

ISO TC204 WG 16: The CALM Architecture

CALM
continuous communications for vehicles

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IMARA project-team / JRU LARA

INRIA ROCQUENCOURT

http://www.lara.prd.fr

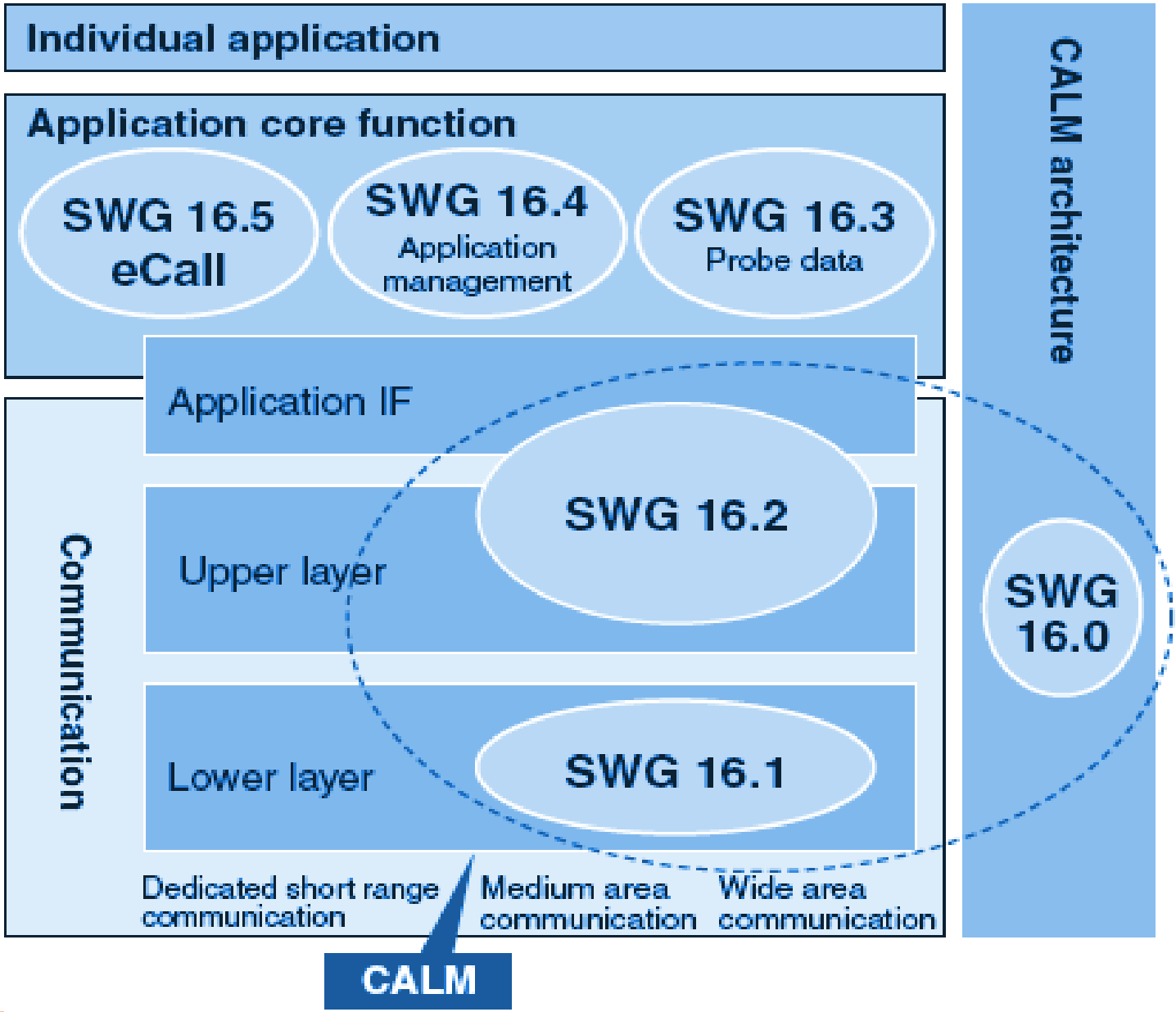
LaRA

ISO TC204 WG16: CALM

- ISO Technical Committee 204: Currently 12 active WGs
  - http://www.sae.org/technicalcommittees/tc204wg16.htm

- WG 16: Wide Area Communications
  - Since Y 2000 / Led by Russell Shields (Ygomi)
  - **CALM**: **C**ommunication **A**rchitecture for **L**and **M**obile
    - **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 Communication Media

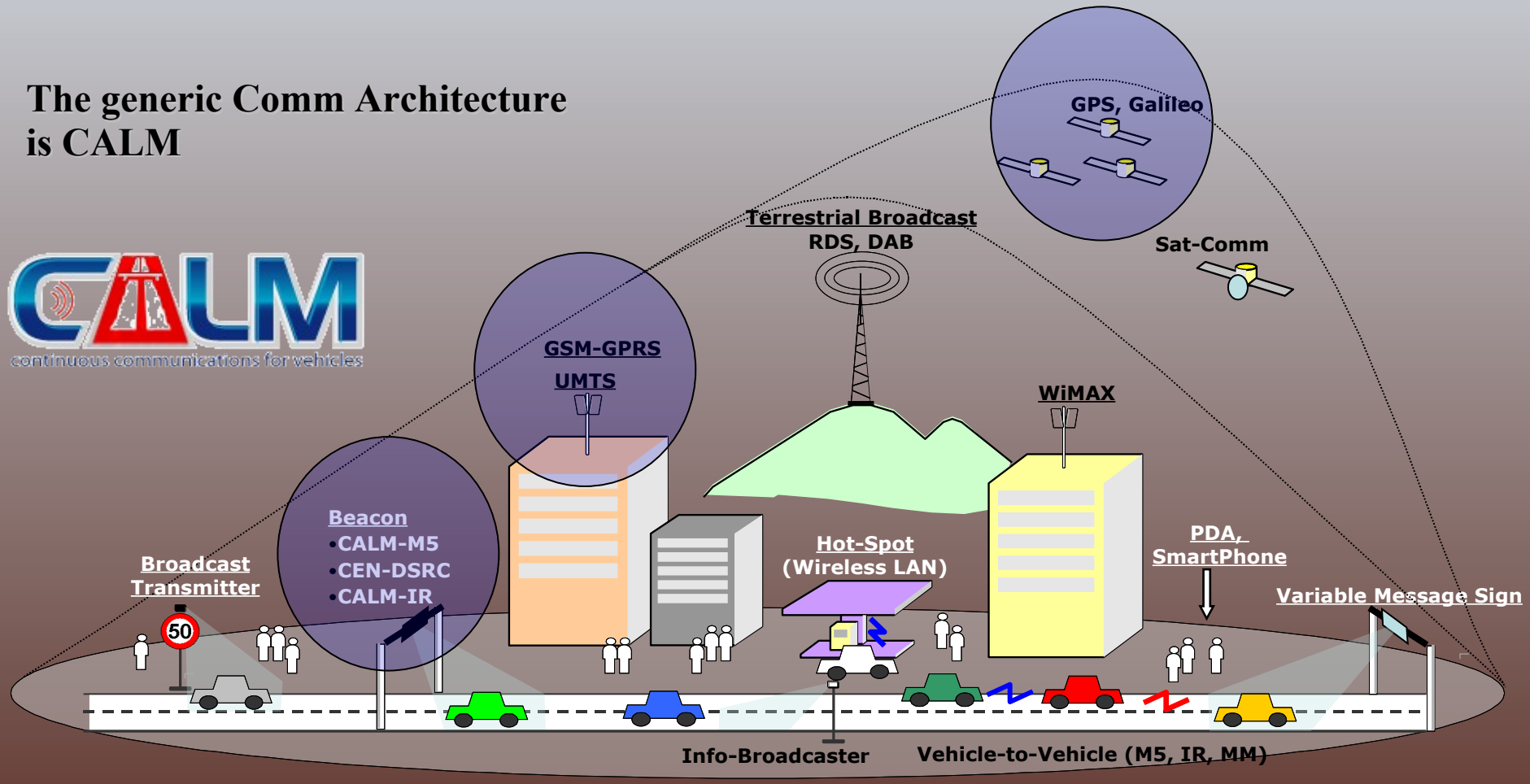
- Communication architecture allowing V2V, V2I and continuous Internet access through multiple radio technologies (potentially used simultaneously)

- Media:
  - Cellular (CALM 2G/3G) – cf CD 21212 & CD 21213
  - Infrared light (IR) – cf CD 21214
  - Microwave (CALM M5) – cf CD 21215
    - **IEEE 802.11 a/b/g (WIFI)**
    - **IEEE 802.11p (mobile WIFI)**
  - Millimeter waves (CALM MM) – cf CD 21216
  - Microwaves CEN DSRC

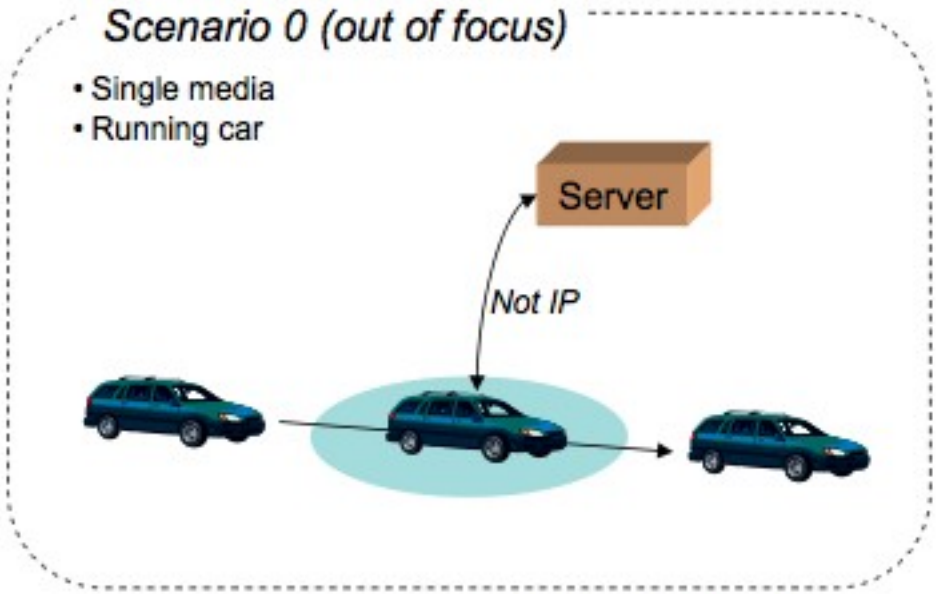
- IPv6:
  - Internet connectivity
  - Unification layer of underlying technologies
  - Standardized at the IETF to replace IPv4 (current version)
  - 2^{128} available global addresses (instead of 2^{32})

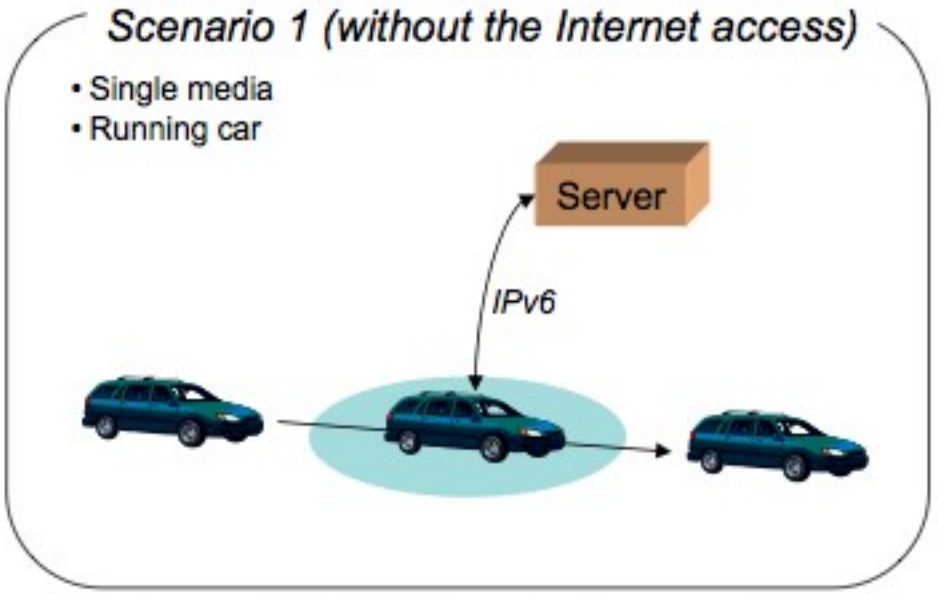
ISO TC204 WG16: CALM Communication Media

