

IPv6 (Internet Protocol version 6) Impact on the ITS sector











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ITS: Need for communications

- Several CPUs in the vehicle
 - CAN network
 - Navigation system
 - Other on-board units (passenger seats, radar detection, radio, mp3)

 Some need to communicate with other vehicles, roadside, central servers

- Benefits of communications
 - Road safety (time critical)
 - collision avoidance / emergency calls
 - Remote control and monitoring
 - fleet management / call-back
 - Road efficiency
 - navigation / road congestion / energy consumption / road access control / billing
 - Infotainment





ITS: Communications and Standards

- We are aiming at the "Always Connected World"
 - Always connected phone
 - Always connected car
 - Always connected individual
- We need standards
 - uniformized vehicular cooperative system (V2V)
 - uniformized exchange of information between vehicles and servers in the Internet (V2I)

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: Why an IP-based communication architecture?

- 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)





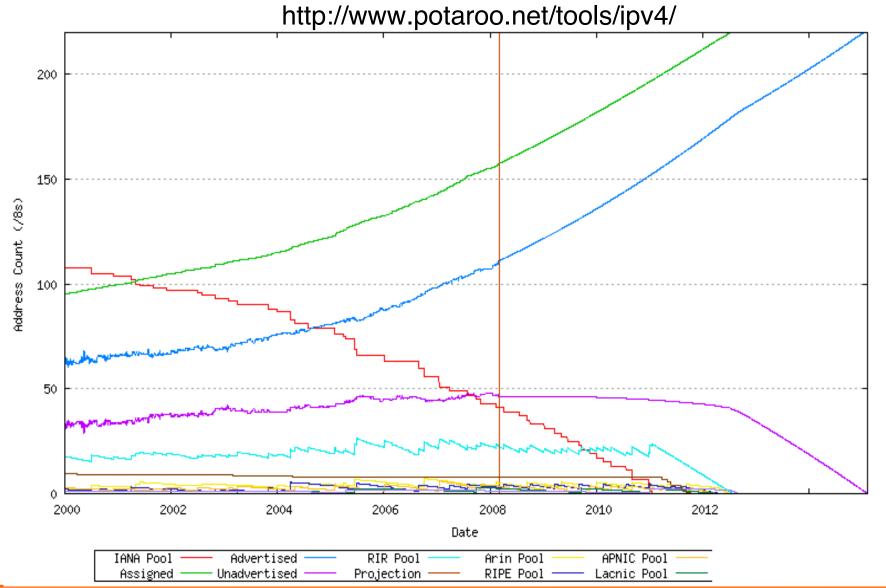
ITS: Why not IPv4?

- IPv4 is the Internet Protocol version currently deployed in the Internet as we know it.
- IPv4 is a non-go for ITS deployment
 - $2^{32} = 4,294,967,296$ adresses (256 /8 where 1 /8 = 16,777,216 @)
 - Millions of vehicles, several IP addressed needed in each
 - Too many vehicles for NAT
 - ITS needs network mechanisms to maintain IP session connectivity while vehicles are on the move
 - No or limited network mobility support in IPv4 (NEMO)
 - No mobile edge multihoming support in IPv4 (MonAmi6)
- IPv4 address space exhaustion projection recently revised
 - IANA count down set to around Dec. 2009
 - Count Down: http://www.potaroo.net/tools/ipv4/
 - RIPE: http://www.ripe.net/news/community-statement.html
 - ARIN: http://www.arin.net/announcements/20070521.html
 - RIR allocations: http://www.arin.net/statistics/statistics.pdf



ITS: Why not IPv4?

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





ITS: What is IPv6?

