IPv6 Network Mobility (NEMO) Standardization & Usages

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JRU LARA

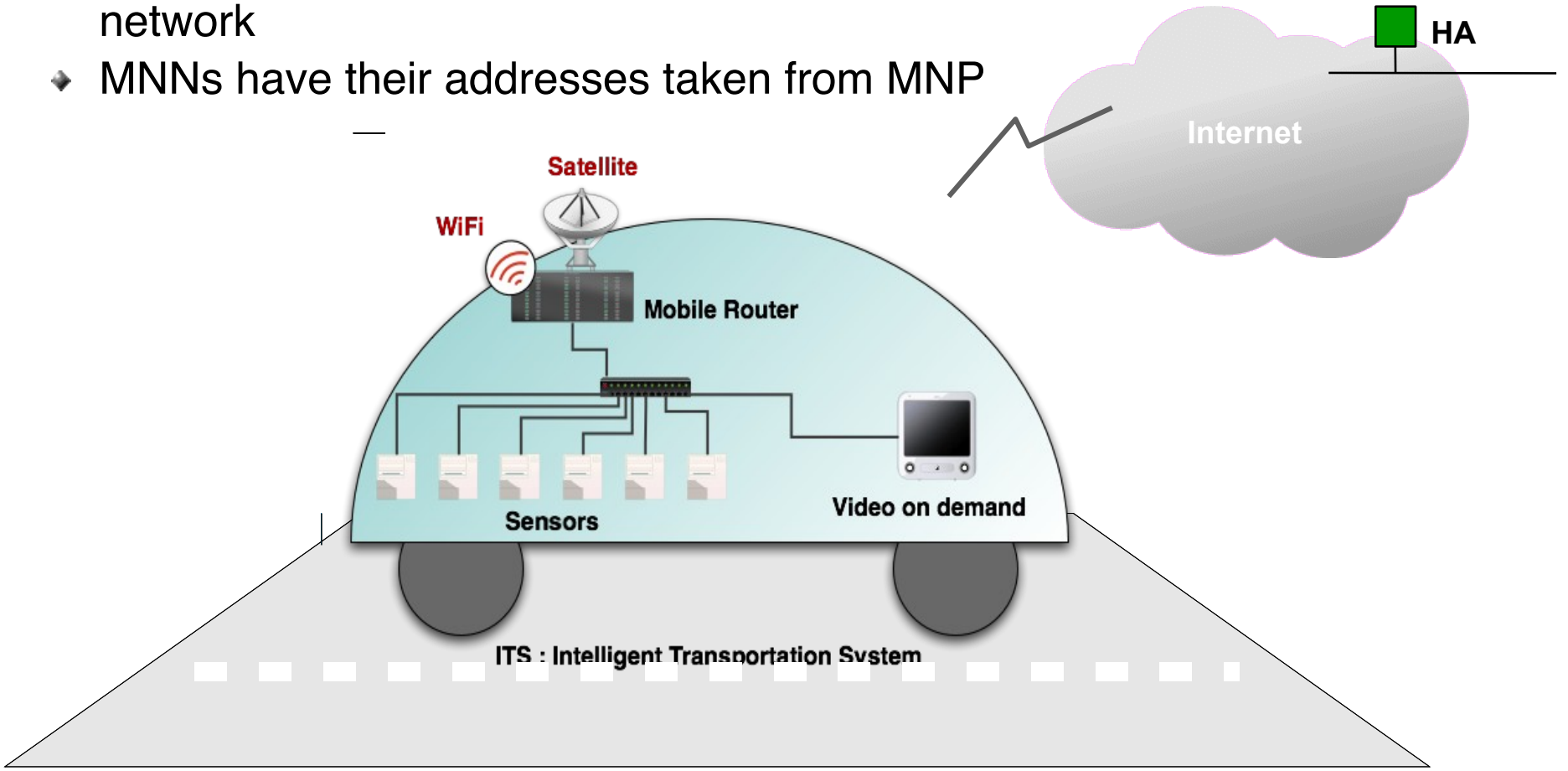
http://www.lara.prd.fr

Introduction: IPv6 Mobility Needs and Usages

- IPv6 is the opportunity to use the Internet differently
  - New usages that nobody would ever think oft in IPv4
  - New usages = new services = new equipments = new business
- End systems are becoming mobile
  - PDAs, Mobile Phones, Laptops, Vehicles
- Networks are becoming mobile
  - Sensor networks in vehicles
  - Access networks in vehicles (bus, aircraft, taxi)
  - PANs (Personal Area Networks): emergency units, army, everyone
- IPv6 Mobility Usages
  - Remote Control & Monitoring
  - On-board entertainment
- Where
  - Health-care (elderly or disabled people)
  - Telematic/ITS (emergency call, fleet management, navigation, ...)
  - Emergency units (Army / Police / Fire Crew)
  - Education / Journalism / Tourism

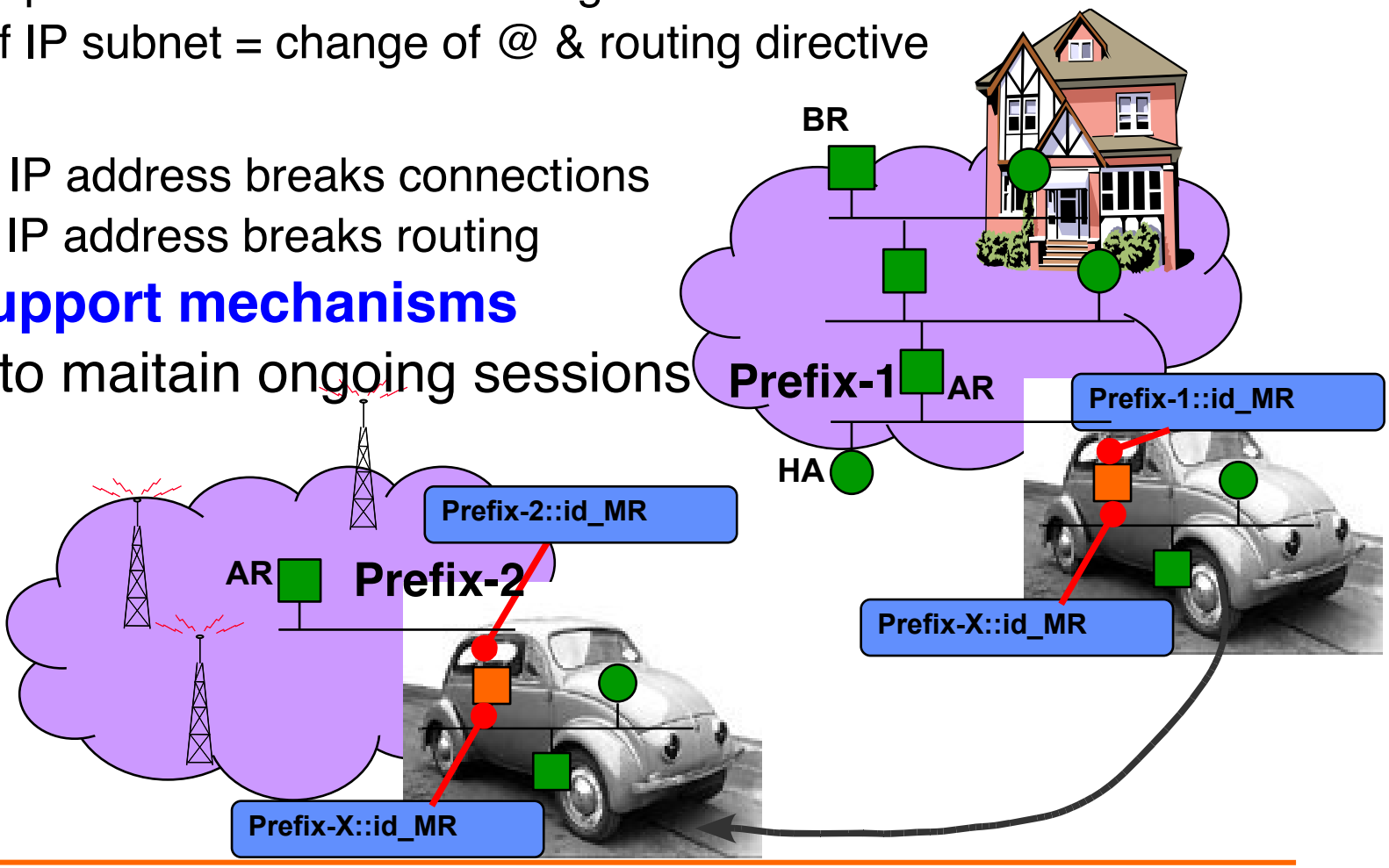
IP-layer Mobility: Addressing in IPv6

- Several IPv6 nodes in the mobile entity
  - Several IP subnets => Mobile network
- Initialisation
  - Prefix (MNP: Mobile Network Prefix) is assigned to the mobile network
  - MNNs have their addresses taken from MNP

