LECTURE

7

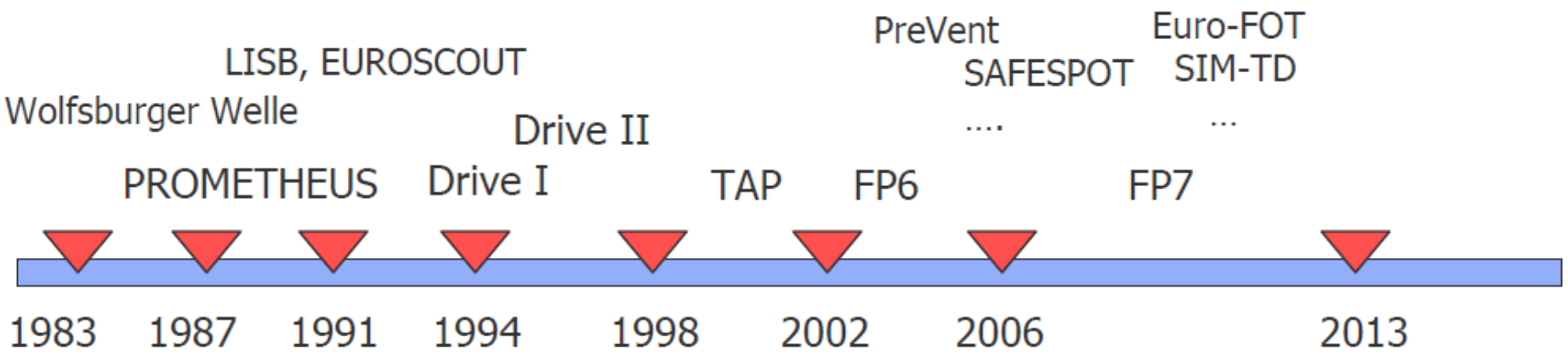
Cooperative systems projects

Lecture 7 - Overview

- Cooperative systems
  - Projects
  - Field operation tests

History of projects dealing with cooperative systems

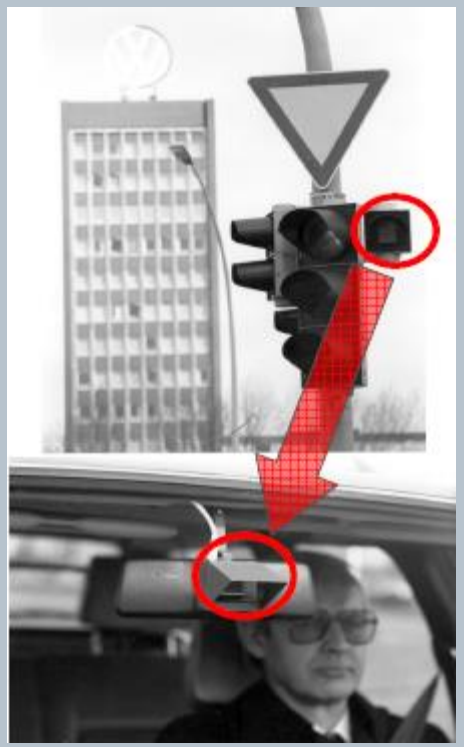
- From the 80s
- Application possibilities so far limited on the technology level



History of cooperative system projects

Wolfsburger Welle project (1981-1983)

- DSRC with infrared
- smoothing flow in Green Waves



Recent cooperative projects

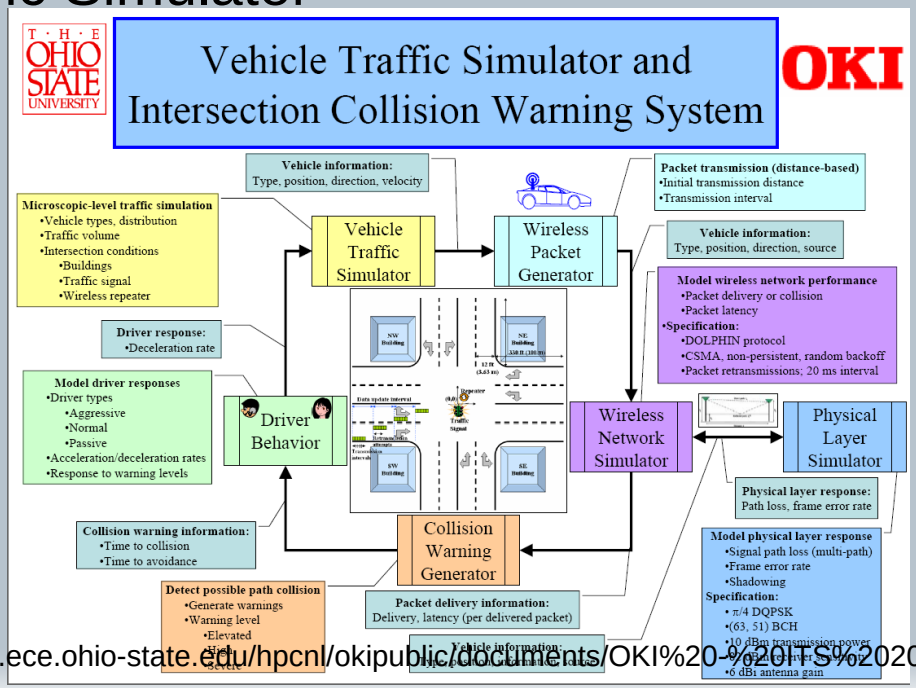
- FleetNet (2000-2003)
- OKI (- 2004)

- Com2React (2006-2007)
- CVIS (2006-2010)
- SAFESPOT (2006-2010)
- COMeSAFETY (2006-2009)
- I-WAY (2006-2009)
- COOPERS (2006-2010)

- **CAR2CAR (consortium)**

OKI

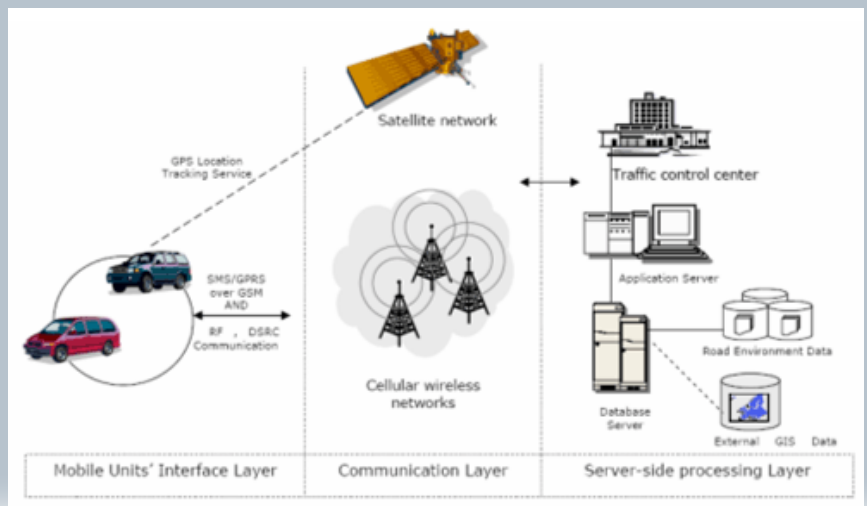
- Project led at the Ohio State University from 2004
- Oriented at the usage of VANET networks (Vehicular Ad-hoc Network) for increasing traffic safety
- Emphasis laid on Intersection Collision Warning System
- For simulation use of two simulators - Wireless Simulator and Vehicle Traffic Simulator



http://www2.ece.ohio-state.edu/hpcnl/okipublic/documents/OKI%20-%20ITS%202004.pdf

I-WAY (2006-2009) (Intelligent co-operative system in cars for road safety)

- FP6 project
- Goal: to offer drivers various information gained both form vehicle systems and from infrastructure
- Information sources
  - in vehicle: vehicle sensing module, data acquisition module, mobile interfaces of the vehicle, situation assessment module, communication module
  - in the infrastructure: road side equipment and road management system
- 14 project partneres



WATCH-OVER (2006-2008)

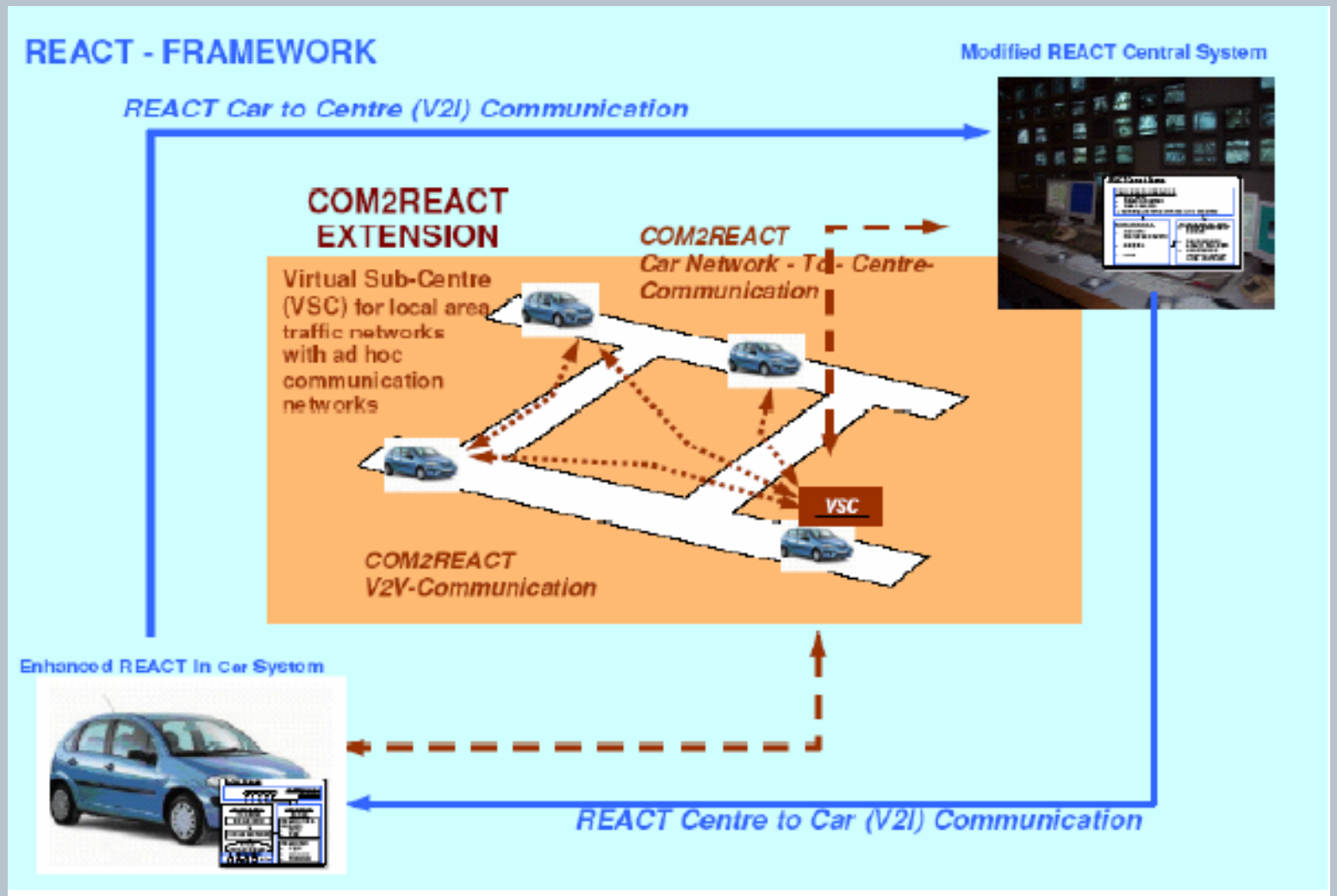
Vehicle-to-Vulnerable roAd user cooperaTive communication and sensing teCHnologies to imprOVE transpoRt safety