- IPv6: Internet Protocol version 6
 - IETF started to design IPv6 in 1995 as a replacement of IPv4
 - IPv6 is an evolution of IP
 - ◆ 128 bits instead of 32 (2¹²⁸ addresses instead of 2³²⁾
 - New IP header
 - New features
 - Fully specified, implemented, operational deployment started
- Compatibility between IPv4 and IPv6 doesn't come for free
 - The network must be configured to provide IPv6 access
 - Routers must be configured to interpret both types of headers
 - DNS must be configured to return IPv6 addresses
 - Applications must be IP-version agnostic
 - Libraries must use lpv6-compatible system calls
 - OSs must implement an IPv6 stack (Linux, Mac OS X, Windows Vista do)
 - IPv6 access must be provided natively, through tunneling or through a tunnel broker



ITS: Why IPv6?

- IPv6 is the recommended version for ITS
 - Not an option for wide development of IP-based ITS applications
 - Scale to millions of vehicles, each requiring several IP addresses
 - ISO TC204 WG16 (CALM)
 - C2C-CC's IPv6 adaptation layer (FP7 GeoNet)
 - CVIS proof of concept of CALM
- Why should we care about IPv6?
 - Not considering IPv6 from the earlier stages will bring more costs
 - Urgent to develop IPv6 awareness within the ITS community
 - The Internet will fully operate IPv6 by the time CVIS output gets deployed
- IPv6 compatibility must be ensured now with IPv4 and non-IP systems in order to save costs in the short term future
 - Avoid disruption of business due to bad design and lack of vision
 - Developing such mind-set in the earlier stages will further ease the transition from IPv4 to IPv6





IPv6: Impact Study on Vertical Sectors (EC Oct. 2007) TANA





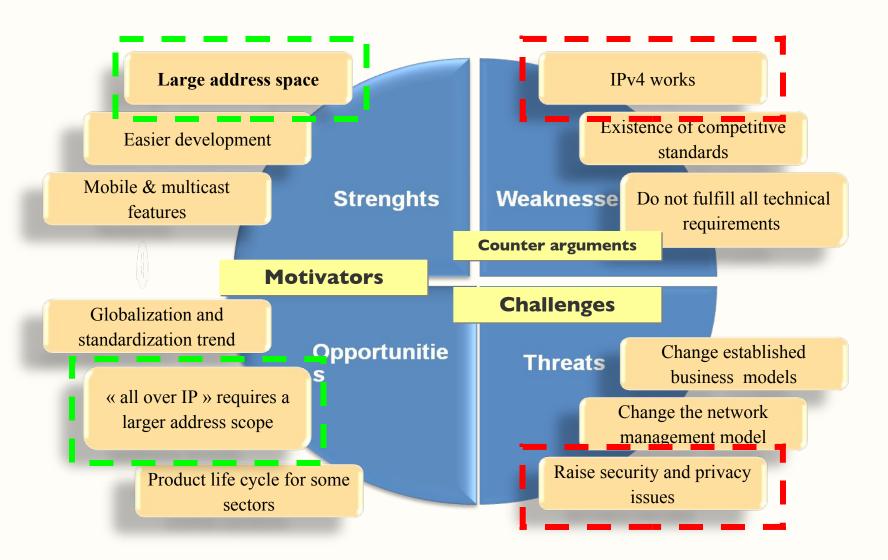
- 15 sec
- Desk research
- 45+ interviews conducted
- Case studies
- Expert group involved (IPv6 and sectors experts)
- Web surveys (ISP and users)

- ✓ Central Government
- ✓ Education
- ✓ Defence
- ✓ Media/Entertainment: Gaming
- ✓ Media/Entertainment: Television
- ✓ Consumer
- ✓ Tourism
- ✓ Service operators
- ✓ Automotive transportation
- ✓ Collective Transportation
- ✓ Health
- ✓ Buildings
- ✓ Public safety
- √ Finance
- ✓ Logistics

SWOT: Strengths, Weaknesses, Opportunities & Threats ANA







Potential evolution if nothing is done







- Momentum to IPv6 is low
- End of IPv4 public addressed availability is close

Demand surge: panic to safeguard infrastructure

Avoidance of consumption:

company are moving to alternate solutions (NAT...)

