



# ***ITS Architectures: The Road to IPv6***

***Workshop on ITS experiences in Europe  
Murcia, 18<sup>th</sup> June 2009***

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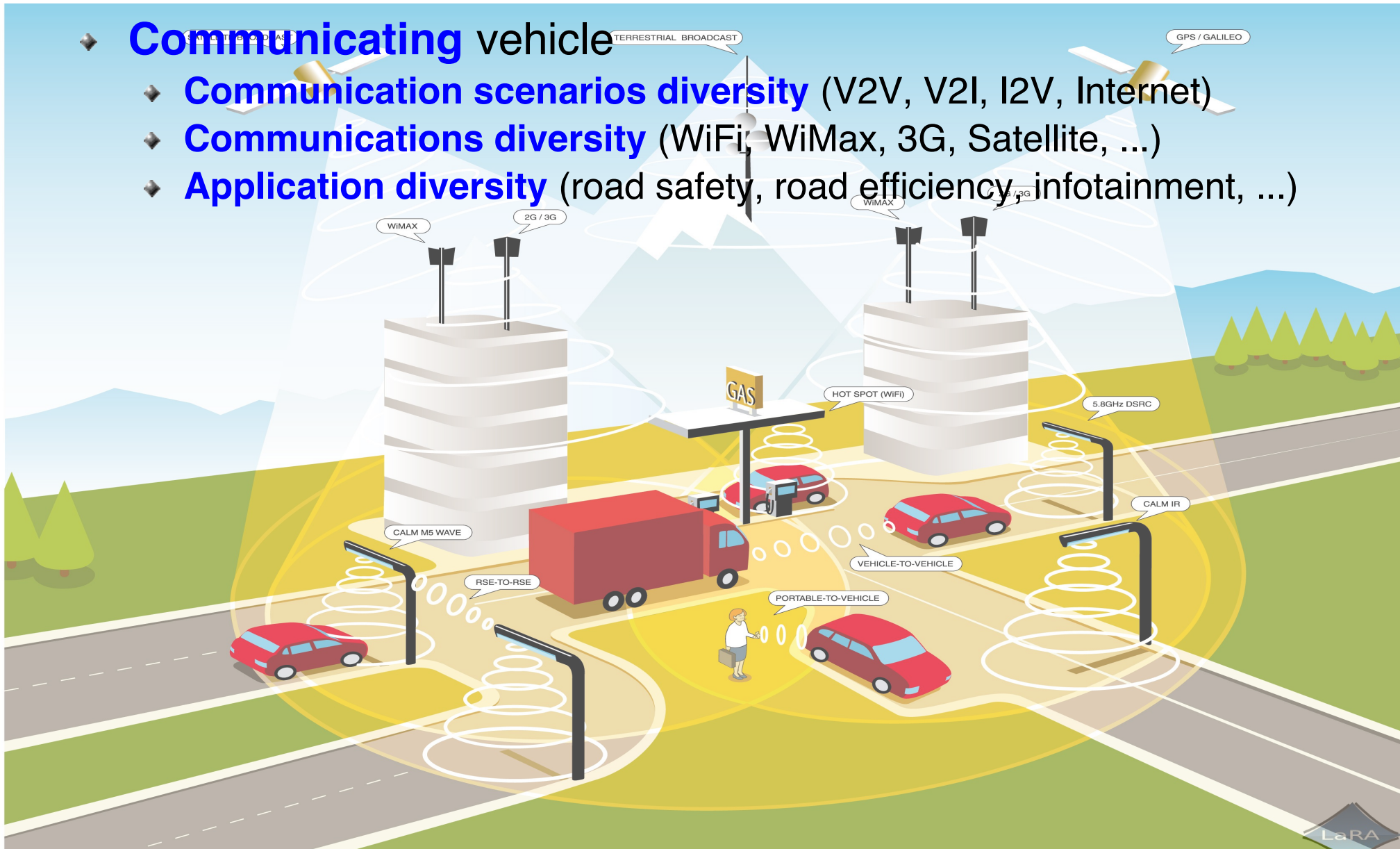
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***LaRA (INRIA IMARA project-team & Ecole des Mines Paris)***

***<http://www.lara.prd.fr>***



- ◆ **Communicating vehicle**
- ◆ **Communication scenarios diversity** (V2V, V2I, I2V, Internet)
- ◆ **Communications diversity** (WiFi, WiMax, 3G, Satellite, ...)
- ◆ **Application diversity** (road safety, road efficiency, infotainment, ...)



# ITS Vision: Communications and Standards

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- ◆ We need **standards**
  - ◆ uniformized vehicular cooperative systems (V2V & V2I)
  - ◆ uniformized exchange of information between vehicles and servers in the Internet

