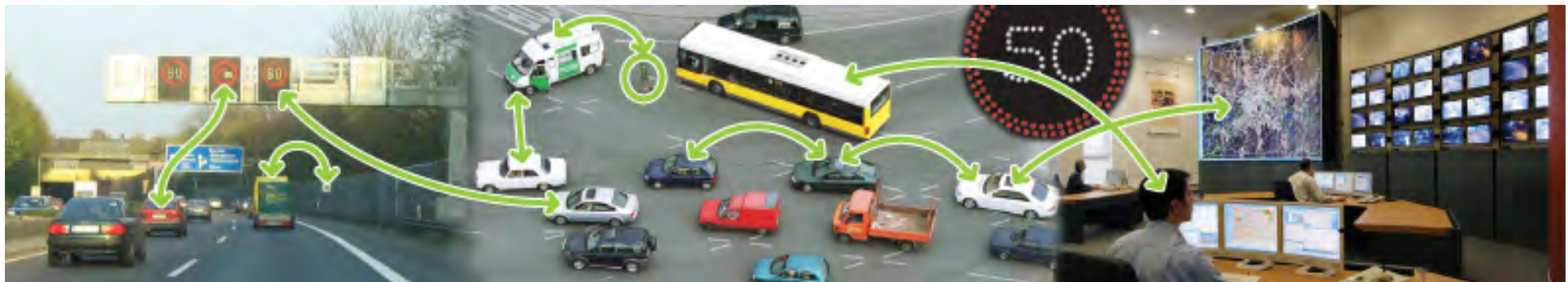# Cooperative V2X Communication for ITS Applications: The CVIS Perspectives

Dr. András Edelmayer
Ramsys Inc.
Head of R&D

Research and Technology Division

Contents

- Introduction to cooperative (ITS) systems
    - *The challenges*
    - *Why cooperative systems?*
    - *What cooperative systems?*

- The CVIS advantage (tech overview)

- The multimodal cooperative communications protocol: CALM

- Status of standardization

- Availability of CVIS technology (HW&SW)
    - *Open Cooperative Systems Alliance*

- Some lessons for Central Europe

The Energy, Safety and Environmental (ESE) challenge

Transport is essential to Europe's prosperity

- EU transport sector: **11% of GDP**
- **15 million jobs**
- 13% of household spending
- It is an important industry and makes a major contribution to the functioning of the European economy as a whole

- Road transport: **44% of Freight**

  85% of Passengers

- Annual growth rates: 2.3 % Freight
  1.9 % Passengers

European Transport Policy aims to provide safe and efficient mobility for our continent while respecting the environment
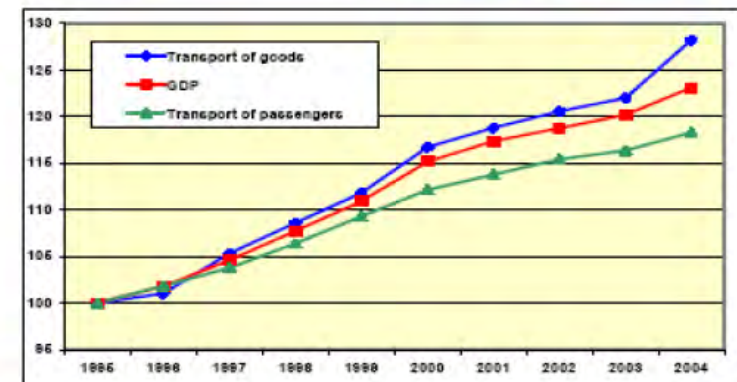
European Transport Policy: The Challenges

Congestion

- Represents alone a loss of 1% GDP yearly, and growing

Energy Efficiency & Emissions

- Transport is responsible for 30% energy consumption in the EU

- 71% of EU oil consumption goes to transport (60% to road transport)

- Transport is responsible for 12% of CO_2 emissions in the EU

Safety

- More than 41.000 deaths on the roads (EU25-2005)

- 1.7 million injured persons (EU25-2005)

- Human error is involved in 93% of the accidents

European Transport Policy: The Goals

Safety

- Halving the number of fatalities from 2001 level by 2010 (25.000 for EU-27)

Energy Efficiency

- Climate change package with the objective of saving 20% of primary energy, 20% target for renewable energy and cutting greenhouse gases by 20% by 2020 (January 2007)

- A set of legislative proposals adopted on 23 January 2008

CO_2

- CARS 21 recommendation for integrated approach (2006)

- Commission's strategy for reducing average CO2 emissions of new car fleet to 120 g/km by 2012, by which 130 g/km with improvements with vehicle technology (February 2007)

- After a public consultation, a draft regulation proposed to the Council and the Parliament (December 2007)

