CVIS: AN INTEGRATED COMMUNICATION SYSTEM SOLUTION FOR ‘ITS’ APPLICATIONS

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Summary: - The CVIS project initiative aims to develop core technology for enabling ITS applications for vehicle to vehicle and vehicle to infrastructure communication by allowing cars to cooperate directly with each other by exchanging on-board driving information as well as sharing information on the latest traffic situation obtained from the infrastructure for greater safety, efficiency and a better environment. This paper gives a brief review on the objectives of the ongoing project by briefly characterizing the novel approaches to a new communication technology proliferating in the ITS field rapidly.

INTRODUCTION

Cooperative Vehicle to Infrastructure Systems (CVIS) is an all European R&D initiative supported by the 6th research framework program of EU. The project is lead by ERTICO, Brussels by coordinating the activities of 62 participating partner institutions coming from the academic field, as well as, from the corporate area of European car making, navigation and telecommunication industry. The CVIS project, in a close cooperation with other main car and traffic safety related EUCAR projects, such as eSafety, SAFESPOT and SeVeCom, just to mention a few, aims to develop the core technology for enabling vehicles to cooperate directly with other nearby vehicles, and with the active elements of the immediate roadside infrastructure by sharing on-board driving information as well as information on the latest traffic situation for greater safety, efficiency and a better environment.

According to the project objectives, CVIS equipped vehicles will be able to connect and communicate via local ad-hoc networks with other vehicles and roadside equipment in the vicinity, and also via an always-on network connection to access a wide range of journey support and other services. The pre-requisite is the availability of a harmonized technology for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication and mobile ad-hoc networking. IP and non-IP based communication technologies are both considered, depending on the expectations of particular applications. This makes the definition and validation of an appropriate architecture and system concept for a number of cooperative system applications necessary, which can be used to support cooperation models in real-life applications and services that will bring advantages to drivers, operators, industry and other key stakeholders.
Development of an open and interoperable concept for cooperative systems, based on a comprehensively negotiated, standards-based open-source technology platform and common software modules for applications is another key idea of the project: as a result, any CVIS equipped vehicle should be able to access and run any application, anywhere in Europe assuming the compatible roadside infrastructure is available. The individual driver can be guided to his destination avoiding the worst congestion, and enjoying a faster journey through the road network. Professional drivers will be linked to both their dispatching centre and the local traffic management centre, reaching their destination more quickly and reliably, and once there will find a free parking or loading space waiting. Hazardous goods shipments can be monitored at all time and given priority on a pre-selected safe route. CVIS develops new systems for cooperative traffic and network monitoring, to detect incidents instantly and anywhere, not just where there are loop detectors or cameras, while vehicles will send more complete monitoring data from rain, fog, ice and air quality sensors.

**WIRELESS ACCESS IN VEHICULAR ENVIRONMENTS**

Obviously, the only available communication solution among moving objects can only be based on wireless, radio technology. Today in Europe, only a small minority of vehicles are equipped for two-way mobile data services, typically telematics applications such as emergency call (e-call), breakdown call, dynamic & off-board navigation and remote vehicle diagnostics.

![Diagram](image-url)

*Fig. 1: Scope and extent of the CVIS project initiative and relationships to other associated R&D activities.*
Mobile cellular communications is the principal carrier, typically GSM, 2.5G (GPRS) and increasingly 3G (UMTS), which offer nearly pan-European coverage. However, the cost of communications has been a barrier to widespread deployment. The key enabling technology for portable computing, Wi-Fi™ or “WLAN” (based on the standards IEEE 802.11 a, b or g) is spreading rapidly as “Wi-Fi hotspots” proliferate and as the cost of the technology falls. Users can surf the Internet on-board, and access e-mail accounts wherever they are in the world, easily and for a reasonable cost. For a brief summary on the subject and extent of the project, see the illustration in Fig. 1.

However, this technology is not yet adapted for use in moving vehicles, because of a number of reasons. Continuous availability, real-time requirements, robustness and fault tolerance of communication are just a few of the never answered questions with regards to the use of the new communication technologies in real-life situations. The problem of mobile routing, based on the new mobile Ipv6 version of the Internet Protocol (IP) combined with the idea of geographical addressing, for example, is subject of intense research in communication engineering recently.

Work to draft such a mobile Wi-Fi standard is currently well advanced (IEEE802.11p), and is the basis of work in ISO (TC/204 WG16, “Continuous Communications Air Interface for Long and Medium Range” or “CALM”), ETSI (TG37), the European DSRC initiative, and amongst a group of European vehicle and system manufacturers called the “Car-to-Car Communications Consortium” (C2CC). Many essential building blocks are currently under standardization, partly, with the support of the CVIS results. These are the NEMO (NEtwork MObility) that are needed to allow users to maintain a continuous Internet Protocol connection while moving; these are developed in the Internet Engineering Task Force (IETF). These will be adapted and translated into working specifications to support the CVIS application environment.

