

# Car-to-X at Mercedes-Benz Applications and Technologies

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Mercedes-Benz

# Clusters of Applications



## Event messaging, V2V, V2X

- In series production with new E-class in 2016
- Further improvements planned

## Infrastructure to vehicle, V2I

- Local projects
- Business model for world-wide deployment not clear

## Platooning for Trucks

- Planned for 20xx

## Driver Assist Safety Applications, AD

- Mercedes' core know how
- Further development of safety use cases
- **Automated Driving** on the roadmap

# Technologies



## Cellular radio UMTS, LTE

- Standard in every car due to e-Call
- Further improvements planned with LTE 5G
- World wide standard

## LTE-V2X @ 5,9 GHz

- Device to device communication
- Telecom industry promises to cover all needs of DSRC 802.11p applications

## DSRC\* 802.11p, ETSI ITS-G5 @ 5,9 GHz

- New infrastructure on- and off-board necessary

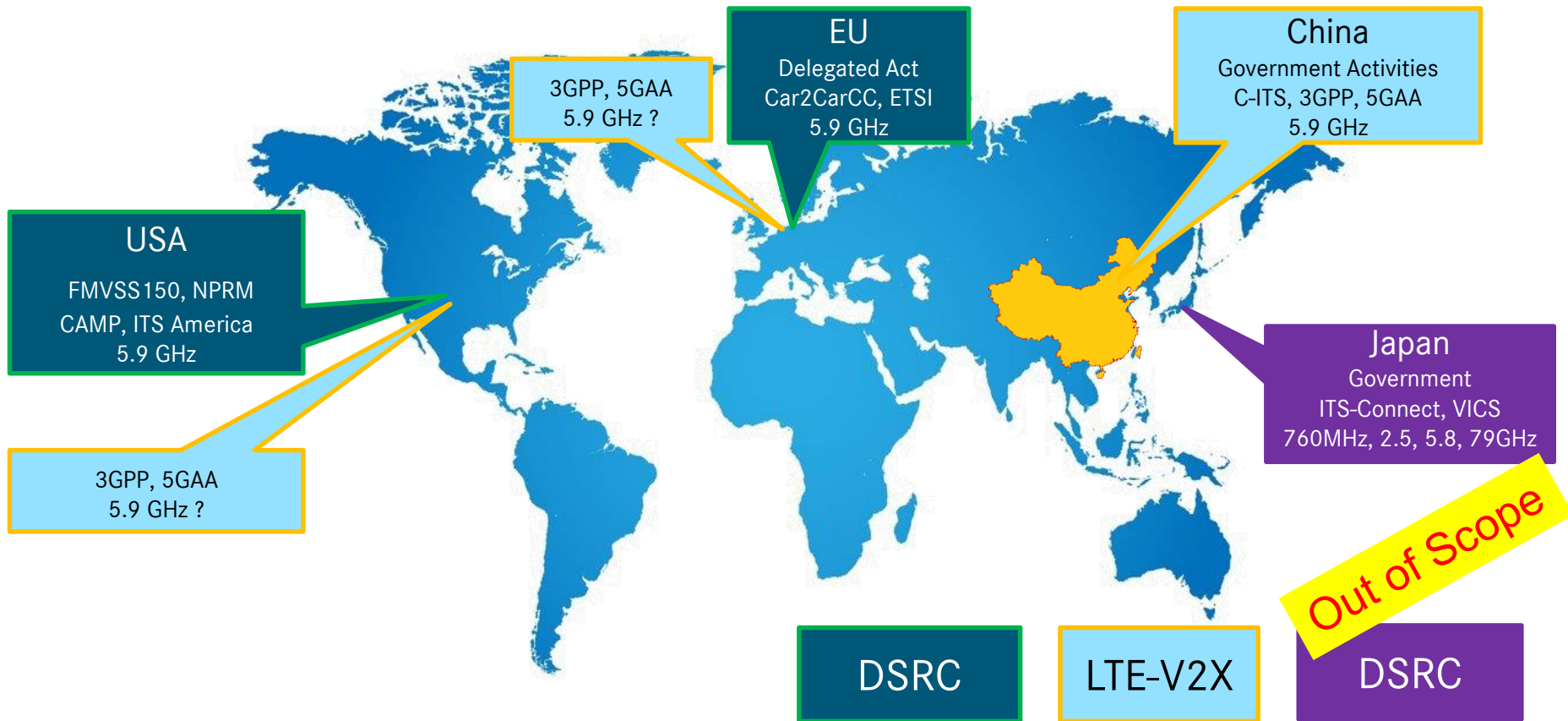
## Onboard sensors radar, camera

- High maturity
- Further improvements planned
- New sensor technologies on the roadmap

## Direct Communication

\* DSRC, Dedicated Short Range Communication

# Market Activities on Direct Communication



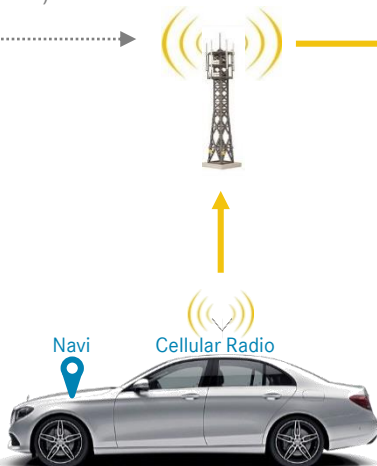
# Car-to-X via Cellular Radio since E-Class 2016



Mobile work zone communicate live from the trailers - market dependent)

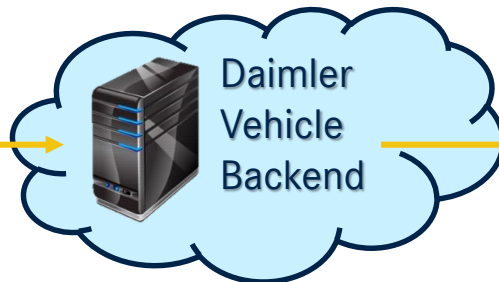


**Mobile work zone ahead**



## Ego vehicle

- Event detection and plausibility check
- No additional components necessary



## Cars are connected to the Daimler Vehicle Backend

- Data filtering and aggregation
- Security and Privacy ensured
- OEMs and Data supplier are invited to share
- Markets: USA, EU, China