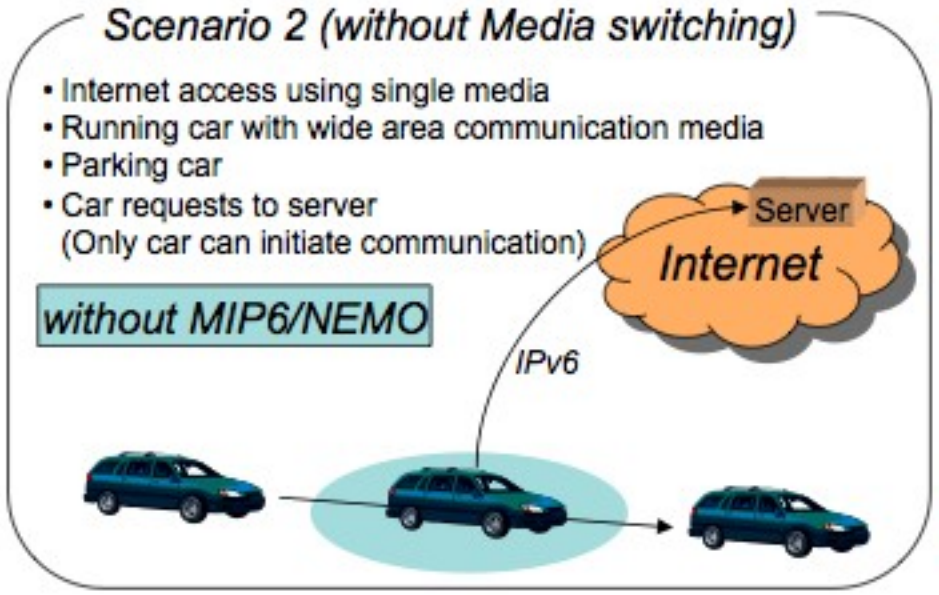
The generic Comm Architecture is CALM

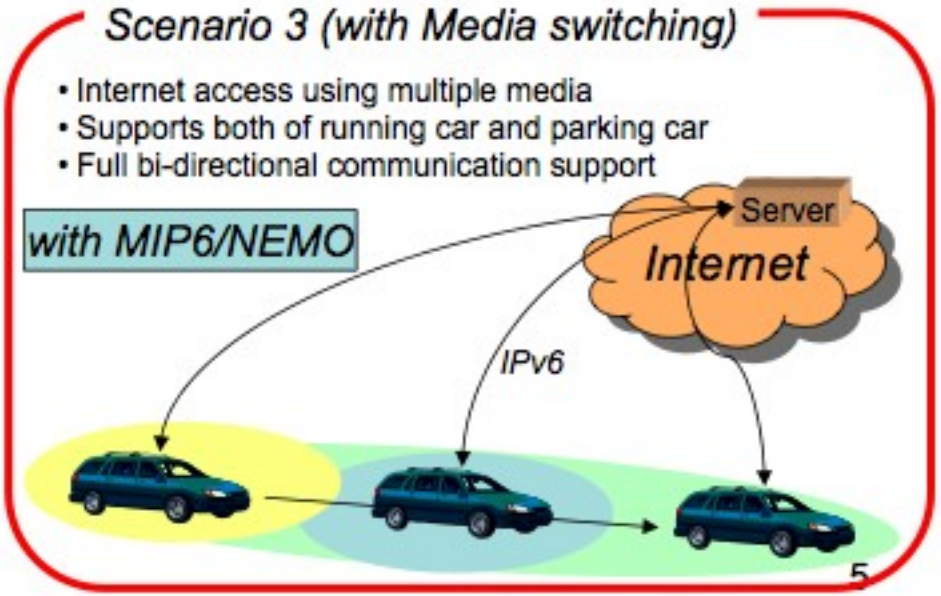


ISO TC204 WG16: Communication Scenarios

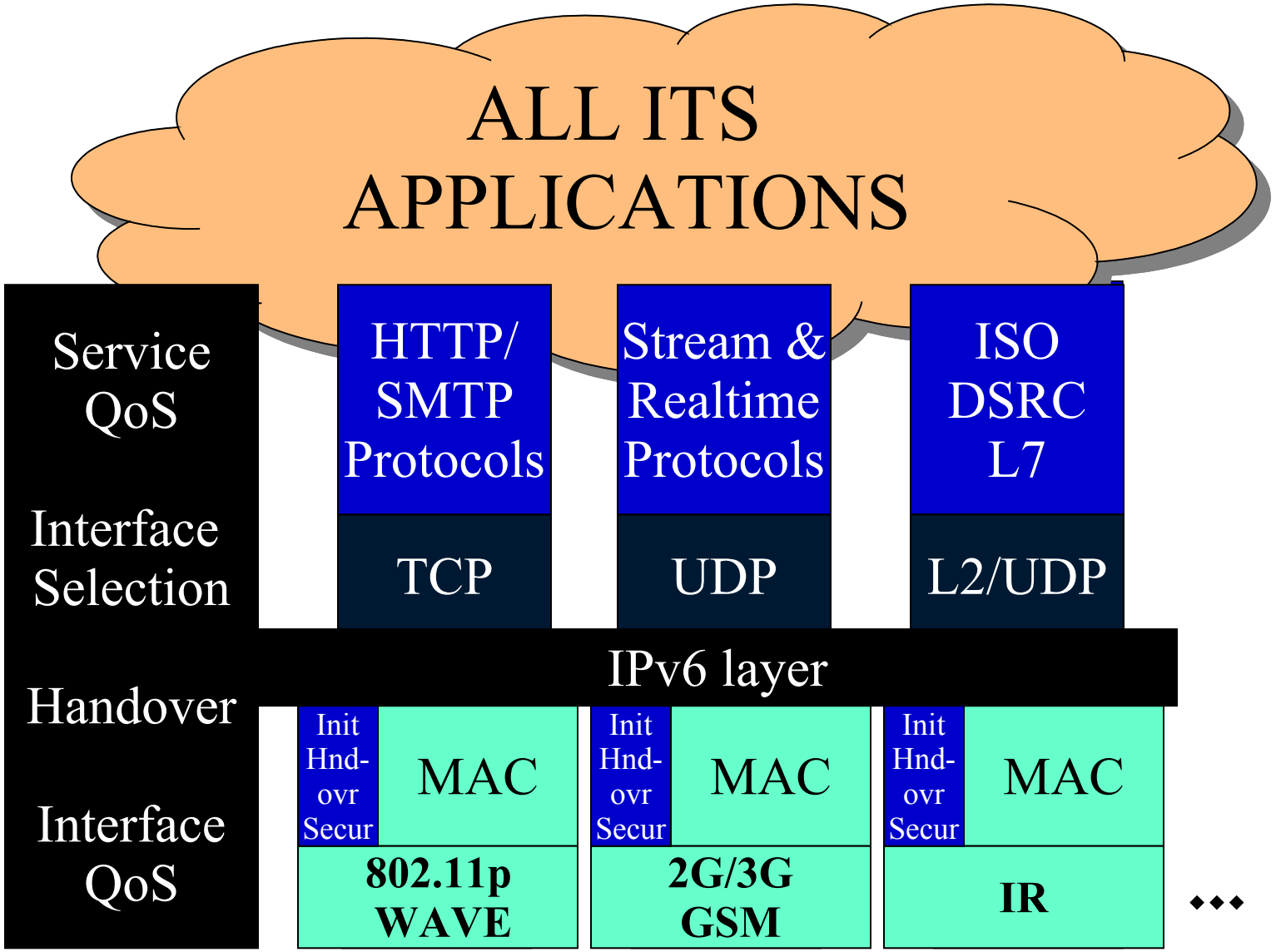




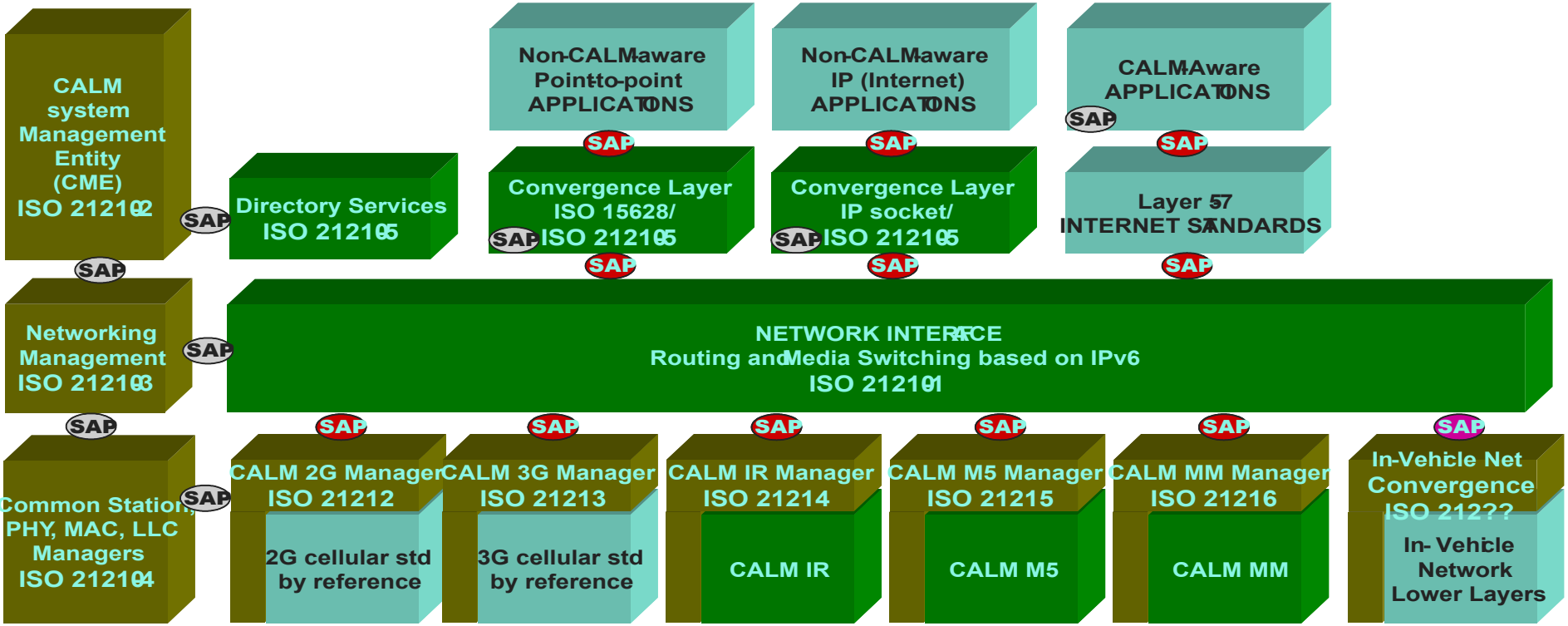




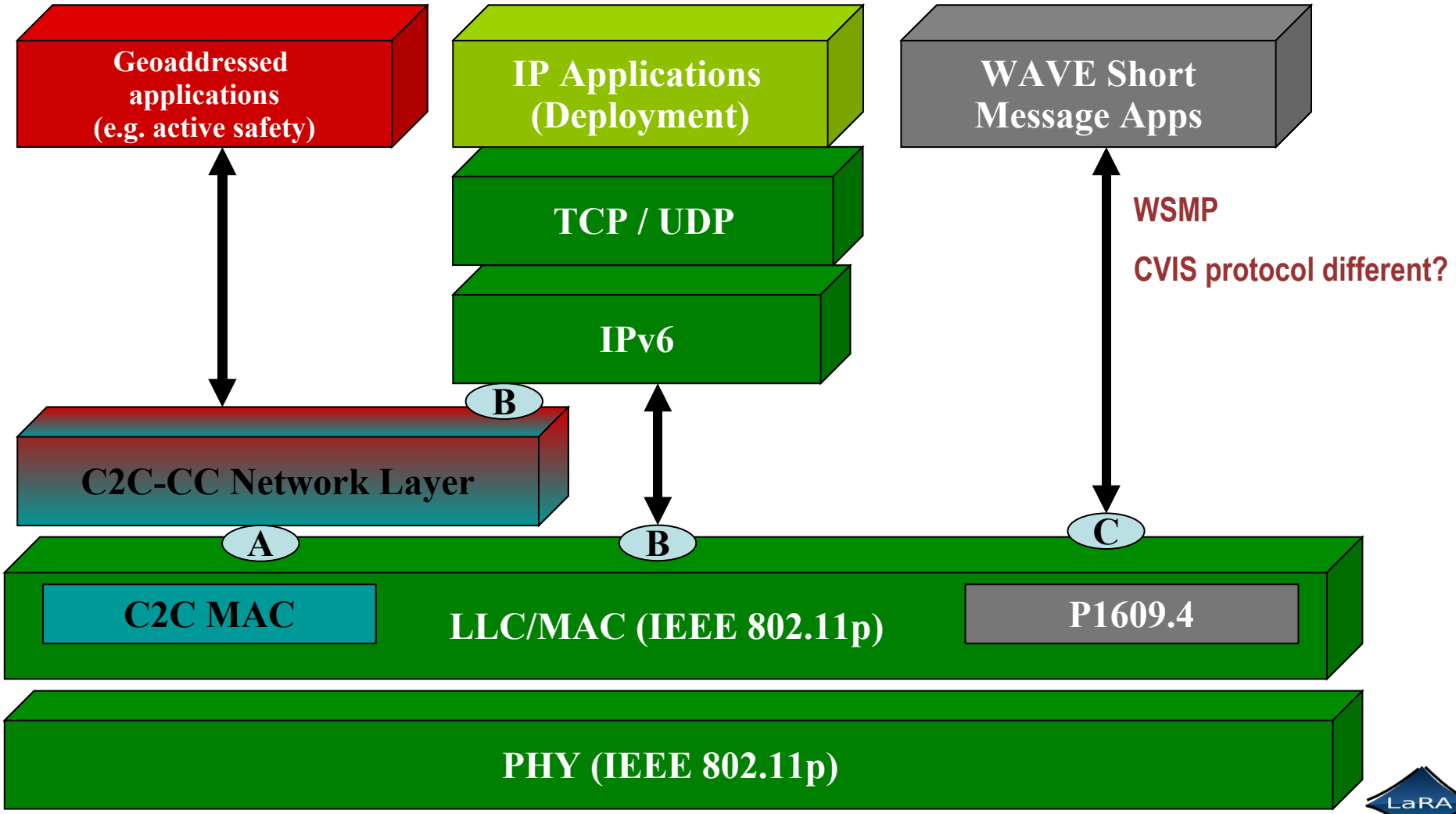
ISO TC204 WG16: CALM Architecture



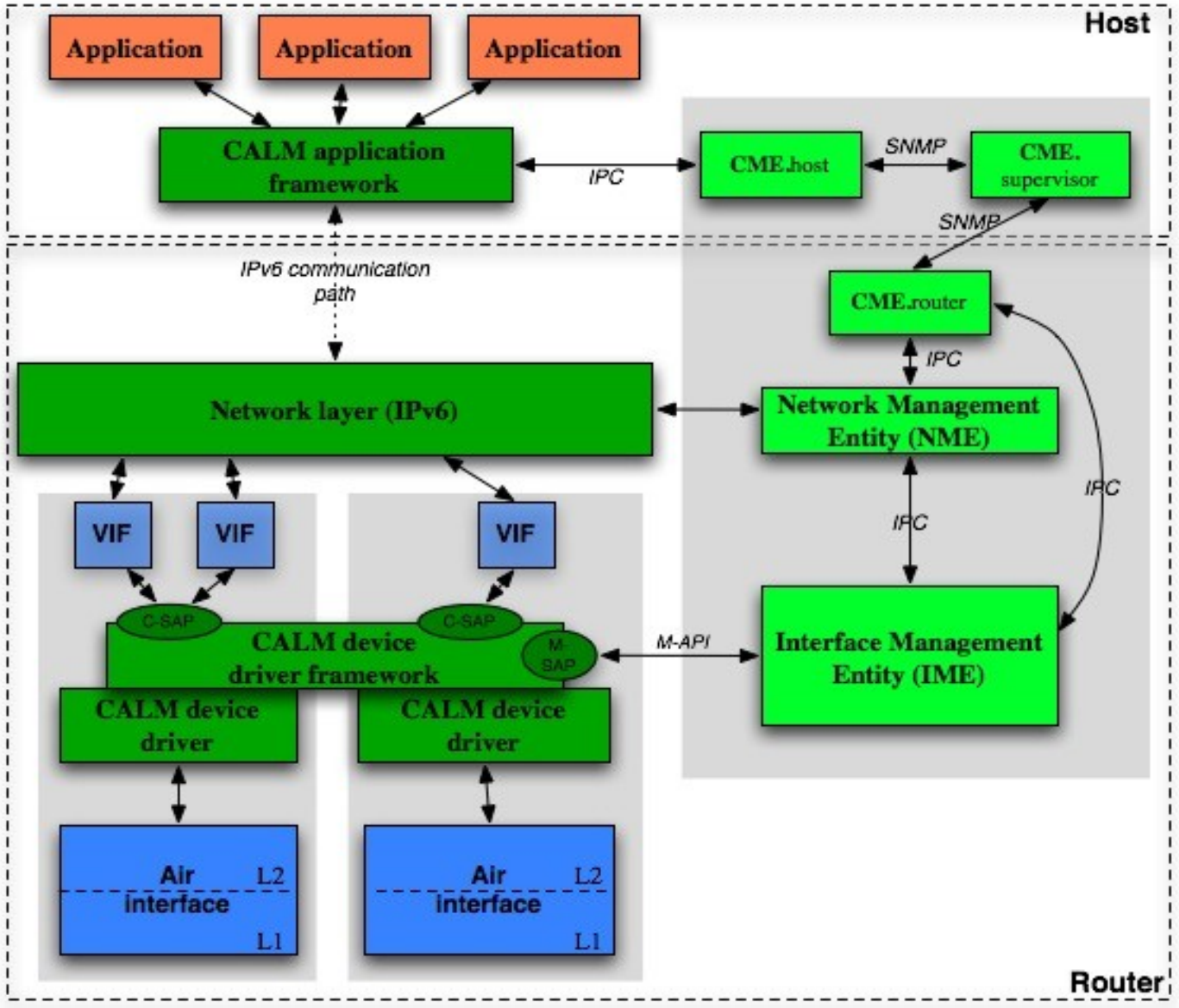
CALM ARCHITECTURE



CALM M5: C2C-CC & WAVE

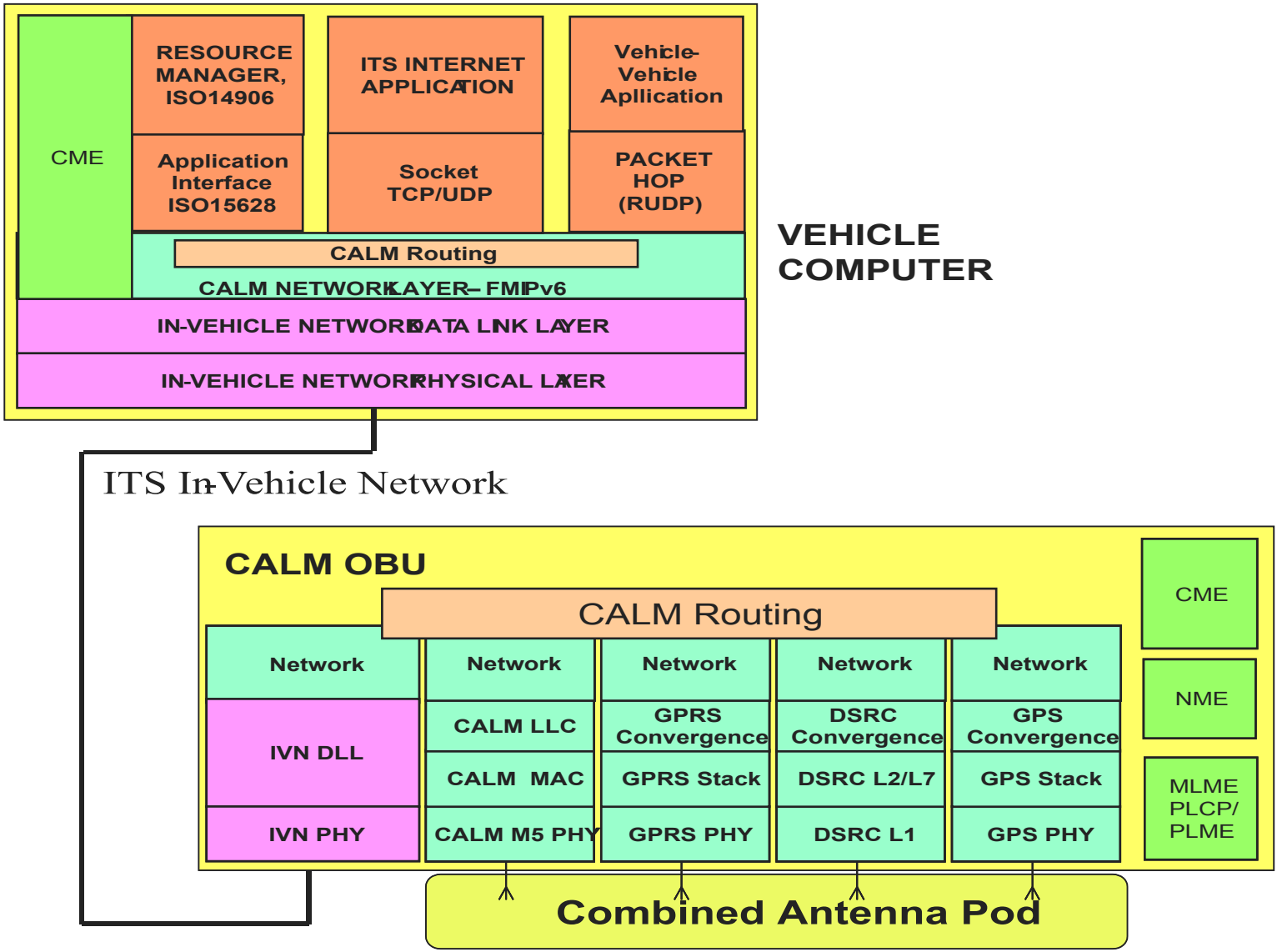


ISO TC204 WG16: CALM Stack



ISO TC204 WG16: CALM Architecture

Implementation Architecture Example



