

Wireless Innovations for Verticals beyond 5G

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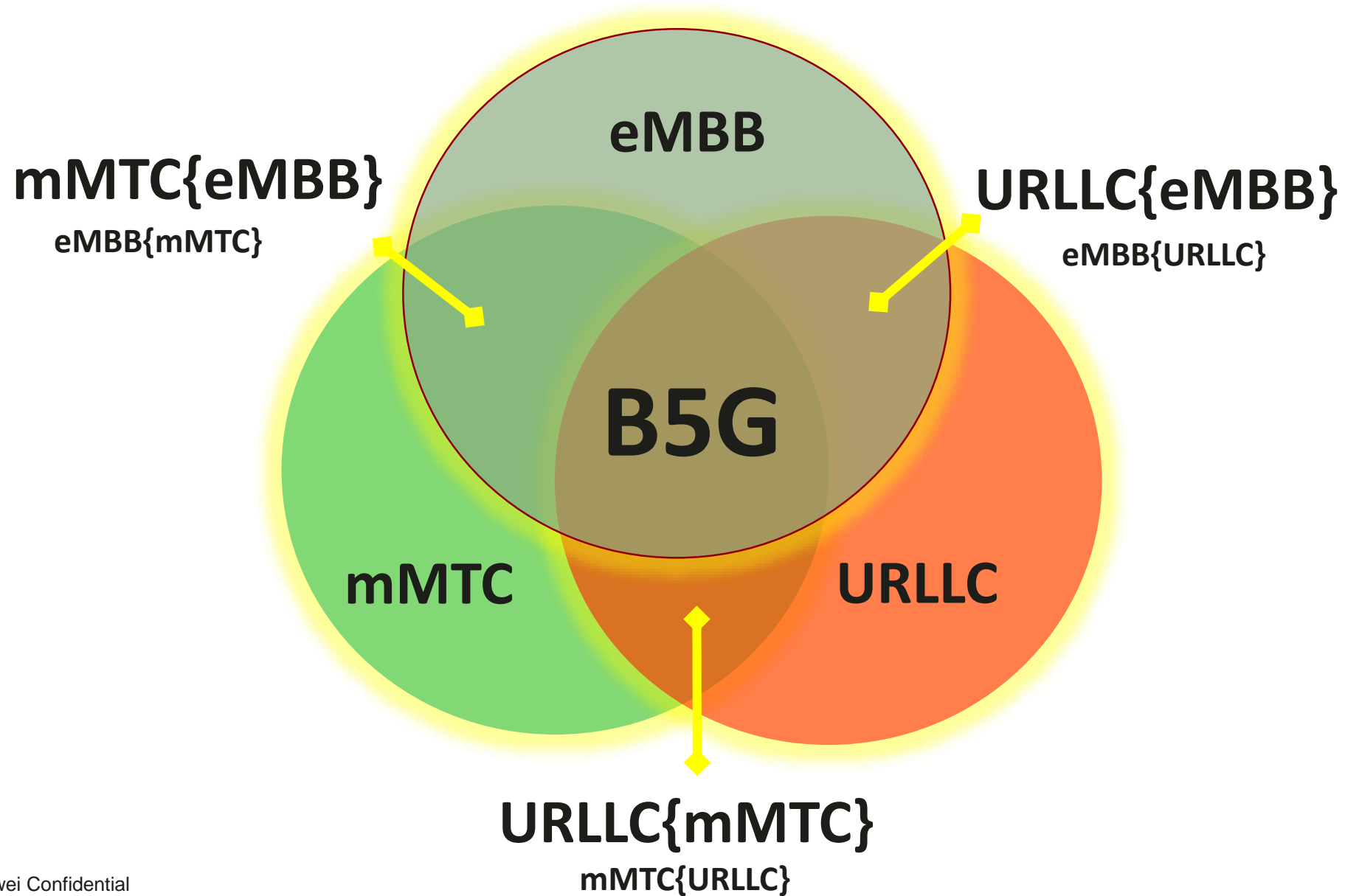


In the year 2050 *):