- FP6 project
- Deals with cooperative systems
- for pedestrians, cyclists, motorcyclists, etc.
- Concept is represented by an on board platform and by a vulnerable user module
- system is based on short range communication and vision sensors

COM2REACT

- COM2REACT will establish a multi-level, scalable cooperative system involving two-way vehicle to vehicle (V2V) and vehicle to center (V2C) communication
- A key feature of COM2REACT is a virtual traffic control sub-centre, which controls a moving group of vehicles in close proximity
- The virtual sub-centre (VSC) functions locally via the V2V communication system, processing data acquired by the vehicles and rapidly providing instructions related to local traffic and safety situations.

COM2REACT principles



COM2REACT Example of application

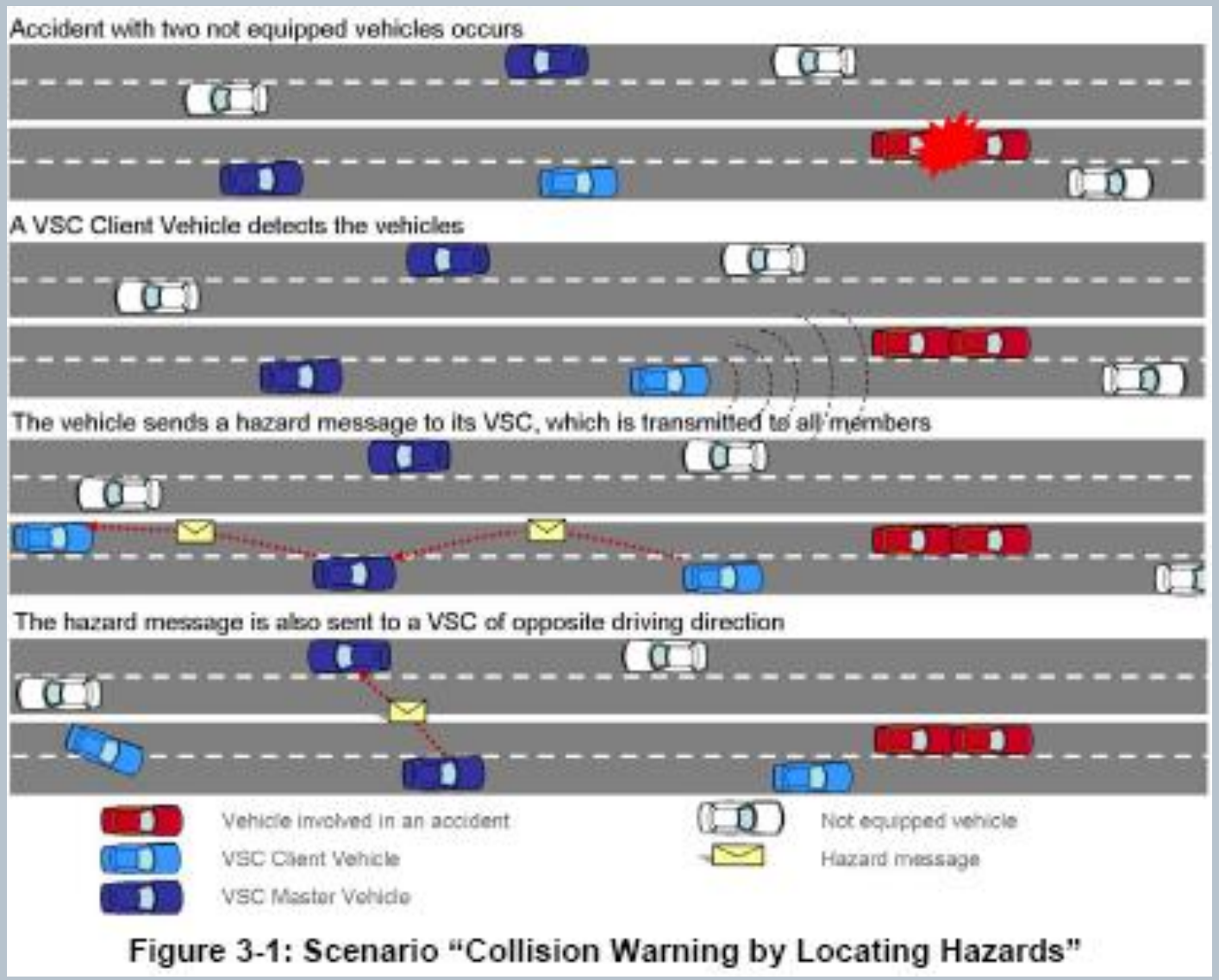
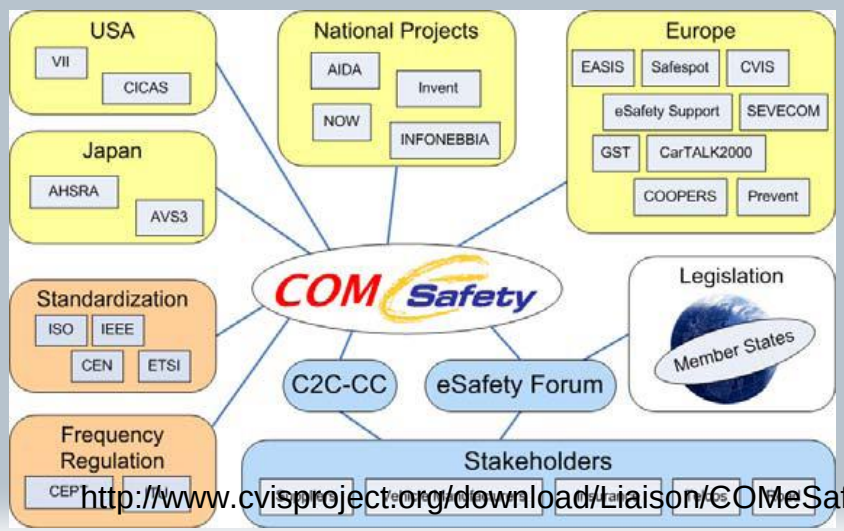


Figure 3-1: Scenario "Collision Warning by Locating Hazards"

Source: Com2React Deliverable 6.2 Evaluation of the system benefit

COMeSAFETY

- FP6 project
- Goal to coordinate and consolidate results from various projects (both European and national) and also from relevant associations (e.g. Car2Car)
- Purpose: e.g. To prepare standardization for cooperative applications for different technologies
- 7 project members – mainly vehicle manufacturers

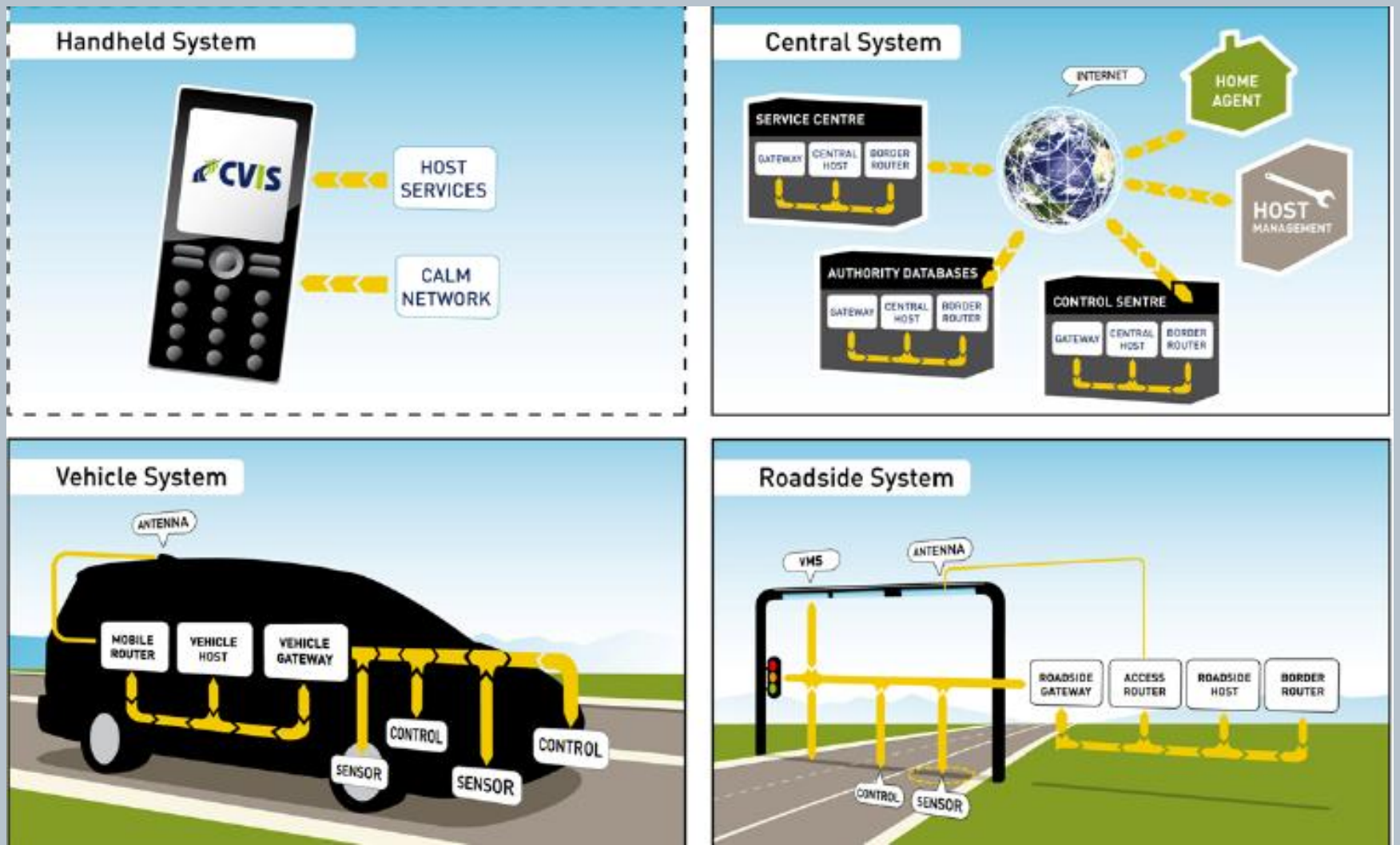


Source: http://www.cvisproject.org/download/Liaison/COMeSafety%20Newsletter%20Issue%20172006.pdf