## AND ALSO

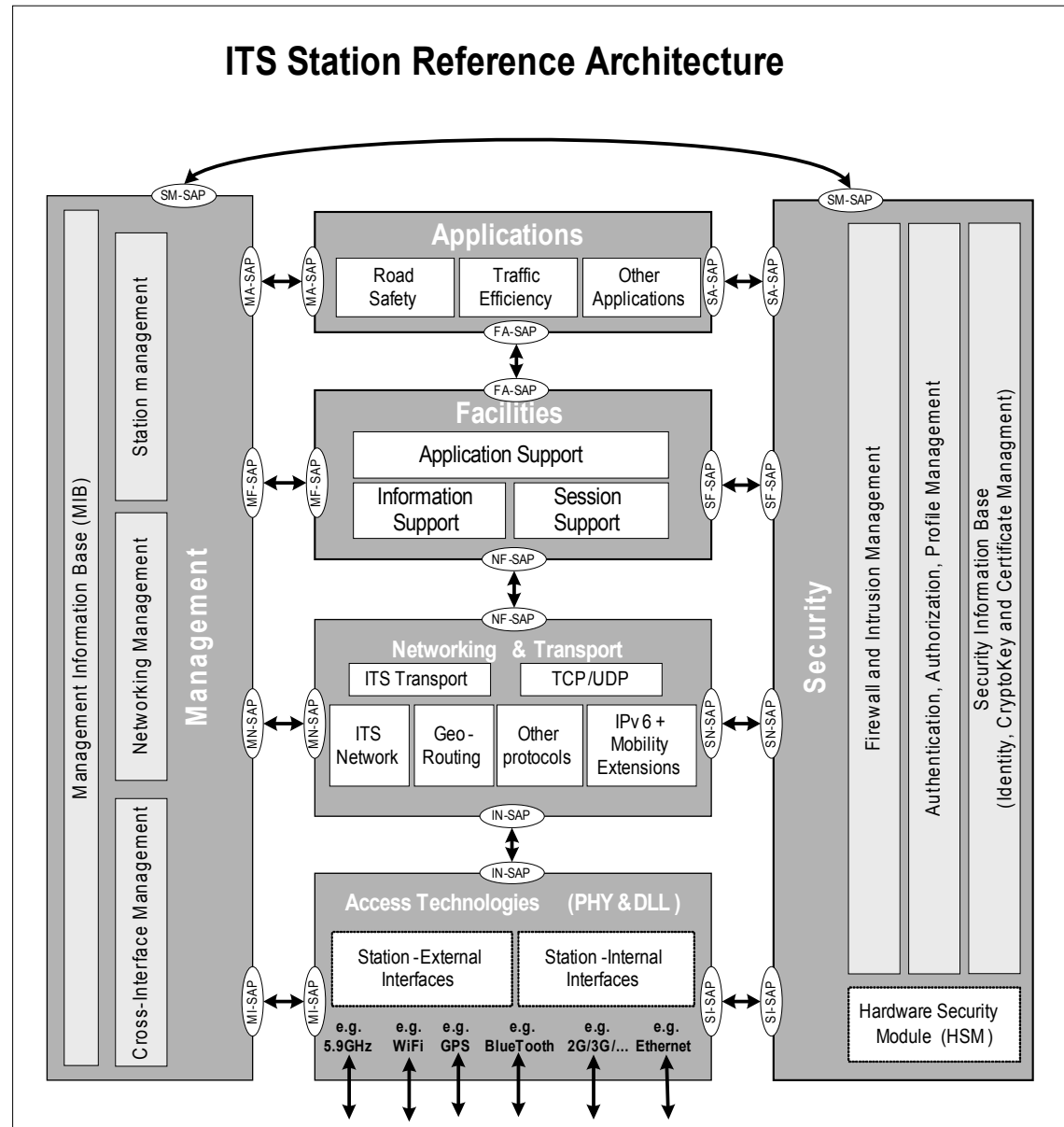
- ◆ uniformized exchange with anything on the network anywhere
  - ◆ **Not only in the automotive sector: ITS is just one small portion of all data exchanges**
  - ◆ **Interoperability between communication systems developed in all sectors must be ensured**
- ◆ The **Internet Protocol (IP)** is the de facto standard
  - ◆ ITS communication architectures must interoperate with it