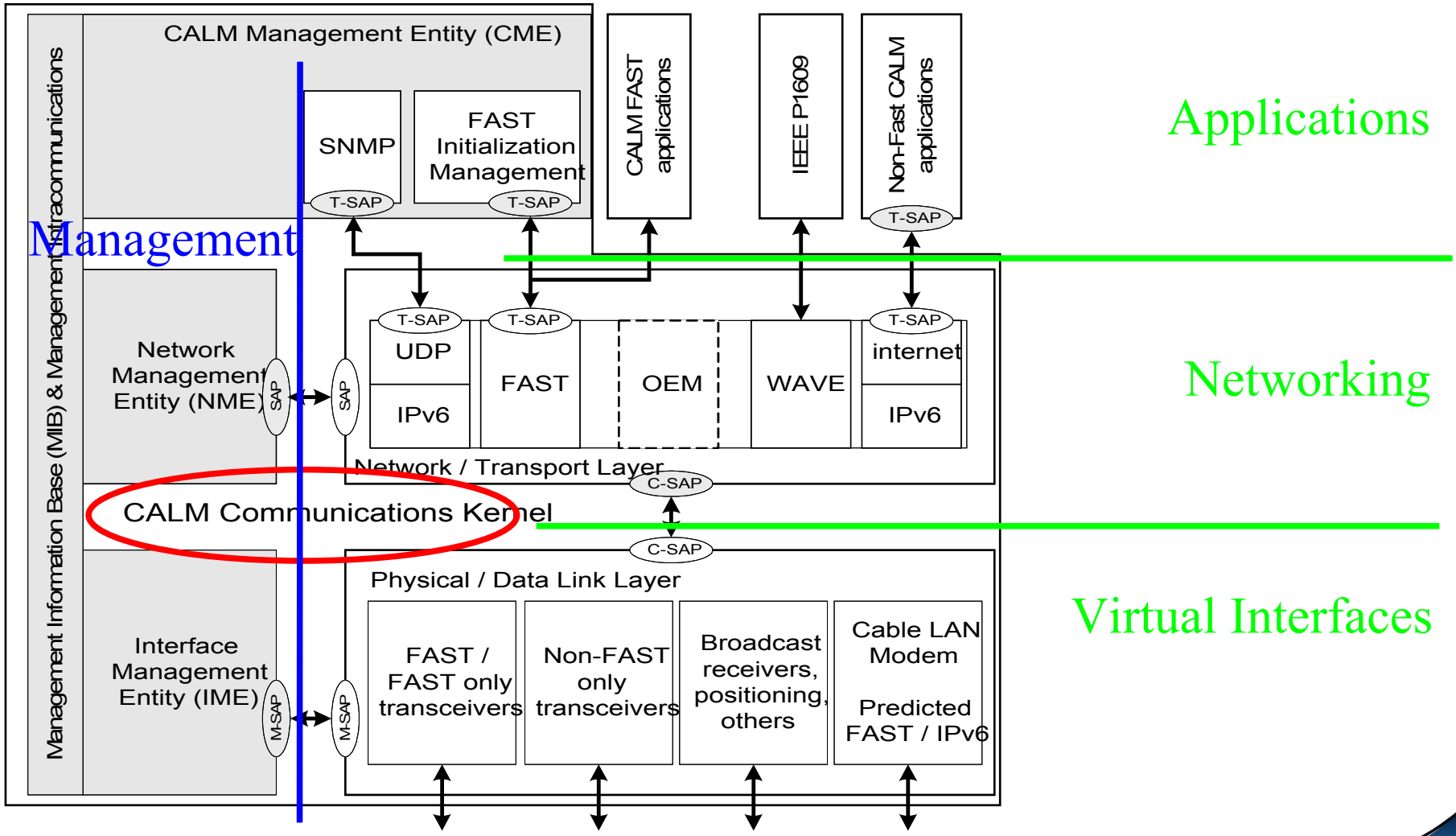
ISO TC204 WG16: CALM Networking

- CALM Networking: ISO 21210
  - 21210-1: Internet Connectivity (Committee Draft)
  - 21210-2: Fast Application (draft)

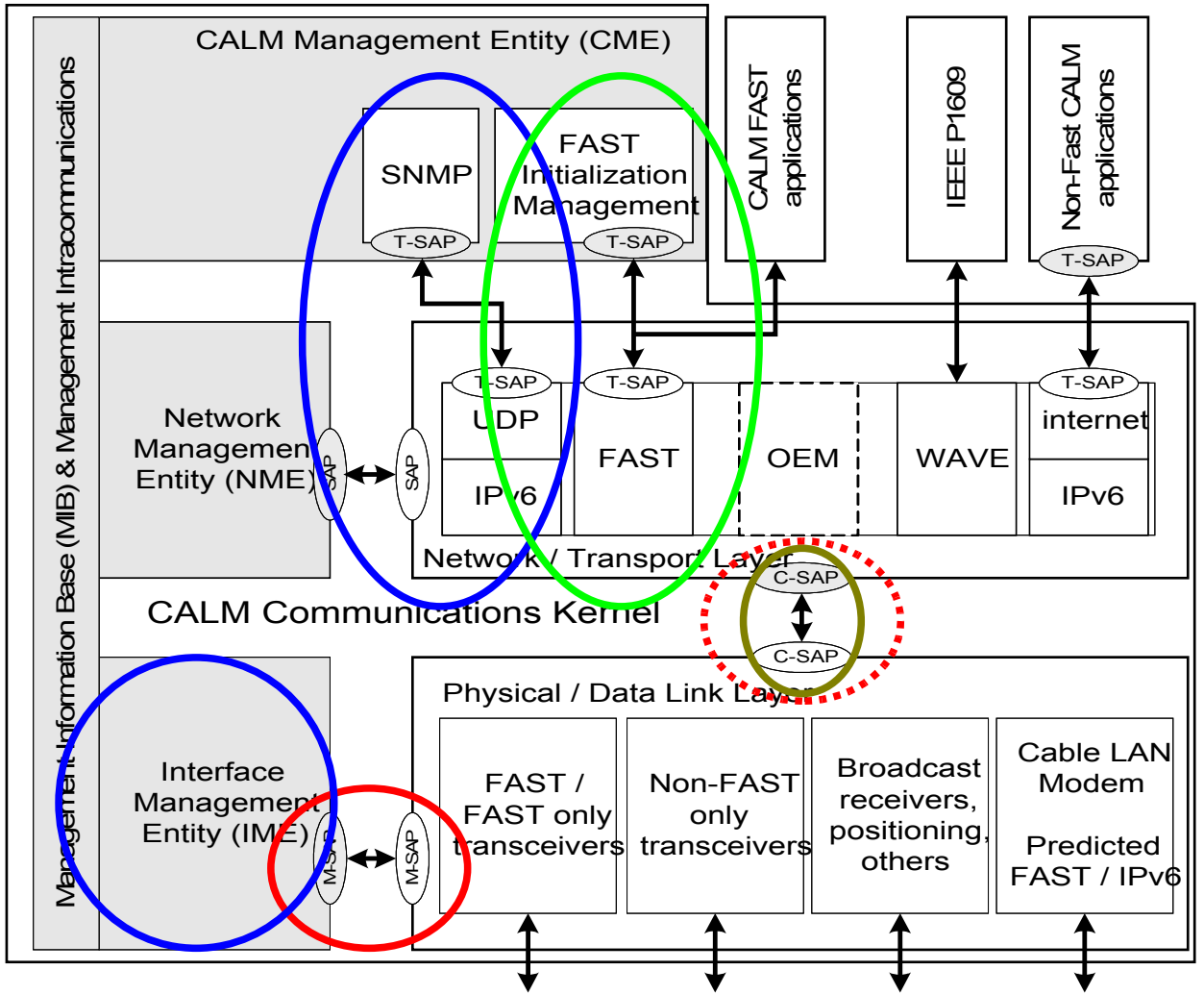
  - Medium Selection & Switching
    - **Horizontal handover: between access points using the same media**
    - **Vertical handover: heterogeneous handovers**
    - **Purpose: Continuous communication during handoff**
    - **Select the most appropriate media based on application needs**