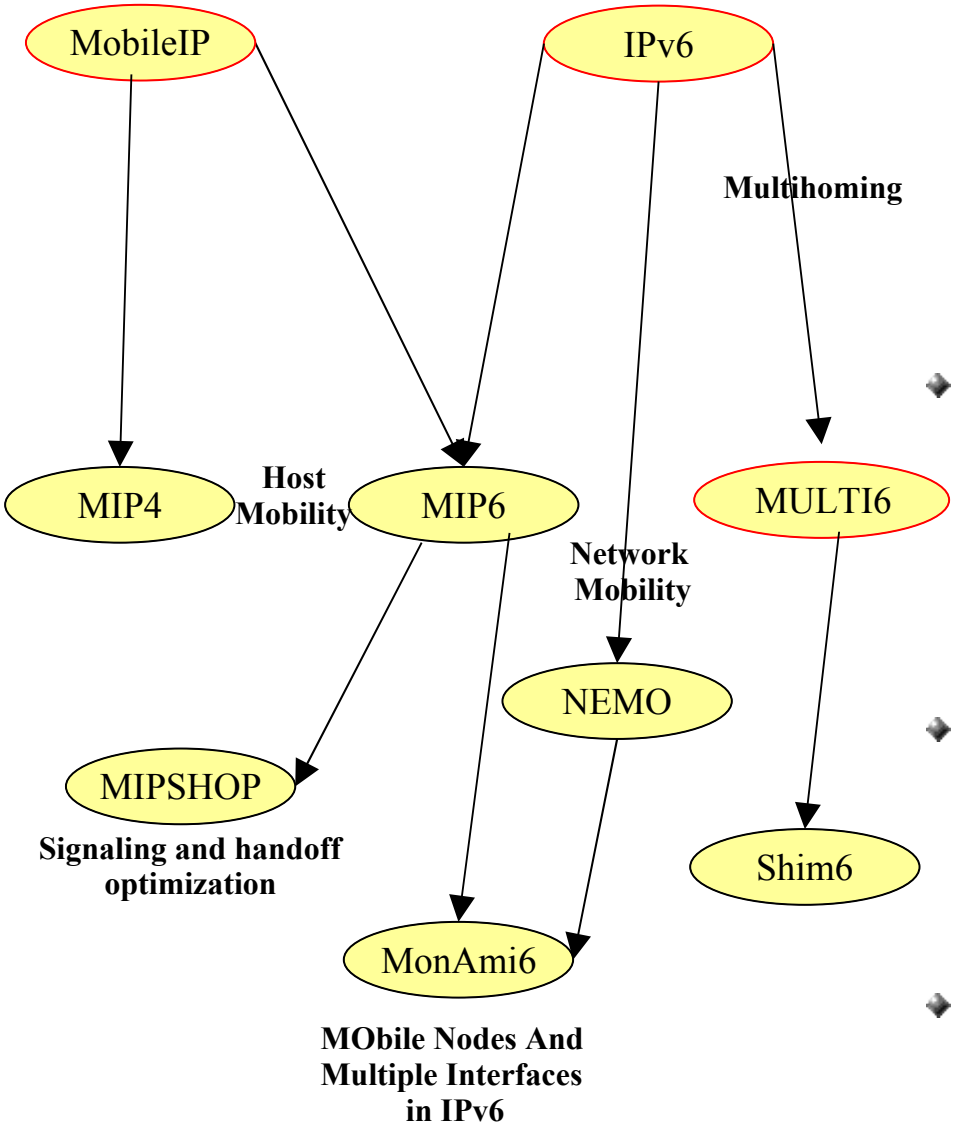


IP-layer Mobility: Addressing in IPv6

- Address must be topologically correct
  - Each interface must have an @ formed after the prefix advertised on the link where it is attached
  - Change of point of attachment = change of IP subnet
  - Change of IP subnet = change of @ & routing directive
- Problem
  - Changing IP address breaks connections
  - Retaining IP address breaks routing
- **Mobility support mechanisms**
  - needed to maitain ongoing sessions



IETF: IPv6 Mobility Activities



- Host Mobility Support
  - Proto: Mobile IP, HMIPv6, FMIPv6
  - End sysyems that change point of attachment
  - WG: MIP4, MIP6, MIPSHOP (+ IRTF MobOps)
- Network Mobility Support
  - Proto: NEMO Basic Support
  - Entire networks that change point of attachment
  - WG: NEMO
- Ad-hoc networks
  - Routing protocols for infrastructure-less networks
  - WG: MANET
- Multihoming
  - WG: MonAmi6, Shim6

IETF NEMO WG: Status

- Charter: http://www.ietf.org/html.charters/nemo-charter.html

- Aug. 2000: Initial discussion started in Mobile IP WG
- Oct.2002: NEMO (NEtwork MObility) WG created
  - Chairs: Thierry Ernst / TJ Kniveton
- 2002-2006 missions
  - define terminolog & requirements
  - standardize a basic solution for network mobility support
  - issue problem statement for RO and multihoming

IETF NEMO WG: Status

- Document Status
  - RFC 3963: NEMO Basic Support
  - RFC 4885: NEMO Terminology
  - RFC 4886: NEMO Goals and Requirements
  - RFC 4887: NEMO Home Network Models
  - RFC 4888: NEMO Route Optimization Pb Statement
  - RFC 4889: NEMO Route Optimization Sol. Space Analysis
  - RFC queue: NEMO Multihoming Analysis
    - **draft-ietf-nemo-multihoming-issues**
  - NEMO MIB: ongoing
  - NEMO Prefix Delegation: ongoing

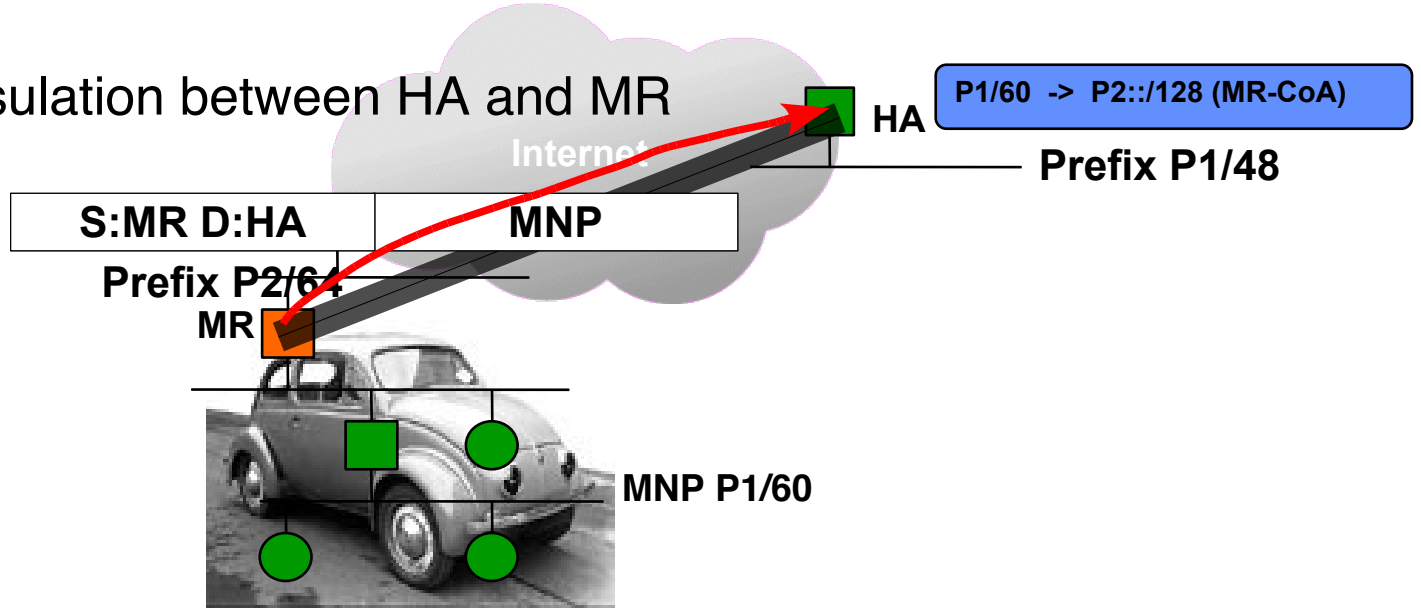
- Related documents in MIP6 WG
  - Problem Statement: Dual Stack Mobility
  - Mobile IPv6 Support for Dual Stack Hosts and Routers (DSMIPv6)

