been most important for this success: the convenient all-electronic charging system that does not need continuous user interaction and the strong role played by contracting body ASFINAG in the procurement and implementation phases.

Czech Republic

The EFC system in the Czech Republic is in many ways a copy of the Austrian system. This is rather surprising since the government plans foresee a first phase where use of all motorways and expressways are to be charged (in which case a DSRC system similar to that deployed in Austria is indeed the right choice).However, in a second phase scheduled six months later, the much larger network of non-motorway interurban routes will also be charged.

These routes are not free of junctions, so there is no clear road segments such as those which exist on motorway networks. It is also difficult to erect physical gantries on the interurban roads since the roads and the surrounding land are owned by many different parties and building permits are difficult to negotiate. DSRC technology works best if only a few gantries are needed and if they can be erected quickly and at low cost. Hence DSRC is not well suited to the second phase of the Czech Republic's EFC implementation and an approach with a GPS-based OBU which requires no physical infrastructure at the road-side would appear to be more appropriate.

For these as well as various other reasons, the government has delayed the second phase and seems to be unclear on how to continue. Revenue charged in phase one from the comparatively small motorway network is flowing in without problems, but there is now no easy development path towards the desired extension of the charged network in phase two.

Technology

Microwave DSRC technology is used, with mandatory OBU as it is in Austria, with contract being won by the same company, Kapsch of Austria.

Acceptance Issues

The system started on time, but there were many uncertainties and concerns from the transport operator side because of what was considered misleading information regarding the start of operations. Fraud is reportedly rather high, apparently due to a not very stringent enforcement policy. As in Austria, the concept of mandatory OBUs was accepted rather well.

Procurement Issues

The scheme was tendered by the Czech Ministry of Transport as a turn-key supply and operations contract in a single-phase approach. Procurement and implementation occurred in a very tight timeframe. The procurement process was also overshadowed by rumours of unfair treatment of some bidders.

Policy and economical issues

Policy remains somewhat vague and, in particular, there was no continuity from one government to the next. Regarding the currently charged phase one network, revenue streams are good, but due to the lack of a clear long-term plan, it is not clear how to progress. It has become apparent that phase two will have to work with different technology and it is not clear how to harmonise this with the existing collection system for the phase one network.

Conclusion

In our opinion the Czech Republic is a good example of the dangers of having no long term policy. The Czech Republic opted for a fast track route to a tolling system by in effect modelling the Austrian motorway tolling system, but has now ended up in a dead-lock situation. The motorway coverage of the Czech Republic is comparatively low and the amount of revenue it can generate is limited. There has always been the desire to move to a second charging phase where more roads become liable, and this was even part of the tendering process.

Germany

The German motorway tolling system is the first system to employ GPS/GSM technology on an EFC on-board unit. The procurement was not without problems as the government apparently also pursued aims for strengthening national industry in the wave of telematics applications expected over the next few years. Implementation faced some problems and delays, not to be unexpected with new technology, but the system finally went into operation and appears to be running smoothly, proving to be a new charging system concept that is not heavily dependent on roadside infrastructure.

Technology

The German scheme has demonstrated that the use of GPS/GSM technology is feasible for tolling, but it does require additional roadside beacons for supporting the charging and enforcement function. However, the chosen booking procedure for users not equipped with an OBU is somewhat cumbersome.

Acceptance Issues

The system started after being delayed twice. As a result, transport operators were reluctant to register and install OBUs. Since the final start of operations, the system has been running properly and has won the trust and acceptance of users. The operational costs of the system, which exceed 20% of the revenue, have been heavily criticised by the press.

Procurement Issues

The scheme was tendered as a turn-key supply project by the German Ministry of Transport, Building and Housing using a two phase approach - capability assessment and a bid/negotiation phase. After being awarded the contract, the successful bidder had just eleven months to implement their totally new and untested system approach. This unrealistic implementation time, in combination with rather loose project control by the Ministry, led to severe delays being experienced before the system went into operation.

Policy and economical issues

As already mentioned, initially there was a relatively low involvement of the public management authority. This led to problems of lack of ownership for parts of the scheme and responsibilities that were unclear. On the industry side, the project was not primarily driven by requirements for charging but by industrial objectives (i.e. value added services). The outsourcing of services to the private sector requires stringent management by the contracting authority.

Since OBU costs are high, a possible extension of liability from the current fleet of vehicles of 12t and above to 3.5 t and above will probably worsen collection efficiency. It would appear the glamour of having the first satellite-based system overshadowed consideration of future policy plans.

Conclusion

The German tolling system was launched on the 1 January 2005 after two postponements. The original date for system launch was the 31 August 2003. The first postponement was as early as the award procedure. Two out of three bidders were rejected for formal reasons, with one bidder being included again after successfully filing an objection in court. These legal actions, plus the corresponding times for appeal, delayed the award procedure for about fourteen months. The dispute was eventually settled with the complaining bidder ending up as a subcontractor of the successful tender. By this time only eleven months remained for the implementation of the system. Everybody involved in the process should have been aware that it would be impossible to keep to this schedule.

A major problem in the implementation phase of the system was the lack of tolling know-how in Toll Collect, the winner of the tender. There was little knowledge of the freight business and little communication with trade organisations. Also, the members of the consortium were not focused on the tolling system. Instead their main motivation was related to specific interests. Examples include generating data traffic via mobile links for the cellular network of one of the partners in Toll Collect (Deutsche Telekom), and the prospect of installing several hundred thousand powerful telematics devices as a free platform for future commercial traffic telematics services (consortium partner Daimler-Chrysler).

Other issues were technical problems with the OBUs, insufficient geographical data about the German motorway network and problems with systems integration. An additional challenge fulfilling the requirement for 300,000 trucks to be fitted with an OBU before the system could be put into operation. This requirement was crucial, since with too many users utilising the manual system the motorway network would suffer from artificially-generated congestion.

There was poor project control by the Ministry as well as poor communication between the contractor and the Ministry. The Ministry was informed just weeks before the scheduled start that the system would not be ready. This lack of external project control was one of the main reasons for delays and for the lack of appropriate counter-measures.

After the management of Toll Collect had been changed and the company had become proactive regarding quality assurance, the system was launched without any critical problems. The system did, however, start with reduced functionality due to not being able to update the data in the OBUs. Only with new software (which required all OBUs to visit a workshop), did the system reach its full functionality.

In 2007 the tolled network was extended by the addition of a few expressways which were being used to bypass the tolled motorways. When implementing this change, restrictions in the flexibility of the system were experienced. The GPS-based system becomes error-prone when minor roads are near expressways (which are often as wide as motorways).

Another apparent limit on flexibility derives from requirements concerning non-discrimination. The OBUs would be able to work with toll tariffs based on the time of day, which is useful in managing congestion. But users of the manual system cannot predict the exact time when they will use a specific road, preventing the implementation of a time-dependent tariff. Due to European non-discrimination requirements, all users have to pay the same, and this means that the additional capabilities of OBUs compared with the manual system are worthless.

Hopes of exporting the technology have not yet been realised. To date the German tolling technology has not been sold to any other country, despite there having been some opportunities.

Also the hopes of the owners of Toll Collect for additional business via added services on the OBUs have not materialised. Under their contract Toll Collect deploys the German tolling OBUs, which are paid for by the government. Consequently, under the European open competition rules Toll Collect is not allowed to make additional private business out of this monopolistic situation.

Switzerland

The Swiss scheme is unique in several respects. Firstly, the fee objective is demand management and internalisation of external costs, with financing playing a secondary role. Secondly, the fee is charged for all distance travelled in Switzerland, independent of road type. It is also unusual that an authority operates the system without outsourcing the service.

Technology

The scheme design chosen in Switzerland requires a sophisticated on-board device which combines several different technologies: tachograph, DSRC, GPS, chip-cards, movement sensors. The Swiss system was the first to use such a complex device. The OBUs and back office systems work reliably and efficiently with low collection costs. Visitors to Switzerland mostly use a manual procedure that simply requires recording the distance covered and does not require the trip to be booked.

Acceptance Issues

The system was well accepted from the beginning both by the Swiss public and the industry, despite the high tariffs.

Procurement Issues

As operator of the system, the Swiss Customs Authority tendered individual bundles of infrastructure and hardware rather than the complete EFC system in one package. This strategy was taken to give the authority maximum control and flexibility, especially when re-procuring system parts in later years.

Policy and economical issues

The political goals have been reached. HGV traffic has been reduced by the predicted amounts, and transport efficiency, for example, expressed in the average load on per truck, has markedly increased. Revenue is comparatively high as trucks now pay both for the internal costs (wear and tear of the road, construction, financing) and the external costs (noise, pollutant emissions, accidents).

Conclusion

The Swiss Heavy Vehicle Fee is successful technically, but even more in terms of its effects. The fee is the implementation of a clear transport policy, and the desired effects on traffic have been reached.

3.3 Digital Tachograph

The tachograph is used to record driving and rest times of drivers of heavy vehicles. European legislation limits the allowed driving times and defines minimum rest times for drivers between consecutive trips. The data recorded by the tachograph is used by enforcement authorities, usually the police, to ensure compliance with these limits.

Europe has a long history of using the tachograph as a means for increasing traffic safety. Fatigue in drivers of commercial vehicles has been (and to some extent still is) a major cause of accidents. The tachograph is mandatory for heavy vehicles above 3.5 t and for buses carrying more than nine people.

Drivers must carry tachograph records with them for all days of the current week and for the last day of the previous week, to enable review by authorities.

Until recently, tachographs have recorded working hours and speed on paper disks that were constantly turned by a clock mechanism. Speed was obtained via a link to the vehicle’s gearbox. Initially a mechanical link, this was later provided by electrical pulses. In recent years the counting of pulses and the calculation of speed has developed from analogue electronics to a digital process but, regardless of the inner workings the recording media, there still remained the paper disk. Figure 9 shows such a disk, including the identification of driver and vehicle.

Figure 9: Disk of an Analogue Tachograph

It was comparatively easy to forge the information recorded on the paper disks, so interest grew in moving to an all-digital device – the digital tachograph. The digital tachograph no longer records by writing on a disk but stores data in digital memory which can be read on Smart Cards. Common European legislation now requires the replacement of the existing analogue tachographs and paper disks with standardised digital tachographs.

The introduction of the digital tachograph is an interesting case study in how policy becomes translated into technology. Although its introduction was postponed several times, the digital tachograph is now technically working and has been mandatory for all newly-registered heavy vehicles in Europe since the 1 May 2006.

3.3.1 Digital Tachograph: Description of application

According to the new EU regulations, all new vehicles put into service since the 1 of May 2006 which have a laden gross weight over 3.5 t or a capacity for more than eight (with the driver nine) people have to be fitted with a digital tachograph. Older vehicles with an analogue tachograph do not have to (but can) be upgraded with a digital tachograph. Retrofitting the entire HGV fleet would simply not be feasible. Even if an existing analogue tachograph breaks down, it is not mandatory for it to be replaced with a digital one. Figure 10 gives an overview of the main system components of a digital tachograph.

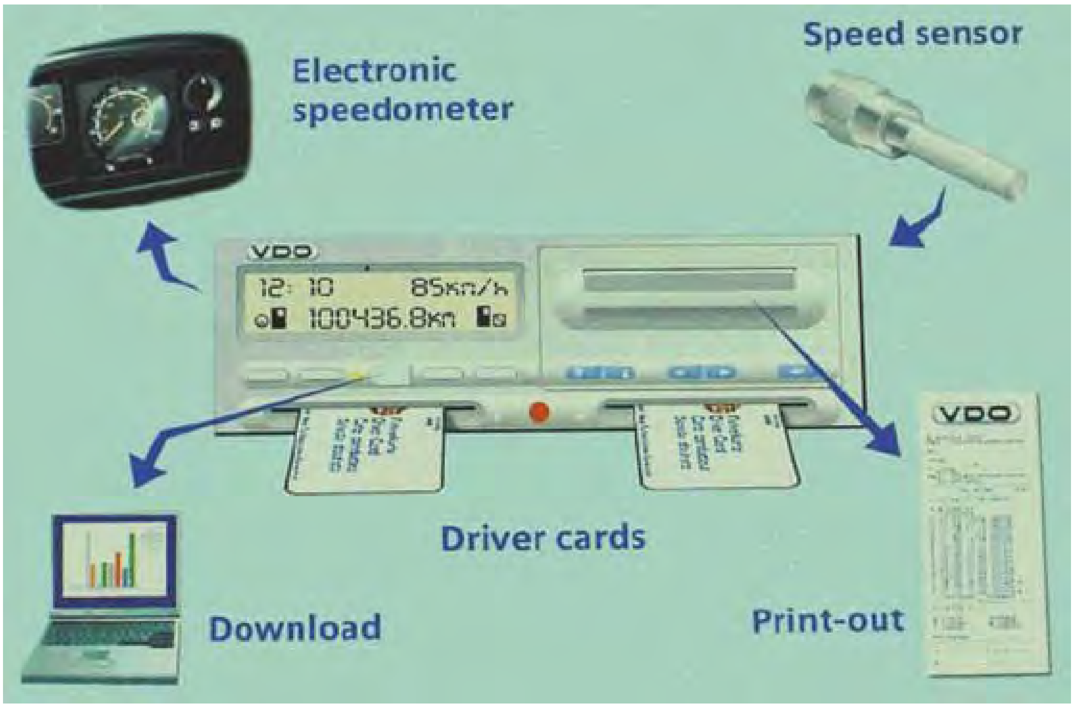

Figure 10: System Components of Digital Tachograph

[Source: http://www.transportoffice.gov.uk/crt/images/cont040238-1.gif]

The digital tachograph is a radio-slot sized unit essentially containing:

- two Smart Card readers
- integrated printer for producing reports for driver and enforcement officers
- display of all the key information, for example current driving and rest times
- real-time clock
- control buttons.

The digital tachograph is connected to the vehicle's gearbox by a sensor. The digital tachograph is the brain of the system and is able to hold in mass memory, data on drivers and their periods of driving and duty covering a period of about 12 months. Other data it holds includes information relating to faults, attempts to tamper or defraud the system, speeding, calibration details and times when data has been accessed (for example by the enforcement authority).

Installation and calibration of digital tachographs are carried out by workshops accredited by the relevant Ministry in each country. These accredited workshops are also in charge of maintaining and routinely testing digital tachographs.

The Smart Cards enable use of and/or give access to the data in the digital tachograph. They consist of a:

- Driver card–used by drivers to allow the recording of drivers' hours
- Company card–for use by the operator to protect and download the data
- Workshop card–available to vehicle manufacturers and authorised calibration centres
- Control card–available for carrying out enforcement tasks (for example Police)

The digital tachograph system relies on several stakeholders, as depicted in Figure 11 and detailed in Table 4.

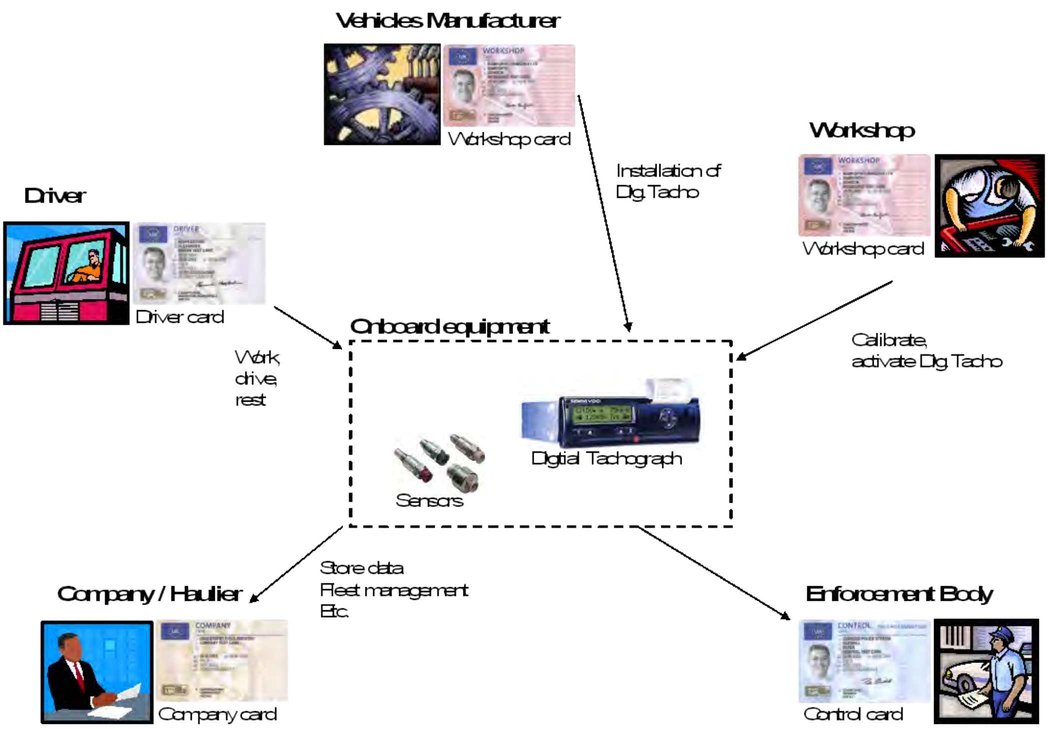

Figure 11: Stakeholders and Infrastructure

Table 4: Digital Tachograph Stakeholders

Stakeholder	Function / Responsibility
Vehicle Manufacturer	The vehicle manufacturer installs the sensors and the digital tachograph and activates the digital tachograph. To activate the digital tachograph, the manufacturer's workshop card is necessary. The recording of the vehicle movements by the digital tachograph starts.
Workshop	The digital tachograph has to be calibrated by the workshop. Parameters and data such as tire diameter, licence-plate number, etc. are entered. For this work, a workshop card is necessary. Each employee of the workshop has his own card with a personal PIN-code. After the first calibration with a workshop card, the encoded communication between the sensors and the digital tachograph is activated. From now on, all attempts at manipulation will be registered and logged, together with the date and time.
Company / Haulier	The vehicle is handed over to the owner of the vehicle. The haulier inserts its company card for the first time and from now on the mass memory on the digital tachograph is locked for his company. The access to the data on the digital tachograph is not possible with any another company card. Using the correct company card, the data can be downloaded at any time (provided it has not been overwritten with newer data).
Driver	Now the vehicle is ready for the driver. Before he starts his journey, the driver has to insert the driver card in slot 1 of the digital tachograph. If a second driver is on-board, he inserts his card in slot 2. Rest times, loading and unloading activities are all entered manually. The card is removed only at the end of work.
Enforcement body	During a control, the driver card stays in slot 1 and the enforcement officer inserts the control card in slot 2 of the digital tachograph. The enforcement officer can now download, print or just have a look at the recorded data on the driver card and the digital tachograph.