  - IP & non-IP services
    - **Based on IPv6 and mobility features (NEMO, MIPv6, etc)**
    - **IPv6 not considered for time critical applications (collision avoidance)**

ISO TC204 WG16: CALM Lower Layers Architecture



ISO TC204 WG16: CALM Standards



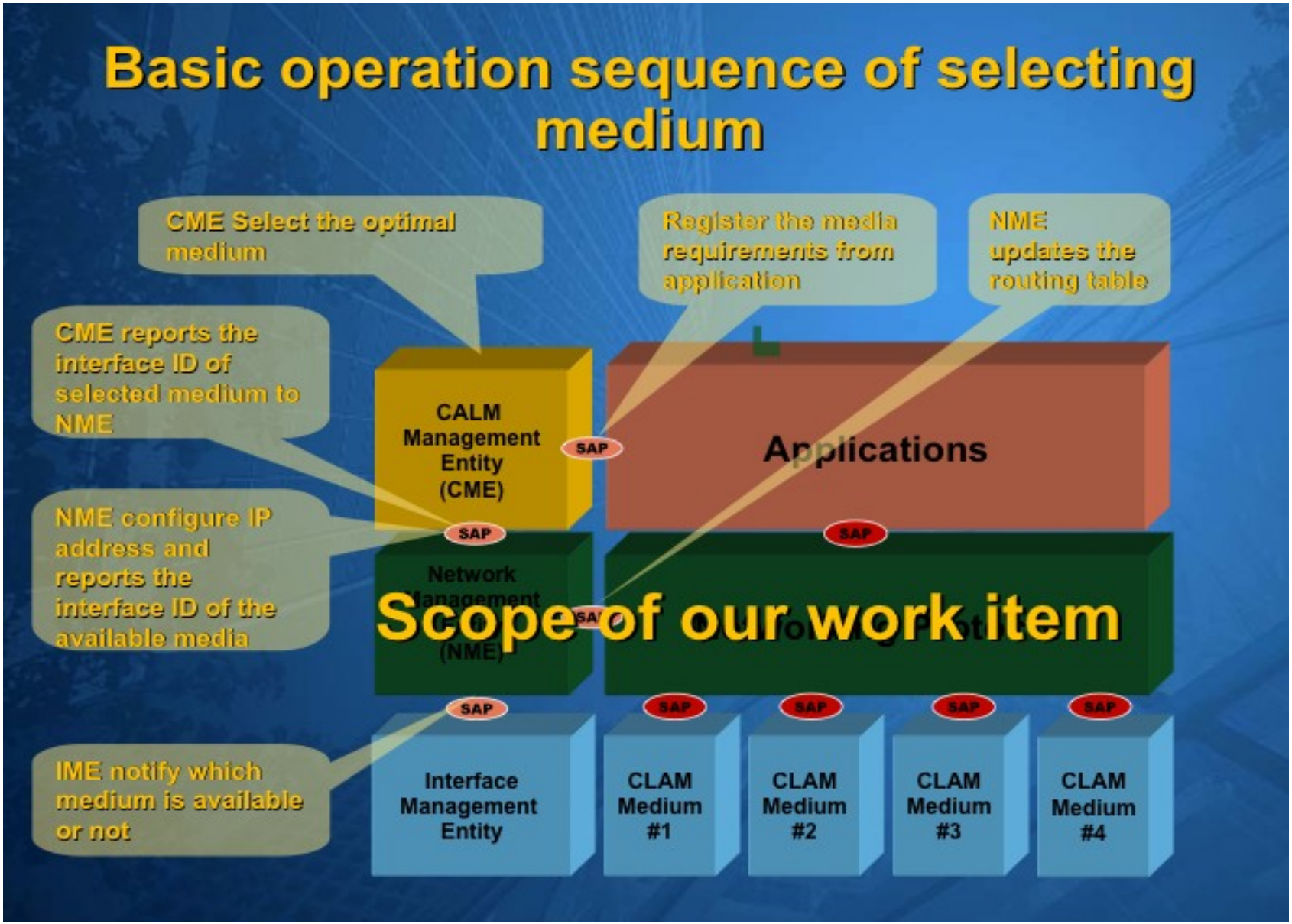
ISO CD 21218

ISO CD 24102

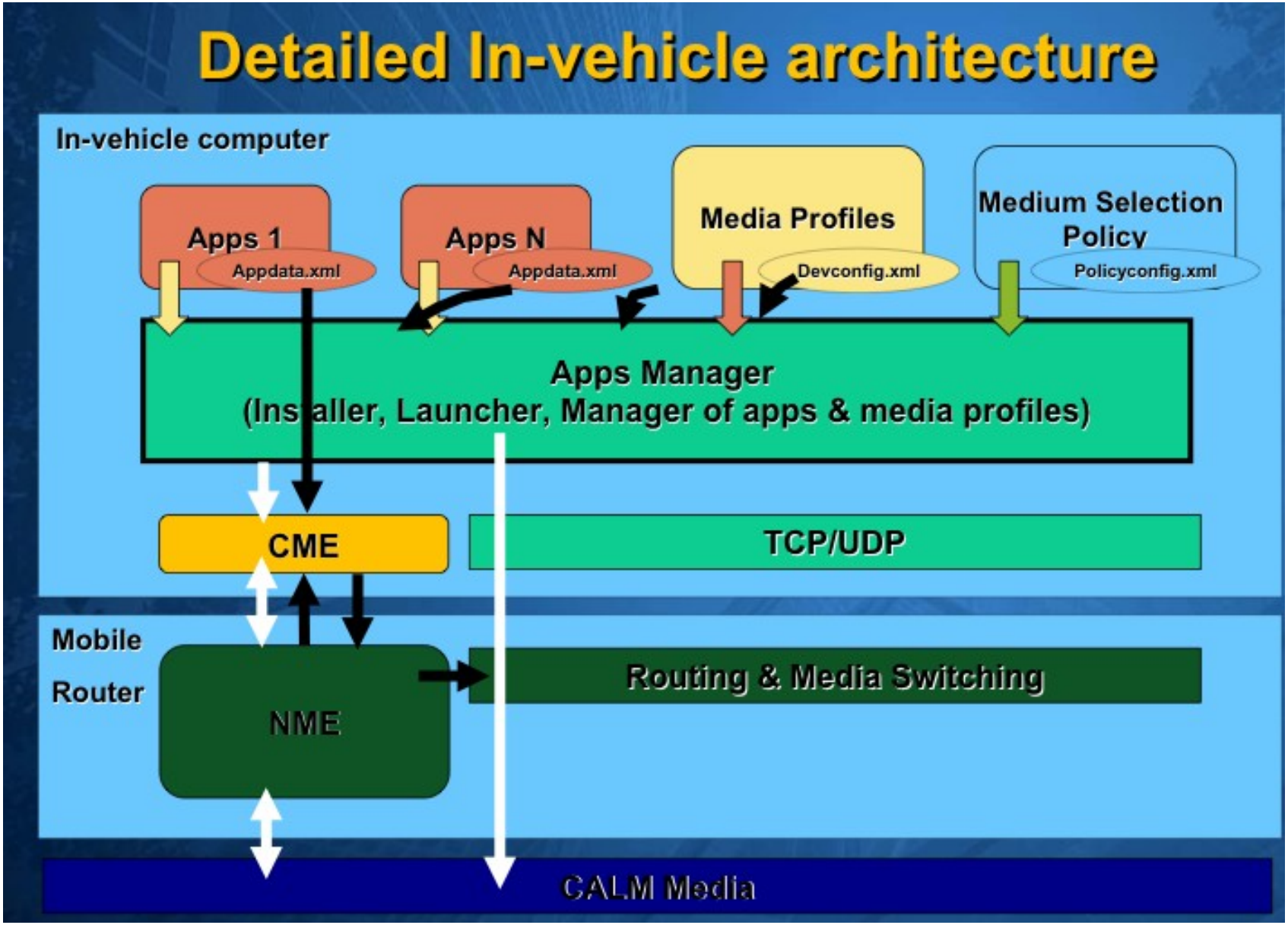
ISO CD 29281

IEEE 802.2

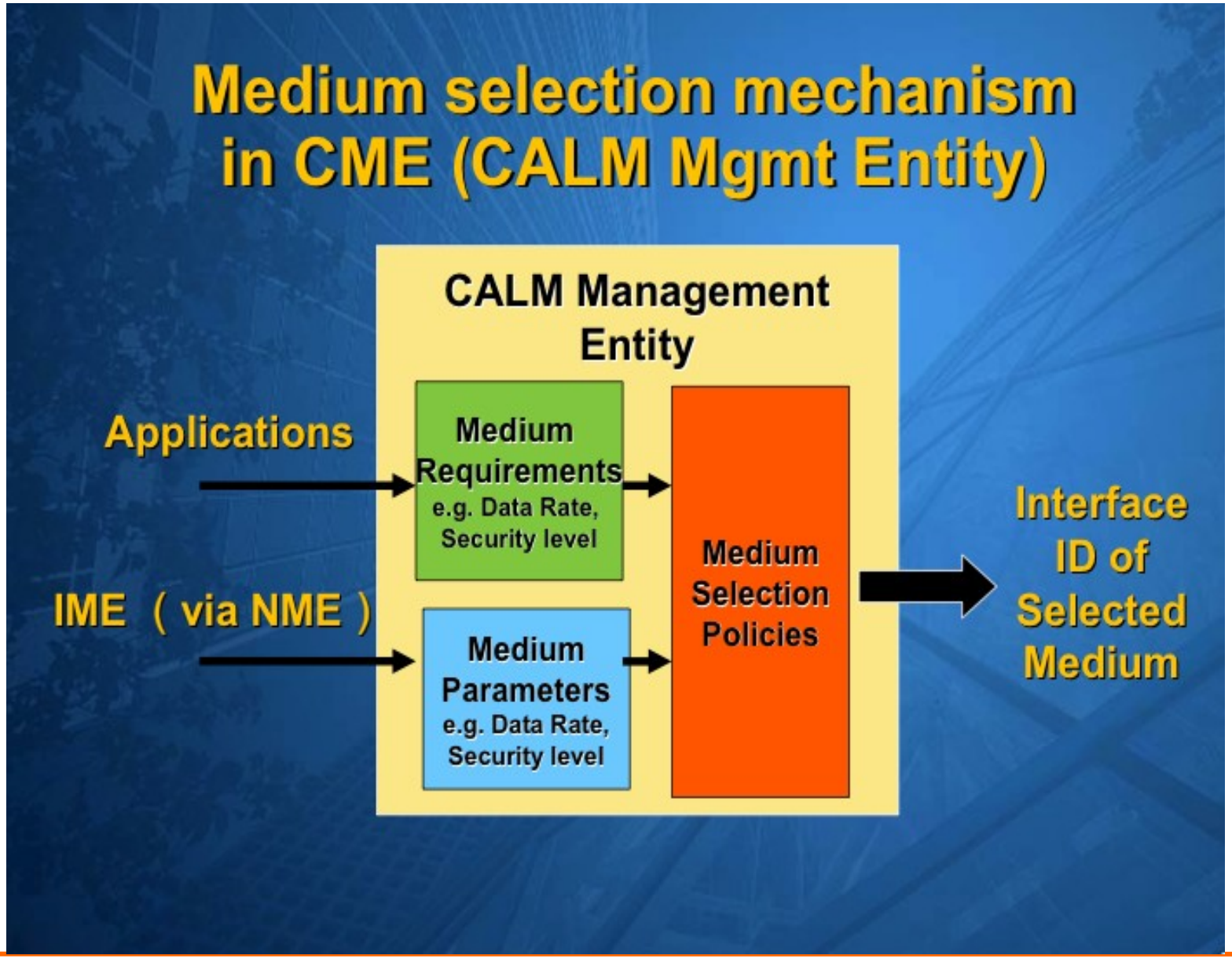
TC204 WG16: CALM Architecture



TC204 WG16: CALM Architecture



TC204 WG16: CALM Architecture





FP6 CVIS European Project
-
A proof of concept of CALM

Thierry Ernst – February 2008

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

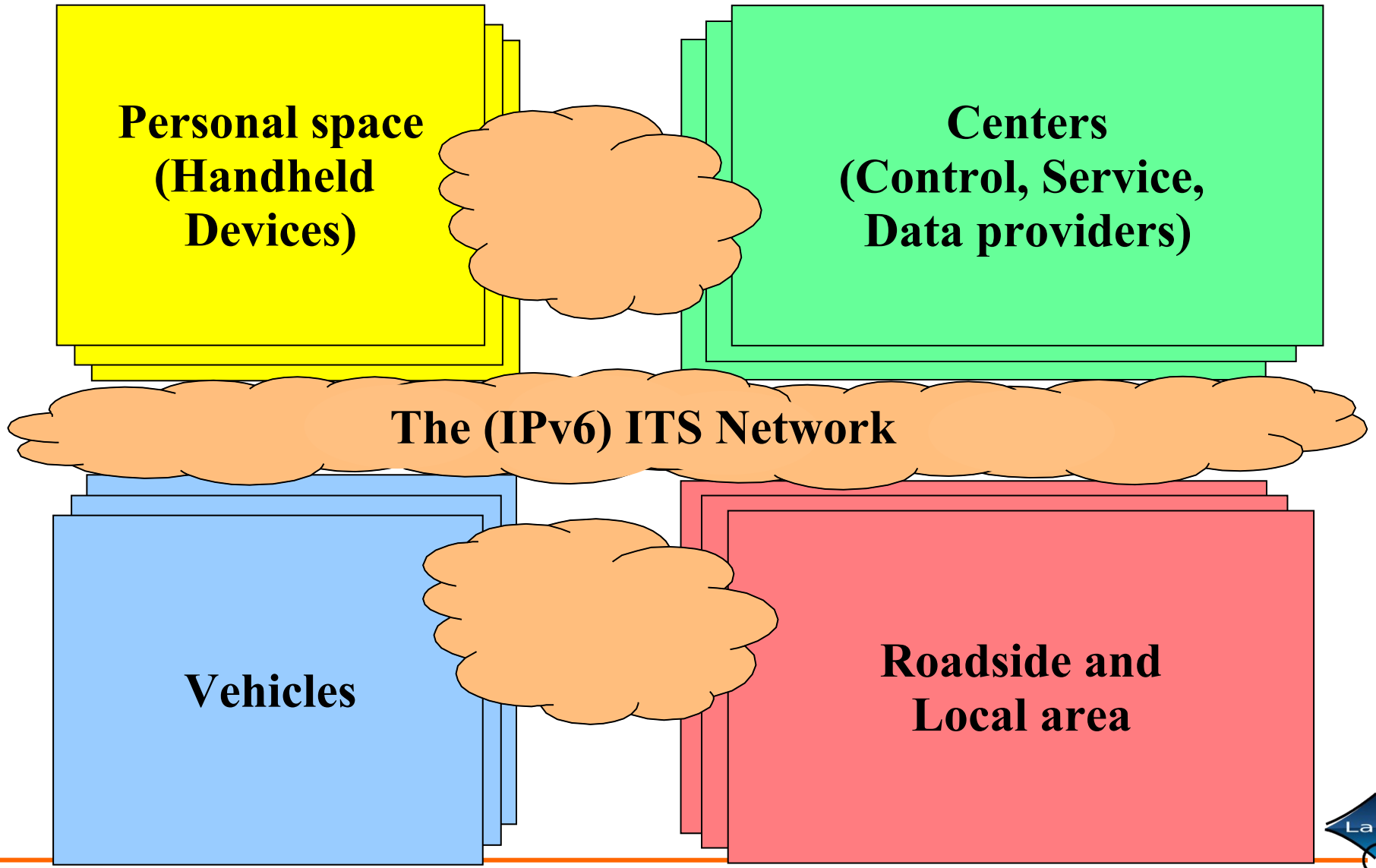
Cooperation links to: **SISTER (EC-Proposal), SEVECOM, COMeSafety**
Car-2-Car Communications Consortium (C2C-CC), Network on Wheels (NoW), INVENT