IETF NEMO WG: Status

- 2007 missions
  - Gather NEMO requirements from 3 use cases
    - Automobile
    - Aviation
    - Personal mobile router
  - 68th IETF presentation material
    - http://www3.ietf.org/proceedings/07mar/index.html
- July 2007: Moving forward
  - NEMO, MonAmi6 and MIP are merging into a single WG
  - Mobility EXTensions for IPv6 (MEXT)

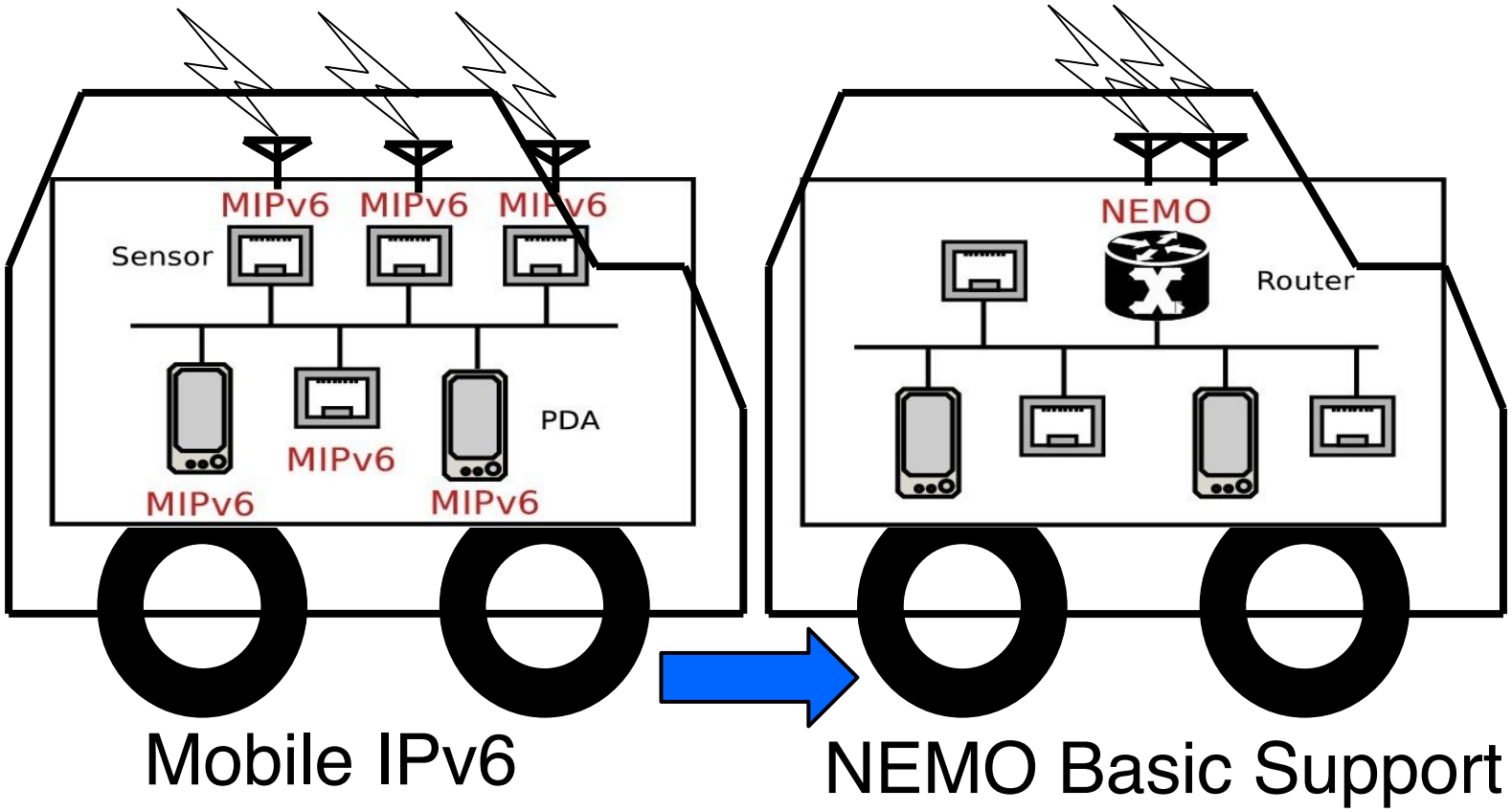
Network Mobility Support: IETF NEMO

- NEMO: NEtwork MObility in IPv6
  - Charter: http://www.ietf.org/html.charters/monami6-charter.html
  - RFC 3963 Network Mobility Basic Support
- Movement to a foreign link
  - MR and MNNs retain their initial addresses
  - MR obtains a CoA on the foreign link
- Registration with HA
  - MNP -> MR-CoA instead of MR-HoA-> MR-CoA
- Routing
  - Encapsulation between HA and MR



Network Mobility Support vs Host Mobility Support: Benefit

- Network complexity brought back to the router
  - Only the mobile router manages mobility and maintains Internet access through ore or several access technologies
  - Nodes behind the mobile router are standard IPv6 nodes with no mobility support mechanisms

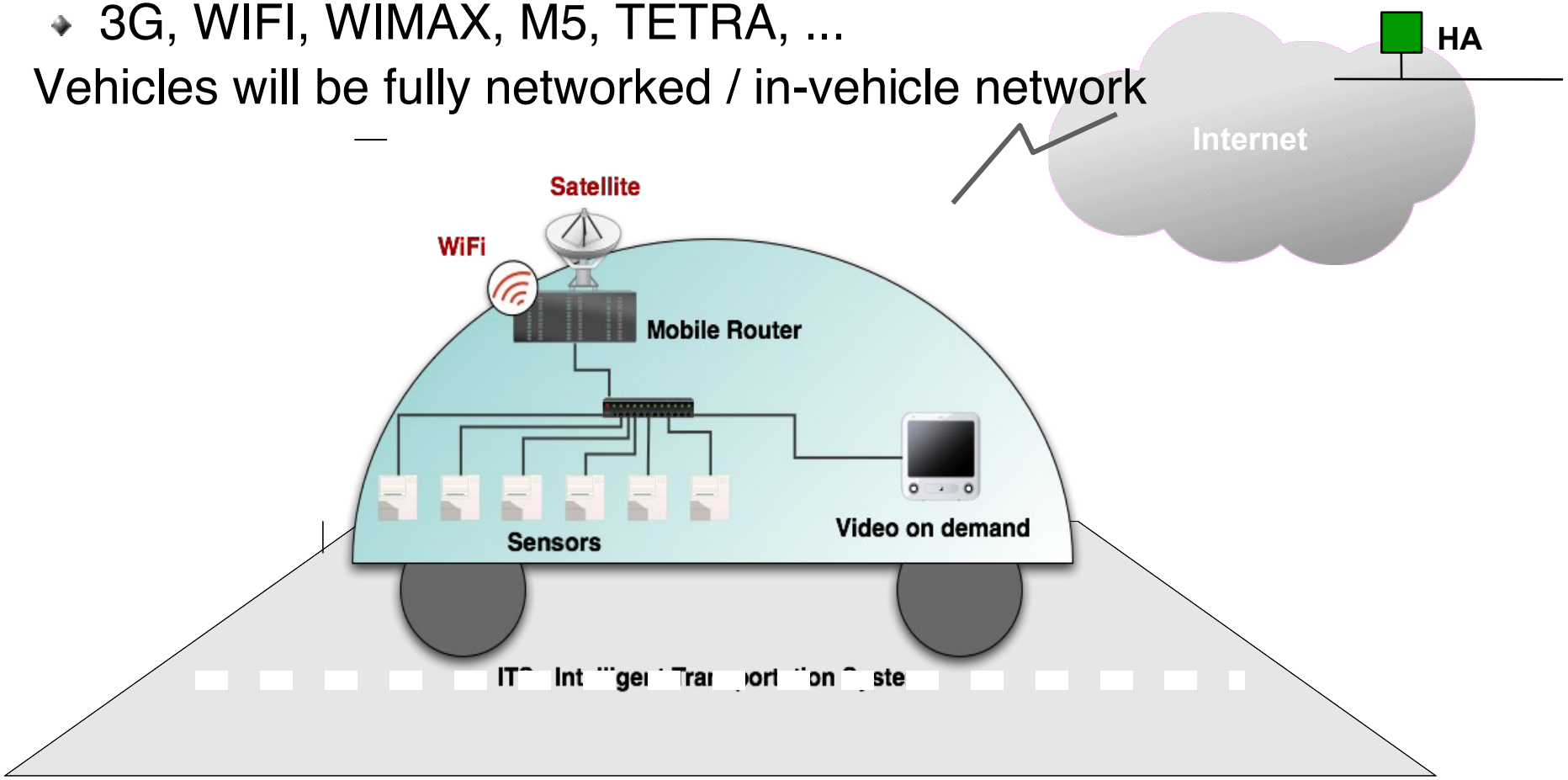


ITS Usage: Intelligent Transportation Systems (ITS)