The tachograph has been mandatory equipment for heavy commercial vehicles in some European countries – such as Germany – since the early 1950s. Some drivers were being pressured to drive for as long a period as possible, leading to many accidents as a result of driver fatigue. A mandatory recorder of driving times appeared to be the only way to protect both the public and the drivers.

Introduced at the end of the 1960s, European Economic Community Council Regulation (EEC) No. 543/69 was the first multinational regulation concerning driving times and rest times of professional drivers. In 1985, by adopting a further Council Regulation, the (analogue) tachograph was finally declared mandatory equipment in the European Economic Community for trucks having a weight of more than 3.5 tonnes and buses carrying more than nine people. The regulation was effective from 29 September 1986.

Twelve years later, in 1998, the council of the European Union adopted a new Regulation which prepared the way for the introduction of a new kind of tachograph, commonly known as the digital tachograph. In 2002, a technical annex to this Regulation was released containing a technical specification which was binding for all European Union (EU) and European Economic Area (EEA) countries. The plan was that from 5 August 2004, 24 months after publication, all new registered vehicles would have to be fitted with a digital tachograph.

Due to difficulties experienced by digital tachograph manufacturers in obtaining type approval and the later delays by member states which had to make the necessary legal and practical arrangements (for example the issuing of Smart Cards) the mandatory introduction date was postponed several times.

3.3.2 Operations and Costs

Based on requirements in the EU Regulations (amongst others, EU2138/98) the European commission prepared a guideline and template for the National Certification Authorities (CA) policy in 2002. Each Member State was responsible for developing its own National Certification Authority policy and to establish the Member State Authority (MSA) which is the owner of and responsible for the National CA policy.

Each National CA policy has to be approved by the European Commission. However, each country was free to define the approach and organisation of their tachograph system, covering the generic functions and responsibility described in the guideline.

The tachograph system is a hierarchical system where a root is established at the EU level (ERCA) and is connected to the different Member States to make a consistent and secure system. The role of the ERCA is to securely certify the root keys of the Member States to establish a trusted certification chain.

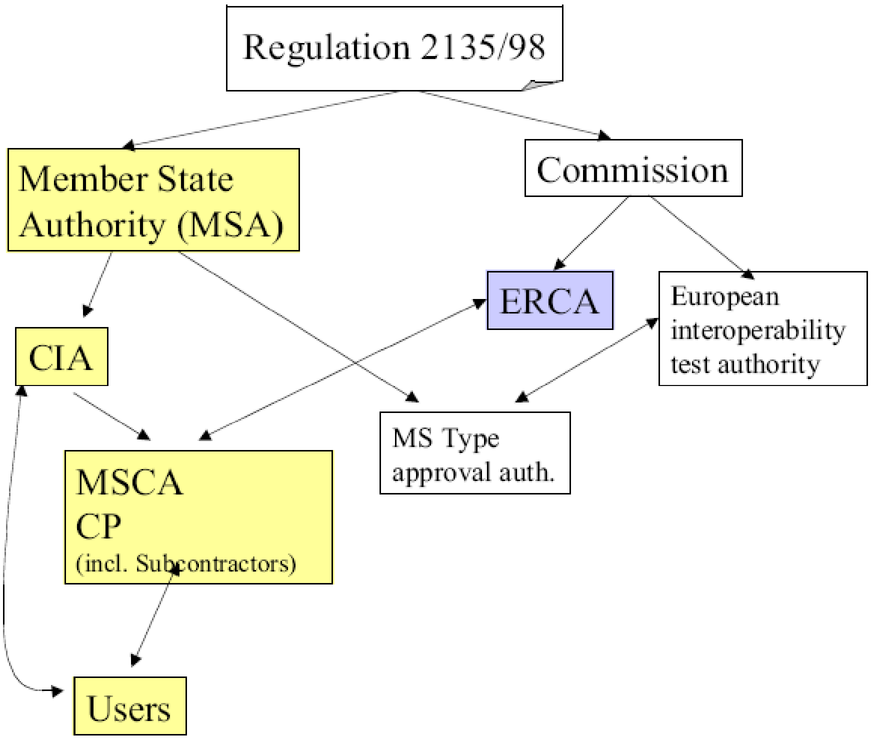

Figure 12: Tachograph system organisation

[Source: Guideline and template for the National Certification Authorities (CA), V1.0, 2002]

The following roles[6] are described in the guideline and their relationships illustrated in Figure 12:

- **Member State Authority (MSA)**
  The MSA has overall responsibility for issuing processes in the tachograph system on Member State level.
- **Card Issuing Authority (CIA)**
  The CIA can be part of the MSA organisation, part of another organisation in the Member State, or a subcontractor appointed by the MSA. The CIA carries out the issuing processes.
- **Member State Certification authority (MSCA)**
  The MSCA can be part of the MSA organisation, part of another organisation in the Member State, or a subcontractor appointed by the MSA. The MSCA carries out certain parts of the issuing processes.
- **Card Personalisation organisation (CP)**
  The CP can be part of the MSA organisation, part of another organisation in the Member State, or a subcontractor appointed by the MSA. The CP carries out certain parts of the issuing processes.
- **Users of equipment** (tachograph cards, vehicle units and motion sensors
  Users are defined as the users of the equipment of the tachograph system.

Based on the guideline for the National CA policy described above, any European country could implement its own system architecture, infrastructure and procedures according to its individual requirements.

Table 5 shows four examples which illustrate the variety of chosen solutions.

[6] Please note that these roles need not be separate organisations, they may be combined in one or more organisations.

Table 5: Digital Tachograph Stakeholders

	Austria	Czech Republic	Germany	Switzerland
				
Member State Authority (MSA) in charge of implementation of digital tachograph	Federal Ministry of Transport, Innovation and Technology Bundesministerium für Verkehr, Innovation und Technologie (BMVIT)	Ministry of Transport (MoT) Ministerstvo dopravy	Federal Ministry of Transport, Building & Urban Affairs (BMVBS)	Federal roads office FEDRO (Bundesamt für Strassen ASTRA)
Card issuing Authority (CIA)	Bundesanstalt für Verkehr (BAV) supported by ASFINAG Maut Service GmbH (MSG)	Ministry of Transport (MoT) supported by private organisation. (see Figure 13)	Federal Motor Transport Authority (KBA, Kraftfahrt-Bundesamt) (see Figure 14)	Federal roads office FEDRO supported by Federal Customs Administration (FCA) and
Card Application Authority (CAA)	[7] DC and CC: ASFINAG Maut Service GmbH. ARBÖ[8] ÖAMTC WK and CC: ASFINAG Maut Service GmbH	Network of contact points across the entire country operated by a private company (Asseco Czech Republic, a.s.).	Determined by the Federal States (Bundesländer) individually.	DC: Cantonal Road Authorites (StVA) CC: StVA WK: FCA EnfC: StVA
Card Manufacturer (CM) / Card Personaliser (CP)	Austria Card Plastikkarten und Ausweissysteme GmbH on behalf of MSG	Private company (Asseco Czech Republic, a.s.).	Federal Motor Transport Authority (KBA) with subcontractors.	Card manufacturer Trüb AG, Aarau
Control Bodies / Enforcers (CB)	Bundesanstalt für Verkehr (BAV)	Customs Dedicated enforcement authority on behalf of the Ministry of Transport	Federal Office of Goods Transport (BAG, Bundesamt für Güterverkehr)	Customs Enforcement bodies for working and rest times (Arbeits- und Ruhezeitkontrolle)
Workshop Approval Authority (WAA)	n/a	n/a	n/a	Federal Customs Administration (FCA)
Number of domestic vehicles	Ca. 90.000	Ca. 150.000	Ca. 3.000.000	Ca. 54.000
Costs per unit	No figures available, estimation about € 500 - 600 (AUD 800 – 1000) excl. installation.			
Costs for installation	No figures available as installation is done either at manufacturer's site or by the vehicle dealer. There is no obligation to retrofit vehicles. Replacement of an analogue tachograph by a digital is only necessary if the analogue tachograph cannot be repaired. "Cost of Installation" of a digital tachograph might be comparable to the installation of a complex EFC OBU € 100 – 150 (AUD 160 – 250).			
Costs of implementation	No figures available	No figures available	No figures available	No figures available.
Costs of infrastructure incl. smart card system	No figures available	No figures available	No figures available	Using the existing smartcard system of the Swiss Heavy Vehicle Fee
Costs of system operation per year	No figures available Depending of number of vehicles registered in the country, number of authorised drivers and changes during the year. Costs are party covered by the fees charged for application of new cards, replacement of stolen and lost cards etc.			

[7] DC: Driver Card, WK: Workshopcard, CC: Company Card, EnfC: Control Card

[8] ARBÖ - Auto-, Motor- und Radfahrerbund; ÖAMTC - Österreichischer Automobil-, Motorrad- und Touring Club (Motorists clubs)

Czech Republic approach to the tachograph system

Figure 13 shows the system architecture implemented in the Czech Republic. Some of the tasks, such as the network of contact offices and the personalisation of the Smart Cards, have been out-sourced to a private company.

The Ministry of Transport is the Card Issuing Authority (CIA) and is also responsible for all interfaces within the system. Drivers and companies can apply for the Smart Cards, which are centrally personalised and then mailed to the applicant.

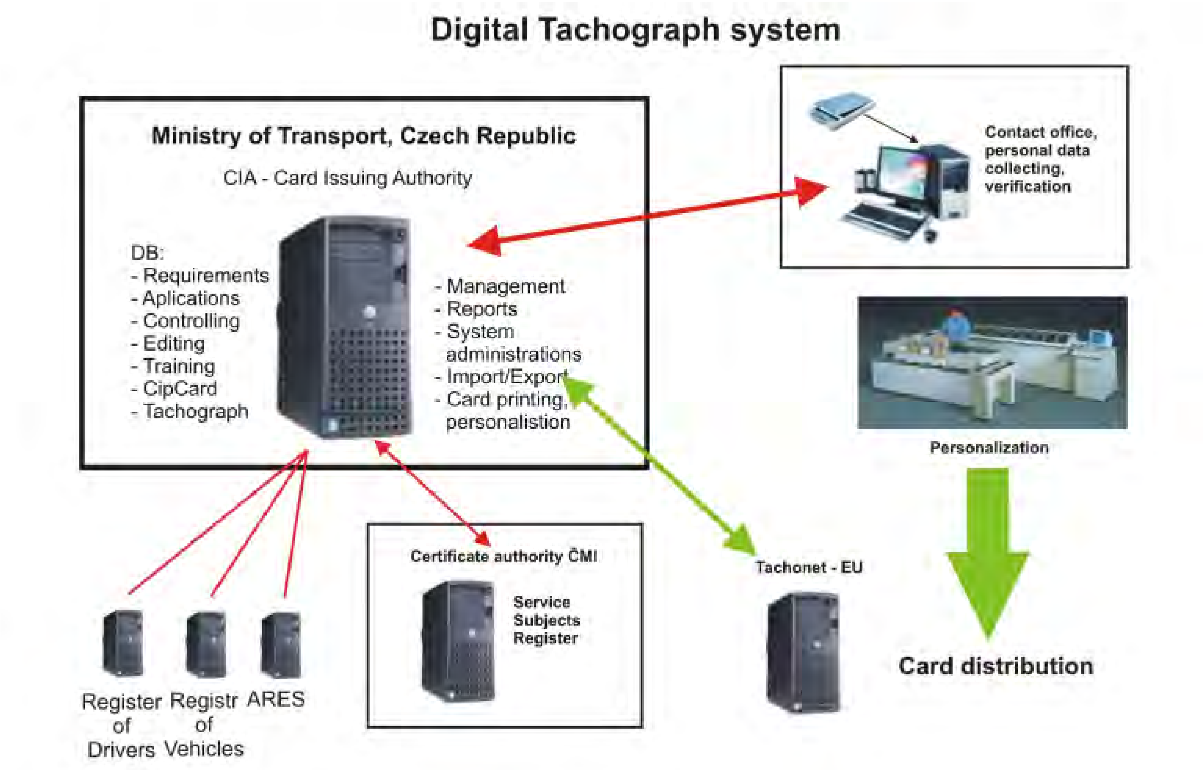

Figure 13: Czech Republic approach to the tachograph system

[Source: http://www.cdv.cz]

German approach to the tachograph system

Since 2005, the Federal Motor Transport Authority has managed the Central Register of Digital Tachograph Cards, which is used for control purposes. Its aim is to ensure that the cards for digital EC-tachographs are issued in EU Member States to authorised persons only and that each authorised person holds only one card. Information from the Register is issued to authorities within Germany via the Central Traffic Information Service (CETIS) and to non-German authorities via the European communication and information system "TACHOnet" (Figure 14).

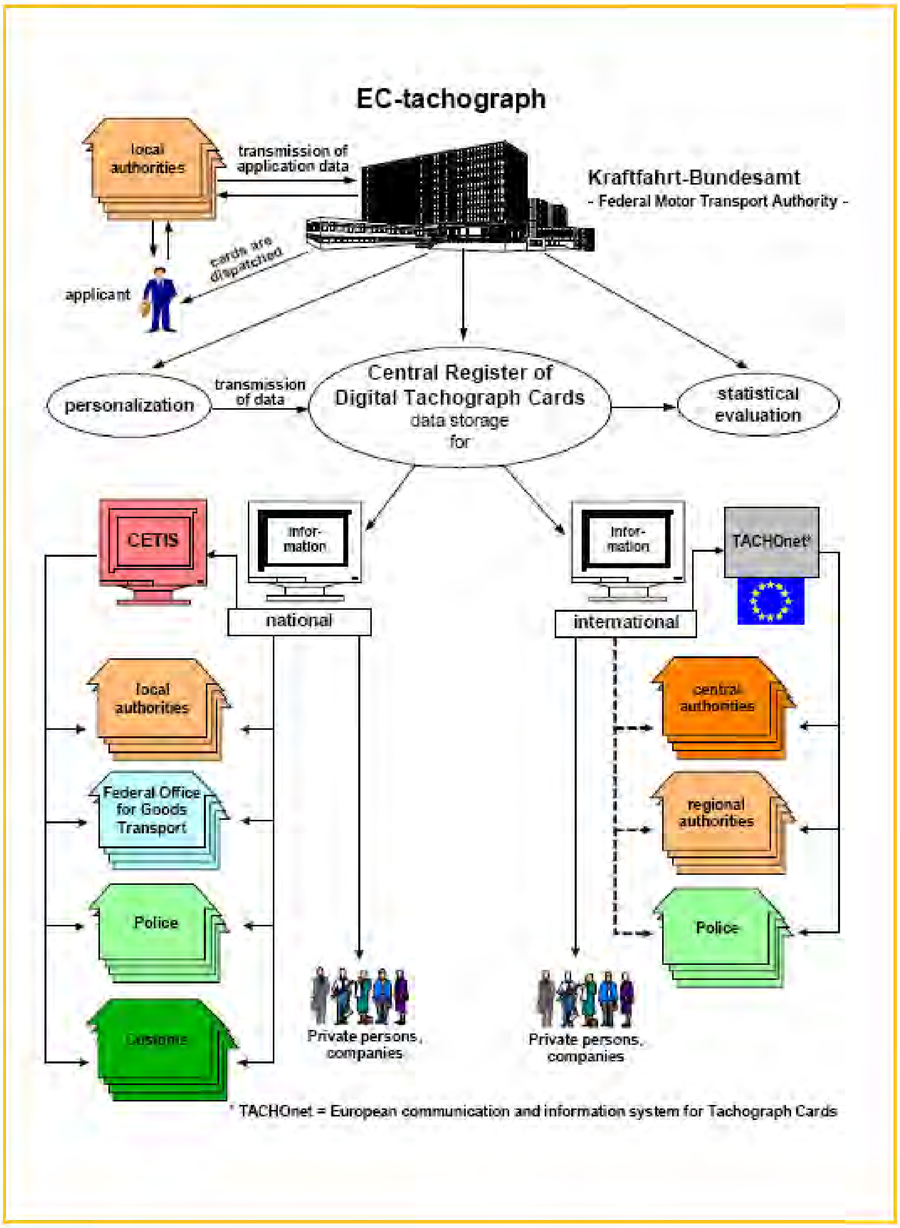

Figure 14: German approach to the tachograph system

[Source: http://www.kba.de]

On behalf of the German Member State Authority (D-MSA), integrated in the Federal Ministry of Transport, Building and Urban Development (BMVBS), the Technical Department of the Kraftfahrt-Bundesamt (Federal Motor Transport Authority) provides the required annual security assessments. The procedure for the assessment has been adopted by the BMVBS (Figure 15).

