

Towards 5G - An Automotive Perspective

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Introduction

■ GM R&D organization

- Wireless
- HMI
- Control
- Sensors
- Powertrain
- etc...

■ Product organization

- OnStar / GCCX
- Engineering



Outline

- Automotive use cases, trends and requirements
- Differences between vehicles and smartphones
 - New bands: new opportunities and challenges
- V2X services: from 4G to 5G
- 5G interfaces to other RAT's



Use cases, trends and requirements

High level:

Bundle \ Trend	Automated driving	Urban mobility	Digital life
Vehicle as a platform/service	High	Medium	High
Reliable & high level communication service	High	Medium	High
Local area communication	High	Medium	High
Safety	High	High	Medium

Automated driving is a 'prime customer' to next generation communication services

Priority

High
Medium
Low

Use cases, trends and requirements

Detailed:

		Automated driving	Urban mobility	Digital life
Vehicle as a platform/service	e-commerce/e-wallet enabled vehicle		Medium	High
Reliable & high level communication service	Ubiquitous coverage (with same 5G radio)	High		Medium
	Operation under vehicle speed conditions	High	Medium	Medium
	Affordable data usage	High		Medium
	High DL throughput	High	High	High
	Several level of Automotive QoS/E (includes Safety)	High		
Local area communication	V2X infrastructure ('in' and 'out' of coverage)	High	Medium	
	V2V infrastructure (also inter operators)	High		
Safety	Low latency	High	High	High
	'SIMless' communications	High	High	

Priority

High
Medium
Low

Differences between vehicles and smartphones

- Lead time is reducing but still of 1.5-2 years over smartphones
- 'Hard reset' for resetting is not an option
- Higher gain antenna: good and bad
- Product life time is much longer:
 - Multiple operators (Multiple bands, SIM swapping) along life cycle
- Roaming strategy is regional (contiguous geography)
- High speed mobility is the nominal state (handovers, Doppler, small cells)
- Variety and clients/sources with different requirements: Telematics, passengers, sensors, WiFi APs, displays
- Power – Ignition on vs. ignition off

Vehicles and smartphones are similar but not the same

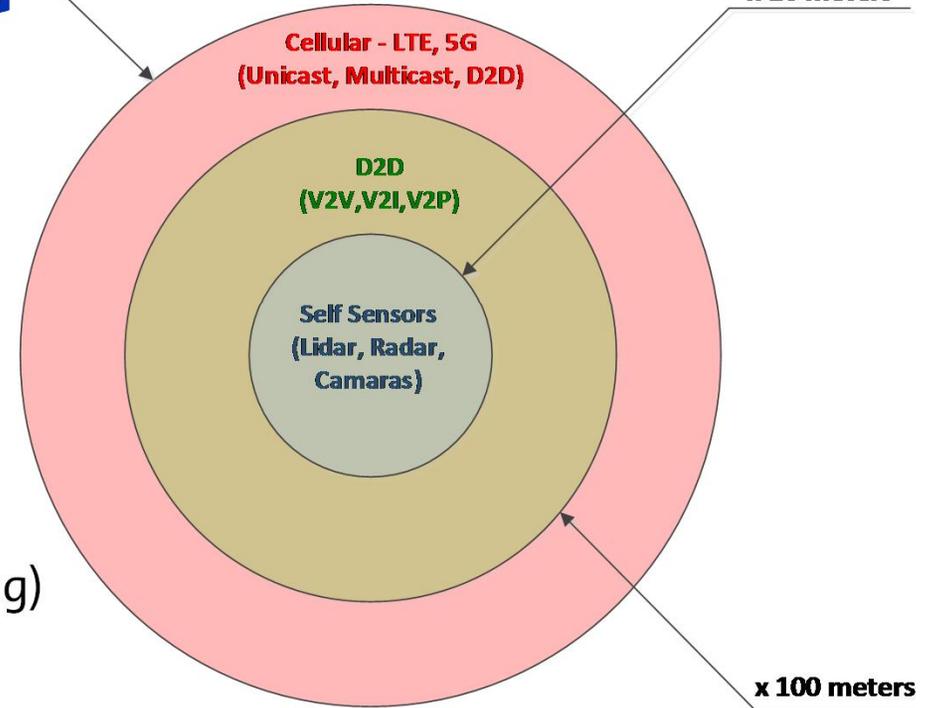
New bands: new opportunities and challenges

- Going above 6GHz
- Challenges that need to be addressed:
 - Larger Doppler frequencies
 - mmWave are challenging for outdoor deployment and more for vehicles
- Opportunities:
 - Potentially onboard large antenna arrays for functional beam forming
 - Efficient backhauling for relays
 - Vehicle based relays (VeRN)
 - More and larger bandwidth
 - Multiple video displays, camera sharing, multiple sensors

