INSTITUT NATIONAL DE RECHERCHE SUR LES TRANSPORTS ET LEUR SÉCURITÉ

The French National Institute for Transport and Safety Research

European perspective on Wireless Communications

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Plan of the presentation

- A technical decomposition in four steps.
- Vehicle-to-infrastructure communication : example of emergency calling and emergency warning systems for road users.
- Vehicle-to-Vehicle communication : introduction of the Electronic Pre-View Mirror and technical effectiveness of current technologies (IEEE 802.11x, HIPERLAN 2, BLUETOOTH… UWB).
- General conclusion.

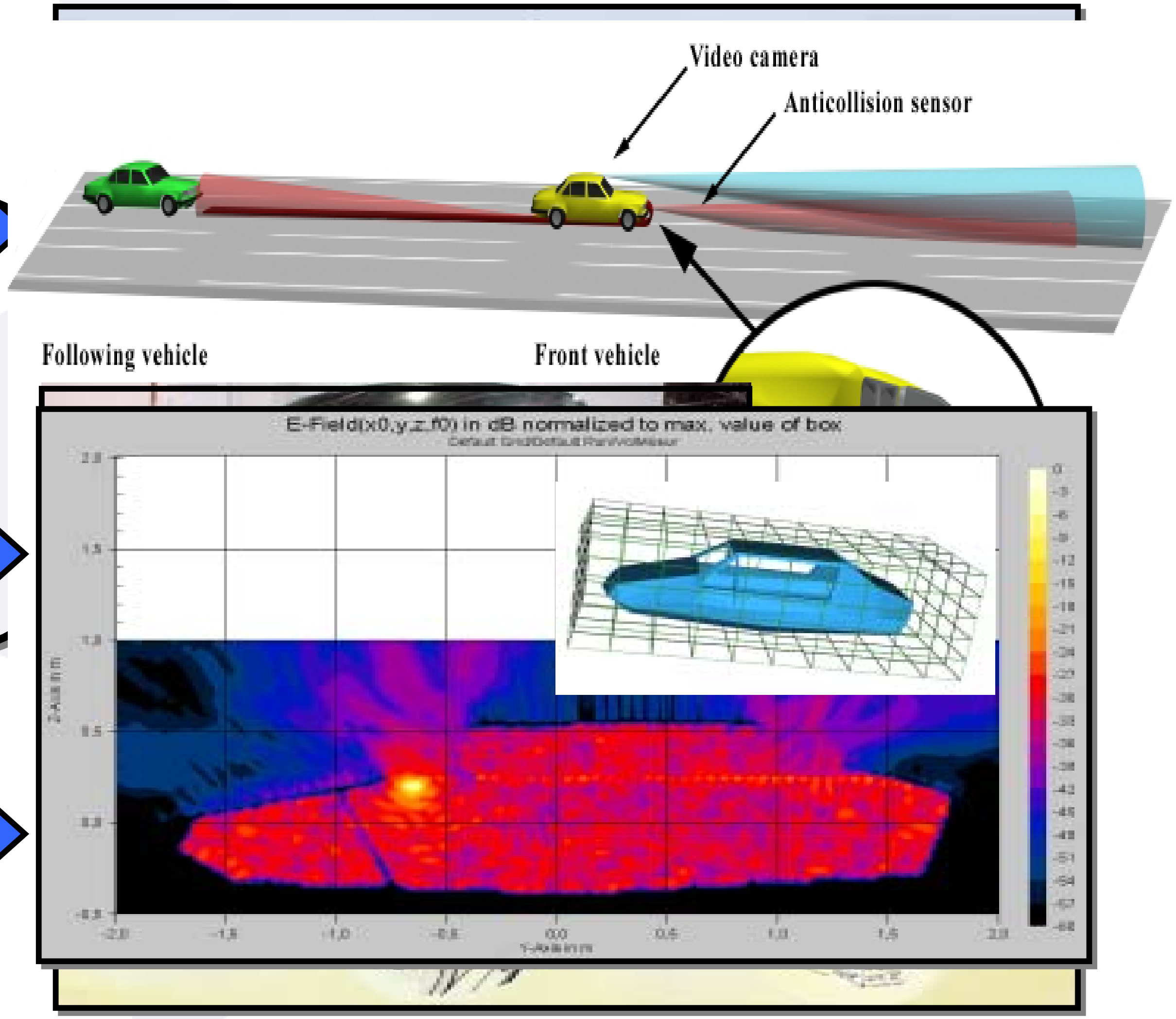
A technical decomposition in four steps

Fixed networks

Vehicule-to-infrastructure communication

Vehicle-to-vehicle communication
(63-64 GHz (CEPT), UWB
IEEE 802.11x, HIPERLAN 2…)

In-vehicle
(terrain networks, Bluetooth
Mobile Communicating Objects)

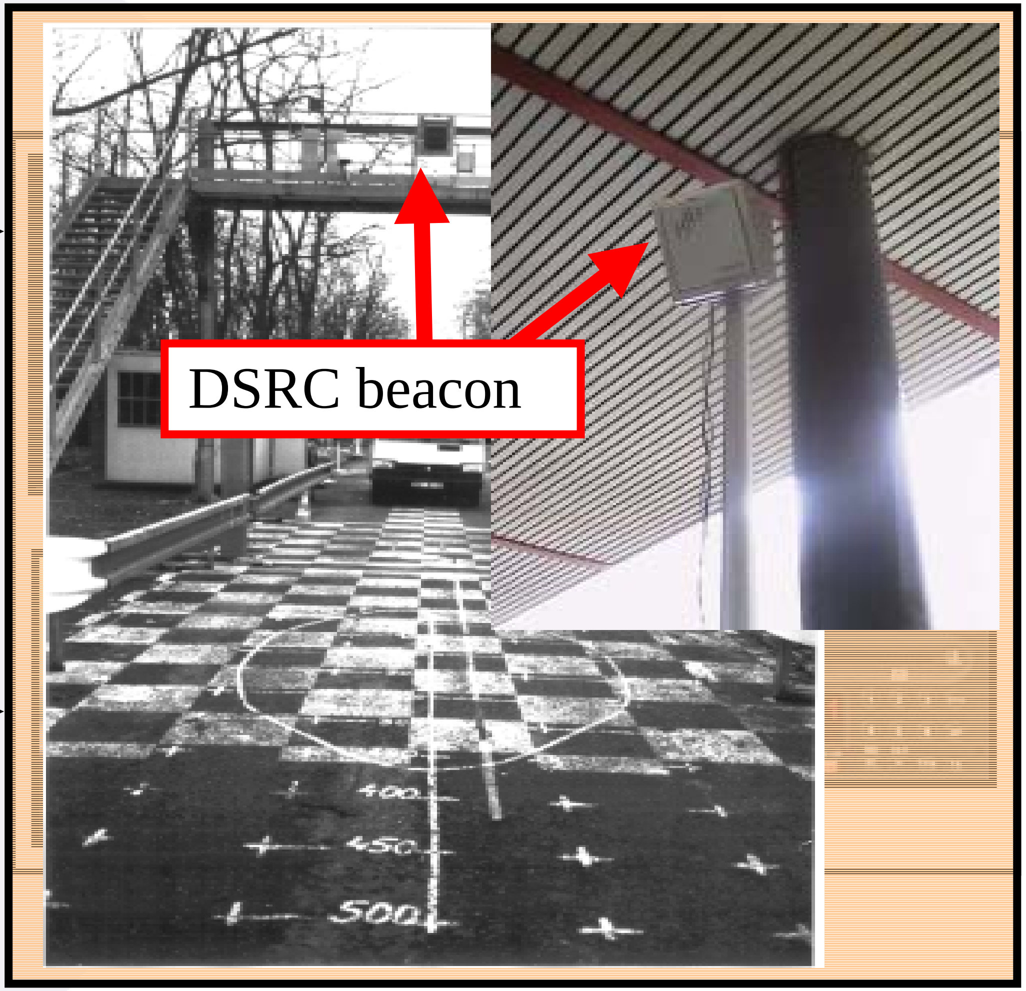


ADASE
Advanced driver assistance systems in Europe

Decomposition in two classes of system (COST 30)

