

# CSA 79 GHz 2nd Workshop

## Geneva, November 7th, 2012



## 79 GHz Functions & Technology

Jürgen Hildebrandt, Robert Bosch GmbH



Chassis Systems Control

CC/ECR4 Hildebrandt | 09.10.2012 | © Robert Bosch GmbH 2012. All rights reserved, also regarding any disposal, exploitation, reproduction, editing, distribution, as well as in the event of applications for industrial property rights.



**BOSCH**

## Vehicle motion and safety - Bridging the gap between safety and assistance

Several themes are currently addressed in different disciplines:

“Vision Zero”

“Always connected”

“Democratization”

“Sustainable mobility”

⇒ **accident-free driving**

⇒ **car2x communication**

⇒ **safety for everyone**

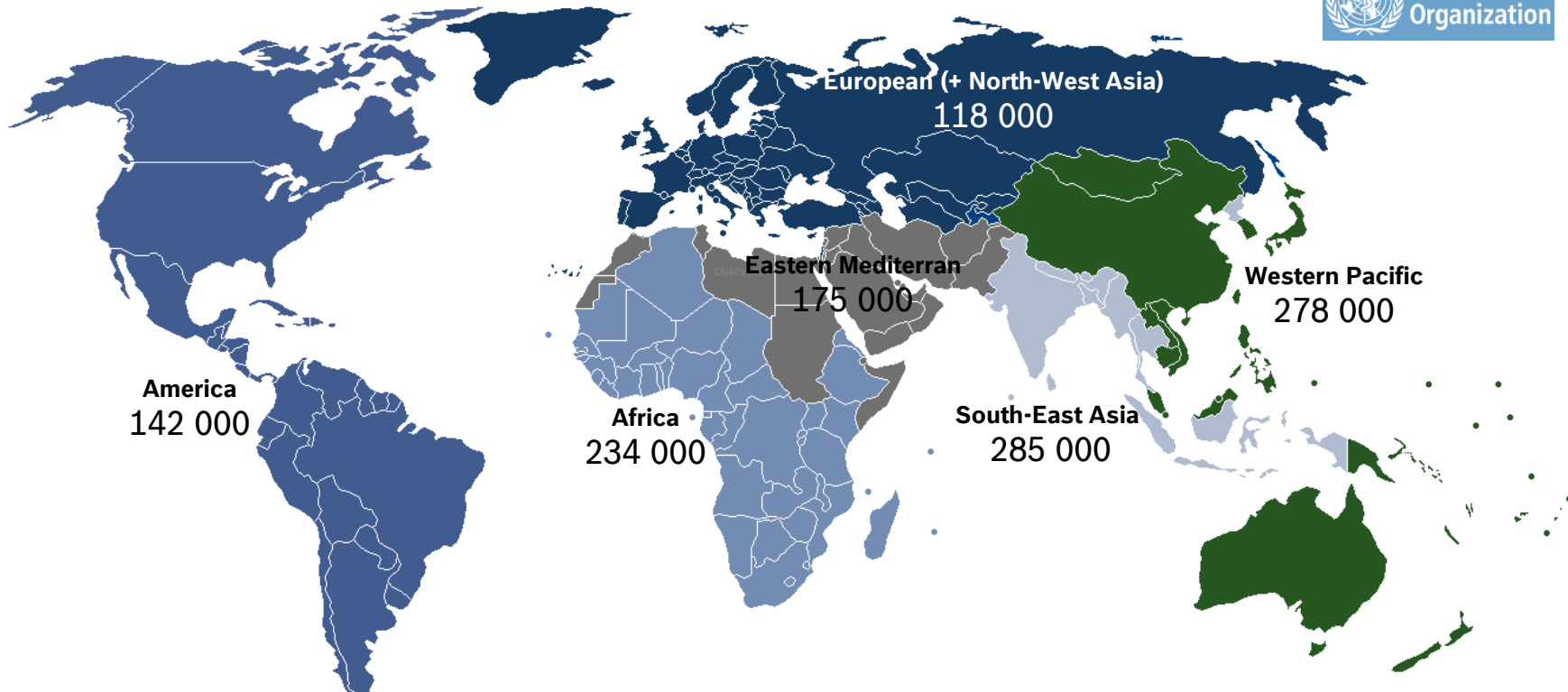
⇒ **keep rolling (CO<sub>2</sub>, e-mobility)**