The main goal of the assessment is to check the compliance with requirements of the Council Regulation for recording equipment as well as with the European and German safety policy.

The following organisations are included in the assessment:

- The German Certification Authority (D-CA), which is responsible for certification of equipment keys for hardware manufacturers.
- The tachograph cards personaliser (D-CP).
- The manufacturers of vehicle units and motion sensors.

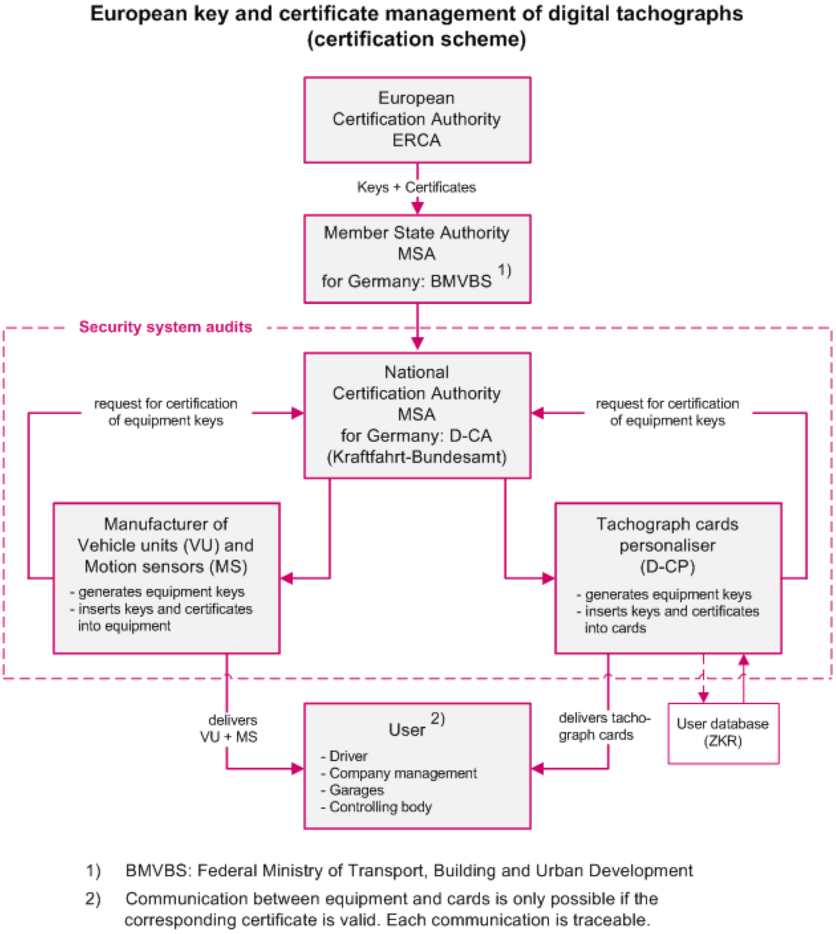

Figure 15: System architecture: German Model

[Source: http://www.kba.de]

Swiss approach to the tachograph system

Switzerland has also adopted the European guideline and template for the National Certification Authorities (CA) policy. Figure 16 is an illustration of how the Swiss tachograph system is organised.

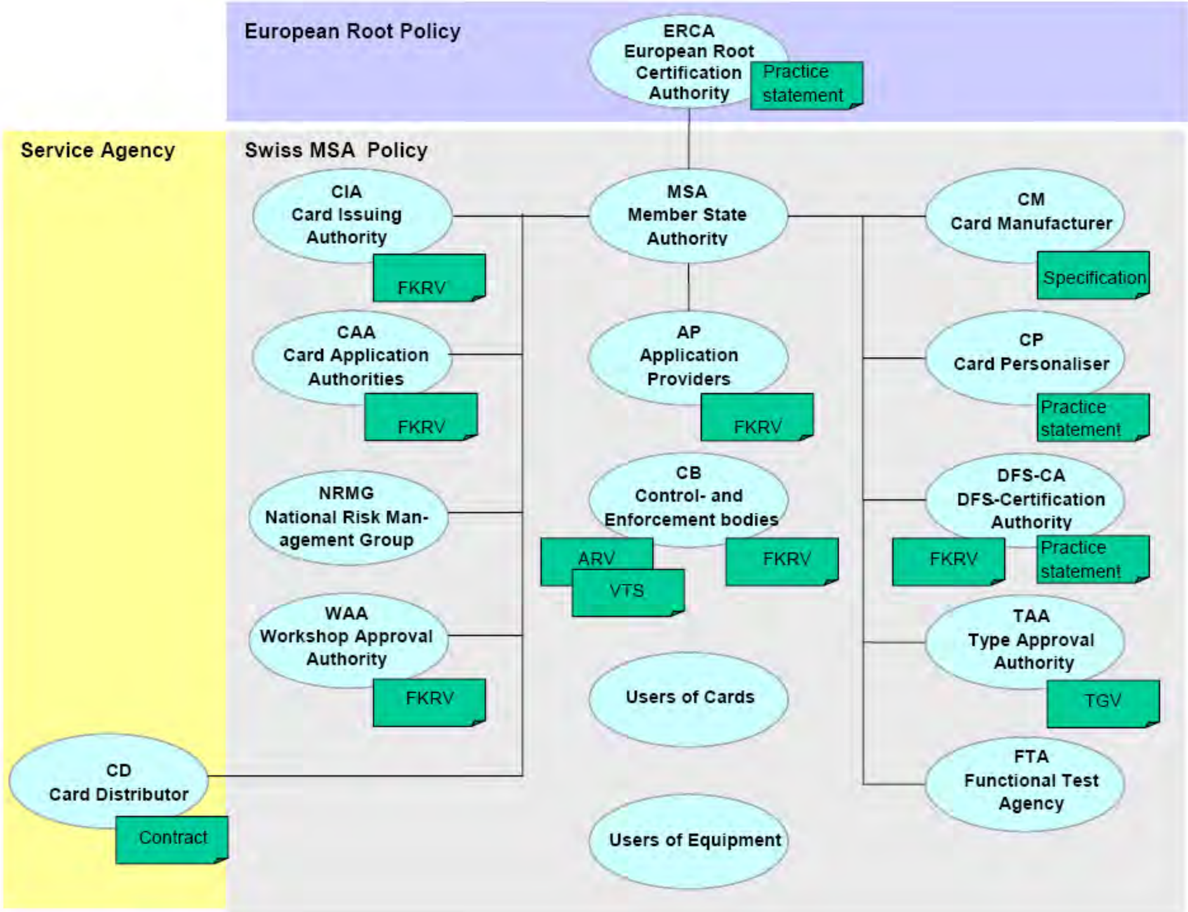

Figure 16: Swiss approach for tachograph system

[Source: http://www.dfs.astra.admin.ch/downloads/CH/default.htm]

3.3.3 Digital Tachograph: Assessment

The EU intended to take advantage of the newly available tachograph technology to ensure the security of the recording of the driver's duty periods. The digital tachograph is less vulnerable to tampering by users, such as attempting to distort the data, and it is basically impossible to manipulate the recording of the data. The digital tachograph also allows easier and better checking for compliance by operators and enforcement authorities.

The introduction of the digital tachograph was difficult and required more time and effort than expected. Several reasons can be identified as to why the introduction was a lengthy process and why implementation had to be postponed a number of times:

- **Approach and structure of the decision-making process in the European Union**
  One of the declared goals was to improve the security of the device. One undeclared motive was to break the monopoly providers had developed over the years. The digital tachograph could be produced by any capable manufacturer of vehicle electronics without the need for special capabilities.

  Other countries were delaying the process since they had little interest in having an overly efficient tool. An optimal device would include, for example, a DSRC interface for remote (and even automatic) readout, which would make very dense compliance-checking possible. The result was that many compromises had to be negotiated in preparing the technical specification.

- **Focus on technology instead of on processes**
  The schedule was far too ambitious because the associated processes received little attention and were poorly defined originally. The complexity of the type-approval process was underestimated. Countries underestimated the time and organisational effort needed to set up national regulations and organisational arrangements, for example the issuing smart cards. Many countries learnt late in the introductory phase that the digital tachograph was not just new hardware, but required a completely new organisational framework, including, for example, the issuing of cryptographic keys to several parties.

- **Specification too technical and too complex**
  The specification covers hundreds of pages of technical prescriptions and is highly detailed. It proved very difficult for industry to produce compliant equipment that could be type-approved. A more functional specification would most likely have been easier to follow.

Today, the digital tachograph lives up to the majority of its original objectives:

- improvement of road safety
- increased resistance of tachograph records to manipulation
- support for the execution and enforcement of social legislation and for protecting drivers against exploitation.

In addition, the design of the new generation of tachographs allows operators to access the data and to utilise the technology to support additional services such as fleet management.

3.4 e-Call / Emergency Call

One focus of regulatory telematics activities in the transport sector in Europe is on improving and harmonising access and handling of emergency calls in Europe. These activities include the introduction of a single common phone number, multi-lingual response by intelligent routing of calls, and the introduction of automatic, GPS-assisted delivery of emergency messages (known as e-Call).

E-Call is one of the key elements of the European Commission's eSafety Initiative. E-Call promotes a pan-European in-vehicle emergency call service that builds on a location-enhanced single European Emergency Number (E112). The e-Call system is made up of the following elements:

- a single European emergency number (112) with multi-language support,
- automatic location transmission calls (E112), and
- manual and automatic triggers.

This section focuses on the institutional hurdles and stakeholder issues associated with e-Call, as the technological aspects are less challenging than the soft aspects.

3.4.1 e-Call: Description of application

An e-Call is an emergency call which can either be generated manually by vehicle occupants or automatically via activation of in-vehicle sensors. The e-Call product is optimised to trigger an emergency call when a set of standardised sensors in the vehicle reaches a threshold value. The sensors include:

- front crash sensors
- rear crash sensor
- side crash sensor
- airbag sensor
- roll over / vehicle inclination sensor.

To avoid false alarms, at least two sensors have to be triggered. In the case of a manually generated e-Call, a double check mechanism is in place to avoid unintended e-Calls. A verification of the e-Call via voice link is possible.

The e-Call sends a Minimum Set of Data (MSD) to the Public Service Answering Point (PSAP). The mandatory MSD includes:

- time stamp
- precise location including direction of driving
- vehicle identification
- identification of service provider
- e-Call qualifier (as a minimum an indication stating if the e-Call has been manually or automatically initiated).

When an e-Call is generated, the system also establishes a voice connection to the relevant PSAP (Figure 17).

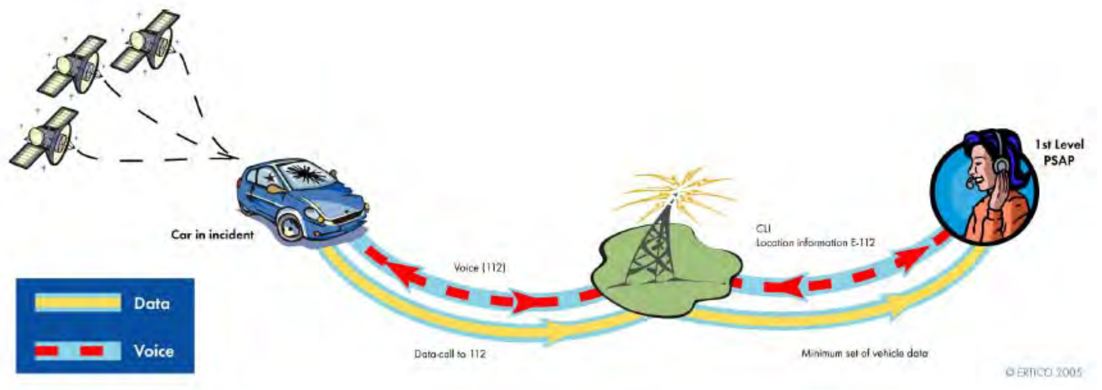

Figure 17: Overview of the basic architecture

[Source: http://www.esafetysupport.org/en/ecall_toolbox/]

Advantages of e-Call

According to the results of an analysis conducted by the E-MERGE project (which is supported by the European Commission), e-Call will allow a reduction in accident response times of about 50% in rural areas and up to 40% in urban areas (Figure 18).

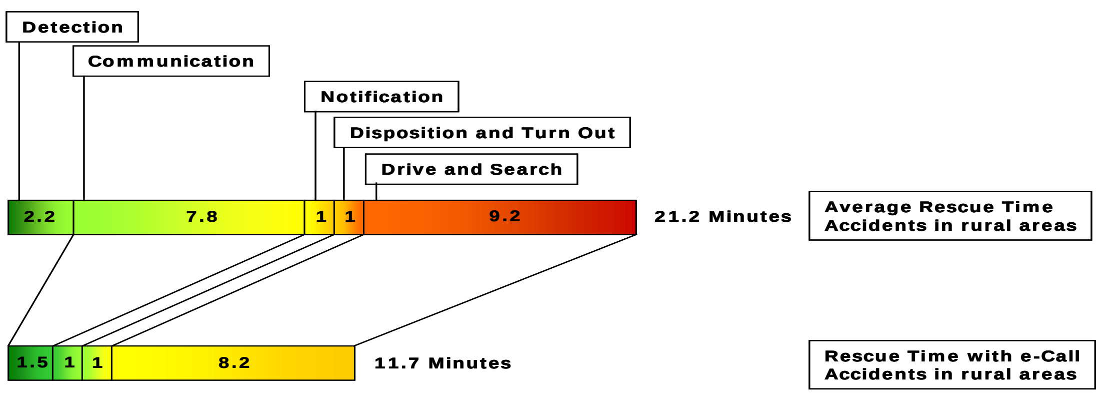

Figure 18: Time saving with e-Call in rural areas

When access to medical care for the severely injured can be provided quickly after an accident, the death rate and severity of trauma can be reduced significantly. Estimates for e-Call indicate that up to 2,500 lives can be saved per year in the European Union.

Road accidents can also lead to traffic congestion and have the potential to cause secondary accidents. By facilitating a shorter rescue time, e-Call can reduce traffic congestion associated with an accident by up to 20%. It also enables other road users to be informed about the incident more quickly.

Shorter response times in providing medical assistance may lead to improved healing and recovery prospects for accident victims suffering serious injuries.

Economically, savings, up to €26 billion (AUD 43 billion) could be saved per annum if all cars were equipped with e-Call.

Even in situations when the driver is unconscious, an automatic call is guaranteed. No false alarms are expected (at least two sensors and double-check mechanism when triggered manually), and a verification of the e-Call via voice link is possible. The PSAP receives direct, real-time MSD with all relevant information.

Due to the standardisation process in Europe, e-Call technology will work in all EU Member states as well as Iceland, Norway and Switzerland.

Stakeholders

The key players involved in the e-Call process are members of four large stakeholder groups (Table 6):

- automotive industry
- mobile telecommunication industry
- public emergency authorities and associated or cooperating service organisations
- public social security organisations and private insurance companies

Table 6: e-Call stakeholders

Stakeholder	Functions / Responsibility
Automotive industry	The industry needs to implement the hardware for e-Call in the vehicle. The sensors have to be installed as well as the button for a manually generated e-Call.
Mobile telecommunication industry	The telecommunication companies have to allocate enough capacity on the network for e-Calls (voice and MSD). They also have to enrich the 112 call with cellular location. It is important that there are no delays in the transmission of the e-Call.
Public emergency authorities and associated or cooperating service organisations	This stakeholder has to ensure that e-Calls can be answered within a reasonable time. That means enough staff is available and trained to handle e-Calls. The infrastructure of the PSAPs has to be ready to handle e-Calls. The whole chain to emergency services has to be without a break (voice and data).
Public social security organisations and private insurance companies	These organisations and companies should support and promote e-Call in order to achieve the benefits of reducing the rate of injuries and deaths. To give e-Call a further push of publicity, the insurance companies should give drivers with implemented e-Call infrastructure in their vehicles some kind of benefit.

3.4.2 Operations and Costs

The implementation of e-Call across Europe is not likely in the short term. Apart from some small-scale research and experimental schemes, no nation-wide schemes are in operation at this stage. As a result, no information about organisational approach and costs can be provided at this time.

Many stakeholders are complaining that the European Commission started the e-Call initiative and is driving it on a political level, without a good business case. At the moment, it is hard to justify e-Call in business terms. The scheme would appear to be driven by other interests, and this may well lead to Member States formally agreeing to the initiative, but in practice do little to support the programme.

3.4.3 e-Call: Assessment

At present, more than 40,000 people are killed and 1.8 million injured annually in about 1.4 million traffic accidents on the roads of the European Union. Those involved in accidents are often not able to call from their mobile phones and often do not know their position, especially on interurban routes and when travelling outside of their home countries.

A Memorandum of Understanding (MoU) on arrangements for implementing the plan, which sets out measures to be taken by the Commission, Member States and the automotive, telecom and insurance industries, now has over 50 signatures (status 15 December 2006) from industry, the European Commission and the Member States.

The original implementation roadmap aimed to implement e-Call all over Europe by 2009. A revised roadmap has been presented together with a Commission Communication adopted on 23 November 2006, "Bringing e-Call back on track – Action plan". The introduction of e-Call as a standard option in all vehicles is now expected to take place in September 2010.