Approaches to the zero vision
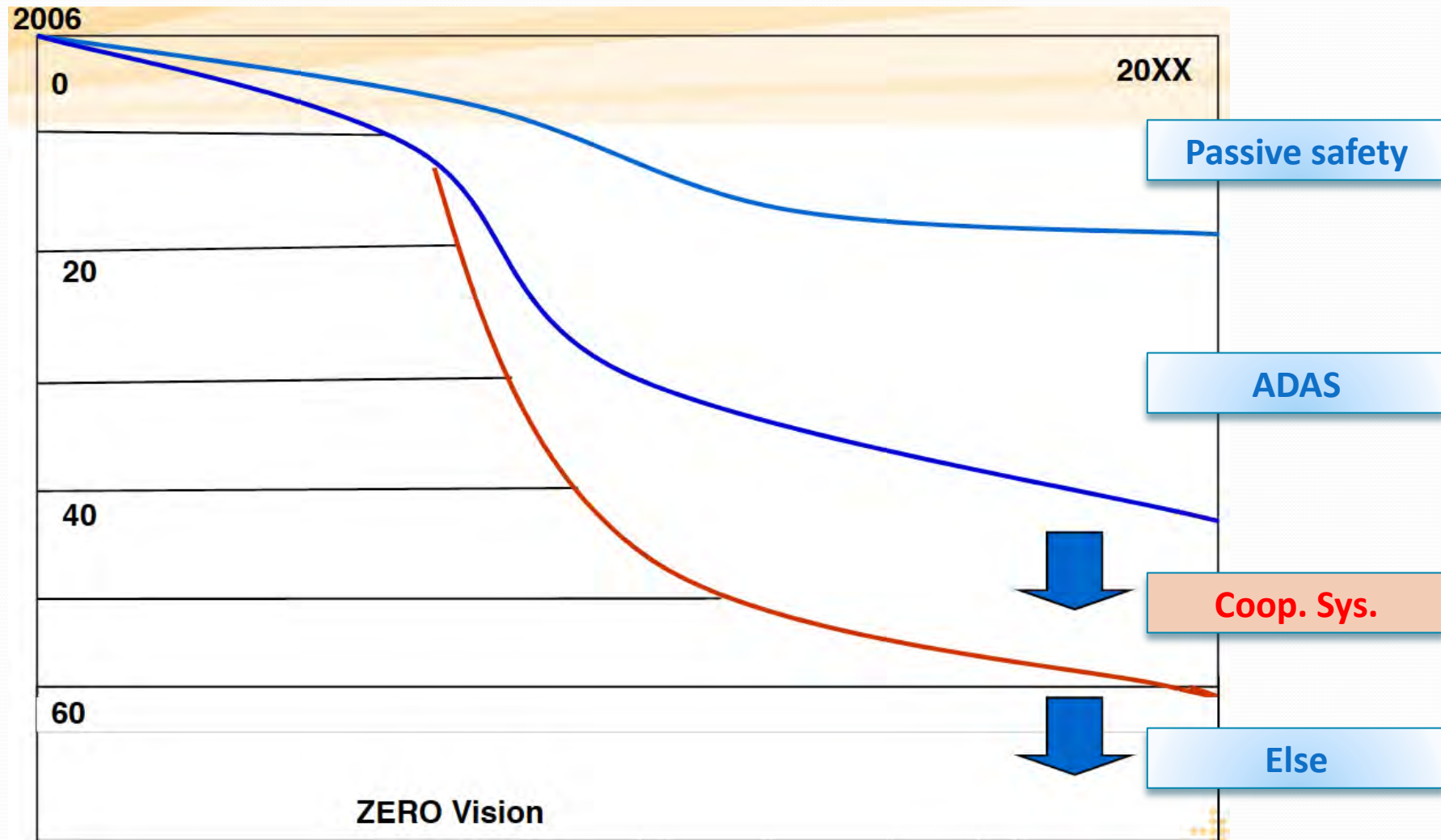
What are cooperative systems?

Cooperation as the utilization of ambient intelligence

"The real world is the interface"

Information embedded in the vehicle platform and in the immediate environment provide decision data for vehicle and traffic control and supervision.

- Sensing and data acquisition.
- Fusioning of raw measurement data.
- Distribution of information via communication.

Ambient Intelligence = Perception + Communication

Cooperative ITS

- Jointly acquire and share information among partners.
- Increase the "time horizon", the quality and reliability of information available to the drivers about their immediate environment, the other (far or nearby) vehicles and road users.
- Provide information about the vehicles, their location and the road conditions to the road operators and infrastructure providers for traffic control or tolling.
- Based on vehicle-to-vehicle and vehicle (V2V) and Vehicle to Infrastructure (V2I) communications.

EU research activities

CVIS

- Coordinator: ERTICO
- Total budget: € 41 Million
- EC contribution: € 22 Million
- Consortium: 61 partners - 12 countries

Core technology

SAFESPOT

- Coordinator: FIAT
- Total budget: € 38 Million
- EC contribution: € 20,5 Million
- Consortium: 51 partners - 12 countries

Car makers

coopers

- Coordinator: AustriaTech
- Total budget: € 16,8 Million
- EC contribution: € 9,6 Million
- Consortium: 37 partners - 14 countries

Road operators

Ramsys RTD

CAR 2 CAR
COMMUNICATION CONSORTIUM

Commercial services

- **Accident/Incident** Warning
- **Weather** Condition Warning
- Roadwork Information
- **Lane Utilisation** Information
- In-Vehicle Speed Limit Information
- Traffic **Congestion Warning**
- Road **Tolling**
- International Service Handover
- Route **Navigation** - Estimated Journey Time
- Route Navigation – Recommended Next Link
- Route Navigation – Map Information Check

Keep left on High Street

E15

Arrival
4:48pm   Menu   Turn in
200m

Traffic efficiency, and road safety services

- **Lane departure** prevention systems
- **Road quality warning**
- **Obstruction** detection
- **Collision avoidance** (side, front, rear)
- **Lane change assistance** systems
- Enhanced **locationing** services
- Local Dynamic Map (**LDM**) based services
- **Radar view and neighbour supervision**
- **Drivers advice on safety margins**
- **Local danger and abnormal situation alerts**
- **Road side safety information display**
- **Enhanced Driver Awareness**

The European needs

o   Requirements for ITS applications and technologies are quite different in the various regions of the World. (USA, Canada, Europe and Asia).

o   Most important in Europe, thus promoted by car industry, is **Road Safety** and **Traffic Efficiency**.

o   **Road Tolling** already today is widely used, and becomes even more important considering dynamic tariffs used for traffic management.

o   Applications like Mobile Internet, Entertainment, Mobile Shopping are of little importance in Europe.

The need for multiple interfaces
and multimodal communications

A single air interface is not sufficient because of:

- **Capacity** of transmission.
- **Performance** (e.g. bandwidth vs. reliability, QoS).
- **Availability** (continuous coverage).
- **Redundancy** is required for reliability.
- Local legal **regulations** and policy.
- Different **functionality** (e.g. directionality).

Variety of air interfaces

- GSM **2G/3G** cellular technology
- **IR** Infrared
- **DSRC** (5.8-5.9 GHz) dedicated short range communication (legacy)
- **WLAN** (802.11 evolutions from Wave to M5)
- **MM-wave** (~ 62 GHz)
- **Satellite** (e.g. IPSTAR)
- **Wi-Fi** (IEEE 802.16e WiMax)
- **Bluetooth, RFID**
- **TBD**

There was a need for a comprehensive technology for mapping applications on a multitude of wireless communication interfaces.

CALM

The CVIS advantage

The CVIS objectives

The project's ambition was to begin a revolution in mobility for travelers and goods, completely re-engineering how drivers, their vehicles, the goods they carry and the transport infrastructure interact.

