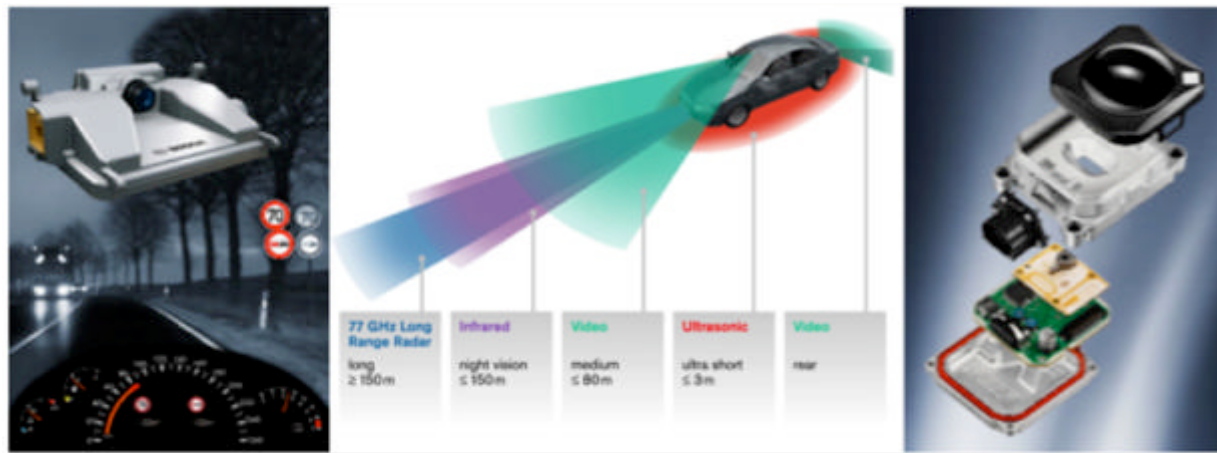


# Intelligent Vehicles – How Smart Can They Get?

Introduction to ME302 – The Future of the Automobile, Spring 2011



Stanford University  
March 29, 2011

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# Personal Mobility - Challenges

**Safety:** Every year 34,000 people killed in motor vehicle traffic crashes in the U.S. in 2009<sup>1</sup>, about 1,200,000 worldwide<sup>2</sup>

**Efficiency:** Impact of traffic congestion in the U.S.: avg. commuter lost 36 hrs, 2.8B gal of fuel are wasted, overall loss \$87.2B<sup>3</sup>

**Pollution:** Transportation in the U.S. alone emits 1.9B tons of CO<sub>2</sub> burning 4.7B barrels petroleum per year<sup>4</sup>

