

# DAIMLERCHRYSLER

Research and Technology North America, Inc.



## Roadside Wireless

Presentation at the Wireless Communication Alliance  
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A Company of the DaimlerChrysler Group



DAIMLERCHRYSLER  
Research and Technology North America, Inc.

### Roadside Wireless – Outline

Overview of DaimlerChrysler RTNA, Inc.

Automotive Safety goes Wireless

Vehicle Infrastructure Integration (VII)

Example DSRC Research Activities

Summary





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## DaimlerChrysler at a Glance

### DAIMLERCHRYSLER FACTS + FIGURES 2004

#### Key data

Worldwide vehicle sales	4.7 m u
Revenues:	142 € bn
Operating profit:	5.8 € bn
Employees	384,723
Market capitalization (12/31/2004)	36 €bn

#### Revenue development



1) F.C. MPV, SUV, P.U.P., 2) MDT/HGT

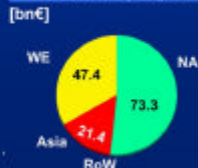
#### Revenue by division



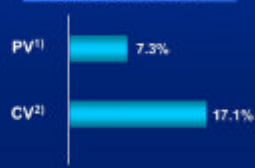
#### Shareholder Structure

Deutsche Bank AG	10%
Kuwait	7%
Inst. Investors	57%
Retail Investors	26%

#### Revenue by region



#### Market share - World





## DaimlerChrysler's Strategy is based on four Strategic Pillars



## DaimlerChrysler Research and Technology





## Role of DC RTNA as the American Portion of DC Research

- **Research unit and proving ground for Vehicle IT and Services activities in the U.S.**

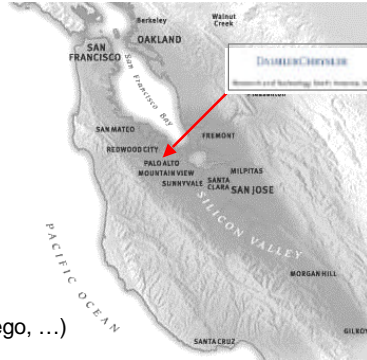
- U.S. technologies / systems / infrastructure
- U.S. field operational tests and pilots
- U.S. market applicability / requirements
- U.S. customer expectations
- U.S. government programs and regulations

- **Partnering hub for collaboration with American**

- CE companies and their research groups (Microsoft, Apple, Intel, Creative Labs, Sony, ...)
- IT companies and their research groups (e.g., IBM, HP, Sun Microsystems, Intel, Cisco, ...)
- Universities and research centers (e.g., Stanford University, UC Berkeley, UC San Diego, ...)

- **Facilitate contacts for North American business units to the lab**

- Chrysler Group and MBUSA



## DC RTNA Research topics: Wireless Connectivity as Enabler

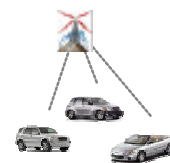
Connectivity between vehicles  
and a back-end network



Connectivity between portable  
devices and the vehicle

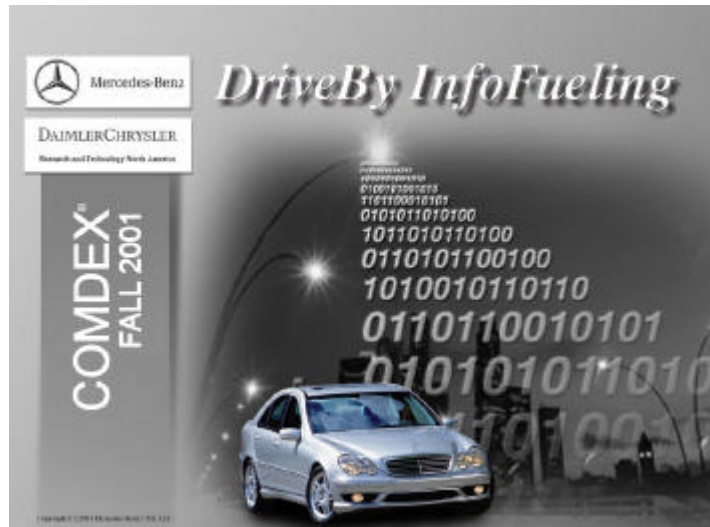


Connectivity between vehicles  
and vehicles and between vehicles  
and the local infrastructure





