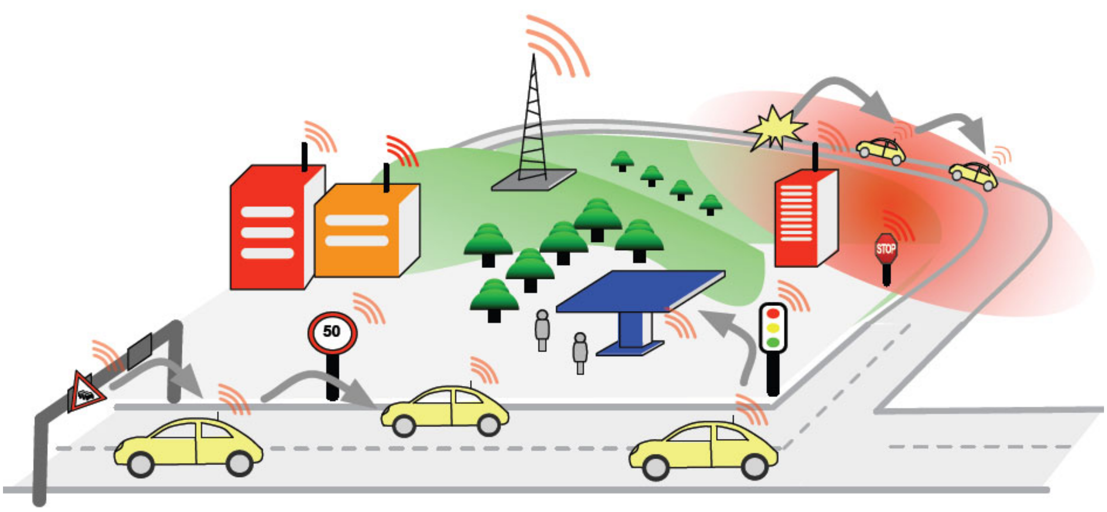
The European Communications Architecture for Co-operative Systems

A Key Enabler for the Development and Wide Scale Deployment of Co-operative Systems for Safe and Environmentally Sustainable Transport in Europe

Summary Document

APRIL 2009



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The European Communications Architecture for Co-operative Systems

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Summary Document

Future European road users will benefit from improved road safety, reduced traffic congestion and more environmentally friendly driving, all enabled by the deployment of Co-operative Systems. The key to achieving these benefits lies in a common and standardised means of communications between the various parts of such systems, whether these components be located in vehicles or in the road infrastructure. This will ensure that equipment from different manufacturers will interoperate in a safe and secure manner. The means of delivering safe, secure, and interoperable Co-operative Systems is a common Communications Architecture, which will provide a basis for wide scale deployment of these systems in Europe.

Europe's road transport network needs Information and Communication Technologies (ICT) based systems if the challenge of achieving virtually accident-free, clean, and efficient mobility in Europe is to be achieved. Co-operative Systems will become a central component of future ICT-based transport systems, and will be crucial in delivering the above benefits. Research in the field of Co-operative Systems, supported by the European Commission's ICT Research Programme, is making major contributions to achieving the realisation of highly innovative systems that promise some major benefits for road users. Focussed on delivering significant improvements in road safety as well as environmental benefits such as improved energy efficiency and emissions reductions, and helping to improve the comfort and sustainability of transport, Co-operative Systems will also contribute towards the goal of reducing road fatalities across the European Union. In the longer term, there is the expectation that these systems will also be important in moving towards achieving the ultimate goal of *near-zero fatalities*, as well as helping to deliver lower energy consumption, for example through less fuel wasted in traffic congestion.

So what is a Co-operative System? These are in fact a very recent development in the area of ICT-based road transport applications. Examples of systems under development include traffic control and management systems; intersection collision warning applications; weather and road condition warning systems; route guidance to avoid traffic congestion and, consequently, wasting fuel; as well as information tools, for example advice on the location of nearby car parks with available parking spaces. Key to the delivery of such applications is communications among vehicles (called vehicle-to-vehicle communications) and also two-way communications between vehicles and Information and Communication Technologies incorporated into the road infrastructure (called vehicle-to-infrastructure communications or, infrastructure-to-vehicle communications).

The usefulness of co-operative road transport applications is very much dependent upon achieving a critical mass of vehicles installed with the equipment and the technologies needed to deliver the desired services. The road infrastructure must also be extensively fitted with the necessary sensing, communications, and information devices. Crucially, ensuring communications between all elements in the system is necessary, and an agreed Communications Architecture is essential for this. And developing such architecture is one of the important objectives of the research that is being pursued in Europe, research that will help to ensure world leadership for Europe's road transport sector. What is more, this architecture will also provide the means of delivering a co-ordinated and integrated European input to the development of standards.