CVIS (2006-2010)

- Creating a unified technical solution allowing all vehicles and infrastructure elements to communicate with each other in a continuous and transparent way using a variety of media and with enhanced localisation
- Addressing issues such as user acceptance, data privacy and security, system openness and interoperability, risk and liability, public policy needs, cost/benefit and business models, and roll-out plans for implementation.
- Achievement is a universal platform environment for cooperative systems with multi-path communication interface
- more than 60 partners from many EU countries

CVIS vision

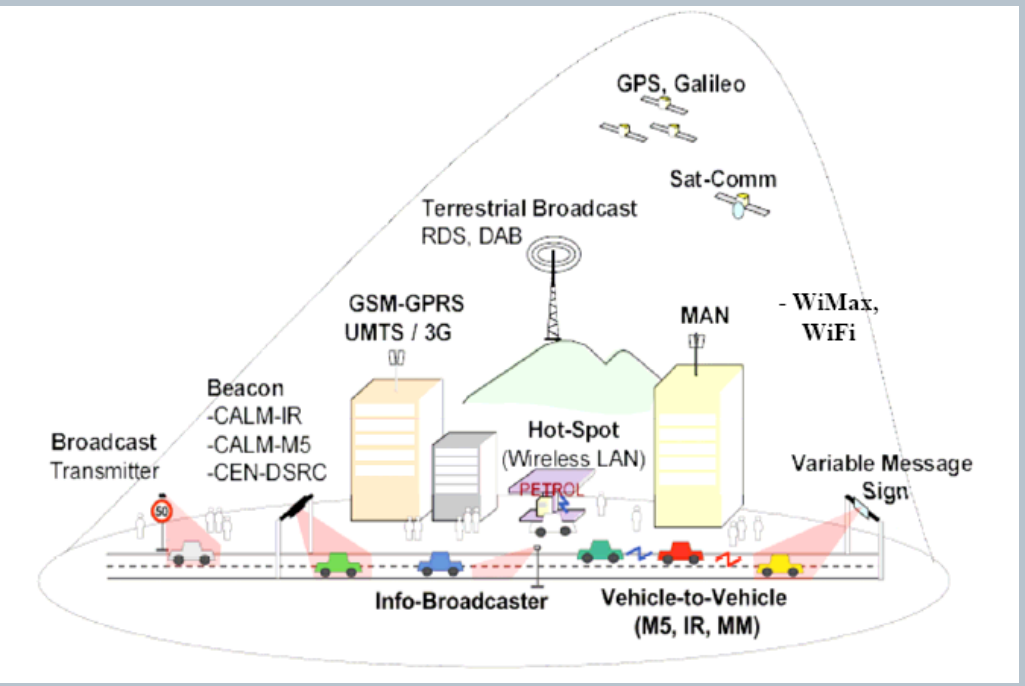


Source: CVIS Deliverably 2.1_System Concept Definition_v9.0

CVIS telecommunication environment

- CVIS communication environment based on a multi-channel terminal capable of connecting to a wide range of potential carriers, including
  - Mobile wireless Local Area Networks (WLAN/Wi-Fi)
  - Cellular networks (GPRS, UMTS)
  - Short-range microwave beacons (DSRC)
  - Infrared (IR)
- Scheme is based on the new international CALM standards that will provide full interoperability between particular controllers

CVIS – telecommunication environment



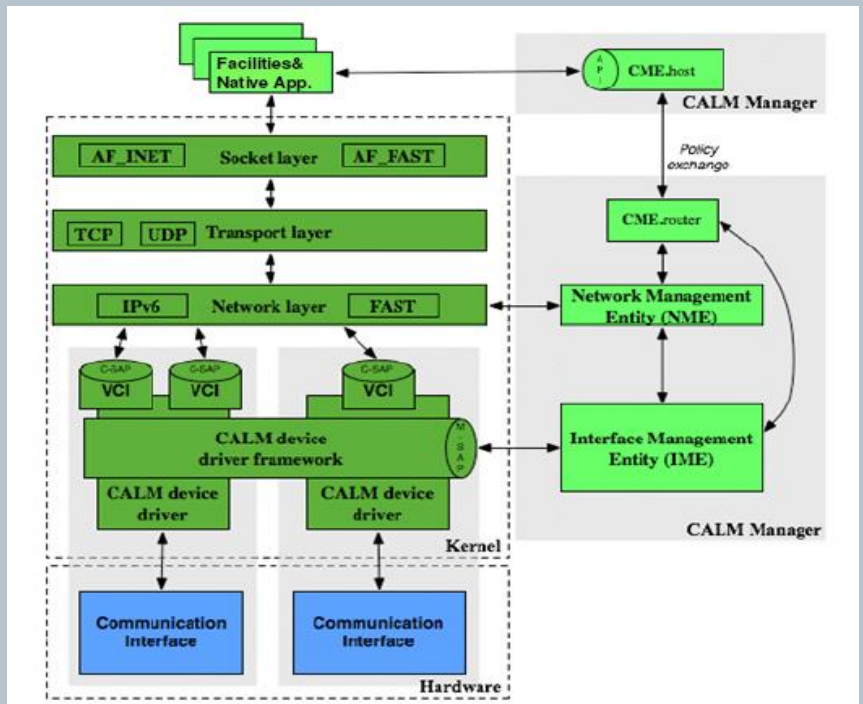
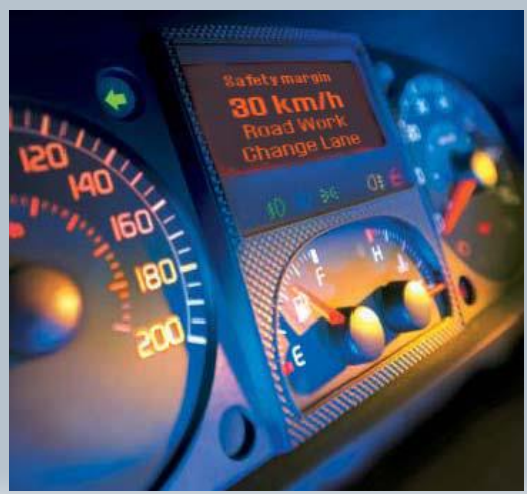


Figure 88: Communication Stack

Source: CVIS presentation, conference ITS Europe 2007 Aalborg

SAFESPOT

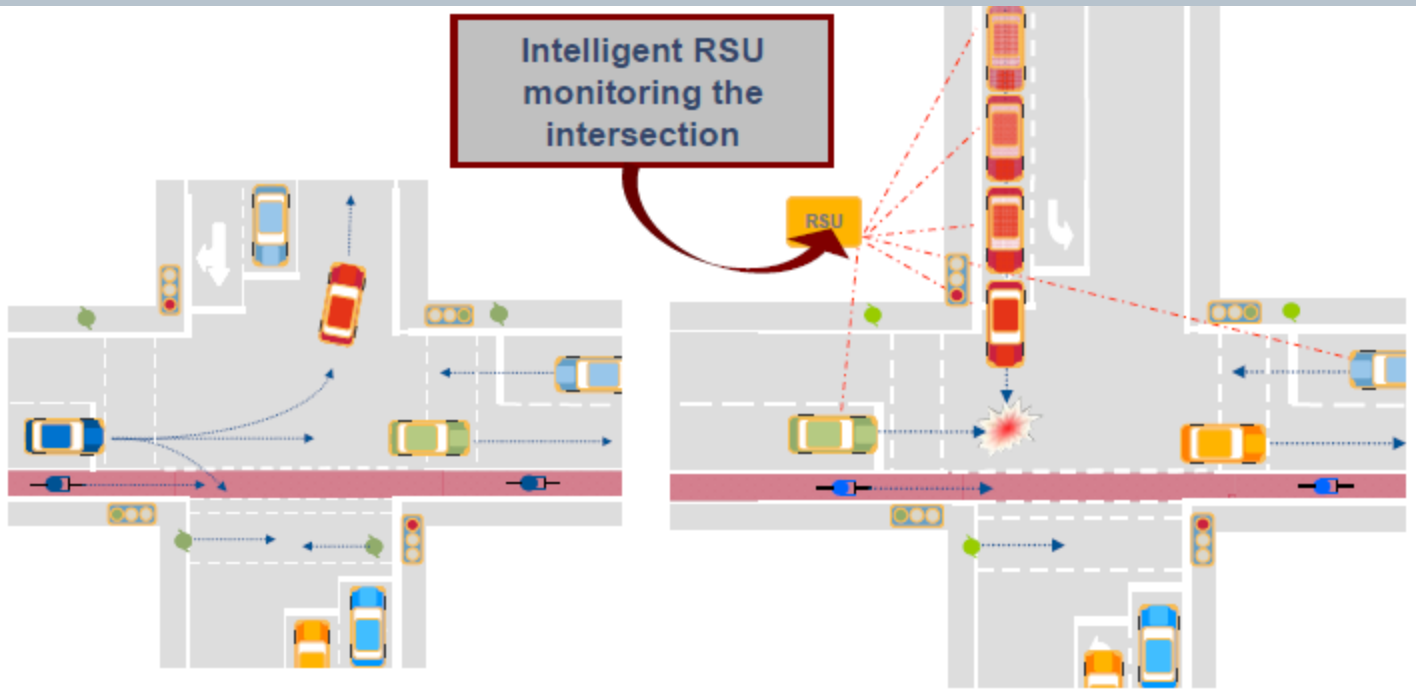
- FP6 project
- Goal to prevent road accidents developing a “Safety Margin Assistant” that :
  - detects in advance potentially dangerous situations,
  - extends “in space and time” drivers’ awareness of the surrounding environment.
- The Safety Margin Assistant will be an Intelligent Cooperative System based on
  - Vehicle to Vehicle (V2V) and
  - Vehicle to Infrastructure (V2I) communication
- More than 50 partners from many EU countries



SAFESPOT activities

- To use both the infrastructure and the vehicles as sources (and destinations) of safety-related information and develop an open, flexible and modular architecture and communication platform.
- To develop the key enabling technologies:
  - ad-hoc dynamic networking,
  - real-time relative positioning,
  - dynamic local maps.
- To test scenario-based applications to evaluate the impacts and the **end-user acceptance**
- To define the practical implementation of such systems, especially in the initial period when not all vehicles will be equipped.