Systems fully dedicated to transport telematics 107.7 MHz, DSRC…

Shared telecommunication resources with other applications RDS, GSM…



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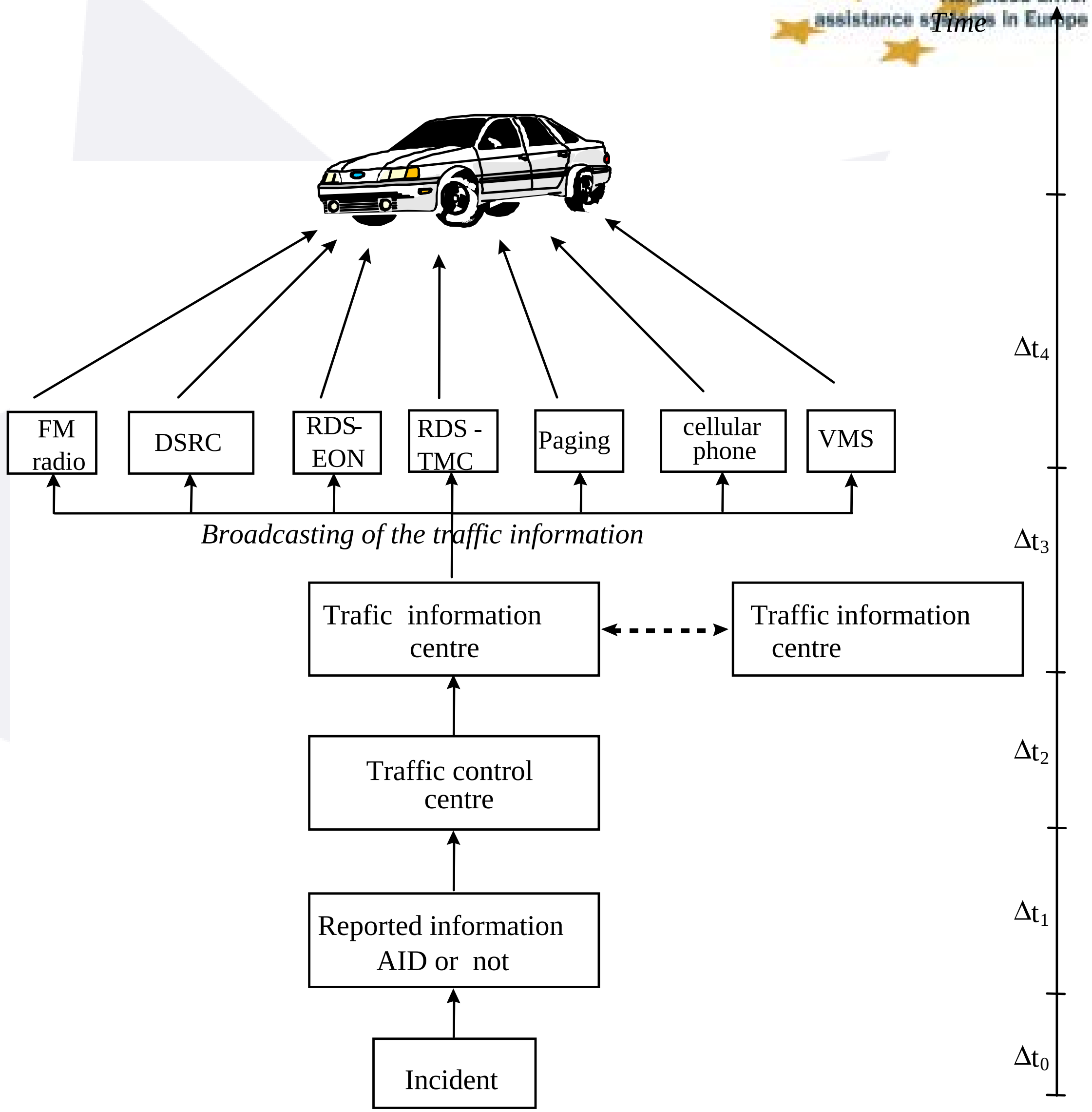
Some of the telecom industry available standards

System	Raw data rate	Mode	coverage	Mobility	Quality
RDS	1187,5 bps	Broadcast	FM national network	yes	Limitations in urban environments
DARC	16 kbps	Broadcast	Potential FM national network	yes	Limitations in urban environments
DAB	Up to 1.5 Mbps	Broadcast	Network to be implemented	yes	Good in urban environments
DVB -T	Up to 30 Mbps	Broadcast	Network to be implemented	To be validated	Good in urban environments
GSM	Function of the standard up to 2 Mbps	Connected or Broadcast	Cellular	yes	Cell dimensions in connected mode

Example of the traffic information chain - Different medias to reach the final users



CEPT dedicated road transport telematics frequency bands

Frequency band	5,795-5,805 5,805-5,815 GHz	63-64 GHz	76-77 GHz
Usage	DSRC automatic tolling	Ground to vehicles and vehicle to vehicle links	Anticollision Radars
Bandwidth	2x10MHz (4 x 5MHz channels)	1GHz (5 to 20 MHz channels)	FM/CW : 100MHz Impulsions : 50MHz
EIRP	3dBw	3-16dBw	16-20dBw
Antenna Gain	10-15dB	10-30dB	30-35dB
	1-3Mbps	A few Mbps	
Modulation	FSK-PSK-AM	FSK-PSK	FMCW pulse

Example : Emergency Calls and Warning of road users

- The emergency calling network currently available to road users along motorways and highways is a public, free of charge, efficient means of alerting the infrastructure staff.
- Emergency call boxes are situated every 2 km along motorways (4 km along some roads).
- The road user in difficulty originates a call from the nearest emergency call box and dialogues directly with the relevant security officer. This officer immediately obtains the location of this call box. He is well trained and effectively in charge of all the security aspects in that particular area. This system is effective.
- However, with the appearance of mobile personal phones, this emergency network is falling into disuse, owing to the convenience of emergency telephone numbers (112, 911).

European e-112 Directive

Europe has adopted a regulatory approach towards location enhanced emergency calls via the e-112.

"Member States shall ensure that undertakings which operate public telephone networks make caller location information available to authorities handling emergencies, to the extent technically feasible, for all calls to the single European emergency call number 112".

Obligation applies to all operators as from July 2003

- Regulators are currently transposing regulation into national law
- EC currently drawing up recommendation to Member States

Legislation may be applied to any national emergency number

EC DG INFSO questionnaire results (2001)

Several operators are expected to upgrade from basic Cell ID

- Timing Advance (TA)…

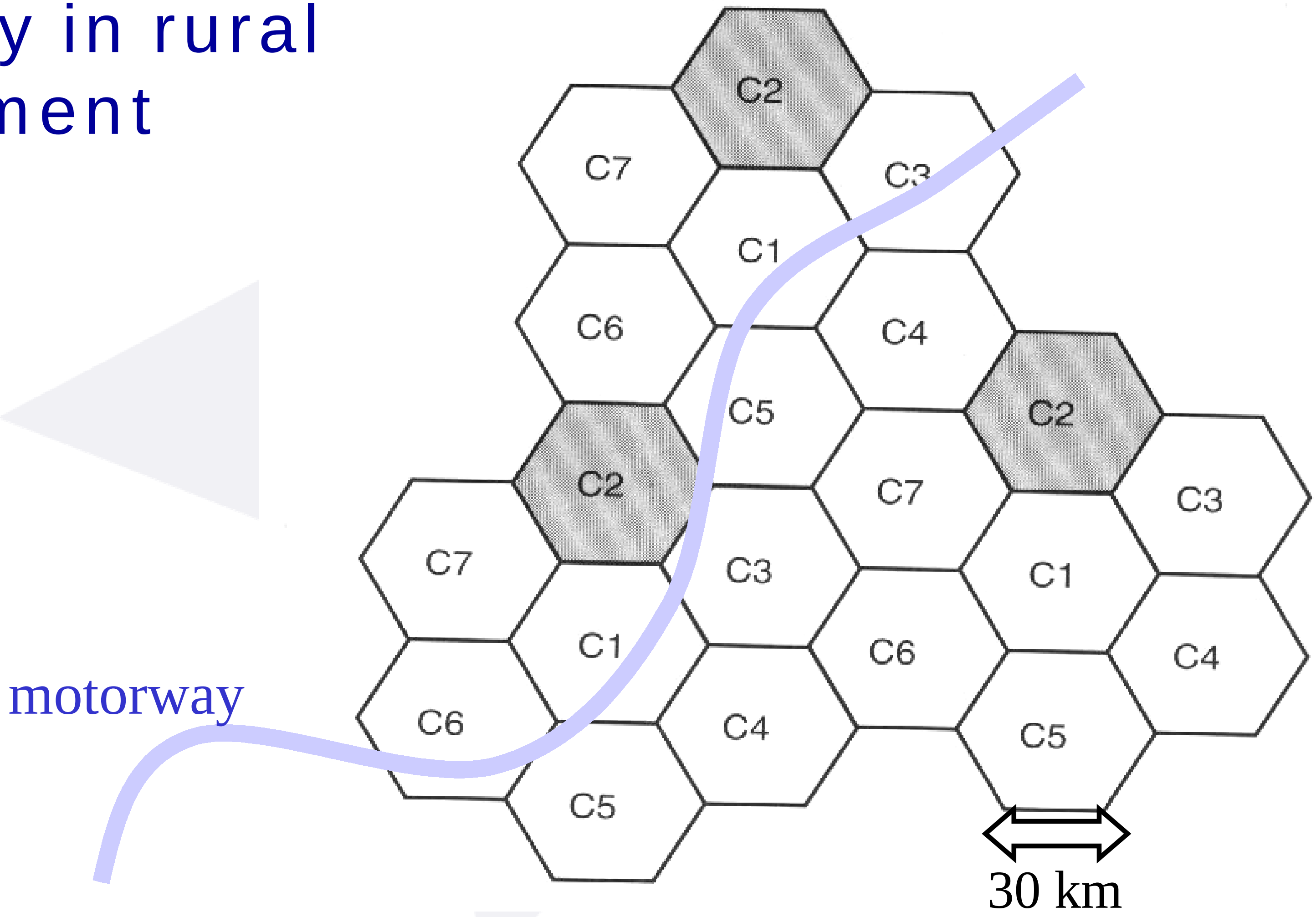
All operators plan to move towards more accurate positioning

- One third will deploy A-GPS only (E-OTD considered too expensive)
- Many operators plan to deploy E-OTD within 3 years
- On average, only 50% of networks may be covered with E-OTD