- V2V & V2I communication crucial for ITS
  - Road safety
    - **collision avoidance**
    - **emergency calls**
  - Remote control and monitoring
    - **fleet management**
    - **call-back vehicles for repair**
  - Road efficiency
    - **navigation**
    - **vehicular congestion avoidance**
    - **cutting Earth warming gas emission**
    - **road access control**
    - **billing**
  - Entertainment
  - Automatic driving

ITS Usage: Intelligent Transportation Systems (ITS)

- Several in-vehicle devices will require (direct) Internet connectivity
- Internet connectivity will be provided transparently to the applications through a range of access technologies
  - 3G, WIFI, WIMAX, M5, TETRA, ...
- Vehicles will be fully networked / in-vehicle network

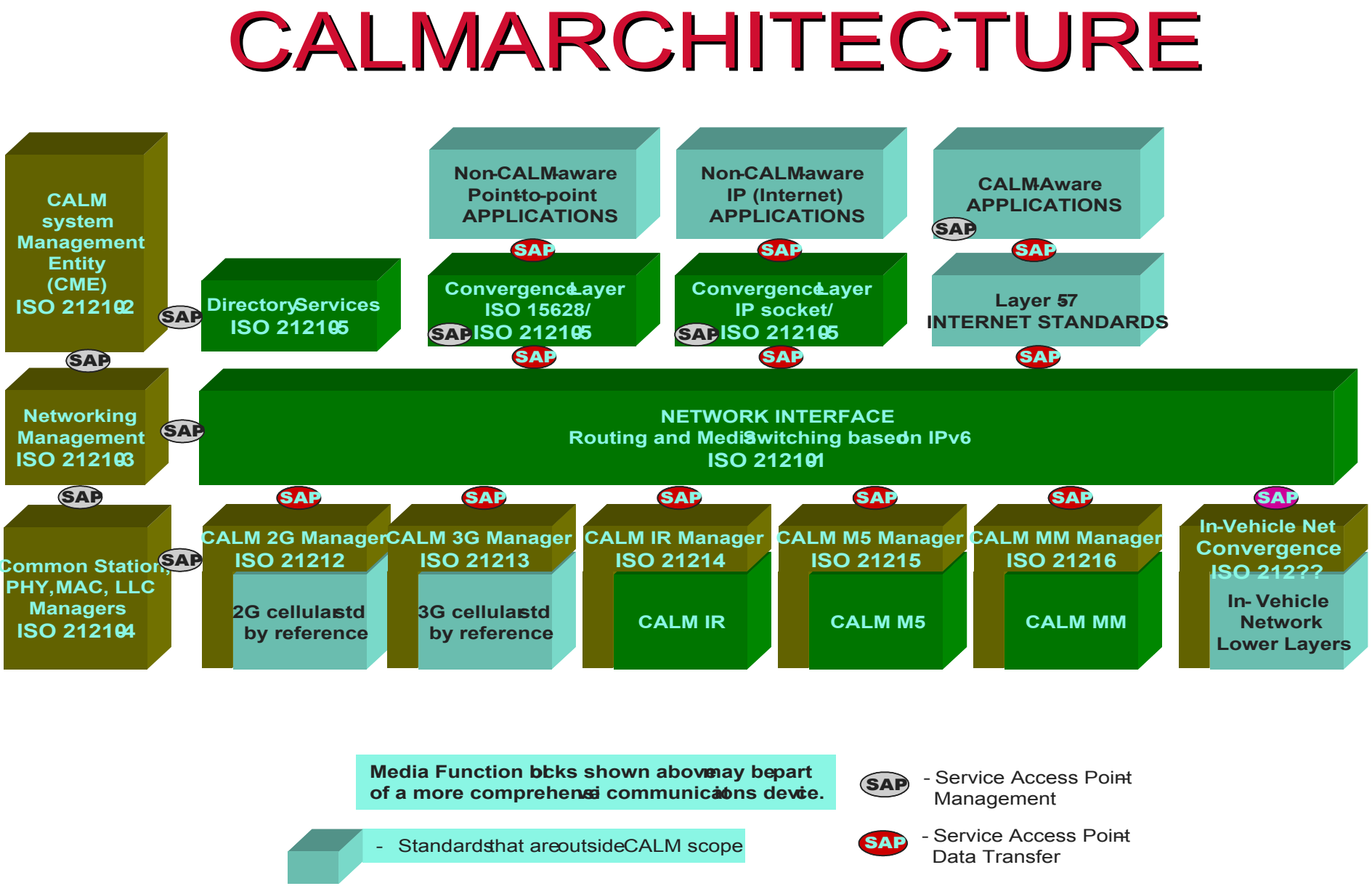


ITS Usage: ISO TC204 WG16: CALM Architecture

- ISO TC204 WG16 defining communication protocol architecture
  - CALM: Communications Air-interface, Long and Medium range
  - CALM Handbook: http://www.calm.hu
  - CALM Networking: ISO 21210
  - 21210-1: Internet Connectivity (Committee Draft)
  - 21210-2: Fast Application (draft)

- Key points:
  - Medium Selection & Switching
    - **Horizontal handover: between access points using the same media**
    - **Vertical handover: heterogeneous handovers**
    - **Purpose: Continuous communication during handoff**
    - **Select the most appropriate media based on application needs**
  - Internet services based on IPv6
  - Non IP services considered for time critical applications (collision avoidance)

ITS Usage: ISO TC204 WG16



ITS Usage: CVIS: FP6 Integrated Project (IP)

- Cooperative Vehicle-Infrastructure System
  - http://www.cvisproject.org
  - From Feb. 2006 till Feb. 2010
  - 61 partners / 12 countries / Total Budget: 41 Millions Euros

- Objectives
  - Develop, trial & demonstrate
    - **Inter-operable architecture for vehicular communications**
    - **Novel applications for:**
      - Cooperative traffic and road network monitoring
      - Cooperative road & traffic network management & control
      - Cooperative logistics & fleet management
      - Cooperative public transport & intermodality
- Vision
  - Use and extend existing standards
  - Produce open design and software
  - Output intended to be reused by other EC projects

ITS Usage: EC Projects around CALM

- Cooperative Vehicle-Infrastructure System

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

Core Technologies

Coordinator: **Fiat Research Centre**
Total budget: € 38 Million
EC contribution: € 20,5 Million
Consortium: 51 partners - 12 countries

Car<->Car

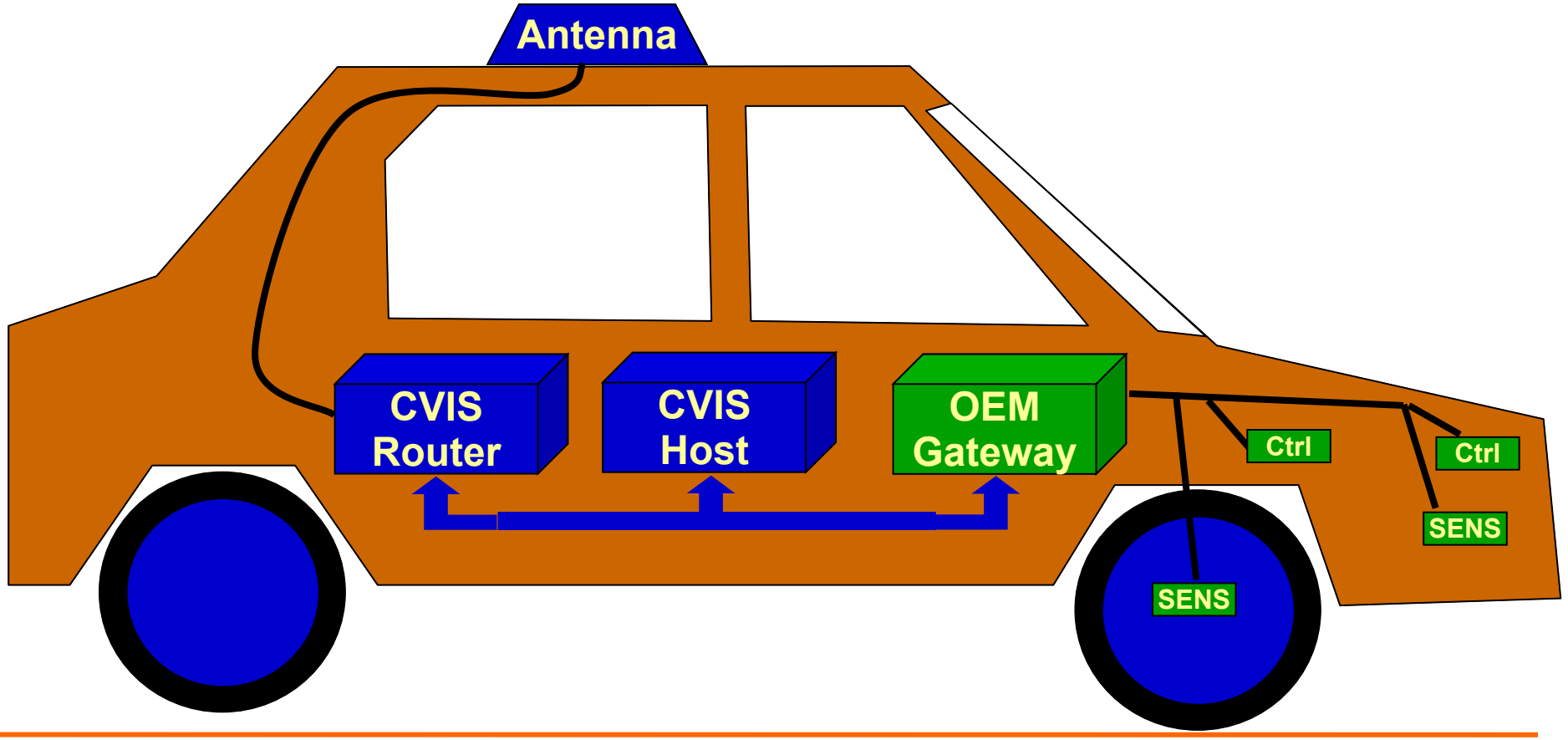
Coordinator: **AustriaTech**
Total budget: € 16,8 Million
EC contribution: € 9,6 Million
Consortium: 37 partners - 14 countries