## Remote Vehicle

- Data relevance check
- Display icon on map
- Generate speech output

# Car-to-X via Cellular Radio since E-Class 2016



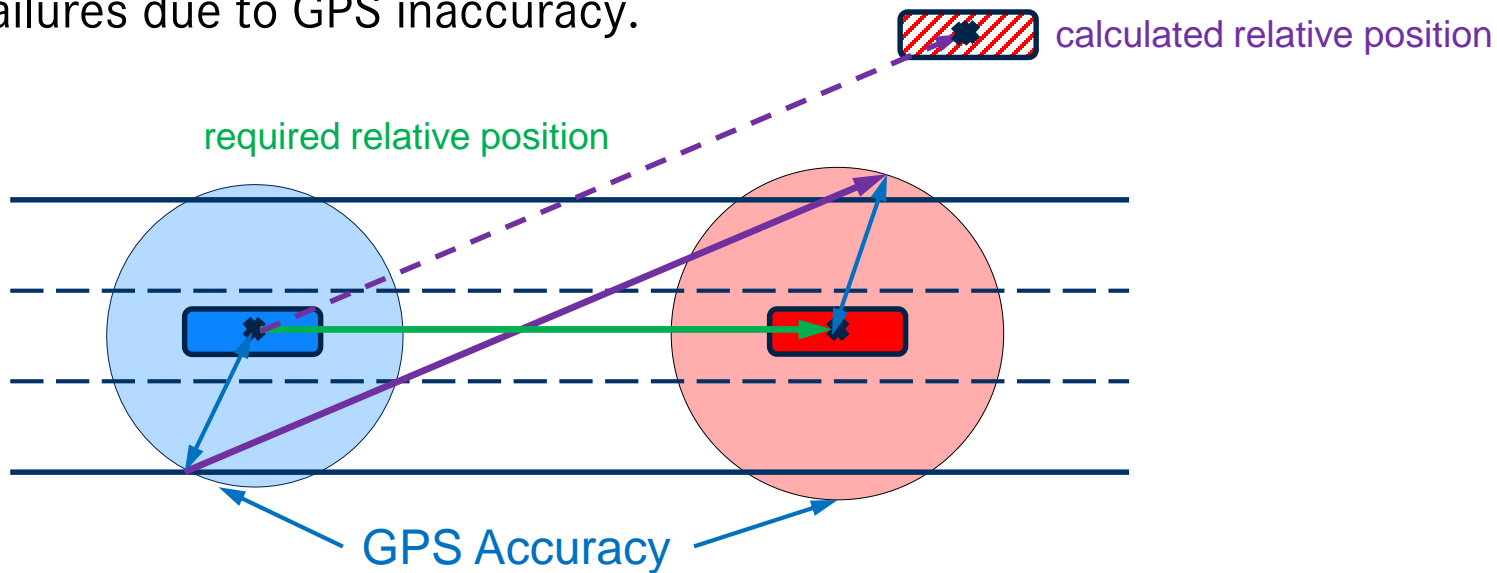
Event	Triggering Conditions	Icon on Map	Speech Output
Broken down vehicle	Vehicle system signals		Yes
Vehicle accident	Air bag inflation and others		Yes
Hazard lights	Hazard light on		Yes
Heavy Rain	Highest wiper level for 20 s		No
Slippery road	Antilock braking system intervention		No
Fog	Rear fog light on		No
Mobile work zone	External data from work zone trailers		Yes
Emergency Vehicle	No data source available	Icon on instrument cluster	
General Warning	Driver manual input		Yes
Cross Wind	ESP Intervention		No

→ Car-to-X enables immediate V2V and V2X functionality via Cellular Radio



# Road Safety Applications require precise relative position

Positioning failures due to GPS inaccuracy.

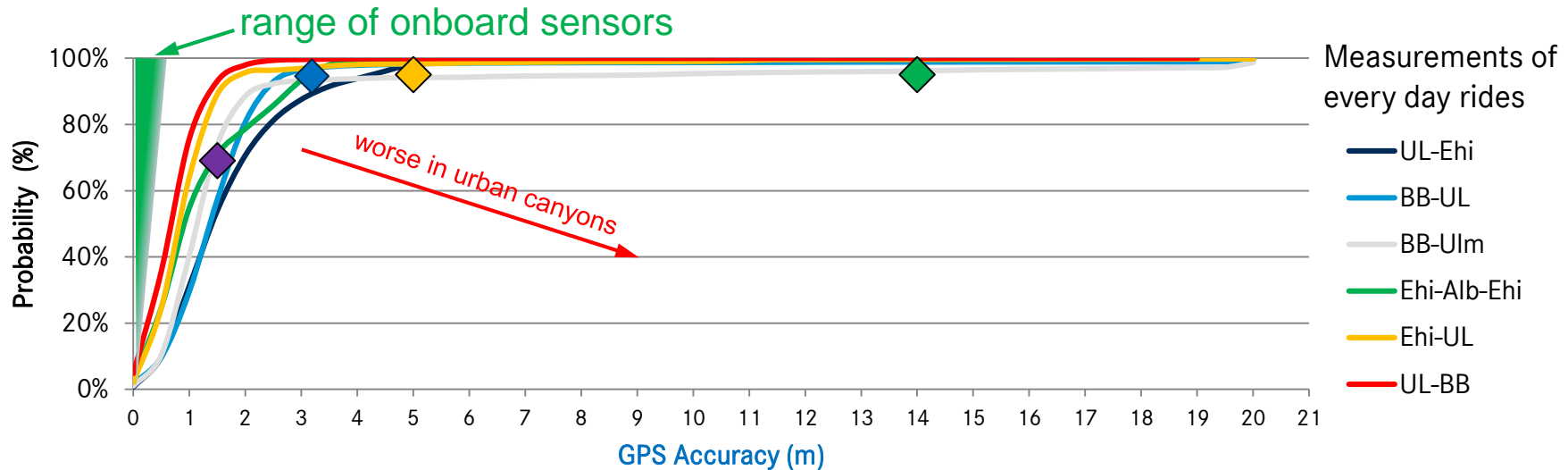


# On Board Sensors provide by far higher accuracy than GPS



GPS Accuracy requirements from standardization:

- EU: Open Sky: < 5 m at 95 % probability  EU: City: < 14 m at 95 % probability 
- US: Open Sky: < 1,5 m at 69 % probability  US: Open Sky: < 3 m at 95 % probability 



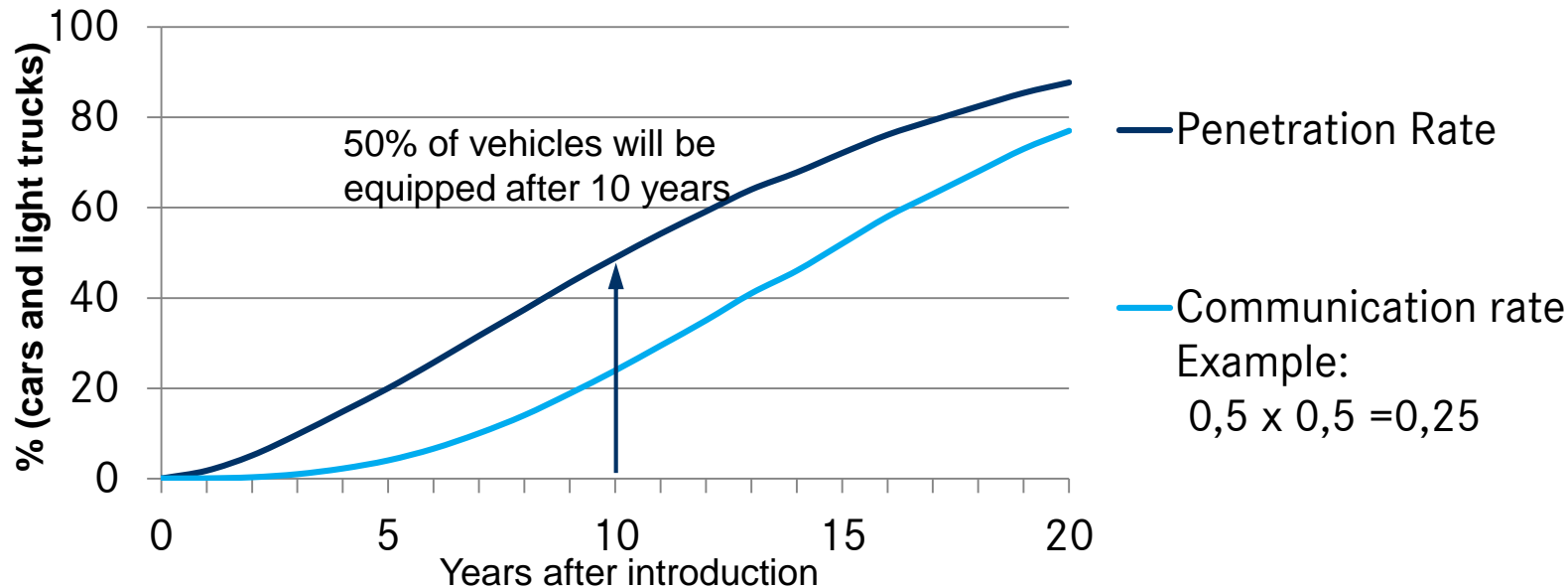
→ GPS accuracy not sufficient for the implementation of safety applications.