The CVIS objectives

Increase efficiency and safety through V2X cooperation enabled by:

- an open architecture and universal platform for sample implementation
- Ad-hoc wireless network amongst vehicles & infrastructure
- a framework for ITS applications management
- enhanced positioning and mapping solutions
- cooperative data management and sharing
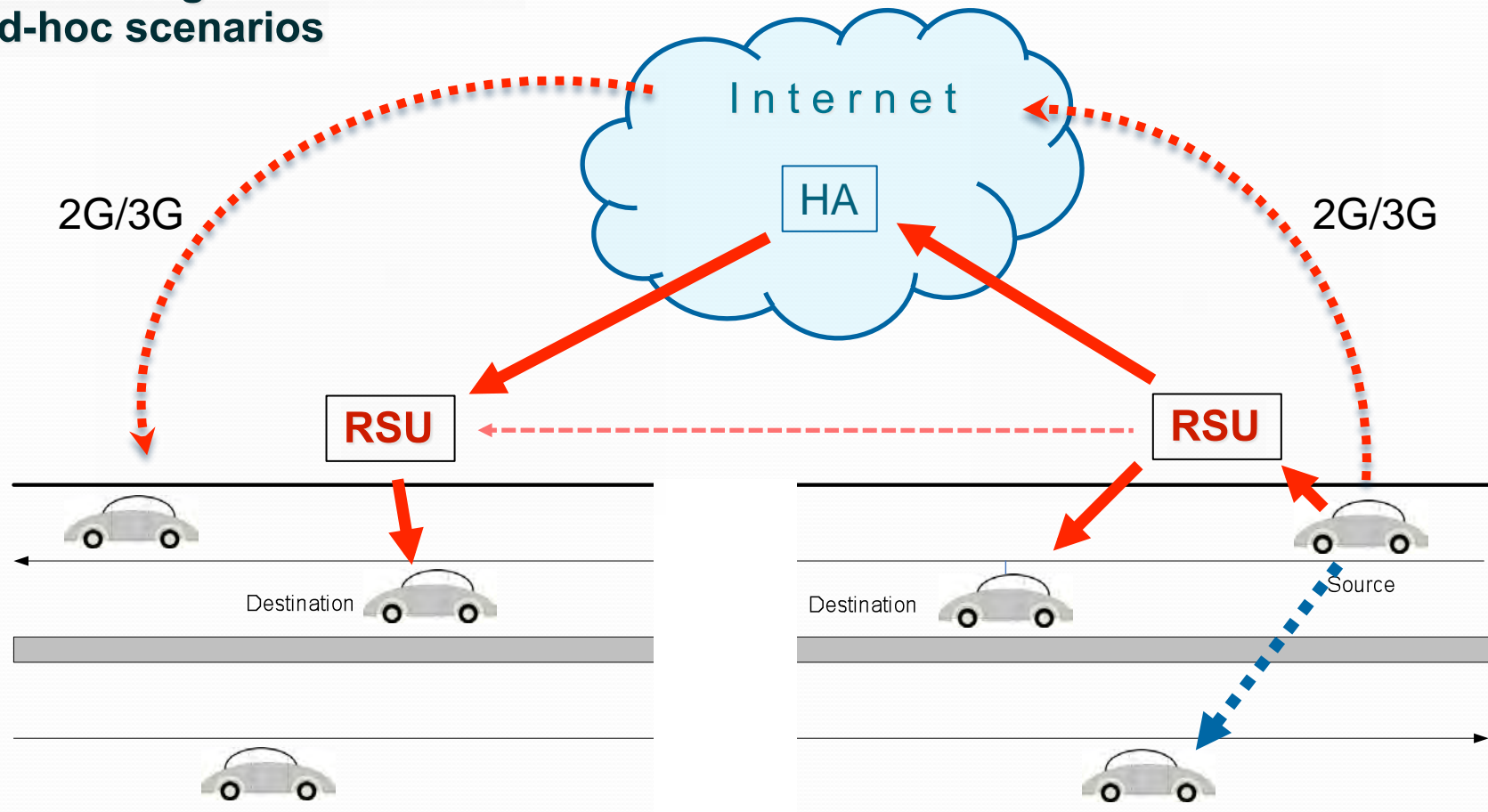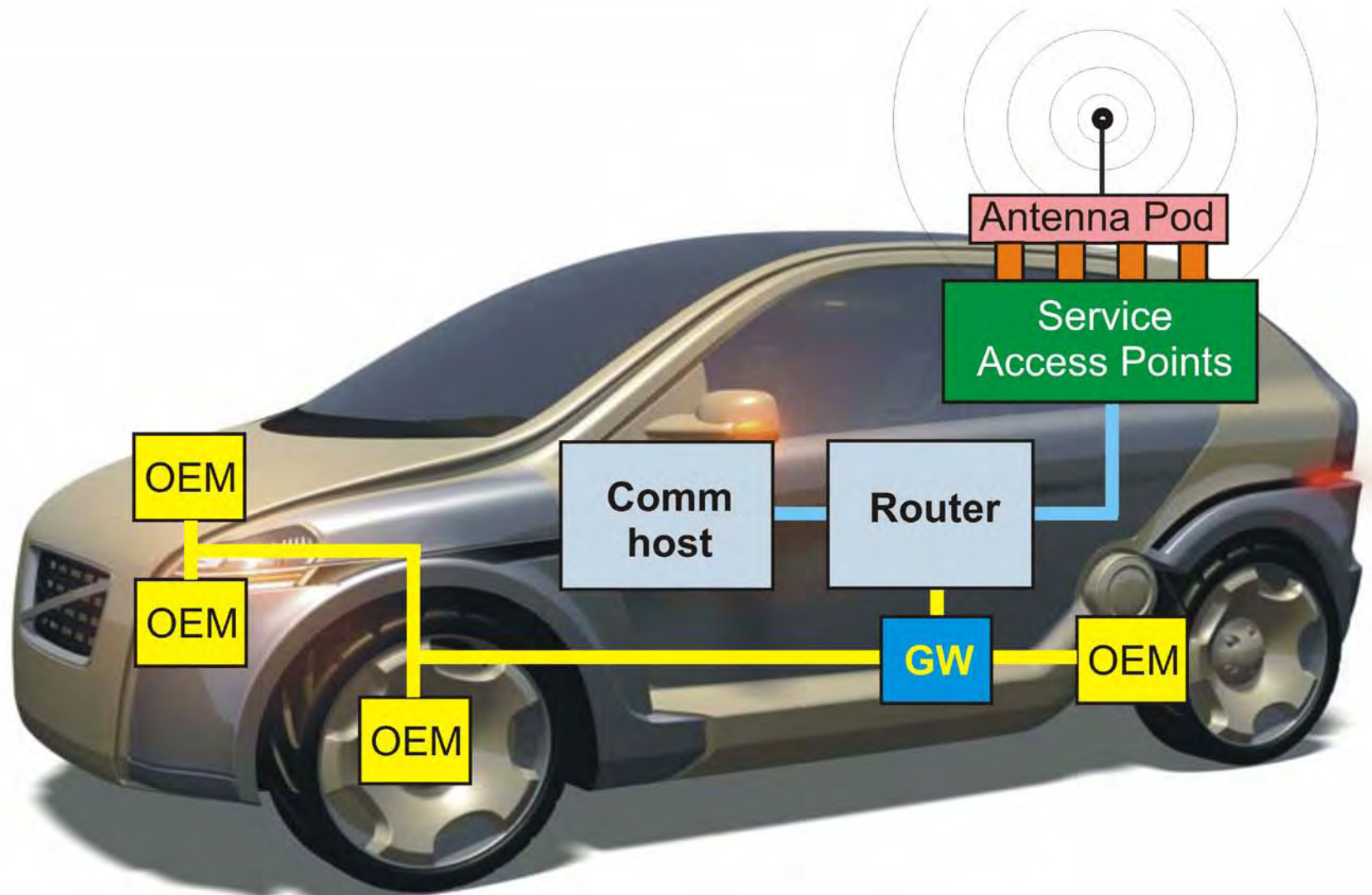- promoting innovative cooperative applications