Car<->Infrastructure

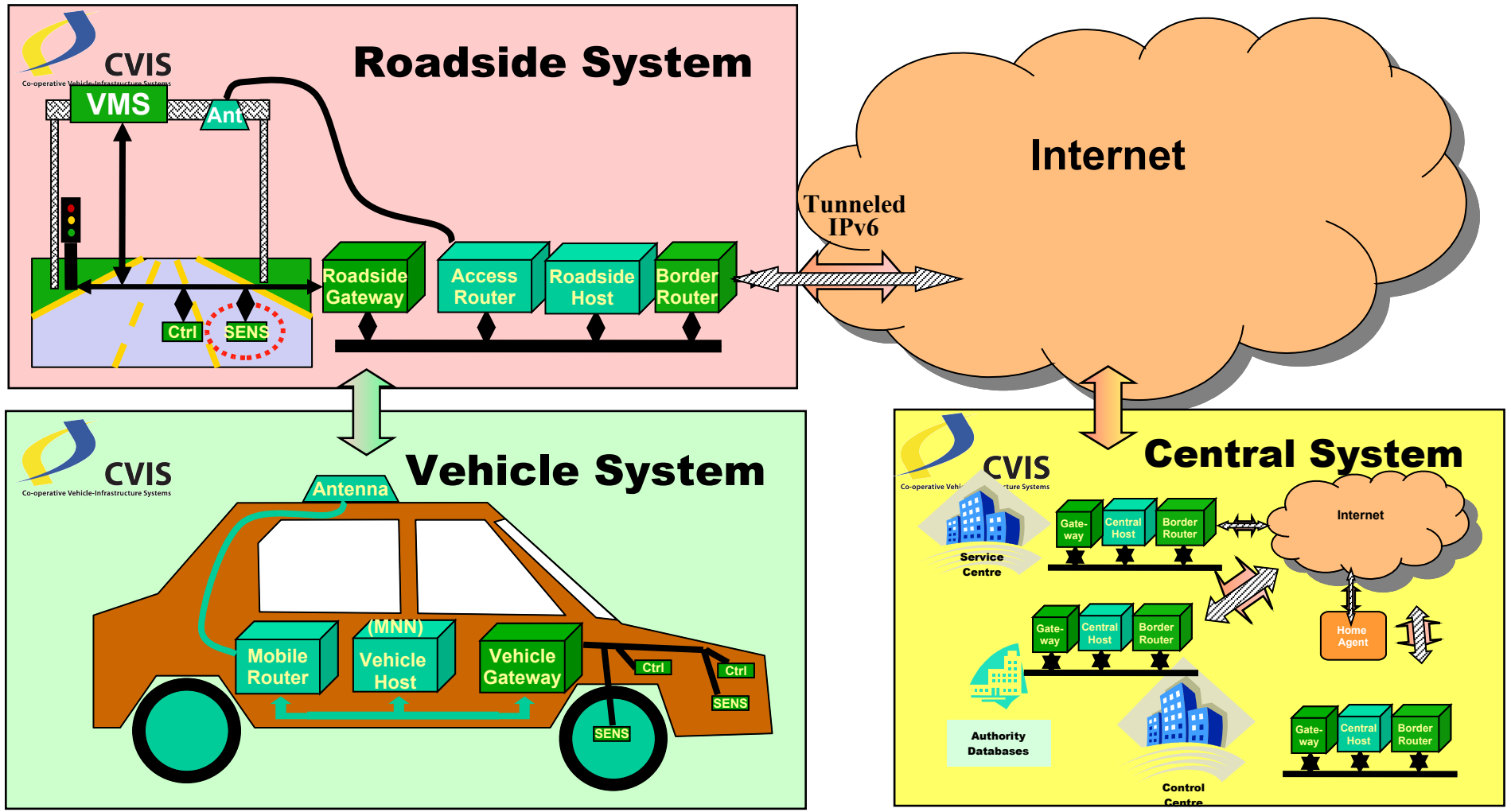
Cooperation links to: **SISTER (EC-Proposal), SEVECOM, COMeSafety**
Car-2-Car Communications Consortium (C2C-CC), Network on Wheels (NoW), INVENT
ACTIV (Germany), CVHS (UK), IVSS (Sweden)

ITS Usage: CVIS: Vehicle Configuration

- In-vehicle IPv6 subnet
  - CVIS Router: Mobile Router maintaining Internet Access through several physical interfaces
  - CVIS Host: run dedicated ITS applications
  - OEM: Gateway between IP and CAN



ITS Usage: CVIS IPv6-Based Communication Architecture



ITS Usage: CVIS Router Platform Layers

Rooftop Antenna

IR

Antenna (Roof Layer)

M5 + DSRC

GPS/ Galileo

2G/3G

IR

Media HW

Advanced Routing

COMM Manager

Media plug-in Manager

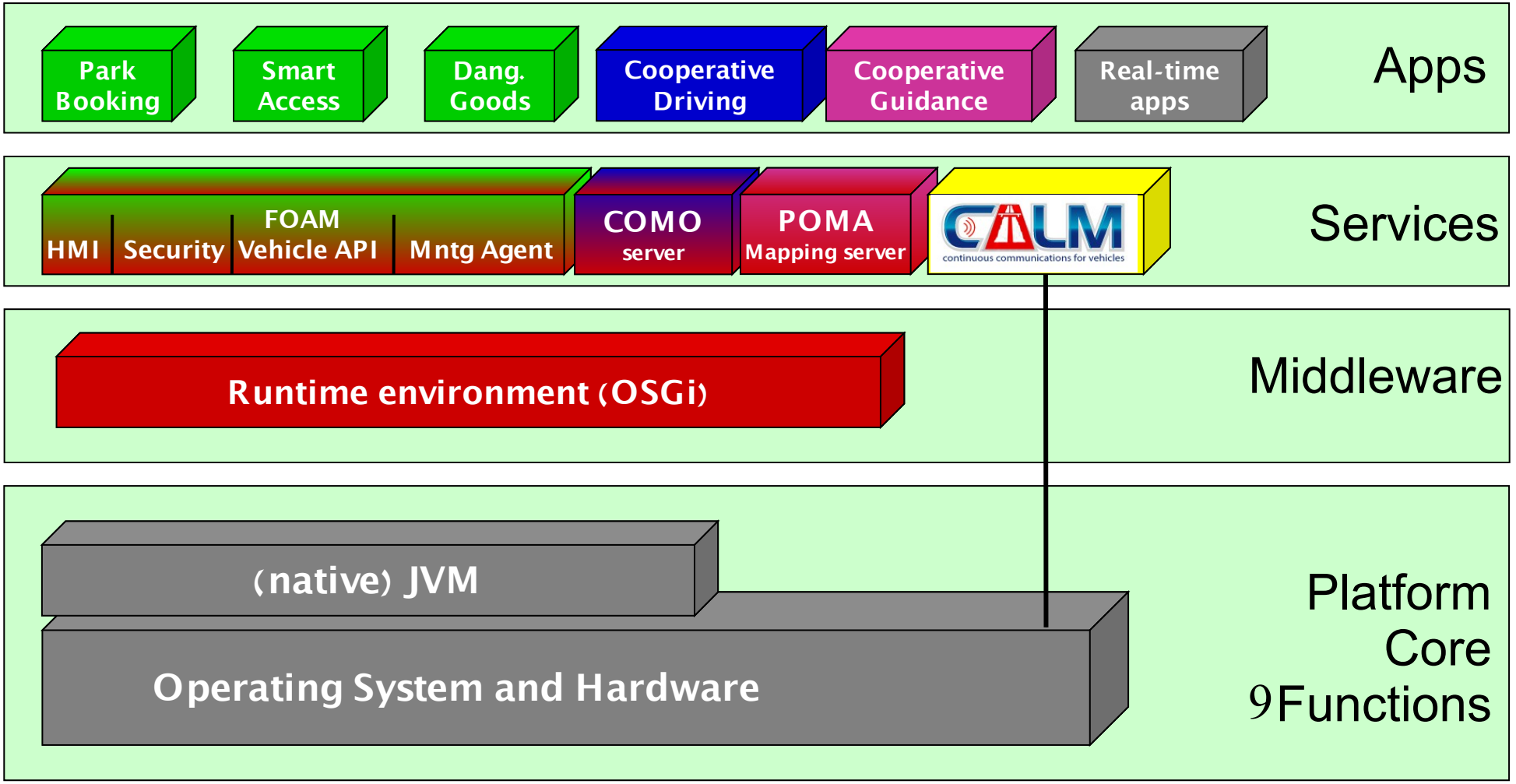
CALM continuous communications for vehicles