## The early beginnings of "Roadside Wireless"



W. Holfelder, WCA 08/16/05

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9



## DC RTNA Research topics: Connecting the trends

- Recent Trends in Consumer Electronics:
  - Infotainment becomes digital and "downloadable"
  - WLAN or WiFi technology becomes pervasive
  - Connectivity and IT technologies enables frequent and automated diagnosis and software updates
- Recent Trends in Automotive/Vehicle IT:
  - CE technology appears in the vehicle challenged by lifecycle differences
  - E/E and Software become more and more significant for our vehicles
  - Quality of E/E and SW systems has become a critical issue
  - Current active and passive vehicle safety are starting to become widespread
  - Dedicated Short Range Communication (DSRC) can provide the next step in safety: *pro-active safety*



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10



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## Commitment to Safety: DaimlerChrysler's Vision of Accident Free Driving

Your car will warn you before they do.

People don't always see accidents coming. But their cars will.

Every part of the street should be a safe place to cross.

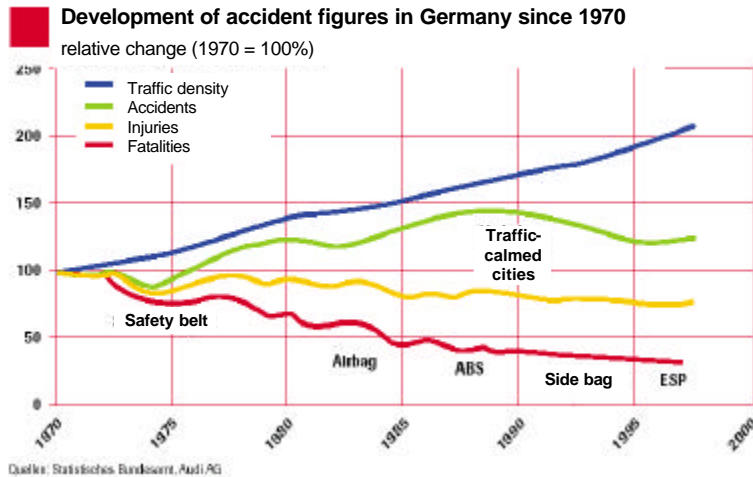
You never see owls crash, do you?

Your car will be watching the road, even if you're not.





## Safety Trends: Very encouraging, but always room for improvement



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13



## The Next Logical Step in Vehicle Safety

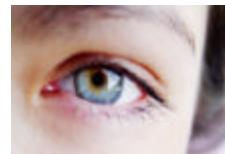
### So far: „Feel“

- Sensing a critical situation by assessing vehicle state and driver actions
- PRE-SAFE® (since 2002)



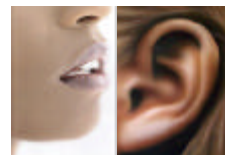
### Today: „See“

- Watching for obstacles on the road with radar
- PRE-SAFE® and Brake Assist PLUS (from 2005)



### In the Future: „Speak“ / „Listen“

- Inform drivers about dangerous situations further down the road
- Warn others (to protect them and yourself)



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14



## DSRC is **THE** Enabler for Communication

### Prerequisite No. 1:

#### Radio Frequency



#### FCC Rulings:

- Allocated exclusive spectrum for DSRC (5.850 – 5.925 GHz)
- Established licensing rules for the operation of roadside units (RSUs) and onboard units (OBUs)

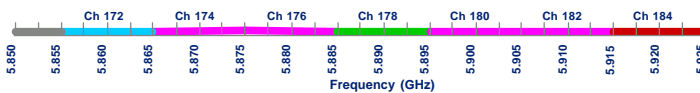
### Prerequisite No. 2:

#### Communication Protocol



#### IEEE Standardization:

- Future part of the IEEE 802.11 family of WiFi standards
- IEEE 802.11p a.k.a. WAVE (Wireless Access for the Vehicular Environment)



## DaimlerChrysler is pursuing communication-based safety

#### DAIMLERCHRYSLER

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Press-Information  
Date  
June 6, 2005