The proposed Communications Architecture, the development of which is a continuing activity, contributes to providing a common understanding of how Co-operative Systems will work together. Providing a high level description and guidance, the Communications Architecture must, crucially, deliver the means of ensuring interoperation (or interoperability) between sub-systems developed by many different vehicle manufacturers, as well as Information and Communication Technologies (ICT) vendors. Importantly, the Communications Architecture must also ensure safe use of Co-operative Systems so that the systems do not lead to dangerous circumstances and accidents. Security is also another essential requirement that the Communications Architecture must address, both to protect personal driver data and to guard against malicious attacks on the systems.

The European Communications Architecture for Co-operative Systems at a Glance

Communications Architecture in the world of Information and Communication Technologies is simply an agreed way of organising the various parts of; in this case, the Co-operative Systems that will constitute a part of ICT-based transport systems. Examples of these components are: the numerous applications that will form the system; security measures to prevent tampering with the system; the different technologies that will be used for communications; and so forth. The Communications Architecture also specifies several critical elements, such as, for example, how security and privacy will be ensured, what applications can be supported, how these applications interact, the required speed of response, etc. The Communications Architecture is also a contribution to the process of developing the standards that will be used in ICT-based transport systems.

Providing a clear organising framework for all parties involved, the proposed Communications Architecture will ensure clarity and the basis for common understanding. These are both essential requirements to enable cost-effective design and implementation of Co-operative Systems. Moreover, these requirements are also essential for the operation, maintenance, and further development of these systems.

The Communications Architecture, which is being developed in the context of several projects supported by the European Commission's ICT Research Programme, covers the issues that need to be considered and elements that should be defined to enable development and deployment of Co-operative Systems in Europe. What are these issues and elements?

In terms of actual building blocks of a particular application, whether such an application is implemented in a vehicle or in some roadside unit, there is a need to define the physical elements of the architecture. This is called the Station Reference Architecture. This is, in essence, just a collection of building blocks that work together to deliver the required application.

What are these building blocks? Naturally, there is a definition of the applications that are supported, be these related to traffic safety, or traffic efficiency, or commercially provided value added services. Below this *layer of applications* there is a definition of the information flows (facilities), considering matters such as geographic coverage of the information and speed of response, with all the applications having different requirements with respect to these two parameters. Then, there is the issue of how all the various parts of the system are networked together, and how data and information are transported among the various components, whether this is via the internet, a mobile telephone network, terrestrial broadcasting services, satellites, etc. Moving beyond networking, the Station Reference Architecture defines the access technologies that can be used. There is a wide range of these, covering both wireless and wired technologies (many in common use throughout society), along with their associated standards. These are the technologies that provide links among the components and also access to them.

Surrounding these basic building blocks, linked to all of them, there are in addition two central architectural building blocks. The first of these is security, a fundamental issue that considers not just the matter of preventing interference and unauthorised access, but also privacy of the data relating to individual drivers and their vehicles. The second central element is system management. This provides the overall co-ordination and control of the various parts of the system, ensuring that specific applications operate in the correct manner with respect to the use of networks, speed of response, and so forth.

But there is more to Communications Architecture than just building blocks of a Station Reference Architecture and the associated technologies and standards: Communications Architectures must also take into account a number of other issues. Consequently, the European Communications Architecture for Co-operative Systems also addresses the policy dimension and organisational elements.

The policy dimension considers critical requirements within the European Union, not just in relation to radio spectrum allocation for Co-operative Systems, but also policy and Directives relating to such matters as vehicle approval regulations, security, privacy, and legal liabilities. The organisational dimension focuses on the fact that the operation of Co-operative Systems will involve many organisations, both public and private, coming together to form a service delivery chain. How this chain could work, for there are various options, needs to be specified, and a number of organisational configurations have been proposed by some of the major European Co-operative Systems research projects contributing to the development of the Communications Architecture.