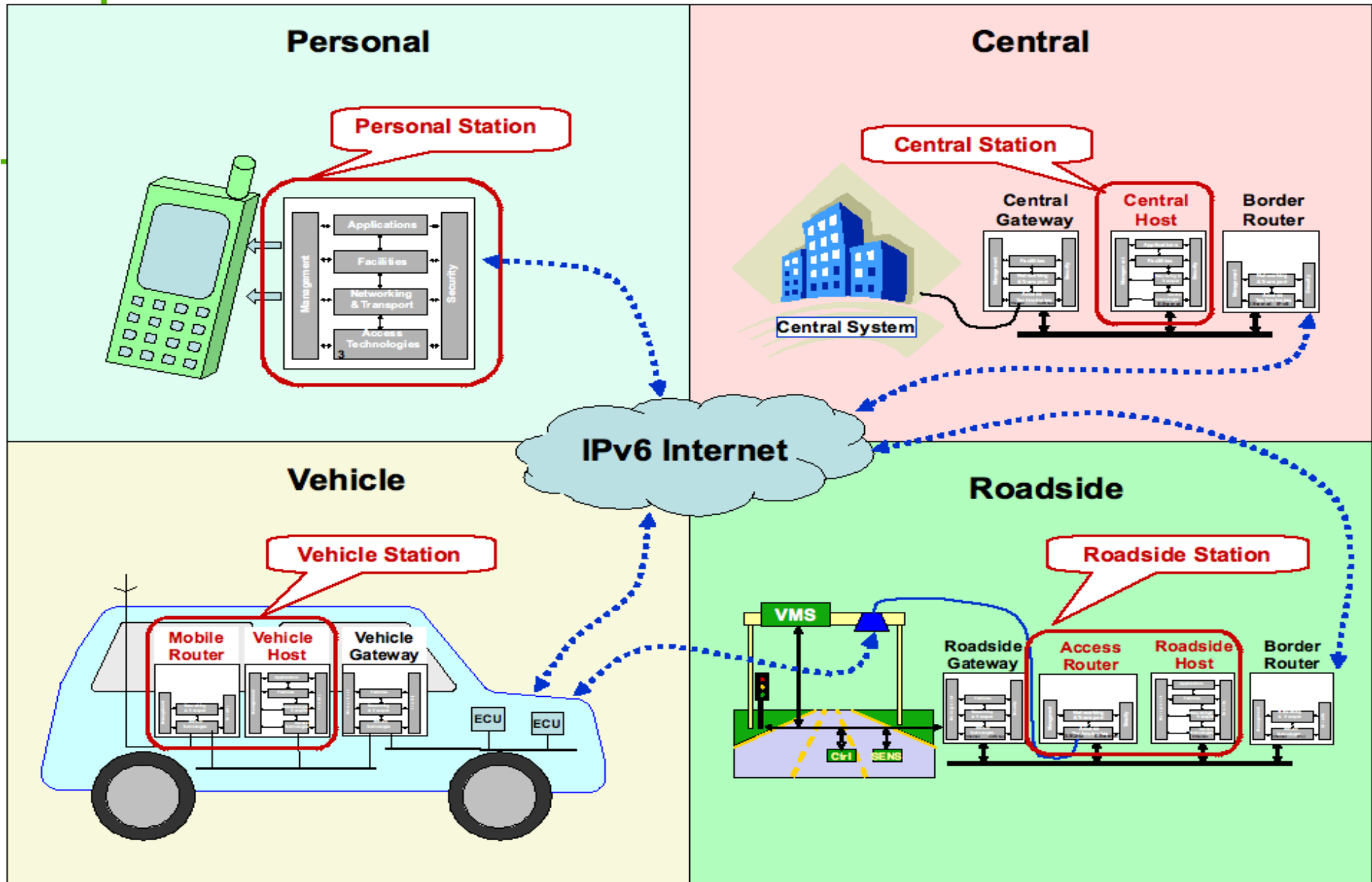
# ITS Vision: Why an IP-based communication architecture ?

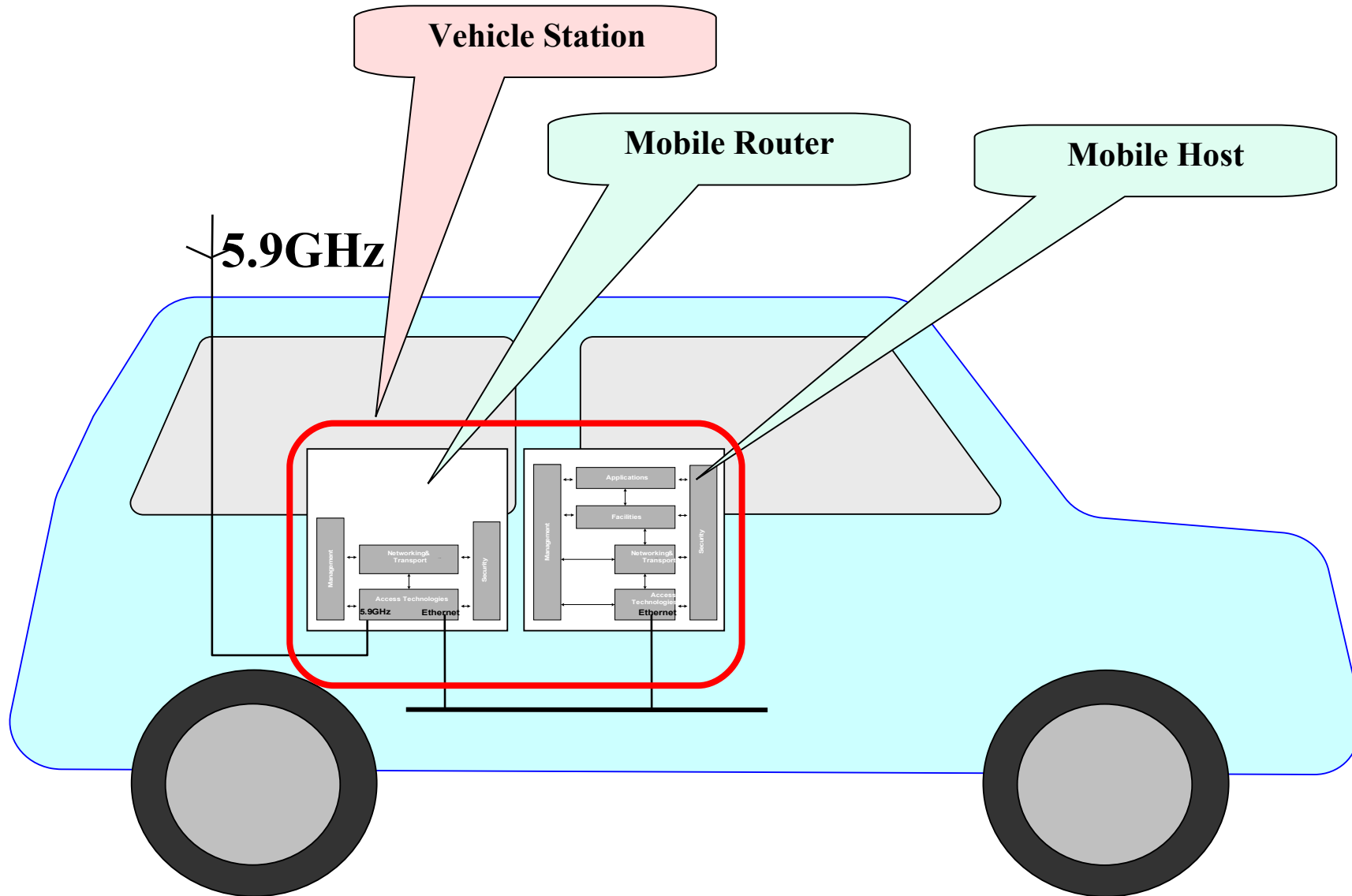
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- ◆ IP provides an **unification layer** of underlying technologies
  - ◆ 2G/3G, 802.11 a/b/g, 802.11p, 802.16, satellite, ...
  - ◆ Any application running over IP is media-agnostic
- ◆ IP ensures **interoperability**
  - ◆ IP everywhere: ITS, education, health-care, army
  - ◆ Not limited to dedicated ITS application
  - ◆ End-host running in a vehicle can communicate directly with an end-host running at the car manufacturer's HQ, parking lot, emergency crews, driver's home
- ◆ IP ensures **portability**
  - ◆ Ordinary uses of the Internet can be brought to the vehicle (web browsing, video streaming, peer-to-peer, etc)
- ◆ IP ensures **wider deployment**
  - ◆ IP equipments are cheaper to develop
  - ◆ Products can be updated constantly (security holes, new features)

