

InternetCAR

~ Internet Connected Automobile Researches ~



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Background and Motivation

- “Give and Take” basis helps society.
 - ➔ Automobile has more than one hundred sensors.
 - ➔ If we can collect these data, useful information can be provided.
 - ➔ This kind of application is called as Probe Car or Floating Car Data
- Frontline base is necessary in emergency situation.
 - ➔ Automobile can move, has battery, can bring heavy/large equipment.
 - ➔ “Communication” is most important capability.
- Internet connectivity can be used for map/music distribution, controlling taxi/bus, web browsing, E-mail and so on.

Key Issues

■ Internet Mobility

- Connect all on-board equipments
- Across radio coverage seamlessly
- Use of heterogeneous communication media to connect automobile to the Internet anytime/anywhere.

■ Platform of Internet CAR

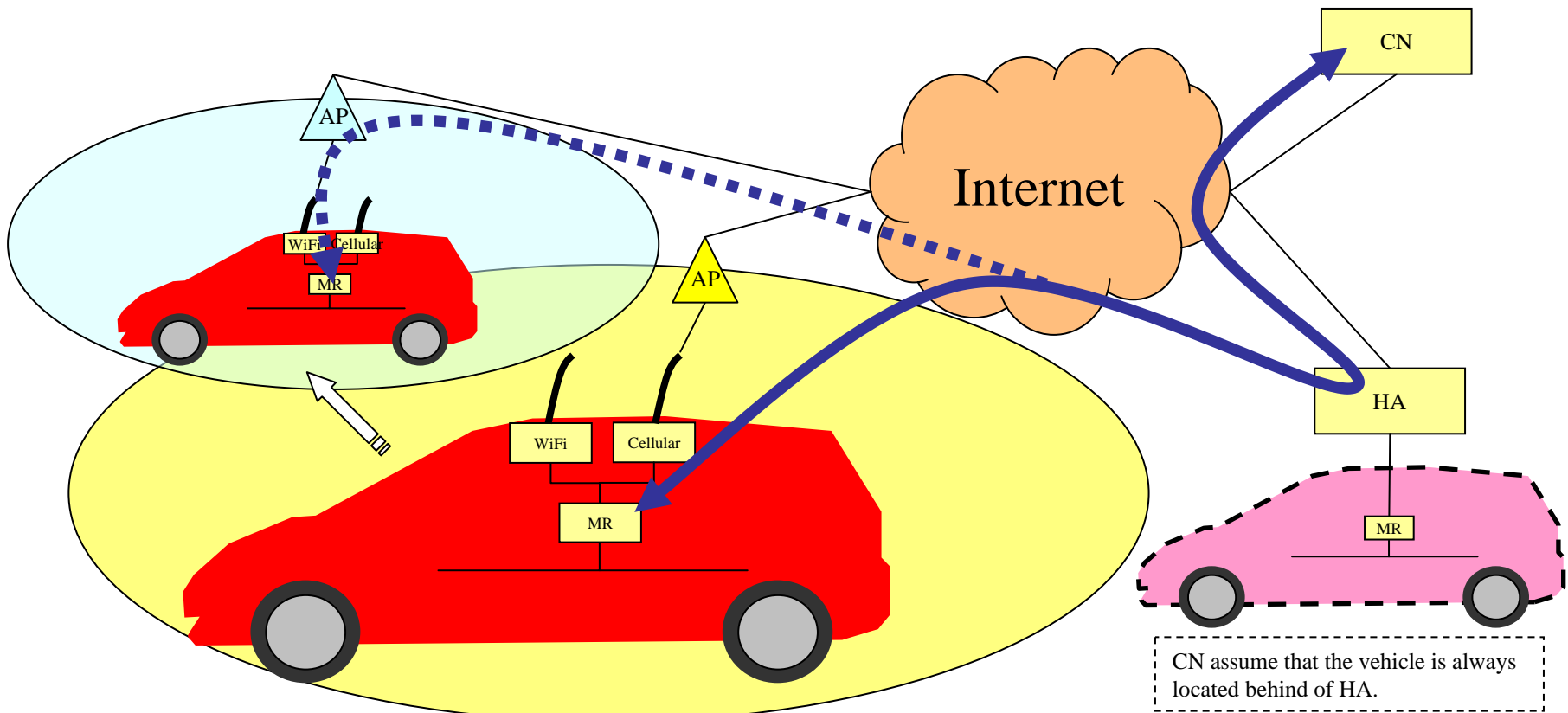
- Data dictionary of automobile have to be standardized to exchange each other.
- Platform of geographical information on the Internet is necessary to develop real space networking.

Connect IVN to the Internet: NEMO

Proposition: *A vehicle uses any communication media seamlessly.*

Solution: *iCAR introduces NEMO to connect IVN to the Internet.*

- Movement: CoA, which vehicle want to use, is changed.
- When a vehicle moves, it report it to its HA.
- Packet will be delivered via a HA.