Extensions

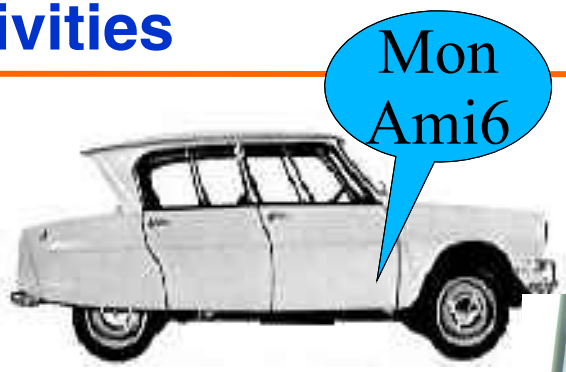
Standard Automotive PC Hardware + RT Linux

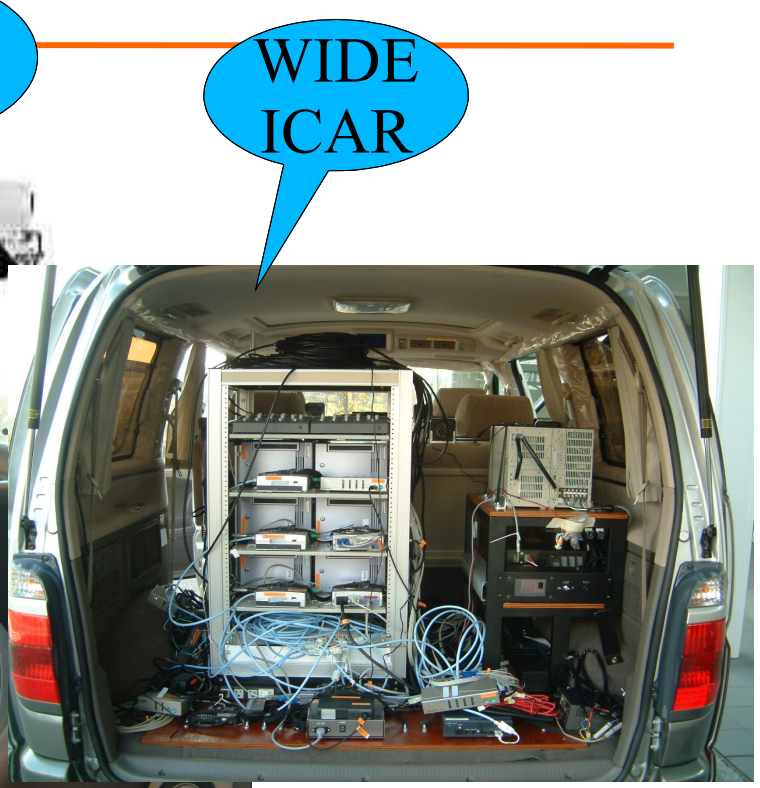
Platform Core Functions

ITS Usage: CVIS Router Platform Layers



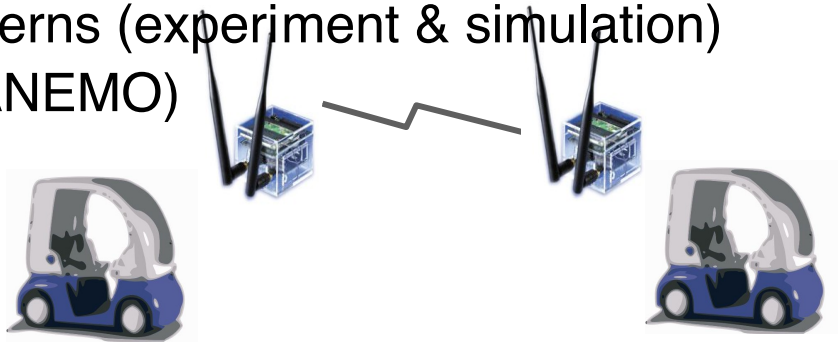
ITS Usage: Related Activities





ITS Usage: Self-Driving Cars (INRIA IMARA / LARA)

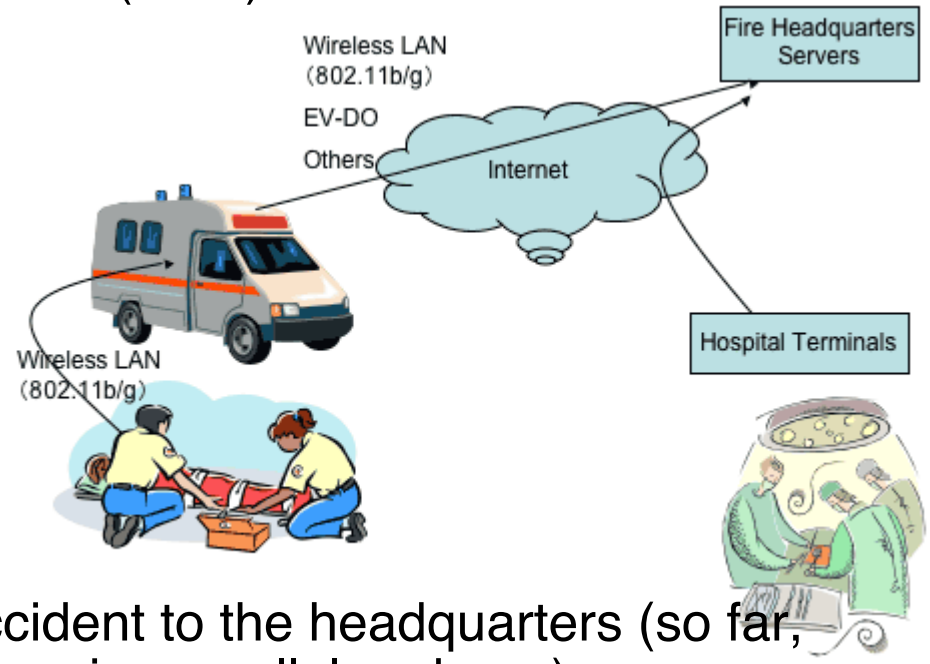
- IMARA Current Activities and Plans
  - Studying V2V and V2I communications under specific vehicular traffic and IP access network patterns (experiment & simulation)
  - Integrating NEMO & MANET (MANEMO)
  - Using CVIS implementation



- We are now actively pushing for IPv6

NEMO Usage: Emergency Units (PAN + Telematic)

- Techno
  - Wearable devices (IP phone, laptop, carrried by emergency doctor) + devices kept in vehicle (heartbeat sensor, GPS, ...)
  - Vehicle maintains access to the Internet (multiple technologies) and provides connectivity to wearable devices (WIFI)



- Services
  - Video/Images transmitted from the accident to the headquarters (so far, dialogue with headquarters was made using a cellular phone)
  - Heartbeat and temperature provided by sensors
- Mobile ER Pilot Test in Japan (NAIST)
  - http://www.ipv6style.jp/en/special/20051031_2/index.shtml

NEMO Usages: PAN (Nautilus6)