CVIS technical subsystems
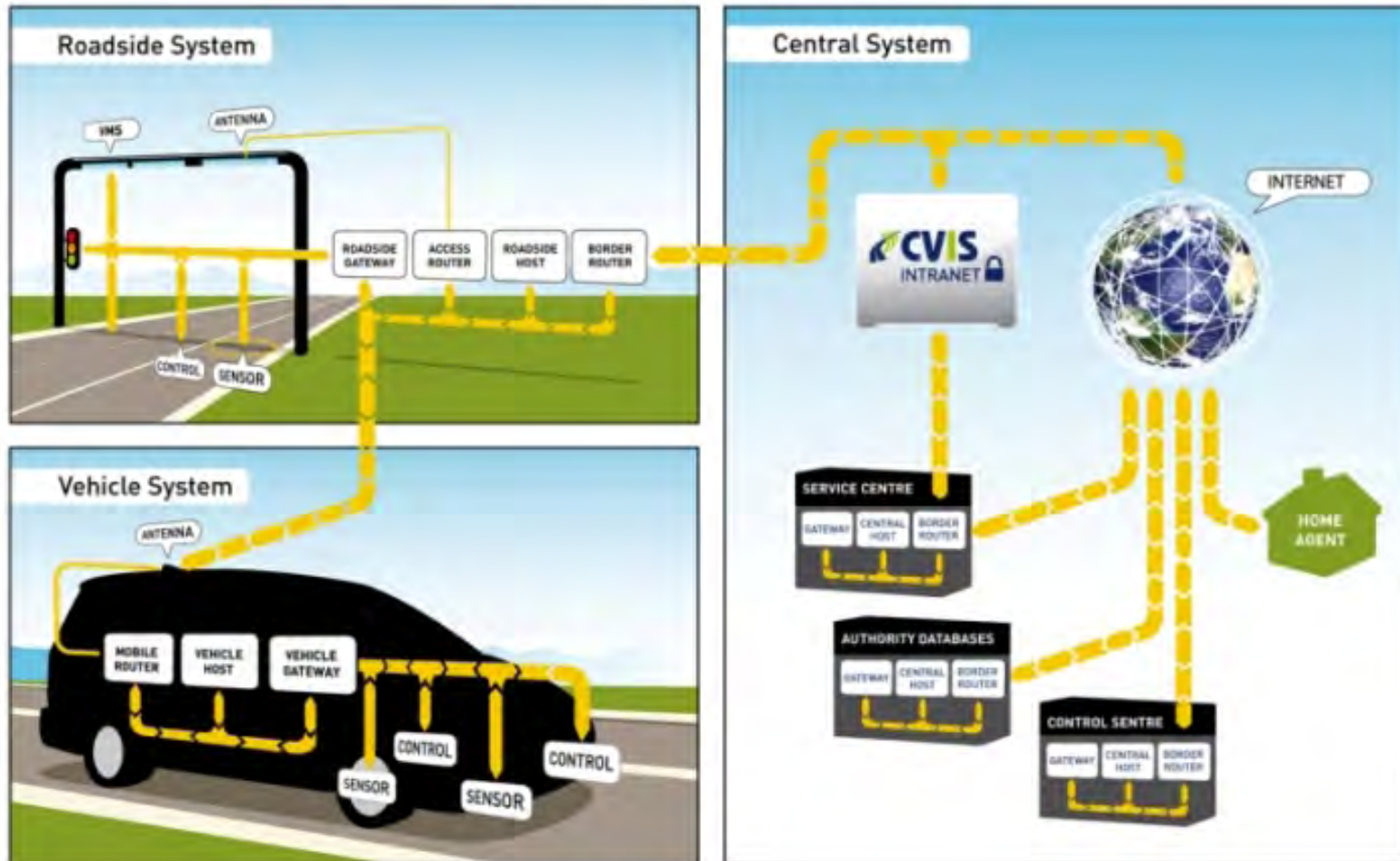
V2X Communications

Is the enabling technology for ensuring:

- **Global vehicle mobility through NEMO IPv6 technology**
- **Safety messaging using non-IP based technologies (CALM FAST, IEEE WAVE)**
- **Access to global resources**
- **Ad-hoc scenarios**

CVIS vehicle platform

CVIS implementation (vehicle)

CVIS Vehicle Antenna

Infrared OBU

**Touch Display**

2G/3G - Stick

CVIS Sensor & M5 card

Gyro

Accelero meter

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 & SoftcoreCPU RealtimeGPS & DSRC sync, sensor fusion/timestamp

Mobile Router

Mobile Host

CVIS Core SW CALM

CVIS implementation (roadside)

Roadside Antenna

Infrared RSU

CVIS Sensor & M5 Card

Accelero-meter

20ch GPS

OBD-II CAN Bus

CEN DSRC

2.5 / 5 GHz 802.11 radios modified for:
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FPGA: PCI, Serial ports & softcore CPU
Realtime GPS & DSRC sync, sensor fusion/timestamp

Router

Host
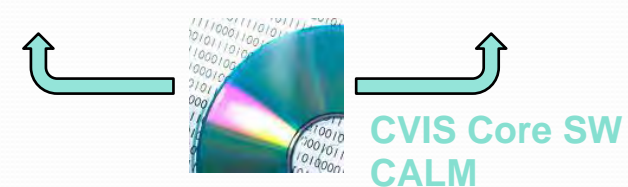
CVIS Core SW CALM

CVIS base technologies

Core Software

- Basic building blocks of the CVIS COMM platform
    - Media device drivers (M5, IR, 2G/3G)
    - Protocol stack implementations for
        - CALM IPv6, CALM FAST, CALM IR
        - CALM management, handover management
    - Framework to bring the services together:
        - Basic services, CALM framework, tools, libraries
        - Policy exchange, QoS, Application provisioning and service announcement, life cycle management of services and applications
- Based on Ubuntu 8.04, Linux 2.6.22