Effort to delay exhaustion point: update of the allocation
process criteria

Scenario before exhaustion date

Trading of IPv4 addresses

space: IT market distortion and increase of the digital divide

Maintenance of the IPv4

Internet: increase of maintenance costs and make future IPv6 integration harder

Options to extend IPv4 Internet

2010 2011 2015+

Sector: transportation (1/2) - Overview







☑ Market description: diverse, huge and global

- Automotive: 300 million cars in Europe
- Airplanes: passengers & fret
- Fret: Trucks, ships and rail
- Global market with strong lobbies

☑ ICT development:

- Road: Intelligent Transportation System (I.T.S.)
- Air Traffic Management
- Tracking and parcel localization
- E-access everywhere

Sector: transportation (2/2) - SWOT







☑ Strengths

- Car manufactures are electronics-oriented to differ themselves from competitors
- Mobility and large address scope

☑ Weaknesses

- Time response
- Infrastructure cost

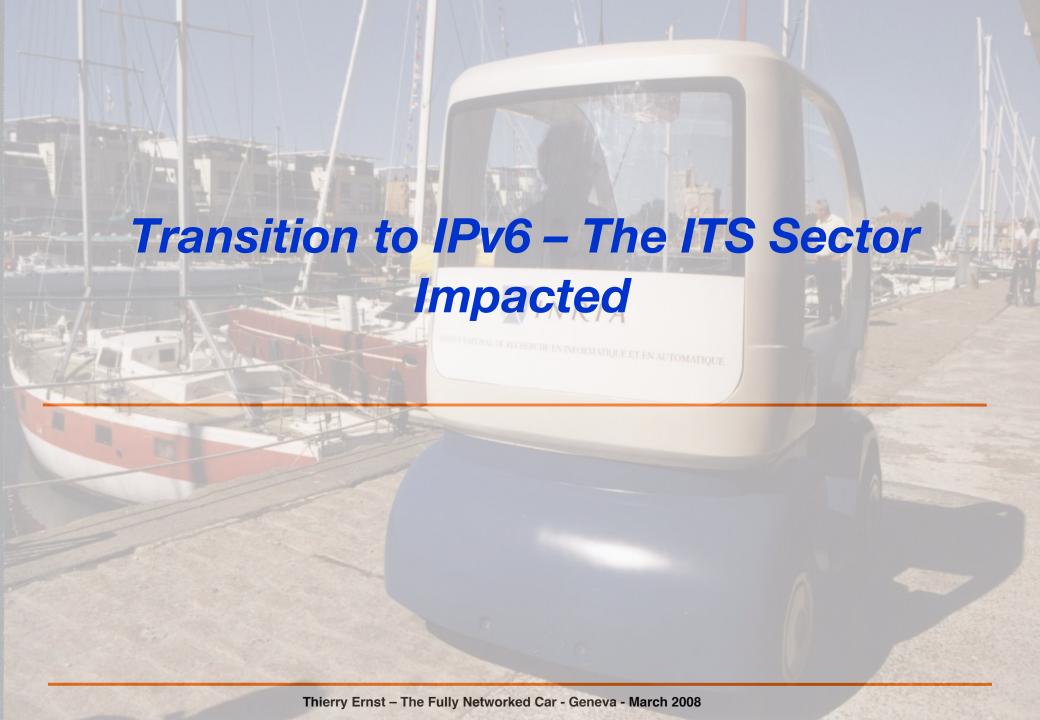
Opportunities

- Telematics enforced by European regulations
- IP convergence and new services

☑ Threats

- Privacy issues
- Multimedia services brings new source of distraction to drivers