The major problem with implementation is that all key members have to sign the MoU before a pan-European e-Call can be realised. Several other implementation issues have also been identified (not all apply to every state):

- European / International standards are not available yet
- investments needed in the public PSAP infrastructure are not clear
- decentralisation of the E112 service
- concerns from some major stakeholders, including the telecommunication industry
- lack of pilot projects
- lack of public information
- lack of user demand (associated with lack of promotion and advertising of the service and the technology).

Different European projects have been launched concerning e-Call, most of them as part of the eSafety initiative.

A number of car manufacturers offer similar products to e-Call. These solutions are on a private basis and the e-Call is not routed directly to the nearest PSAP but to a Private Service Provider. If the Private Service Provider is unable to talk to the driver or decide that emergency services are needed, they inform the PSAP and provide information about the vehicle and its position.

When considering the slow development on the regulatory side, one gets the impression that stakeholder commitment is low. One reason might be that e-Call is certainly not the killer application that will promote wide-spread deployment of traffic telematics. For industry, there is little to gain. The devices are low-cost, invisible and difficult to market.

During private discussions with decision-makers in different authorities, it became clear that people generally believe e-Call does not have a convincing business case. It would appear the savings in rescue-time offered by e-Call are either not well explained or are not viewed as real. Since e-Call is a Commission initiative there is also an element of resistance to being pushed into something by the central bureaucracy of Europe.

3.5 Tracking and Tracing of Dangerous Goods (TTDG)

The transport of dangerous goods by road carries with it the risk of serious incident in the case of an accident. Spillage of dangerous goods may lead to fire, explosion, chemical burns or environmental damage. Carriage of dangerous goods by road or rail is regulated internationally by agreements and by European Directives.

Several initiatives are using telematics technologies to address the improved handling of the transport of dangerous materials. Applications in this domain, while appearing to be especially interesting for the early deployment of telematics services to the market, have so far failed to be successful.

The following sections highlight the difficulties and misconceptions that have occurred in this area and assess what conclusions can be drawn for similar approaches.

3.5.1 TTDG: Description of application

In Europe several projects concerning telematics-assisted approaches to improve the transport of dangerous goods have been launched but as yet none have been adopted for commercial use. Volume 2 describes several projects that are representative of these approaches. A typical example is the TradgGIS project conducted in Finland, which is discussed here.

TradgGIS

The Finnish Ministry of Transport and Communications has, together with several other organisations, participated in a large scale project, called TradgGIS, financed by the EU-Life fund. The aim of the project was to create a GIS-based tool for managing environmental risks associated with the transport of dangerous goods. As part of the TradgGIS project, a classification system was developed for environmental risk factors, based on the soil and water properties of the transport routes. Simultaneously, an IT tool was developed aimed at enhancing mitigative measures both in the planning stages and during immediate and longer term clean-up operations.

The system was piloted in Central Finland during the European summer of 2000. Once the Life project ended, the resulting GIS-based data management system was made available through the Ministry of Transport and Communications website under the name VAKSU - a tool for planning the transport of dangerous goods.

A risk classification of traffic areas was created with the main objective being to assist in soil and water conservation. The traffic areas were divided into smaller sections that represent different environmental risk types. The data was subsequently transferred into a GIS. The data stored in a GIS database can easily be used and modified for environmental management purposes.

As illustrated in Figure 19, the main functions of the pilot system were:

1. **Input of Transport Data**

The data relating to the transport task and the cargo are entered into the database using a web-form from the TradgGIS system. This is done by the vehicle driver or by the company.

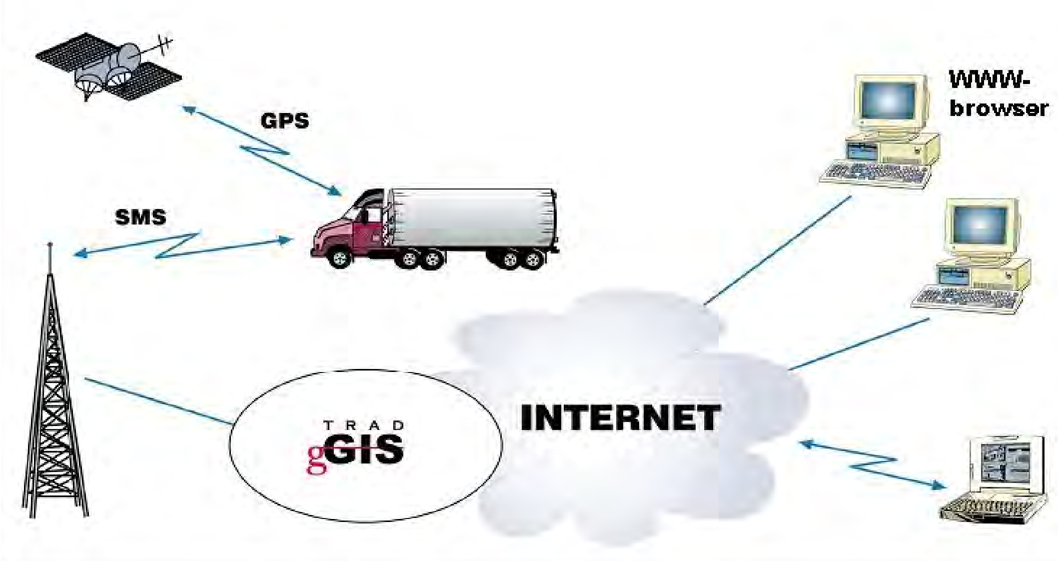

Figure 19: Architecture of the TradgGIS system

2. Observation of the position and status of the transport vehicle

The system receives the vehicle's position data. The vehicle's position is determined by time intervals or by when the vehicle entered certain areas. Authorised users see the position of the vehicles via an Internet browser on a zoomable map. In the event of an accident, the system receives position data and alarms from the vehicle. When a vehicle carrying dangerous goods is involved in an accident, an alarm passes via the system to the users. Details of the accident are received by all users connected to the system. The alarm and the messages concerning the position of the vehicle are passed to the system as SMS via GSM network.

3. Control of an accident

In the event of an accident the latest data on position, transported goods, the circumstances of the accident site (i.e. the risk classification of the traffic area), the operation instructions and contact information of specialists are obtained from the system. The system also sends a notice to predefined e-mail addresses.

4. **Examination of previous accidents**

Accidents can be searched from the database by position, time and by transported goods. The GIS is responsible of storage and use of the following data:

- risk classification of the traffic areas including operation instructions
- surface water, ground water and soil conditions
- map data
- data of an ongoing transport task
- data concerning the cargo
- contact information of specialists
- accidents which occurred.

3.5.2 Operations and Costs

The tracking and tracing of dangerous goods presents a similar situation as e-Call applications. Due to the lack of large-scale or nation-wide operational schemes no realistic information about organisational approach and costs is currently available.

However, what has become clear through several national studies is that there is no business case in commercial terms. In previous studies Rapp Trans has found that dangerous goods transport is about a factor of ten less dangerous than the average goods transport. The reasons for this appear to be that dangerous goods vehicles are well maintained and their drivers have been specially trained and are tightly supervised.

In addition to this, accidents with dangerous goods transport vehicles are often no different to other accidents. Only in rare cases are dangerous goods spilled and endanger a larger population or critical environments such as water supplies. In fact, most of the high-impact accidents in recent years have been caused by vehicles with loads that have not been classified as dangerous.

3.5.3 TTDG: Assessment

The experience gained from the occurrence of serious accidents in road tunnels in recent years (e.g. the Tauern Tunnel and Mont Blanc Tunnel 1999, Gotthard Tunnel 2001) have not only confirmed weak points in the management of the transport of dangerous goods, but also the danger of such transport movements at critical sections of the major motorway network. The transport of dangerous goods represents a high safety risk, particularly in tunnels and areas with large traffic volumes or in sensitive ecological environments.

Accidents in road tunnels have led to the launch of numerous initiatives and programs across Europe, including research projects regarding the tracking and tracing of dangerous goods transport and the testing of numerous pilot systems. Despite this, to the authors' knowledge, none of these numerous research and pilot projects launched across Europe have been migrated into real operation. No commercial or governmental system for TTDG is in real operation at the moment.

It appears that the introduction of systems for TTDG is complex and additional efforts are required before TTDG can become a standard application. The reasons why TTDG has not been implemented in Europe include:

- lack of European Regulations and standards to implement TTDG applications across Europe
- complexity of the requirements and the necessary measures to be taken to guarantee proper functionality of TTDG
- operation and maintenance of TTDG is complex and is said to be quite costly.

The EU-financed TradgGIS project in Finland identified a number of related specific questions:

- How can the companies be motivated to release transport data to the authorities' systems?
- Is it possible to specify generally-acceptable methods of action and data transmission in order to obtain the required data from the companies? The companies cannot be expected to enter information concerning cargo and transport into the systems manually. Input must be automated.

As an overall appraisal of the prospects of TTDG, the view can certainly be taken that action needs to be taken to improve the response to transport involving dangerous goods. However, it should be noted that none of the large tunnel accidents that received a great deal of attention in recent years involved goods classified as dangerous prior to the accident.

The fires were large because the calorific content of the material (margarine in one case, old tires in another) was large and the fires developed large amounts of smoke. An analysis conducted by Rapp Trans for a Swiss national research project found that road accidents involving dangerous goods were no more severe than ordinary accidents, and were less frequent by a factor of ten due to very stringent regulations on driver training, maximum driving hours and maintenance of the vehicles. In fact, the transport of normal goods proved to be much more dangerous. (This does not hold true for transport by rail, where hazardous goods by their sheer volume can lead to destruction on a much larger scale.)

Nevertheless, accidents involving hazardous goods require special treatment, and telematics support would be welcome. The technology is available, but apparently there is still no clear view about a suitable application.

3.6 European Electronic Toll Service

European legislation, and specifically EU Directive 2004/52/EC on the interoperability of electronic fee collection systems, mandates that the diverse electronic charging systems in Europe become interoperable through the use of prescribed technologies (GPS, GSM and DSRC) and according to a fixed time-plan. The new interoperable service is known as the European Electronic Toll Service (EETS).

The prescriptive and regulatory approach to a classically private application is interesting in itself, and the ongoing process gives valuable insights into issues regarding the relationship between the private with regulatory sectors, the difficulty in prescribing a business case and the harmonisation of procedures across diverse environments.

3.6.1 EETS: Description of application

The European Commission has been promoting interoperability of the European road charging systems for more than 10 years. The activities are fuelled by one of the core principles of the European Union: the free movement of goods and services. By promoting interoperability, the Commission intended to remove a potential obstacle to trans-European goods transport.

In more recent years, a second motive has become important: the industrial policy to develop an Intelligent Transport Services industry in Europe. The policy is driven by the vision to improve the flow and effectiveness of road traffic and transport through the use of modern telematics technologies, especially satellite localisation (GALILEO).

The EC has pursued the two policy objectives of developing EFC interoperability and of developing an ITS industry, initially through sponsoring European research projects and more recently through the framework of an Interoperability Directive.

It has also become obvious, especially for heavy vehicles, that there is a need to make available single, harmonised technical access to all charging systems currently deployed in Europe. Several charging systems for heavy vehicles have been deployed in recent years, all working from different charging principles, policy objectives and technologies (Figure 20).

Figure 20: For heavy vehicles interoperability of charging systems becomes a necessity
Picture taken from a truck at a Swiss/German border crossing with the following equipment on the windscreen: (from left to right) navigation system, Austrian DSRC-based OBU, Swiss Tachograph-based OBU, German GPS-based OBU.

Interoperability is formally defined as the ability of different systems to exchange services with other systems. More practically, and with regard to EFC, this means that a user must be able to pay in several charging systems using "only one OBU and with only one contract".

In general, three levels of interoperability can be identified – technical, procedural and contractual. There is a hierarchy among them, where the higher levels of interoperability can only be achieved when the lower levels are in place.

Technical Interoperability

Technical interoperation is achieved when the same technologies are used and technical interfaces are realised in a compatible way. This is the arena for standardisation.

The foundations for interoperability are laid on this technical level. Proven and mature standards for DSRC are available. For GPS/GSM systems, standardisation is rapidly evolving. For new systems, there is no technical reason why they should not be interoperable with each other. For legacy systems, individual solutions and migration strategies have to be found.

Procedural Interoperability

Aspects of procedural interoperability are:

- tariff models and tariffication principles
- vehicle classification
- exception handling and enforcement
- privacy issues and regulations
- security framework (security policy, security services, security procedures, monitoring, etc.)
- responsibilities (who is responsible for what in legal and/or financial terms).

EFC systems are fundamentally different. Even the legal basis can be different, with a privately collected usage-fee at one extreme and a national distance-dependent tax at the other. In different EFC schemes there may be different tariff structures and different vehicle classification principles. They may be with or without value added tax and may be operated by entities of differing legal status which have different operational principles, for example, regarding which data are held on-board and off-board.

Over the years, toll chargers have co-operated in European research projects in order to develop harmonised approaches to procedural interoperability. The understanding of the problems involved grew over time, and with every new insight new complexities arose. For several years, the number of problems identified was increasing at a faster rate than solutions were being found. In recent times, these problems have been addressed through the efforts of the toll operators themselves working together.

Contractual Interoperability

Building on the pillars of technical and procedural interoperability, contractual interoperability had a late start, and also proved to be a completely underestimated problem. To a large extent this is due to the lack of a clear business case, but it is also due to the large number of participants. These participants - tolling operators, road operators, authorities, banking institutions, service providers, manufacturers, enforcement agencies, etc. - have different legal status and a different scope of activities in different countries. As yet it is not clear how to establish commercial arrangements between them that will enable a roaming service for the user.

The contractual structure itself is difficult to find. At one extreme there is a solution that builds on a single Memorandum of Understanding (MoU) binding all participants, at the other there is a solution based on an incredible multitude of bilateral contracts. None of these basic approaches is without problems. An MoU type of approach suffers from problems of harmonising all the national legal and institutional peculiarities; the bilateral approach is difficult because of the sheer numbers involved – national authorities in about 25 concerned countries, some 300 tolling companies, and probably hundreds of companies that want to become EET Service Providers.

As a result of the reference model and framework architecture proposed in CESARE III, a 2006 European research project, many believe that a solid basis for commercial arrangements has now been found. However practical proof is still lacking and the narrow business case may leave little room for negotiating contracts.

The Interoperability Directive

The European Commission has concluded that leaving the problem to market forces alone will not lead to a solution. It has decided to follow the regulatory path in order to introduce interoperability of electronic fee collection systems within a reasonable time. European Directive 2004/52/EC on "the interoperability of electronic road toll systems in the community" was adopted in April 2004. The Directive requires all large electronic fee collection systems in the Member States to offer an OBU that enables users to travel across Europe with the one OBU and the one service contract. This new interoperable service is complementary to the existing services, meaning that the local arrangements can remain unchanged, but the user has an additional fee payment option.

The Interoperability Directive covers all types of road fees on the entire Community Road Network: urban and interurban, major and minor roads, and various structures such as tunnels, bridges and ferries. The objective of the Directive is to create a "European Electronic Toll Service (EETS), where users can use all charged road networks.

To achieve this goal, the technologies used for charging are prescribed. The Directive mandates that "all new electronic toll systems brought into service on or after 1 January 2007 shall, for carrying out electronic toll transactions, use one or more of the following technologies: satellite positioning, mobile communications using the GSM GPRS standard and 5.8 GHz microwave technology".

The Interoperability Directive only gives a framework; it does not define details. Details will be covered in Commission Decisions which the European Commission has to prepare. The decisions are drafted using input from 12 expert groups and from European research projects, especially the CESARE III project. The drafts are then discussed with the Member States, who will eventually take a vote on the final decisions.

In 2006, three draft Commission decisions were presented and discussed:

- Decision 1 contained some basic definitions, a specification of the supported vehicle classification parameters and the specification for the DSRC transaction of the EETS.
- Decision 2 contained some material regarding GPS/GSM systems.
- Decision 3 addressed procedural aspects of the EETS.

Although draft Decision 1 was basically accepted by the Member States, draft Decisions 2 and 3 received little support. The draft Decisions were also submitted to a Commission-internal "inter-service consultation" process. All three drafts failed to get approval.

As of early 2007, the process of preparing the Decisions has to be set onto new foundations. There is an obvious willingness of Member States that are close to specifying and procuring new national charging systems to contribute actively to the drafting process. These Member States fear that unless there is a stable definition of the EETS their procurements might lead to systems that later turn out to be non-compatible with the European system. It is expected that re-drafted decisions will be put to vote by end of 2007.

3.6.2 Operations and Costs

The operational arrangements of the EETS are currently being defined. Member States have complained that, once again, a piece of European Legislation has been introduced without the presentation of a clear business case.

What has become obvious, though, is that the number of participating users will, at least in the first years of operation, be rather small and the start-up costs for Service Providers will be high. This makes it unclear under what conditions equipment and the service will be made available.

3.6.3 EETS: Assessment

European interoperability of electronic fee collection systems has been a goal since the early 1990s. Progress has been incredibly slow despite the large efforts invested in terms of European money in research projects, in standardisation activities and in policy statements.

Slow progress is somewhat counter-intuitive. Fast progress was expected for the following reasons:

- Interoperability and the free roaming of users in GSM has been a rather fast and successful development, both technically and commercially. The ability to roam freely throughout Europe, and even worldwide, has become one of the success factors for the mobile phone boom of the 1990s. Most people expected a parallel development in EFC.
- DSRC technology is - as the name implies – dedicated for tolling. People expected such a specially developed technology, with a narrow scope and high standardisation efforts, to quickly lead to interoperation.
- "Roaming" users, i.e. mostly international commercial traffic by heavy vehicles, have expressed demand for interoperable solutions. An apparent drive from the market was expected.
- Policy makers (and especially the European Union) have in their statements always given high priority to interoperability. This was interpreted as a clear commitment by the major stakeholders.