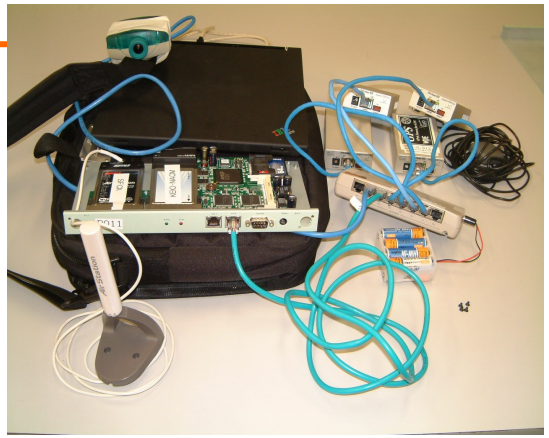
- Nautilus6 : http://www.nautilus6.org

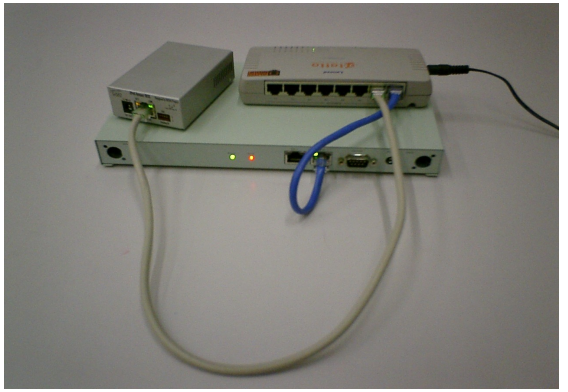
- Project initially set within the WIDE organization and later joined by French labs
  - Japan: Keio Univ, Tokyo Univ, JAIST, IIJ
  - France: INRIA, ULP Strasbourg, ENST-B, INT, France Telecom R&D

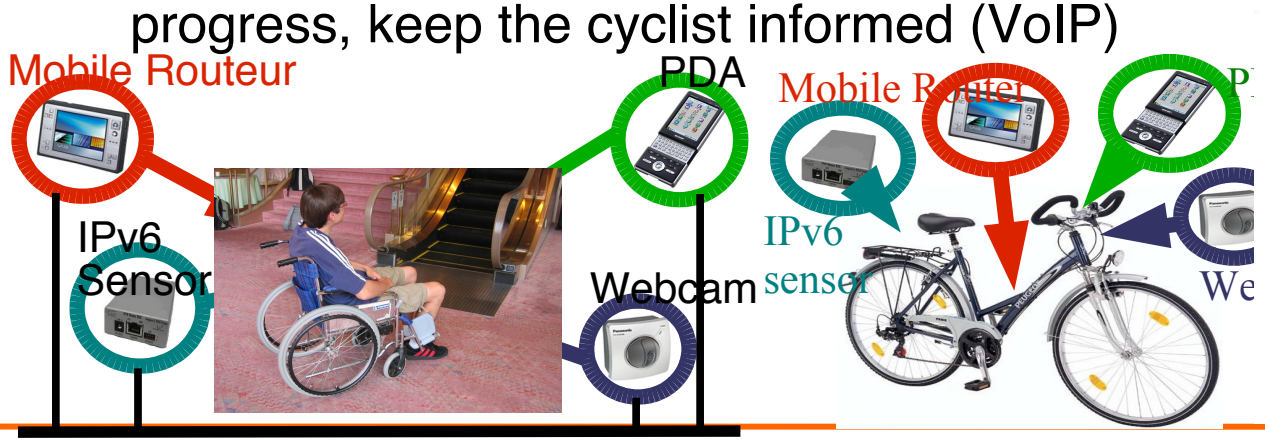
- Nautilus6 works on
  - IPv6 mobility solutions: NEMO, MIPv6, Fast MIPv6, ...
  - And associated tools: Analysis (SONAR), Acces Control tools (Diameter, etc), Operation (HA) [work originated in N6 and is still part of the N6 roadmap]
  - Objectives: Research / Testing / Development / Standardization / Demonstration / Promotion / Deployment

NEMO Usage: PAN (Personal Area Networks)

- e-Wheelchair: for people with disabilities and the elderly
  - Health monitoring
  - Remote communication between wheelchair and third party (hospital, doctor, family)
  - Increased independence
- e-Bicycle: for sport and tourism
  - Sport training: monitoring of the performance / health condition of the cyclist
  - Tourism: assist people in visiting cities (e.g. Bicycle rental at Kamakura) with navigation, historical guidance, etc
  - Sport competition / rallyes: live monitoring of progress, keep the cyclist informed (VoIP)