→ Large sector but competing proprietary protocols



ITS and IPv6

The ITS world

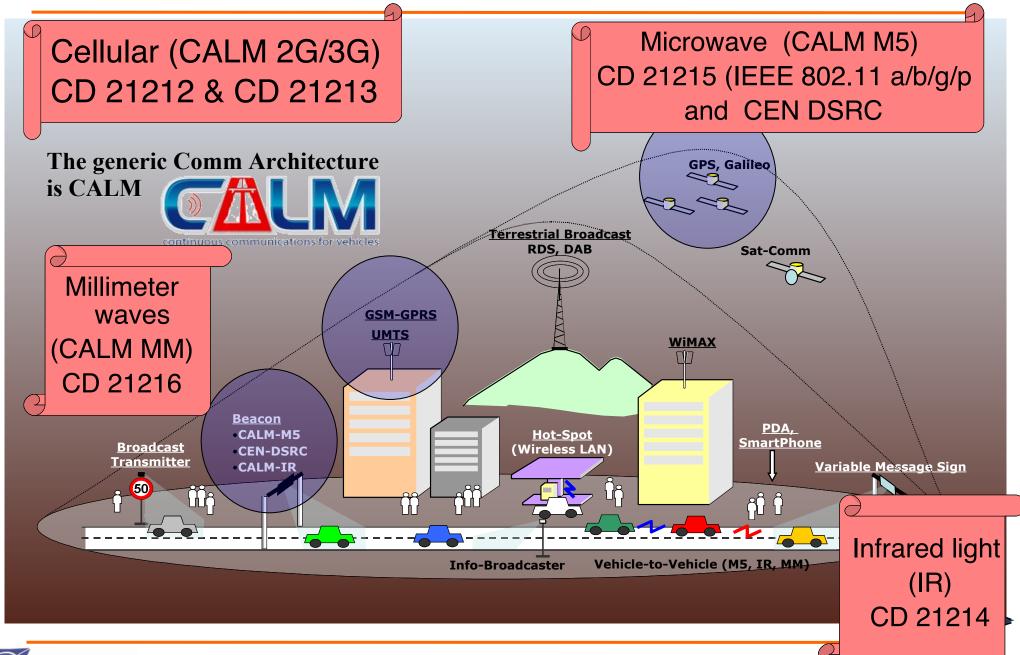
- Well-marketed and organized industry
- Existing businesses very reluctant to new technologies
- Strong inertia to change
- Proprietary communication systems
- Limited IP-based solutions / use cellular networks

The IST world and IPv6

- Only discovering IPv6
- No experience in IPv6 development and operation
- Doesn't know what are the benefits of IPv6 and the limits of Ipv4
- The more informed ones think that the transition from IPv4 to IPv6 is transparent to their business
- IPv6 not an option for wide development of IP-based ITS applications
- Not considering IPv6 from the early design will bring costs