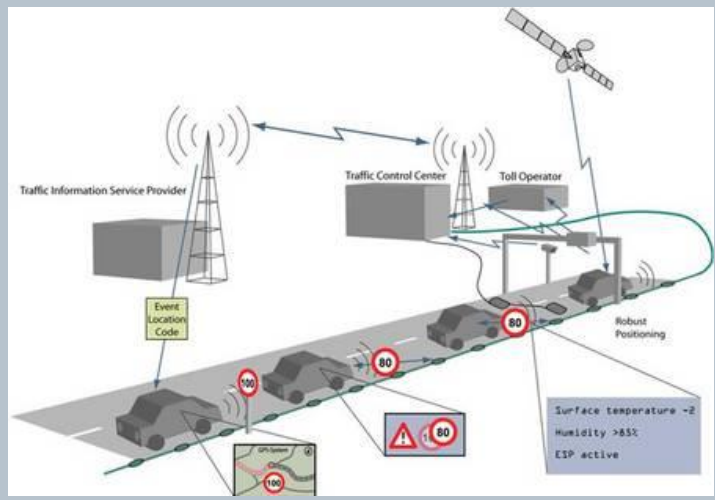
SAFESPOT –example of applications



- Safe signalized intersection (red light violation) – two phases
- Safe signalized intersection (right turning)
- Safe signalized intersection (left turning)
- Emergency vehicle approaching a controlled intersection

COOPERS (2006-2010) (CO-OPerative SystEms for Intelligent Road Safety)

- FP6 project
- development of innovative telematics applications on the road infrastructure
- Improving traffic sensors on the infrastructure to fulfil the demands of C2X applications
- Development of communication concept (reliability, real-time, robustness), using different technologies (DAB, CALM, IP networks)
- Demostration of results, development of implementation strategies
- More than 40 partners from European countries

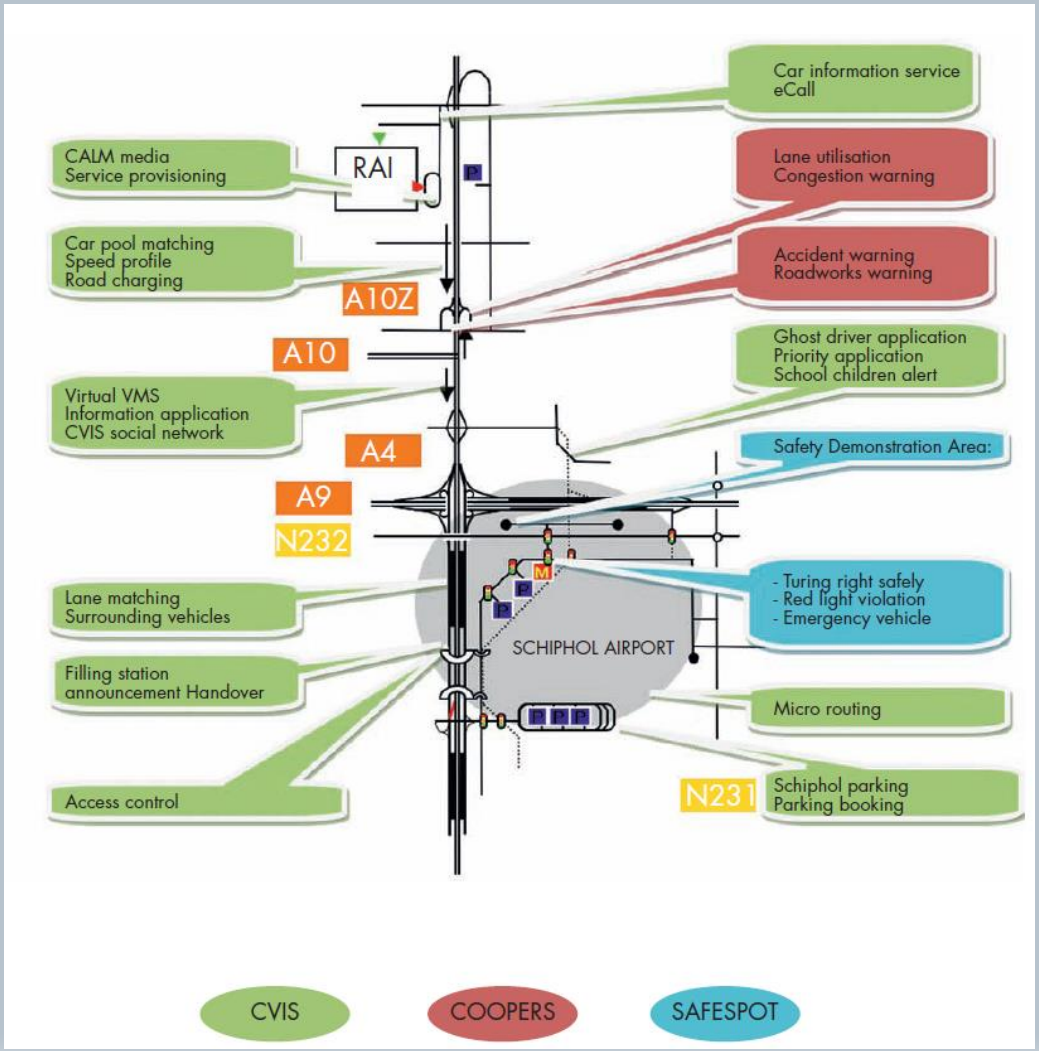


Presentation of cooperative project results - Cooperative Mobility Showcase 2010

- Cooperative Mobility Showcase 2010: smart vehicles on intelligent roads, March 2010, Amsterdam
- Main projects presented
  - Coopers
  - Safespot
  - CVIS
- Demonstration of prototype applications of cooperative systems

Prototype applications at Mobility Showcase

Presented in March 2010 at the Cooperative Mobility Showcase – results of European projects

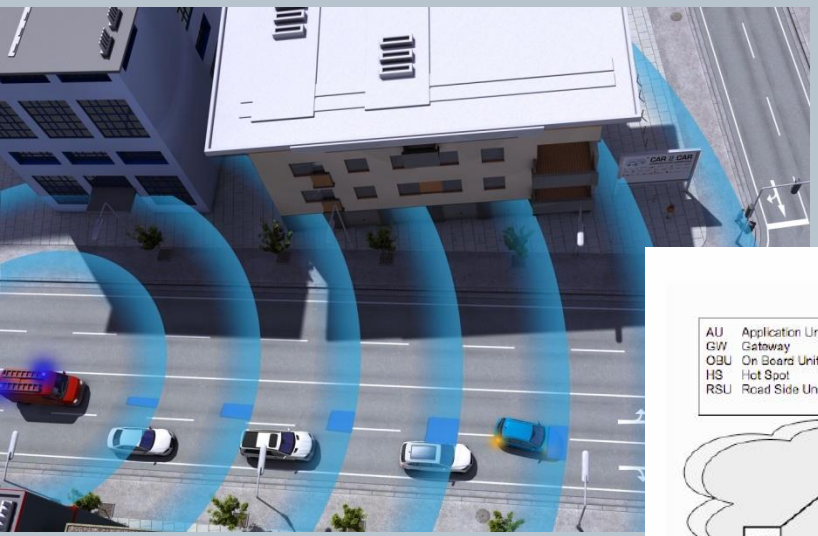


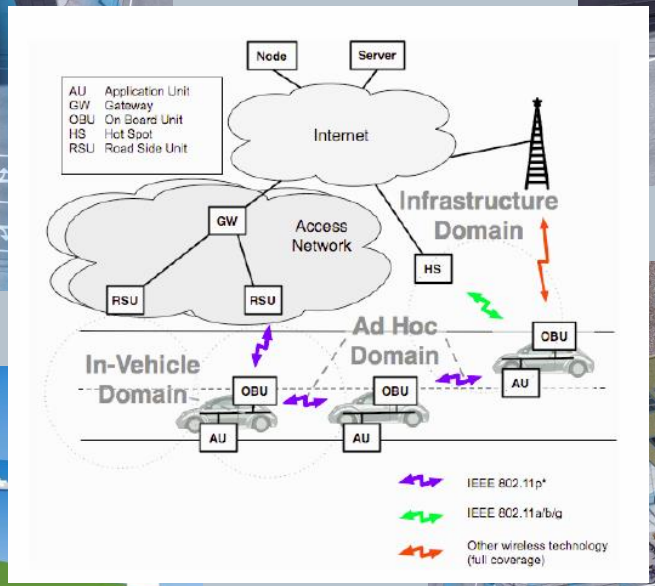
Source: Cooperative Mobility Demonstration Guidebook http://www.cooperativemobilityshowcase.eu/nl/en/2010/Documents/Demo_Guide_FINAL.pdf