ACTIV (Germany), CVHS (UK), IVSS (Sweden)

CVIS: FP6 Integrated Project (IP)

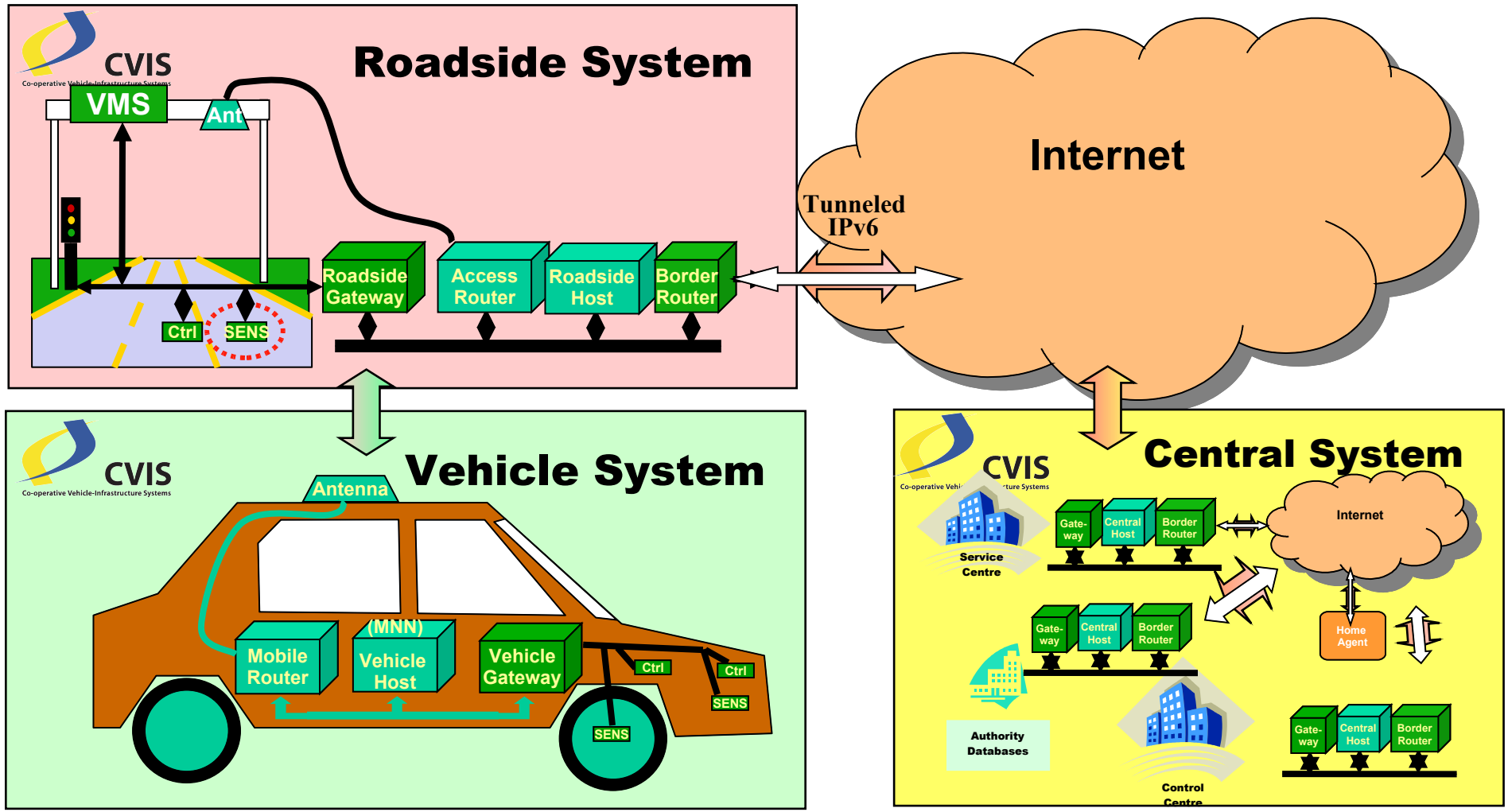
- Cooperative Vehicle-Infrastructure System
  - http://www.cvisproject.org
  - From Feb. 2006 till Feb. 2010
  - 61 partners / 12 countries / Total Budget: 41 Millions Euros

- 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

European ITS Architecture



CVIS: IPv6 Communications between subsystems



CVIS: FP6 Integrated Project (IP)

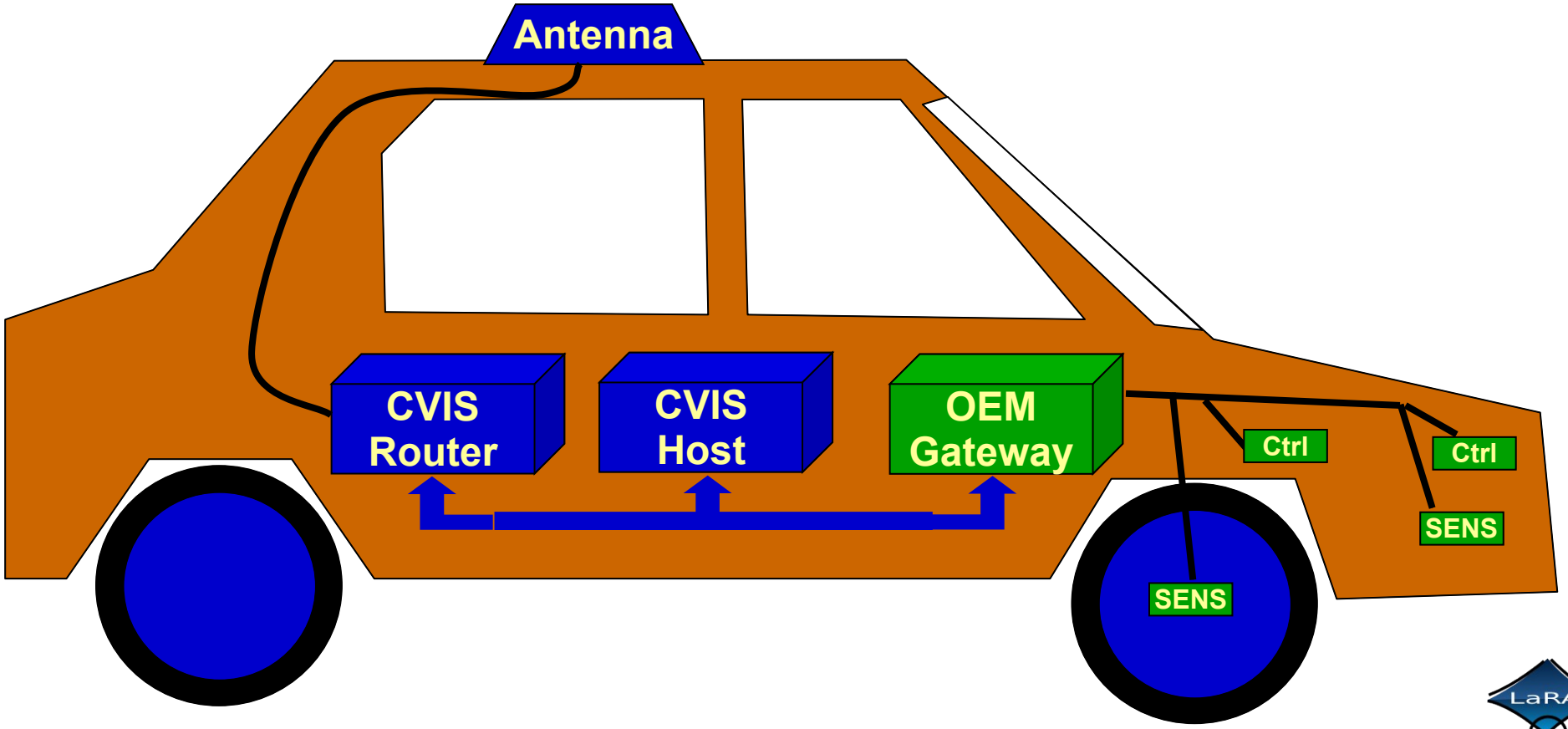
- Communication Sub-Project (SP 2.1 COMM): Vehicle-Infrastructure communications
  - ± 23 partners
  - Approx 23% of CVIS overall budget
  - Specify & Implement communication architecture
  - Liaison with other EU-funded projects / ISO / IETF / C2C-CC

- Communication architecture inspired from ISO TC 204 WG16 'CALM' architecture
  - CALM is adapted and simplified