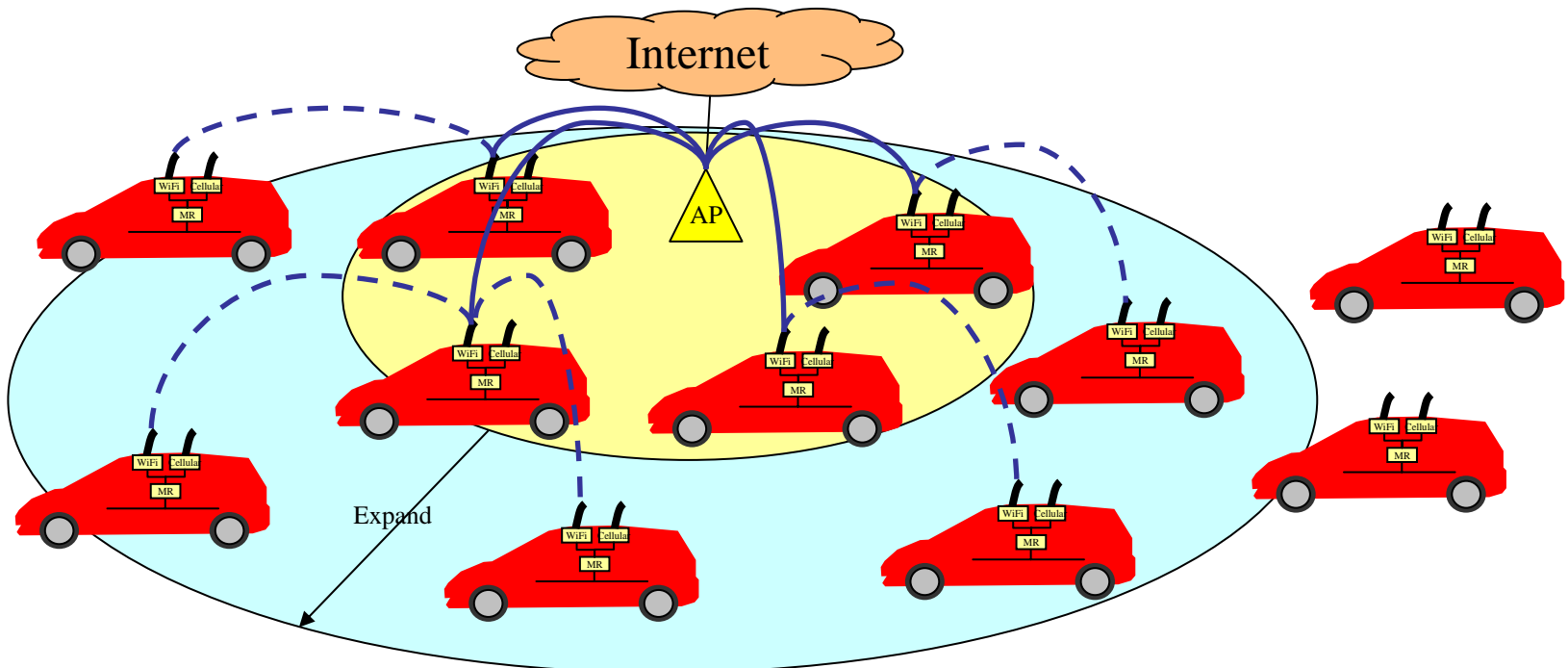


Expands radio coverage: L2.5 MANET

Proposition: *Vehicles prefer to connect via a wideband medium.*

Solution: *iCAR introduces L2.5 MANET to expand BB media coverage.*

- Global MANET segment is constructed with AP as a center.
- Local MANET segment is constructed with a vehicle as a center.
- Local MANET segment is twice bigger than Global MANET segment to follow general IPv6 manner.
- Reactive MANET algorithm can be applied to L2.5 MANET.
- MANET segment acts as “subnetwork of Internet”.



Infrastructureless communication

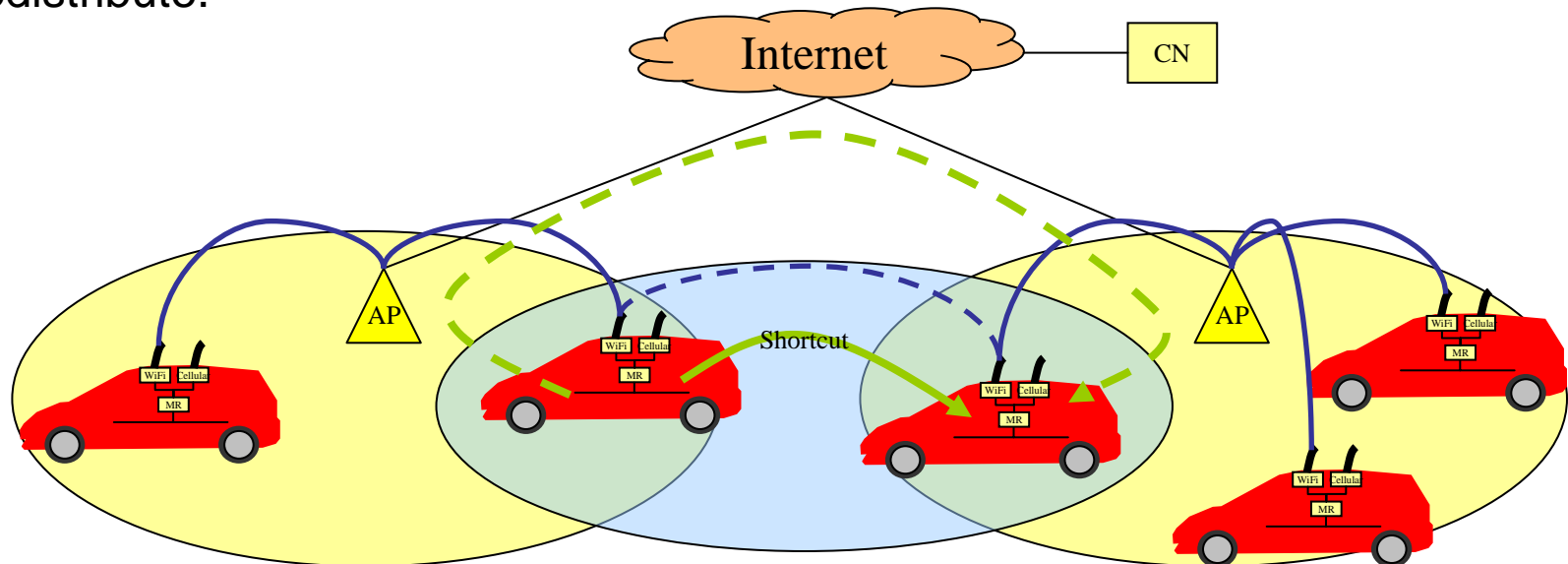
Routing optimization: L3 MANET

Proposition: *Vehicles communicate using shortest path.*

Vehicles connect each other without any infrastructure.