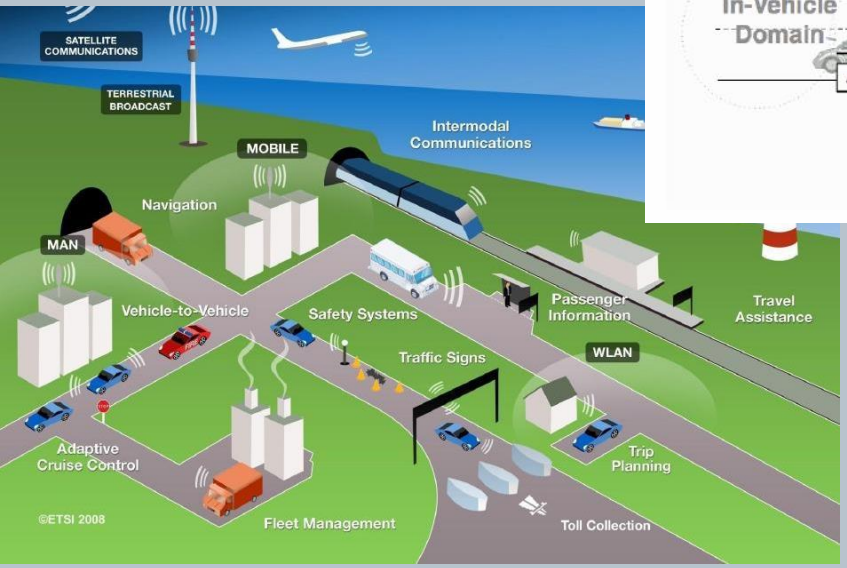
CAR2CAR consortium

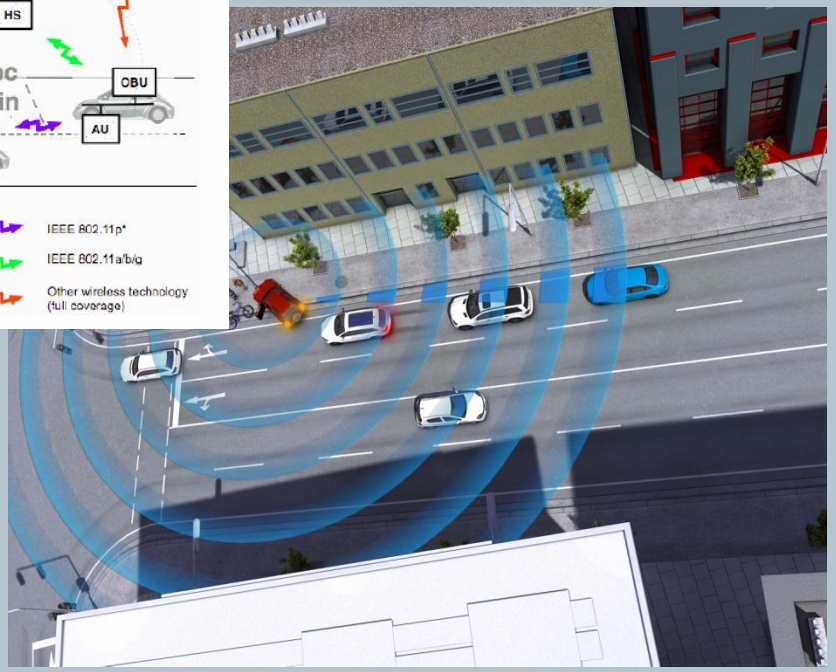
- Goal to create and establish an open European industry standard for Car-2-Car Communication Systems based on wireless LAN components and to guarantee European-wide inter-vehicle operability
- Enable the development of active safety applications by specifying, prototyping and demonstrating the Car-2-Car System
- Push the harmonisation of Car-2-Car Communication Standards worldwide (The goal to promote the allocation of a royalty free European wide exclusive frequency band for CAR 2 CAR applications was achieved in 2008)
- Communication based on IEEE 802.11a, b, g, p
- Develop realistic deployment strategies and business models to speed-up the market penetration
- Consortium formed by 8 car manufacturers and several associated members

CAR2CAR application visions









Source: CAR 2 CAR Communication Consortium

Recent cooperative systems projects

Main focus on cooperative systems testing

- DRIVE C2X (2011-2013)
- COMeSAFETY 2 (2011-2013)
- FOTsis (2010-2014)
- Ko-Fas (2009-2013)
- Car manufacturers‘ research and development

DRIVE C2X

- 31 partners
- addresses large-scale field trials under real-world conditions
- multiple national test sites across Europe
- Using common European architecture for cooperative driving systems defined by COMeSafety
- Using 802.11p

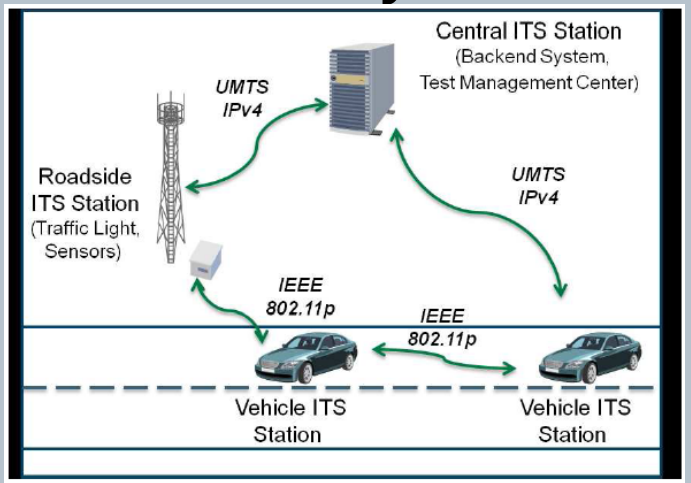


Figure 2: DRIVE C2X architecture

Source: Andreas Festag, Long Le, Maria Goleva. Field Operational Tests for Cooperative Systems: A Tussle Between Research, Standardization and Deployment. VANET, Las Vegas. 2011

DRIVE C2X – project test sites

- Tampere, Finland
- Gothenburg, Sweden
- Helmond, the Netherlands
- Frankfurt, Germany
- Yvelines, France
- Brennero, Italy
- Vigo, Spain

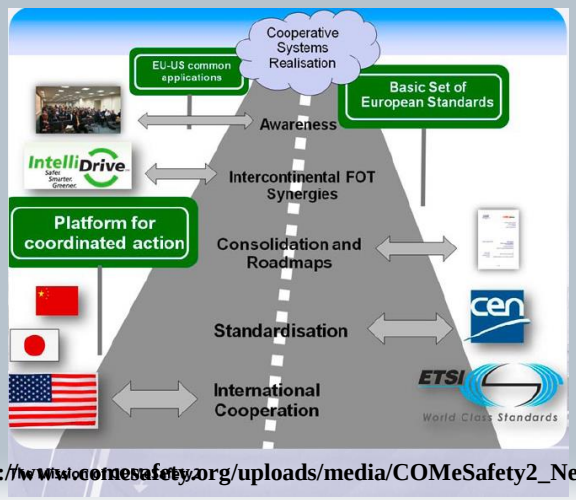
Source: http://www.drive-c2x.eu/test-sites

DRIVE C2X

- Overview eight functions implemented in the test sites for user tests
  - Approaching Emergency Vehicle Warning (AEVW)
  - Traffic Jam Ahead Warning (TJAW)
  - In-Vehicle Signage (IVS)
  - Road Works Warning (RWW)
  - Obstacle Warning (OW)
  - Car Breakdown Warning (CBW)
  - Weather Warning (WW)
  - Green Light Optimal Speed Advisory (GLOSA)

COMeSafety 2 (2011-2013)

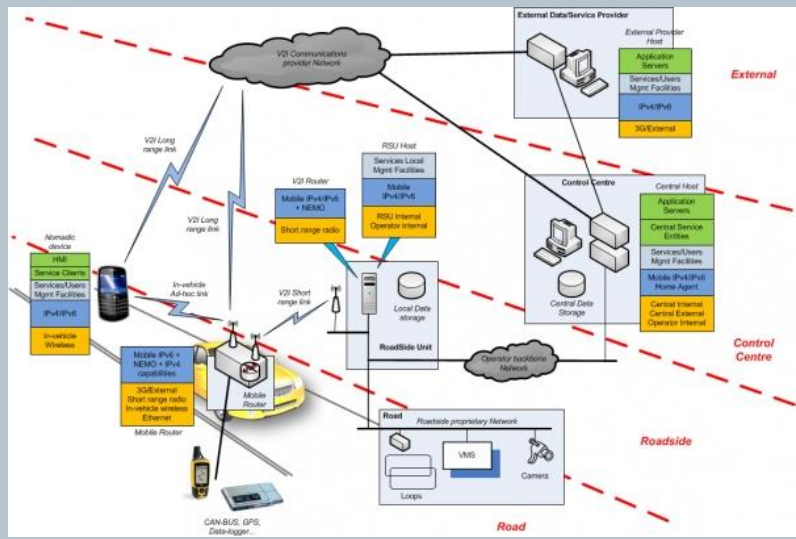
- coordinate actions towards standardisation and harmonisation eventually leading to a basic set of European standards for cooperative ITS.
- exploitation of international FOT results
- established a continuous exchange of information among international stakeholders comprising public stakeholders, car industry, standardisation organisations and end users



Source:http://www.comesafety.org/uploads/media/COMeSafety2_Newsletter_6_screen.pdf

FOTsis

- European Field Operational Test on Safe, Intelligent and Sustainable Road Operation
- 2010-2014
- 24 partners
- Testing of seven functions
  - S1: Emergency Management
  - S2: Safety Incident Management
  - S3: Intelligent Congestion Control
  - S4: Dynamic Route Planning
  - S5: Special Vehicle Tracking
  - S6: Advanced Enforcement
  - S7: Infrastructure Safety Assessment



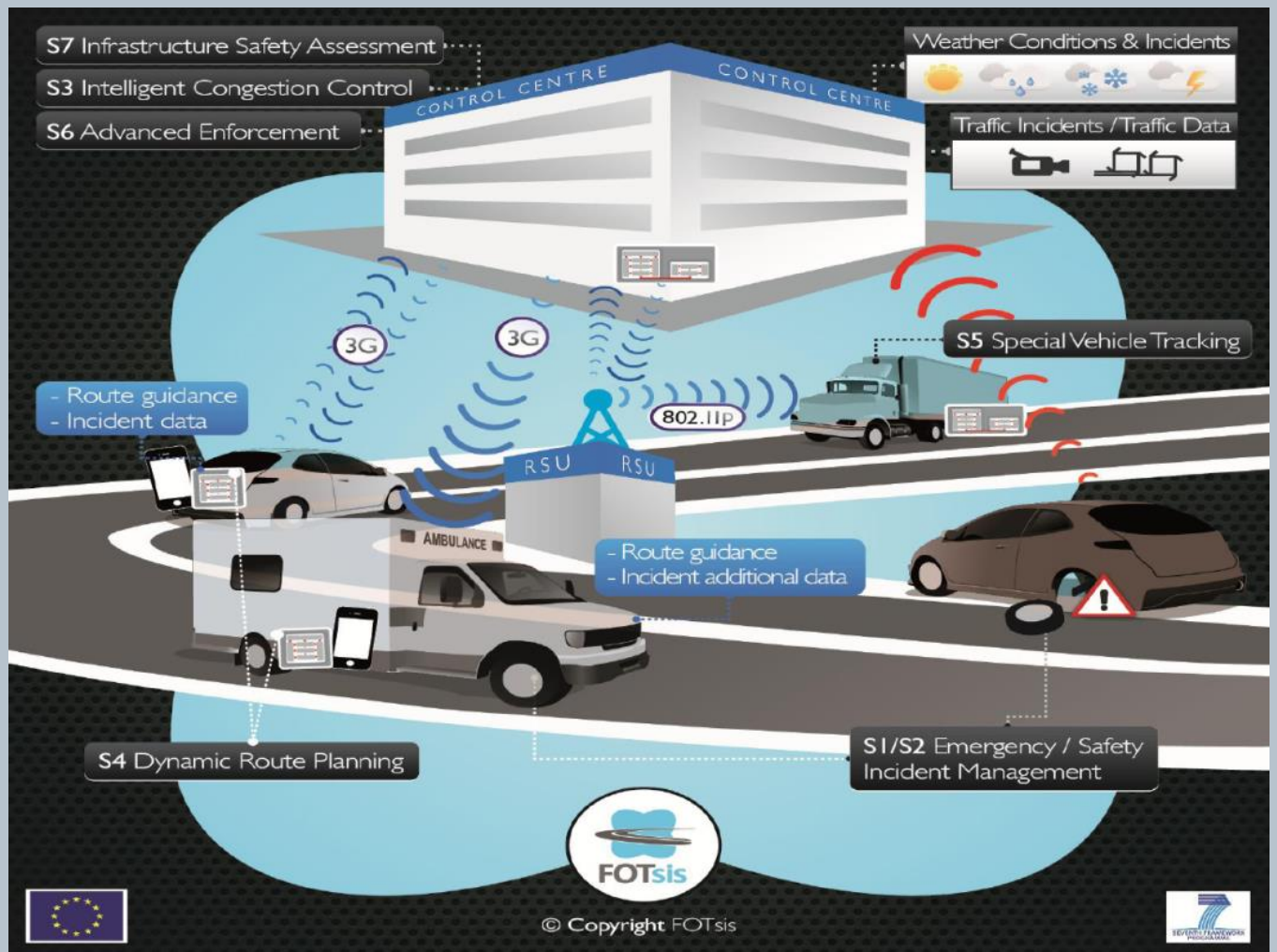
source:
http://www.fotsis.com/index.php/fotsisarchitecture/integrated-architecture