## Some daily Traffic Scenarios



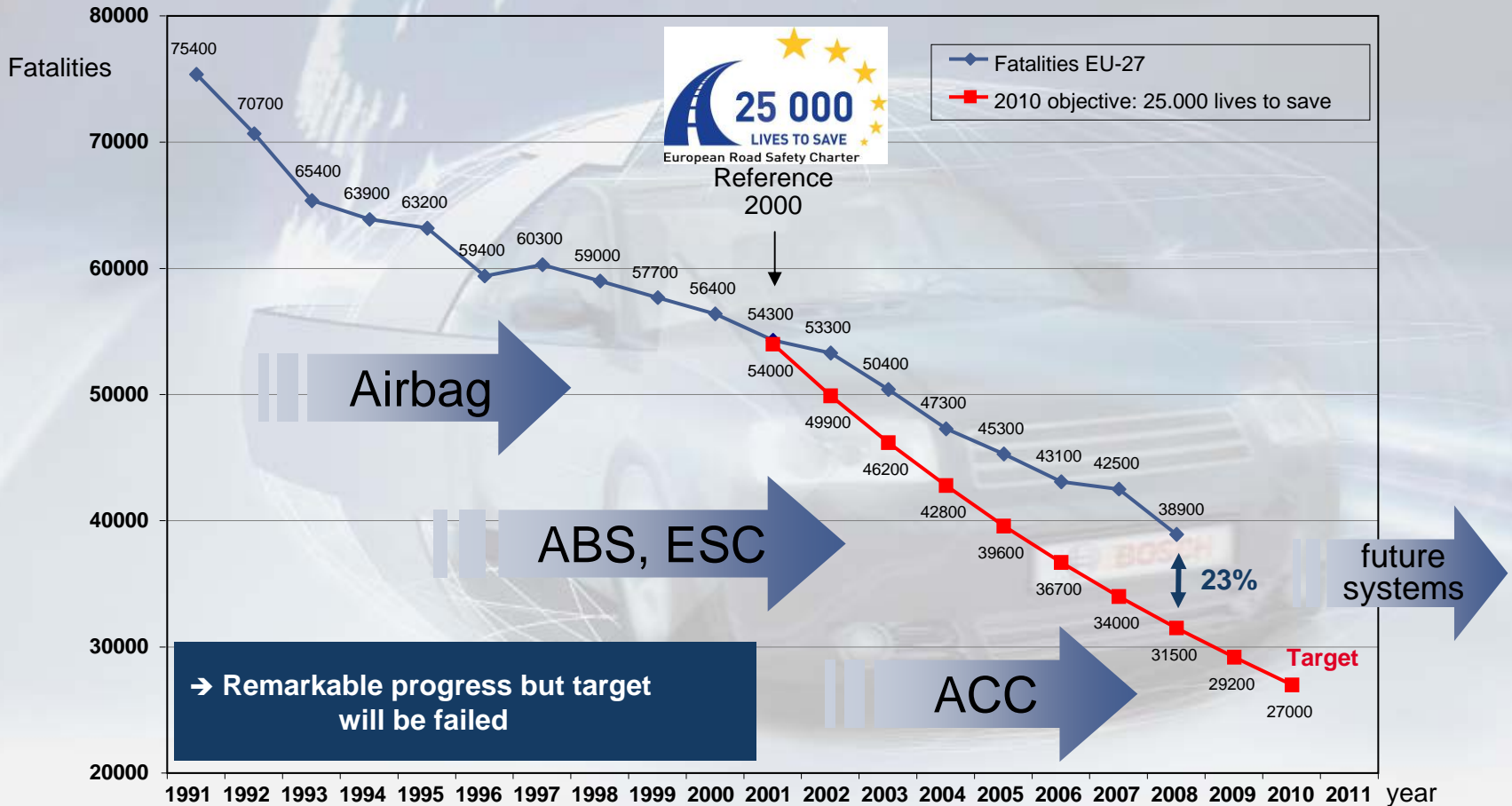
## Road traffic deaths by WHO region



Worldwide approximately 1.23 million fatalities per year

source: global status report on road safety, WHO 2009

## Evolution of European Road Fatalities (EU-27)



Source: CARE or national publications; EC Directorate General Energy and Transport December 2007

### Chassis Systems Control



## Market Drivers for Advanced Driver Assistance

### Legislation & Regulation

- EuroNCAP+ plans to include ADAS\* in 2014/ 2016
- NA NCAP & JNCAP: showing clear hints to ADAS, e.g. @ safecar.org
- EU: LDW & emergency brake assist mandatory for HDV\*\* (2013)

### Availability DA Functions

- Low Speed Active Braking and Collision Warning already standard in some cars
- Active Pedestrian protection
- Democratization of DA functions (availability in compact car segment)

### Consumer

- Consumer surveys indicating willingness to buy
- EuroNCAP+ advanced and consumer tests (e.g. ADAC) raise end-consumer awareness



### Technology

- Radar and video dominating but no dedicated sensor concept yet as standard settled
- Need for sensor data fusion
- Cost/benefit ratio major focus



## Who is the Euro NCAP?

Euro NCAP was set up by the Transport Research Laboratory, for the UK Department of Transport. Subsequently governments from France, Germany, Sweden, The Netherlands and the Catalonian part of Spain have joined the programme.

Euro NCAP itself is an International Association under Belgian law. It is independent of the industry and political control and no individual member can bias Euro NCAP towards their individual interests.



**Euro NCAP is totally independent of the automotive industry.**

## Board members of Euro NCAP



Department for Transport (DfT)