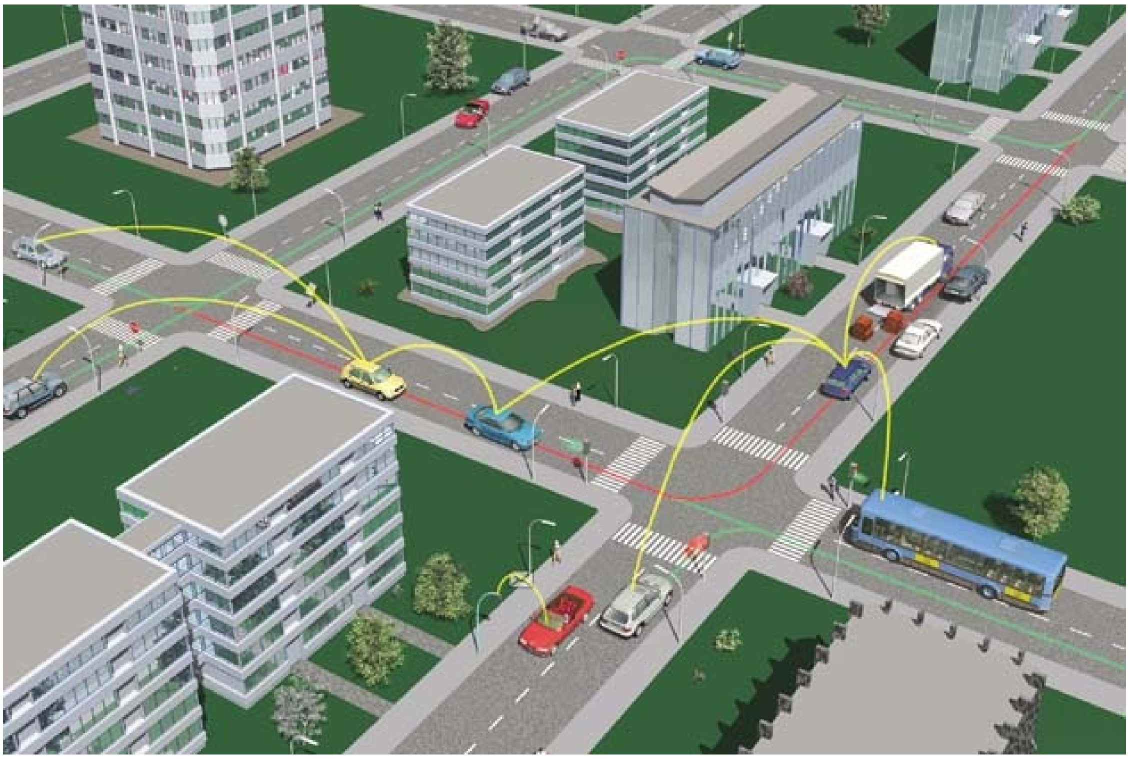
The European Communications Architecture for Co-operative Systems has been developed under the leadership of the COMeSafety Project. It established an Architecture Task Force for the purpose of developing the architecture. The Task Force, which consists of 16 experts drawn from European industry and the European Commission, has integrated emerging results from research and development work undertaken in several important European research projects. COMeSafety will continue work on the development of the architecture in collaboration with the PRE-DRIVE C2X Project, which will eventually take over from the COMeSafety Project when that project comes to an end.

Three European Commission supported Co-operative Systems *flagship* research projects have a central role in the development of the European Communications Architecture for Co-operative Systems.

COOPERS (Co-operative Systems for Intelligent Road Safety) focuses on the development of innovative applications in the road infrastructure with the long term goal of achieving *Co-operative Traffic Management* between vehicles and infrastructure. Enhancement of road safety through the direct communication of up-to-date traffic information between infrastructure and vehicles, specifically on motorways, is the goal of COOPERS.

CVIS (Co-operative Vehicle-Infrastructure Systems) is developing and testing the technologies needed to allow cars to communicate with each other and with the nearby roadside infrastructure. These Co-operative Systems will allow drivers to influence traffic control systems directly, and to receive guidance on the quickest route to their destination. Additionally the project is addressing interoperability of communication between different makes of vehicle and between vehicles and different types of roadside systems. A number of non-technical obstacles to deployment are also being addressed.

SAFESPOT is working to develop an understanding of how intelligent vehicles and intelligent roads can co-operate to produce a breakthrough for road safety. The aim is to prevent road accidents through a *Safety Margin Assistant* that detects, in advance, potentially dangerous circumstances. This in effect will extend, in terms of time and distance from vehicles, drivers' awareness of the surrounding environment. This *Safety Margin Assistant* is an Intelligent Co-operative System based on vehicle-to-vehicle and vehicle-to-infrastructure communication.



Picture 1: Co-operative Systems in a built-up area (Source: BMW Group)

These three projects will participate in the proving of the European Communications Architecture. In particular common testing is planned. Demonstrating the inter-operability between different systems from several manufacturers will be an important aspect of this.

The architecture also combines requirements from the three projects, based upon all the co-operative services being developed. These requirements can be used in the development of Co-operative Systems within Information and Communication Technologies based transport implementations. Some of these requirements are already established ones relating to earlier generations of applications, but many are new as Co-operative Systems generate new requirements not previously foreseen.

In addition to these three *flagship* projects, a number of other European Commission supported projects are contributing to the development of the Communications Architecture.

Specifically, the development of the Communications Architecture builds on the work of early projects that go by the generic name of FRAME. FRAME-S and FRAME-NET further developed and promoted the European Intelligent Transport Systems Framework Architecture originally produced by the KAREN project.

The most recent FRAME project, called E-FRAME, is expanding the Framework Architecture to include support for the deployment of Co-operative Systems in

European implementations of ICT-based transport systems. The work of the project will enable FRAME to be used as a *tool* by those implementing systems, providing support to the generation of information for use in procurement processes.