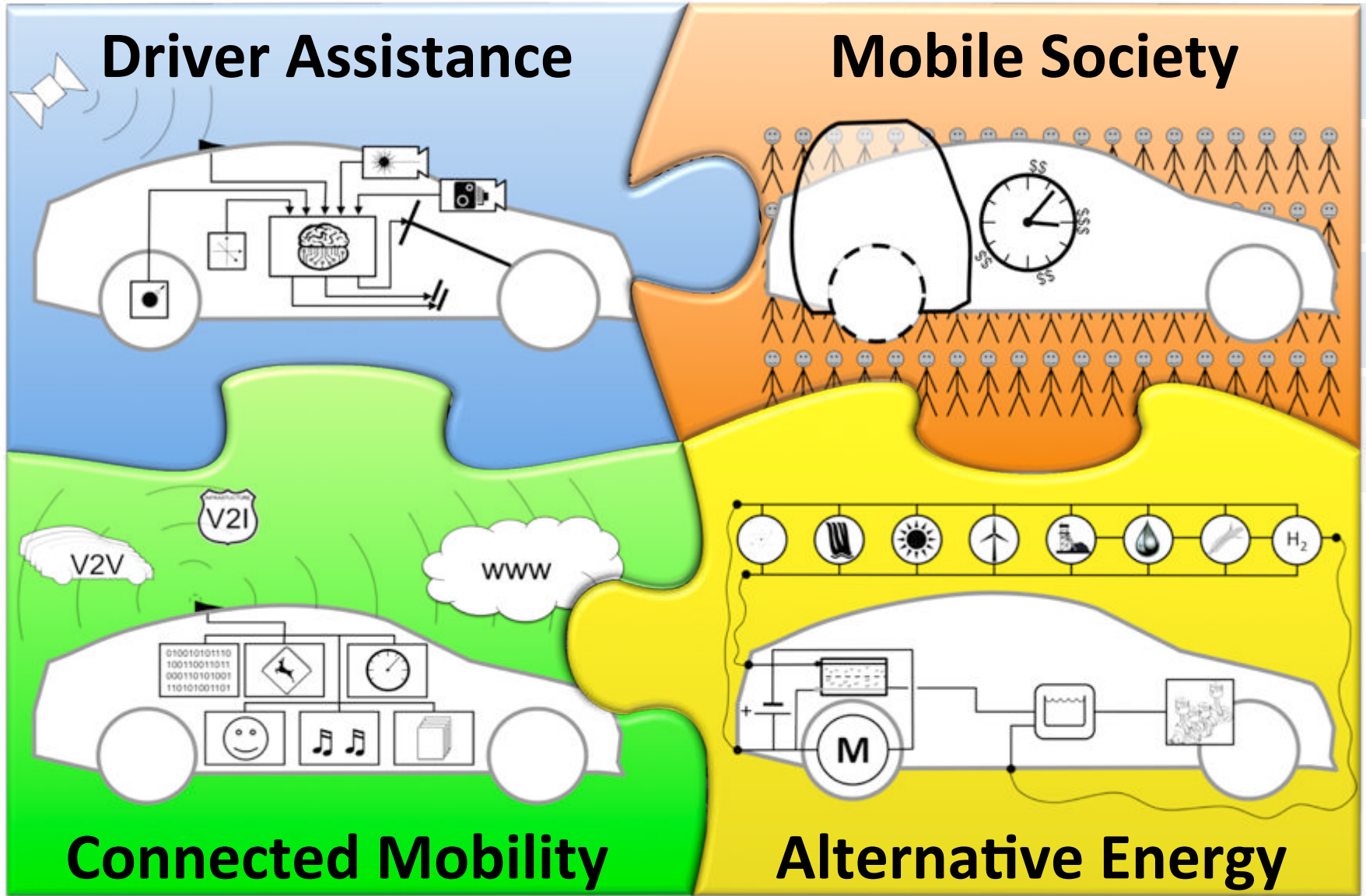
**Cost:** Average annual cost per consumer spent on transportation: \$8,758 (only second to housing)<sup>5</sup>



1. NHTSA, Washington, DC, 2010
2. NHTSA, Washington, DC, 2008
3. Texas Transportation Institute, College Station, TX, 2009

4. Energy Information Administration, Washington, DC, 2010
5. U.S. Dept. of Labor, Washington, DC, 2009

# Personal Mobility - Solutions



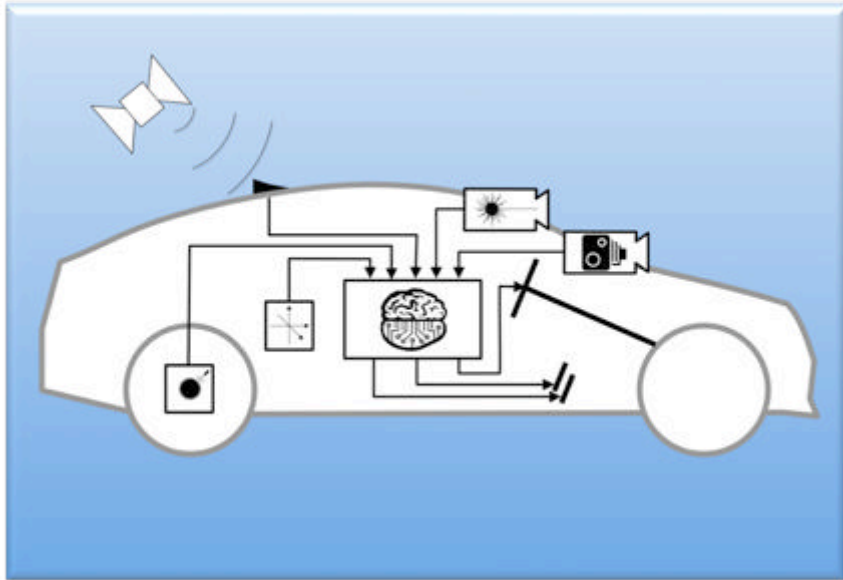
**Driver Assistance**

**Mobile Society**

**Connected Mobility**

**Alternative Energy**

# Driver Assistance – Autonomous Driving



## Benefits<sup>1, 2</sup>

- Safety: Elimination of driver errors
- Efficiency: Anticipatory and integrated vehicle / traffic control
- Convenience: Driver can focus on other tasks while driving, elderly / impaired / young people can stay / become mobile