Dutch Ministry of Transport,  
Public Works and Water  
Management



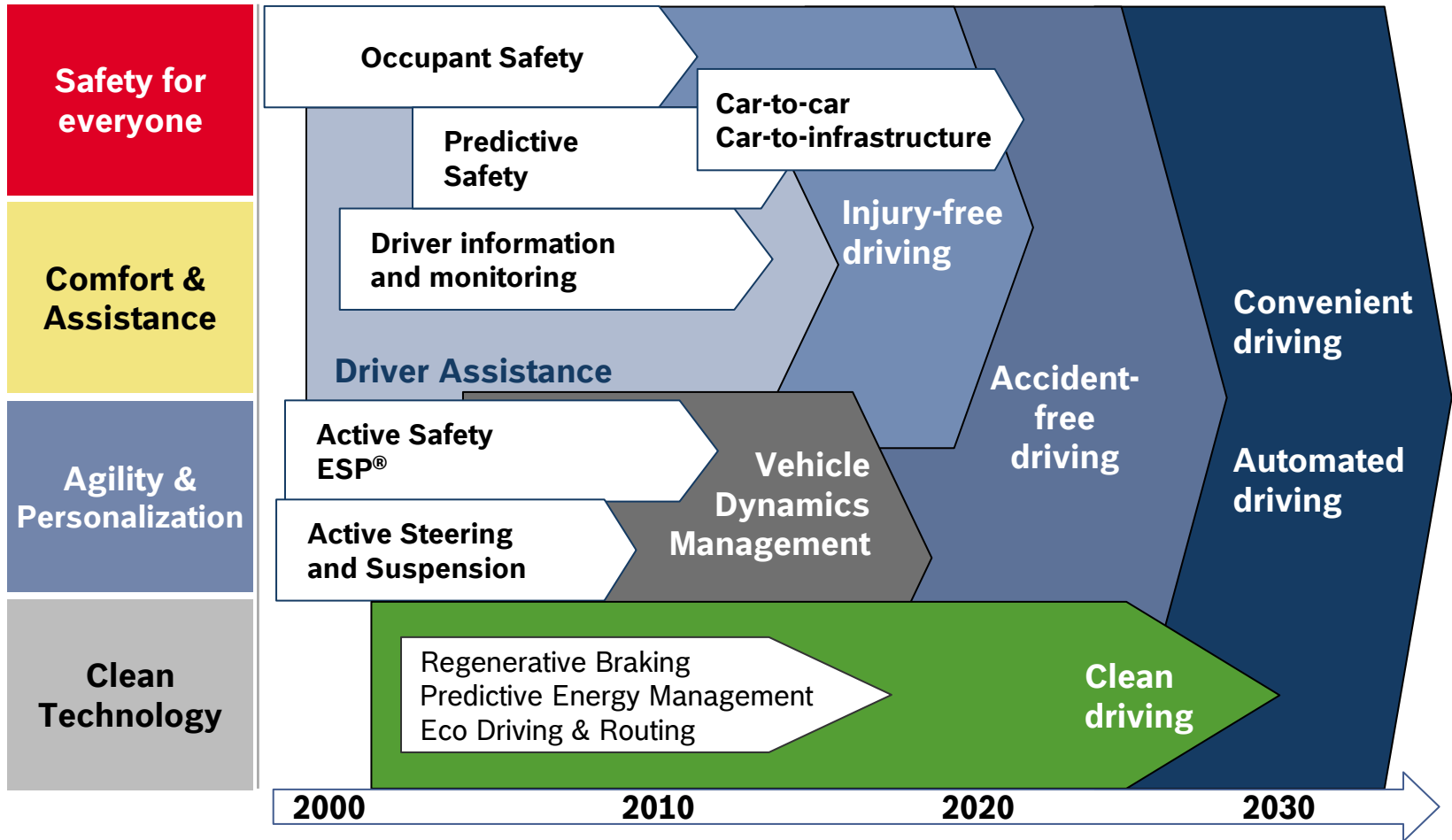
Ministère de l'Écologie, de l'Énergie,  
du Développement durable  
et de l'Aménagement du Territoire



ACI - Automobile Club d'Italia



## Fields of actions and milestone roadmap



## Radar Based Driver Assistance Systems

### Comfort Guidance

- **Heading Distance Indicator**
- **ACCbase** (30...160 km/h)
- **ACC Stop & Go** (0 -200... 250 km/h)
- **Green ACC**  
ACC S&G with  
CO<sub>2</sub> optimized strategy
- **Traffic Jam Assist**  
(Data fusion with camera)  
Integration of longitudinal and lateral  
guidance



### Predictive Emergency Braking

- **Predictive Collision Warning**
- **Emergency Braking Assist**
- **Automatic Emergency Braking**  
automatic partial / full braking for
  - reaction time gain
  - collision mitigation
  - collision avoidance at low speed
- **Evasion Support**  
(Data fusion with camera)  
Predictive steering support