Other Co-operative Systems projects

Several European Commission supported projects are also relevant to the Communications Architecture. One example is the SeVeCom (Secure Vehicular Communication) Project. This focuses on providing a full definition and implementation of security requirements for vehicular communications. SeVeCom addresses security of future vehicle communication networks, including both the security and privacy of inter-vehicular communication and of the vehicle-infrastructure communication. A full list of relevant projects is given in the annex.

Development of the Communications' Architecture is also undertaken in co-operation with the CAR2CAR Communication Consortium. This is a non-profit organisation initiated by European vehicle manufacturers, membership of which 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 European Communications Architecture for Co-operative Systems in more Detail

Co-operative Systems, based on vehicle-to-vehicle and vehicle-to-infrastructure communications can deliver very significant benefits for road users in terms of safer, cleaner, and more energy efficient transport. By increasing drivers' *time horizon*, the quality and the reliability of information available to drivers about their driving environment is enhanced and improved. Building upon and expanding the functionality of stand-alone in-vehicle and infrastructure-based systems, Co-operative Systems offer the potential for increased information about vehicles and road conditions. This information can be shared between drivers and road infrastructure operators, and can provide the basis for decision making that will improve the use of available road capacity, and enable better responses to incidents and hazards.

However, unlike stand-alone systems, many of the potential benefits of Co-operative Systems require a minimum level of take-up in terms of installed systems in vehicles and the road infrastructure. Consequently, barriers to wide scale deployment must be eliminated. One of the most significant issues here is safe and proven interoperation of equipment developed by different companies, both vehicle manufacturers and their suppliers, as well as vendors of Information and Communication Technologies for roadside infrastructure.

The importance of this interoperation, that is to say interoperability, for future market development is fundamental. If interoperability is not achieved, then different brands of vehicle will not be able to communicate with one another. Moreover, if a particular brand of vehicle cannot identify and access services provided in every location, or in every country, then wide scale deployment across Europe will not be achieved. In these circumstances, Co-operative Systems would, at best, just remain as local services for local drivers.

Clearly something fundamental needs to be done to enable wide-scale deployment and here lays the strategic importance of the European Communications Architecture for Co-operative Systems. Through this agreed and standardised framework it will be possible to ensure interoperability of the applications and technologies that will form the basis of Co-operative Systems. European and international standards supported by the architecture are two ways in which the desired interoperation capability is addressed.

So what applications are foreseen and will be supported by the Communications Architecture? Broadly, these can be classified into three areas: Traffic Safety; Traffic Efficiency; and Commercial Value Added Services.

Traffic Safety Application Examples

Using Co-operative Systems, it becomes possible to add new functionality to in-vehicle safety systems as well as to create new e-safety applications. For example, Co-operative Systems make possible a new form of *Overtaking Vehicle Warning System* that can not only alert drivers to the approach of an overtaking vehicle, but also provide information about the type of vehicle, its speed, etc. Another example *is Post-crash Warning*, whereby vehicles involved in an accident send alert messages to other vehicles approaching the scene of the accident, enabling approaching drivers to take appropriate actions.

Traffic safety applications cover two areas. The first of these is Co-operative Awareness Applications. An example is lane change assistance, giving drivers information about approaching vehicles in their vicinity. The second application area is hazard warning. An example of this would be advance detection of a slow vehicle ahead. Key here is the fact that this information is not just based on in-vehicle sensing of the local environment, but on inter-vehicle communications.

Traffic efficiency is focused on three distinct areas: Inter-Urban Traffic Efficiency; Urban Traffic Efficiency; and Freight and Fleet Applications. Inter-urban traffic efficiency considers adaptive electronic traffic signs, for example incident detection and management, variable message sign display management, lane use management, speed management, and so forth. Also forming part of inter-urban traffic efficiency are road condition advice, route guidance and navigation (for example on-trip guidance using real-time traffic data with special routes for particular vehicle types), etc. Urban traffic efficiency covers traffic flow optimisation, for example through incident detection and management, minimising traffic delays and queues at intersections, priority for buses and emergency vehicles, and speed management. Route guidance and navigation is also covered, but in the context of the urban environment, hence additional factors, such as advice on the availability of car parking, are incorporated. The final traffic efficiency area is freight and fleet applications, which covers such things as the booking of delivery slots and management of hazardous goods vehicles, these being just two examples.

Traffic Efficiency Application Example

Route guidance is an important application to help drivers avoid traffic congestion and hence to improve their fuel efficiency and to reduce unnecessary emissions. By informing vehicles of local traffic conditions, and providing advice in real time about alternative routes, drivers can be guided towards their destination using less congested routes. This type of functionality is enabled by Co-operative Systems that can exchange information and then use this to undertake decision making to suggest better routes for drivers.

Commercially offered value-added services are also addressed by the Communications Architecture. Such services include local access to vehicle-to-vehicle or vehicle-to-roadside connections to provide services beyond those made available free to drivers. Also included in the domain of value-added services are such things as high speed internet access for services such as journey planning and identification and booking of hotels, restaurants and so forth.

