



5G/Cellular Connectivity for Road Transportation

ARPA-E Kickoff
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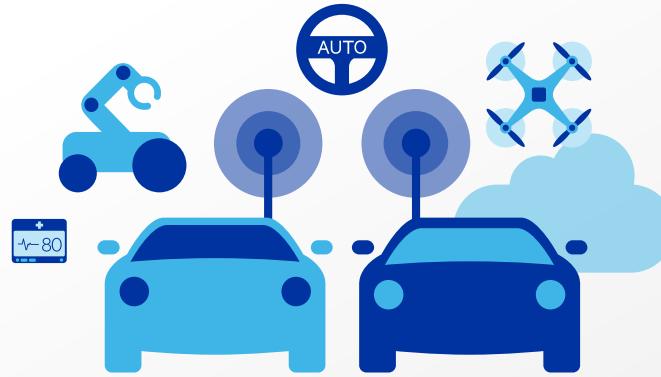


5G will be a key enabler for our automotive vision

Providing a unifying connectivity fabric for the autonomous vehicle of the future



Enhanced mobile
broadband



Mission-critical
services



Massive Internet
of Things

Unifying connectivity platform for future innovation

Convergence of spectrum types / bands, diverse services, and deployments,
with new technologies to enable a robust, future-proof 5G platform;

Starting today with Gigabit LTE, C-V2X Rel-14, and massive IoT deeper coverage

Paving the road to tomorrow's autonomous vehicles

Leveraging essential innovations in wireless and compute

Unified connectivity



- Providing always-available, 4G/5G secure cloud access for vehicles
- Vehicle-to-Everything (V2X) communications

3D mapping and precise positioning



- Active ranging and positioning
- Embedded GNSS with DR¹
- VIO²/lane-level accuracy
- Cloud Based Assistance for 3D mapping

On-board intelligence



- Heterogeneous computing
- On-board machine learning
- Computer vision
- Sensor fusion
- Intuitive security



Autonomous car

Power optimized processing
for the vehicle

Fusion of information from
multiple sensors / sources

Continuous V2X technology evolution required

Continuous technology evolution to 5G
while maintaining backward compatibility

Basic safety
802.11p or C-V2X R14

Established foundation
for V2X

Enhanced safety
C-V2X R14

Enhanced communication's range and reliability
Supports higher speeds and additional safety needs, e.g., in NLOS and challenging road conditions

Advanced safety
C-V2X R15+ (building upon R14)

Higher throughput
Up to 1Gbps for sensor sharing

Higher reliability
Up to 99.999% for automated driving

Wideband carrier support
For accurate ranging and positioning

Lower latency
~1ms for automated driving

Supporting rapidly evolving safety requirements and use cases

Continuous technology evolution to 5G while maintaining backward compatibility

Basic safety
802.11p or C-V2X R14

E.g. day 1 use cases



Forward collision warning and basic platooning

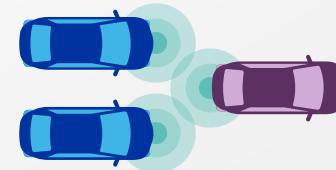
Enhanced safety
C-V2X R14

Extending electronic horizon, providing more reliability and NLOS performance



Advanced safety
C-V2X R15+ (building upon R14)

For autonomous driving in real world conditions



High throughput communications for sensor sharing



Partially to highly automated driving



Cooperative driving

Thank you

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