FOTsis test sites

- Test sites in Spain, Portugal, France, the Netherlands, Germany, Austria, Finland and Greece

FOTsis

- FOTsis communication architecture



Source: http://www.fotsis.com/index.php/fotsisarchitecture/integrated-architecture

Ko-Fas project

- Cooperative Vehicle Safety (Ko-FAS) research initiative
- Germany's biggest funded research project on cooperative vehicle safety
- 17 partners (e.g. BMW, Daimler; Continental, Delphi; universities,)
- 4-year (2009-2013)
- **Ko-TAG - Cooperative Transponders.** Ko-TAG explored cooperative sensor technology on the basis of transponder systems
- **Ko-PER - Cooperative Perception.** to capture a complete picture of the local traffic environment using distributed sensor networks.
- **Ko-KOMP - Cooperative Components**
- different concepts of protection that can be combined with the cooperative sensor systems and that offer considerable potential for preventing accidents or mitigating their consequences

BMW concept

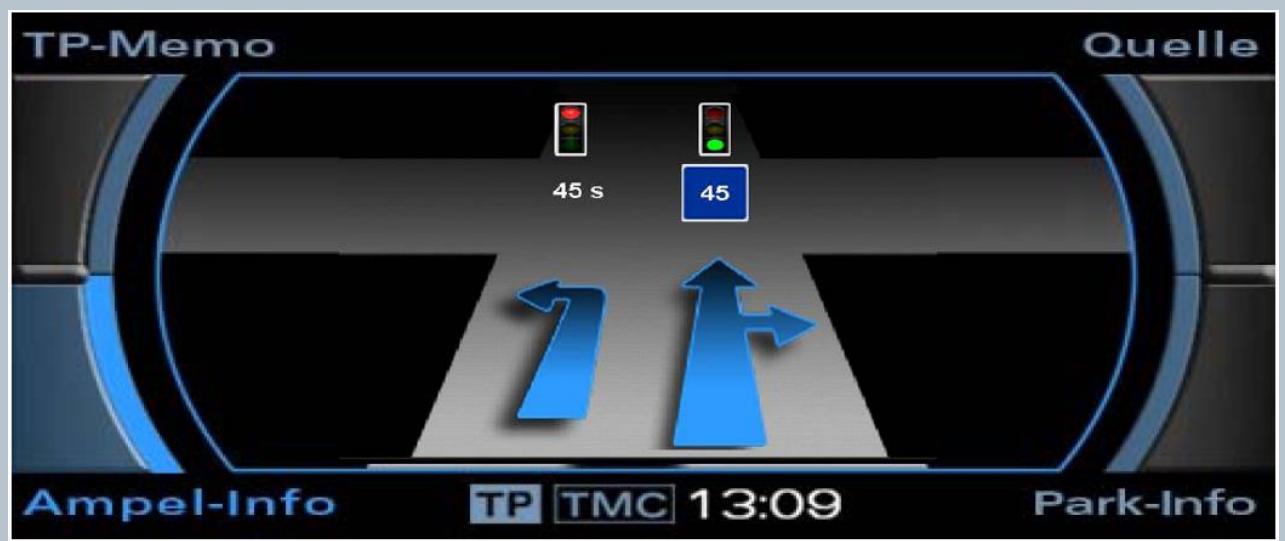
- Research initiative „Cooperative Vehicle Safety“ – Subproject „Cooperative Transponder Technologies” (09/2013)

Source https://www.press.bmwgroup.com/global/pressDetail.html?title=the-bmw-group-explores-the-future-of-vehicle-safety-in-the-ko-fas-research-initiative-the-results-of&outputChannelId=6&id=T0145929EN&left_menu_item=node__5236

Audi travolution project

- Light-to-car communication
  - Goal – optimizing passage through crossroad
  - Effect: fuel saving, traffic flow optimization

  - Project of Audi in cooperation with Technical University in Munich



Zdroj: Audi, projekt Travolution

Audi travolution project

- Audi connect

- Verona, Italy
- In cooperation with SWARCO

/Current-News/SWARCO-AND-AUDI-GIVES-YOU-GREEN-LIGHT

Cooperative systems outside Europe

Cooperative systems in the USA

- Connected Vehicle Project
  - Safety Pilot Driver Clinics
    - August 2011 - January 2012
    - each of the sixdriver clinic had over 100 drivers testing in-vehicle wireless technology
    - Conclusion: drivers across age groups and gender desire vehicle-to-vehicle (V2V)
  - Safety Pilot Model Deployment

Connected Vehicle Project

- Safety Pilot Model Deployment
  - 3,000 cars, trucks and buses equipped with “connected” Wi-Fi technology
  - Conducted by University of Michigan’s Transportation Research Institute (UMTRI)
  - 2012 to 2014
  - dedicated short-range communications (DSRC)

Connected Vehicle Project - continuation

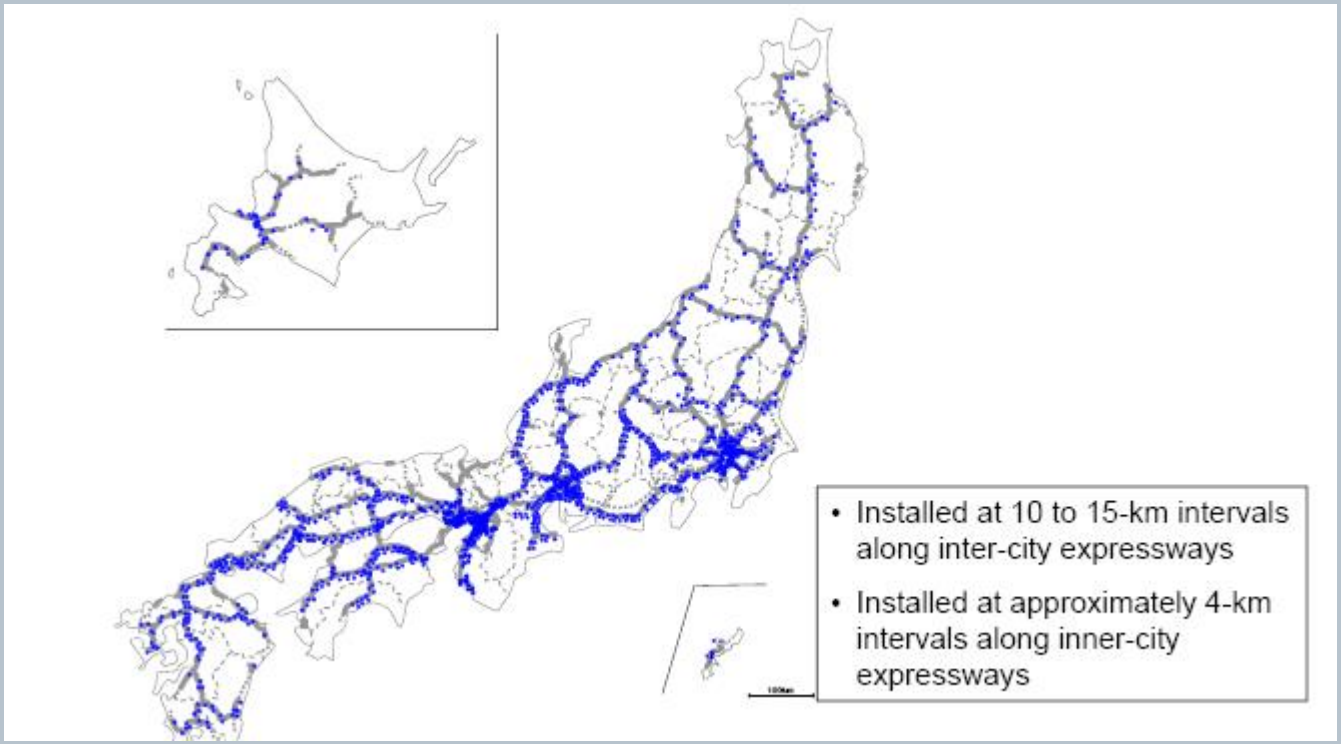
- Construction of an unique, simulated urban environment for testing connected and automated mobility systems
- Joint project of university, industry and government
- Goal: develop and implement an advanced system of connected and automated vehicles for moving people and freight on the streets of south-eastern Michigan by 2021
- Off-roadway test site
  - network of approximately four lane-miles of concrete and asphalt roads with intersections, traffic signs and signals, sidewalks, roundabouts, simulated buildings, streetlights, and obstacles such as construction barriers
  - to be completed by the spring of 2015 with a construction cost of $6.5 million

Connected Vehicle Project - background

- National Highway Traffic Safety Administration (NHTSA) On August 18, 2014 announced an advance notice of proposed rulemaking (ANPRM) for V2V communications,
- this Request for Information (RFI), seeks information related to the security system that will support V2V operations but will not be established by NHTSA regulation. Goals:
  - Become aware of private entities that may have an interest in exploring the possibility of developing and/or operating components of a V2V Security Credential Management System (SCMS);
  - Receive responses to the questions posed about the establishment of an SCMS;
  - Obtain feedback, expressions of interest, and comments from all interested entities

Japan - ITS Spot service

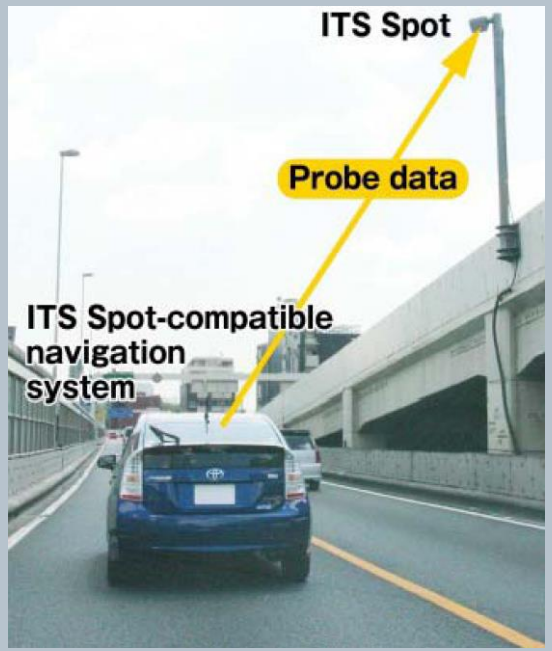
- Vehicle-infrastructure cooperative system installed in 2011.
- Services provided via 5.8 GHz DSRC
- 1,600 ITS Spots installed on highways in Japan