- ◆ Proposed European ITS Communication Architecture
- ◆ Joint development:
  - ◆ ETSI TC ITS
  - ◆ COMeSafety+ R&D projects







# ITS: IP address requirements

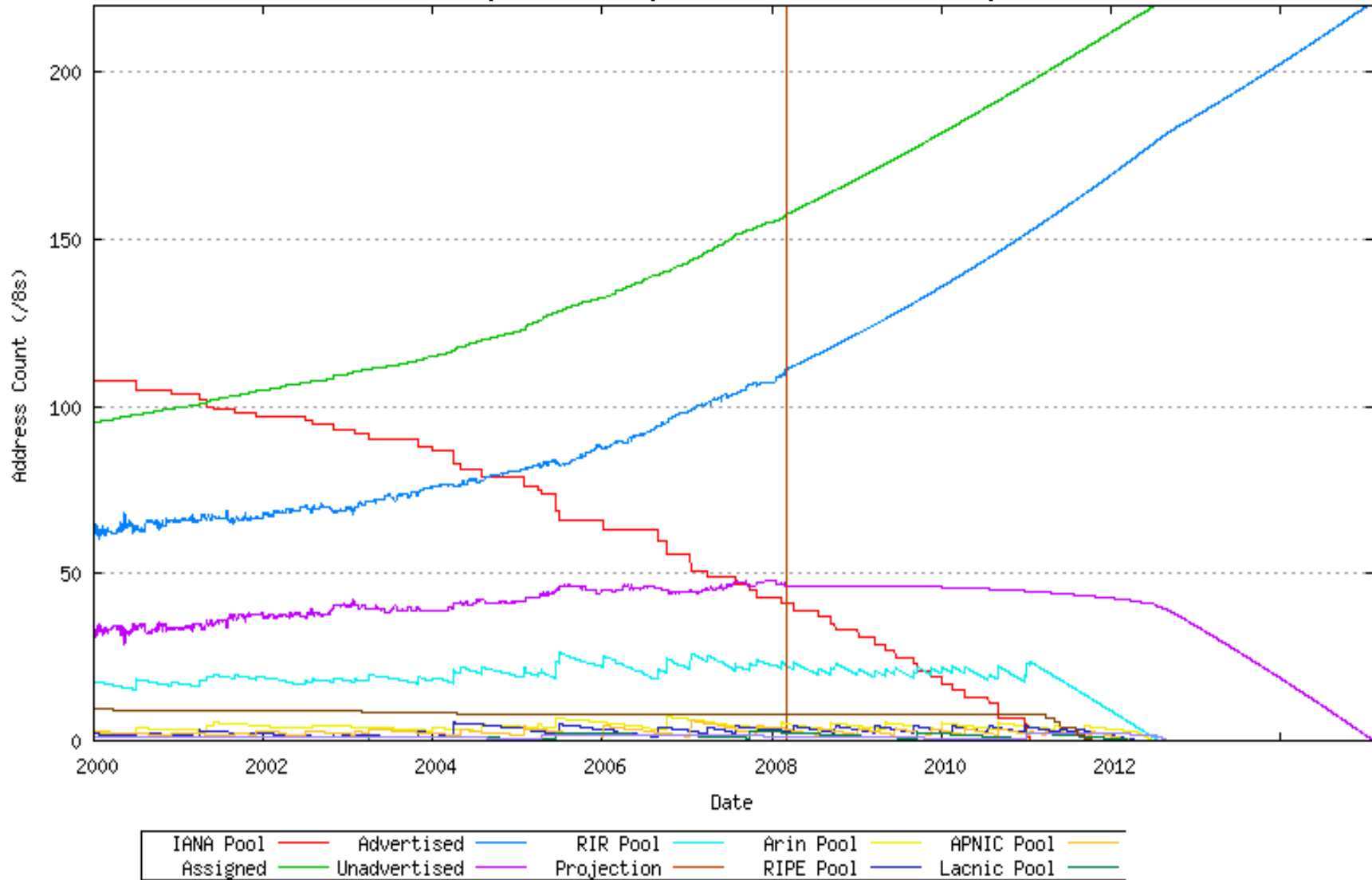
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- ◆ Vehicles are connected to the Internet
  - => Several IP addresses per vehicle**
    - ◆ On-board units (**OBU / Router**) maintaining **Internet access** through **several** medias (3G, 802.11p, ...)
    - ◆ Application Units (**AU / Host**) running **ITS applications**
    - ◆ Hand-held devices running **multimedia applications**
    - ◆ OEM: Gateway between IP and CAN
- ◆ Number of cars worldwide
  - ◆ 1997: 600 millions
  - ◆ 2030: 1200 millions (at present trend)
- ◆ IPv4 is a non-go for ITS deployment
  - ◆  $2^{32} = 4,294,967,296$  addresses
  - ◆ Too many vehicles for NAT
  - ◆ Limited mechanisms for IP session continuity (**NEMO**, mobile edge multihoming, etc.)