Solution: *iCAR introduces L3 MANET to establish a shortcut routing path.*

- By default, a vehicle supports NEMO.
- When two vehicles know routes which can reach each other, it can be “shortcut” paths.
- Any dynamic routing protocol can be used to make shortcuts. But MANET protocols work well than others due to dynamicity.
- Proactive MANET algorithm can be applied well.
- Bidirectional path is necessary.
- MANET have to have hop limitation. In addition, route information must not redistribute.



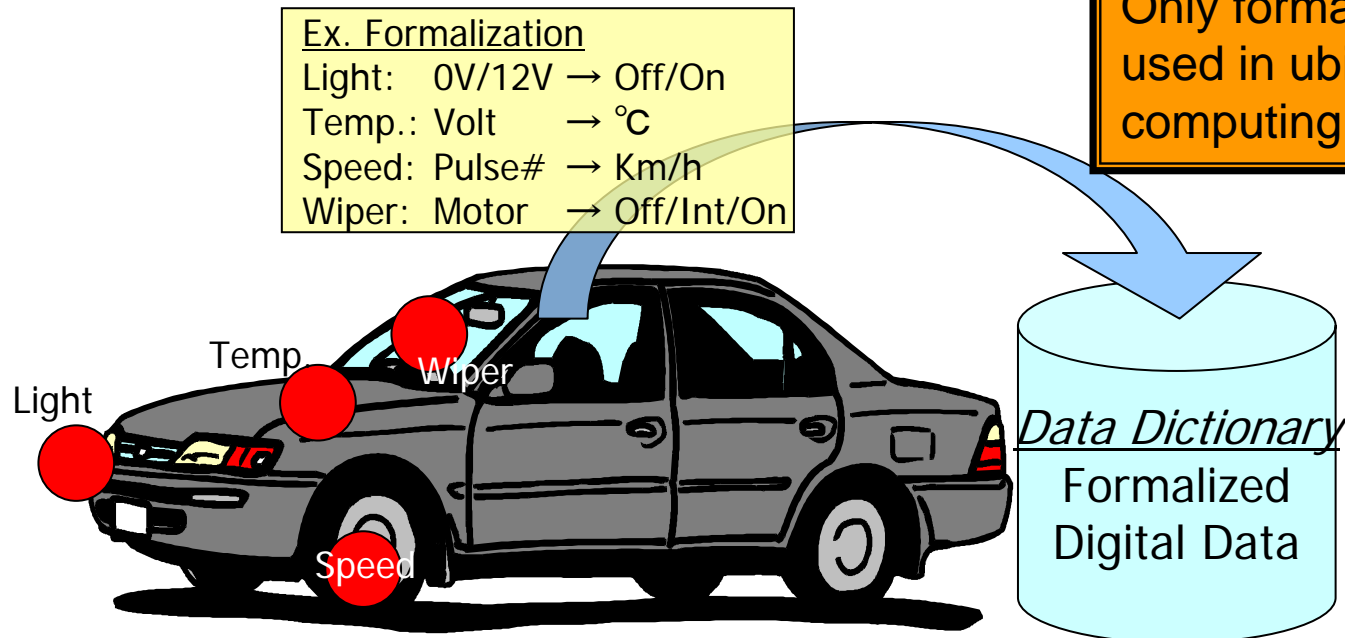
Exchange data and information: Data dictionary

Proposition: *Vehicles exchange their data and information each other even if types of vehicle or manufacturer is different.*

Solution: *iCAR introduces data dictionary model.*

- Each vehicle has its particular dataset and element types.
- Physical value can be defined in theory.
- Each data can be used for any applications.
- Extensible format is important to long use.
- Any protocol can be used to exchange data.

Only formalized data can be used in ubiquitous computing environment.