Despite these favourable circumstances, the goal of "one on-board unit, one contract" has remained a moving target for fifteen years, while always appearing within reach in the next two to three years. This is still the case. The following notes analyse the reasons for this.

Interoperability is difficult

The three aspects of interoperability (technical, procedural and contractual) build upon each other. Technical interoperability is the foundation upon which procedural harmonisation can be achieved. Contractual interoperability, including the commercial arrangements between the Toll Chargers and the EETS Service Providers, is the final building block that puts the whole system into operation. In the process of working towards interoperability the complexity of the problem was completely underestimated. Every step was more difficult than expected, and considerably more time-consuming.

Unfortunately, many people consider the problem of interoperability to be mostly a technical one. However, those with experience in the process understand that basically:

- Technical interoperability is comparatively easy to achieve.
- Procedural interoperability is a very complex problem with no easy solutions.
- Contractual interoperability is very time-consuming to negotiate.

In summary, when reviewing the past 15 years work on interoperability, it can be said that the problem is indeed a difficult one and the long delays encountered in the process can to a large part be attributed to the surprising complexity of the problem.

Lack of a clear business case

In recent years it has become obvious that there is no clear business case for interoperability and in fact it has it has never even been properly investigated. Interoperability was seen as a common European political matter, like the introduction of the Euro or the GALILEO satellite system. In addition to this, external motives were strong drivers behind the will of some parties to go for interoperable solutions. All in all, none of those involved appears to have a strong business case that would result in commitment and the will to move forward:

- Toll Chargers receive income from tolling irrespective of whether the user uses an interoperable service or pays using one of the methods provided locally.
- Few users can benefit from interoperable devices. For the private user, roaming mostly during holidays, the credit card as a universally accepted means of payment already provides for enough interoperation.
- For industry delivering tolling equipment, interoperability does not bring obvious benefits.
- For service companies the market is comparatively small and the margins likely to be low.
- Member States hold the flag of interoperability high in their policy statements, but commitment has been – at least until recently – rather low.

In summary, European interoperability has always been high on the agenda, but with little commitment by the concerned stakeholders. Accordingly, progress has been slow and haphazard.

Driven by external and unrealistic motives

The topic of international interoperability has only to a small extent been driven by a genuine interest in both enabling users to freely roam through Europe and removing potential barriers to trade, as asked for by the very principle of the European Union. In reality, activities were mainly driven by the following interests:

- to develop traffic telematics as a new business for European industry
- to pave the way for traffic-related value added services as new business for service providers
- to promote the use of the GALILEO satellite localisation system.

As these motives do not lead to a genuine interest in interoperability itself, there was little motivation by stakeholders in tackling the critical and difficult aspects. Focus has to a large extent been on aspects of technology, with little effort being invested in defining processes, arranging for the proper legal background and investigating suitable commercial arrangements for the provision of interoperable services.

To a large extent, the slow progress of interoperable solutions for electronic fee collection in Europe can be attributed to “doing the right thing for the wrong reasons”.

Recently interoperability of European EFC systems has begun to pick up momentum again. There is now an obvious willingness from countries that are close to procuring new national charging systems to contribute actively to the process. These countries fear that unless there is a stable definition of the EETS, their procurements may result in systems that in the future are not compatible with the European system. It can now be expected that in the years ahead the old dream of a Europe without borders will finally be realised for electronic fee collection.

3.7 Alpine Crossing Exchange

The routes over the Alps (see Figure 21) are of major importance for trade between northern/central and southern Europe. Traffic through the Alps is growing constantly and has doubled in the period from the late 1980s through until today. Due to the limited capacity of the Alpine passages (tunnels with traffic restrictions for trucks due to safety reasons), congestion has not only become a problem for the people living in the Alpine area, but also for the transport operators.

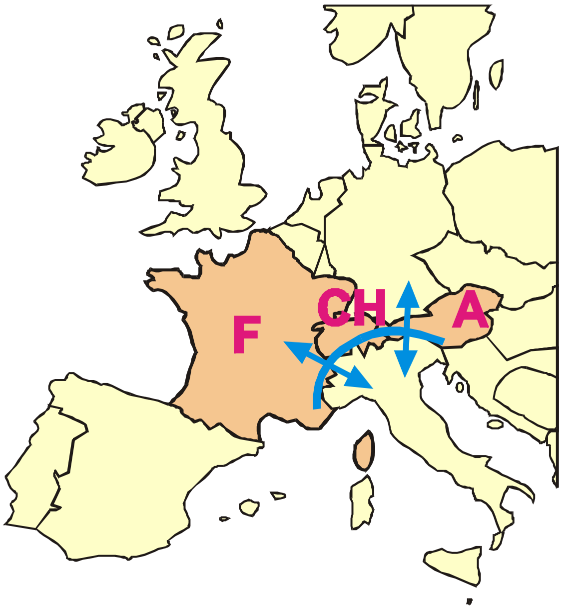

Figure 21: The Alpine ridge is a natural barrier for North-to-South traffic, spanning from France (F), over Switzerland (CH) to Austria (A)

As a countermeasure, Switzerland introduced the Heavy Vehicles Fee LSVA in 2001, see Section 3.2. This charge has helped to stabilise the growth of Alpine transit, at least through the mountain passes in Switzerland. However Swiss law requires even further reductions of heavy goods vehicle movements through the sensitive Alpine area. As a result, Switzerland has continued to investigate possibilities for managing the demand for Alpine crossing trips.

The Alpine Crossing Exchange (ACE) is a proposal for an efficient and market-conformant means for managing the capacity of the Alpine passages. The basic idea is to consider the Alps as a resource with a limited capacity and, instead of having congestion, to limit demand to allow the market to manage demand by trading the available transit capacity.

A government-funded research study analysed two basic models of market mechanisms that would set prices by trading in order to reduce congestion as well as limit the traffic to the legally required maximum level of heavy goods vehicles passing over the Swiss Alps.

Switzerland has taken the initiative in this development since - unlike its neighbours Austria and France - it is not a member of the European Union and is not bound by European legislation regarding the free movement of goods that might restrict options for trading transit rights.

3.7.1 ACE: Description of application

Cap-and-Trade

The Alpine Crossing Exchange is a market economy instrument designed to limit the number of transalpine freight journeys. An ACE based on the *cap-and-trade principle* is a mandatory system with tradable Alpine Crossing Permits aiming at the reduction of transalpine journeys of heavy goods vehicles on the roads. It is intended to provide an economically efficient implementation of a volume-based restriction of transalpine, road-based freight traffic.

Under this system, the crossing rights would be auctioned off. The auction would guarantee an efficient form of an initial allocation.

After the allocation, crossing rights could be freely traded. The trade could take place either directly between the freight transport companies, via intermediaries or by means of a special platform through which the allocation could be developed. The crossing rights will be issued in the form of an electronic permit, which can be printed out before the trip or which could be captured by and displayed on wireless devices.

Checks will be made at suitable locations as to whether all the vehicles have valid crossing rights. The location could, for example, be before the Gotthard road tunnel, or at the foot of the Alpine crossing. The law on the transfer of traffic to rail sets out that by 2009 a maximum of 650,000 vehicles per year will be allowed to cross the Alps by road. This target could be implemented with the ACE. Similar platforms could be developed for Alpine crossings in other countries. However, experience gained with international agreements on the environment shows that the negotiation of volume-based targets is an extremely difficult undertaking.

Slot management with dynamic pricing

This method concerns a voluntary system of cost-based, negotiable reservation rights, which authorise the passage of an Alpine crossing point during a specific time window or slot. The aim is to improve the utilisation of road capacity and to reduce traffic queues and waiting times. At the Gotthard road tunnel for example, the system would take over the task presently carried out by the trickle-counting system. This could lead to capacities of from 60 to 150 HGVs per hour, or a total daily capacity of from 2,000 to 5,000 HGVs in both directions.

An ACE based on the principle of slot management would be a further development of a reservation system and would operate in the same way, with the sole difference being that transport companies would have to pay a market price for reservations. The sale of the reservations would most easily be developed by means of an electronic platform. The reservation rights would be sold either at a fixed or at a variable (demand-based) price. They could also be traded, but not given back. Booking and evidence of reservations would be made in the same way as for the reservation system.

Slot management with dynamic pricing allows lorries with a time-critical shipment to make a more rapid journey through one of the Alpine crossings. Vehicles that do not have a reservation will have to spend more time queuing.

At today's traffic volumes the system would show substantial time gains on only 30 days. The time gained would be insignificant on more than 200 days. This could mean that on these days the supply of reservation rights would exceed demand. The acceptable price for a reservation would then have to be set lower. On days with high volumes of traffic and correspondingly long waiting times, scarce slots would be allocated on the basis of willingness to pay.

In slot management with dynamic pricing, generally no other effects are to be expected than for the reservation system. In economic terms, however, the distribution of the reservations based on willingness to pay would be more efficient than a system where reservations are allocated to those who are in a position to book at the earliest possible time.

3.7.2 Operations and Costs

In the research study "*The alpine crossing exchange: feasibility study*"[9] (VSS / ASTRA Ref.Nr. FB 1174; 2006/012), the operational approach has been described and costs have been estimated.

The following organisational model has been elaborated and proposed.

The government has the supervision of the "complete ACE system". It takes care that the necessary functions for the operations are administered conveniently. However, it remains open as to who will perform these functions. An assessment of the possible different forms of organisation for the implementation of an ACE was not an objective of this study. But based on a first analysis, a mix between governmental and private implementation, with specific responsibility for a few positions, becomes apparent:

- Supervision is administered by a governmental committee.
- The allocation of ACU (auction, collection), the operation of the ACP register and the point of sales as well as their interfaces to the roadside implementation and to the enforcement are tendered periodically in bundles. Private companies apply in competition for these tasks.
- Trade is operated in the private sector. The function of the market maker will be tendered with the aim that several market makers will ensure a transparent ACU-market.
- Roadside implementation and enforcement shall be carried out by source. They can be effected either by a governmental agency or are publicly tendered.

The expected investments amount to between 50 and 60 million CHF. Reductions due to the interoperable use of the OBU, synergies with the Swiss heavy vehicles fee and optimisation by custom-made operational processes are possible. The minimum level of operational costs is estimated at 15 million CHF per year**.** If the potential for cost reduction with the OBU and the common and personnel cost is not realised, the operational costs may rise to 20 million CHF per year.

These cost estimates are based on a cost model which was developed for various road charging concepts based on conservative assumptions and market prices for the relevant components. The estimate of investment costs can therefore be described as well-founded.

Full costs were estimated. The cost model considers all elements which would be necessary for the implementation and operation of the system. The individual elements of costs are generally part of every model of organisation. For a common operation of the system with several countries, the investment and operational costs would not increase proportionally.

[9] German Title: Alpentransitbörse: Untersuchung der Praxistauglichkeit; Forschungsauftrag ASTRA 2006/012 [http://shop.vss.ch/nPDM/vssNormen/Forschungsberichte/Inhalt/1174Inhalt.pdf]

A major cost element of the operational costs is personnel costs which depend on the amount of system users (especially for enforcement) and therefore less synergy is expected for operations than for the investment. The macroeconomic effects of the ACE will be addressed in summary. A quantitative analysis, based on a traffic model, shall be carried out at a later date. A rough estimate shows that net income of the ACE system would amount to 100 million CHF per year.

3.7.3 ACE: Assessment

Both the *cap-and-trade* and the *slot management with dynamic pricing models* for an Alpine crossing exchange are technically and operationally feasible; they are efficient and effective instruments of a transport policy.

As a market-based instrument, they provide incentives for the optimal use of infrastructure, generate valuable information, and ensure that the desired goals are achieved in a cost-effective manner. The physical infrastructure is to a large extent already available, and control and trading structures could be set up with very little expenditure.

In early 2007 Swiss policy makers committed themselves to pursuing the cap-and-trade approach and are advertising the idea in neighbouring countries. It remains to be seen whether an agreement can be negotiated with the European Union that will allow such an instrument to be introduced.

The instrument is noteworthy in the context of regulatory telematics applications as it tackles demand management in a novel and market-conformant way.

Road pricing, which after the successes of Singapore, London and Stockholm is gaining popularity among cities - and also for nationwide applications (plans are being considered in The Netherlands and Sweden). In road pricing the prices are fixed by the authorities. At times of low demand these prices may be too high, and at times of high demand they may be too low (in transport economical terms).

Singapore is constantly managing price levels in order achieve optimal utilisation of road space. A market-based approach to setting prices for limited road capacity is a novel approach and would automatically set prices appropriate for a given demand and capacity.

Naturally one cannot easily trade a right to travel into the city every day, but the idea is applicable to any scarce resource where it is possible to plan ahead and there are sufficient alternatives in the case of prices soaring.

4. Emerging Technologies

4.1 Overview

Because technologies are strongly linked to the applications they support, for the most part they will be discussed in the chapter on telematics applications. However, there are some technologies that are important independent of a specific application, and which might trigger or enable new applications. Such technologies that will have an impact on devices and applications for commercial fleets are described and assessed.

The five following technologies or systems are considered as the most relevant ongoing telematics developments in Europe:

- Galileo - the European satellite navigation system
- Open telematics vehicle networks
- Car-to-Car Communications
- Advanced Driver Assistance System
- Pay As You Drive.

4.2 Galileo - the European satellite navigation system

One of the most ambitious projects in Europe with relevance to future telematics applications is the European satellite navigation system GALILEO.

Galileo has multiple objectives including providing higher precision to all users than is currently available through GPS or GLONASS, improving availability of positioning services at higher latitudes, and providing an independent positioning system upon which European nations can rely even in times of war or political disagreement. The current project plan has the system as operational by 2010, two years later than originally anticipated.

4.2.1 Background of Galileo

The main reason for establishing a European satellite navigation system is that the existing satellite systems - the American Global Positioning System (GPS) and the Russian Global Navigation Satellite System (GLONASS) - are operated and controlled by military authorities (i.e. Department of Defence) of those two countries and could be turned off for civil use in the event of a military conflict or for other reasons.

With a system of its own, Europe would reach independency in a key base technology. Furthermore, the project can be seen as a technology driver for European industry. Galileo is to be designed to overcome existing accuracy and reliability deficiencies in demanding civil telematics services which are to be introduced in Europe.

Galileo is the first joint project of the European Union (EU) and the European Space Agency (ESA) and is part of the Trans-European Networks (TEN) program. The development phase is financed equally by all parties. In addition to the EU, China, India, Israel, Ukraine, Morocco, and Switzerland are participating in the project. Countries negotiating regarding future participation are Argentina, Australia, Brazil, Chile, Canada, Malaysia, Mexico, Norway, and South Korea.

4.2.2 Description of Galileo

System layout

The fully deployed Galileo system will consist of 30 satellites (27 operational plus 3 active spares), positioned in three circular Medium Earth Orbit (MEO) planes at 23,222 km altitude above the Earth. Once this is achieved, the Galileo navigation signals will provide good coverage even at latitudes up to 75 degrees north (which corresponds to the North Cape) and beyond. The large number of satellites together with the optimisation of the constellation, and the availability of the three active spare satellites, will ensure that the loss of one satellite will have no discernible effect on the user.

Figure 22 provides an impression of the Galileo satellite constellation.

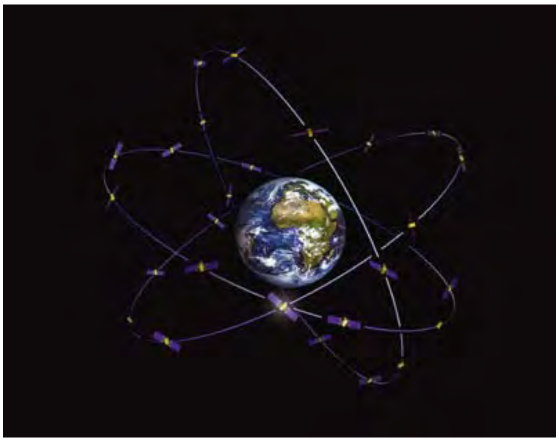

Figure 22: Galileo satellite constellation

[Source: http://www.esa.int]

Two Galileo Control Centres (GCC) will be implemented on European territory to control the satellites and to perform the navigation mission management. The data provided by a global network of twenty Galileo Sensor Stations (GSS) will be sent to the Galileo Control Centres through a redundant communications network. The GCCs will use the data of the Sensor Stations to compute the integrity information and to synchronise the time signals of all satellites and of the ground station clocks. The exchange of data between the Control Centres and the satellites will be performed through up-link stations located around the globe.

As a further feature, Galileo will provide a global Search and Rescue (SAR) function, based on the operational COSPAS-SARSAT system. To do this, each satellite will be equipped with a transponder able to transfer the distress signals from the user transmitters to the Rescue Co-ordination Centre, which will then initiate the rescue operation. At the same time, the system will provide a signal to the user, informing them that their situation has been detected and that help is on the way. This latter feature is new and is considered to be a major upgrade compared with the existing system, which does not provide feedback to the user.

Services offered by Galileo

The following Galileo services are planned:

- Open Service (OS)
- Commercial Service (CS)
- Safety-of-Life Service (SoL)
- Public Regulated Service (PRS)
- Search and Rescue Service (SAR).