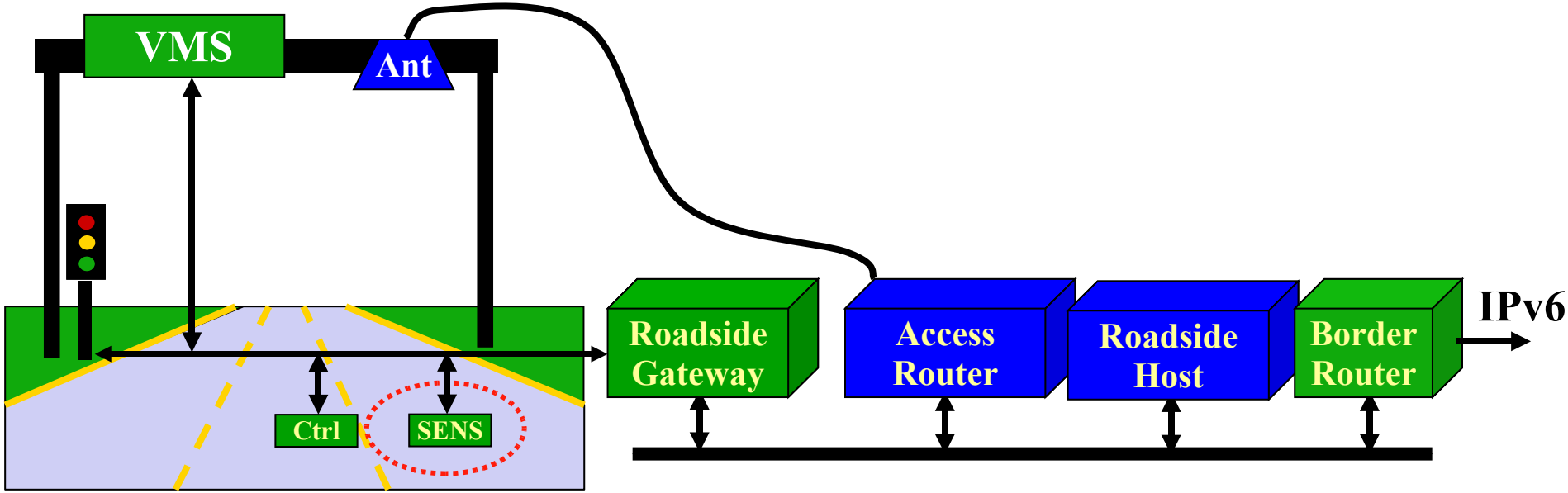
- CALM: Communications Architecture for Land Mobile
  - CALM Handbook: http://www.calm.hu

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: Roadside Configuration



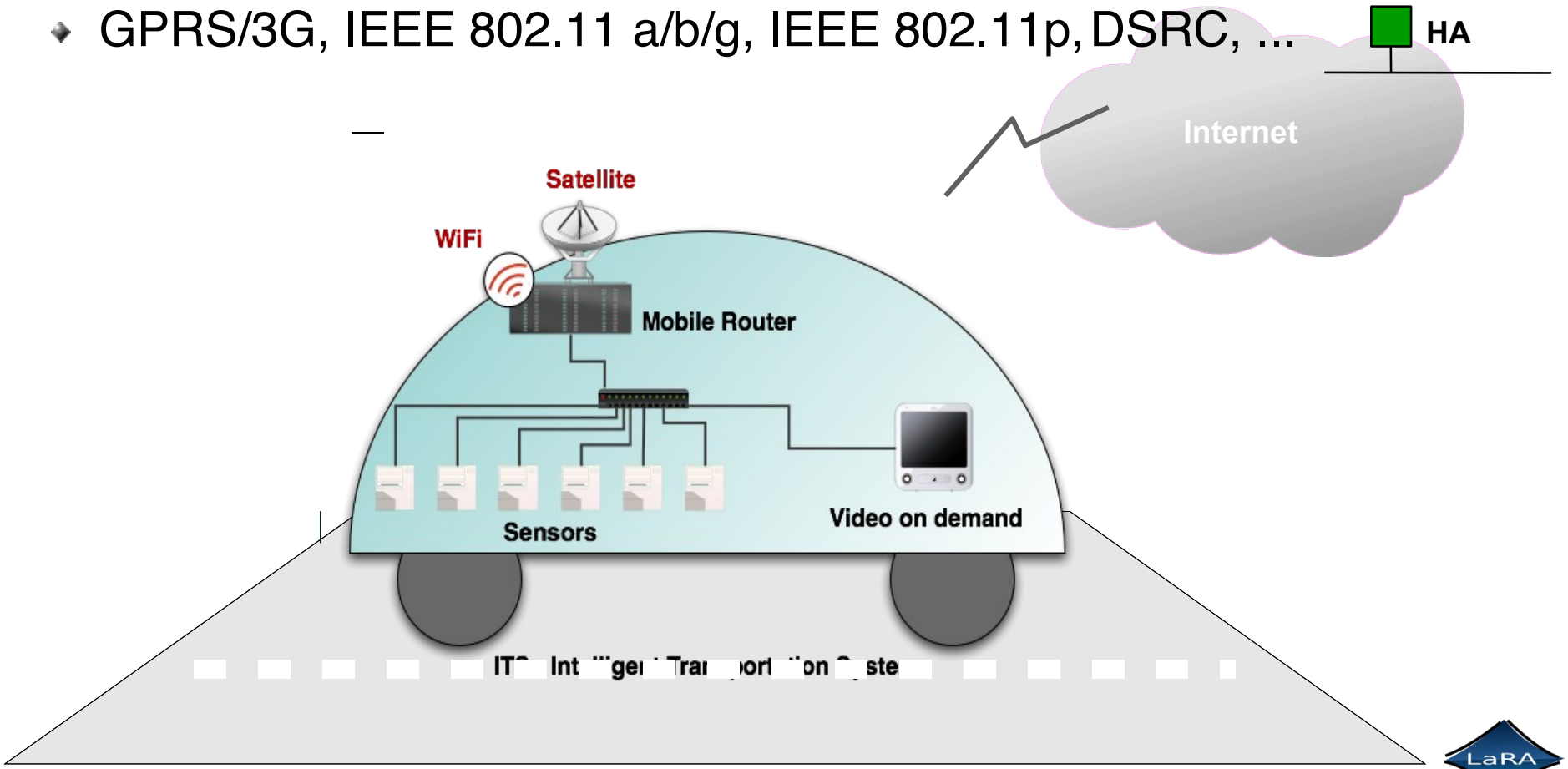


CALM: NEMO RO and Multihoming needs for deployment

Thierry Ernst – February 2008

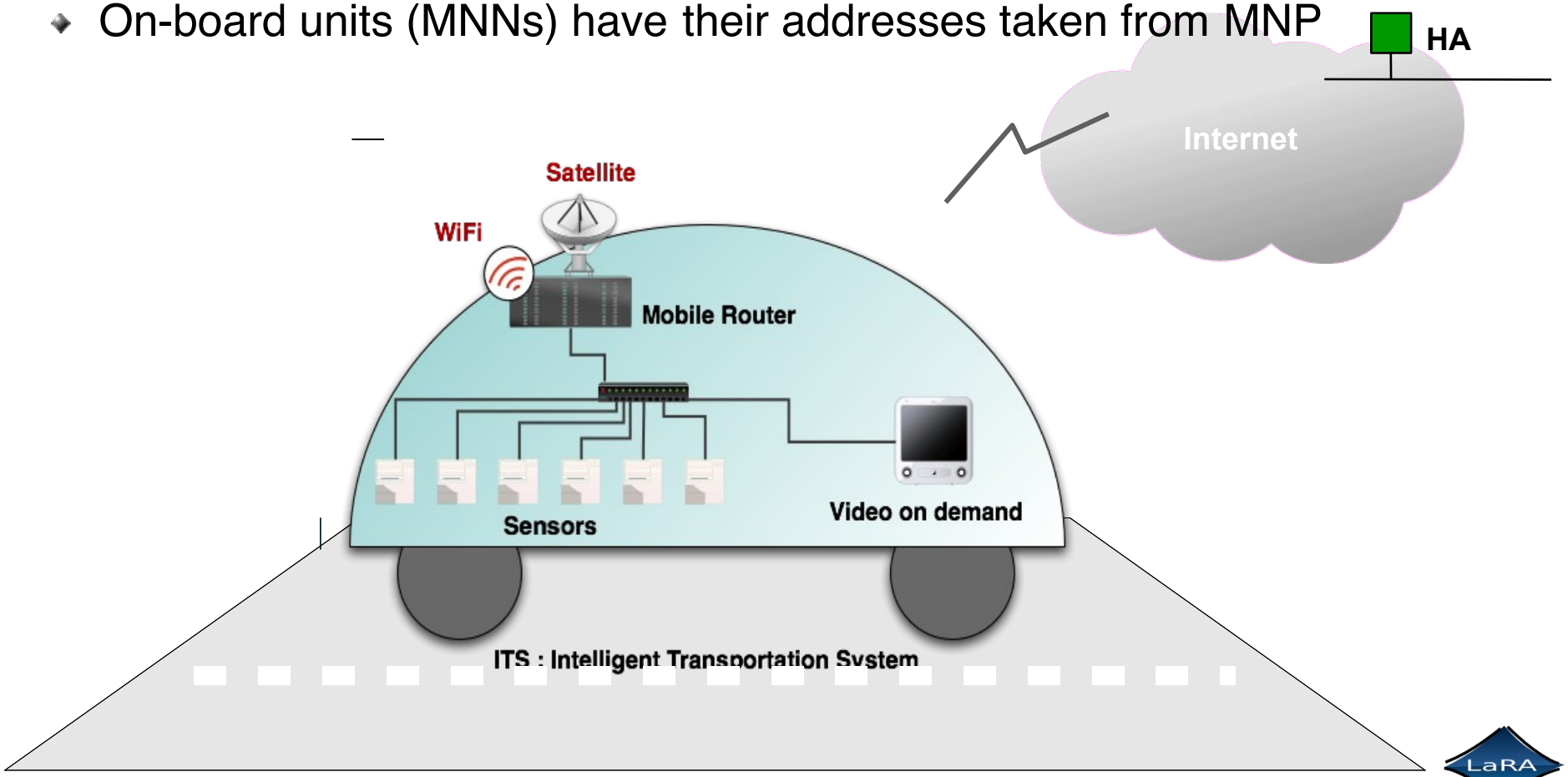
CALM: IP-Layer Mobility: Various communication medium

- V2V & V2I communication crucial for ITS
- In-vehicle devices will require (continuous) Internet connectivity
- Internet connectivity will be provided transparently to the applications through a range of access technologies
  - GPRS/3G, IEEE 802.11 a/b/g, IEEE 802.11p, DSRC, ...



CALM: IP-layer Mobility: In-vehicle network

- Vehicles will be fully networked
  - In-vehicle network
  - Prefix (MNP: Mobile Network Prefix) is assigned to the mobile network
  - On-board units (MNNs) have their addresses taken from MNP

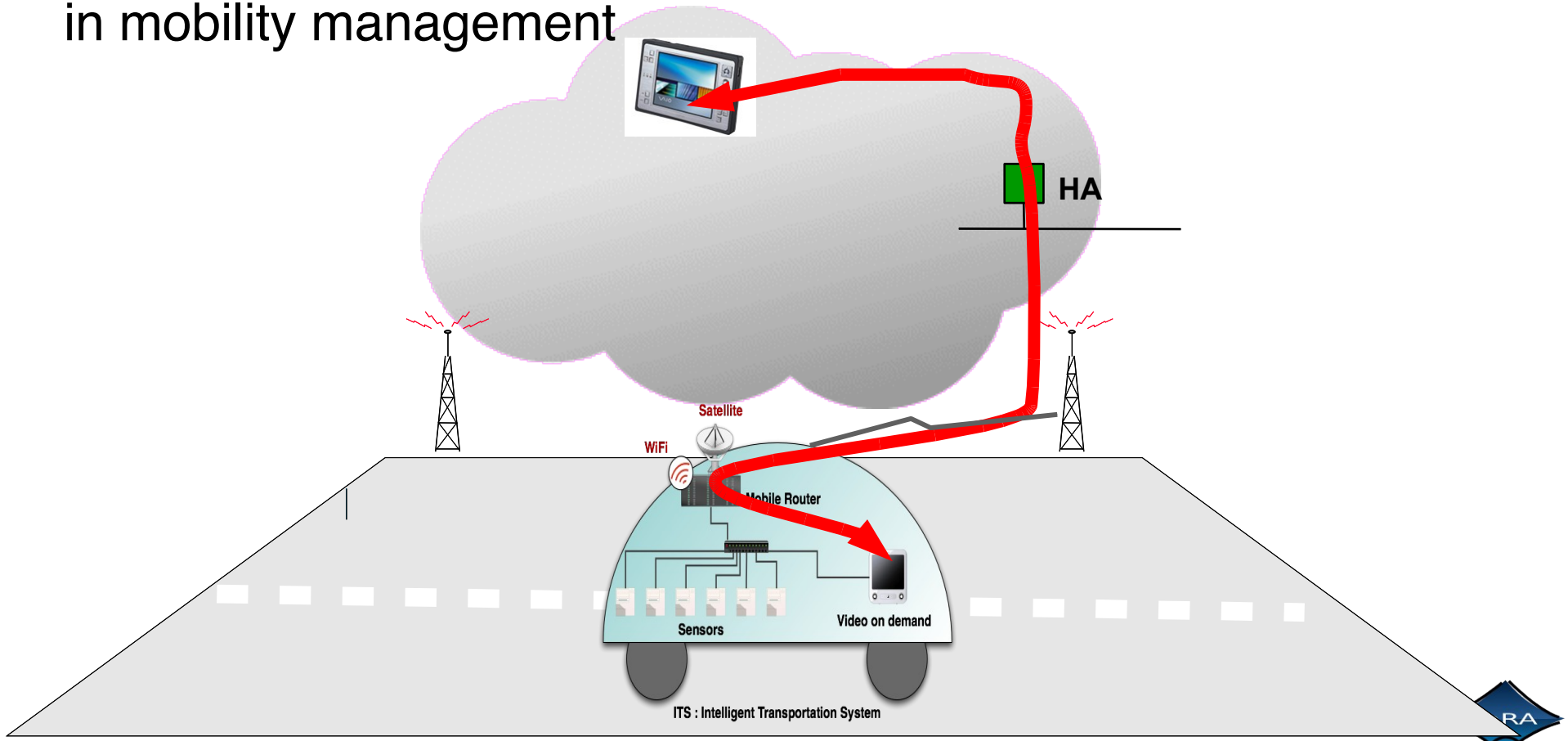


CALM: Communication Architecture Key Features

- NEMO: Maintain Internet access
  - Continuous communication during handoff
  - Horizontal handover: between access points using the same media
  - Vertical handover: heterogeneous handovers
- MonAmi6: Mobile Edge multihoming
  - Manage simultaneous access to the Internet (multiple interfaces)
- Medium Selection & Switching
  - Select the most appropriate media based on application needs
- IPv4-IPv6 Transition
  - Allow IPv6 communications over IPv4 access networks
  - Allow CVIS nodes to communicate with IPv4
- IP & non-IP services
  - IP not considered for time critical applications (e.g. collision avoidance)