Varied hopes for market penetration of accurate positioning

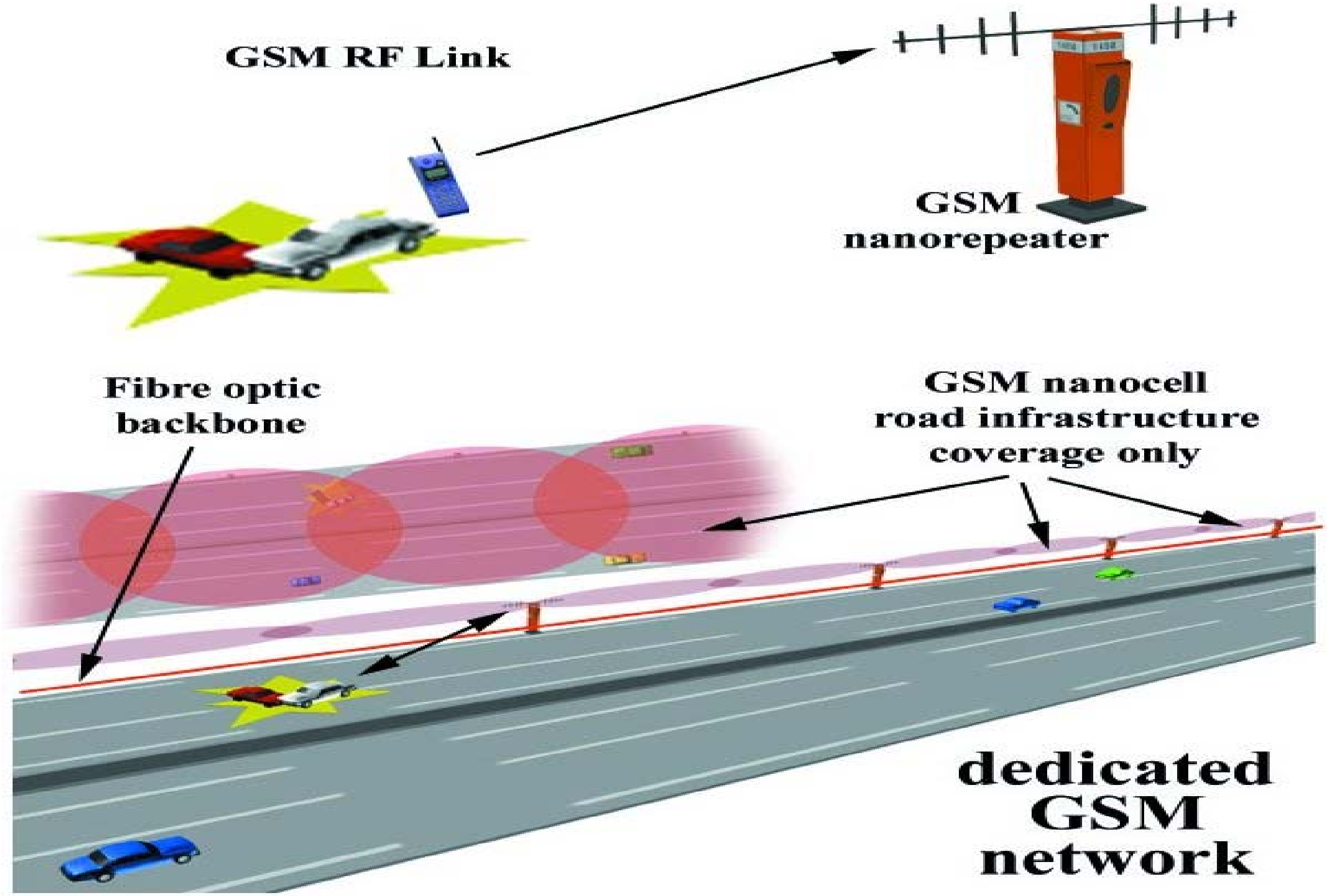
- 75% by end of 2006 ?
- 5-10% increase per year ?

Cell-ID leads to poor accuracy in rural environment



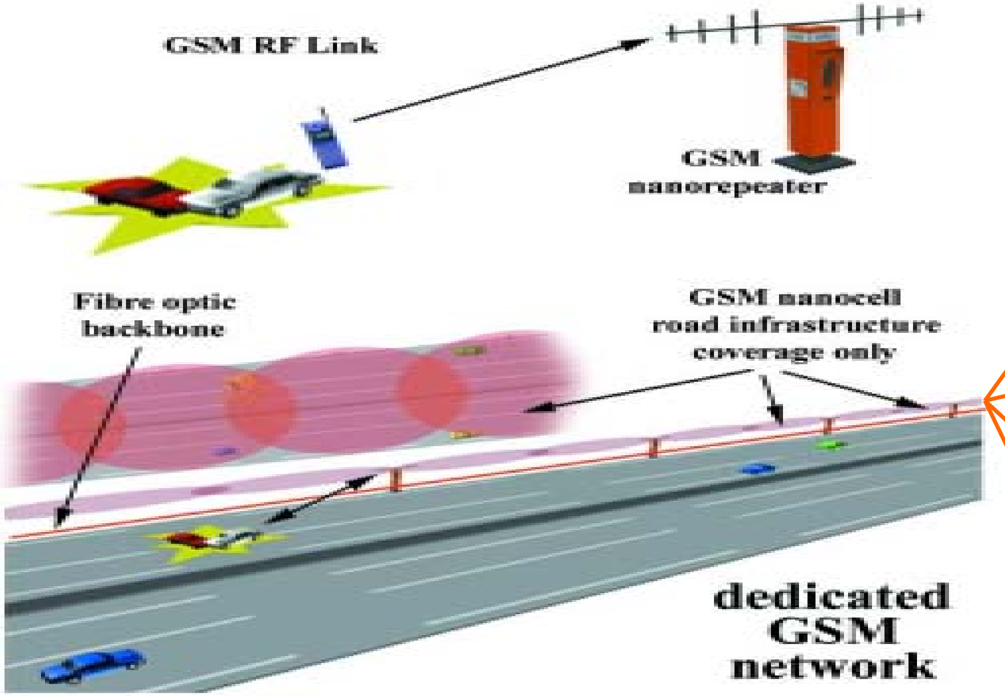
- Conventional cellular phone emergency calling system generates several problems :
  - In case of an accident on a rural motorway involving many vehicles, the telephone cellular network, dimensioned for a low interurban level of traffic, is quickly saturated by a great number of calls.
  - These emergency cellular phone calls do not always reach the relevant infrastructure manager easily.
- Security services (fire brigades, infrastructure staff, ambulances, breakdown services…) generally have their proprietary dedicated analogue communication network that are difficult to operate between each other.
- It seems interesting to merge the cellular phone and the road emergency calling network advantages…

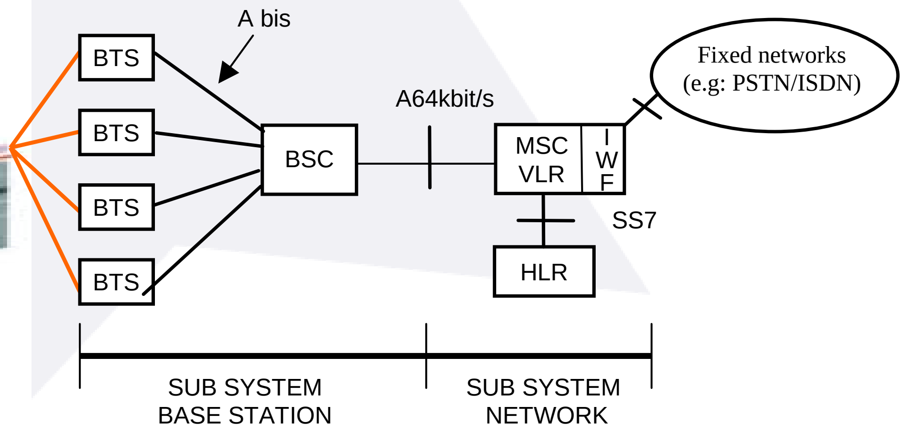
Emergency call boxes equipped with GSM nano-repeaters and directive antennas.



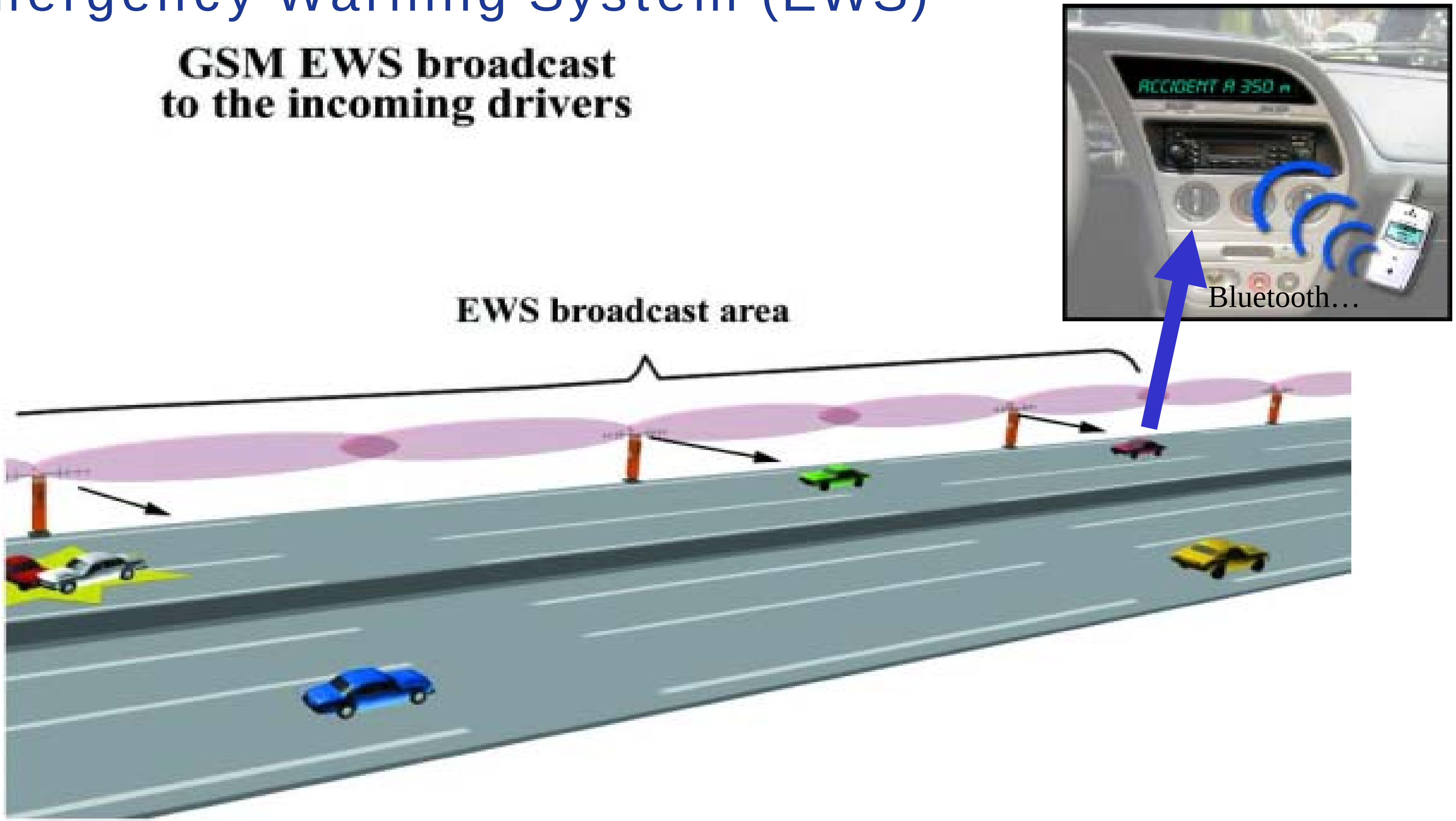
Cellular phone signals transmitted by the fiber optics network up to a TCC GSM dedicated network

The user enters the dedicated GSM network using a special number (107 ?)