# ITS: Why not IPv4 ?

Exhaustion prediction: IANA Dec.2009 - 1st RIR: Aug. 2010

<http://www.potaroo.net/tools/ipv4/>





# ITS: What is IPv6 ?

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- ◆ **IPv6**: Internet Protocol version 6
  - ◆ Designed by the IETF since 1995 as a replacement of IPv4
  - ◆ IPv6 is an **evolution** of IP
    - ◆ **128 bits instead of 32** ( $2^{128}$  addresses instead of  $2^{32}$ )
    - ◆ **New IP header**
    - ◆ **New features**
  - ◆ Between 1 564 & 3 911 873 538 269 506 102 addresses / m<sup>2</sup>
  - ◆ An address for **everything on the network**
  - ◆ Fully specified, implemented, operational deployment started



- Coordinator: **ERTICO**
- Total budget: € 41 Million
- Consortium: 61 partners - 12 countries
- Focus: Efficiency – V2R services

Core Technologies



- ◆ Coordinator: **Fiat Research Centre**
- ◆ Total budget: € 38 Million
- ◆ Consortium: 51 partners - 12 countries
- ◆ Focus: Safety – V2V low latency

Car<->Car



- Coordinator: **Austria tech**
- Total budget: € 16,8 Million
- Consortium: 37 partners - 14 countries
- Focus: Roadside / Infrastructure

