Cooperative Vehicle-Infrastructure Systems

European vision for V2I communications

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Head of Development
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Outline

Vision
The CVIS project
Technologies
Applications
 Deployment issues
European framework
Background

- Europe is 27+ individual countries, united in a “Union” responsible for some common matters
- EU “government” has limited competencies
- Growing awareness of potential for cooperative systems
- ...but no organisational basis, evidence of benefits
- ...so no “VII” or “Smartway” national programme
- ...instead some large R&D projects, all stakeholders
- ...able to produce key results and input to standards.
CVIS Vision

“Create a wireless network between vehicles & infrastructure”

“Increase efficiency & safety through vehicle-infrastructure cooperation”
A cooperative system network...

- Driver
- Traffic light
  - Truck
  - Bus
  - Car
- Traffic info centre
  - FCD database
  - Police
  - Traffic centre
  - Service provider
  - Payment clearer
- Map server
- Road sign
  - “CVIS-net”
We recommend those vehicles travelling to ... should divert via ... The road ahead is congested...

Travel time on the next link is...

I want to go to...

Controllers on section ..., please do ...

I am in a traffic jam.... My attributes are...

You may use the bus lane temporarily...

I will change in 7 sec...

I want to park...

I measure. I display ...

You can download services...

The best route to the car park is via... A space is reserved for you on the 2nd floor ...
About the CVIS project
CVIS in Brief

Coordinator:
ERTICO – ITS Europe

Duration:
Four years to 31 Jan 2010

Total budget:
€41 Million (€22 Million EU)

Consortium:
60 partners (12 countries)
CVIS core technology: CALM*

*ISO TC204 WG16, ISO 212XX
Why “CALM”? 

- Provides “Continuous Communication” for V-I & V-V 
- Select most appropriate comms medium, according to application requirements, urgency, QoS, value 
- Supports roaming & handover between base-stations, operators, different media, and service suppliers 
- Supports ITS and Internet Services 
- Full DSRC, 2G/3G, WiFi and broadcast receiver integration using a convergence layer 
- Based on 802.11p, GSM, 3G, IR, milli-metric, DSRC, GPS 
- Based on IPv6, with Network Mobility (NEMO)
Vehicle-infrastructure communications
(CVIS in blue shading)
CALM architecture (2007)

- non-IP support
- fast protocol/security support
- geo-routing protocol support
- proprietary protocol are now supported
- broadcast manager
- simplified stack management
- global operation for 5.9 GHz and 802.11abg supported in CALM M5
CALM-M5 Active 5.9 GHz Microwave

- International superset of WAVE (IEEE 1609), adapted for European and international regulations and multimedia requirements
- Enables omni- and semi-directional communication (up to ~500m)
CALM-2G/3G Cellular

- Adaptation of existing cellular systems to the CALM vehicular environment
- Cellular adds wide range communications
- Can support rescue (eCall) and subscriber based services like on-line navigation and traffic information
CALM-Infrared

- Adds beaming capability (line-of-sight)
- High data rate
- Position-dependent messages (e.g. lane selective)
- High transmission reliability and privacy
CVIS architecture
CVIS sub-project architecture
**CVIS service architecture**

- End users
- Nomadic
- Service Centre
- Nomadic
- Service Centre
- Host Management Centre
- Roadside
- in Veh

**Flows:**
- Information flow
- Software flow

**Entities:**
- Governing Organisations
- Service Providers
- Software Suppliers
CVIS subsystems
CVIS Sensor & M5 card

- Gyro
- Accelerometer
- 20ch GPS
- OBD-II CAN Bus
- CEN DSRC
- 2.5 / 5 GHz 802.11 radios modified for:
  - Euro 802.11p
  - DSRC RT sync
  - GPS time sync
- FPGA: PCI, Serial ports & softcore CPU
- Realtime GPS & DSRC sync, sensor fusion/timestamp
CVIS Reference antenna

2-6 GHz Antenna 1

GSM/UMTS Antenna

2-6 GHz Antenna 2

GPS Antenna

CEN DSRC Antenna
CVIS technology sub-projects
COMM - communication services

- Service Discovery (register/query mechanism)
- Service Advertisement (publish/subscribe mechanism)
- Broadcast pool function (non-IP)
- Communication protocol between vehicle gateway and CVIS host
- Router for IP addresses
- Network mobility support
COMM - communication & network services

IP communication within core infrastructure

IPv6 Access Router - manages local IP addresses

IP communication within access network

Geo-Addressed protocol header is added/stripped here

Realms of Vehicle-Vehicle communication

Vehicle-Infrastructure communication

On-board computer

NEMO Mobile Router

Access Server - Manages vehicle data access for a certain area

Correspondent Node - any communication partner

IP v6 Home Agent - fixed point of attachment for an end-device in the Internet

In-vehicle data distribution
FOAM - open application management

Provides

- access control
- services discovery
- communication
- remote management
- JAVA OSGi platform
- open and future-proof application platform
FOAM - Distributed Directory Service

- Find another application (provide URI=IP:port)
- Notify the presence of a certain application
POMA - positioning subsystem

CVIS Vehicle

L1/L2 GPS
3-axis IMU
Compass
Speed Sensor
Optional ext. Sensors

L1 GPS
OBD I/F
Accelerometer
Gyro

Router PC
OEM Gateway
Vehicle wheel sensors

COMM Modules

Infrastructure

DGPS Augmentation
Wireless Sensor Network (Loops, Cameras, Beacons, etc.)
WLAN Network

COMM Modules

Radio Link

Standard setup (minimum)

Optional extended setup

POMA components
COMM components

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POMA - positioning techniques

WLAN localisation

WSN localisation

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COMO - Cooperative Monitoring
CVIS applications
CVIS Applications

Cooperative Monitoring
- XFCD, fusion with infrastructure sensors

Urban
- Cooperative network management
- Cooperative area destination-based control
- Cooperative acceleration/deceleration
- Dynamic bus lanes

Interurban
- Enhanced driver awareness
- Cooperative travellers' assistance

Freight and Fleet
- Access control
- Dangerous goods
- Parking booking
CURB - urban
CINT - interurban
CF&F - freight/fleet
# Demonstration plan

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<td>Vehicle Access Ctrl Sensitive Zones</td>
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**ERTICO**

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Looking towards deployment
Enabling CVIS Deployment

Openness and interoperability
Safe, secure and fault-tolerant design
Utility, usability and user acceptance
Costs, benefits and business models
Risks and liability
CVIS as policy tool
Deployment road-maps
Topic 4 - Utility, usability and user acceptance

Questionnaire - Assess user needs
- 14 different languages, 2500 responses expected

How do you rate these systems in terms of usefulness?

1. Of no use
2. Neutral
3. Very useful

Flexible Lane Allocation

Imagine: your car can receive information about the availability of bus lane
You could... use bus lanes without upsetting the public transport system
Other European initiatives
Extend the driver’s “Safety Margin” to detect and prevent potential accidents.

“Dynamic vehicle net” and “vehicle to infrastructure net” extends range of on-board vehicle systems.
COOPERS
Conclusions

• Adaptable, future-proof technology built on global standards
• Feasibility of creating extensive vehicle-infrastructure networks
• Enables rich provision of services
• Interoperability and openness are essential
• Business model is not yet clear
• Need for European - and global - “Cooperative Systems Alliance” to begin deployment
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