## Challenges

- Technology: situation awareness, object classification (sensors, algorithms)
- Implementation: Transition from conventional to autonomous (esp. legal)

## Status

- Autonomous cars have been proposed since the early 1900s and seriously researched since the 1960s
- Highly developed computing and sensing performance since the 1980s has led to automated highways and autonomous vehicles in research, and now a variety of driver assistance systems in production

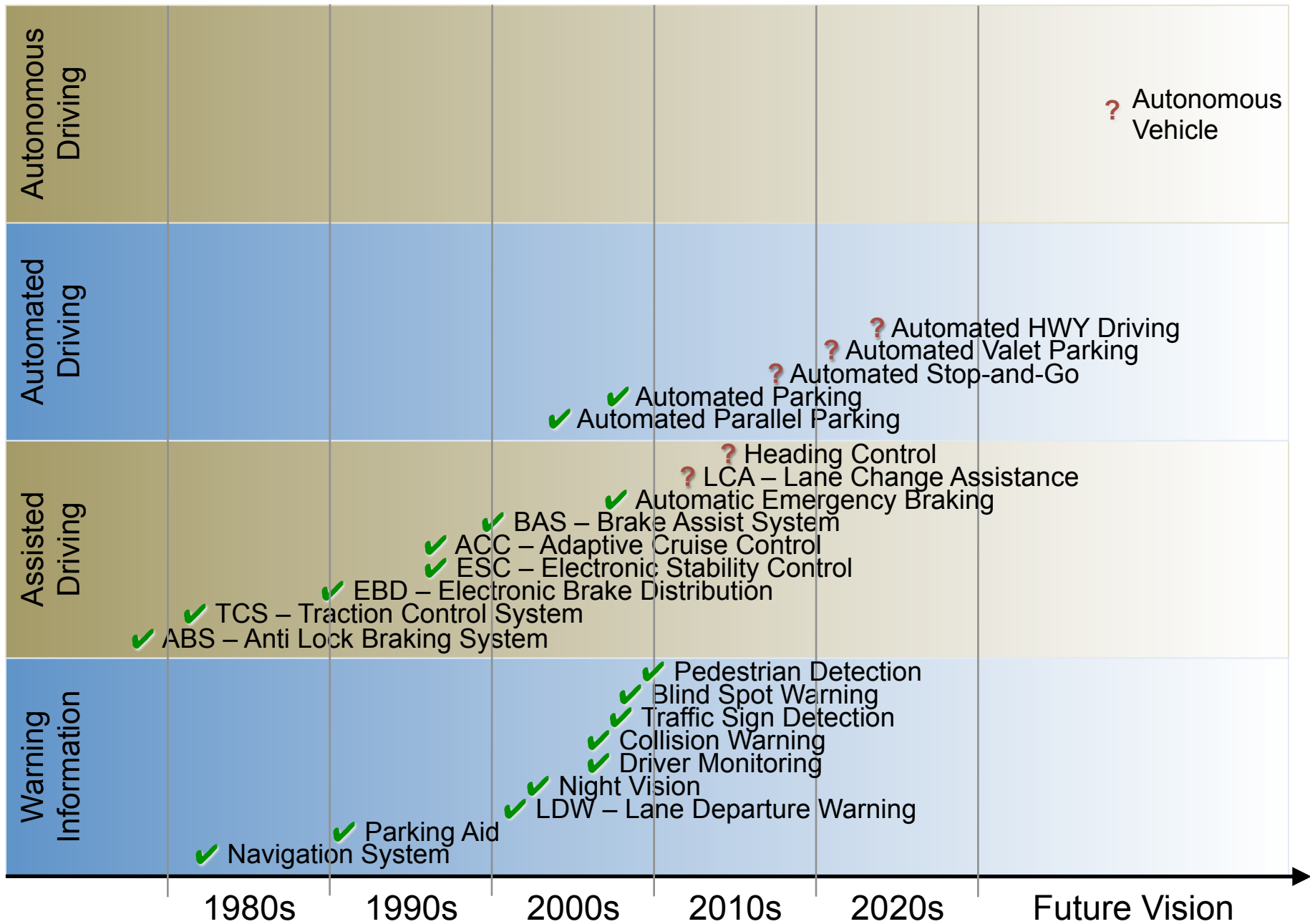
## Description

- Sensors (cameras, laser, radar, GPS...) capture the environment and location of the vehicle
- Computer algorithms process all sensor data, detect obstacles, categorize situations, plan path, and drive actuators
- System acts in addition to the driver to drive, brake, and steer the vehicle