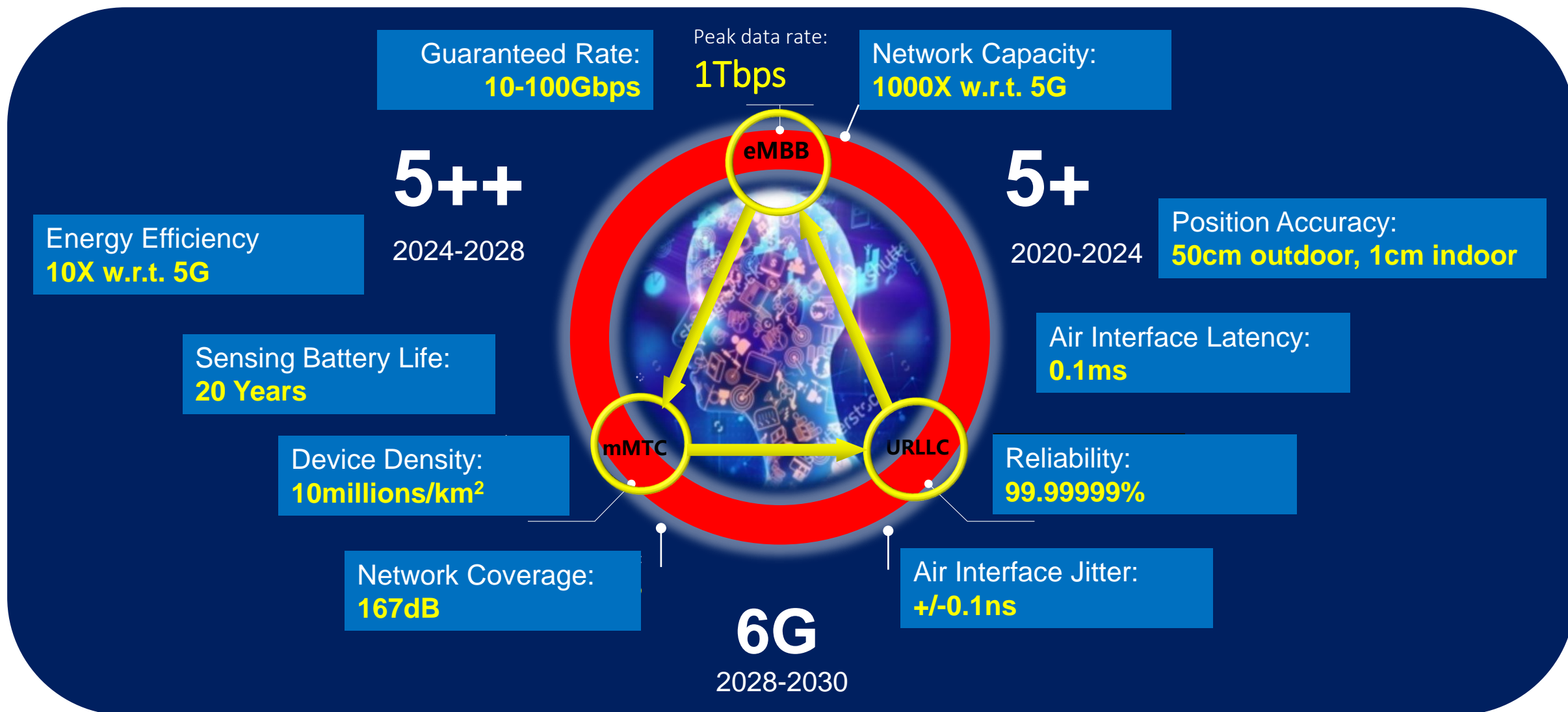


- Human driving is forbidden
- You see your doctor everyday
- Marilyn Monroe shoots new movies
- Computers fire and hire
- A robot commits bank robbery
- Portugal's national football team loses against a Spanish robot football team
- TV news produced without humans
- We will live eternally in our bots
- ...
- **What can wireless contribute ?**