Fig. 2: Idea of vehicle-to-vehicle and vehicle-to-infrastructure communication.
CORE TECHNOLOGY DEVELOPMENT OF COMMUNICATION AIR INTERFACES

Another challenge of CVIS lies in the design and reliable operation of heterogenous air communication interfaces embedded in a highly jammed environment, disturbing by and interfering with other communicating vehicles in the near neighborhood.

CVIS aims to develop a multi-channel terminal capable of connecting with a wide range of potential carriers, including cellular networks (GPRS, UMTS), mobile wireless local area networks (WLAN, or Wi-Fi), short-range microwave beacons (DSRC) or infra-red (IR). This will be based on the new international CALM (Continuous Air Interface for Long and Medium Range Communication) standard, ensuring full interoperability between different makes of car and of traffic management systems. Development of techniques for enhanced vehicle positioning and the creation of local dynamic maps, using GPS, Galileo and the latest methods of location referencing is in the core of the technology.

The CVIS air interface technology will use policy-based rules to select the optimal communications channel at any time and place. CVIS introduces a network concept where all CVIS enabled devices both in vehicle and in infrastructure are connected via the mobile version of the newest IP (mobile IPv6). The air interfaces are included in the system through one or more CVIS Routers per vehicle or per roadside station. This will ensure a high-capacity continuous connection with roadside infrastructure, and between the vehicle and other vehicles.

![Fig. 3: Main components of the on-board CVIS info-communication system embedded in the OEM based vehicle control system architecture. The connection is realized by using a communication gateway to the OEM vehicle network.](image)

It is expected that on-board electronic system architectures, both for personal and commercial uses, will support one of these communication technologies, which will be adopted by OEM car manufacturers in the very near future. The Car2Car communication consortium, for example, embracing the most relevant car manufacturers in a single R&D division, supports this
new principle of communication. For the idea of CVIS integration to OEM platforms, see the illustration in Fig. 3.

![Fig. 4: Sketch of basic architecture of mobile on-board CVIS equipment](image)

**REPRESENTATIVE APPLICATIONS OF CVIS CORE TECHNOLOGY**

Relying on this new communication technology, CVIS implements applications for different types of road user and of road environment. A new world of innovative applications and services will be opened up when every vehicle can communicate directly with nearby vehicles and infrastructure, using a continuous wireless IP-based connection. Roadside traffic managers and operators can link directly to individual vehicles, or address them according to their location. Vehicles can exchange data with other nearby vehicles, sharing information on local traffic conditions and information related to safety, efficiency and environmental impact. The CVIS project will develop the minimum toolkit necessary to enable this promising world of cooperative systems.

The CVIS integrated project will focus on developing the specific technological and operational innovations needed as the foundation for future cooperative system deployment. It will devise, develop, test and demonstrate a small number of credible reference applications that use these new technologies. The technical development of the CVIS project will work towards a comprehensive and integrated platform that supports cooperative applications. This platform can be configured in a version that is optimized for the in-vehicle environment and a version that is optimized for the roadside infrastructure environment. Each version can be further optimized to allow a light or full deployment depending on platform and cost constraints.

The platform will be specified and implemented as an open design that can easily be ported into commercial products. Benefits of cooperative applications could be analyzed or simulated in theory, but bringing them ‘on the road’ requires a suitable set of basic services that provides exactly the seamless and location aware, high definition communication links that are a mandatory requirement for cooperation in the first place. The CVIS platform that allows
to bring cooperative services ‘on the road’, comprising components that work closely together and that have been developed and implemented by one of the following technical subprojects:

- **COMM** for components for communication and networking.
- **FOAM** for the open framework for the development, deployment, provisioning and management of end-to-end road management and transport safety applications.
- **POMA** for components of advanced positioning, map update, location referencing and dynamic local maps of current driving conditions
- **COMO** for the components for hybridized probe-vehicle and infrastructure-based monitoring data collection, access and fusion.

The benchmark applications, developed by the above subprojects, will be translated to working software modules to be installed in both vehicle and roadside equipment. The applications and core technologies will be trialed at test sites in six European countries, and in urban, inter-urban and commercial environments. The trials will aim to prove the compliance of innovative cooperative system concepts with users expectations and indicate the potential effectiveness, impacts and benefits of the principles of cooperation.

**CONCLUSIONS**

This article briefly summarizes the basic objectives and technology approach of the CVIS project aiming to develop core technology and enabling services for cooperative vehicle and infrastructure communication as well as for other car safety oriented projects and applications. The project has been launched in February this year. The prototype CVIS implementation will be based on an open-source platform facilitating the general acceptance of the CVIS communication principles and paving the way for deployment as part of customized OEM systems. One of the basic goals of CVIS is to develop an open communication framework for using both the infrastructure and vehicles as sources (and destinations) of information, and definition of an open, flexible and modular communications architecture. Developing the key enabling technologies, such as accurate geometric localisation, ad-hoc dynamic networking, on-line dynamic traffic maps edition. Evaluating the safety, security and liability aspects, moreover, regulations and standardisation issues are key factors of the professional project activities.

Ramsys Inc. Budapest is contributing to the design, specification and realization of the so-called **CVIS Reference Execution Platform** liable to host the sample implementation both on mobile and road-side platforms.