# Benefit of DSRC based Safety Applications, US



Source: NHTSA „Readiness of V2V Technology for Application“ 08/2014, scenario 2: no aftermarket deployment



- With DSRC the benefit on traffic safety increases only with the communication rate.
- Pedestrians, bicyclists, trucks, trailers, fixed obstacles and parked vehicles are not protected.
- On board sensor based systems don't suffer from these facts

# DSRC Safety Applications, US, Overview



- Source: NHTSA „Readiness of V2V Technology for Application“ 08/2014, Table VI-1

Crash Type	V2V Safety Application	Mercedes System (sensor based)
Rear End	Forward Collision Warning	Active Brake Assist (warning and <b>autonomous braking upon vehicles, bikes and pedestrians</b> ), standard
	Electronic Emergency Brake Light	Adaptive Brake Lights (flash upon emergency braking, currently not allowed in US, standard in rest of the world), Multi Object Radar (radar detects decelerating vehicle ahead of lead vehicle)
Opposite direction	Do Not Pass Warning (“90% drifting into opposite lane“)	Active Lane Keeping Assist (warning and <b>single-sided braking</b> ), standard
	Left Turn Assist	Turning Maneuver Function ( <b>braking</b> )
Junction crossing	Intersection Movement Assist	Active Brake Assist: Cross Traffic Function (warning and <b>autonomous braking</b> )
Lane change	Blind Spot Warning, Lane Change Warning	Blind Spot Assist (warning), Active Blind Spot Assist (warning and <b>single sided braking</b> ), Active Lane Change
→ Sensor based safety applications cannot be replaced by V2V/V2X		

# EU Priority Services are already in the market



- Source: Commission Delegated Regulation 2019, ANNEX 1, Page 4

Vehicle-to-Vehicle Services via DSRC	Mercedes Series Systems	Technology
Dangerous end of queue	Live Traffic, Car-to-X Hazard Light (Speech Output)	Cellular Radio
Traffic jam ahead	Live Traffic, End of Traffic Jam Function	Cellular Radio
Stopped vehicle	Active Distance Assist DISTRONIC	Radar, Camera
Broken-down vehicle	Car-to-X Broken-down vehicle (Speech Output)	Cellular Radio
Post-crash	Car-to-X Vehicle Accident, eCall	Cellular Radio
Emergency vehicle in operation	Car-to-X Emergency vehicle signage in instrument cluster	Cellular Radio
Stationary safeguarding emergency vehicle	Car-to-X Emergency vehicle signage in instrument cluster	Cellular Radio
Stationary recovery service warning	Live Traffic	Cellular Radio
Request impact reduction container	PRE-SAFE Sound	Radar, ESP
Response impact reduction container	PRE-SAFE Belt Tensioner, closing windows, braking	Radar, ESP
Electronic emergency brake light	PRE-SAFE PLUS: Flashing Rear Hazard Lights, braking	Radar
Automatic brake intervention	Active Brake Assist, standard	Radar, Camera
Reversible occupant restraint system intervention	PRE-SAFE Belt Tensioner	
Fog	Car-to-X Fog	Cellular Radio
Precipitation	Car-to-X Heavy Rain	Cellular Radio
Traction loss	Car-to-X Slippery Road	Cellular Radio

# EU Priority Services are already in the market



- Source: Commission Delegated Regulation 2019, ANNEX 1, Page 4

Infrastructure-to-Vehicle Services via DS <b>DSRC</b>	Mercedes Series Systems	Technology
Dynamic speed limit information	Speed limit assist, standard	Camera
Embedded variable Message signs 'free text'	TMC, TPEG in Navigation	Cellular
Other signage information	Traffic Sign Assist including Wrong Way Alert	Camera, Navi
Accident zone	Live Traffic, Car-to-X Hazard Light (Speech Output)	Cellular
Traffic jam ahead	Live Traffic, End of Traffic Jam Function	Cellular
Stationary vehicle	Car-to-X Hazard Light, Active Distance Assist DISTRONIC	Cellular
Weather condition warning	Car-to-X and weather service	Cellular
Temporarily slippery road	Car-to-X slippery road	Cellular
Animal or person on the road	Active Brake Assist crossing Pedestrian	Cellular
Obstacle on the road	TMC, TPEG in Navigation	Cellular
Lane closure (and other restrictions)	Live Traffic	Cellular
Road closure	Live Traffic	Cellular
Road works - mobile	Car-to-X Mobile Work zone	Cellular
Green light optimal speed advisory	Traffic Light Recognition	Camera
Public transport prioritization	(already widely deployed with existing technology)	Other

# Competition of Technologies