#### Pioneering Initiative: Dedicated Short-Range Technology™ Builds an "Information Bridge" from Car to Car

- First driving demonstration of car-to-car communication between Mercedes-Benz E-Class and Dodge Durango
- The innovative technology helps to optimize traffic flow and appreciably enhances traffic safety
- DaimlerChrysler is preparing demonstration tests together with the Federal Department of Transportation and several states

**Washington/Stuttgart** – A pioneering initiative is being shown at the DaimlerChrysler Innovation Symposium by research engineers from the Research and Technology Center North America, based in Palo Alto, California. For the first time, DaimlerChrysler is presenting a dynamic driving demonstration of broadband car-to-car communication between a Mercedes-Benz E-Class and a Dodge Durango. With this initiative, DaimlerChrysler is the first automaker to publicly test this new wireless communications technology.

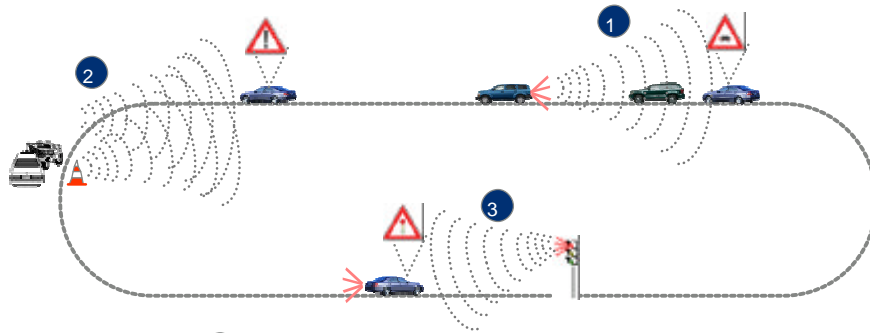






## DSRC Examples

DSRC allows vehicles to communicate with each other and with infrastructure.



- 1 V2V: Extended Electronic Brake light
- 2 V2V (V2I): Hazard Warning
- 3 V2I: Traffic Signal Violation Warning



## Video





## More DSRC-based Safety Applications

### Between Vehicles:

- Approaching Emergency Vehicle Warning
- Blind Spot Warning
- Cooperative Adaptive Cruise Control
- Cooperative Collision Warning
- Cooperative Forward Collision Warning
- Emergency Electronic Brake Lights
- Highway Merge Assistant
- Lane Change Warning
- Post-Crash Warning
- Pre-Crash Sensing
- Vehicle-Based Road Condition Warning
- Vehicle-to-Vehicle Road Feature Notification
- Visibility Enhancer
- Wrong Way Driver Warning

Source:  
Vehicle Safety Communications Consortium

### Between Vehicles and Infrastructure:

- Blind Merge Warning
- Curve Speed Warning
- Emergency Vehicle Signal Preemption
- Highway/Rail Collision Warning
- Intersection Collision Warning
- In-Vehicle Amber Alert
- In-Vehicle Signage
- Just-In-Time Repair Notification
- Left Turn Assistant
- Low Bridge Warning
- Low Parking Structure Warning
- Pedestrian Crossing Information at Intersection
- Road Condition Warning
- Safety Recall Notice
- SOS Services
- Stop Sign Movement Assistance
- Stop Sign Violation Warning
- Traffic Signal Violation Warning
- Work Zone Warning



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## Introduction Strategy

For communication you always need at least two parties to communicate...

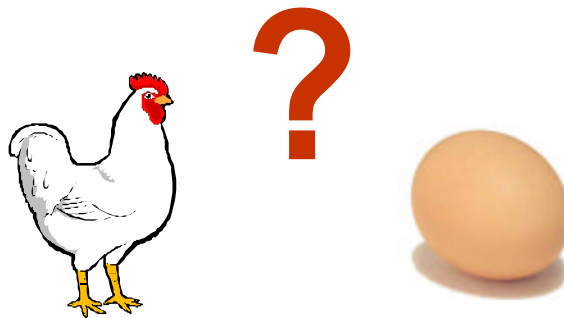


... and to make matters worse, for wireless communication, the other party needs to be within the range of the wireless communication system.