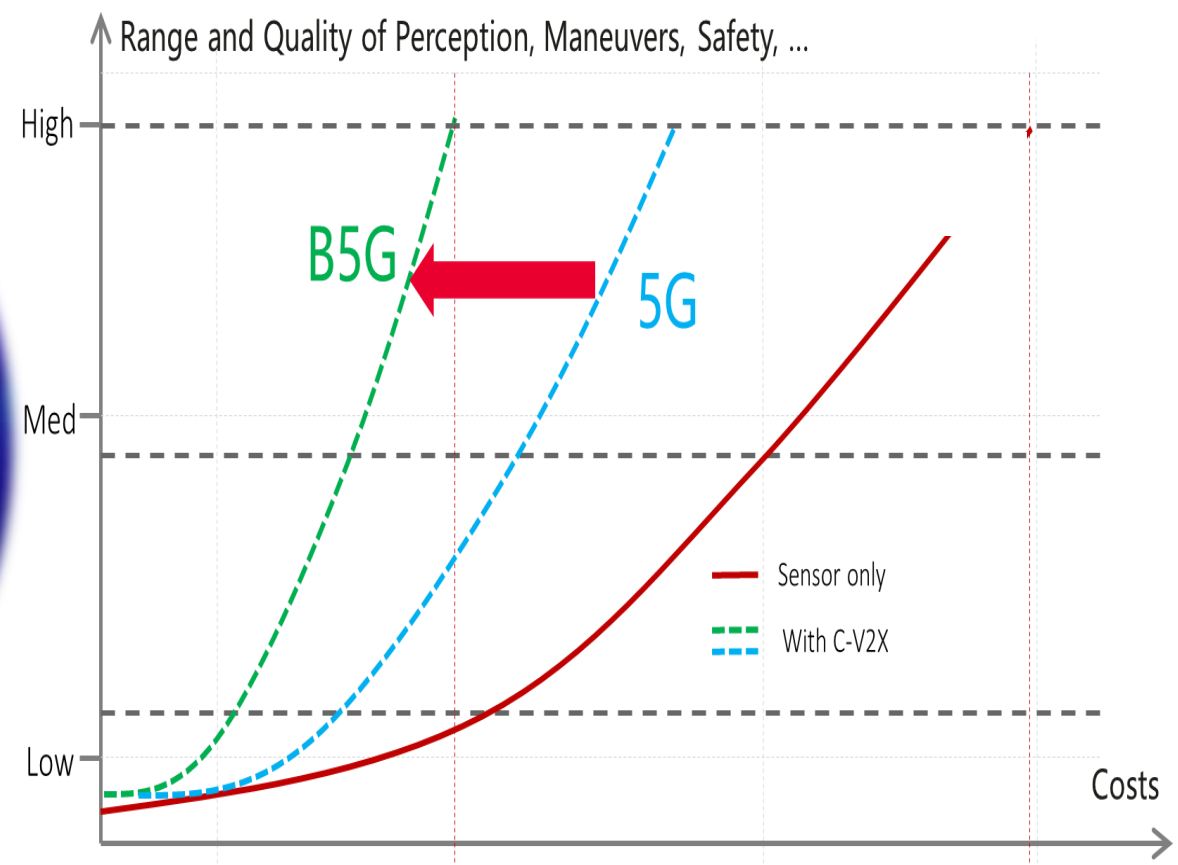