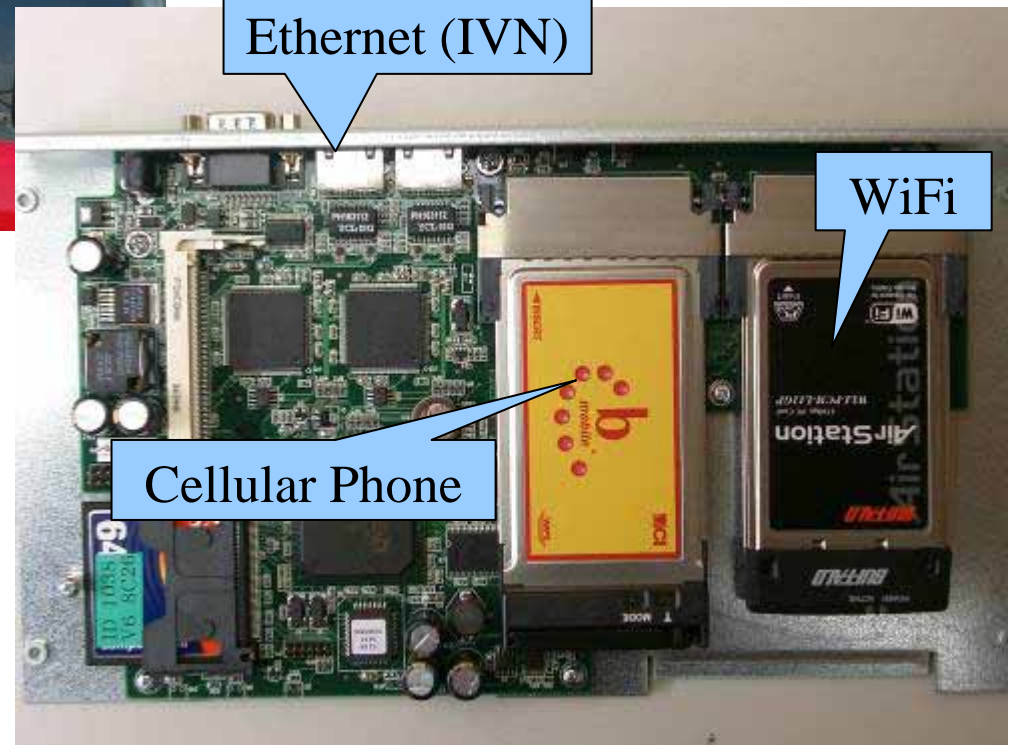
History of InternetCAR Project related activities

FY	Internet CAR(WIDE)			IPCar(JSK)			Internet ITS		
	1996	1997	1998	1999	2000	2001	2001	2002	2003
Characteristic	First testing	Introducing Mobile IPv4	Development of On-board system	Possibility check of Probe Car system	Feasibility study of Probe Car system	Improving accuracy of Probe Car system	Introducing IPv6, Design of Internet ITS Platform	Joint work of more than hundred organization	Interoperability check
# of Cars	1	7	10	10	270	270	1640	1490	1490+30
Location	Fujisawa	Fujisawa	Fujisawa, Nara, Ishikawa	Kouhoku	Yokohama	Yokohama	Nagoya, Kawasaki	Nagoya	Nagoya, Yokohama
Type of Car	<ul style="list-style-type: none"> • Test Car 	<ul style="list-style-type: none"> • Passenger car 	<ul style="list-style-type: none"> • Passenger car 	<ul style="list-style-type: none"> • Test car 	<ul style="list-style-type: none"> • Taxi • Bus • Commercial car • Truck • Garbage car 	<ul style="list-style-type: none"> • Taxi • Bus 	<ul style="list-style-type: none"> • Taxi • Passenger car 	<ul style="list-style-type: none"> • Taxi 	<ul style="list-style-type: none"> • Taxi • Bus
On-board system	<ul style="list-style-type: none"> • PC 	<ul style="list-style-type: none"> • Note PC 	<ul style="list-style-type: none"> • sic2000 	<ul style="list-style-type: none"> • Proprietary system 	<ul style="list-style-type: none"> • Proprietary system 	<ul style="list-style-type: none"> • Proprietary system 	<ul style="list-style-type: none"> • Proprietary system 	<ul style="list-style-type: none"> • Proprietary system 	<ul style="list-style-type: none"> • Proprietary system • MR+IPv6Sensors
Retrieved Information	<ul style="list-style-type: none"> • Location • Speed • Wiper • Light 	<ul style="list-style-type: none"> • Location • Speed • Wiper 	<ul style="list-style-type: none"> • Location • Speed • Wiper 	<ul style="list-style-type: none"> • Location • Speed • Wiper 	<ul style="list-style-type: none"> • Location • Speed • Wiper 	<ul style="list-style-type: none"> • Location • Speed • Winkers • Side break 	<ul style="list-style-type: none"> • Location • Speed • Wiper • Hired/Vacant 	<ul style="list-style-type: none"> • Location • Speed 	<ul style="list-style-type: none"> • Location • Speed • Camera • Temp. • Humidity • Acceleration • Winker
Communication Media	<ul style="list-style-type: none"> • PDC-P 	<ul style="list-style-type: none"> • PDC-P • PHS • Wireless LAN 	<ul style="list-style-type: none"> • PDC-P • Wireless LAN 	<ul style="list-style-type: none"> • PDC-P 	<ul style="list-style-type: none"> • PDC-P 	<ul style="list-style-type: none"> • PDC-P 	<ul style="list-style-type: none"> PDC-P, cdma1x, PHS, PHS-DATA, WiFi, DSRC 	<ul style="list-style-type: none"> • PDC-P • SWIFTCOM 	<ul style="list-style-type: none"> • PDC-P • WiFi • PHS-DATA

Testing Environment



WiFi Antenna

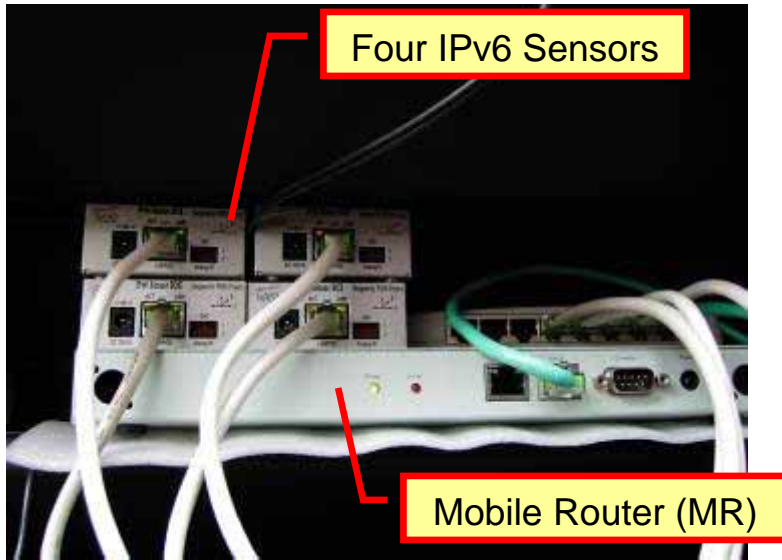


Ethernet (IVN)

Cellular Phone

WiFi

Testing Environment



MR and IPv6 Sensor



IPv6 based on-board equipment



Vehicle information can be retrieved using SNMP/IPv6

CALM ~Communication, Air Interface for Long and Medium Range~

■ What is “CALM”?