CVIS middleware

Application development framework
*based on Java OSGi Knopflerefish SDK*

CAM

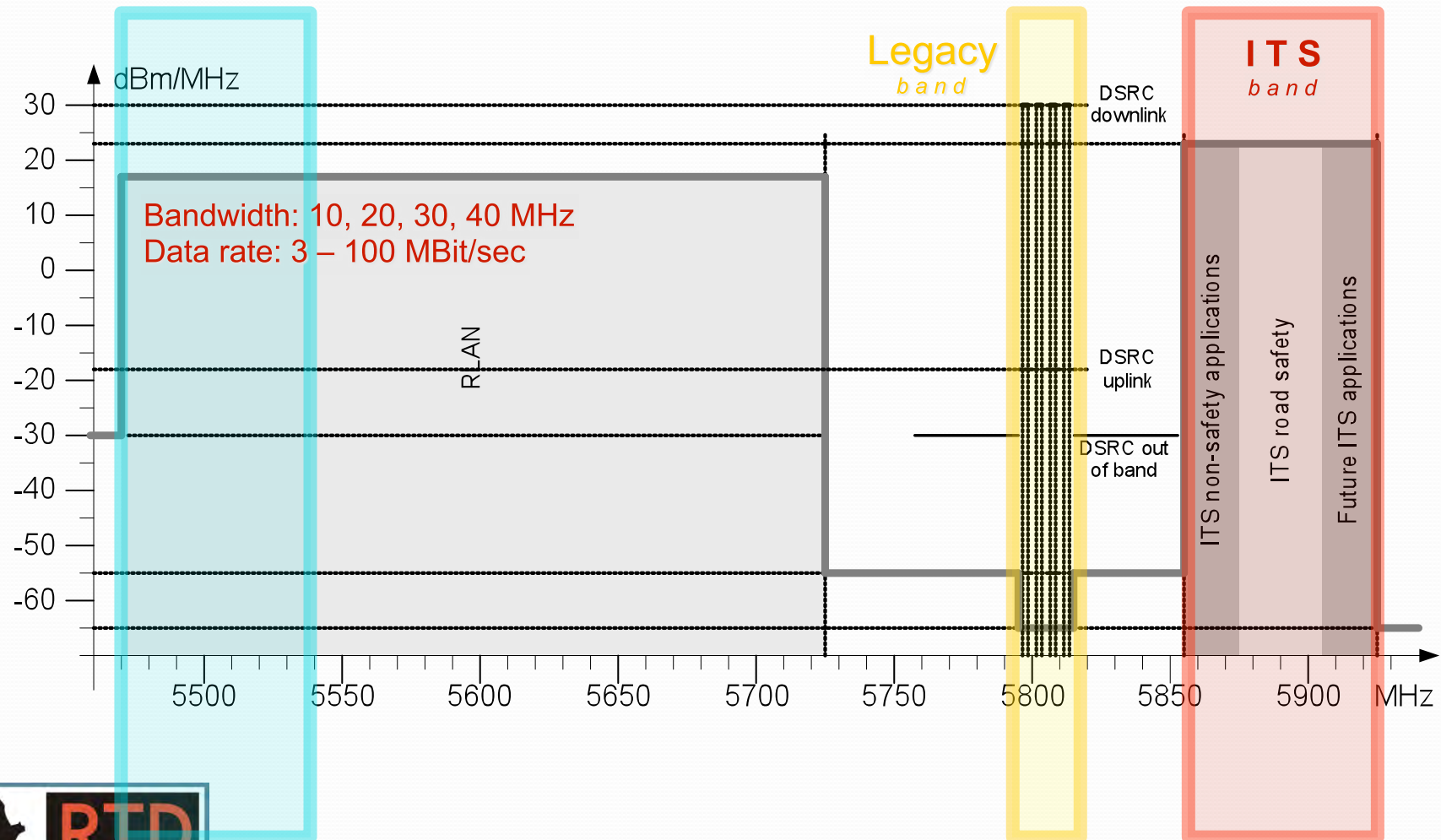*Cooperative Awareness Message protocol*

- Low latency messaging mechanism for safety related vehicle applications
- Specified by COMeSafety
- Event-driven periodic broadcasting (beaconing) using CALM FAST
- Interoperable with Safespot, including
  - message format,
  - protocol (CALM FAST) and
  - encoding of data
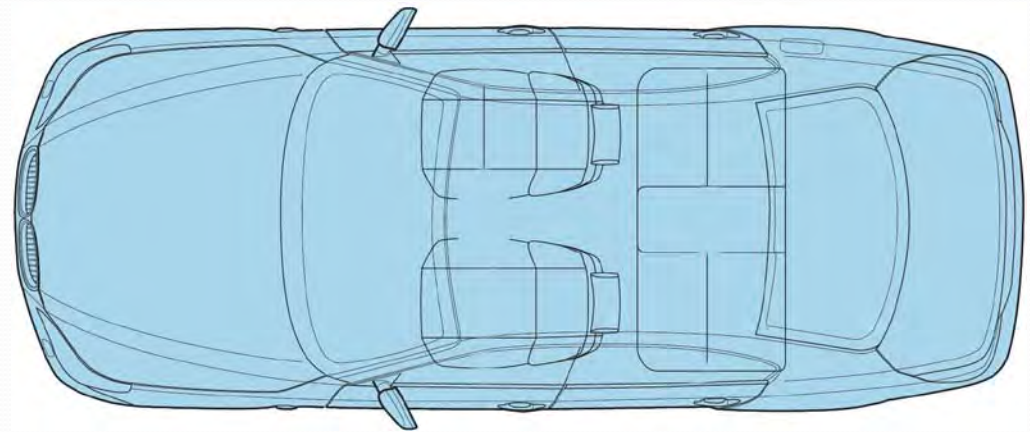
Local Dynamic Map (LDM)
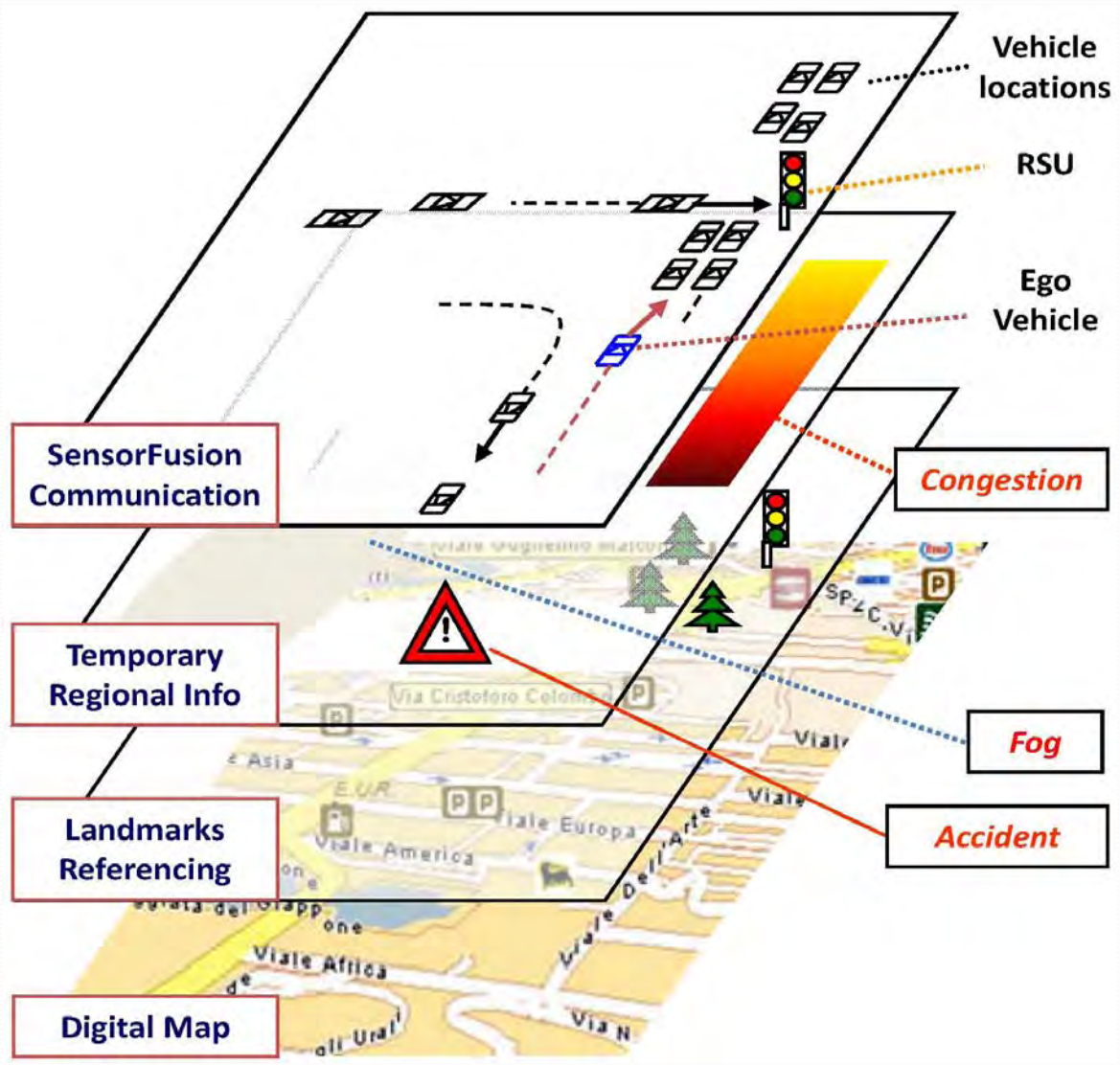
Standardization

CALM: What's in the name

Communications

Access   for

Land

Mobiles

CALM: Scope

The scope of CALM is to provide a standardized set of air interface protocols for the best use of resources available for:

- o short, medium and long-range,
- o high-speed, guaranteed response time (safety)
- o V2V and V2I ITS communication,
- o using one or more of several media,