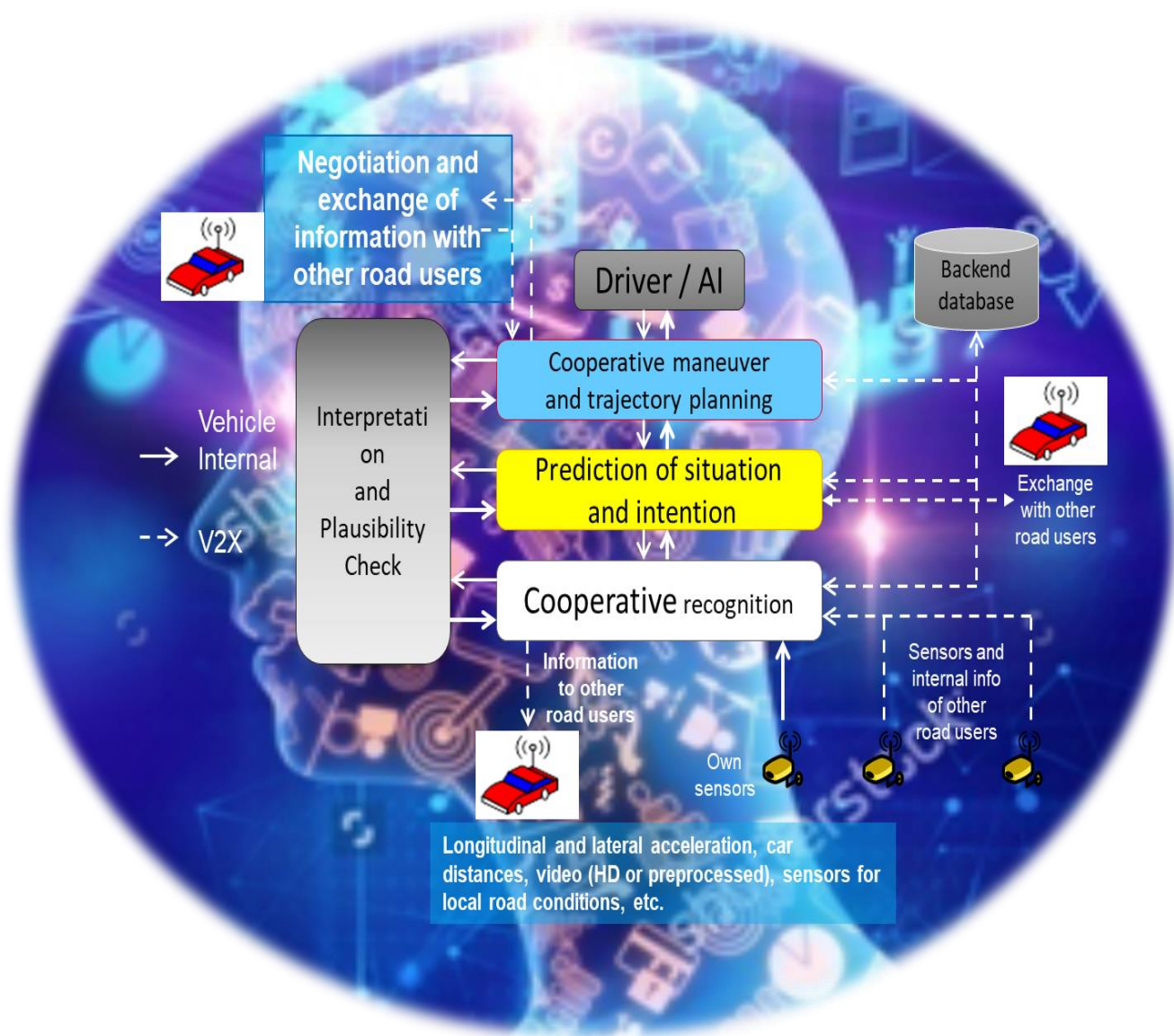
5G & Evolution