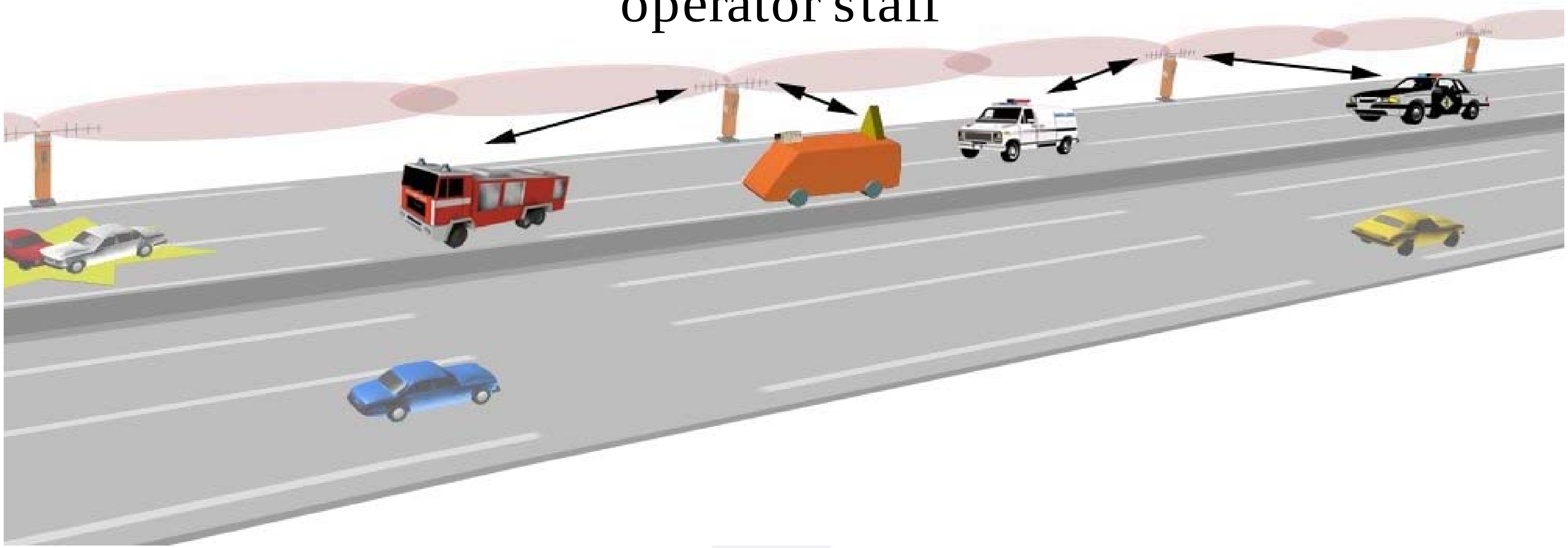




For an effective Emergency calling and Emergency Warning System (EWS)



Interoperable communication infrastructure using standard cellular phones + priority, preemption of the calls...

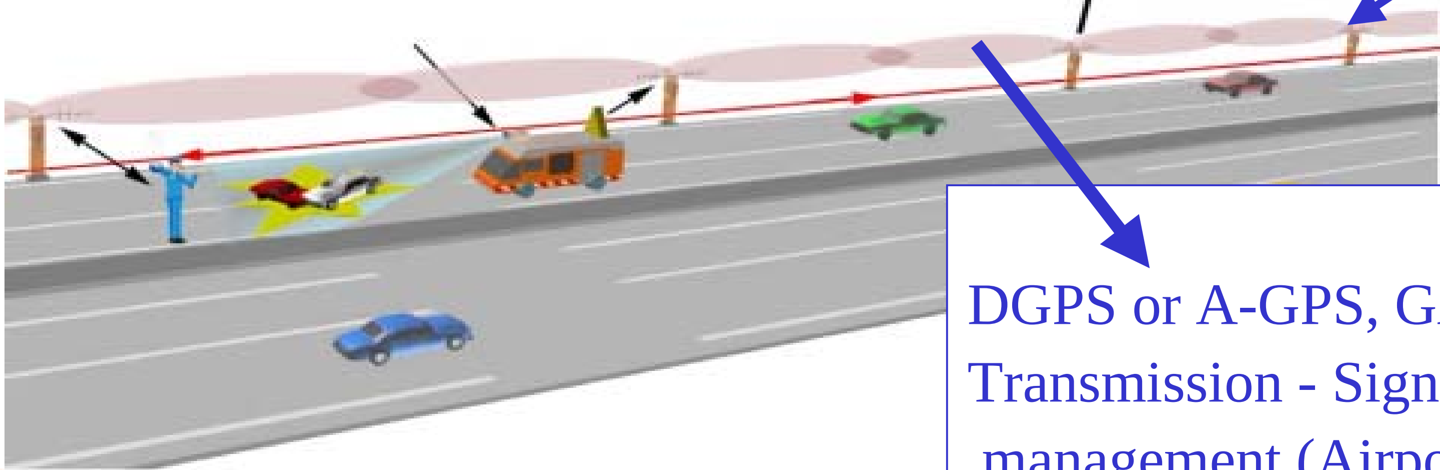


Perspectives : transmission of signals for future road transport services

Monitor in infrastructure manager communication and control room

Several GSM channels to transmit video information from the patrol car to the CCR.