ISO TC204 WG16: CALM Communication Media

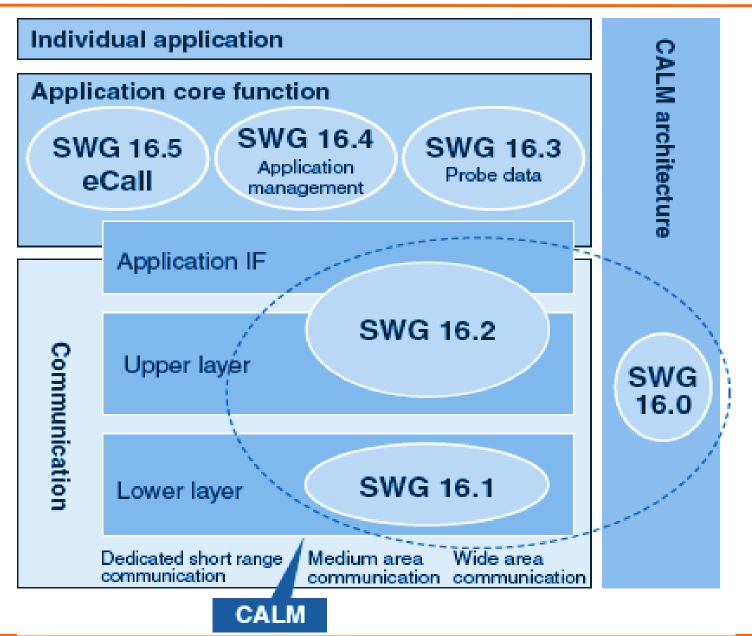


ISO TC204 WG16: CALM

- ISO Technical Committee 204: Currently 12 active WGs
 - http://www.iso.org/iso/iso_technical_committee.html?commid=54706
- WG 16: Wide Area Communications
 - Since Y 2000 / Led by Russell Shields (Ygomi)
 - CALM: Communication Architecture for Land Mobile
 - Renamed from Communications Air-interface, Long and Medium range
 - Docs:
 - Web: http://www.calm.hu
 - CALM Handbook
 - 7 sub-WGs
 - SWG 16.0: CALM Architecture
 - SWG 16.1: CALM Media
 - SWG 16.2: CALM Network
 - SWG 16.3: Probe Data
 - SWG 16.4: Application Management
 - SWG 16.5: Emergency notifications (eCall)
 - SWG 16.6: CALM ad-hoc subsystem



ISO TC204 WG16: 7 Sub Working Groups

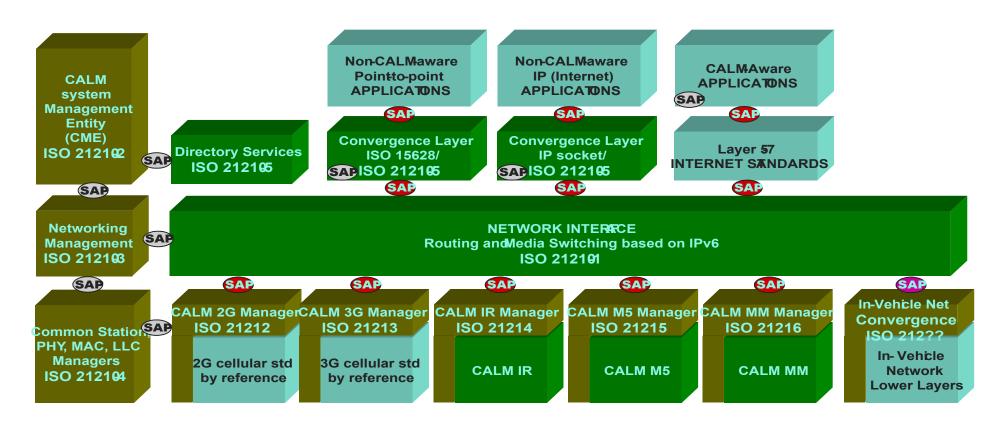




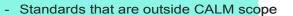


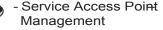
ISO TC204 WG16: CALM Architecture

CALM ARCHITECTURE



Media Functioblocks shown above may be part of a more comprehensive communications device SAP











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





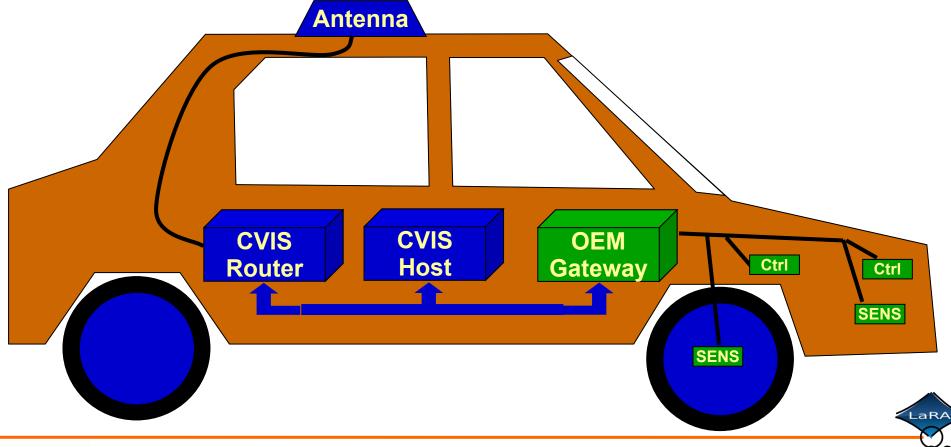
CVIS: FP6 Integrated Project (IP)