5G & Evolution



Communications complement AI and drivers in vehicles

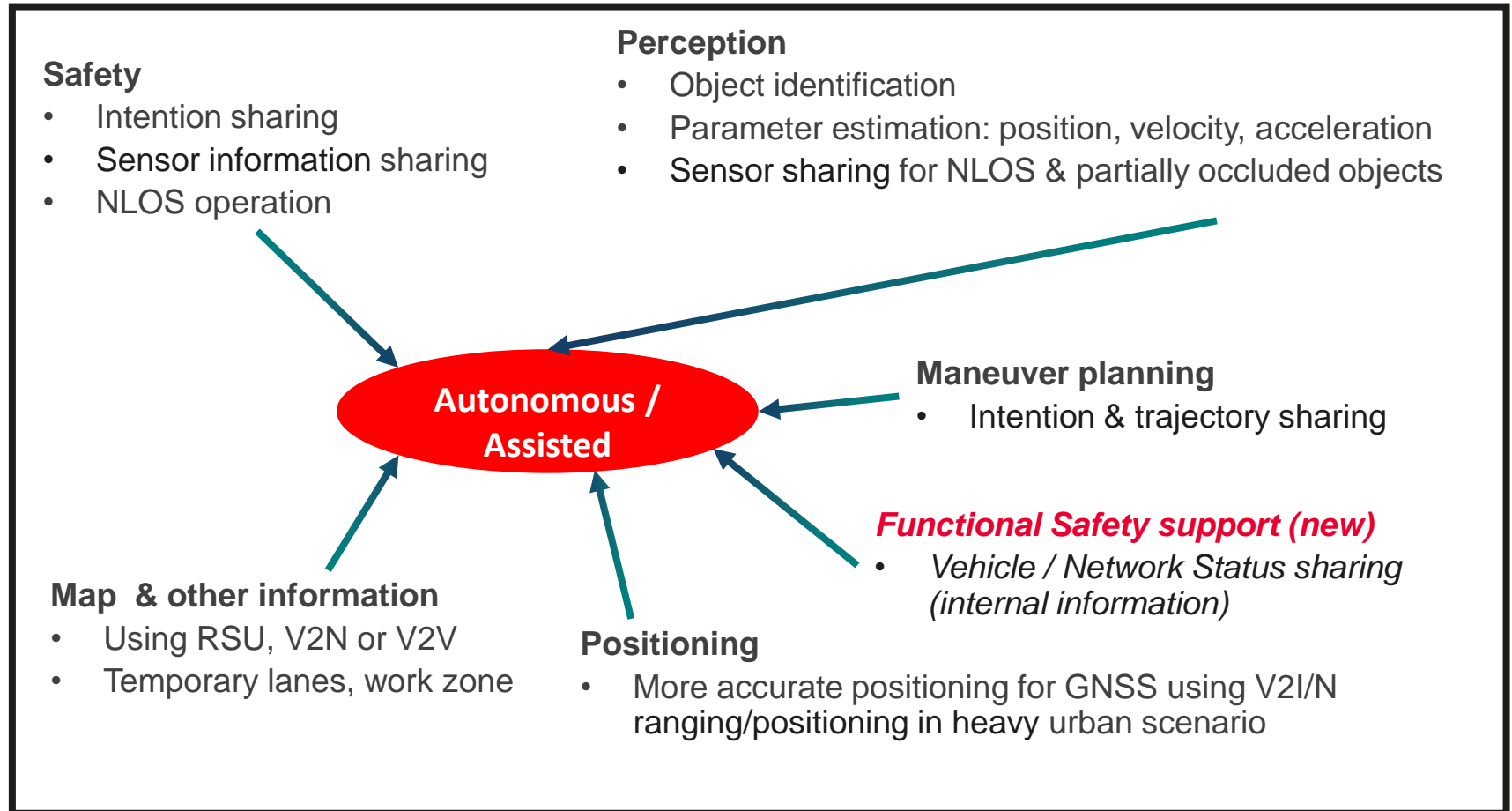


Today's view on 5G-V2X for autonomous, assisted and safe driving



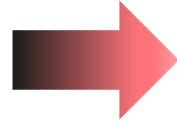
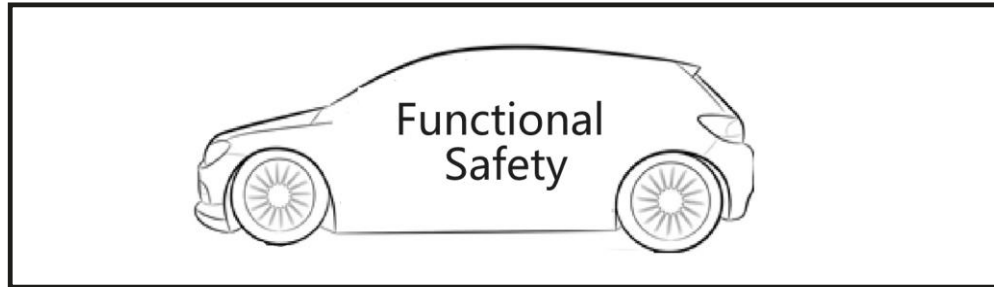
Use Case	Spectrum Requirement (MHz)	Notes
Safety messages	20	Safety messages
Sensor sharing (object sharing)	50	10s visibility, up to 40 objects of 50 bytes each On an average ~5X traffic compared to Safety messages.
Trajectory sharing	100	[2000] byte packet for 10s trajectory with 10ms resolution On an average ~10X traffic compared to Safety messages.

- Total demand: ~170 MHz
- 5.9 GHz ITS band has 70 MHz



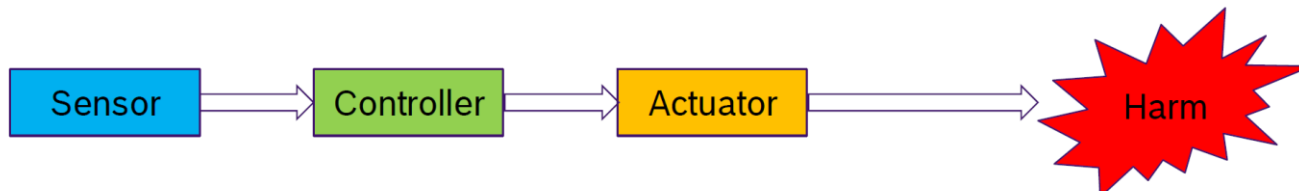
Additional Required Spectrum = 100 MHz (w/o Functional Safety demands)

Today and future Functional Safety design



- IEC 61508
 - Functional safety of electrical/electronic/programmable electronic safety-related systems
 - ISO 26262 Road vehicles - Functional safety
- SOTIF (Safety of the Intended Functionality)
 - ISO 21448
 - Errors not resulting from systematic errors or hardware failure
 - Physical limits of sensors