video camera

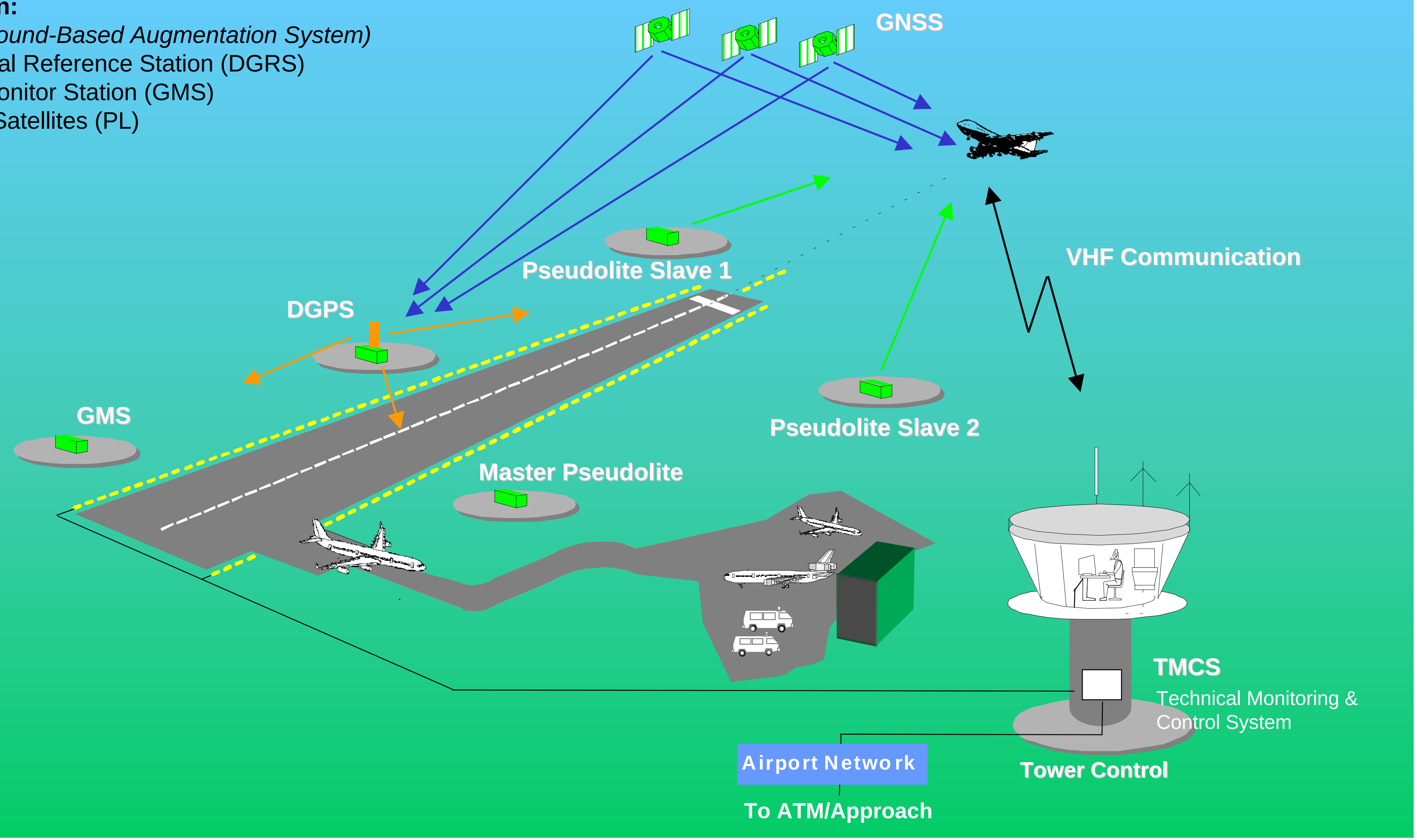


Pseudolites in tunnel

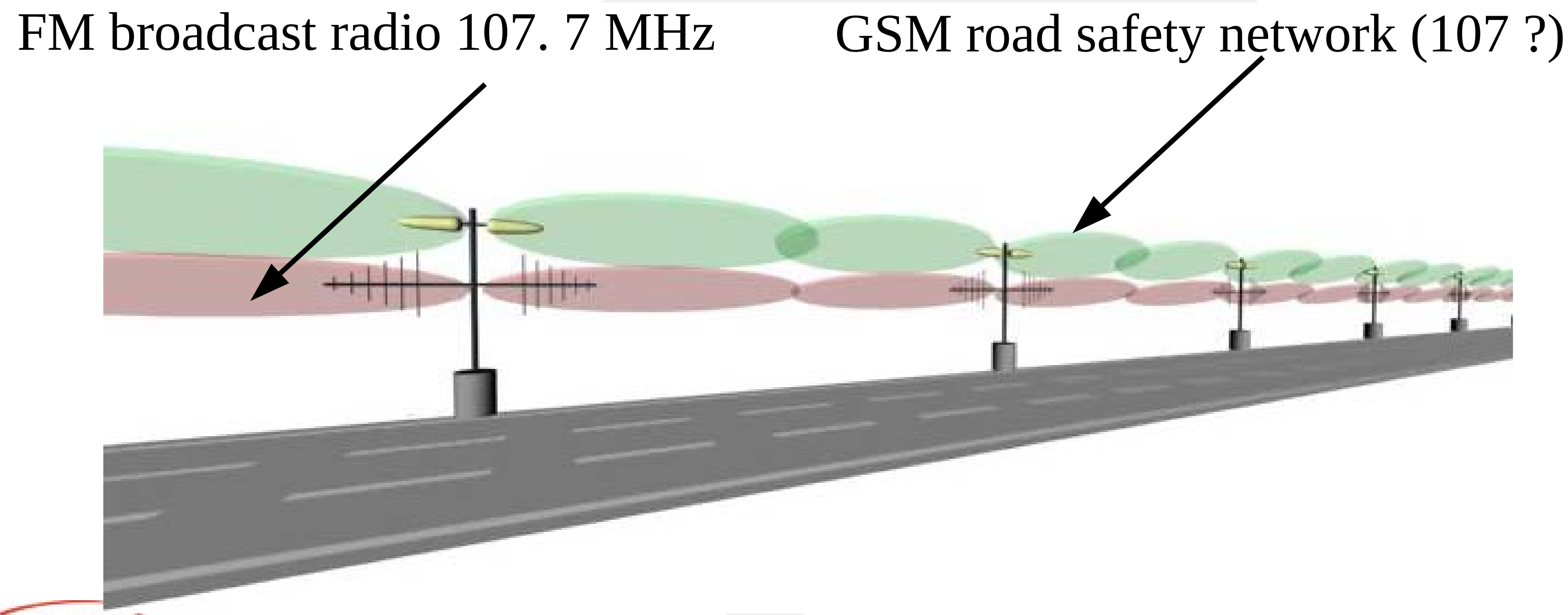
DGPS or A-GPS, GALILEO
Transmission - Signal integrity management (Airport like)

GNSS GPS – GALILEO local augmentations on an airport (all weather landing) CNS/ATM // CNS-Terrestrial Transport

Navigation:
GBAS *(Ground-Based Augmentation System)*
- Differential Reference Station (DGRS)
- GNSS Monitor Station (GMS)
- Pseudo-Satellites (PL)

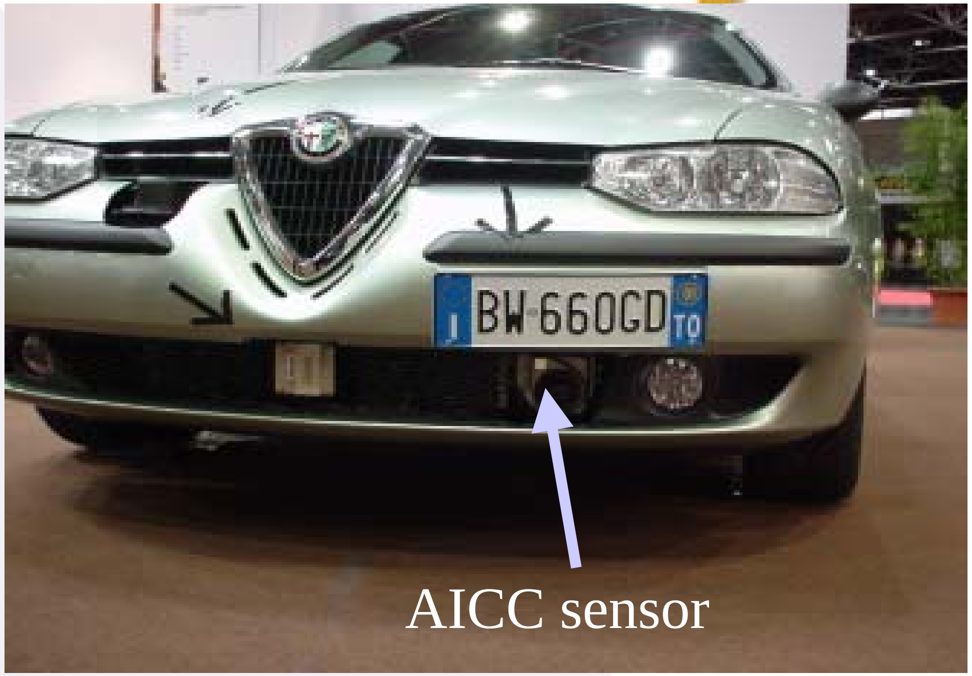


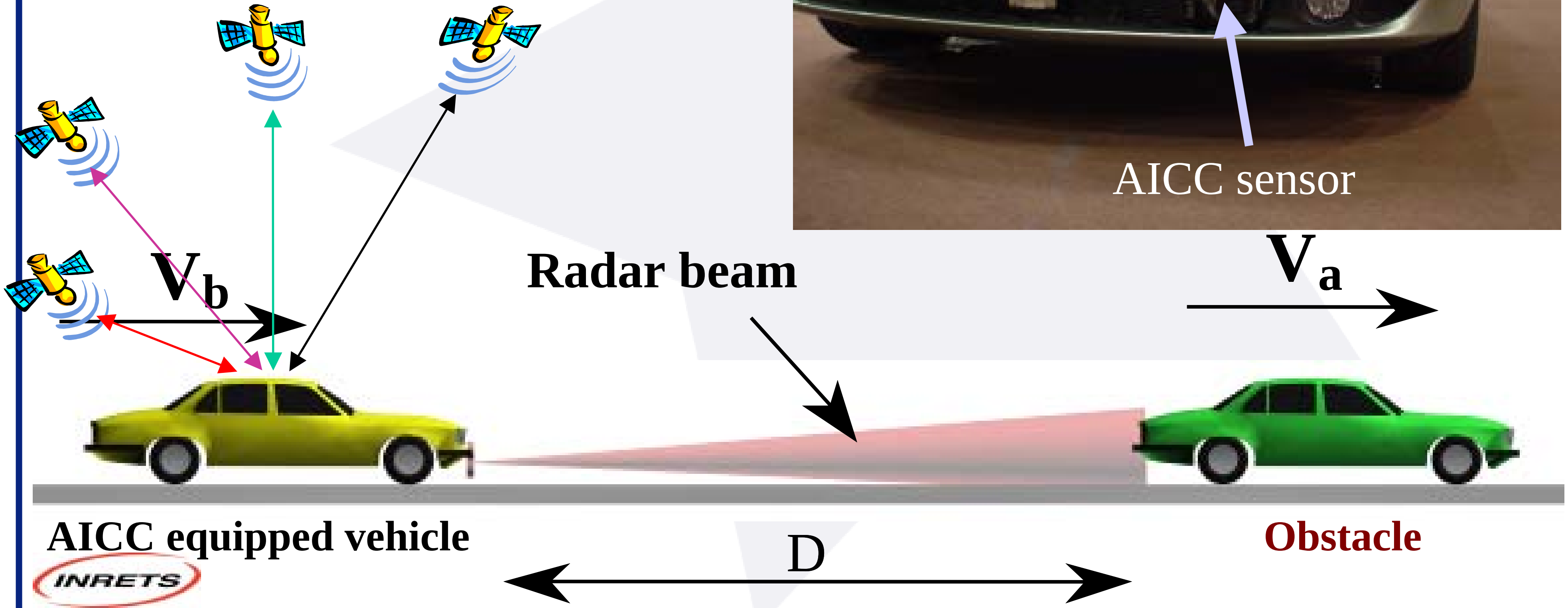
Alternative architecture : using the FM radio existing infrastructure to add to a broadcast only system, a two-way pan-european vehicle-infrastructure communication system.