- ISO/TC204/WG16 is working to define New ITS Networking architecture.
- CALM Supports...
 - continuous communications
 - both of ITS services and Internet services
 - Support master/slave and peer-peer modes
 - Support user transparent networking and handover spanning multiple media, media providers and beacons

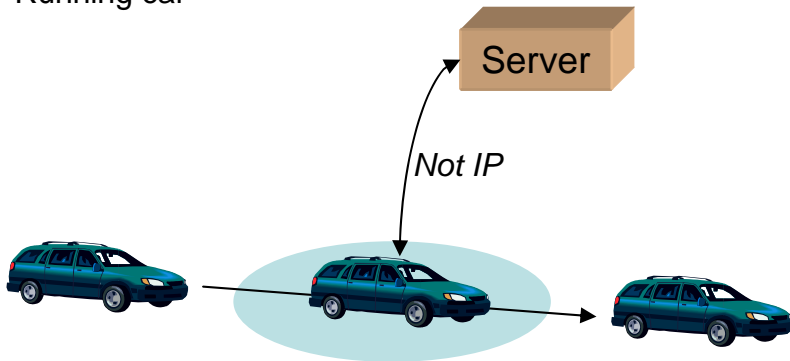
■ History

- Apr. 2001
 - Proposed PWI with other CALM Medias
 - Start to consider the requirements
- Feb. 2003
 - Convener was changed from US to Japan
- Apr. 2004
 - NP ballot. Passed.
- Oct. 2004
 - First version of Working Draft was published
 - Call for comments

CALM Scenarios

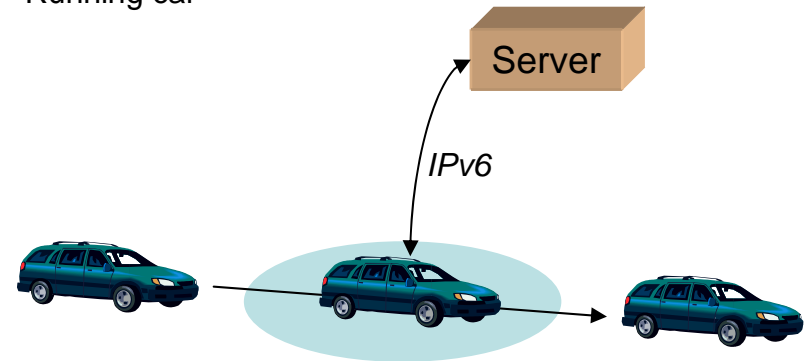
Scenario 0 (out of focus)

- Single media
- Running car



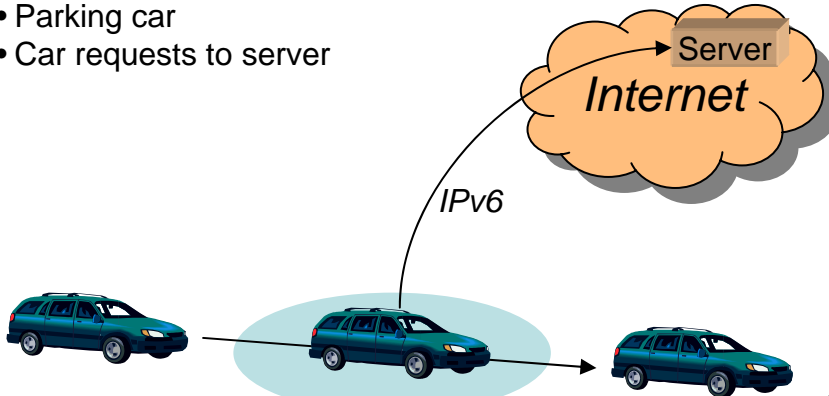
Scenario 1 (without Internet access)

- Single media
- Running car



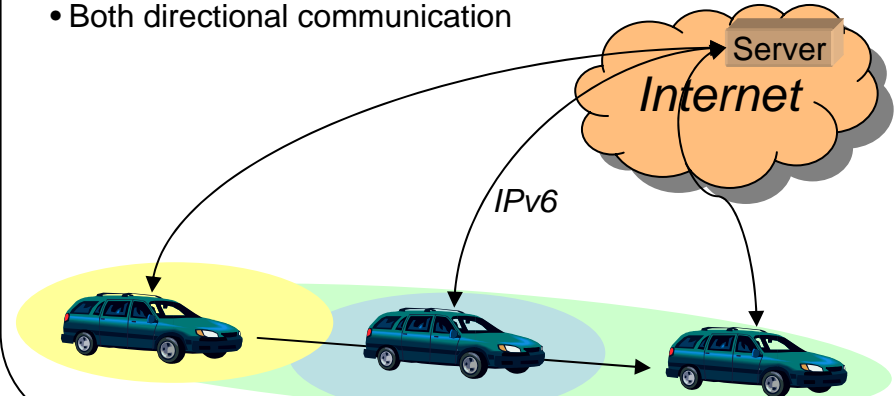
Scenario 2 (with Internet access without Media switching)