- o with multipoint (mesh) transfer
- o transfer between routers (horizontal handover)
- o transfer between media (vertical handover)

CALM: Core Standards

ISO TC204/WG16 and ETSI activities
(Recently more than 25 related standards)

- o 21217: CALM Global Architecture
- o 24102: CALM Management Stack
- o 21210: CALM Networking for Internet Connectivity
- o 29281: CALM Non-IP networking (CALM FAST)
- o 21218: CALM Lower Layer Service Access Points
- o 21214: CALM IR Medium
- o 21215: CALM M5 Medium
- o 21216: CALM MM Medium
- o 24101: CALM Application Management

ITS Station Architecture

Multimodal communications for ITS applications in ad-hoc vehicle networks

It became the basis for European Interoperability

Received wide acceptance in international standardization (ISO, ETSI)

Built on the foundations of ISO CALM architecture

Accepted by IEEE

ITS Station Reference Architecture
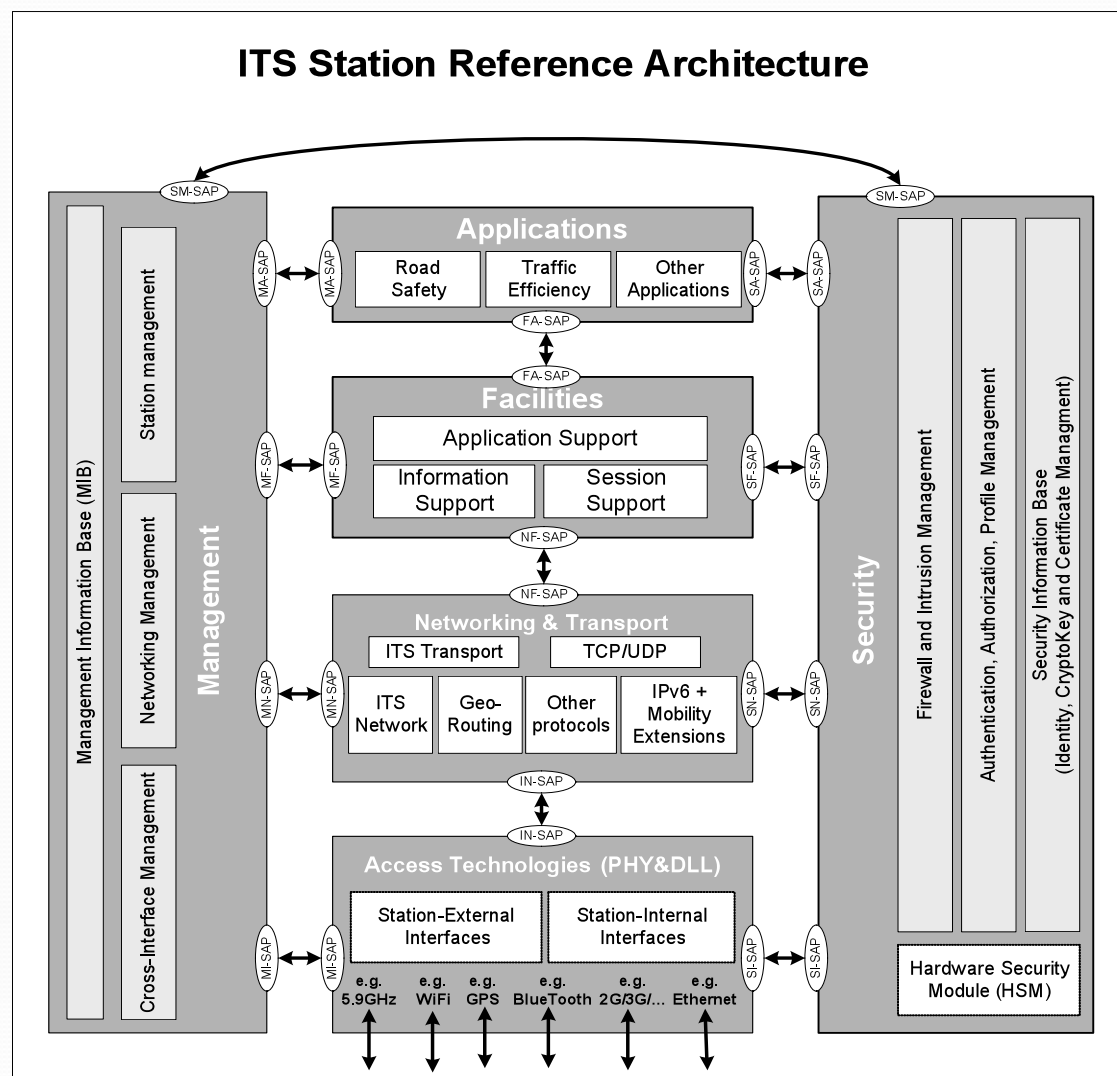
Access and network layers