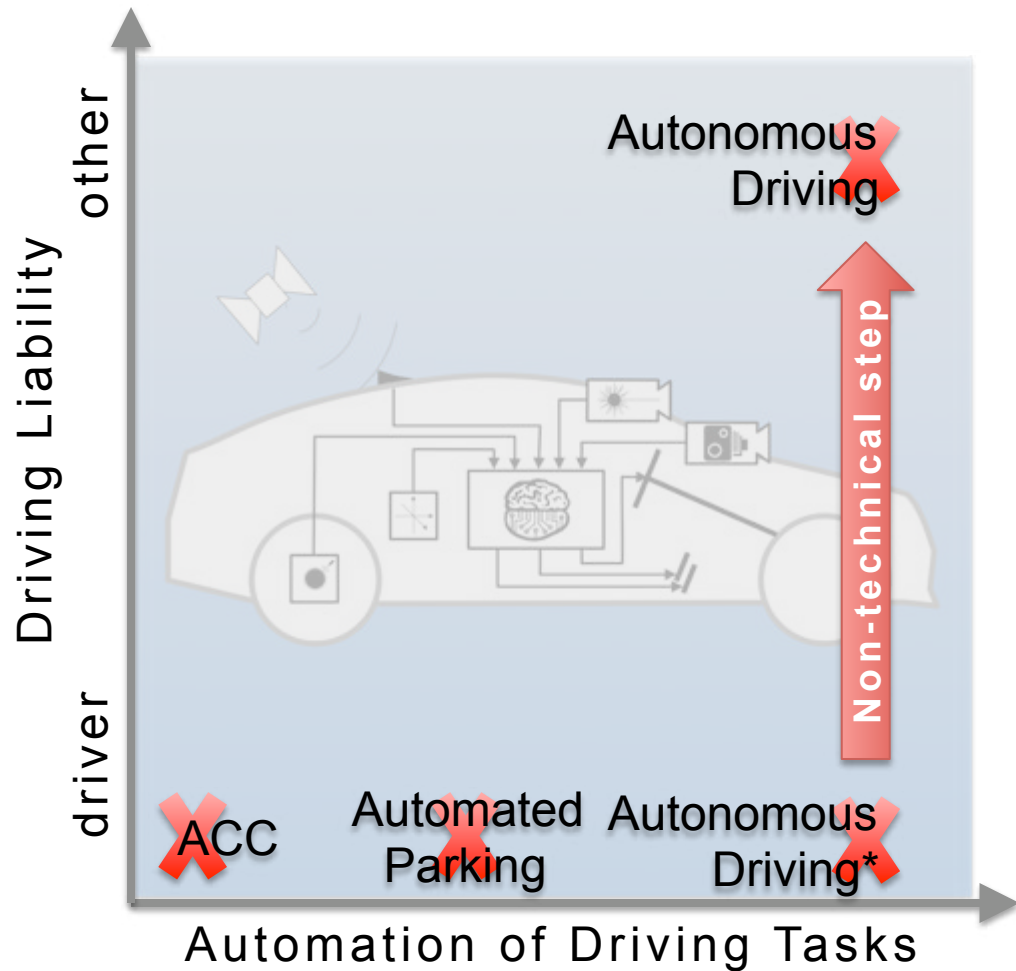
Sources: 1. "Automated Electric Transportation", Utah State University Energy Lab, Oak Ridge National Laboratory (2009)

2. "Vehicle Platooning and Automated Highways", PATH Program, University of California (1998)