- Single media
- Running car with large range communication media
- Parking car
- Car requests to server



Scenario 3 (with Internet access with Media switching)

- Multiple Media
- Both of running car and parking car
- Both directional communication



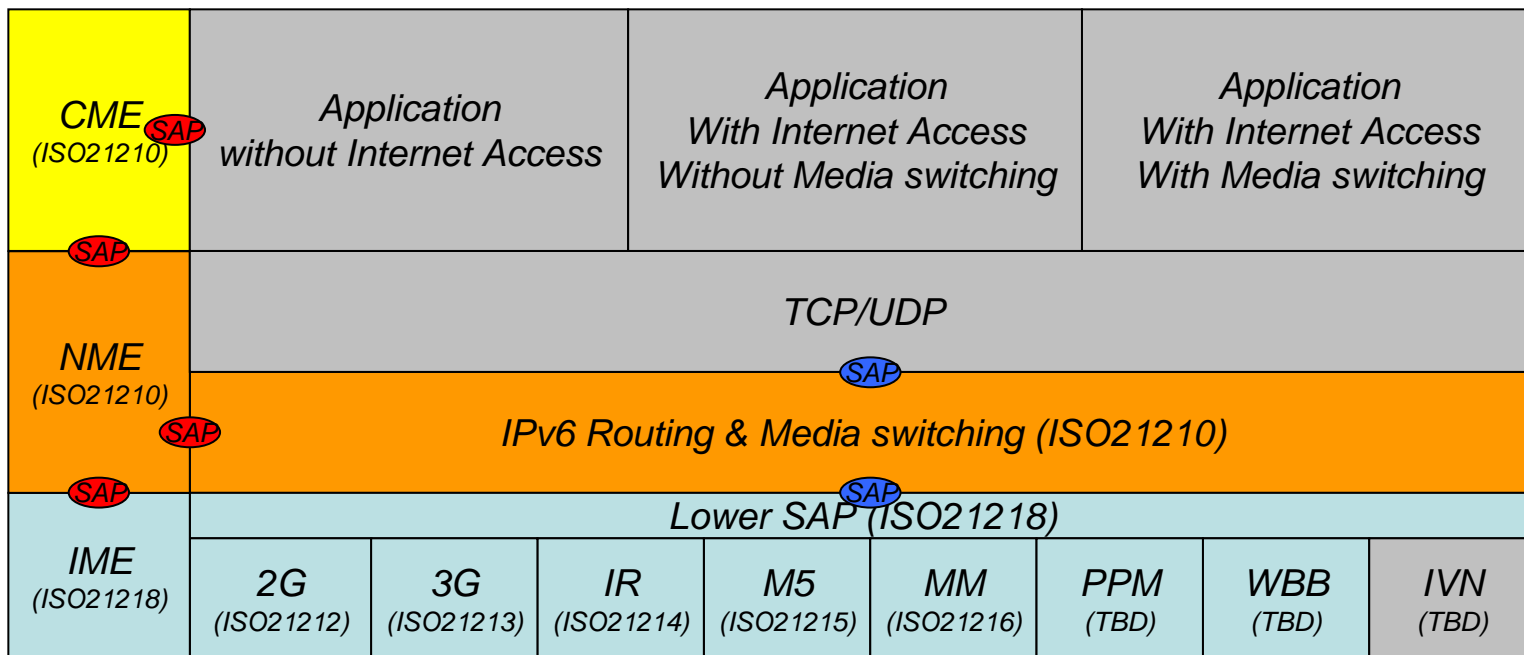
CALM Architecture and SAPs of Network part

- CME: CALM Management Entity
- NEM: Network Management Entity
- IME: Interface Management Entity