V2X services: from 4G to 5G

above x 100 meters

x 10 meters



■ LTE Rel. 13/14 status:

- Small payload (e.g. position and heading)
- Latency - 100 mSec

■ Towards 5G:

- Sensors sharing (e.g. cameras, Radars) – larger payload (i.e. UL and DL)
- Autonomous driving - latency < 10mSec
- Embedded sub meter ranging capability
- Operation in in-coverage and out-of-coverage

5G interfaces to other wireless access technologies

- WiFi
- WiGig

- Seamless end-to-end
 - Hybrid modes: cellular feeding WiFi/Gig hotspots connectivity for passengers
 - Vehicles connected to WiFi/Gig APs
 - Handovers between 5G and WiFi/Gig
 - IP continuity
 - Minimizing overhead / bottlenecks

Summary

- Automotive trends are defining requirements for 5G
- Vehicles are similar but not smartphones
- New bands introduces opportunities and challenges to be addressed
- V2X
- Holistic wireless connectivity

Backup

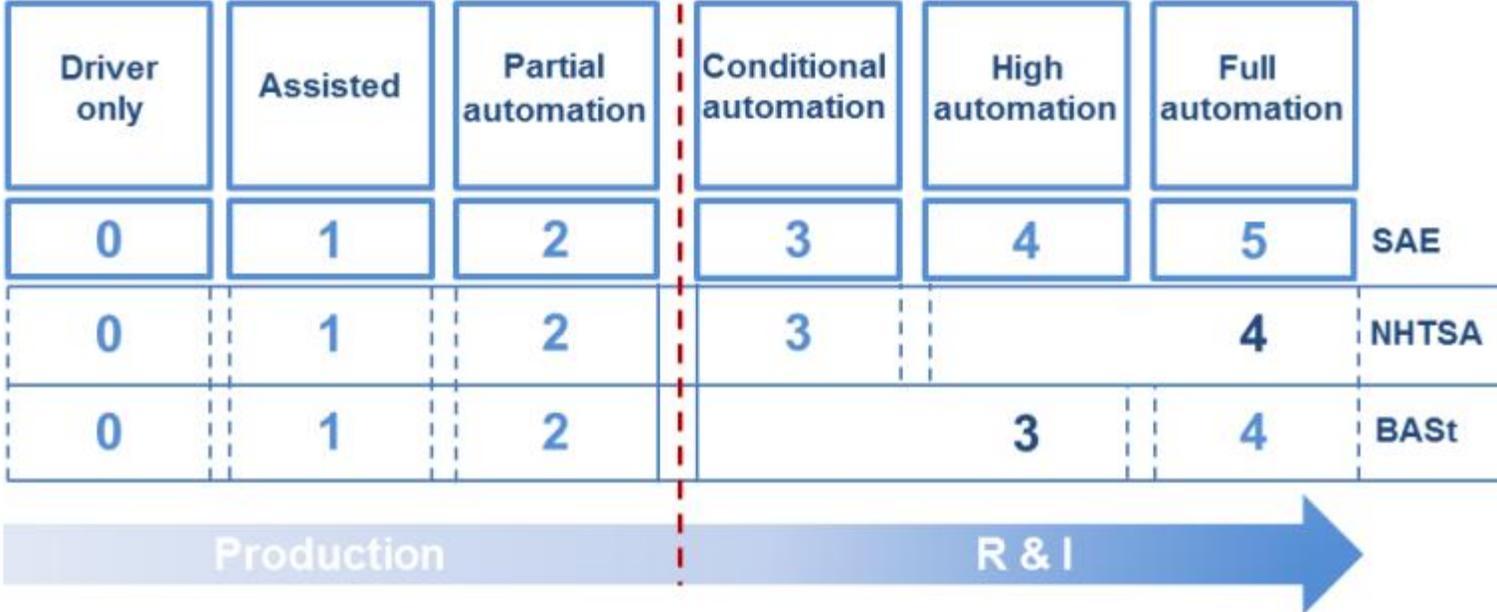


Figure 1: Levels of automated driving as defined by e.g. SAE. For comparison, definitions of automation levels are also given for BASt and NHTSA. For level 3, BASt comprises definitions of conditional and high automation while NHTSA’s level 4 (high automation) covers high and full automation.

Source: EPoSS; http://www.smart-systems-integration.org/public/documents/publications/...EPoSS%20Roadmap_Smart%20Systems%20for%20Automated%20Driving_2015_V1.pdf