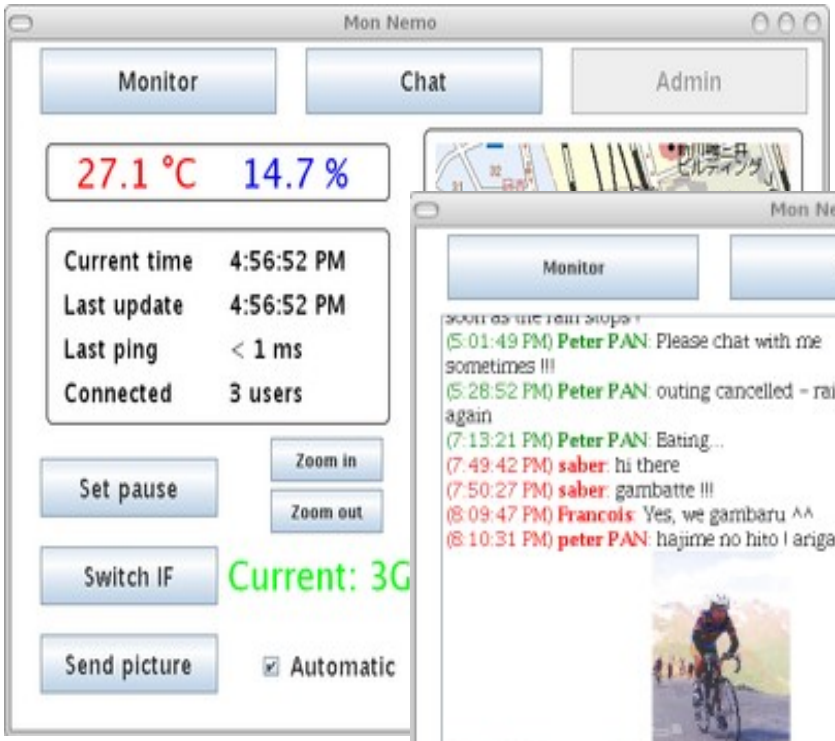


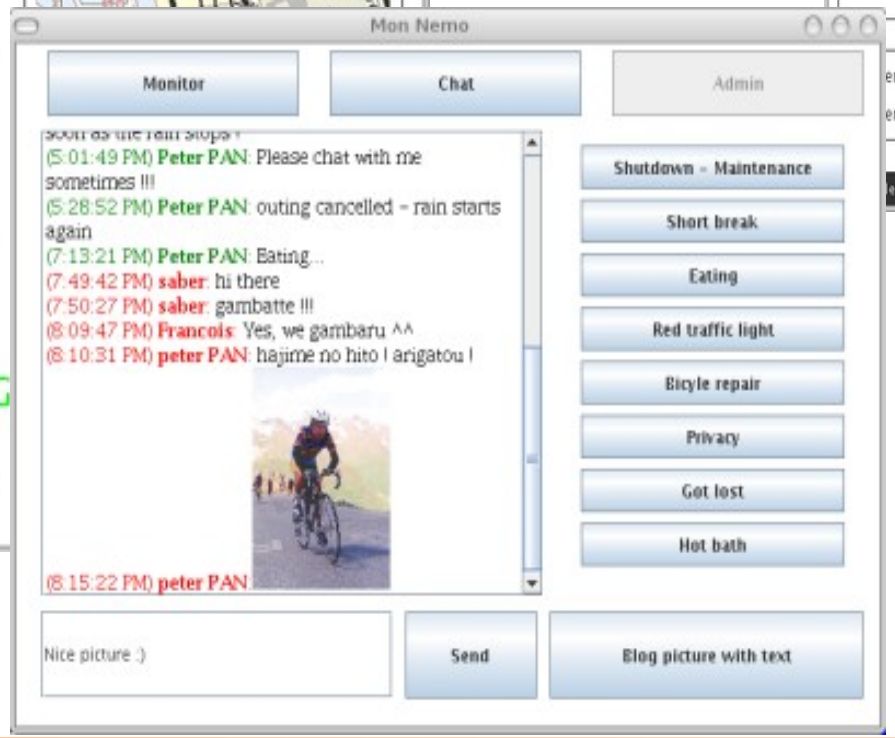


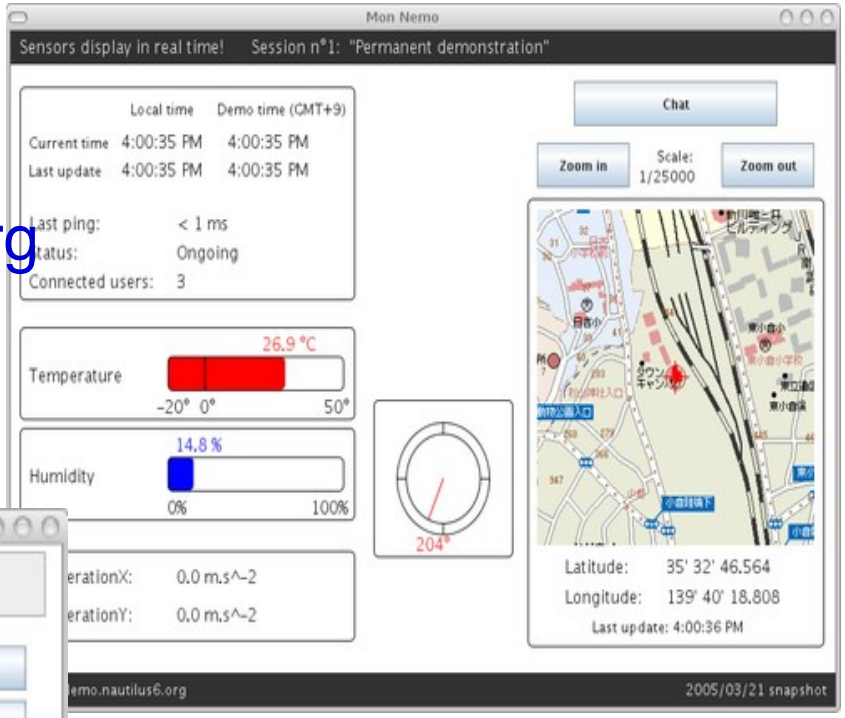


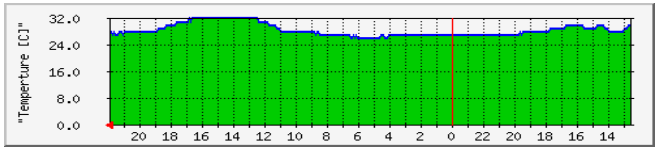
NEMO Usage: PAN : Nautilus6's MonNemo

- Monitoring Application
- Designed by Nautilus6
  - http://www.nautilus6.org
  - Demos: http://demo.nautilus6.org









NEMO Usages: Validation

- Conformance and Interoperability testing
  - ETSI
    - **IPv6 test specifications and methodology (based on TTCN3 new testing language)**
    - **Plugtests**
  - TAHI IPv6 and Moonv6 interoperability events
  - European Commission and associated projects
    - **STFs (236, 256, 276)**
    - **Go4IT, ANEMONE projects, …**
  - IPv6 Logo Program Word-Wide Initiative
    - **5 teams in the technical committee (v6LC) linked to the IETF: Asia (TAHI, BII, TTA), USA (IOL-UNH),**
    - **NEMO Basic Support in Gold logo**

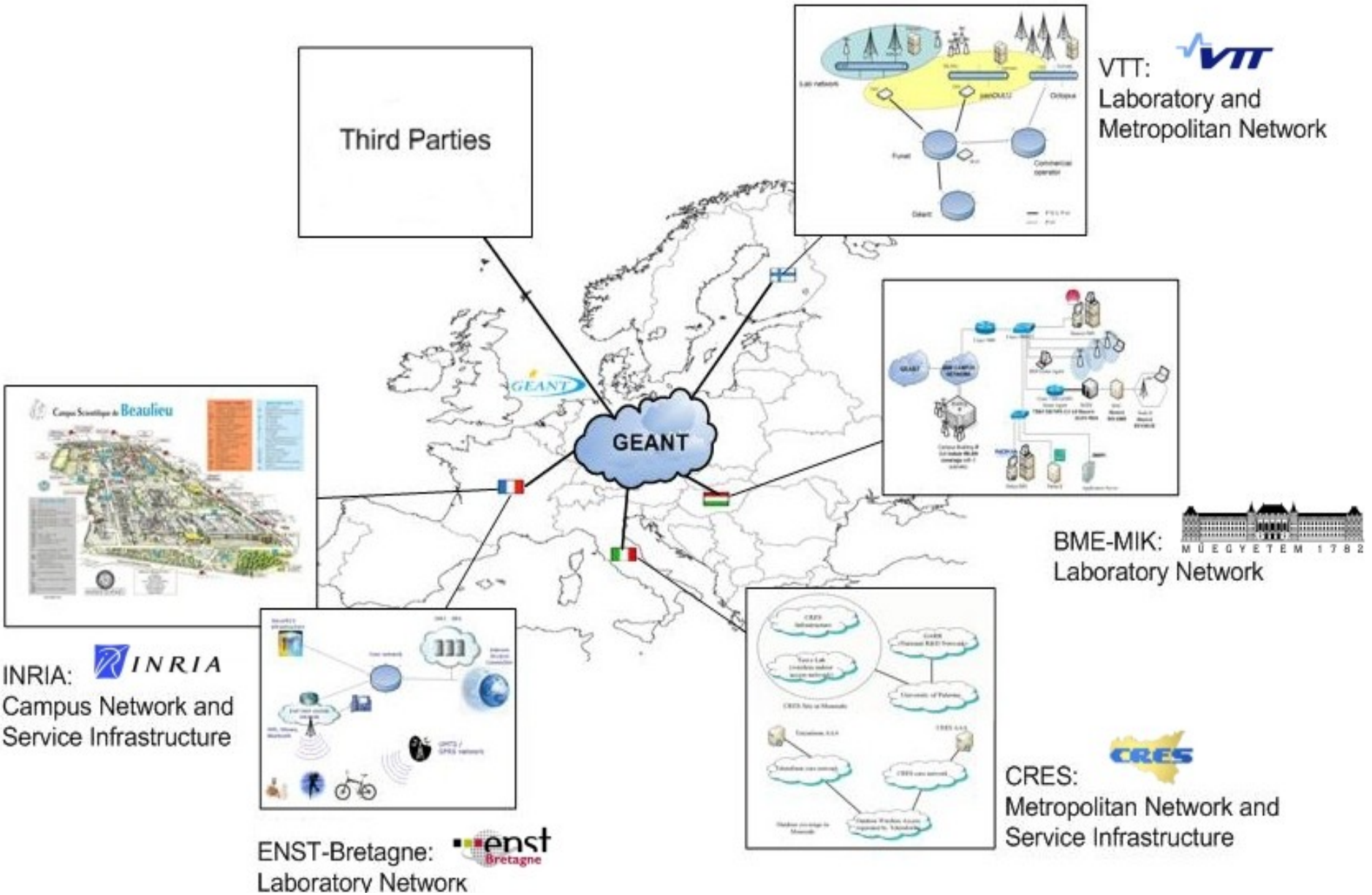
- Current trend in EC projects is towards IPv6 (& NEMO)
  - a testbed is needed for evaluating scenarios and solutions in real-life conditions
  - setting up required components of testbed is cumbersome

NEMO Validation Testbed: ANEMONE

- FP6 STREP
  - First large-scale IPv6 mobility-oriented testbed in Europe
  - http://www.ist-anemone.eu

- Variety of test sites
  - Wide-area outdoor & Indoor
  - Types: Campus / Metropolitan
- Multiple IPv6 access technologies
  - 802.11 a/b/g, HiperLan, UMTS, GPRS)
- Mobility services
  - NEMO / MIP6 / MCoA
  - HA
- IPv6 multimedia services
  - Web, Voice over IP, IP TV, Video on Demand
  - Experimental IP Multimedia Subsystem
- Security & Access control mechanisms
  - TLS / IPsec

NEMO Validation Testbed: ANEMONE



Conclusion: NEMO from Research to Deployment

- IETF is in charge of IPv6 protocols standardization (bricks)
  - WGs NEMO / MonAmi6 / MIP6 / etc.
- Complete architecture are defined somewhere else
  - ISO for ITS (ISO TC204 WG16 – CALM)
  - PAN: Nautilus6
    - **Health-care: e-Wheelchair**
    - **Education & Tourism: e-Bicycle**
  - Aviation: Boeing
- NEMO implementations & products:
  - SHISA (BSD), NEPL (Linux), CISCO
- Test & Validation
  - ANEMONE (EC IST 6th Framework http://www.ist-anemone.eu/)
  - Proof of Concept: Progressing technical know-how (e.g. CVIS)
  - Conformance test & interoperability
- Deployment:
  - coming soon

Conclusion: IPv6 Facts

- Addressing needs
  - Millions of devices, each requires a public global address
  - Millions of vehicles, each require several adresses
    - Too many vehicles for NAT

- IPv4 address space exhaustion date recently revised
  - IANA count down set to Dec. 2009
  - http://www.potaroo.net/tools/ipv4/
  - http://xkcd.com/c195.html
  - http://www.arin.net/statistics/statistics.pdf
  - http://www.arin.net/announcements/20070521.html

- Deployment
  - IPv6 is currently being deployed (not an utopia) and doesn't require to shut down IPv4
  - Will be the norm by the time new usages get deployed

Questions ?

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