Specific realisations of Co-operative Systems must not be constrained in terms of which type of communications mechanisms that are used. For this reason the Communications Architecture supports both wired and wireless access technologies.

Wireless Access Technologies

Many wireless access technologies are supported by the European Communications Architecture for Co-operative Systems:

- Short range technologies
  - CEN DSRC; European 5.9 GHz ITS; WLAN 5 GHz; Infrared;
- Cellular systems
  - WiFi; WiMAX; GSM; GPRS; UMTS;
- Digital broadcast systems
  - DAB and DMB; DVB and DVB-H; GPS.

Both short range and long range communications are possible. Moreover, all the main communication techniques in use in society, such as digital audio broad-casting (digital radio), mobile phone networks, wireless networks, and internet communications are available for use. For each of these the associated standards are supported.

This latter point relating to standards is very important, and the communications aspects of the European Communications Architecture for Co-operative Systems take into account developments in international standards undertaken in the context of the International Standards Organisation (ISO). Specifically, the international standards for Intelligent Transport Systems communications are considered. The set of standards in question goes by the name CALM (Communications Architecture for Land Mobiles).

What is significantly new about the European architecture is that it provides much better security, more fully defined applications support, and much improved traffic safety communications. So while the CALM architecture has many similarities to the European Communications Architecture for Co-operative Systems, the latter can be viewed as an improvement to and extension of the existing CALM architecture.

Importantly, to help improve the functioning of the global marketplace for Co-operative Systems, the European developments need to be fed back into the International Standards Organisation CALM standards setting process. This will help reduce technology barriers between the world's geographic regions. It will also help improve safety for travellers, since handheld or nomadic Co-operative Systems devices could then be used anywhere in the world.

Since the CALM standards setting process has strong links to other standardisation bodies such as the European Telecommunications Standards Institute (ETSI), this will help facilitate a rapid take-up of the European concepts by a wider international audience.

Beyond the matter of international standardisation, Co-operative Systems applications of the type outlined must comply with European regulation and policies. In this respect, there are a number of key areas that have been considered.

In-vehicle elements of Co-operative Systems must conform to the relevant Directives under the European motor vehicle type approval system. In the case of Co-operative Systems, relevant Directives are radio interference/electromagnetic compatibility, and also interior fittings. For mopeds and motorbikes, there are equivalent provisions under other Directives. It is possible that further Directives may also need to be taken into account, for example, the Directive addressing radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

A key requirement for in-vehicle Co-operative Systems is compliance with the European Statement of Principles on Human Machine Interfaces. This relates to safe and efficient use of in-vehicle information and communication systems.

Security of Co-operative Systems is a critical requirement to ensure that the applications proposed will be protected from malign intervention. Such malicious attacks on systems could compromise the safety of road users and would, if successful, also destroy the credibility of Co-operative Systems.

A number of threats are taken into account. These include network jamming, the insertion of fake warning messages, the corruption of data, and taking control of part of the system to create false information about road or traffic conditions. Handling such a wide variety of attacks is a challenging task, complicated by the fact that some security measures require a heavy computational load to implement, which compromises the ability of the system to handle safety related tasks, most of which need to be undertaken rapidly. This is one area where the development of the Communications Architecture is still subject to continuing development.

Related to the security issue is the matter of privacy. Co-operative Systems will imply the creation, storage and exchange over wireless communications links, of personal data. In particular, it is expected that Co-operative Systems will generate a huge amount of location data, which can be considered as personal data as it provides the capability to track the movements of individuals.

The results of a European survey, carried out in 2006 regarding the perception of the use of intelligent systems in vehicles, clearly shows that privacy concerns vary according to application. Automated emergency call services (eCall), for the majority, do not raise major privacy concerns, since the usefulness of the system outweighs the disadvantages with respect to privacy. However, with regard to real time traffic and travel information (RTTI) systems, there are serious concerns among the public. Significantly, many respondents considered such systems to be intrusive and they would not like to have them in their cars. This is especially so for 26% of the French respondents and 25% of the German respondents.