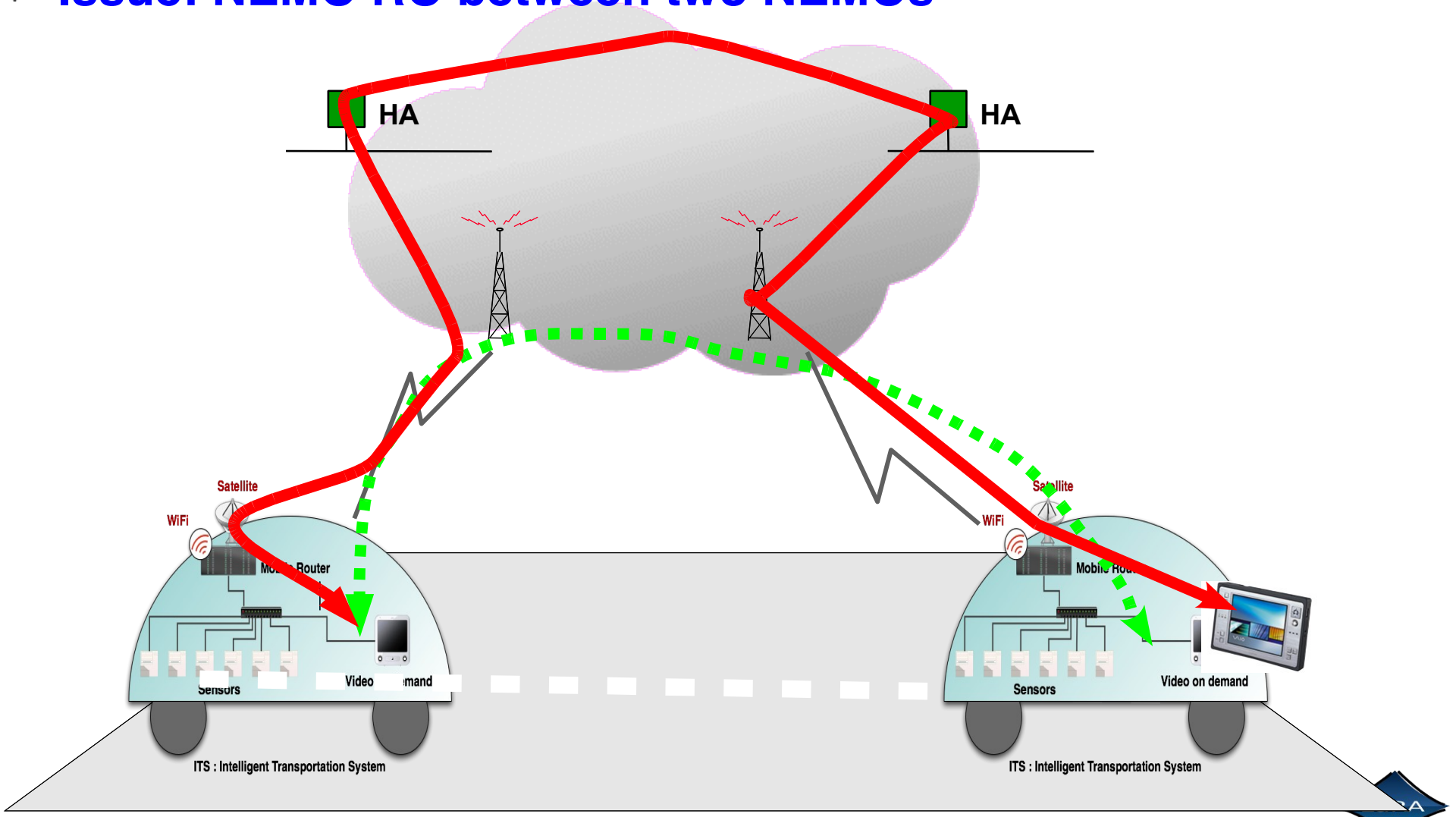
CALM: Mobility Management with NEMO (NEtwork MObility)

- **NEMO Basic Support** manages mobility of the entire network.
- Only the **Mobile Router** manages mobility
- Current address recorded at the HA (dedicated server)
- Nodes inside the moving network do not need to participate in mobility management



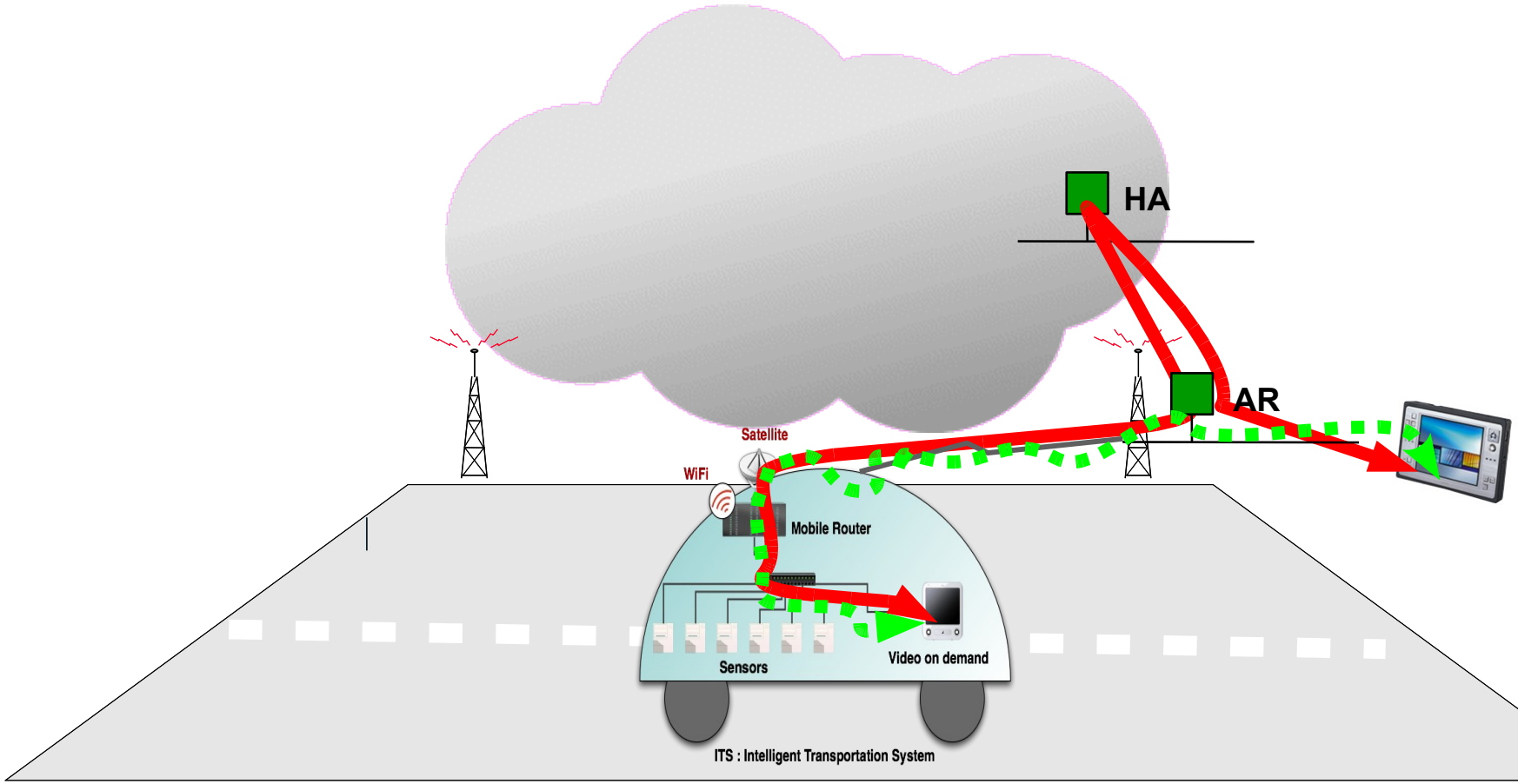
CALM: V2V via the infrastructure

- Direct V2V is not always possible
- **Issue: NEMO RO between two NEMOs**



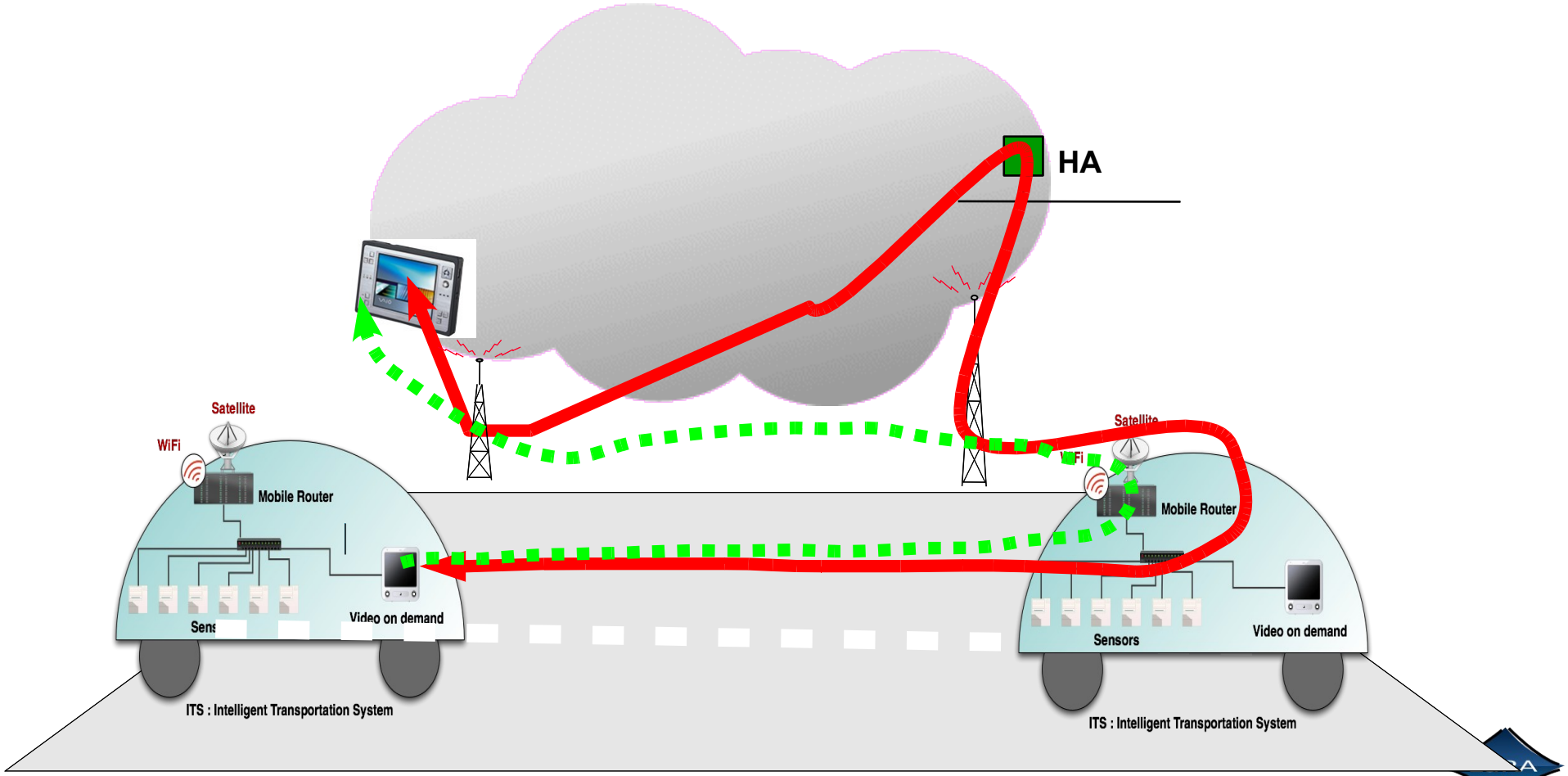
CALM: V2I with destination on the roadside

- Service provided by the roadside through a number of ARs on the road
- **Issue: NEMO RO with CN topologically close to MR**