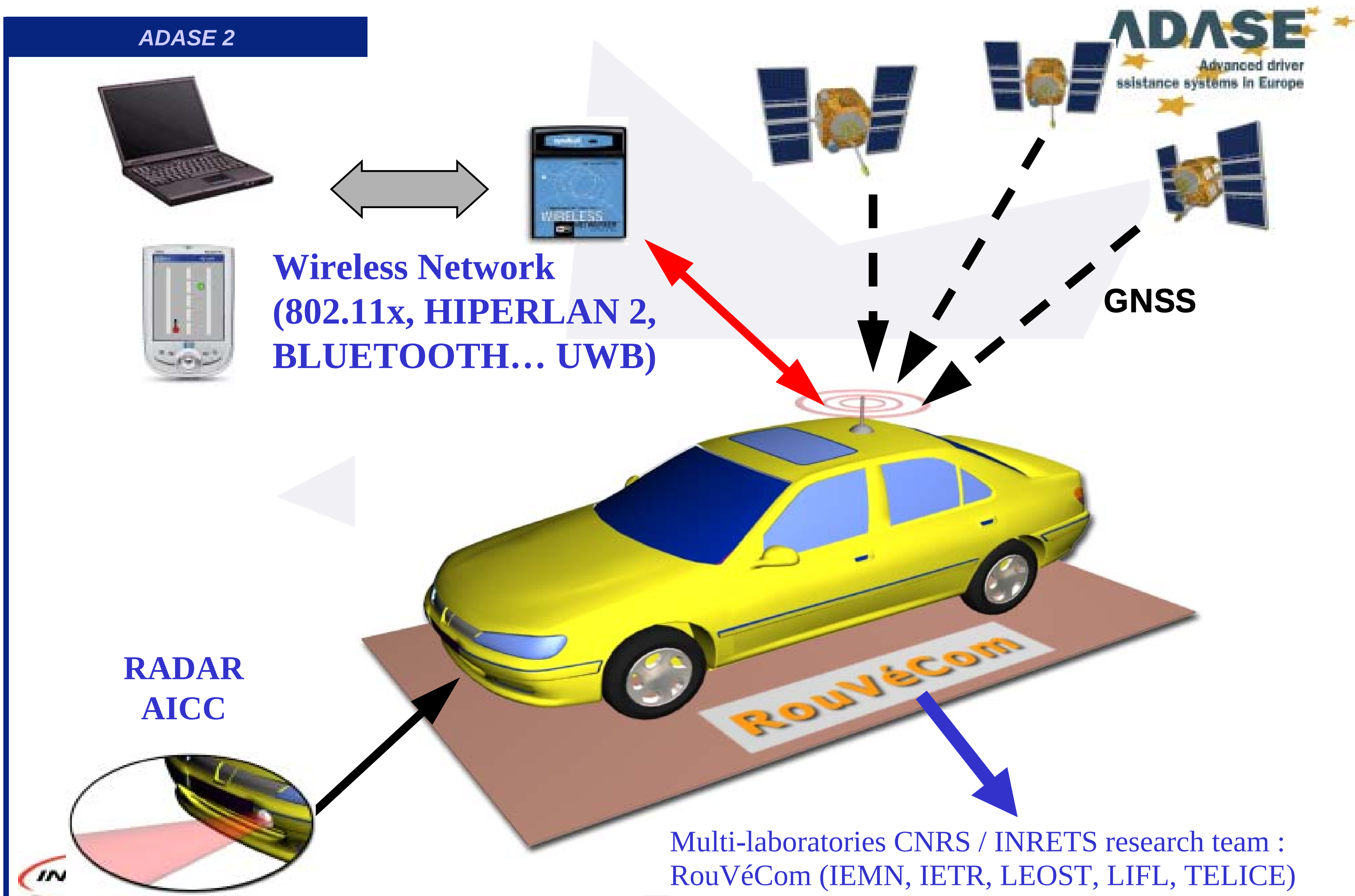
Vehicle-to-Vehicle communication

AICC current industrial evolution towards the « Predictive Cruise Control ». It is based on the accurate location of the equipped vehicle (GNSS) coupled to an on-board cartography (road topography, curves, lateral signs, slippery road...).





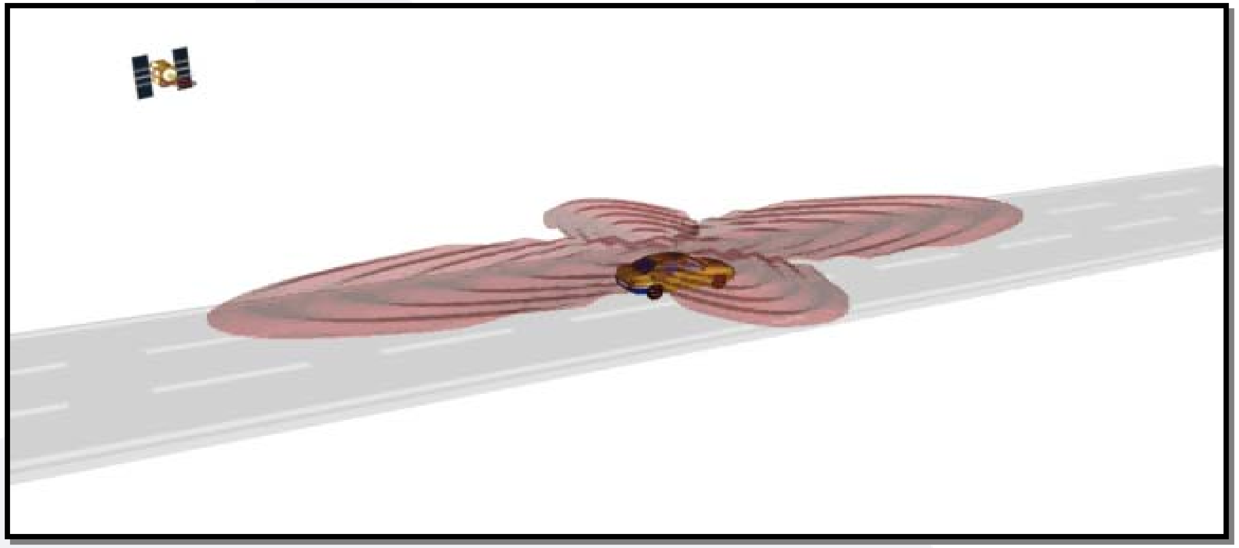
ADASE 2



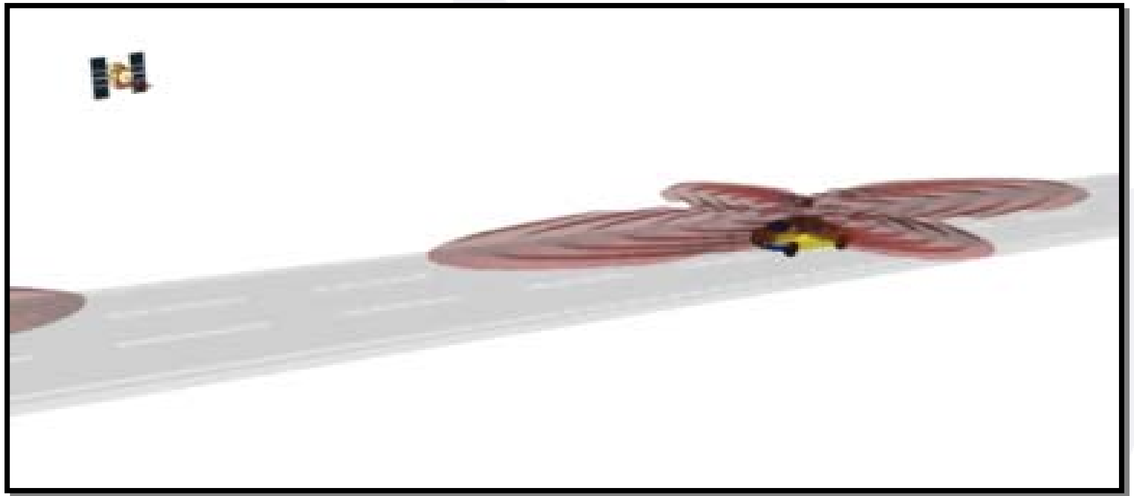
Multi-laboratories CNRS / INRETS research team :
RouVéCom (IEMN, IETR, LEOST, LIFL, TELICE)

Vehicle-to-Vehicle communication

First approach : Sharing telecommunication resources



Localization data are broadcasted/exchanged with potential surrounding vehicles through a 802.11x, HIPERLAN 2, UWB… communication system.



Vehicles among a platoon exchange their absolute coordinates and localize themselves along the road network
(further step : video transmission ?)