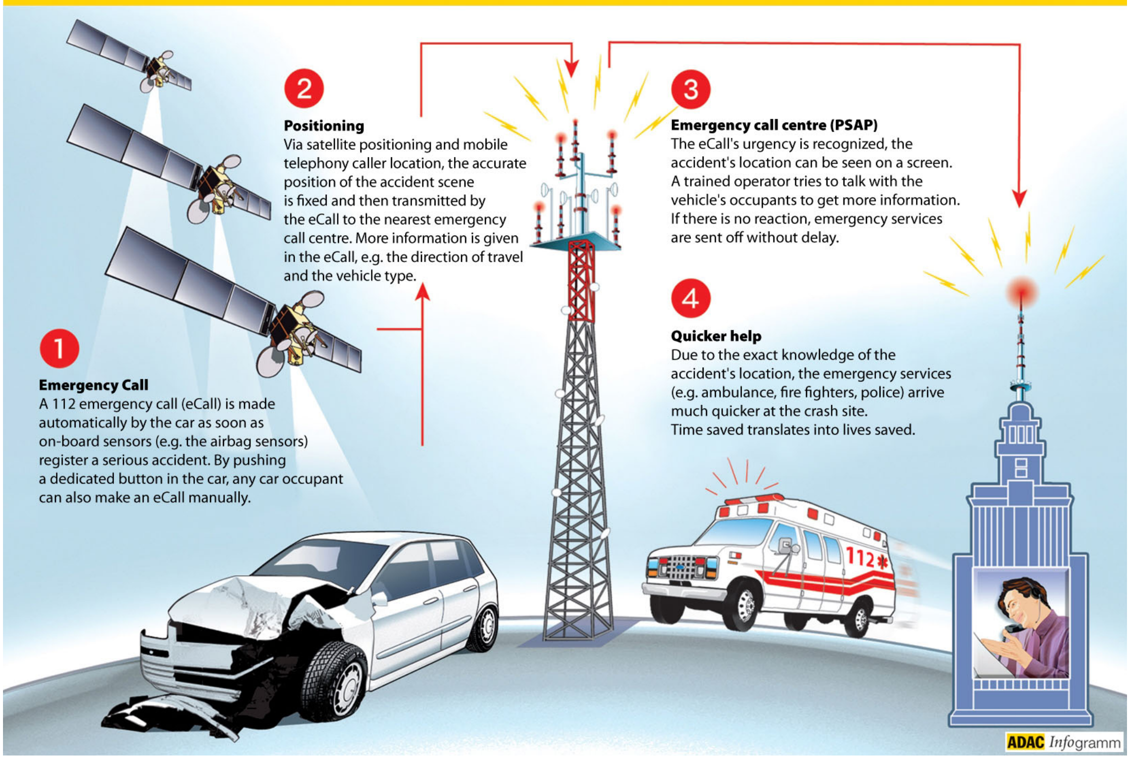
Ensuring both security and privacy therefore are both key requirement for successful wide-scale deployment of Co-operative Systems.

How are security and privacy issues addressed in the Communications Architecture? A number of key principles have been adopted. First, as some of the communication standards that will be used in Co-operative Systems have not been finalised, a clear separation has to be made between the architecture and the specific technologies used to implement it. Consequently, the security component of the Communications Architecture is designed to be *future proof*, that is to say, the architecture is fixed, even though some technology standards will change, or specific technologies may be replaced in the future with better ones. Second, as vehicles will be periodically broadcasting their position and sending other information, the identity of vehicles will be concealed to protect privacy against both malicious and casual observation. This means that permanent identifiers and addresses will never be communicated over the air. Third, to ensure trust in messages, these have to be digitally signed. Signing of messages is designed to ensure that tracking and tracing will not be possible, and is based on the use of assigned temporary pseudonyms, which are periodically revised, thus making it difficult for outsiders to fabricate digital signatures.

A central component of the Communications Architecture is system management. System management is crucial for control and its role is to amalgamate different applications, networks, and interfaces in a specific implementation of the Station Reference Architecture. Such implementations might, as examples, be a simple stand-alone unit in a vehicle, or a large roadside network.

Management is very challenging since the management unit has to differentiate between the very contrasting requirements of safety and non-safety based applications. Typically, the characteristics of safety critical applications are rapid speed of response, an interference free environment, and applications linked to one specific interface.

eCall: The crashed car calls 112!



Picture 2: eCall – A safety-critical application

The characteristics of most other applications are that speed of response is often less important than guaranteed delivery of information, interference can be accepted if communication succeeds in the end, and applications can usually utilise any interface.

Realisation of the management function is organised into four sub-blocks, with the station management block dealing with management of the particular implementation. The remaining three sub-blocks address specific issues, respectively: networking management; interface management; and data management.

Finally, the European Communications Architecture for Co-operative Systems does not prescribe or express any preferences for organisational designs in relation to the deployment and delivery of services based on Co-operative Systems. The reason for this is that there are many workable organisational designs. And this fact is reflected in the three major Co-operative Systems *flagship* research projects supported by the European Commission, each of which has a different organisational model. The starting point for these organisational models is the technical solution adopted for the various systems and networks being developed.

One of the possible technical solutions is a bi-directional data network with strong centralised functionality. In such a case, the operator of the data network (and road infrastructure network) would have the main responsibility for collecting, processing, coding and distributing high quality traffic information and road safety relevant information to travellers. Therefore this operator would take on responsibility for assuring service quality, continuity, and improvements to the data network. This approach is followed by the COOPERS Project.

Another possible technical solution is to use peer-to-peer networks, with changing characteristics of responsibility and roles among those involved in the delivery of services. System responsibilities for set-up, service operation, and improvement would in such circumstances be defined according to business and deployment models. These however have yet to be developed in detail, and this matter is being addressed by the CVIS Project.