Open service (OS)

The Open Service is the basic service offered by Galileo which allows the user to determine his position to an accuracy of a few meters. The signals can be received without usage fee, but the manufacturers of the signal receivers have to pay a license fee. This service can be directly seen as competition to the free basic GPS service but with higher accuracy. The higher number of satellites used with Galileo leads to an improvement of signal coverage in urban areas. An even better coverage can be reached by the possible combination of both systems where the signals of up to 15 satellites can be received at the same time.

Commercial Service (CS)

This service has to be paid for and is offered in an encrypted way. The use of additional transmission frequencies allows a higher data transmission rate of up to 500 bit/s. This higher rate enables the sending of correction data to achieve a better position accuracy. This service is also designed for use in safety-relevant applications such as air traffic control. It is planned to provide a guarantee of availability for this service.

Safety-of-Life Service (SoL)

Safety-of-Life service is mainly focused on use in safety-relevant applications such as in air or rail traffic. It is corrective to the risks which can appear in commercial applications. It provides, for example, information and warnings to the user regarding the system availability and when the system should not be used for dedicated applications anymore. It is planned to provide a guarantee of availability for this service as well.

Public Regulated Service (PRS)

The regulated service is only offered to public authorities for sovereign tasks, such as police, coastguard, secret service etc. It is a dual-use system available for military applications as well. The signals used are encrypted and as far as possible protected against tampering. It is meant to provide high accuracy and availability.

Search and Rescue Service (SAR)

This service is provided in cooperation with COSPAS-SARSAT and MEOSAR and assures a fast, worldwide location of emergency call transmitters in ships and airplanes. A feature of this service is that, for the first time, it will be possible to send a response from the rescue centre to the emergency caller.

4.2.3 Status of implementation of Galileo

The overall project is divided into 4 phases:

- Planning phase I
- Planning phase II (development)
- Implementation
- Operation.

Planning phase I

The first project phase covered the definition of tasks and was completely financed by ESA (€100 million or approx. AUD 167 million). This planning and definition phase ended with the installation of two test satellites and the related earth station in January 2006.

Planning phase II

This phase was characterised by the development, installation and testing of the first four operational satellites. The costs of about €1.5 billion (approx. AUD 2.5 billion) are borne by the EU and ESA.

Implementation phase

In this phase the system will be rolled out. All of the 30 satellites are installed and able to communicate with the earth stations. The complete earth segment comprises:

- two control centres (GCC) having equal rights, one in Germany and one in Italy
- two performance centres for signal evaluation purposes (most probably located at the GCC sites)
- one control centre located in Spain for checking the Safety-of-Life Signal and as an additional standby control centre
- five satellite control stations (TTC) for satellite communications
- thirty signal control receiver stations
- nine up-link stations (ULS) for updating the transmitted Galileo navigation signals.

The costs for this phase are estimated at a minimum of €2.5 billion (approximately AUD 4.2 billion), with 70 percent borne by private concessionaires and 30 percent by public authorities in a Public Private Partnership (PPP) model.

Operation phase

The fourth phase covers the operation and maintenance of the system. The operational costs are estimated to be around €220 million annually (approximately AUD 370 million). From 2008 on, these costs are also to be borne by the private concessionaires.

4.2.4 Assessment

Galileo will without doubt improve signal availability and location accuracy. As a new feature it will also include integrity information, such as information that allows the user to judge whether they can assume that the location information obtained is within certain error bounds. This feature is crucial, for example, in automatic steering in aviation.

On the other hand, Galileo is currently facing difficulties, with the start date being shifted backwards.

It is suggested that Galileo is a *strategic* undertaking, and not necessarily a *commercial* one. Nevertheless the European Commission wanted to avoid lengthy discussions with the Member States of the European Union about financing, and as a consequence tried to advertise Galileo primarily as a new commercial opportunity. There were doubts among some stakeholders. Galileo appears to be a good example of infrastructure that should best remain a common public asset, rather than aiming for privatisation without a clear business case to support the decision.

Regarding the telematics services discussed in this report, Galileo is actually not required. Almost all telematics applications make use of satellite localisation, but GPS has proven to be sufficient. The major problem with GPS – namely poor availability at certain locations (tunnels, urban canyons) and multi-pathing in cities – are not improved by Galileo. In addition, a new generation of GPS is to be launched, so for commercial applications the available localisation service will be totally sufficient for the foreseeable future.

In a sense, all the pressure to make Galileo a business hindered the free development of telematics applications in Europe. European research money was mostly available for applications involving Galileo, even if the business case was slim. As a result, the development was driven by the wish to find applications for a given technology, rather than developing services to fulfil market demands.

4.3 Open telematics vehicle networks

Much attention is given by the EU to setting up a basis for a technical framework which allows different manufacturers and service providers to offer their telematics applications using open standards. For this purpose the EU has been financing integrated projects that were intended to mobilise the critical mass of activities and resources needed. One of these integrated projects, with a large potential impact on further development of telematics applications, is the Global System for Telematics (GST).

4.3.1 Background of GST

The GST is an agreement between a number of telematics stakeholders (car manufacturers, automotive suppliers, telematics and telecommunication service providers, research institutes, etc.) on a telematics best practice framework. This agreement comprises the protocols used, the definition of interfaces between them, and basic components and technologies.

These agreements will lead to the deployment of service applications to a service aggregator, provision of software to mobile systems, consumption of services by the service user in a secure way, and the payment and billing of service consumption.

Figure 23 and Figure 24 provide an overview of the GST architecture and the technical specifications.

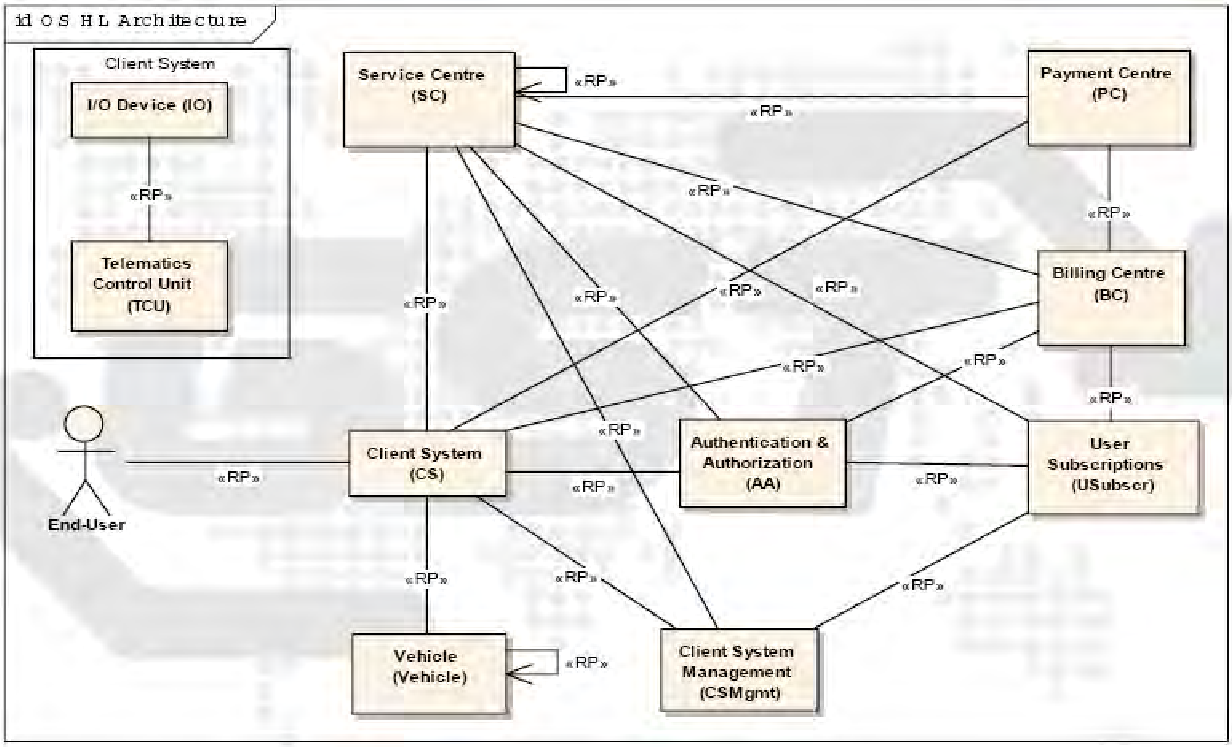

Figure 23: Overview of the GST architecture

[Source: http://www.gstforum.org/download/Service_Submission_Contest/PRE_SSC_Anatomy_of_a_GST_Service.pdf]

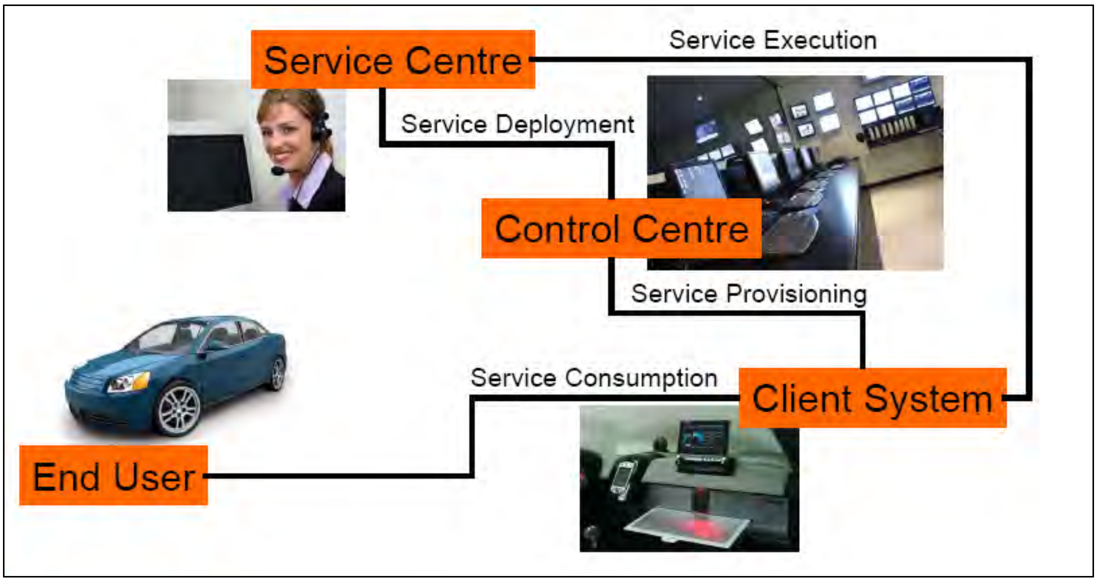

Figure 24: Service architecture

[Source: http://www.gstforum.org/download/Public%20documents/London/GST_20061010_ITS_WC_London_PV_v8.pdf]

4.3.2 Description of GST

To reach its challenging goals, the GST project has been divided into technology-oriented sub-projects, where the aim is to create a horizontal market for on-line services, and into service-oriented sub-projects aimed at bringing key safety and market-enabling services to the market.

Technology-oriented GST sub-projects are:

- Open systems: enabling co-operation and infrastructure sharing between all sectors
- Security: protection of system and its data, privacy and reliability
- Service payment: common approach for payment and billing
- Certification: promoting rapid service deployment onto the market

Service-oriented GST sub-projects are:

- Rescue: Closed loop including emergency vehicle to help introduce e-Call as a standard feature in future cars
- Enhanced Floating Car Data uploads and Safety Channel broadcast/downloads to allow a wide range of safety-enhancing and added value services

Results of GST

The GST and its sub-projects agreed on the protocols listed in Table 7. The agreed set of protocols is organised in ‘protocol stacks’ in order to solve service provisioning and consumption.

Table 7: GST protocols

Service	Used Protocol
Provisioning	SyncML DM acc. OMA (Synchronization Markup Language for Device Management / Open Mobile Alliance)
Consumption	SOAP (originally from Simple Object Access Protocol)
Broadcasting and vehicle-to-vehicle	TPEG (TEC) (Transport Protocol Experts Group / Traffic Event Compact)
Rescue	USSD (Unstructured Supplementary Service Data)
Lower layers	HTTP, OBEX, IPv6 (Hypertext Transfer Protocol, Object Exchange, Internet Protocol version 6)

Beside the agreed protocols, the following components have been standardised to facilitate service application development:

- Positioning interface
- Interface to vehicle sensors
- Connection manager
- Provisioning client

Implementation guides, including technical requirements for each subproject (technology and services), have also been developed to reach a real market penetration of telematics services and applications.

4.3.3 Status of implementation of GST

As previously explained, the GST project aimed to develop a set of agreements regarding basic architectural requirements, protocols and interfaces to enable widespread traffic telematics services. To test and validate the results of the developed specifications, seven test sites have been set up in different European countries.

The final results were presented to a workshop held in February 2007. The main conclusion was that GST fulfilled its main objectives and has created an open and standardised end-to-end architecture for automotive telematics services, enabling vehicles to communicate with each other and with the outside world. This open platform also allows vehicle manufacturers, public services and certified companies to provide and distribute their own services to consumers.

4.3.4 Assessment

GST is an initiative that points in the right direction, namely standardisation. Telematics applications will only become widespread if markets are open and hardware and software can be freely exchanged. Whether the definite architecture for telematics services in Europe will finally be defined by GST or similar initiatives, (by car makers for example), remains to be seen, but regardless, it can be expected that standardised service platforms will become available.

4.4 Car-to-Car Communications

4.4.1 Background of Car-to-Car Communications

For many years now, car manufacturers have been working towards making their cars safer, reducing the dangers involved in driving. Further increases in road safety will only be possible with the aid of new, active safety technologies. Novel wireless technologies for Car-to-Car Communications can make a valuable contribution here (Figure 25).

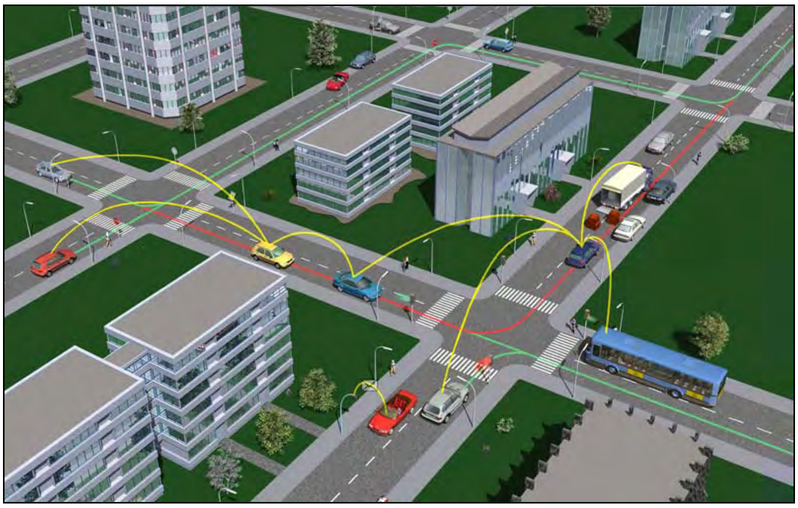

Figure 25: A visualisation of Car-to-Car Communication

[Source: http://www.car-to-car.org/index.php?id=131]

4.4.2 Description of Car-to-Car Communications

An accident occurs on the highway. A few seconds later, the cars behind approach the scene of the accident at high speed – without being warned and without braking. In such critical situations, it is often impossible to avoid pile-up accidents, because the car drivers almost entirely depend on their ability to react quickly and to instinctively respond correctly to the driving situation as it develops.

Approach and idea

The idea of car-to-car communications is to extend the driver's horizon outside the range of vision (Figure 26).

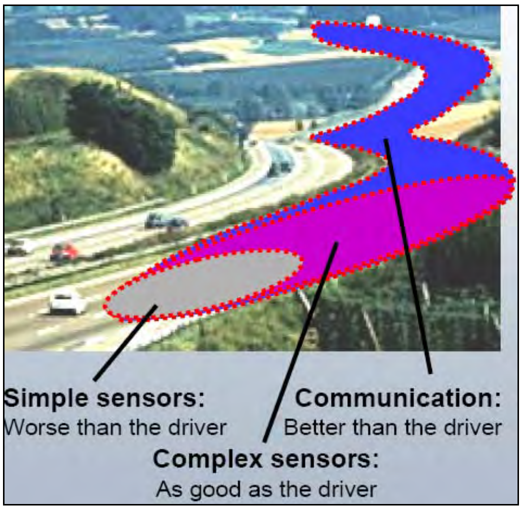

Figure 26: Extend the driver's horizon

[Source:http://www.ist-daidalos.org/daten/events/06-06-29-ws/Presentations/Public-WS-20060629-Car-to-Car.pdf]

For example, Car-to-Car Communication can be helpful:

- in hazardous situations as an immediate warning to help avoid or reduce the consequences of rear-end collisions or other accidents. The hazardous situation information reaches the driver much faster than conventional methods.
- during road works where a lane is temporarily closed. The information is received by the driver further away from the effective lane closure, giving them time to react (change lane).
- for emergency vehicles where the driver of a car is informed that an emergency vehicle is approaching. The time for clearing the lane is increased and the degree of obstruction for the emergency vehicle decreased.

Technology used

Car-to-Car Communication is based on WLAN (IEEE 802.11 family). The first tests have been made with the protocol IEEE 802.11b. Now the aim is to use only IEEE 802.11p in the 5.85 to 5.925 GHz frequency band. The advantages over other communication technologies such as GSM or UMTS are:

- Independence from infrastructure
- Enabling time critical safety applications
- Very low data transmission delay
- Royalty-free frequencies

As the range of a single Wireless LAN link is limited to a few hundred meters, every vehicle is also a router and allows messages to be sent in multiple hops to vehicles farther away (Figure 27).