- Communication Sub-Project (SP 2.1 COMM): Vehicle-Infrastructure communications
 - ± 23 partners
 - Approx 23% of CVIS overall budget
 - Specify & Implement communication architecture
 - Liaison with other EU-funded projects / ISO / IETF / C2C-CC
- Communication architecture inspired from ISO TC 204 WG16 'CALM' architecture
 - CALM is adapted and simplified (and also complemented)



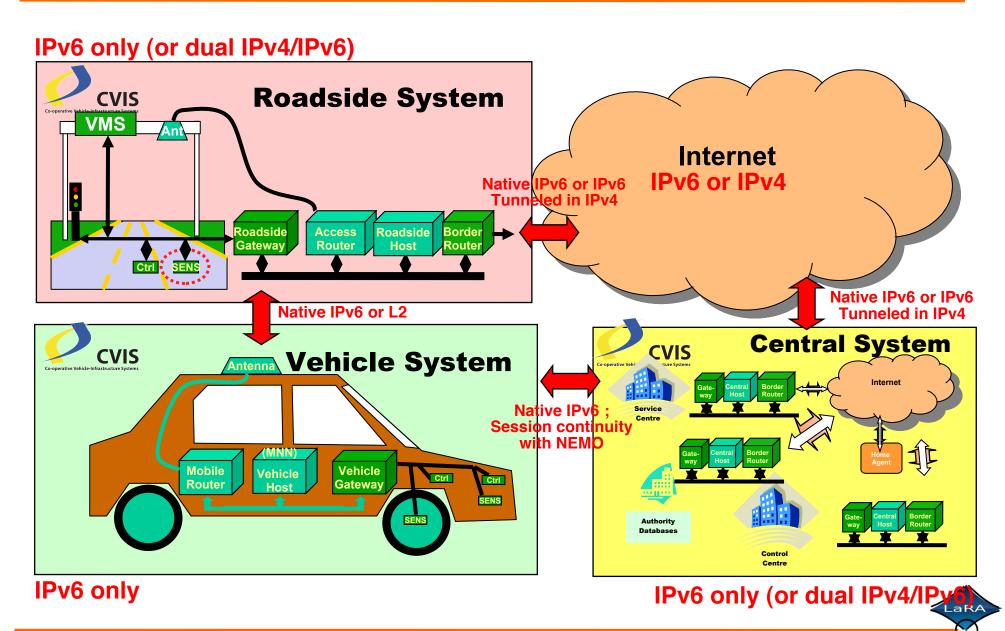
CVIS: Vehicle Configuration

- 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





CVIS: IPv6 Communications between subsystems



ITS and IPv6: Challenges

- Technical issues
 - What IPv6 addressing scheme fits ITS ?
- Operational issues
 - Who is going to provide the IPv6 address space ? (central entity, government, operator, car manufacturer ?)
 - IPv6 training
 - Compatibility with legacy systems
- Legal issues
 - Privacy: where is the boundary between safety, security and human rights?
 - Ownership (IPRs, address space, etc)