## Potential sensor configuration towards Autonomous Driving

### Customer benefits

#### Front

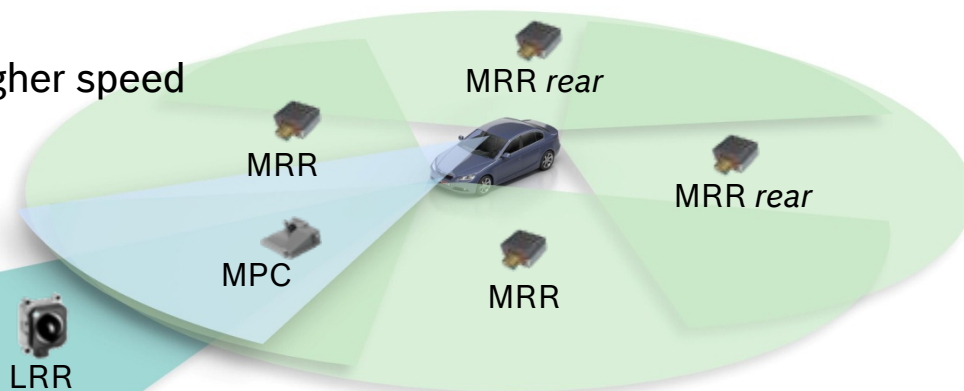
- Left turn assist
- Evasive assistance
- Integrated Cruise Assist / Traffic jam assist
- Pedestrian protection
- Automatic Emergency Brake at higher speed

#### Front/Side

- Front cross traffic alert

#### Rear/Side

- LCA, BSD
- Rear cross traffic alert
- Active brake/steering intervention



### Properties

- Usage of known technologies
- Data fusion of Radar and Video
- Flexible sensor architecture