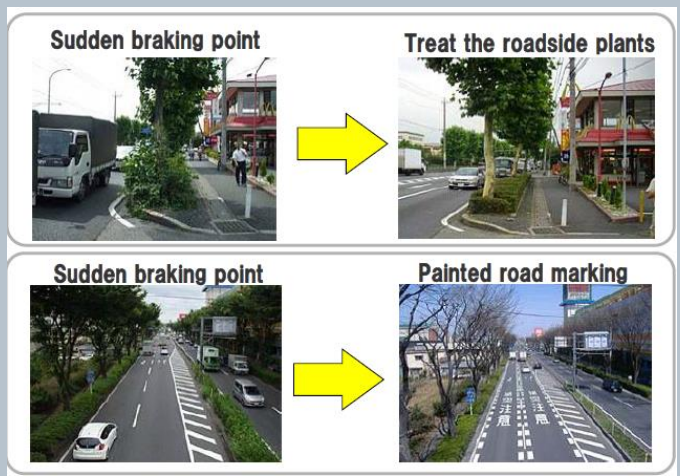
Sourcehttp://www.mlit.go.jp/road/ITS/pdf/CooperativeSystemandProbeData.pdf

Japan - ITS Spot service

- Three basic services
  - Dynamic route guidance
  - Safety driving support:
  - Electronic toll collection



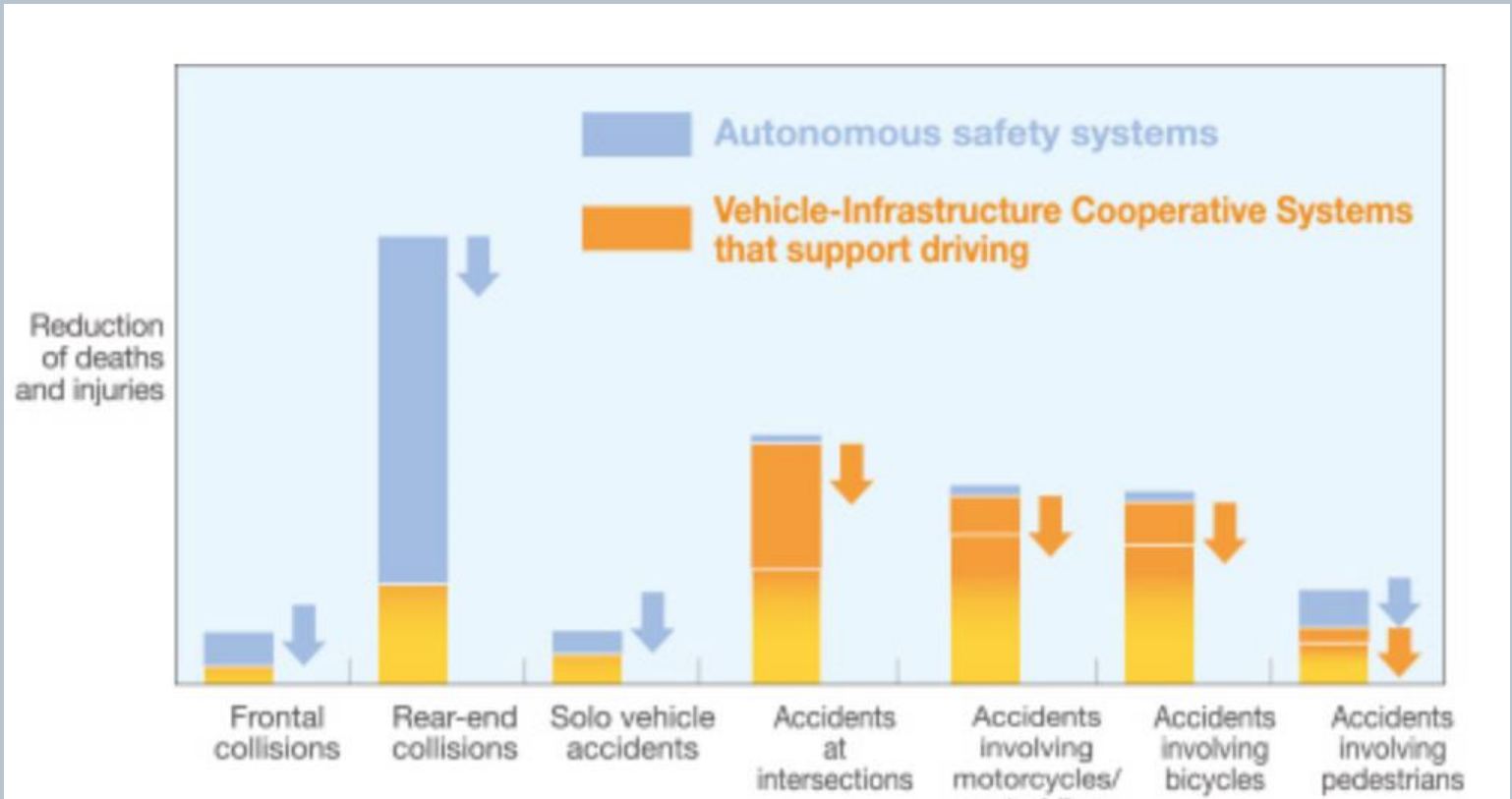
- Utilizing probe data in road administration
  - E.g. Probe data indicates sudden braking points.
  - Taking counter measures



Source: http://www.mlit.go.jp/road/ITS/pdf/CooperativeSystemandProbeData.pdf

Toyota concept

- Motivation



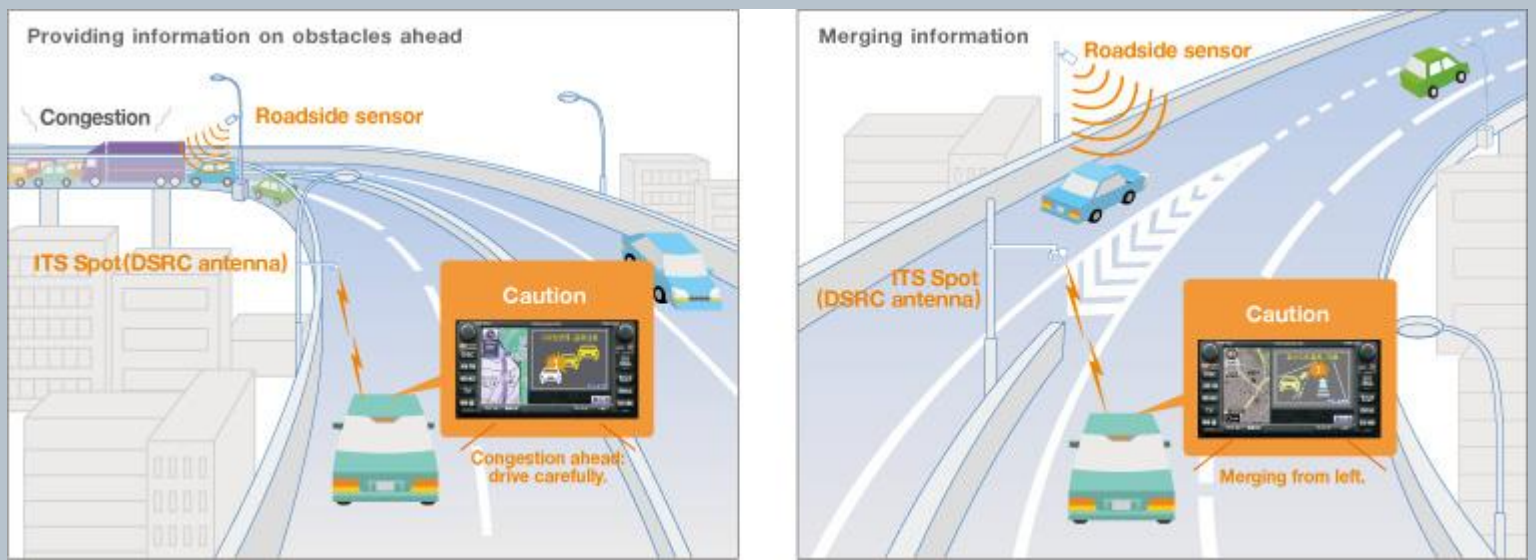
Source http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Toyota concept

- Existing systems:
  - ITS spot services (DSRC)
  - DSSS: Driving Safety Support Systems
- Further Evolution
  - Efforts for Communication System between Vehicles and Pedestrians or Among Vehicles

Toyota concept

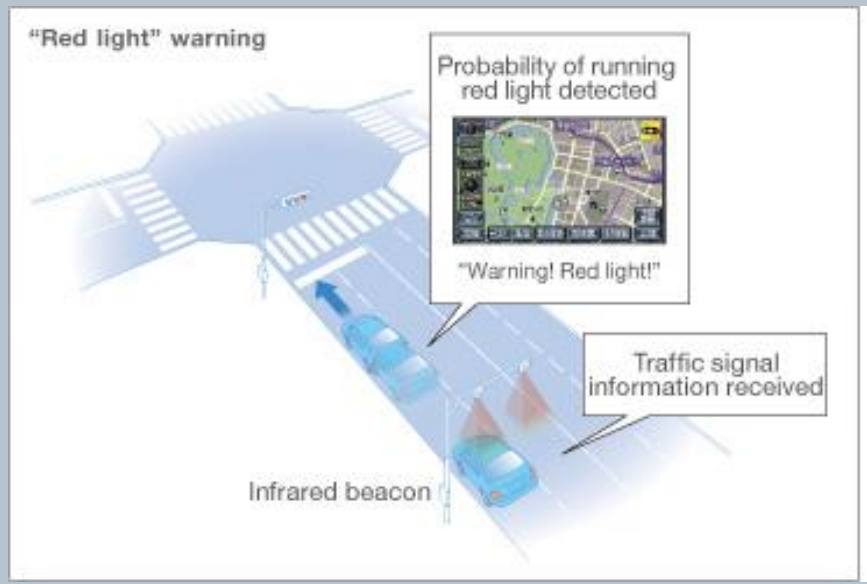
- Vehicle-to-infrastructure systems
  - ITS spot services (DSRC)