- IPv6
  - Future proof Internet technology
  - Direct addressing of mobile units
- Seamless communication
  - Handovers between M5, IR, 3G
  - Management of continuous sessions
  - QoS
- CALM FAST
  - Short range distribution of time critical traffic massages
  - based on 802.11p
  - GeoNet
  - Geographic addressing protocol over IPv6 and CALM FAST
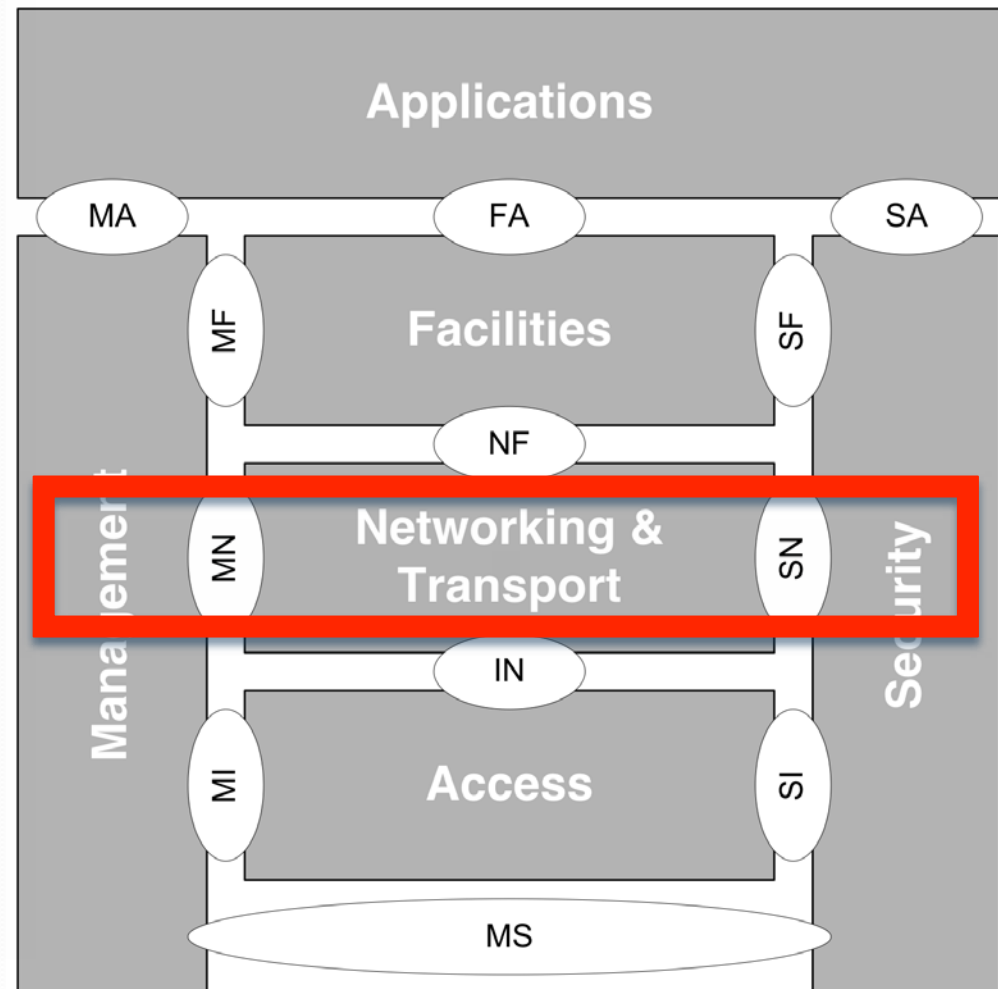
# Open framework for applications management