Yet another possible technical solution is one that is based on what is called *a vehicular ad-hoc network*. This essentially involves a network that is forever changing, taking advantage of chance meetings among network nodes, for example vehicles on the road. These nodes have roles in the data communication depending on the specific scenario. Therefore the main responsibilities would generally not be defined for long periods, but rather for short timeframes. The SAFESPOT Project is investigating such an approach.

All these organisational models have yet to be tested and verified through extended experimentation.

Future Developments

The development of the European Communications Architecture for Co-operative Systems is still a work in progress. Several issues are still being considered.

In the sphere of radio spectrum, the allocation of radio bands is in the hands of Member States who have regulatory authority. However, harmonisation of radio spectrum use across the EU Member States is needed to enable wide scale deployment of Co-operative Systems. Consequently a Commission Decision was adopted on August 5th, 2008, with the objective of harmonising the use of the 5875 - 5905 MHz frequency band for use by Intelligent Transport Systems applications, including Co-operative Systems. In Europe therefore, Co-operative Systems will most likely operate within this frequency band.

With respect to roadside equipment, relevant regulation as a general rule is left to individual Member States. As a result, different policies on licensing are applied. Certification of devices and services is also an open issue. Self-certification of devices by manufacturers might be sufficient in some cases, where no external certification is required, but certification of services will still need to be obtained from the relevant authorities. To ease the deployment of Co-operative Systems, a co-ordinated approach to certification and licensing of roadside equipment is needed at European level.

The circumstance with regard to legal liabilities related to Co-operative Systems is very complicated. One major element of legislation that restricts the functionality of Co-operative Systems is the United Nations' Economic Commission for Europe Convention on Road Traffic (the Vienna Convention), signed in November 1968, which stipulates that drivers must control their vehicles at all times. Major developments in technologies used in vehicles and infrastructure make modern cars and the driving environment totally different from those of 1968. Moreover, traffic has become more complex, making drivers' tasks increasingly difficult. Current technologies could be much more efficiently used in supporting drivers, if vehicle systems were allowed to intervene in controlling the vehicle. Many systems currently on the market are already entering a *grey zone*, since the means by which driver control of the vehicle is achieved, is fundamentally different from earlier systems, and also open to different interpretations.

In relation to the above, the United Nations' Economic Commission for Europe World Forum for the Harmonisation of Vehicle Regulations has developed a common understanding with regard to in-vehicle ICT-based applications. The basic principle is the concept of the Driver in the Loop. This implies that in-vehicle systems should be designed such that the driver is always in control of the vehicle under normal conditions. Consequently, a number of principles for designing in-vehicle systems have been suggested.

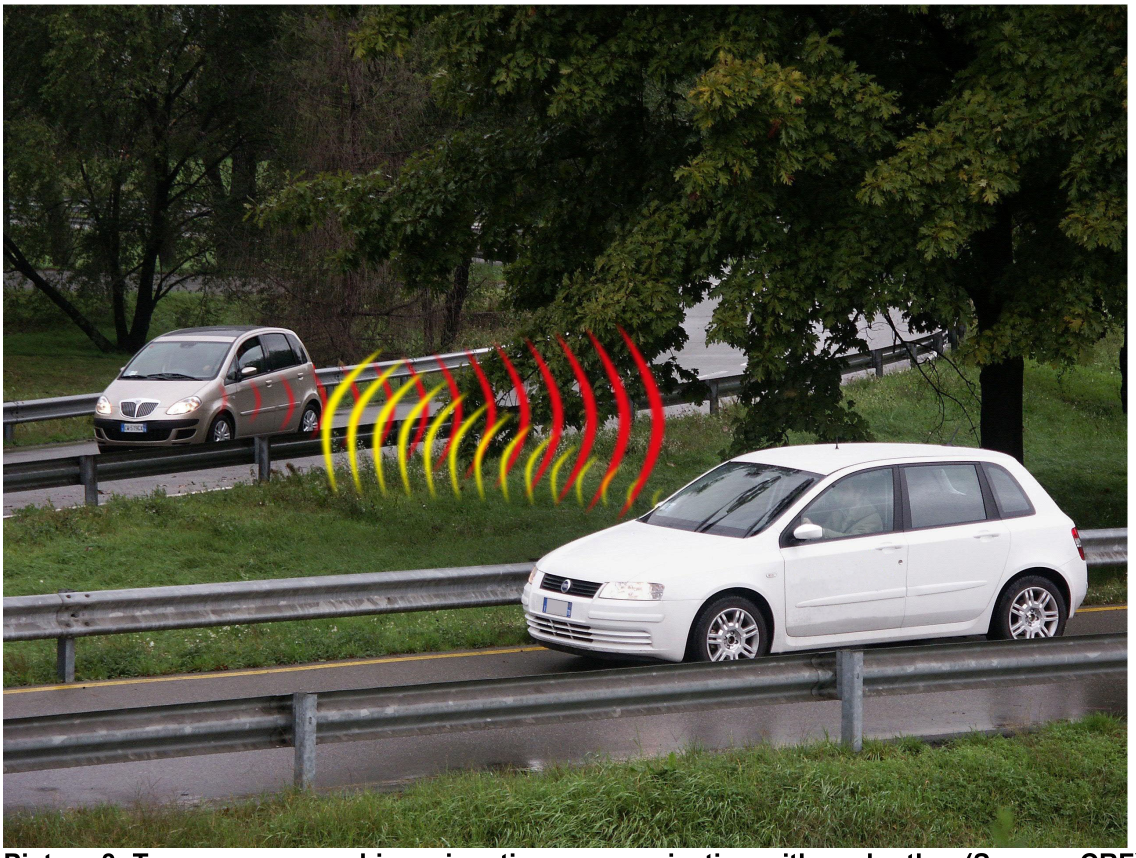
The key principle is that drivers should always be held responsible for their driving and systems must be designed with this as a requirement. Hence auditory or visual announcement devices providing information on the system functioning should be installed in vehicles. Moreover, control systems activated under normal driving condition should be designed based on the *driver in the loop* principle. For this purpose several design rules should be followed:

- announcement should be made when the driving initiative is transferred from system to driver;
- driver involvement in driving operations should be maintained, so for example, the initiative for starting a driving action should not be given to the system;
- the driver should be able to switch systems off, and systems should allow drivers to override decisions and actions.

As for control systems that are activated under pre-crash conditions to reduce collision speed, then, in conditions where collision is no longer avoidable, there is no room or necessity for overriding by the driver.

However, there are also other complications with regard to legal liabilities that arise as a result of differences between Member States with respect to the implementation of product liability Directives, and the fact that safety standards for vehicles are also covered by vehicle type approval Directives. Responsibilities for traffic rules and traffic liability are also still left to individual Member States and thus there is no harmonisation with respect to these issues.

Consequently actions are needed to further consider identifying the legal consequences of Co-operative Systems, as well as to consider revisions to the Vienna Convention. Moreover, progress by the United Nations' Economic Commission for Europe World Forum for the Harmonisation of Vehicle Regulations needs to be monitored and assessed with regard to common understandings and regulations affecting the design of Co-operative Systems.



Picture 3: Two cars approaching a junction communicating with each other (Source: CRF)

In the research area there are still several issues that require further consideration. An example of this is how to achieve high levels of security, while maintaining rapid speed of response for safety critical applications. Another is how to manage and co-ordinate the various parts of ICT-based systems with respect to combining very contrasting requirements that arise from safety and non-safety focused applications.

Moreover, demonstration, testing and proving of the Communications Architecture is also needed. Intentions here are to begin some demonstration, testing and proving in 2009 and 2010, with the COOPERS, CVIS and SAFESPOT projects working together to plan and deliver such. Proposals for testing will consider co-ordinated activities at each project's test sites to determine which applications will be tested, and with what infrastructure and vehicles, and by which projects, and where. Additionally, demonstrations are being planned for the ITS World Congress, which is to be held in Stockholm in September 2009. Furthermore, a high visibility show case demonstration, to be held sometime in 2010, is being considered.

Given that the technical solutions underlying the Communications Architecture will change with time as technologies evolve, the European Communications Architecture documentation will also need to be revised and extended. Future revisions to the documentation will also arise as a result of lessons learned from demonstrations, and as a consequence of the results emerging from continuing efforts at developing standards, and feedback from consultations with stakeholders.

Annex: Internet addresses of research projects under Framework Programmes 6 and 7 (FP6/FP7), whose work is relevant for the European Communications Architecture for Co-operative Systems
(links checked on 26 March 2009)

FP 6 projects:

COM2REACT:	www.com2react-project.org/
COMeSAFETY:	www.comesafety.org
COOPERS:	www.coopers-ip.eu
CVIS:	www.cvisproject.org
eSAFETYSUPPORT:	www.esafetysupport.org
GST:	www.gstforum.org
MORYNE:	www.fp6-moryne.org
SAFESPOT:	www.safespot-eu.org
SEVECOM:	www.sevecom.org
WATCH-OVER:	www.watchover-eu.org

FP 7 projects:

E-FRAME:	www.frame-online.net
GEONET:	www.geonet-project.eu
INTERSAFE 2:	www.intersafe-2.eu
NEARCTIS:	www.nearctis.org
PRECIOSA:	www.preciosa-project.org
PRE-DRIVE:	www.pre-drive-c2x.eu

The European Communications Architecture for Co-operative Systems' entire set of documents can be downloaded from: http://www.comesafety.org.

More information on the mission and portfolio of unit 'ICT for Transport' can be found at: http://ec.europa.eu/esafety

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