**Function Extension Feasible:**  
Fusion with ultrasonic sensors  
and rear range camera

## Traffic Scenarios with High Resolution Requirements



Side Impact



Evasion Maneuver



Narrow Pass Assistant



Pedestrian Protection



Parking Assistant



Proximity Warning



Cross Traffic Alert

Source: Daimler AG

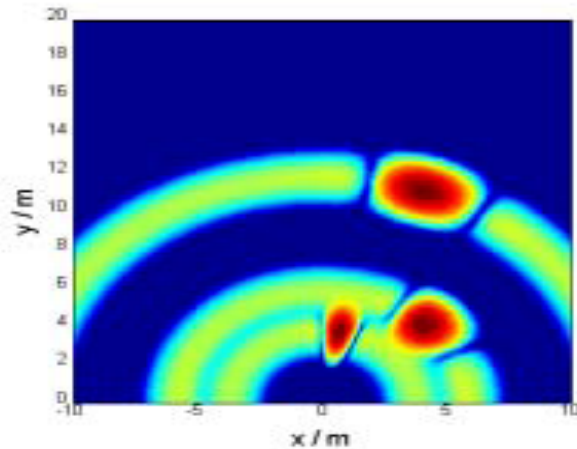
Chassis Systems Control





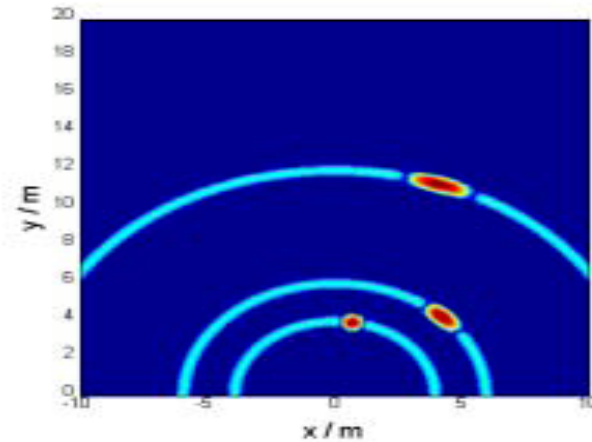
## Target separation capability

B = 250 MHz



Typ. Long Range Radar Bandwidth

B = 1500 MHz



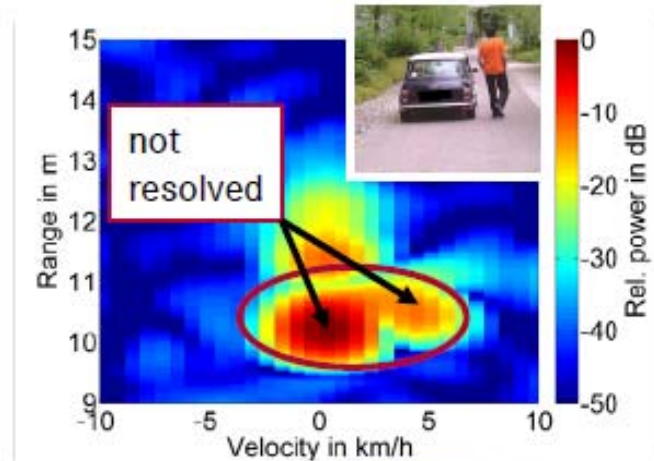
Typ. High Resolution Radar Bandwidth

## Bandwidth Influence on Range-Velocity Processing

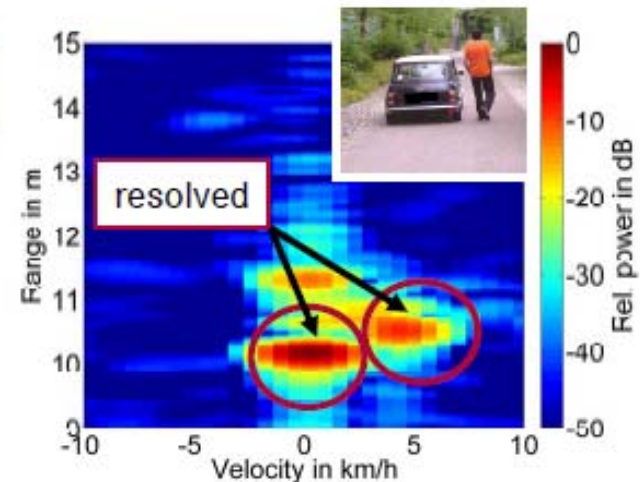
### Measurement Setup

- Carrier frequency: 79 GHz
- Polarization: vertical
- Amount of chirps: 32
- Chirp duration: 144  $\mu$ s (@B=1.35GHz)
- Ramp rep. interval: 160  $\mu$ s
- Velocity resolution: 1.36 km/h
- Max. range: 49.9m
- Max. velocity:  $\pm 21.69$  km/h