- **Upgraded IEC 61508 for Distributed Systems**
 - Functional safety of electrical/electronic/programmable electronic safety-related systems (**including V2X gateways, network**)
 - ISO 26262 Road vehicles - Functional safety
- SOTIF (Safety of the Intended **Distributed** Functionality)
 - ISO 21448
 - Errors not resulting from systematic errors or hardware failure **or network outages**
 - Physical limits of sensors (**+ remote sensors**)



Increasing connectivity demands

For improved Functional Safety and Autonomous Driving:

1. Internal sensor and status information

- Car dynamics (accelerations)
- Actuators, wheel status
- Situation analysis
- ECU internal data

2. Sensor information for Environmental Model

- Video, Radar, Lidar, Ultrasonic

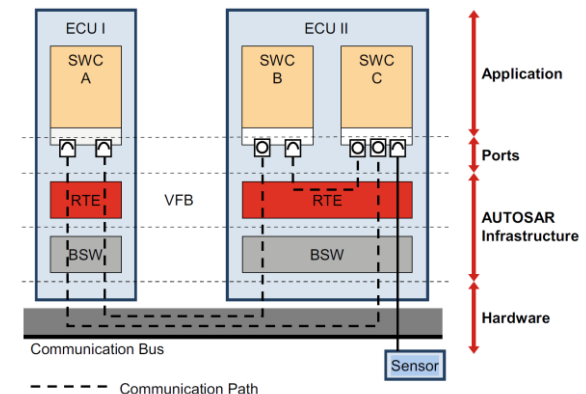
3. B5G's Integrated sensing and communication (radar and e.g. E-Band comms)

System Requirements *		V2Cloud cruise assist	High-resolution map generation & distribution	Intelligent driving
Major Data Source		Video Stream	Still Image (road surface image)	ECU data
Data Generation in vehicle		~ 1215EB/month ¹	~ 375EB/month ²	~ 22.5EB/month ³
Response Time	Uplink	< 10 seconds	< 1 week	< 1 week
	Downlink	< 10 seconds	< 1 week	< 10 minutes
Required Availability	Uplink	Continuous	Occasional	Occasional
	Downlink	Continuous	Occasional	Continuous

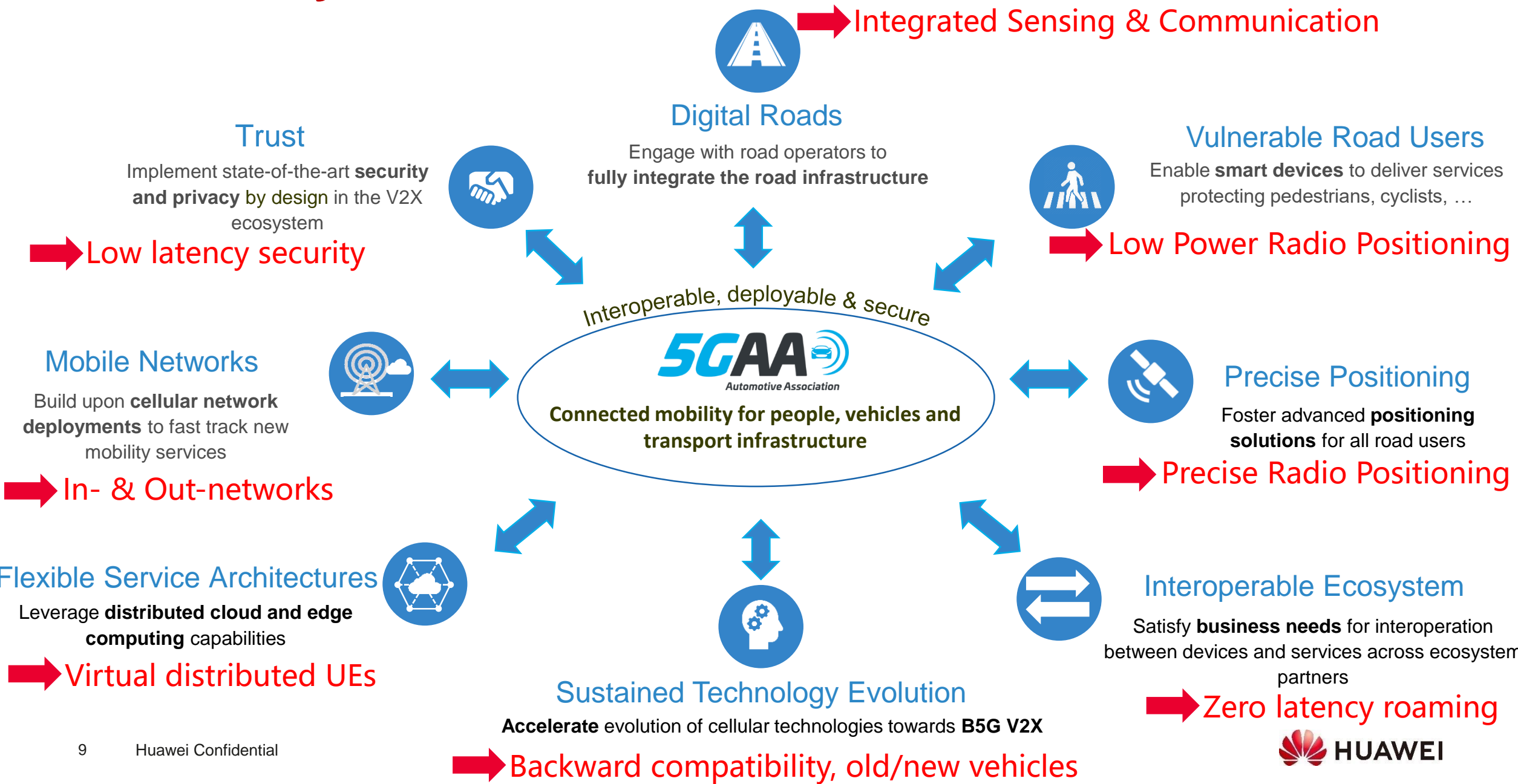
AECC: Car in use for 15 hours / month, each car produces ca. 1 TB / h