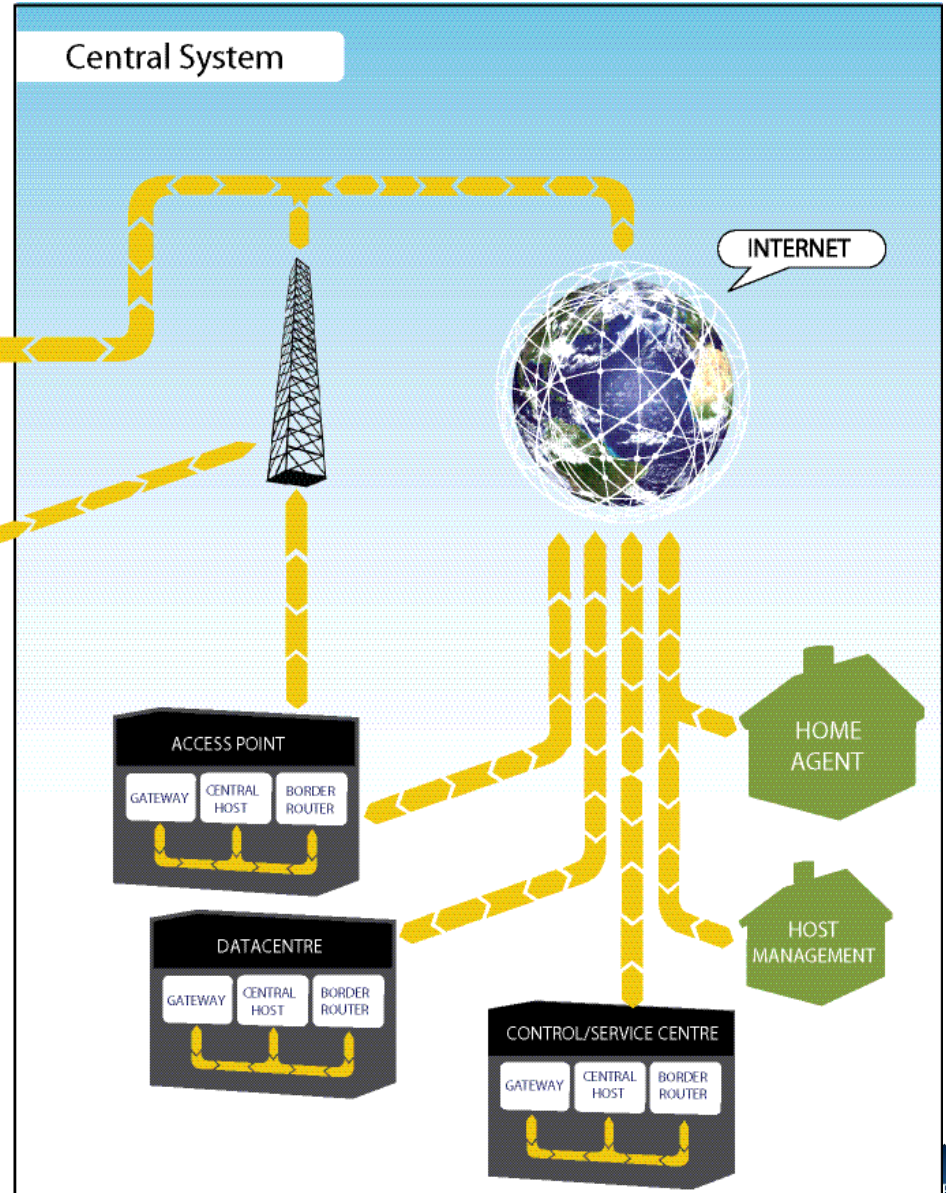
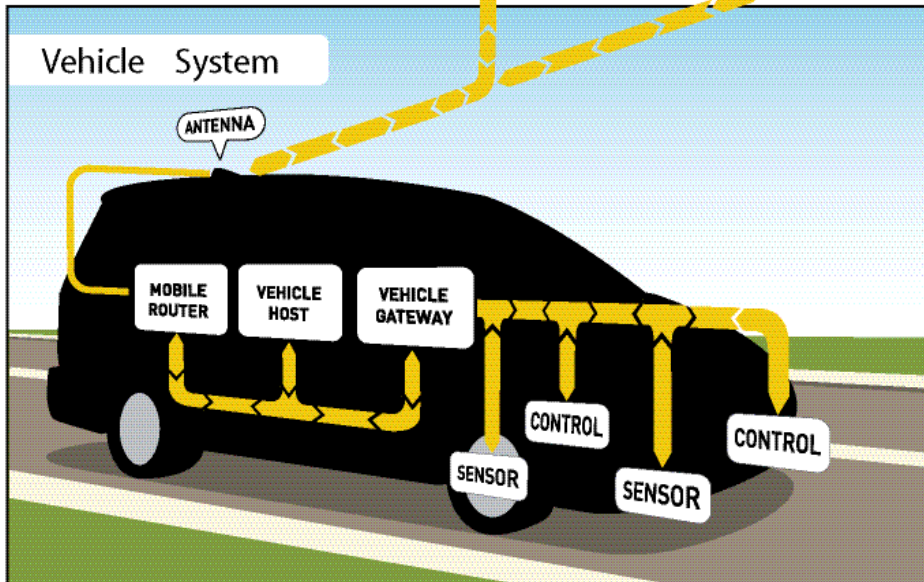
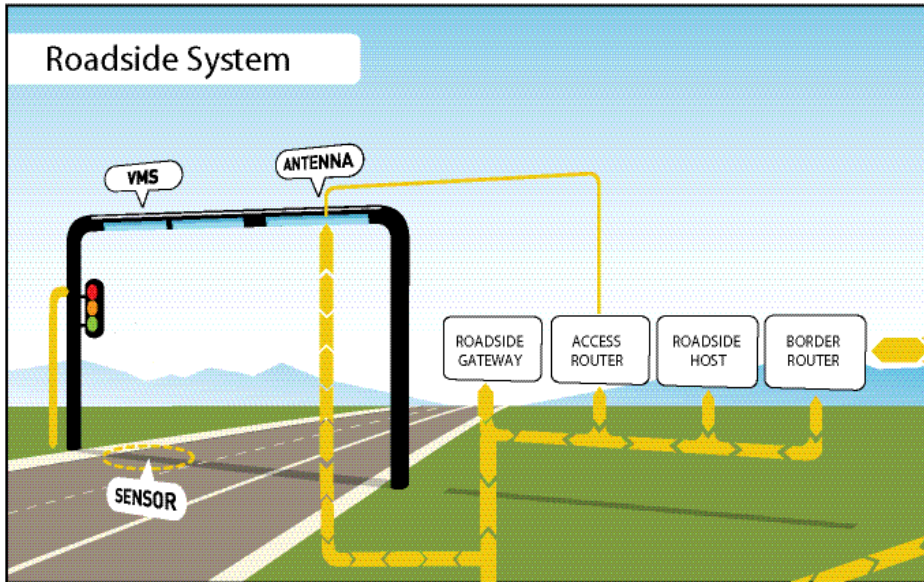
Car<->Infrastructure

- Co-operating projects also includes: **SEVECOM, COMeSafety, Car-2-Car Communications Consortium (C2C-CC), Network on Wheels (NoW), INVENT, ACTIV (Germany), CVHS (UK), IVSS (Sweden)**