$B_{net}$ : 0.5 GHz



1.35 GHz

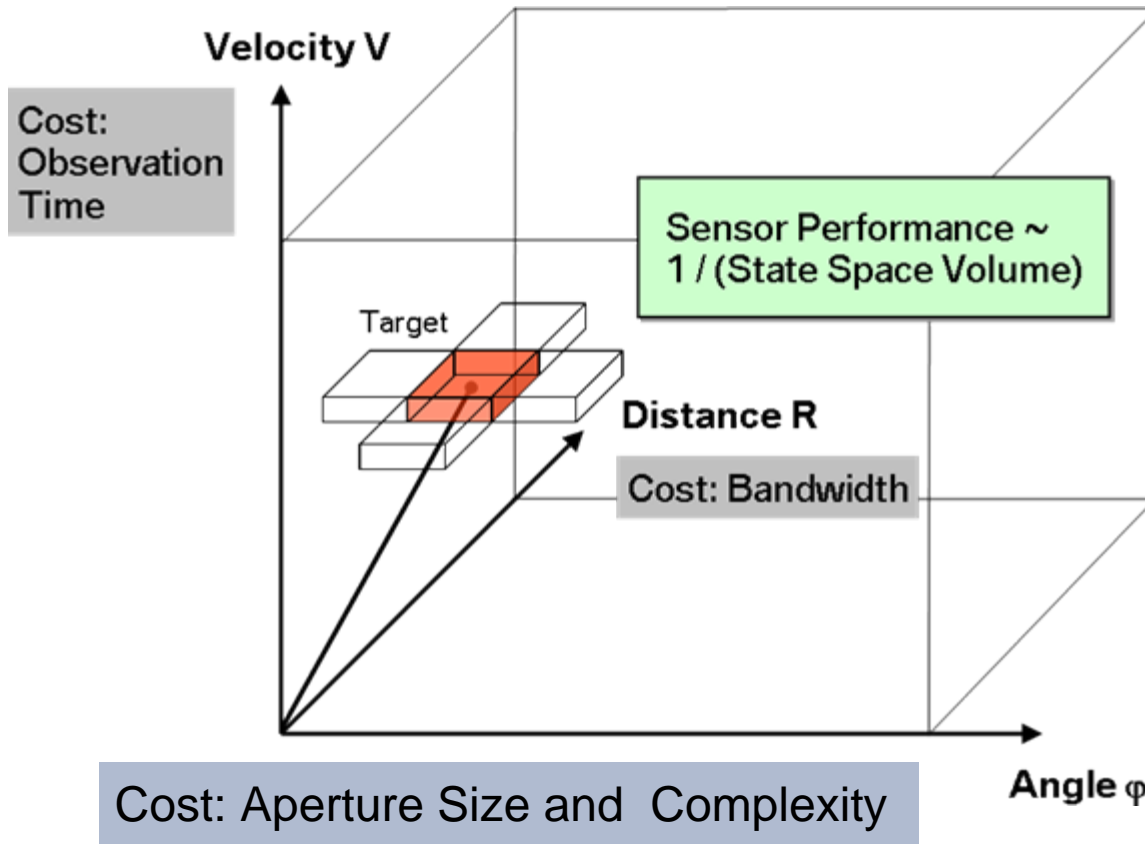


→ Increased bandwidth resolves pedestrian and car.

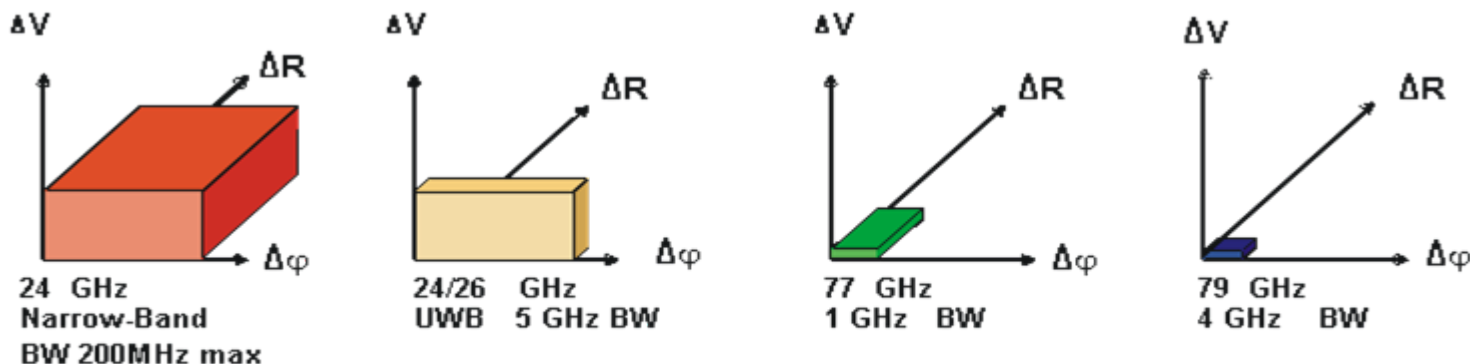
Source: Daimler AG

Chassis Systems Control

## Automotive Radar Sensor Performance



## Comparison of Automotive Sensor Performance



### Legend:

$\Delta V$  : Velocity Axis

→ Doppler resolution of object distance is RF frequency dependant  
Higher RF frequency enables better Doppler resolution

$\Delta \phi$  : Angle Axis

→ For a given aperture, the resolution increases with frequency.  
Angular resolution depends on antenna aperture.