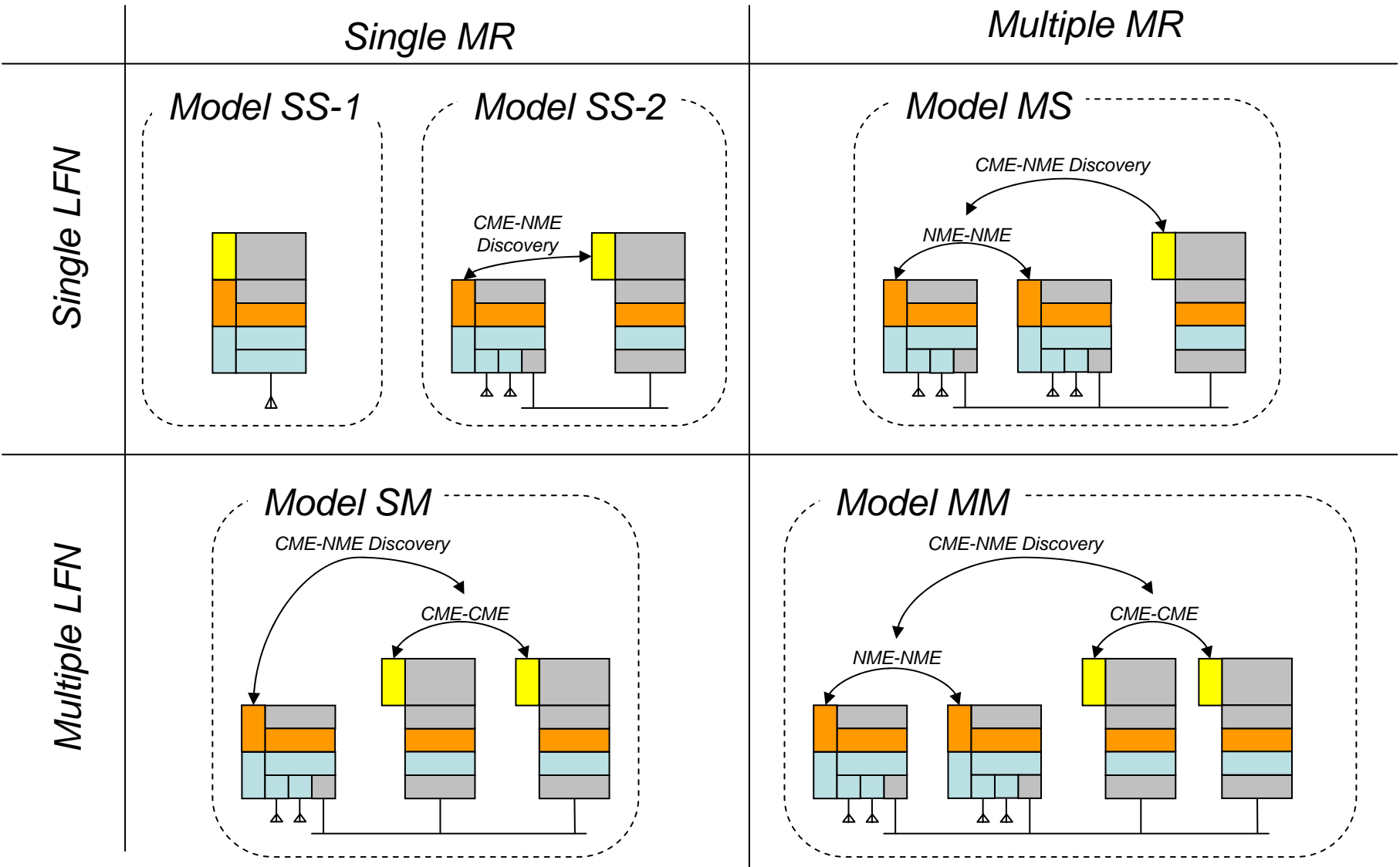
- 2G: 2nd Generation Cellular Phone
- 3G: 3rd Generation Cellular Phone
- IR: Infrared
- M5: 5GHz Band ITS Media
- MM: Microwave Media
- PPM: Point to Point Millimeter wave
- WBB: Wireless Broadband
- IVN: In-Vehicle Network