Conclusions: IPv6 Facts

- ITS needs communications and most (at first) if not all (at some point in time) will be based on or interface with IPv6
 - IP is a convergence layer
 - IPv6 is the only way forward for ITS deployment
 - IPv6 will boost innovation and save costs
 - ISO's CALM architecture based on IPv6
- When do we need to start to think about IPv6? NOW!
 - IPv6 is currently being deployed (not an utopia) and doesn't required to shut down IPv4
 - Developing IPv6 awareness at all levels is crucial
- Everyone need to understand ignoring IPv6 will bring costs
 - IPv6 may take some time to fully deploy, but it will come (rather sooner than later)
 - The later we transition from IPv4 to IPv6, the harder it will be
 - ◆ IP-based products are just emerging = limited deployment
 - User's acceptability / Training and know-how / Business continuity



References and Links

- "IPv6 for ITS" portal
 - web page recently set up content under progress
 - http://lara.inria.fr/ipv6/
- IPv6: Impact study
 - Conf: http://www.ispa.be/default.aspx?pid=105&sitelang=english
 - Study: http://www.zaltana.fr/2007/11/29/ipv6-study
- IETF's work on IPv6 issues for the automotive industry
 - Mobility EXTensions for IPv6 (MEXT)
 - Charter: http://www.ietf.org/html.charters/mext-charter.html
- Cooperative Vehicle-Infrastructure System
 - http://www.cvisproject.org
- ISO TC 204 WG 16: CALM Standard: http://www.calm.hu
 - Next ISO TC204 WG 16 meetings
 - → 2008 March 10-14: Jeju, Korea
 - 2008 June 9-13: Paris, France (hosted by AFNOR)
- IPv6 Task Force France (chaired by Thierry Ernst)
 - http://www.g6.asso.fr/tff



A few words about INRIA's IPv6 activities related to ITS

INRIA IMARA project-team / JRU LARA http://www.lara.prd.fr

LARA: From automatic driving to IP communications

Originally, the project is working on self-driving cars



- Now, we bring in advanced communication systems
 - Telecommunication becoming crucial for ITS applications
 - Many access technologies: 3G, GPRS, DSRC, Wi-FI, M5, WIMAX, MM, ...
 - Applications: Road safety, emergency call, fleet management, infotainment, navigation, automated driving, ...





IMARA: ITS Communications Activities

Now, we are actively pushing ...



... for IPv6

- Pros for IPv6 Migration
 - Unification layer of underlying technologies
 - Number of available global addresses
 - Mobility, Security, Autoconfiguration
 - Peer-to-peer communications