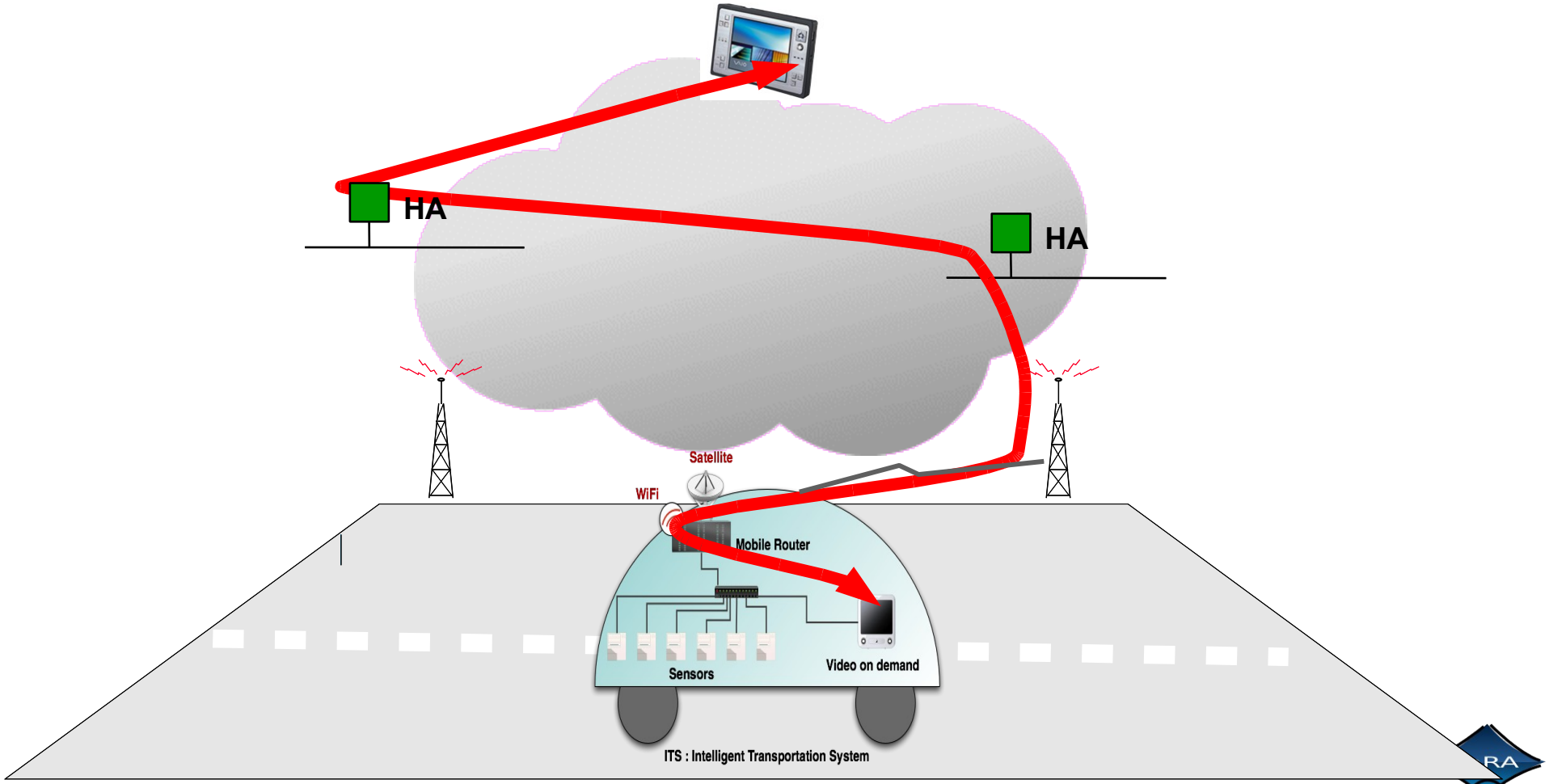
CALM: V2I via another vehicle

- Direct V2I is not always possible
- **Issue: RO with CN in the infrastructure over a multihop adhoc network (MANEMO ?)**



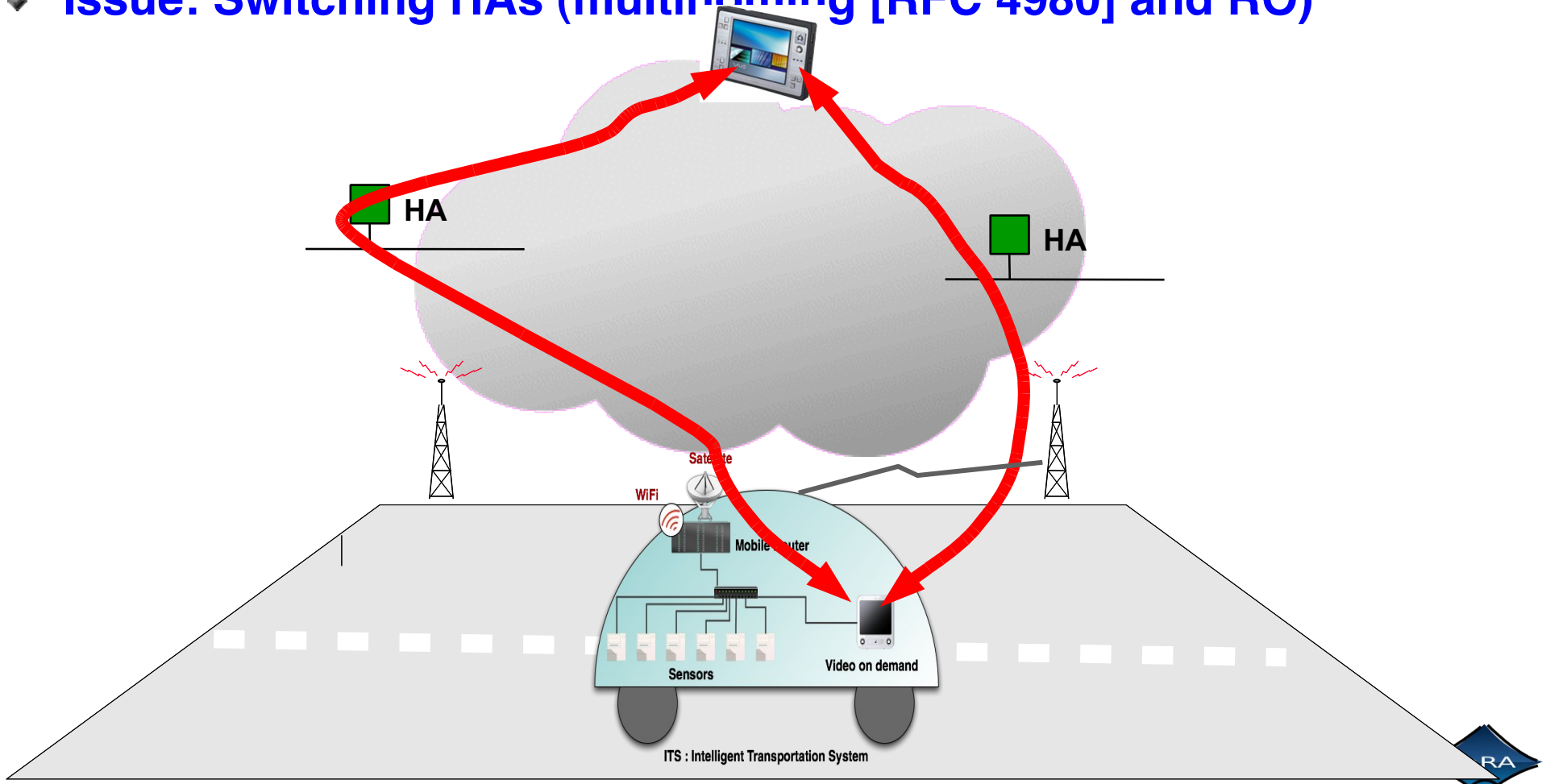
CALM: nested NEMO (VMNs)

- VMNs: Hand-held devices should be allowed in the architecture
  - Might be operating MIPv6 (or not)
- **Issue: RO between MR and VMN's HA**



CALM: Multiple HAs

- Owned by distinct institutions depending on services
- Vehicle may switch to a more local HA (agreement between operators)
- **Issue: Switching HAs (multihoming [RFC 4980] and RO)**



CALM: Multiple MRs

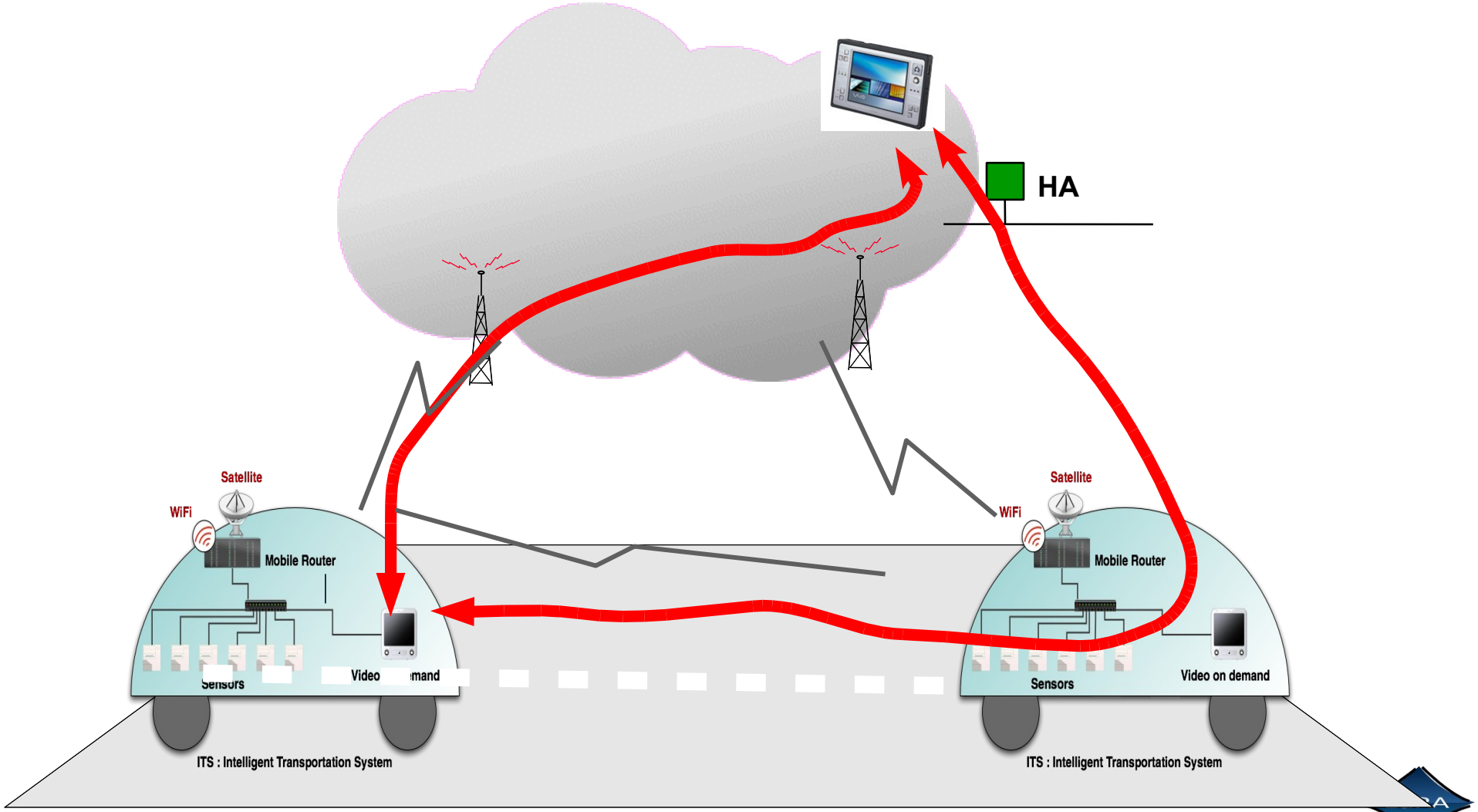
- One default in-vehicle embedded MR
- Other MRs could be brought in
  - e.g. personal hand-held devices acting as MR
- **Issue: MRs coordination (multihoming: [RFC 4980])**

CALM: Multiple MNPs

- Multiple in-vehicle networks and purposes => specific addressing requirements
  - 1 MNP for in-vehicle embedded sensors
  - 1 MNP for multimédia
- **Issue: multihoming [RFC 4980]**
  - ingress filtering
  - address selection

CALM: Multiple types of V2I routes

- Via the access network or via another vehicle
- **Issues: Multihoming [RFC 4980], QoS**



CALM Needs: Conclusion

- All scenarios may not be deployed at once, but the communication architecture should not prevent them (e.g. Multiple MRs, nested NEMO)
- A RO and multihoming solution may not be provided to accommodate all needs
- While RO is challenging, multihoming issues are easier to fix (multiple HAs, multiple MRs):
  - **Focus MEXT work on this first ?**
- Didn't mention about security, location privacy, etc. and non-MEXT related features since the above discussion is related to the IETF MEXT Working Group only
  - We may need to look at this from a wider angle



General Conclusion

Conclusions

- ISO is defining the CALM architecture
  - Uses IETF standards (IPv6, NEMO, etc)
  - CVIS is validating the CALM architecture concept
  - CVIS know-how can improve ISO standards and help the IETF to develop new standards needed for ITS communications

- IP is the convergence layer
  - will allow interoperability between V2V and V2I architectures
  - will allow interoperability between dedicated ITS applications and other Internet usages
  - will save costs and boost innovation

- IPv6 is the recommended version for ITS
  - Not an option for wide development of IP-based ITS applications
  - ITS needs the advanced features provided by IPv6 (NEMO, etc)
  - Millions of vehicles, each require several addresses
  - Too many IP addresses needed for NAT

Conclusions: Next Steps & Challenges

- Improve the communication architecture
  - Communication security
  - User privacy
  - Reliability / Performance
- Non-Technical challenges
  - Urgent to develop IPv6 awareness within the ITS community
  - Enforce participation to standardization bodies and establish liaison between ITS bodies and the IETF
- Open questions:
  - Who is going to provide the IPv6 address space ?
  - Who is going to operate the IPv6 access network(s) ?
  - Who is going to define policies ?
  - Who will be liable in case of miss-use ?

Conclusions: More about IPv6 and CALM

- ISO TC 204 WG 16: CALM Standard: http://www.calm.hu
- IPv6 applicability to ITS: http://lara.inria.fr/ipv6/

- Next ISO TC204 WG 16 meetings
  - 2008 March 10-14: Jeju, Korea
  - 2008 June 9-13: Paris, France (hosted by AFNOR)

- Cooperative Vehicle-Infrastructure System
  - http://www.cvisproject.org



Merci pour votre attention

Questions ?

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INRIA Rocquencourt – IMARA / LARA

http://www-rock.inria.fr/imara

http://www.lara.prd.fr