$\Delta R$  : Range Axis

**The smaller the cubic the better the radar performance**

Source: BMW AG

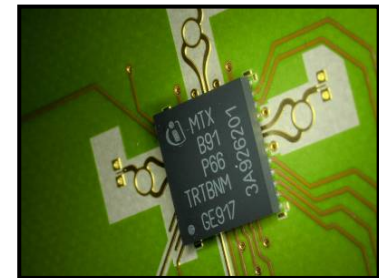
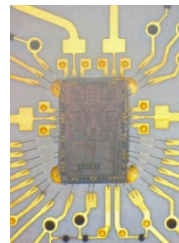
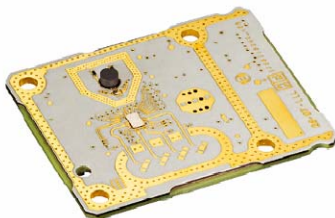
Chassis Systems Control



- 76 GHz SiGe - Technology is in series production and radars have been installed worldwide since 2009
- 76 GHz and 79 GHz technology is identical; some differences in broadband antenna design and antenna technology
- Released components (MMICs, substrates, plastics) for 79 GHz available



- Pre-series high resolution sensors are available for evaluation
- Cost situation today: 79 GHz is cost comparable with 24 GHz and will gain at the same time **higher performance**

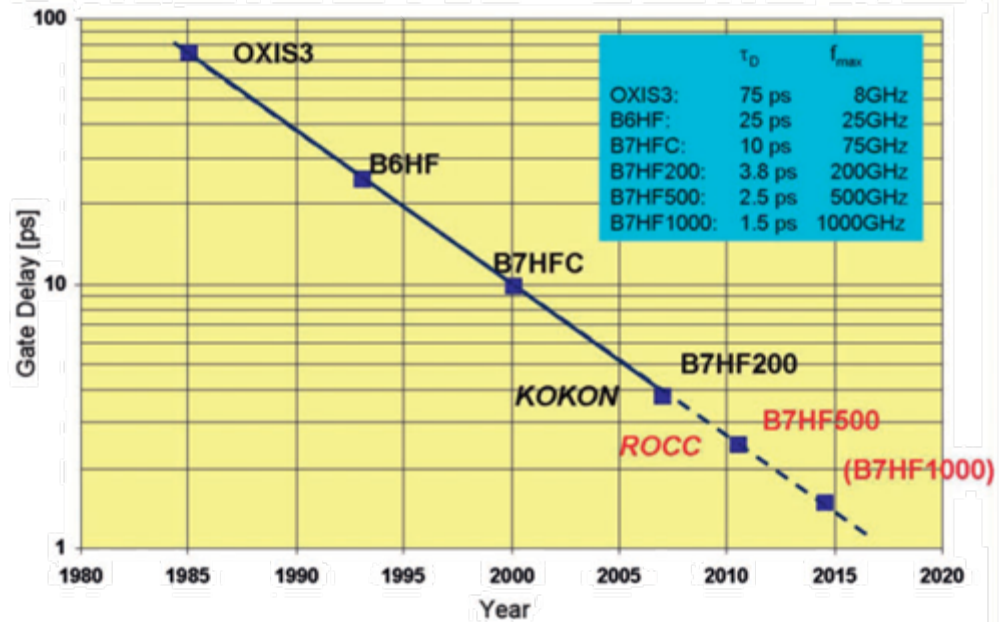


## SiGe Technology Roadmap

### Generic

	2007	2008	2009	2010	2011	2012	2013
ITRS (GHz) PeakFmax In production	280	305	330	350	370	390	410
DOTFIVE PeakFmax (GHz) in R&D		330	400	500			500 in production

### IFX



## Summary

- The main drivers for high resolution 79 GHz automotive radar sensors have been identified by challenging safety related functions and road scenarios
- Industry stakeholders have invested a lot of effort and money in this field
- 79 GHz national and european funded projects are on track (e.g. CSA 79 GHz, RASSUR 79; France)



For long-term proliferation of vehicular radar systems there are further challenges to overcome besides the classical topics like improved performance, lower cost, smaller size, better (multi)-functionality, etc.

**Essential is the allocation of harmonized, globally available frequency ranges for future success**

Without a valid equipment authorization not a single sensor can be sold in any country of the world



**More people  
need to get  
aware of this !**