NGMN: Passenger infotainment: 2.25 TB / h for 4-5 persons

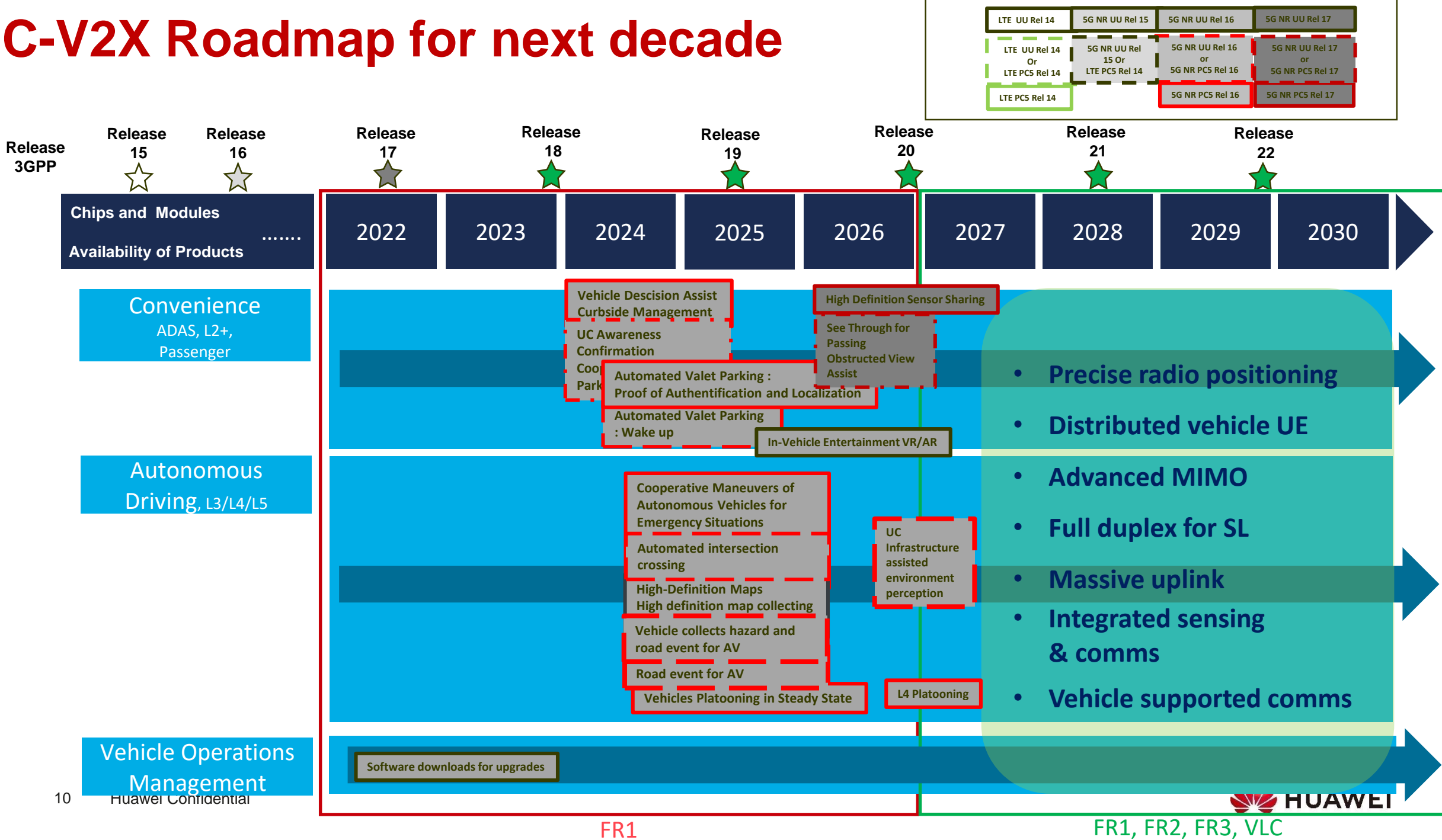
* - The numbers in Table 1 are total values for 100 million connected cars.