## A classical Chicken and Egg problem...

Install DSRC first in the infrastructure or first in the vehicles?





## The Vehicle Infrastructure Integration (VII) Initiative

Transportation authorities and vehicle manufacturers will need to join forces to deploy DSRC. The VII Initiative forms the platform for this cooperation.



## Vehicle Infrastructure Integration (VII) Goal

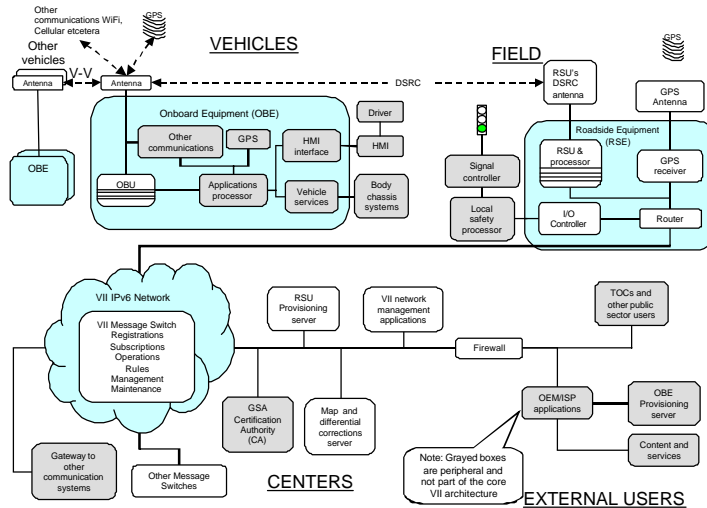
INFORMED national decision by the end of this decade on whether or not to deploy a nationwide, short range wireless communications system to support vehicle/vehicle and vehicle/infrastructure applications and services.

The primary use of this system is for safety, but it can be used for anything that does not conflict with the primary purpose.\*

\*Explicit realization that OEMs must be incentivized to provide in vehicle portion of system.



## VII Architecture currently under Discussion



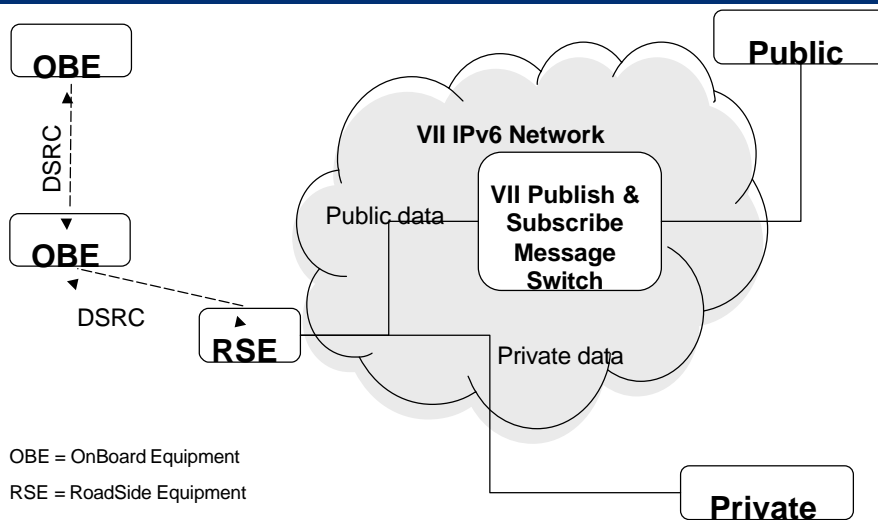
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29



## Simplified VII architecture



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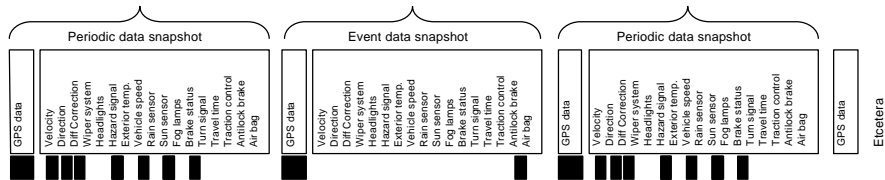
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30