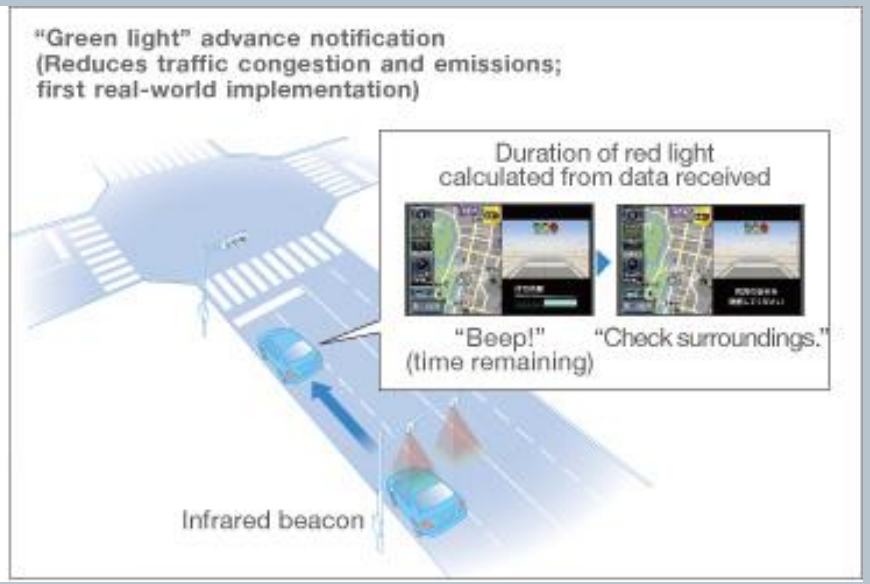


Source http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Toyota concept

- Vehicle-to-infrastructure systems
  - DSSS: Driving Safety Support Systems

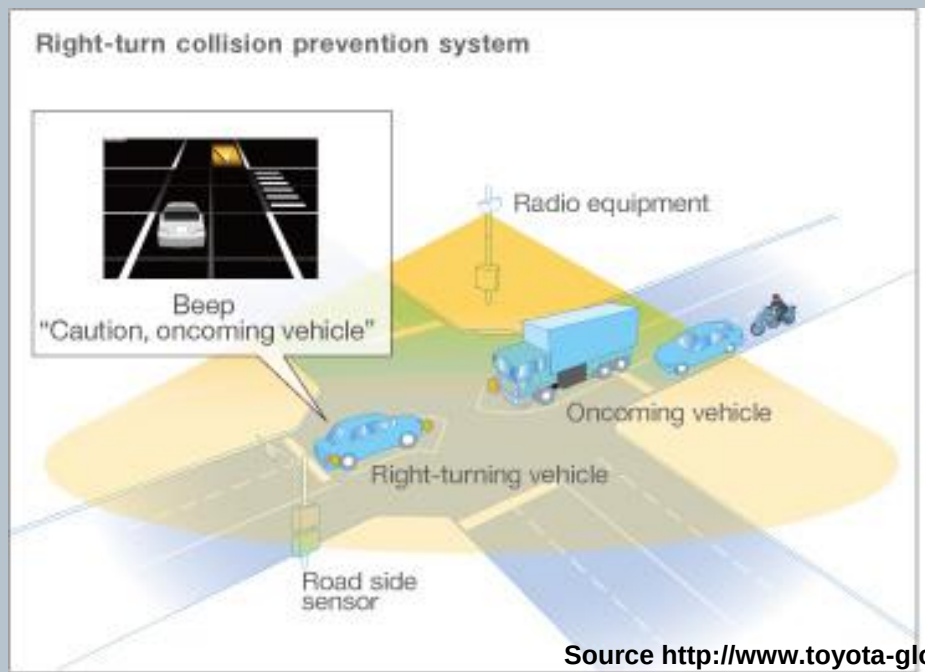


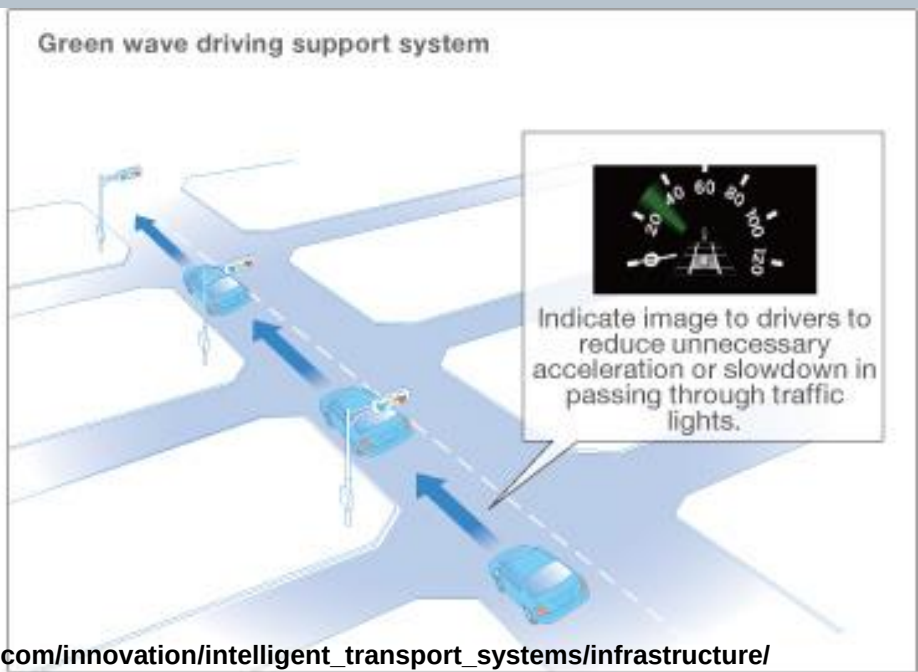


Source http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Toyota concept

- Further Evolution
  - Efforts for Communication System between Vehicles and Pedestrians or Among Vehicles
  - Utilization of UHF Band Radio Waves



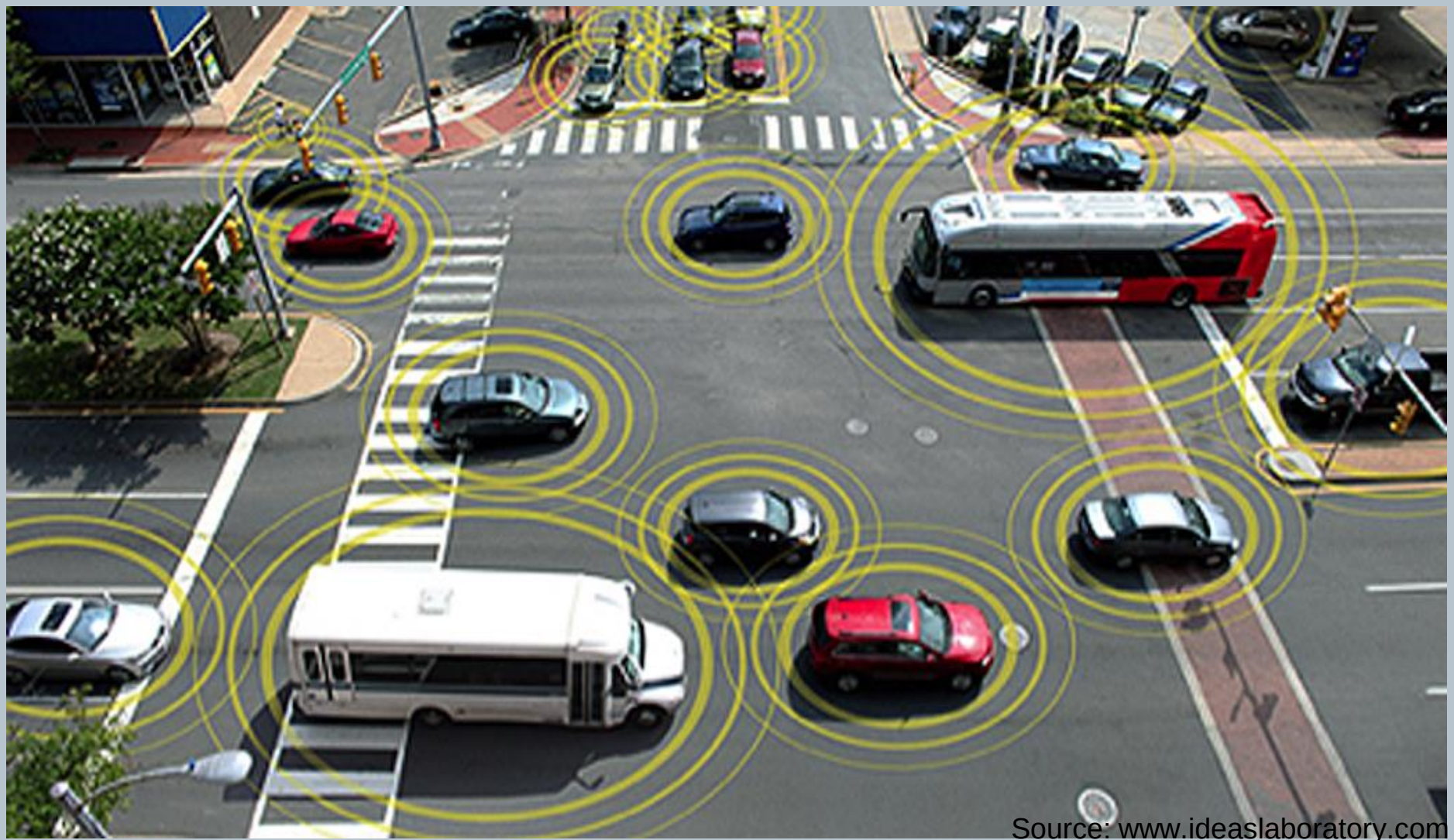


Source http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Cooperative systems projects

- And many more ....

Thank you for your attention



Source: www.ideaslaboratory.com

References

- http://www.intellidriveusa.org
- http://www.et2.tu-harburg.de/fleetnet/index.html
- http://www.ece.osu.edu/hpcnl/okipublic/
- http://www.com2react-project.org/
- http://www.cvisproject.org/
- http://www.safespot-eu.org/
- http://www.comesafety.org/
- http://www.iway-project.eu
- http://www.car-to-car.org/
- http://www.watchover-eu.org/
- http://www.sigmobile.org/
- http://ec.europa.eu/information_society/activities/esafety/research_activ/research_activ_fp6/index_en.htm
- http://ec.europa.eu/information_society/activities/esafety/research_activ/research_activ_fp7/index_en.htm
- http://www.esafetysupport.org/download/working_groups/Implementation_Road_Maps/busch1.pdf
- http://isotc204wg16.org
- http://www.etsi.org/WebSite/document/Technologies/16_Design_Principles_of_CALM.pdf
- http://www.cooperativemobilityshowcase.eu/
- http://www.cvisproject.org/download/qfree_CommCalmCvis_aalborgbrochure.pdf
- http://www.youtube.com/watch?v=cSP9xlTDY3o
- **The Future of Intelligent Transportation Systems is in Michigan, Beaubien engineering, 2014** http://beaubienengineering.com/2014/09/the-future-of-intelligent-transportation-systems-is-in-michigan/
- **Vehicle-Infrastructure Cooperative System and Probe Data in Japan,** http://www.mlit.go.jp/road/ITS/pdf/CooperativeSystemandProbeData.pdf