# Timeline: Driver Assistance to Autonomous Driving



# Scenarios for Driver Assistance



## Forecasts (external sources)

2019 Automated vehicle platooning, *Volvo, Sartre '09*

2020 Vehicles in part controlled by infrastructure, *U.S. DOT '00*

2030 Fully autonomous driving, driver out of the loop, *various sources*

## Public Perception in US



- Autonomous driving expected soon
- Relief from daily commute

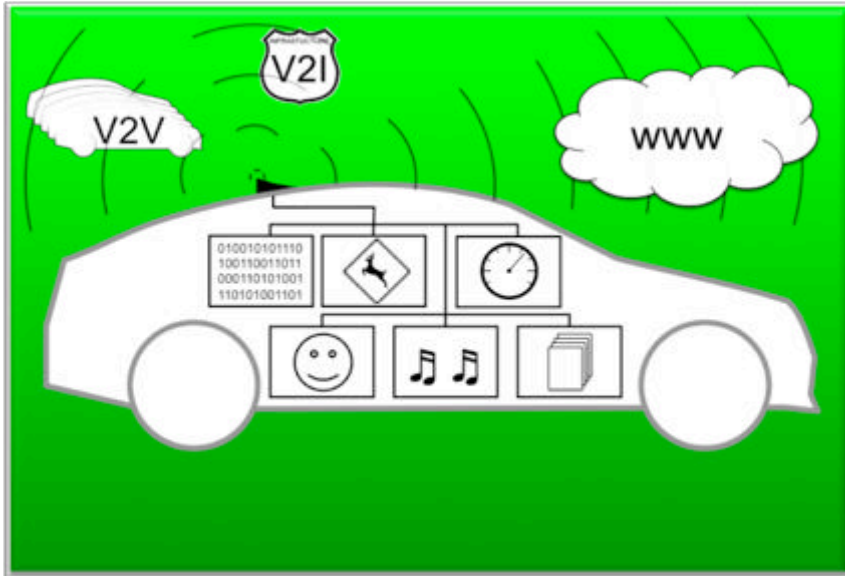
## Public Perception in EU



- Driver assistance systems evolving
- Assistance in difficult situations

- How much driver assistance is possible / marketable without responsibility transfer?
- Will autonomous driving be a revolution or an evolution in driver assistance systems?
- Which aspects will benefit the establishment of autonomous driving?

# Connectivity – Communication



## Benefits<sup>1, 2</sup>

- Safety: Time-location-situation accurate warnings (road condition, traffic, ...)
- Efficiency: Time-location-situation accurate and route-relevant traffic info
- Convenience: Information / entertainment virtually unlimited, ext. mobility experience

## Challenges

- Technology: Robust data connection
- Implementation: Infrastructure cost
- Safety: Driver distraction, data accuracy
- Legal: Data privacy

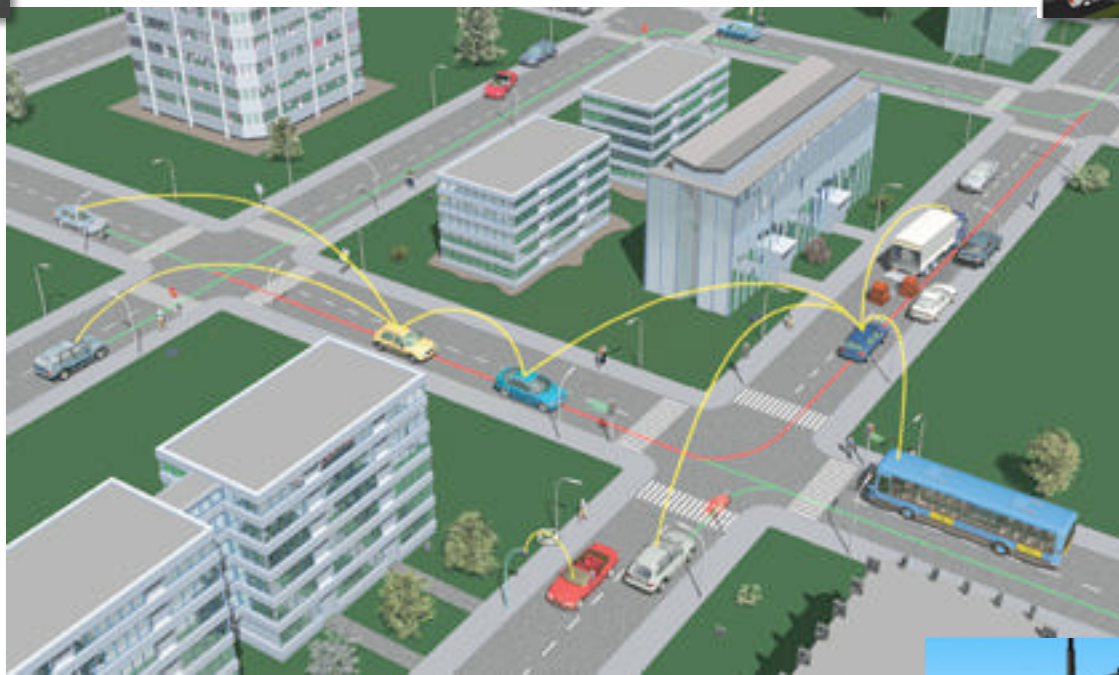
## Status

- Vehicle-to-vehicle and to-infrastructure communication researched since 2000
- Wireless ubiquitous internet available since the mid 2000s through cell phone technology, bandwidth increasing
- First mobility-specific applications since mid 2000s with manufacturer operated portals, business case challenging