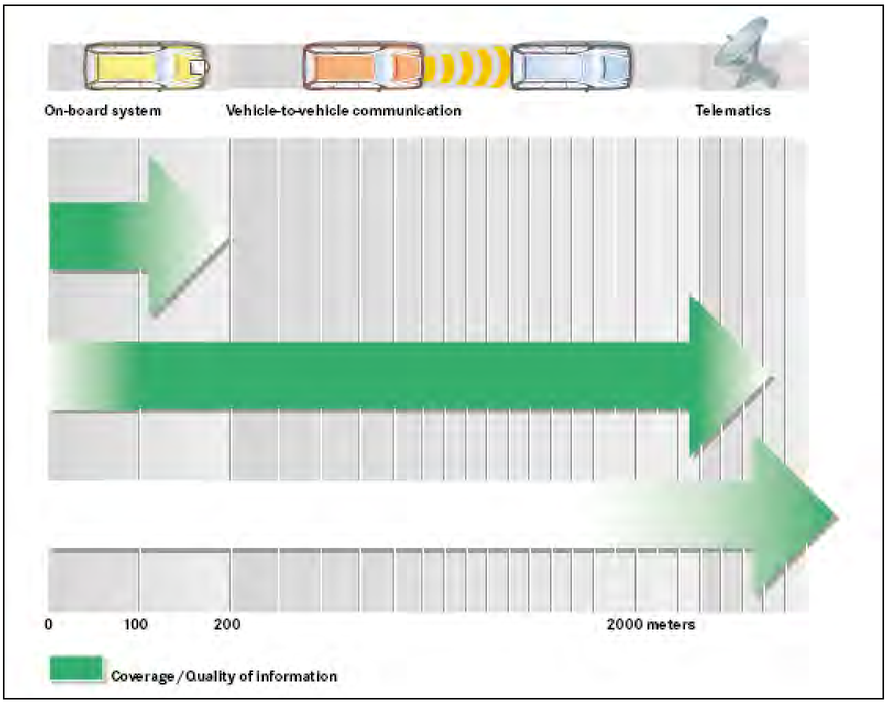

Figure 27: Range of different communication systems

[Source: http://www.cartalk2000.net/bausteine.net/file/showfile.aspx?downdaid=5497&sp=E&domid=687&fd=2]

4.4.3 Status of implementation of Car-to-Car Communications

Older European projects in the early 1990s were CarTalk2000 and Fleetnet. Ongoing projects include network-on-wheels (Germany) and Car2Car Communication Consortium.

The Car2Car Communication Consortium is a non-profit organisation initiated by European vehicle manufacturers and is open to suppliers, research organisations and other partners. The Car2Car Communication Consortium is dedicated to the objective of further increasing road traffic safety and efficiency by means of inter-vehicle communications. The Consortium mainly considers three application areas:

- Advanced driver assistance: increasing road safety by reducing the number of accidents as well as reducing impact in the event of non-avoidable accidents
- Decentralised floating car data: improving local traffic flow and efficiency of road traffic
- User communications and information services: offering comfort and business applications to driver and passengers.

The current road map shows that the first draft of a full specification is expected to be ready by December 2007 and the frequency allocation by December 2010.

4.4.4 Assessment

Before the cars on Europe's roads can warn each other about dangers, the industry associations and the researchers will have to master a number of challenges. On the technical side, the stability of the wireless networks and the protection of transmitted data against external manipulation top the list. It is also important to ensure that warning messages reach the right drivers at the right time.

Once the technical issues have been resolved and a uniform European standard is in place, there will be yet another stumbling block to overcome: In order for the early-warning system to become effective, a sufficient number of cars must be equipped to form an ad-hoc mobile network. Achieving sufficient market penetration will be difficult since early adopters have no benefits.

There is still much development work to be done in the field of automotive communications. Nevertheless, it is already clear that, in the future, innovations in the field of electronics will continue to improve safety for those who travel by car.

4.5 Advanced Driver Assistance Systems

Advanced Driver Assistance Systems (ADAS) are electronic components in cars that help the driver in certain situations. Safety aspects as well as the increase of driving comfort are in the foreground. These systems intervene semi-autonomously or autonomously in engine, steering or brake control, or warn the driver shortly before or during a critical situation. At present most advanced driver assistance systems are designed in a way that the driver remains fully in control of the vehicle and also holds full responsibility.

4.5.1 Background of ADAS

ADAS have been introduced in the course of reducing road deaths. They create increased safety through active technology and contribute to safety on the roads by preventing vehicle collisions and consequently helping to reduce road injuries and deaths. Industry sees ADAS as selling points, especially for higher-priced models. Most car manufacturers are pursuing projects in order to gain competitive advantages.

The systems are usually developed and financed by a consortium. Car manufacturers, research institutes, universities, ministries and automotive suppliers cooperate in developing ADAS.

4.5.2 Description of ADAS

Numerous intelligent vehicle technologies exist to assist the driver in operating the vehicle safely. Systems are available to aid with navigation while others (such as vision enhancement and speed control systems) are intended to facilitate safe driving during adverse conditions. Other systems assist with difficult driving tasks such as transit and commercial vehicle docking. Different technologies (for example laser, radar, and infrared) are used.

4.5.3 Status of implementation of ADAS

Table 8 gives an overview of the available systems.

Table 8: Available systems for driver assistance

Name	Description
Adaptive Brake Lights	Triggered by the strengths of brake activation the rear brake lights are illuminated at different intensities to indicate emergency braking manoeuvres to the following vehicles.
Adaptive Head Lights	The system consists of electromechanically-controlled headlights to ensure optimum illumination of the lane in bends. The headlight is directed into the bend as soon as the vehicle begins cornering. A reduction of glare to the upcoming vehicles is possible. Vehicle speed, yaw-rate and steering wheel angle can be used as input data for the controller of the system.
Alcohol (inter)lock	The system checks the alcohol intoxication of the driver (breath test) when starting the vehicle and prevents the vehicle starting when driver is intoxicated.
Automatic Headlight Activation	When activated the system switches on the headlights automatically when major environmental conditions for the use of headlights are present. The system detects the darkness and the light conditions in the environment.
Blind spot monitoring	There are normally blind spots at both sides of a vehicle when using a mirror for rear viewing. Different systems can provide better vision into the blind spot area or supplemental information regarding an obstacle being there, e.g. by warning signals.
Driver Condition Monitoring	The system monitors the condition of the driver. Parameters include drowsiness, distraction, and inattention.
Dynamic control systems	Active Front Steering, Electronic Stability Program, Active Body Control - several applications belong to this group.
Lane departure warning system (LDW)	Warning given to the driver in order to avoid leaving the lane unintentionally. Video image processing is the most important technology.
Lane Keeping Assistant	Active lane-keeping support through additional and perceptible force e.g. in the steering wheel.
Obstacle and Collision Warning	System detects obstacles and gives a warning when collision is imminent. Current solutions with limited performance are a separate feature of Adaptive Cruise Control systems, which use information obtained from radar sensors to give visual and acoustic warnings. Future systems will use long/near range radar sensors or LIDAR and video image processing.
Runflat Indicator/ Tire Pressure Monitoring System	In the event of air loss in a tire the system gives a warning to the driver. With the run-flat indicator the system detects the different rotational speed of the tire which is under-inflated. In a tire pressure-monitoring system the air pressure in each tire is directly measured and displayed if necessary.
Vision enhancement	Assistance functions with camera techniques such as infra-red which enhance the perception of pedestrians and other relevant objects at night or in otherwise bad vision conditions.
Extended environmental information	Data from different sources of the vehicle (e.g. lights switched on, windscreen wipers on, fog lights on, information from ABS, stability control systems) can be used to create useful information about the environmental situation which the vehicle is driving through.
High quality traffic information	This is information to the driver about the traffic (congestion) and weather conditions for choosing the most effective route or for preparing to cope with the foreseeable situation ahead on the route.
Infrastructure Based Warning Systems / Local Danger Warning	Warning systems about dangerous locations or situations do not necessarily have to rely on vehicle-based technology. Solutions exist which are only based on the infrastructure to warn the drivers. Spot-wise warning can be given via variable message signs, flashing or electronic beacons, radar-based excessive speed information.
Inter-vehicle Hazard Warning	The function uses technologies of wireless local area networks between cars to transmit warnings about hazards and extended data to other vehicles in the vicinity. Vehicles can be used as sender, receiver and relay stations for that information. Other technologies using communication infrastructure can provide local hazard warnings with the help of extended floating car data too.
SpeedAlert (Intelligent Speed Adaptation)	The system alerts the driver with audio, visual and/or haptic feedback when the speed exceeds a limit set by the driver or the legal fixed speed limit. The speed limit information is either received from transponders in speed limit signs or from a digital road map, requiring reliable positioning information.
Traffic signs recognition	Camera and image processing is used to recognise traffic signs and give an alert about the content of the sign to the driver. The HMI is an important aspect of the information process.

Name	Description
Dynamic Vehicle Safety Management Systems (DVSMS)	By helping drivers avoid accidents, these systems help reduce fatigue and stress, allowing the driver to feel more confident and in control.
Adaptive Cruise Control (ACC)	Introduced in 2000, ACC provides drivers with extra support. With the help of a radar sensor, the system recognises preceding vehicles, calculates their speed and keeps the distance required by acting on the brakes and engine.
Perceiving vehicle surroundings	System which involves recording a complete take of all surroundings (360 degrees) using all available sensory data and combining this data to create a holistic model of the vehicle environment.
Roll Stability Control system (RSC)	By continuously monitoring the vehicle's movement and its relationship to the road surface, the RSC system automatically applies brakes and/or reduces engine power when a potential rollover situation is identified.
Attention control system	A camera installed in the cockpit to monitor the driver's eye blinking movements will eventually help to save lives, given that 25 % of all road deaths are attributable to the sleepiness of drivers.

4.5.4 Assessment

European car manufacturers are investing heavily in developing driver assistance systems. While sometimes only marginally related to telematics since the telecommunications aspect is often missing, it is development that brings processing power into vehicles. This is already changing the electrical architecture of vehicles and might eventually lead to an integrated approach, where different services share common elements, ranging from a common power train to common processing means. As such the developments in ADAS can be seen as facilitating the introduction of telematics services.

It has to be noted though, that users today are more prepared to invest in hardware than in services. When buying a vehicle, users often opt for high-priced extras rather than for continuous payment for services. This might explain why investment into ADAS development is higher than into developing a telematics services market.

4.6 Pay As You Drive

The Pay As You Drive (PAYD) insurance model is a telematics application where certain parameters of vehicle usage are recorded, particularly distance travelled, time-of-day travelled and driving behaviour (the latter especially in terms of acceleration/deceleration). The parameters are then used to determine the insurance fee.

4.6.1 Background of PAYD

Current insurance models usually give some limited discounts to low-mileage drivers. Otherwise the insurance premium does not depend on actual behaviour but only on certain static parameters that are statistically associated with risk, such as sex, age, motor power, etc.

Insurance could offer more tailored tariff models if actual risk exposure or risk behaviour could be taken into account. Such tailored models could lead to interesting business cases, where an insurance company can offer superior tariffs to certain low-risk groups, or to people in high-risk groups, but with a responsible driving style.

In Switzerland, for example, there is one notable social group with a high average risk that has big difficulties in obtaining car insurance at affordable prices. This social group tends to buy powerful sports cars and drive irresponsibly. This group has an accident risk that is significantly higher than the average population in the same age category. Even if this is a well known fact, it causes problems to insurance companies. Openly grading tariffs according to cultural or national origin would be regarded as a discriminatory act, so insurance companies either simply reject certain individuals without justification, or only offer bad tariffs in the hope that these “bad risks” move to other companies.

If individual risk behaviour could be measured, people from difficult groups but with individual low-risk behaviour could be insured at affordable rates. Such considerations have led insurance companies to investigate pay as you drive (PAYD) models of car insurance.

4.6.2 Description of PAYD

Concept

The simplest form of PAYD bases the insurance premium on the actual number of miles driven. More sophisticated models of PAYD also include parameters on where, when and how you drive.

Vehicle insurance is a significant part of total vehicle costs. A typical motorist spends almost as much on insurance as on fuel. It is the largest vehicle cost for many lower-income motorists. Insurance is currently considered a fixed cost with respect to vehicle use; a reduction in mileage or more responsible driving usually does not lead to a comparable reduction in insurance premiums.

PAYD insurance reflects the market principle that prices (what consumers pay) should be based on costs (the costs of providing a good or service). Research indicates that within existing price categories, annual claims increase with annual vehicle mileage. Mileage is just one of several factors that affect crash rates. It would not improve actuarial accuracy (i.e., how well premiums reflect insurance costs for a particular vehicle) if mileage was used instead of other rating factors - for example, to charge all motorists the same per-mile insurance fee.

However accuracy improves significantly if annual mileage is incorporated with existing rating factors. Any other price structure overcharges low-mileage motorists and undercharges high-mileage motorists within a given rate class.

PAYD means that the insurance premium is calculated dynamically, according to measured behaviour. Driving is monitored using a secure OBU to record driving times and GPS for localisation and speed measurement. Recorded data have to be sent to the insurance company via USB-Sticks or via GSM. Figure 28 shows an example of an OBU used by a German insurance company for commercial fleets.

Two different approaches are possible. The more usual one is measuring risk exposure, where parameters associated with higher risk are recorded, for example:

- Time of day: driving between midnight and the early morning hours has more than ten times the risk than driving during the day.
- Road type: driving on urban roads is high risk in terms of damage, driving on motorways much less so.

In the second approach, actual risk behaviour is assessed:

- Speed: driving above speed limits is high risk behaviour.
- Acceleration: high acceleration and deceleration in the driving direction, i.e. pressing both the accelerator lever and the brakes rather hard, and high acceleration in side direction, i.e. taking turns at high speeds, are signs of a risky driving style.

Risk exposure is contractually easier to handle, since there is little reason to dispute whether or not a certain exposure has occurred – the recorded data show risk exposure quire clearly. Risk behaviour is harder to assess technically.

Figure 28: On-Board Equipment used by the DBV-Winterthur insurance company in Germany

[Source: obs/DBV-Winterthur Versicherungen]

Barriers to implementation

The insurance industry has for a long time opposed PAYD pricing because it requires changes to their practices and may reduce long-term profits by reducing total income from premiums. PAYD insurance requires changes in the way fees are calculated, for example, a network of odometer auditors, and so it is difficult for an individual insurance company to implement. Our experience in discussing this with Swiss insurance companies is also that insurers today have inadequate statistics to allow them to design sophisticated tariff schemes.

Higher-mileage motorists tend to oppose PAYD insurance because it would increase their costs. Most consumers are unfamiliar with the full benefits of PAYD insurance, and many are sceptical of change.

Potential benefits

- Commercial benefits to the insurance company from better alignment of insurance with actual risk.
- Improved customer segmentation and attractive tailor-made insurance products for customers.
- Cost-savings for responsible customers and for customers that use their car only for limited amount of kilometres per year.
- Social and environmental benefits from more responsible and less unnecessary driving.

Potential drawbacks

- Tracking of vehicles 24 hours a day could be seen by many people as an unacceptable infringement on their right to privacy.
- The system recognises only codified, rather than actual, risk. A speeder, for example, would be heavily penalised in comparison with someone who drove in observance of the speed limit. This would not take into account the circumstances involved, for example if the speeding driver in question was driving in an otherwise safe manner, or if the slower driver was changing lanes abruptly, or driving in an inattentive or careless manner.
- Charges would be very high for young drivers, especially at night, and as such would strongly discourage them from driving to social events. In many areas public transport is non-existent at night, and high charges could have a negative impact on their quality of life.
- The potential of PAYD systems for automated traffic law enforcement could result in a reduction of the use of traffic police as has been reported since the widespread introduction of speed cameras. This could result in the reduced detection of drunk driving and other dangerous offences.

4.6.3 Status of implementation of PAYD

In several European countries insurance companies offer PAYD insurance options.

In the UK, Norwich Union Insurance began offering PAYD insurance to drivers on a limited basis in 2003, and is looking into further developing its PAYD program to meet growing demand. Marketing research estimates that approximately half of all English drivers are willing to consider the possibility of subscribing to a PAYD insurance policy. At the moment about 5000 users take advantage of the new insurance model. Norwich Union addresses in particular young drivers under 24 years of age, but also offers a product for all potential users.

In Germany DBV-Winterthur has launched a PAYD insurance model as well. DBV-Winterthur mainly addresses small and medium business car fleets and one of the main selling points is the additional use of the recorded data for fleet management issues. There are no figures available about the number of users. Commercial vans are a high risk group with high tariffs and hence an interesting group for flexible premiums.

In Austria, UNIQUA announced in 2006 that it planned to launch a PAYD insurance model. The concept is close to common mobile phone pricing models featuring a flat monthly rate and a usage-dependent charge. The product is called NoVi (NoVi; “Nutzungsoptimierte Versicherung”, usage related insurance) and in a first step will be tested with 300 users.

4.6.4 Assessment

PAYD insurance models have potential for certain groups where individual risk varies strongly, such as young drivers or for light delivery vans.

For groups where the individual risk does not vary strongly from one customer to the other, PAYD appears only to add overhead costs to an otherwise simple arrangement.

It is the personal impression of the authors, gained from projects involving Swiss and French insurance companies, that the business models are not well understood yet. In particular it remains unclear what will happen in a saturated market. Today, a PAYD company can attract “good risks” by offering these customers attractive premiums. When most companies are offering such schemes this competitive advantage will fade away, but considerable hardware and operational costs remain.