## VII collects probe data from DSRC equipped fleet, ...

Public data from OBE to RSE to VII Message Switch



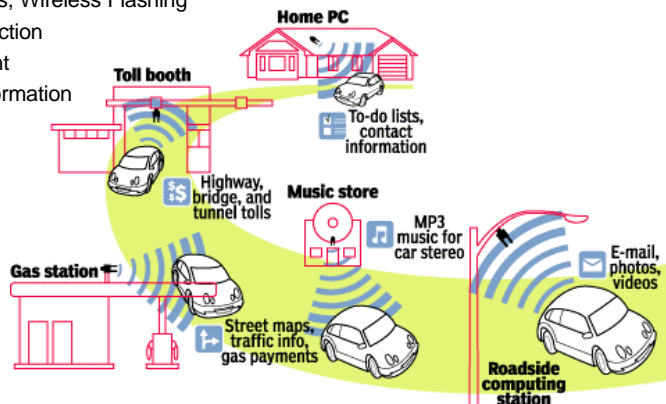
When the vehicle comes within range of a roadside unit (RSU) that is designed to accept such data, selected stored probe data are sent to the RSU from the vehicle and immediately forwarded to a VII Message Switch for subsequent dissemination.



## More than safety will be supported by DSRC/VII

If a short range communication device is installed on the vehicle, the following non-safety applications could be available to the customer at almost no extra cost:

- Drive-through payments (gas station, parking garages, fast food, ...)
- Wireless Diagnostics, Wireless Flashing
- Electronic Toll Collection
- Digital Entertainment
- Point of Interest Information
- Digital Map updates
- Etc.







## DSRC Application Examples



Home Entertainment  
Sync and Go



Digital Map  
Updates



Wireless  
Diagnosis



Probe-Data  
Collection



Emergency Vehicle  
Warning



Inter-vehicle Hazard  
Warning



Intersection Collision  
Avoidance

Next



## Home Entertainment Sync and Go

### Home Entertainment Sync and Go

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## Digital Map Update

### Digital Map Update

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## Wireless Diagnosis

### Wireless Diagnostics

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## Probe-Data Collection

### Probe Data Collection

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## Emergency Vehicle Warning

### Emergency Vehicle Warning

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## Inter-Vehicle Hazard Warning

### Inter-Vehicle Hazard Warning

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## Intersection Collision Avoidance

### Intersection Collision Avoidance

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## Roadside Wireless – Outline



## Example DSRC Research Activities (from an automotive OEM perspective)

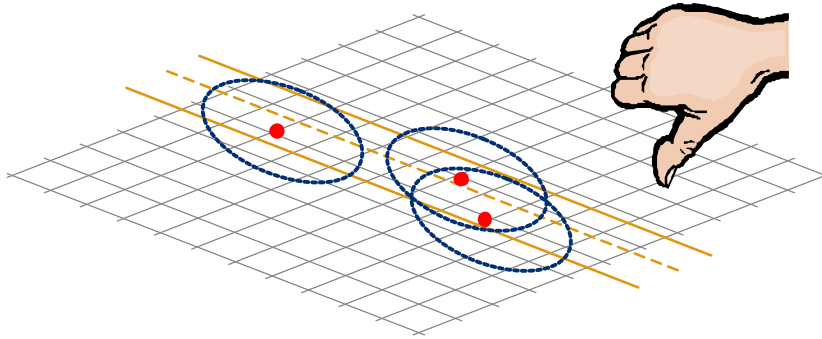
- DSRC research and design is most valuable, when grounded in real physics
  - RF Models based on the real world (communication range, interference range, variable power, multi-channel architecture, etc.)
  - Mindful of real traffic flow and traffic behavior patterns (speed, density, etc.)
  - Mindful of real deployment scenarios (initially very low penetration rates, later scalability, event-based vs. routine messaging, etc.)
- It is furthermore important to understand and embrace automotive requirements and implications of vehicle safety communications:
  - Security, Anonymity, Privacy
  - Trust (immediate, resilient)
  - Safety (absolute priority)
  - Cost (one radio design)
  - Long Vehicle Lifecycles
  - And many more...