## Description

- Dedicated frequency spectrum to be used for V2V and V2I communication – position, vehicle data, warnings, ...
- Manufacturer operated portals offer specific safety / convenience features, general internet access basically possible
- Media-vehicle integration varies: “built-in, brought-in, beamed-in”

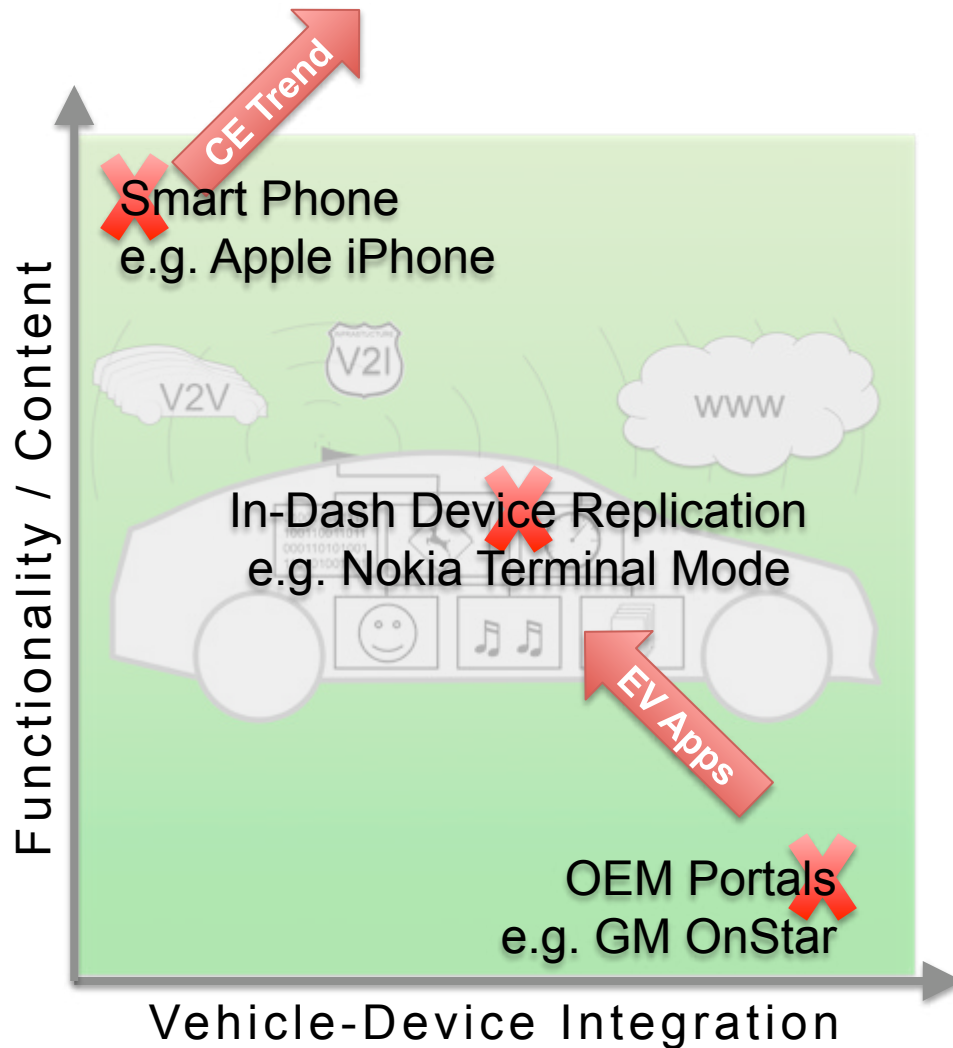
# Applications for Vehicle Safety Communication



Connected Vehicle  
Technology Challenge



# Scenarios for Connected Mobility



## Forecasts (external sources)

2015 Vehicle-to-vehicle safety communication, *U.S. DOT*

2015 Internet in the car is mainstream, *ABI Research, Hughes, iSuppli...*

## General Trends

- Telematics / connectivity becoming key factor in purchasing decision
- Communication protocols for mobility following cell phones
- Internet access has become more important than access to automobile

- Which communication content / application is really mobility / vehicle specific?
- Will a standard for device integration evolve?
- Which policies will evolve for use of communication systems / devices while driving?