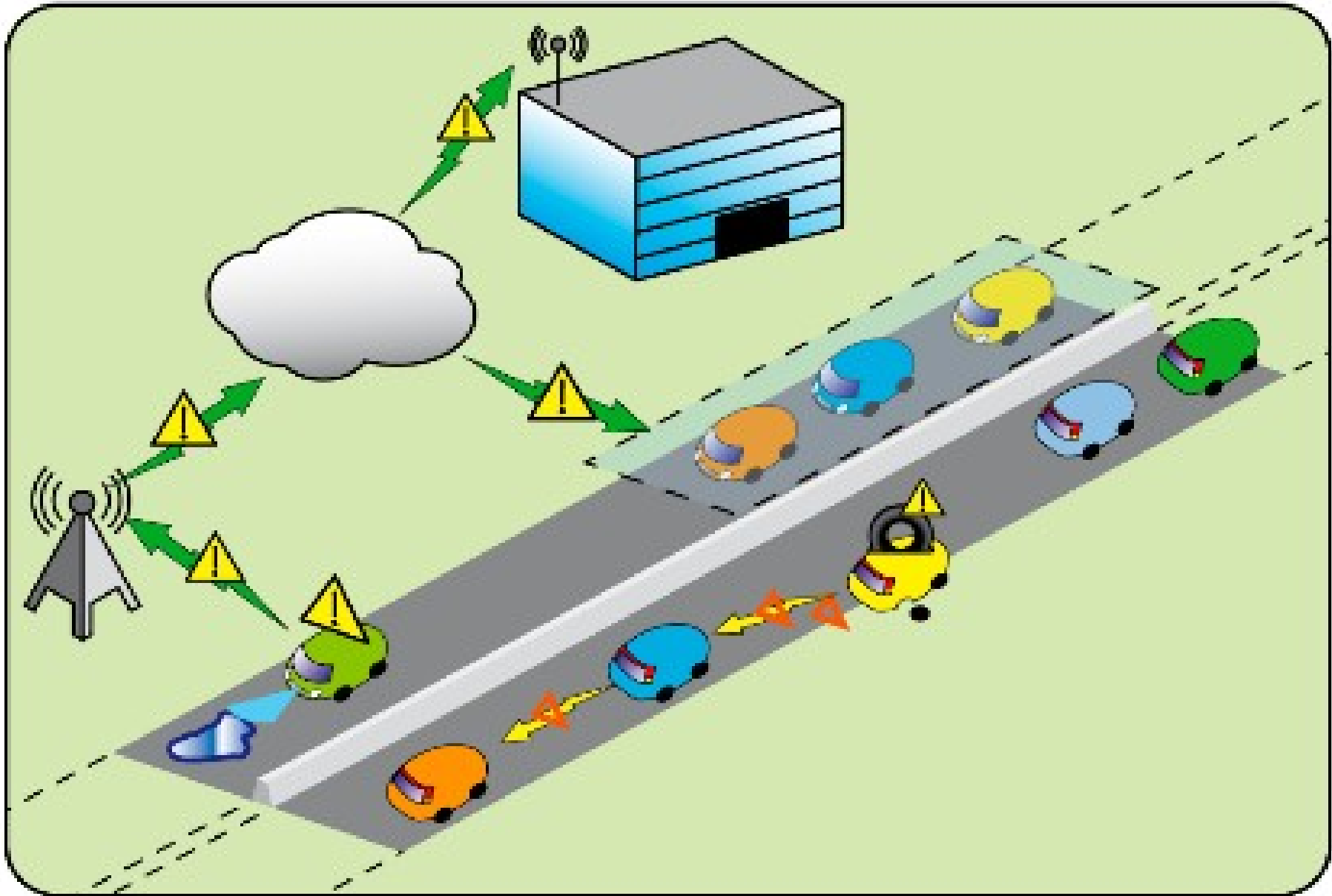
# The vehicle of the future: CVIS and GeoNet EU Projects

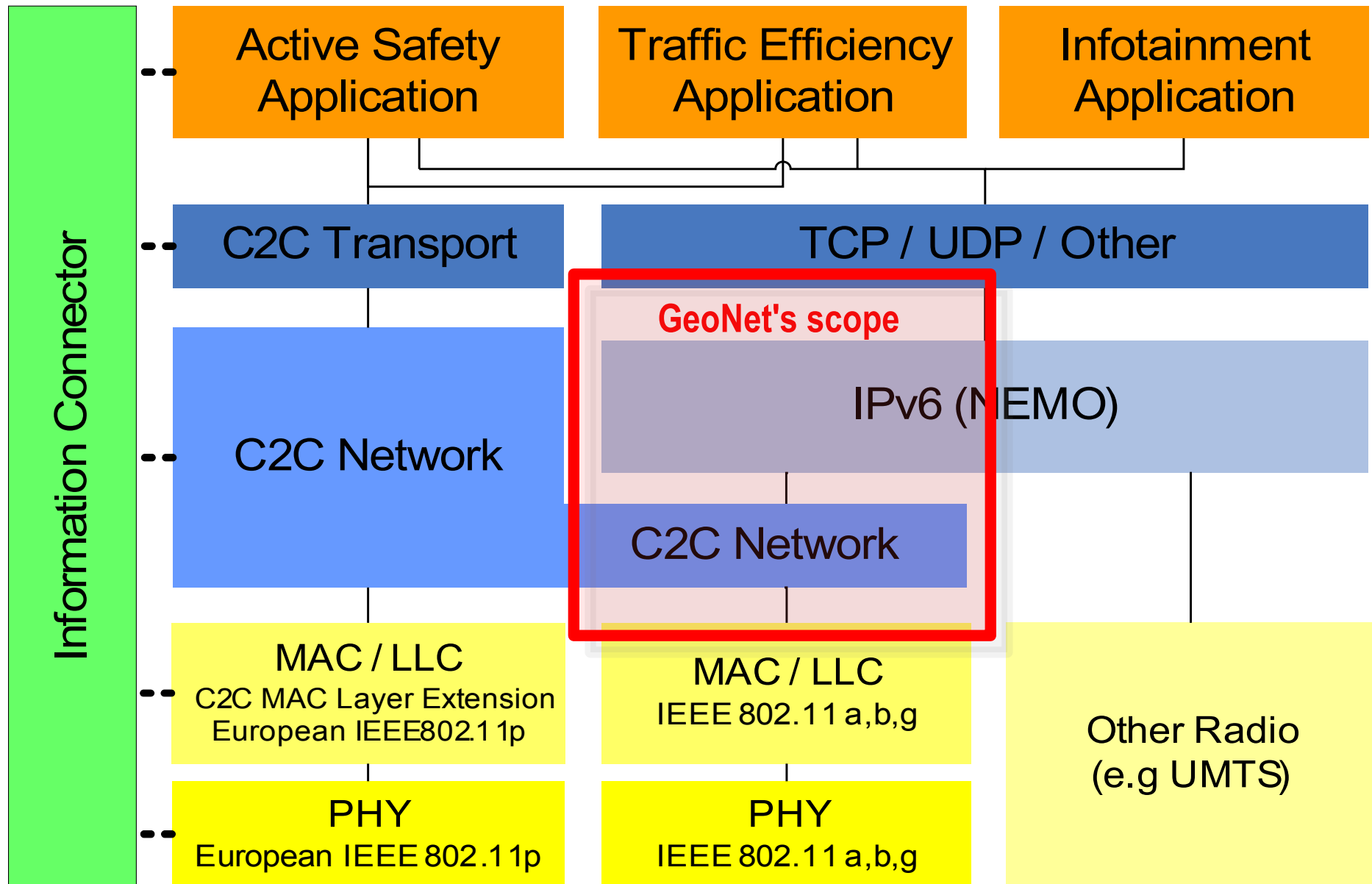
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- ◆ **CVIS (FP6)**
  - ◆ <http://www.cvisproject.org>
  - ◆ IPv6 communications between cars & central systems
  - ◆ Communication architecture inspired from CALM
  - ◆ CALM:
    - ◆ **ISO TC204 WG16**
    - ◆ **C**ommunication **A**rchitecture for **L**and **M**obile
    - ◆ <http://www.calm.hu>
- ◆ **GeoNet (FP7)**
  - ◆ <http://www.geonet-project.eu/>
  - ◆ Combination of IPv6 (IETF) and C2C-CC standards
  - ◆ Geographic addressing and routing