SAP SAP defined in ISO21210

SAP SAP defined outside of ISO21210

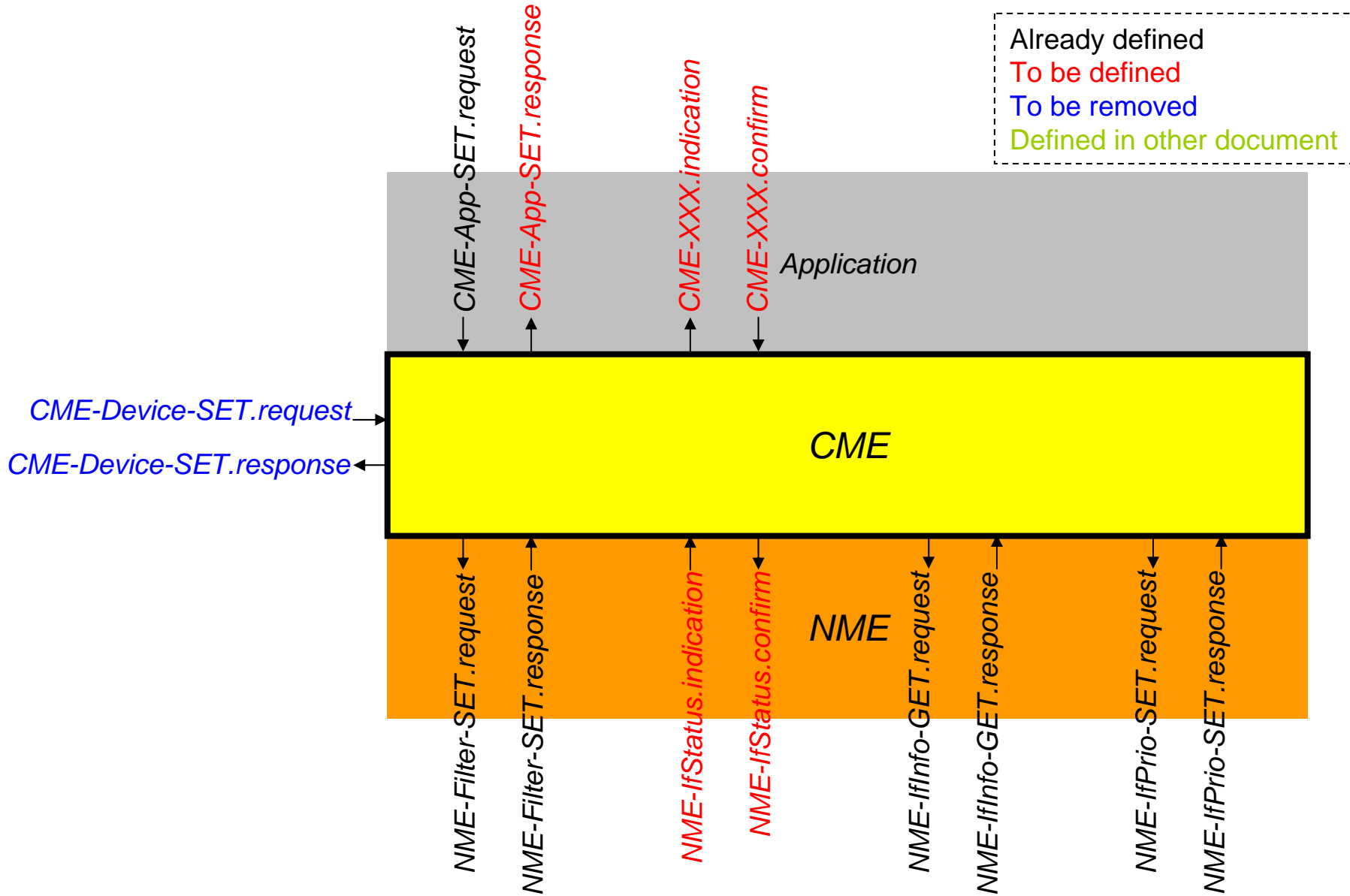


Possible CALM physical configuration

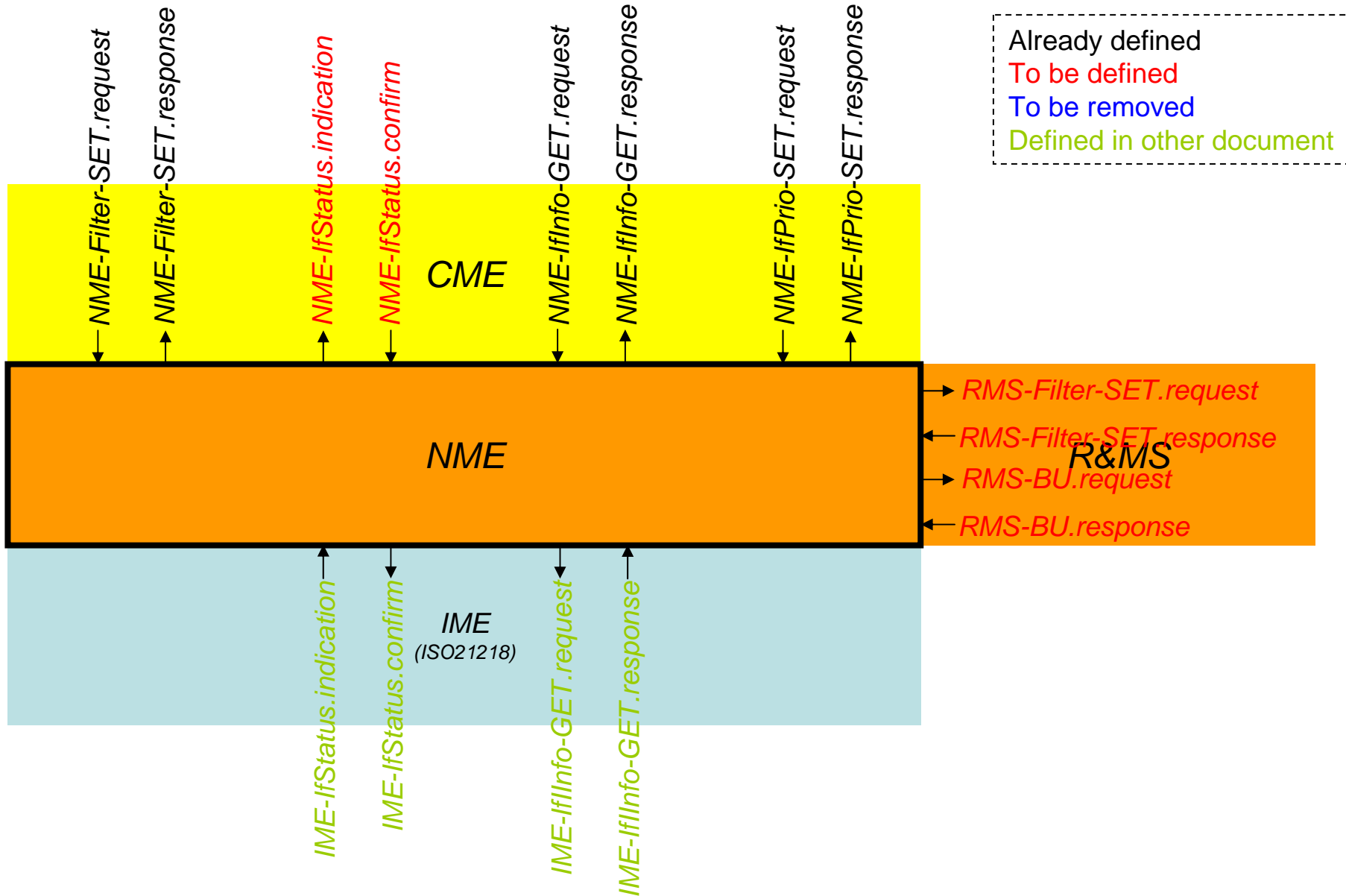


“CME-NME discovery”, “NME-NME”, “CME-CME” will be defined in next step.

CME – CALM Management Entity



NME – Network Management Entity



Conclusion

- IPv6 makes you happy with various applications.
 - Safety / Smooth traffic / Low pollution / Entertainment
- Key technologies for ITS PLATFORM are already available.
 - Network technology
 - Application platform
 - CALM – Communication Air interface, Long and Medium Range
 - Multiple wireless communication media
 - Seamless media switching based on IPv6
 - Multiple application
- We should support this idea, if...
 - we can provide active safety (Driving assistant)
 - we can reduce traffic jam (Pollution, Safety)
 - We know that these technologies helps above. We can do something already.