Vehicle-to-Vehicle communication

Second approach using a dedicated equipment

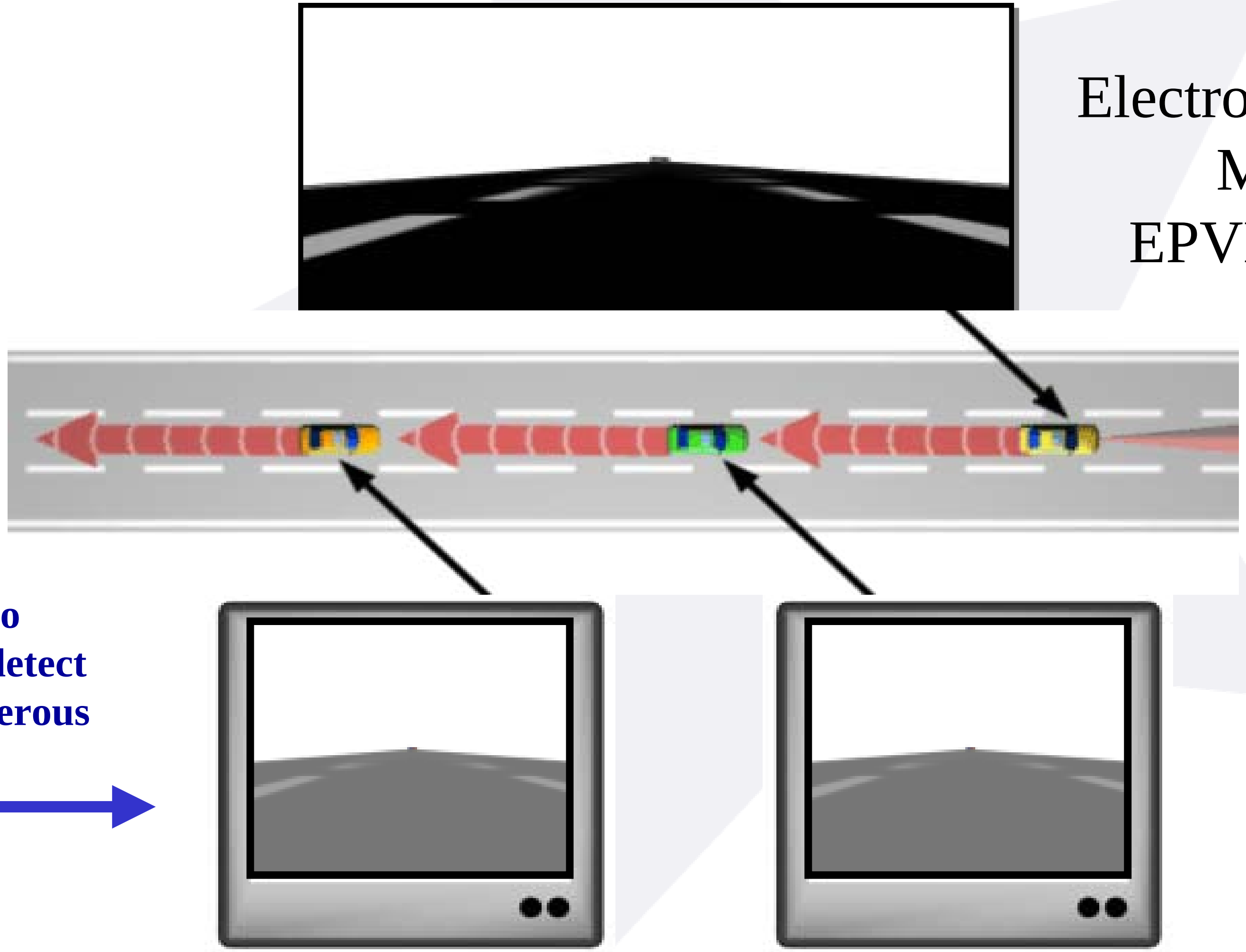
Key elements

- Within a platoon, car drivers use information about the speed and position of the preceding and following vehicles in order to elaborate and update a real time driving solution.
- AICC systems as well as anti-collision radars only track the first preceding vehicle to deduce its speed and position. This computed information remains on board.
- Within a platoon, the frontal road perception of the first vehicle is very particular and highly significant.
- It seems interesting that this information be real time shared with the following vehicles within the platoon.

→ Electronic Preview Mirror concept

- ***Technically, two technologies are considered :***
  - ***Using* 802.11x, HIPERLAN 2, BLUETOOTH… UWB technologies.**
  - ***Extending the functions performed by an AICC 76 GHz sensor.***

Real time sharing the first platoon vehicle road perception with the other platoon vehicles