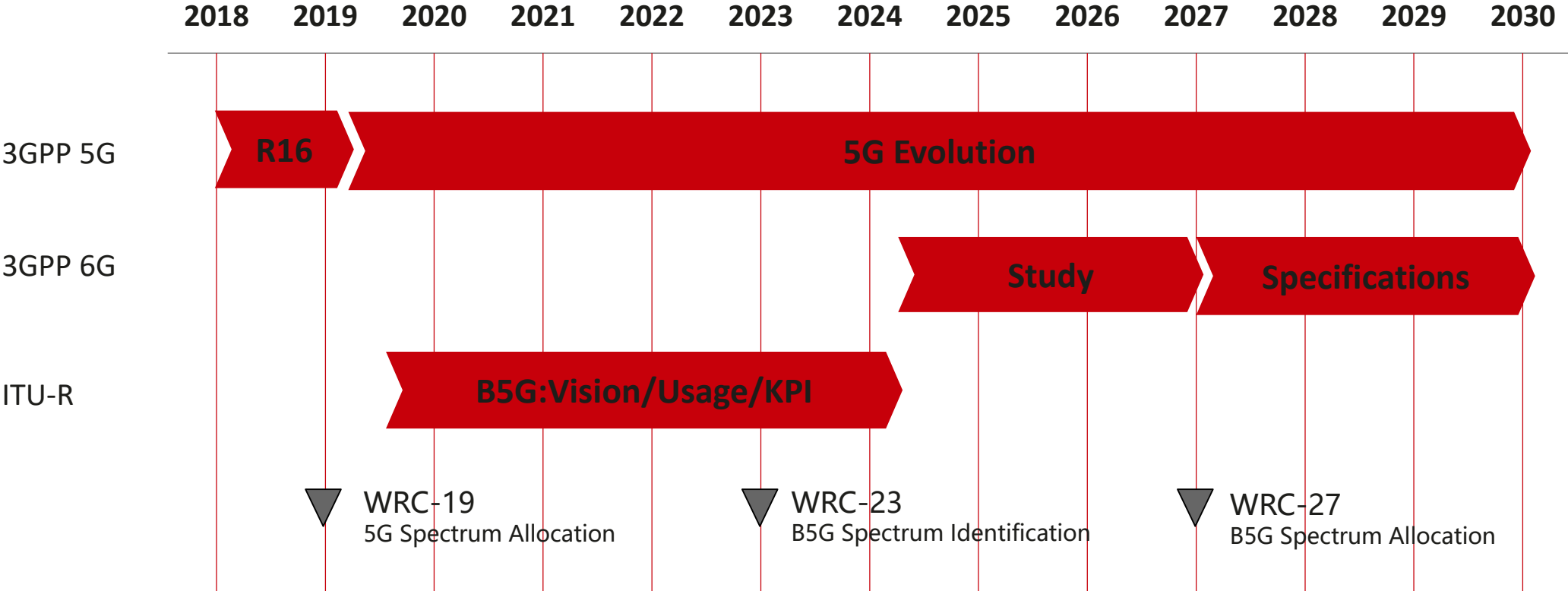
5GAA Priority Areas and need for B5G



C-V2X Roadmap for next decade



3GPP, ITU Time line in next decade



JOIN US IN
BUILDING A BETTER CONNECTED WORLD

THANK YOU

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