- Support of basic facilities:
  - Service provisioning and deployment
  - Distributed Directory Service
  - Security
  - Access to RS and Vehicle sensors
  - CALM functionalities
  - Graphical User Interface
- Support of domain facilities:
  - Positioning
  - Traffic Data
  - LDM
- Based on Java/OSGi
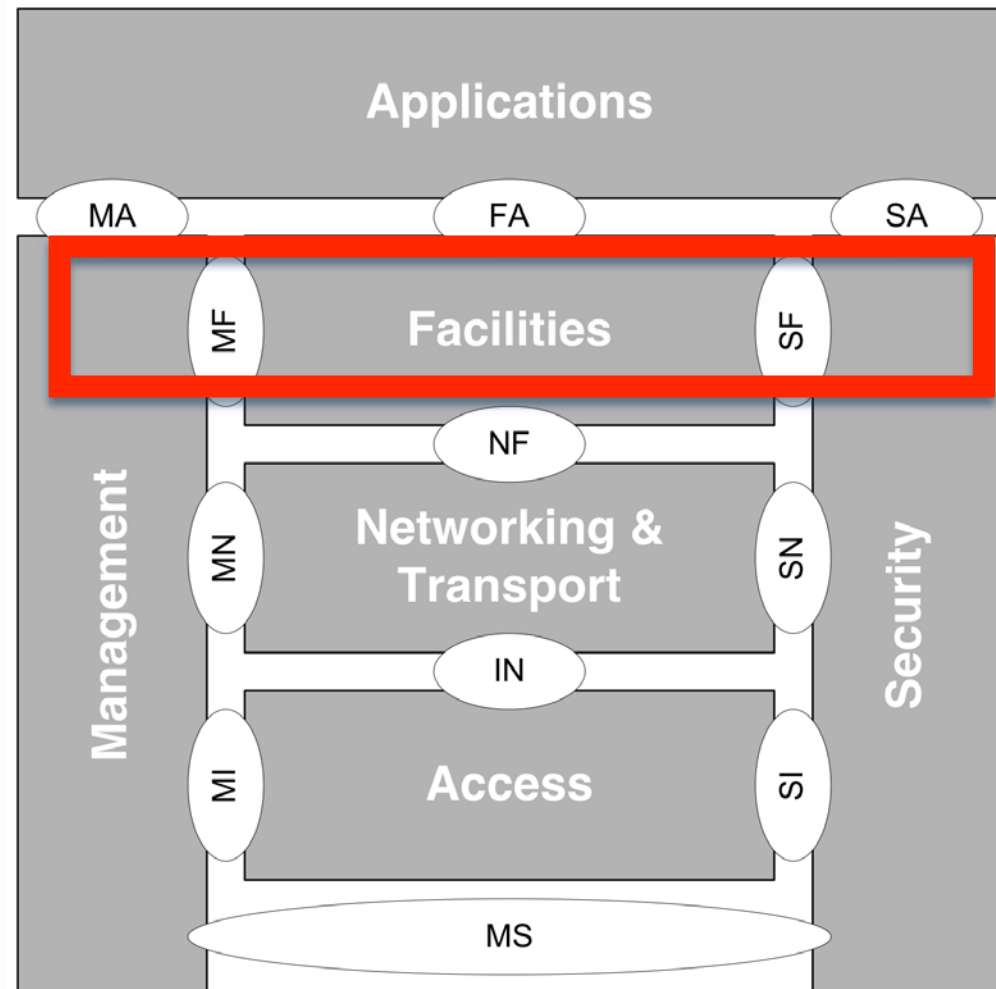
Basic set of ITS applications

- Basic set of applications (ETSI TR 102 638) published in April 2009
- CVIS is focussing on efficiency and traffic management applications and use case for:
  - Cooperative Freight & Fleets
  - Cooperative Interurban Applications
  - Cooperative Urban Applications
  - Cooperative Traffic Management

Taxonomy
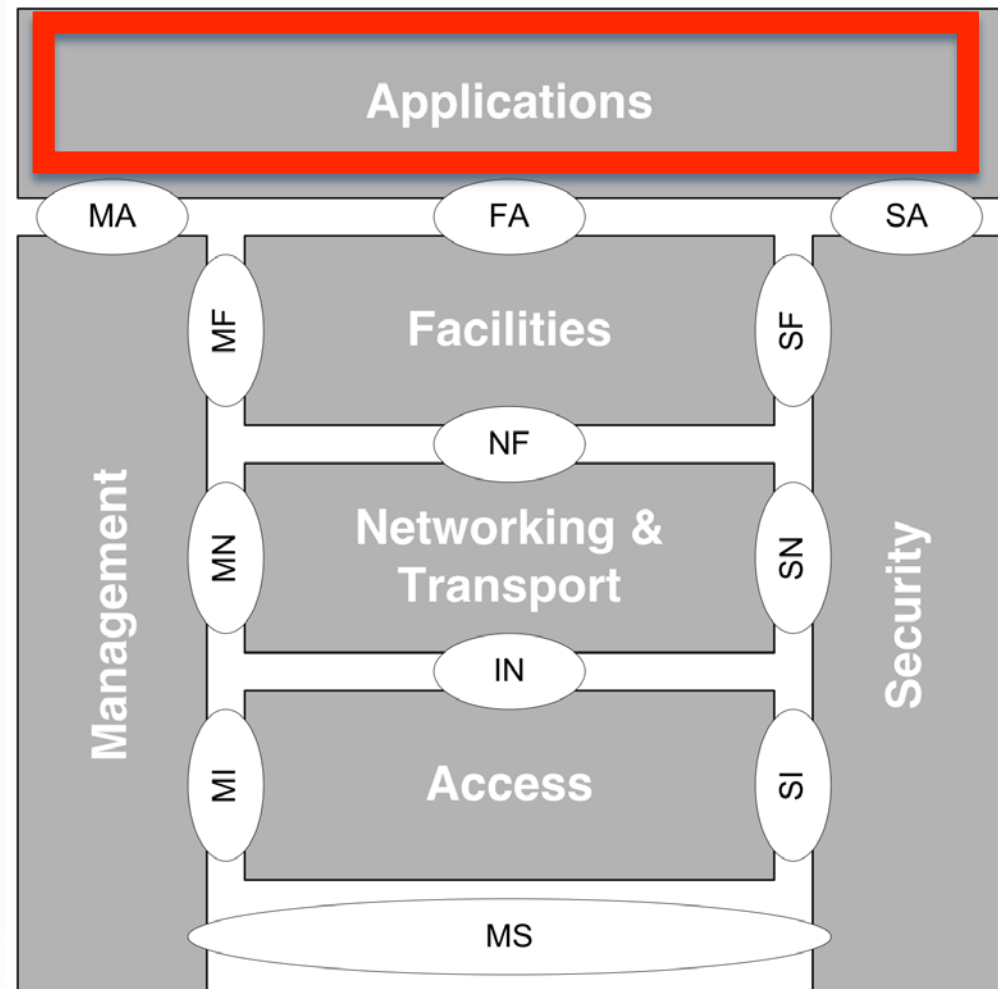
Availability of CVIS technology (HW & SW)

The CVIS 1.1 initiative

Router:
Combined with the Vehicle Antenna

Host: UMPC with touch screen

CVIS tech on proprietary platforms

Cooperative ITS
Open Systems Alliance

An open, standards based platform for safe, efficient and environmentally friendly cooperative mobility enabled by vehicle-infrastructure and vehicle-vehicle communication using open protocols and open interfaces for services innovation.

- Represent and promote the open platform concept for cooperative ITS systems.
- IPR and licensing framework for R&D and commercial activities.
- Maintain, support and enhance the specifications and reference.
- Validate the platform through trials and demonstrations.
- Convergence/Profile definition. Striving towards interoperability.
- Standardisation support.
- Certification (including privacy and security aspects).
- Business validation (organisational models and business aspects).
- Legal aspects (liability issues and responsibilities).
- Liaison with relevant bodies and platforms.

Thank you for listening