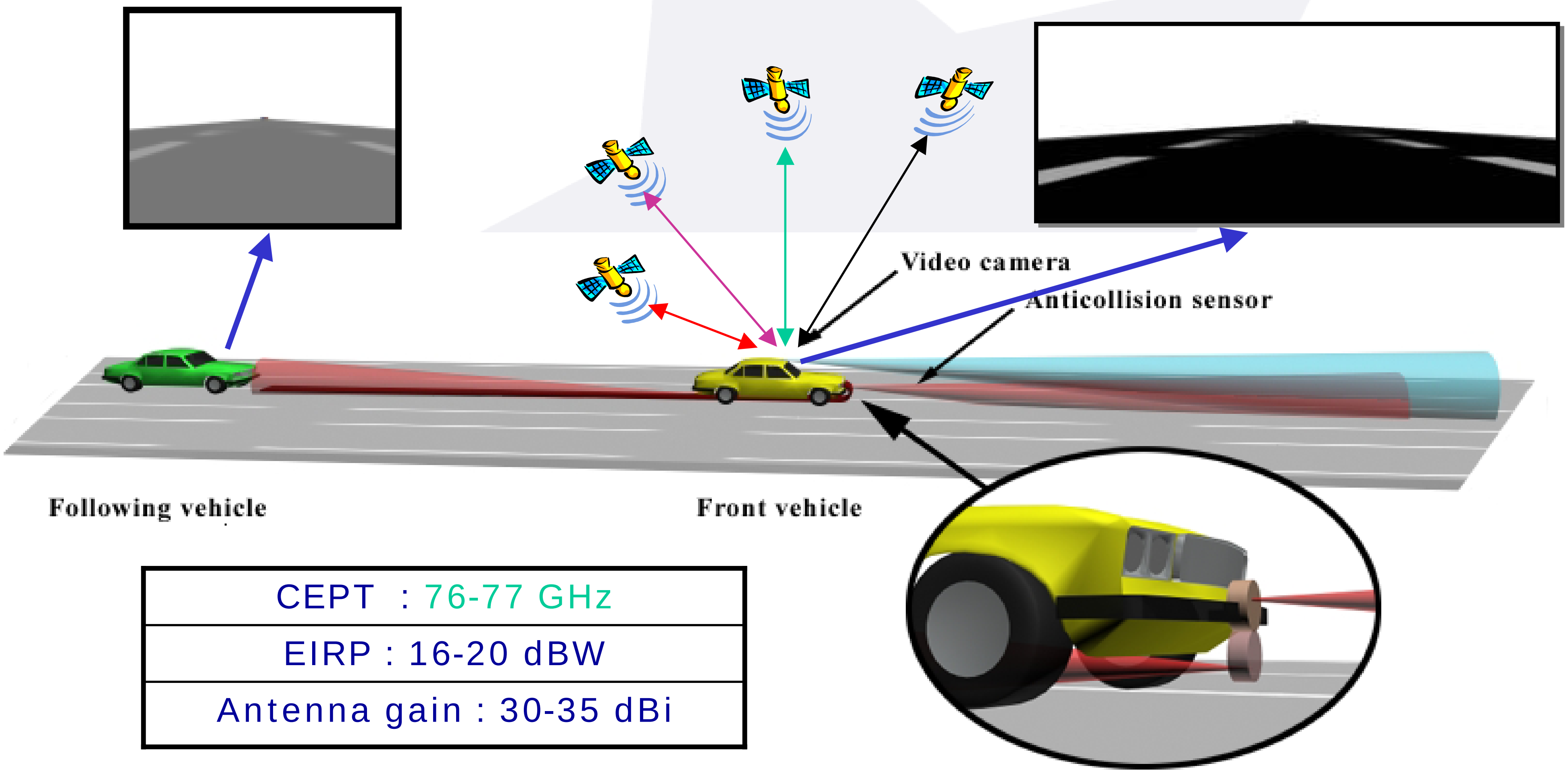


Electronic PreView Mirror - EPVM concept

On-board video processing to detect potential dangerous road driving conditions

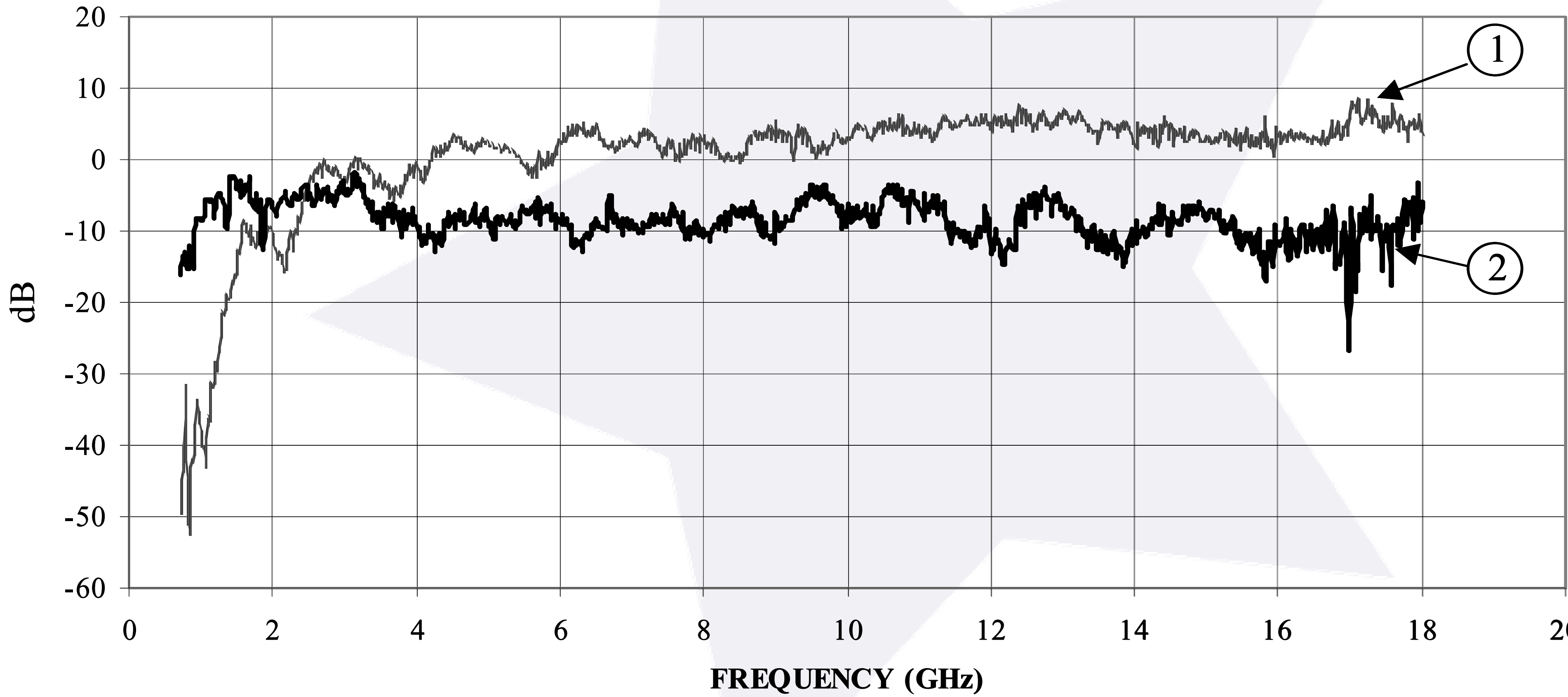
AICC based EPVM

Goal : Anticipation of the car driving task



CEPT : 76-77 GHz
EIRP : 16-20 dBW
Antenna gain : 30-35 dBi

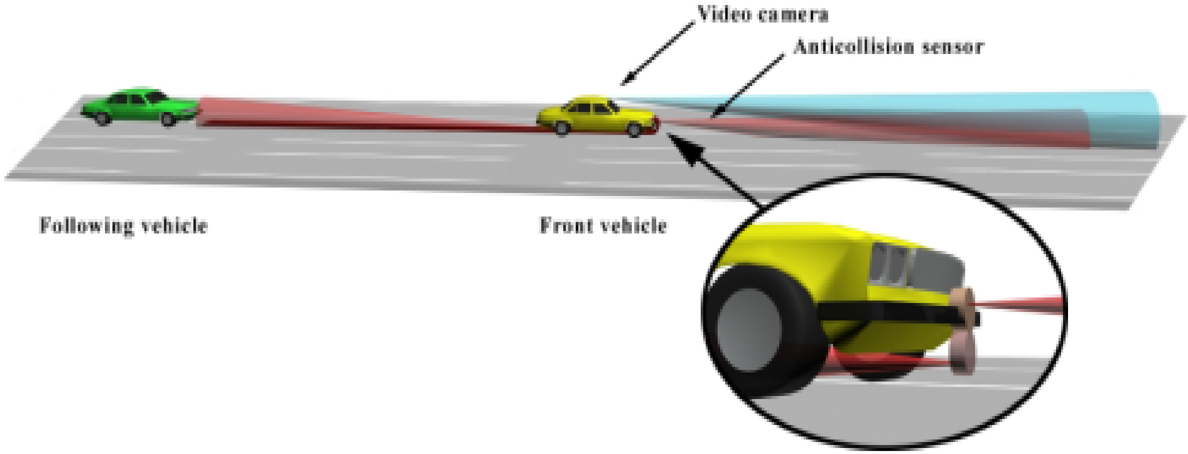
Example of measured attenuation (polarization H-H)

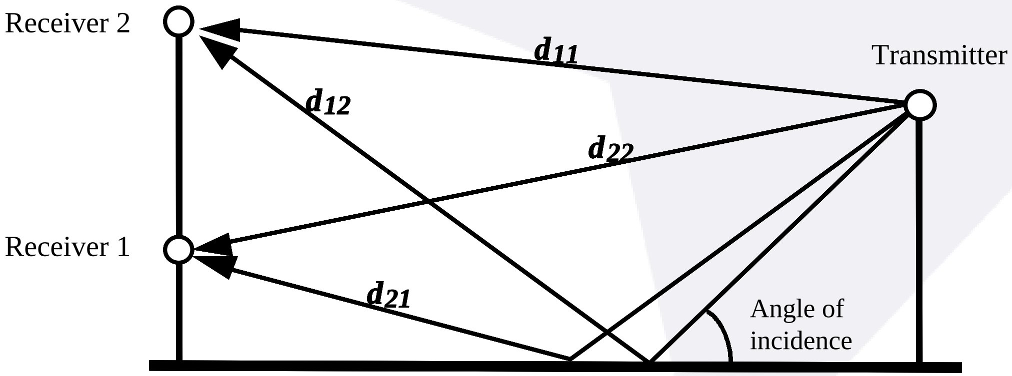


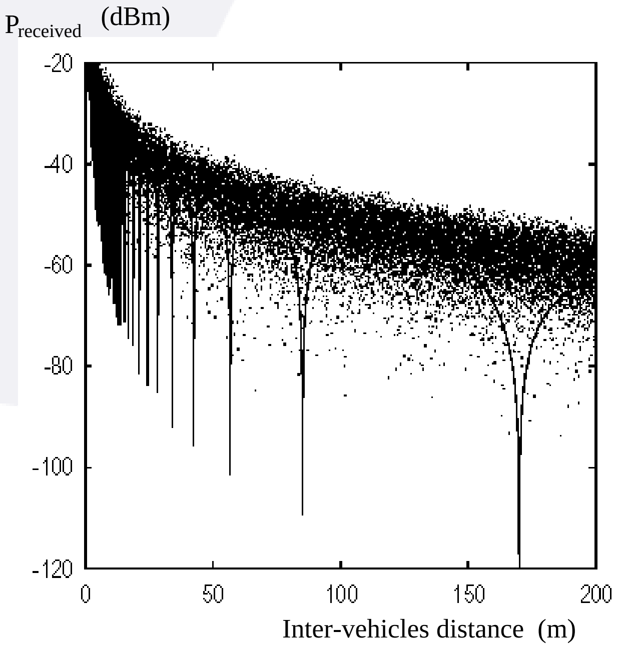
1 Beneath the car 2 Through the windscreen

ADASE Advanced driver assistance systems in Europe

Millimeter wave RF channel model







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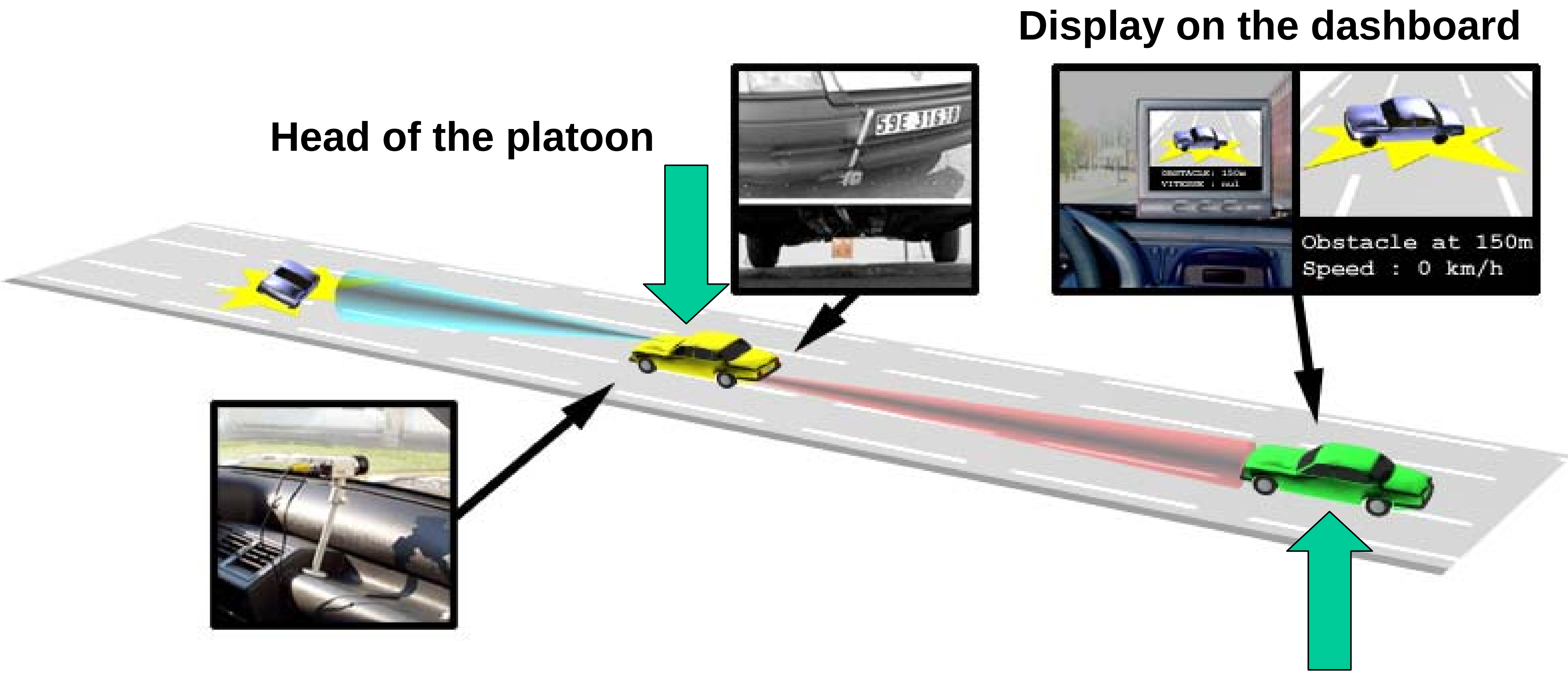
The first EPVM demonstrator



EPVM conclusion

- The EPVM function can be built technically using different technologies.
- We have explored the possibility of extending the function provided by an AICC (radar) sensor to a high rate vehicle-vehicle communication link. The under-car microwave radio path is effective to transmit information to following vehicles.
- A correlation type radar (AICC) architecture can easily be modified to support these two functions simultaneously and that the hardware characteristics of the sensor easily accept MPEG-x type modulation frames.
- Initial experimentation has shown that this communication link can be exploited on paths up to several hundred meters.
- 802.11x, HIPERLAN 2, BLUETOOTH… UWB technologies are also now currently considered by the RouVéCom team in order to support this EPVM function.

ADASE Advanced driver assistance systems in Europe

General conclusion

There is an need for the integration of :

- **C**ommunication (fixed networks, vehicle-to-infrastructure, vehicle-to-vehicle an in-vehicle)
- **N**avigation (GNSS 2, GPS, GLONASS, GALILEO, cellular phone…)
- **S**urveillance (AICC, radar LRR-SRR, video…)

systems in order to achieve an efficient global system :

CNS-2T (Terrestrial Transport)

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