INRIA's vehicles

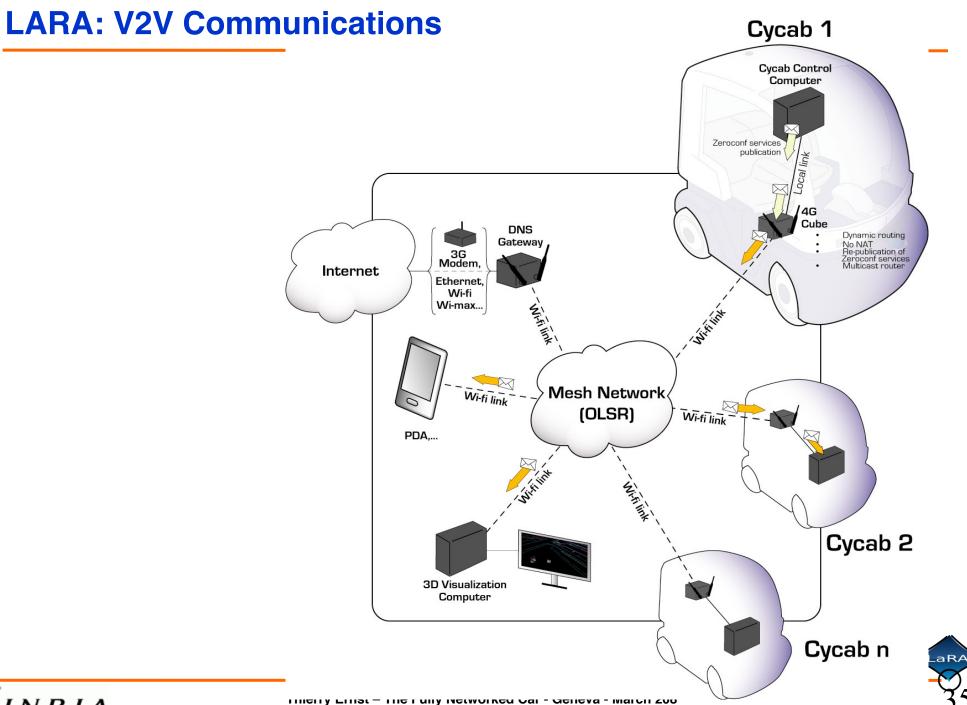


INRIA's vehicles



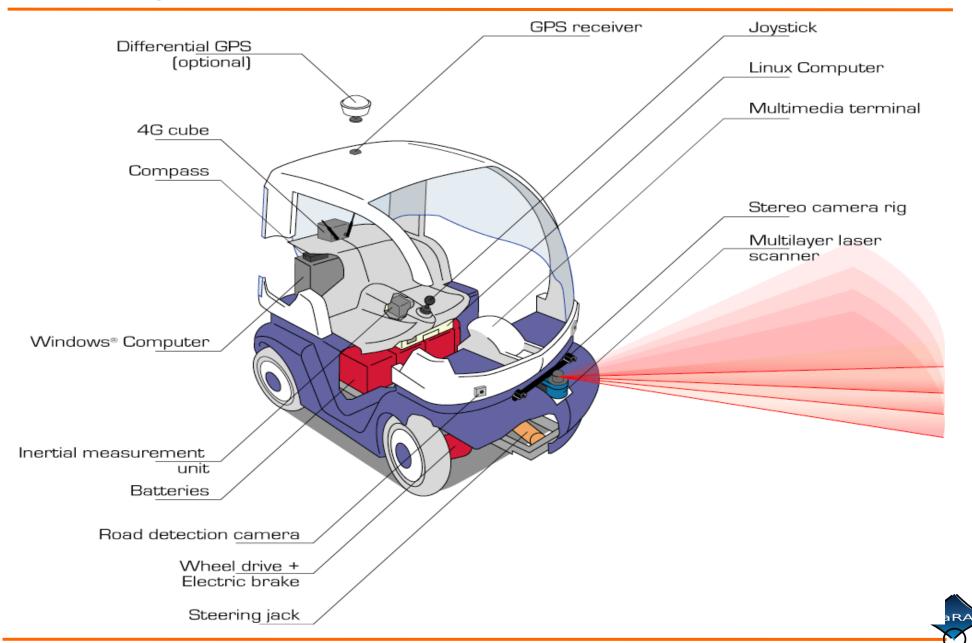
INRIA's vehicles







INRIA's CyCab Architecture







Questions?

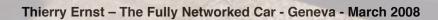
Thierry.Ernst@inria.fr

IETF NEMO WG & MonAmi6 WG Chair

INRIA IMARA project-team / JRU LARA

http://www.lara.prd.fr





MAP OF THE INTERNET THE IPV4 SPACE, 2006



THIS CHART SHOWS THE IP ADDRESS SPACE ON A PLANE USING A FRACTAL MAPPING WHICH PRESERVES GROUPING -- ANY CONSECUTIVE STRING OF IPS WILL TRANSLATE TO A SINGLE COMPACT, CONTIGUOUS REGION ON THE MAP. EACH OF THE 256 NUMBERED BLOCKS REPRESENTS ONE /8 SUBNET (CONTAINING ALL IPS THAT START WITH THAT NUMBER). THE UPPER LEFT SECTION SHOWS THE BLOCKS SOLD DIRECTLY TO CORPORATIONS AND GOVERNMENTS IN THE 1990'S BEFORE THE RIRS TOOK OVER ALLOCATION.

from http://xkcd.com/195/