The business case for insurers is a complex one, and not only in terms of balancing risk with premium. One large factor for insurers is the cost associated with resolving accidents. For instance, in high-cost accidents, where people become disabled and have lifelong costs, reasons for an accident are scrutinised in detail, and this causes high costs to insurers. The accident investigation departments are a considerable cost factor in insurers’ business models. These costs could be lowered with cars carrying PAYD devices that simultaneously act as accident recorders, much like the black-boxes in commercial aircrafts.

For the purpose of this report, these developments would not be of much interest were there not the connection to other telematics services. Norwich Union offers its insurance product on a platform that is at the same time used for a kind of e-Call service and an optional satellite navigation service. It might be that PAYD equipment becomes one of the openings for commercial telematics services.

4.7 Sources of material on emerging technologies

Galileo
Additional information can be found at:

- http://www.esa.int/esaNA/index.html
- http://www.european-satellite-navigation-industries.net/
- http://ec.europa.eu/dgs/energy_transport/galileo/index_en.htm

GST
The complete project deliverables of the project can be found at: http://www.gstforum.org/
The download area contains implementation guides for the applications:

- Open systems
- Service payment
- Certification
- Rescue
- Enhanced Floating Car Data
- Safety Channel

Car-to-Car Communications
Additional information about car-to-car communications can be found at:

- www.car-to-car.org
- http://ec.europa.eu/information_society/activities/esafety/doc/esafety_2006/spectrum_28feb2006/7_c2c_eu_workshop_280206_v1.pdf
- www.cartalk2000.net
- http://www.network-on-wheels.de/
- http://www.comesafety.org
- http://www.alexandria.unisg.ch/Publikationen/30950
- http://www.et2.tu-harburg.de/fleetnet/english/vision.html

ADAS
The following links give more detailed information regarding specific ADAS applications:

- http://www.prevent-ip.org/
- http://www.itsoverview.its.dot.gov/green_level.asp?System=DAS
- http://www.esafetysupport.org/en/learn_about_esafety_systems/esafety_systems/esafety_systems.htm
- www.ertico.com

PAYD
Additional information about PAYD can be found at:

- http://www.payasyoudriveinsurance.co.uk
- http://www.presseportal.de/story.htx?nr=741873&firmaid=11912
- http://www.uniqa.at/uniqa_at/cms/privat/vehicle/NoVi.jsp

5. Assessment and conclusions

The following two sections contain views rather than hard facts. Based on our experience with many projects in Europe, we try to summarise the current situation of regulatory telematics applications, and to develop conclusions for developments in the near future. In a separate section we analyse the possible relevance of the often typical European way of approaching things to applications in Australia.

5.1 Assessment of regulatory telematics applications

A general conclusion when reviewing the material collected on the six selected regulatory telematics applications is that new technologies were the focus, with applications standing in their shadow. People were looking for new technology, or were trying to sell advanced technologies like GPS and Galileo. The focus was rarely on developing an innovative application. Some points underlining this observation:

- According to a statement from the German Ministry of Transport, "Germany will become a technical precursor of a widely automated HGV toll collection system. This will launch new market opportunities for the industry and secure jobs. The first implementation realisation worldwide of such a system can initiate an investment boom in other fields of information technologies." (Bundesministerium für Verkehr, Bau- und Wohnungswesen, Fakten zur LKW-Maut, 2003-2004.)
- The Interoperability Directive that asks for the EETS, an interoperable European EFC system, prescribes the use of the three technologies DSRC, GPS and GSM, but does not talk about operational arrangements, the rights and obligations of parties or about the business case.
- In the case of the digital tachograph, introduced as new technology, the associated service provisions and the required organisational framework and management were nearly forgotten, leading to large delays.
- Galileo is driven by the desire to control this technology. Applications to justify the investment are still missing.
- Tracking of hazardous goods has seen many technology demonstration projects showing that trucks can indeed by traced by GPS. An application that would improve road safety and a business case showing clear benefits above other measures are both still missing.

There are many more examples in this report that show that the focus of both policy makers and industry has been strongly technology-oriented, and to a much lesser extent focussed on applications, processes and business case. Such a technology focus might work for products where technology and application are nearly indistinguishable, like the CD player or the mobile phone. Mobile phone technology brought us the opportunity of being able to phone while being mobile. Traffic telematics by contrast is not especially innovative in terms of technology; it is new in terms of integrating existing technologies (*tele*coms plus infor*matics*) to create new services.

The failure to put the service before all considerations, to think about business processes rather than about hardware has lead to failures, delays and inefficiencies. With regard to the applications highlighted above, notable shortcomings were:

- The German HGV tolling system was introduced late, with revenues of hundreds of millions Euro lost, because the focus was on having a GPS-based system and a high-tech telematics platform, and the processes of tolling were not considered and defined until far too late.
- The definitions for the interoperable European Electronic Tolling System EETS are progressing very slowly because EETS was driven by the desire to find an application for Galileo, and not by a genuine interest in improving the situation for roaming users. Accordingly stakeholder commitment is low and the business unclear.
- Introduction of the digital tachograph has faced considerable delay because the focus was on the digital technology and not on implementing an improved regulatory service. Some countries even completely failed to recognise that they had to set up a new management and authorisation structure.
- Tracking of dangerous goods remains one of the often cited new technical possibilities offered by telematics devices which incorporate GSM and GPS. However no application has been developed into a working application. In fact the true costs and benefits of a 'tracking and tracing' related application for hazardous goods transport remain obscure.

There are few examples where the right approach was taken, namely starting from an identified need.

The LKW-Maut in Austria, the Swiss Heavy Vehicle Fee LSVA, and the Alpine Crossing Exchange are notable exceptions, where the business processes were the starting point rather than the end point. The Alpine Crossing Exchange is still under political discussion, but the Heavy Vehicle Fees in Austria and Switzerland are operational and have been introduced without any noticeable problems or delay. A very notable non-European example for a successful application-driven telematics implantation that underlines our argument is the Intelligent Access Program (IAP) in Australia, which receives high attention in Europe.

While the analysis above deplores the wrong approach taken in Europe in general, we remain convinced that traffic telematics is the only way to tackle the traffic problems that this century will bring. We are convinced that managing traffic will be one of the key issues that will shape our future. The famous statement by the former Mayor of London Ken Livingstone that we "cannot build our way out of congestion" is certainly true. As far as we can see the only (partial) answer is making traffic more intelligent through traffic telematics applications. We therefore expect a bright future for traffic telematics, especially for regulatory applications.

Demand management via pricing will certainly remain the most promising and widest deployed application in the years to come. But, and this is especially the case for heavy vehicles which are increasingly viewed as becoming a burden to society, we believe that other solutions that help keep the business sustainable will also be required.

The European Commission launched a small project on a "Mobile Location Unit" two years ago. This was also driven by the wish to find an application for Galileo, but there was the idea of a policy behind it. The idea of the project was to research whether it would make sense to mandate on a European scale that every truck should have a "European regulatory telematics box" installed. Much like the tachograph, every heavy vehicle in Europe would be required to have such a box installed.

This box would be a single platform for several regulatory services that aim at improving traffic safety and managing demand. For example, possible applications in the box could be:

- tachograph for compliance checking regarding work and rest hours
- electronic fee collection for demand management
- tracking and tracing for handling hazardous goods and livestock
- e-Call service
- accident black box.

As this report has demonstrated, the elements to produce suitable equipment and define applications are available. The policy elements are also developing, for example charging with the Interoperability Directive or with the e-Call initiatives. It is not unrealistic to suggest that a box that integrates all regulatory traffic telematics applications will one day become mandatory for heavy vehicles in Europe.

5.2 Applicability to Australia

The statements regarding the benefits and the future of regulatory vehicle telematics in general made in this section equally apply to Australia, although probably with different emphases. Applications will differ due to a different problem situation, but certainly the general statement remains true that vehicle telematics is currently the only realistic means to manage traffic in a sustainable way in the coming years.

Some considerations regarding the specific applications highlighted in the report, and their relevance to the Australian situation are given in the following points.

Charging of Heavy Goods Vehicles in Europe

Whether or not heavy vehicles will be charged in Australia will naturally be a policy decision made independently of any European developments. However, lessons regarding implementation can still be learned from European projects. From the examples presented in this report, it is already possible to draw some conclusions regarding best practice:

- Processes need to be well defined. Charging is not a technology-driven application, but is all about processes involving the user: informing them, distributing the equipment, setting up an account, recording vehicle data, sending an invoice, settling the invoice, changing data, etc. Although not obvious at first glance, the business processes involved in charging are very complex. These processes have to be defined as functional requirements *before* going to market. Otherwise there is high risk that there will be endless discussions with associated delays.

- The technology is there. Almost any charging concept can be realised with existing and proven technology. None of the tolling projects had technological problems or shortcomings.

- Making an OBU mandatory is a tested option. If no real installation is required and outlets are widespread, then users can obtain OBUs without undue hassle and acceptance will be high. Systems based on mandatory OBUs are lean and cost effective to operate.

- The contracting authority has to take a strong leading role and has to remain responsible and in control during the whole process of tendering the charge collection service and has to remain so during the whole implementation phase. In projects where authorities were managing and supervising the projects stringently, introduction of electronic fee collection was a smooth process (in Austria and Switzerland for example). Where authorities have outsourced responsibility delays have occurred, as in Germany.
- The freight business is not necessarily against road usage charges if they cause only little administrative overhead for them. A road charge only increases costs of freight and will be passed on to the customers. It does not distort competition amongst freight companies. Freight companies do strongly oppose road charges if a road charge has complex associated processes that cause them costly administration.

Digital Tachograph

The tachograph is an interesting application in itself, whether analogue or digital. The tachograph application is firmly established in the European regulations concerning work and rest time regulations and has proven to be quite effective in preventing driver fatigue when enforced properly.

We cannot judge whether or not the tachograph application would fit into the Australian regulative and cultural environment in general, but it is conceivable that it could find uses in certain areas. If hazardous goods were to be tracked for example then it would make sense to add tachograph functionality to the application, since the hardware requirements of a tachograph can be fulfilled by almost any telematics platform (assuming proper functional specifications are available).

The tachograph application only works in an institutional environment with certified fitters, trusted issuers of security elements, and above all with a committed enforcement agency. Ideally one would build on existing structures. At first glance, mapping of the tachograph processes on an IAP-like organisational structure appears to be feasible. In addition to monitoring access conditions, IAP Service Providers could also monitor compliance with maximum driving time conditions.

Without an existing background of mandatory tachograph-like recording and enforcement of driving time restrictions, it will be politically difficult to establish such a practice within a reasonable time. In Europe the application has been growing over the years. The concept might be more fruitful on a voluntary basis. For example, it would be conceivable to allow high risk transporters to use routes they would otherwise not be allowed to use, if they voluntary subject themselves to a tachograph-like monitoring. It would also be possible to offer other benefits for companies that allow themselves to be monitored, such as lower fees in certain areas (lower annual registration fee, lower IAP fee etc.).

The above is true for the tachograph application, regardless of technology. The digital tachograph itself, as a technology or a device, is not especially relevant for Australia, since its specifications mainly reflect long negotiations between European member states. The recording functionality can practically be done on any sufficiently tamper-proof telematics box that has a possibility of driver identification.

However two aspects of the digital tachograph are certainly relevant for Australia. Firstly trucks imported from Europe will have tachographs on-board. These are equipped with standard interfaces (CAN bus) that can be accessed by other applications. The data obtained might be useful in some contexts, but without proper calibration and setup the data will have only limited value. Nevertheless, since tachographs replace odometers in trucks, speed and distance information is available in electronic form in good quality.

The second interesting aspect of the digital tachograph is in learning lessons about the introduction process. It is an excellent case study which shows that processes and organisational arrangements are not something to design when close to setting a system into operation, but have to be the starting point of system design. Any failure to make the business processes and the organisational environment the heart of a project will result in unsatisfying outcomes.

e-Call / Emergency Call

Applications similar to e-Call obviously are interesting in a country as vast as Australia. Reporting accidents, and their exact location and circumstances quickly to rescue organisations can greatly improve response times and response quality. We assume that emergency calls are already part of many telematics services packages for the freight industry. What makes e-Call different from a normal package offered by a service provider is the unified approach.

E-Call lives on standards. The true benefit of the initiative is standardising the messages and the operational architecture. Only with standardised messages can the systems become transparent and all participation partners have access to the right data. Rescue organisations are not prepared to answer a multitude of private protocols. They need clear interfaces, where the semantics of messages (the exact meaning and interpretation of an alarm) is specified in detail.

Thus e-Call might provide an interesting stimulus for similar harmonised activities in Australia. Again, it has to be noted that e-Call requires an organisational framework. In this respect Australia is clearly better off, since in Europe every country has its own arrangements. Above all, an institution is required that can play a leading role and that will maintain ownership of all specifications.

Tracking and Tracing of Dangerous Goods

Technically, tracking and tracing of hazardous goods is no different to the IAP.

However, as we have tried to explain, matters are more complex. All initiatives in Europe have shown that the technical realisation does not pose any problems, but that the organisational framework has up to now proven to be insurmountable. The required network of entities and the number of processes that are involved is impressive, and some of the stakeholders have little commitment to participating actively.

It is already difficult enough to ensure that all hazardous goods movements are registered and that the data recorded are correct. The sheer number of ongoing movements per day means that one has to rely on self-declaration and only a limited amount of checking is possible. However it would be helpful if, in the event of an accident or spillage, data could be available in short time. One experience from spillage events in European countries is that often the information on the hazardous goods signs on the vehicles themselves - including the classification code - is not sufficient for a proper reaction of the emergency operations.

Probably a less prescriptive approach should be thought about, and, more for example about decentralisation of the service. Hauliers would probably be more prepared to enter information about the goods into an on-board device, and then only transmit them in an e-Call type way in the event of an incident. This could lead to a lean implementation that builds on existing infrastructure.

Another possibility would be to monitor especially high risk product movements in a manner similar to the IAP, and prescribe routes and times of day, for example for the transport of high-risk products.

In any event, the approach tried in several projects in Europe apparently is not the right one, and new applicative ideas have to be found.

European Electronic Toll Service

Obviously the application itself does not apply, since there are no heavy vehicle charges in Australia. For normal electronic tolling, interoperability has been established.

What is of general relevance though, is the new architecture that has been developed for the EETS. For Europe this constitutes a true paradigm shift. Traditionally every toll operator also was the issuer of OBUs and contracts to his users. Interoperability meant accepting OBUs from other operators, and then clearing the transactions with them. Until two years ago this “clearing between operators” model was the paradigm in Europe. Now a new thinking has emerged for the EETS, and is even already in operation in France in the national interoperable motorway tolls for heavy vehicles. The new paradigm is that the functions of “toll charging” and “payment service provision” are split.

For heavy vehicle tolls in France this now means that the (approximately) ten toll concession companies only operate the DSRC road-side systems and the back-office; they no longer issue on-board units. On-board units are issued by special service providers. Currently there are three on the market: Axxess, Eurotoll and Total. These service providers equip users with the required OBUs and invoice them monthly for the trips made with the various concession companies. The service providers have contracts with the toll concessions, and guarantee them payment for passing users. The toll concessions do not have any relation to the user. For them the user simply appears as a passing OBU that carries an account number from a recognised service provider. Payment by the service provider is guaranteed. The service provider asks both the user and the concessions for a service fee.

These service providers have already started to market to their user not just the interoperable toll service (with the slogan “one OBU, one invoice, all toll systems”) but also additional telematics services. This new arrangement, with the split between the concession operating the road-side and the service providers dealing with the users, is a much better fit into the environment of telematics service provision in general. Now the telematics service provider for your truck in his services package offers the option of paying the tolls via his OBU and his services. For Australian telematics service providers this might well be a business case worth investigating.

Alpine Crossing Exchange

The Alps have pressing problems without any obvious solutions, so there is a readiness to look into less mainstream ideas. Initially all experts involved in studies of this trading approach believed that the concept was too academic and totally unrealistic. However, in-depth studies have shown that auctioning transit quotas and creating a market for them is feasible, and is actually the only market-conformant instrument we know that guarantees that a certain annual quota of journeys is not exceeded.

Some years ago people were similarly doubtful about trading emission values, but trading of SO_2 or CO_2 emission certificates is now an established practice. The main argument presented at the beginning of this report for the need for regulatory traffic telematics was the continuing growth in traffic demand, and the limited capacity that can be provided. Ultimately this means that road capacity, as a limited resource, will have a price and in our society price is set by the market. For this reason, trading of road usage rights will be a development that will become a reality in the long term.

The model applies to any scarce resource. Trading is certainly a model worth considering if access to certain roads is limited by capacity, or if access to certain areas is to be limited (in inner cities for one example, or by no more than a certain number of 40 ton trucks per day as another), or in especially sensitive areas such as tourist resorts or protected environments.

General conclusion

It is hoped this report has been able to highlight the importance of proper application definition, of setting standards, and of driving the development of regulatory traffic telematics applications through a strictly process-oriented approach, as opposed to simply rushing after technology.

Whether applications are mandatory or voluntary, and what the exact nature of the applications should be are secondary matters, provided there is a regulatory body that sets standards, certifies service providers, and manages the overall organisational structure.

In general the IAP constitutes an excellent organisational basis on which to build a telematics application framework. It is based on a functional specification and does not prescribe a certain technical solution, meaning more applications can be added into the framework with additional specifications. Many of the European initiatives presented here would have benefited had a similar pragmatic practice had been followed.

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