- ◆ FP7 European Project (STREP)
  - ◆ Feb. 2008 – Feb. 2010
  - ◆ Web: <http://www.geonet-project.eu>
  
- ◆ Partners
  - ◆ INRIA (Coordinator)
  - ◆ Hitachi
  - ◆ NEC
  - ◆ Eikon
  - ◆ Lesswire
  - ◆ Broadbit
  - ◆ IMDEA networks
  
- ◆ Objective: Design the concepts linking geographic addressing and routing with IPv6 mobility mechanisms (**IPv6 geonetworking**)
  - ◆ Combination of **IPv6** (IETF) and **C2C-CC** standards





# Conclusions

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- ◆ ITS systems to be reachable on the Internet must speak IP
- ◆ **IPv6 is necessary** for wide development of IP-based ITS applications
  - ◆ IPv6 scales to millions of vehicles, each requiring several IP addresses & provides new functionalities
  - ◆ IPv6 is currently being deployed (not an utopia) and will be fully operational by the time ITS systems get deployed
- ◆ ITS community mostly agree that IP means IPv6
  - ◆ ISO TC204 WG16 ([CALM](#))
  - ◆ [C2C-CC](#)'s IPv6 adaptation layer (FP7 [GeoNet](#))
  - ◆ [COMeSafety](#): European ITS Communication Architecture
  - ◆ [ETSI](#) TC ITS
  - ◆ [WAVE](#)
- ◆ Concept currently under validation
  - ◆ [CVIS](#): proof of concept of CALM
  - ◆ [GeoNet](#): combination of IPv6 with C2C-CC architecture

## Conclusions: Lessons learned on IPv6

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- ◆ ITS community still lack understanding on what is IPv6 and training of their engineers
  - ◆ how to get trained on IPv6
  - ◆ where to get IPv6 access from
  - ◆ how to adapt IPv6 standards to ITS needs (e.g. geonetworking, addressing, security)
- ◆ Hands-on experience of the ITS sector largely not sufficient
- ◆ Urgent to develop **IPv6 awareness and know-how** within the ITS community
  - ◆ Avoid disruption of business due to bad design and lack of vision
  - ◆ Considering IPv6 at the earlier design stage will further ease the transition from IPv4 to IPv6 and save costs
  - ◆ IPv6 compatibility must be ensured now

- ◆ ISO TC 204 WG 16 (CALM): <http://www.calm.hu>
- ◆ CVIS: <http://www.cvisproject.org>
- ◆ COMeSafety: <http://www.comesafety.org>
- ◆ GeoNet: <http://www.geonet-project.eu/>
- ◆ IPv6 for ITS portal: <http://lara.inria.fr/ipv6/> (under construction)
- ◆ LaRA: <http://www.lara.prd.fr>
- ◆ European commission's IPv6 page
  - ◆ IPv6: Enabling the Information Society
  - ◆ [http://ec.europa.eu/information\\_society/policy/ipv6/index\\_en.htm](http://ec.europa.eu/information_society/policy/ipv6/index_en.htm)
  - ◆ See Action Plan for the deployment of Internet Protocol version 6 (IPv6) in Europe
  - ◆ [http://ec.europa.eu/information\\_society/policy/ipv6/docs/european](http://ec.europa.eu/information_society/policy/ipv6/docs/european)



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