## Real World Example (1/3)

Obvious but often overlooked facts about wireless communication:

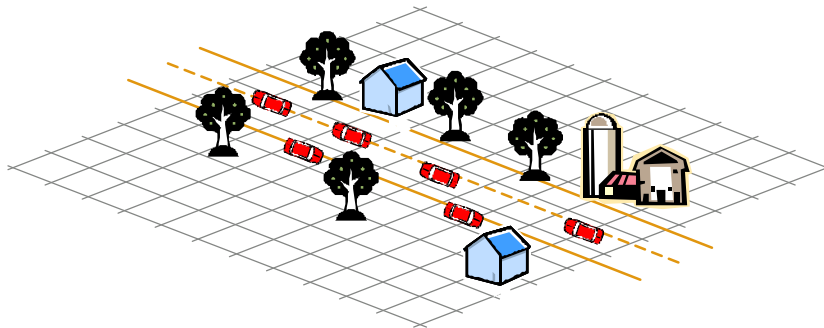
- Reception does not happen in some nice round circles with sharp boundaries, nor does interference



## Real World Example (2/3)

The “unfortunate” reality:

- DSRC is to be used in a real world, and therefore its research and design should be grounded in real physics
- Instead of being in an abstract and flat 2 dimensional space, DSRC is used in vehicular environments with cars, trees, buildings, bridges, and hills around, all affecting the RF propagation

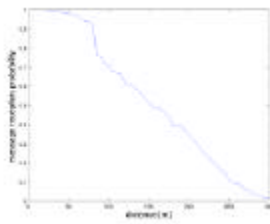




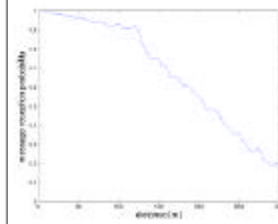


## Real World Example (3/3)

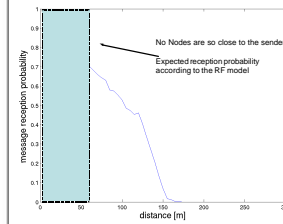
### Preliminary DSRC test results in real world environments



Freeway Broadcast Reception



Urban Canyon Broadcast Reception



Urban Corner Broadcast Reception

Vehicle to vehicle communication quality was measured on freeways and in typical urban intersection

- The test equipment was based on the 1<sup>st</sup> generation VSC DSRC prototype radio and antenna
- The transmission power was restricted to only 100mW (up to 2W allowed)

There are significant deviations in DSRC communication behavior in real world environments

The presence of large tails (beyond the "reception range") creates complex and interesting interference implications



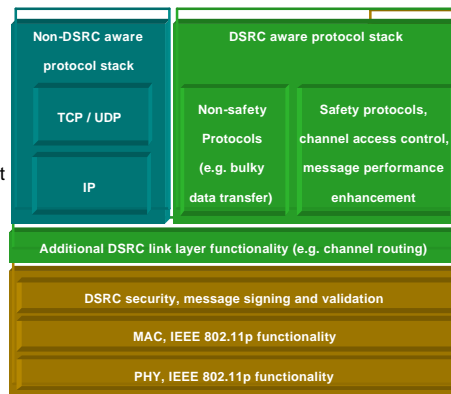
## Co-existence of safety and non-safety services

Safety communication is the driving force behind the DSRC spectrum allocation and DSRC deployment and must always have priority.

Therefore non-safety DSRC applications can not be designed in a vacuum

- Any application/protocol design that can not co-exist with safety would likely not to be adapted and not be successful

Architecturally, DSRC-aware and Non-DSRC-aware protocols and applications need to be harmonized





## Roadside Wireless – Outline



## Summary

- DaimlerChrysler is committed to Safety and its Vision of Accident Free Driving.
- V2V and V2I Communication has the potential to have a significant contribution to the future of road safety and traffic efficiency.
- DSRC (IEEE 802.11p) is **the** enabling technology.
- VII (Vehicle Infrastructure Integration) will provide the necessary business and deployment framework over the next few years.
- There are many exciting opportunities for other industry participants to benefit from a DSRC/WAVE and VII deployment.



WAVE = Wireless Access for Vehicular Environments

*Are you catching the WAVE?*



For Further Information

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