

3GPP TSG RAN Meeting #79
Chennai, India, March 19 – 22, 2018
Agenda Item: 9.1.2

RP-180384



Motivation for new SI proposal on 5G V2X

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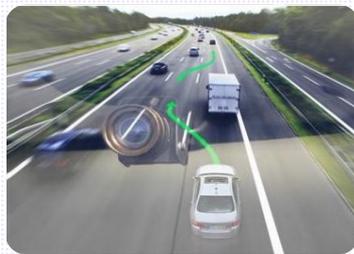


NR-V2X: Requirements for Autonomous Driving

Uses Cases for Autonomous Driving Applications (SA1 TS22.186)



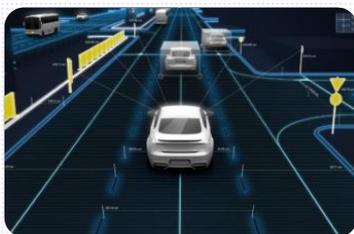
Vehicle Platooning



Cooperative Operation, Sensor sharing



Remote Driving



Advanced Driving

NR-V2X Requirements for Autonomous Driving (SA1 TS22.186)

Use Cases	E2E latency (ms)	Reliability (%)	Data rate (Mbps)
Vehicle Platooning	10	99.99	65
Advanced Driving	3	99.999	53
Extended Sensors	3	99.999	1000
Remote Driving	5	99.999	UL:25, DL:1
	Lateral (m)	Longitudinal (m)	
Positioning Accuracy	0.1	0.5	

Note: 5GAA may adjust the above requirements as per the inputs from car OEMs.

Scope of R16 NR-V2X Study Item

Scenarios

- a. NR sidelink operation in NR coverage, in LTE coverage and out of coverage

Architecture

- a. V2X Slicing/E2E QoS
- b. Multi-operators support

Coexistence

- a. Not co-channel coexistence with LTE-PC5 and non-cellular RATs (e.g. 802.11p)

Flexible Selection Mechanism of LTE-V2X/NR-V2X

- a. Application & QoS based

NR-UU Enhancements

- a. Multicast (for e.g. HD-map download)
- b. URLLC enhancements (for Remote Driving)
- c. Mobility enhancements

NR-Sidelink

- a. Low latency & High reliability Sidelink, High data rate Sidelink
- b. Relay and UE Cooperation
- c. UU and Sidelink multi-connectivity

Positioning

- a. Sidelink based Cooperative Positioning

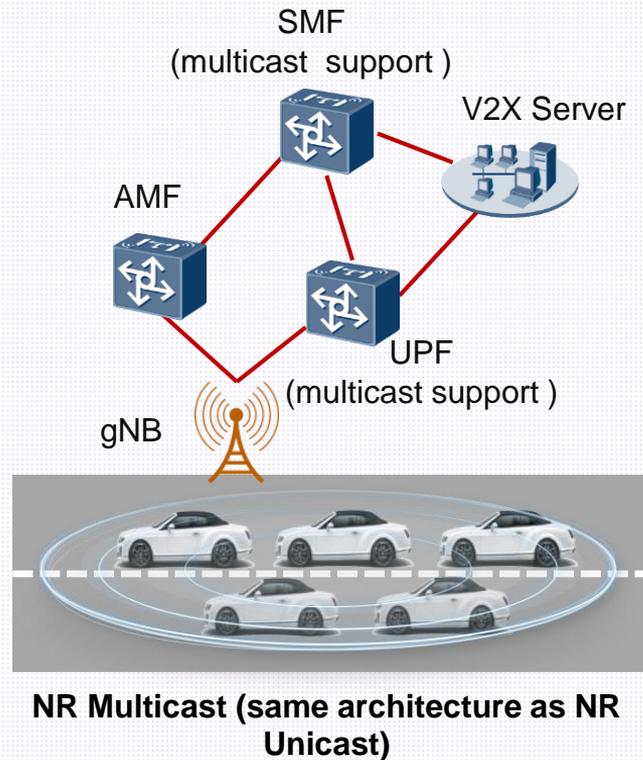
NR-V2X UU: Multicast

Motivation:

- Several V2X use cases (e.g. high-definition map download, software download) will benefit from Multicast technology.
- **As captured in TR 38.913:** The RAN design for NR V2X shall provide communication via infrastructure, including MBMS support, for V2X services and advanced V2X services.

Considerations :

- Same architecture as NR Unicast (to avoid the complicated architecture of LTE MBMS, i.e. BM-SC, MCE and MBMS-GW)
- Multicast and Unicast can dynamically share radio resources
- High efficiency and high reliability (support MIMO, beamforming and HARQ/CSI feedback)
- Unicast and Multicast switch/coordination, service continuity



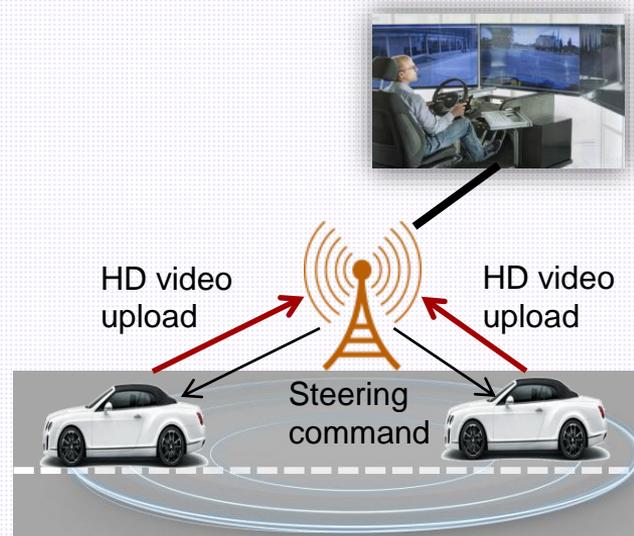
NR-V2X UU: URLLC Enhancements

Motivation:

- Requirements of Remote Driving (Data rate= UL25Mbps/ DL1Mbps, Reliability=99.999%, E2E latency=5ms) go beyond the URLLC capability of R15 NR.
- Remote Driving requires NR network to provide URLLC capability in a wide area, including cell edge

Considerations:

- URLLC operation with high UL data rate
- Enhanced cell edge performance



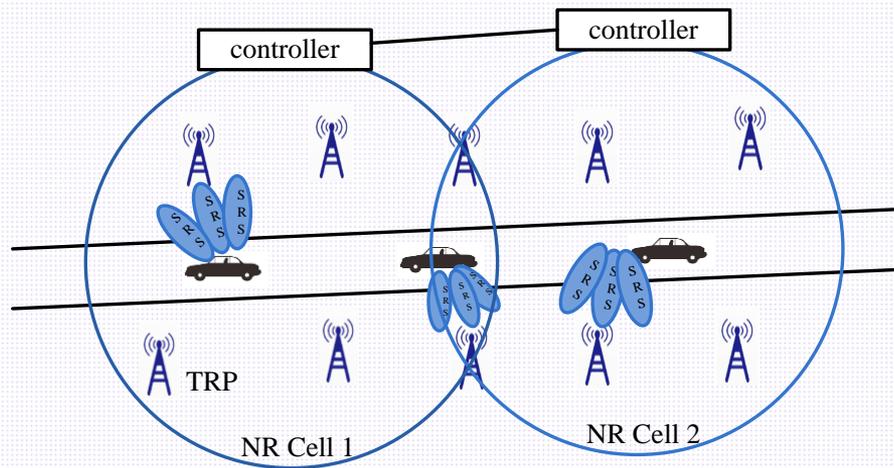
NR-V2X UU: Mobility Enhancements

Motivation:

- R15 NR provides basic mobility support (i.e. DL-based RRM with SS block and CSI-RS)
- UL-based mobility can provide UE centric mobility experience and zero interruption time
- Vehicle UEs have no concerns on power consumption due to the transmission of UL tracking signals (e.g. SRS)

Considerations :

- UL-based RRM and mobility
- UL tracking scheme



NR-V2X Sidelink: Considerations

Scheduling mode

- gNB scheduling mode (high priority) and UE autonomous scheduling mode

Synchronization source

- GNSS, gNB, Sidelink

Transmission Mode

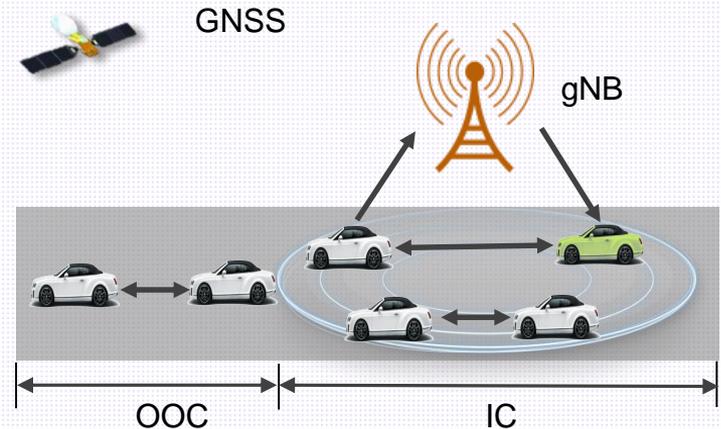
- Unicast, Groupcast and Broadcast

Physical layer design

- **Low latency, high reliability and high data rate Sidelink:**
 - (Flexible) Numerology, Short TTI, feedback and link adaptation
 - Multi-antenna, MIMO, Beamforming/Beam management
 - Wideband, High frequency, CA
 - Interference coordination
 - Relay and UE Cooperation
- **Sensing & Resource allocation enhancements:**
 - Optimization for busy traffic
 - Power control

High layer design

- Flexible switch/duplication between UU and Sidelink



NR-V2X Sidelink: Relay and UE Cooperation

Motivation:

The direct link between two nodes (vehicle, gNB, RSU) may not be good enough to support efficient and reliable transmission:

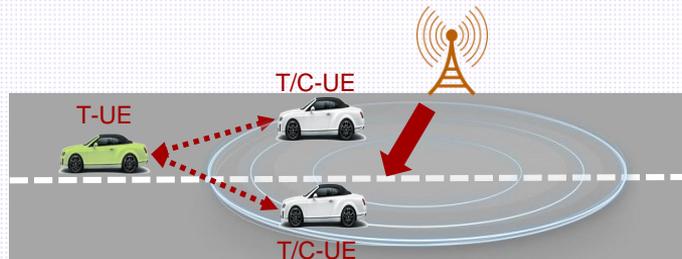
- A vehicle platoon may consist of 5-20 vehicles, and the head vehicle needs to communicate with the tail vehicle(s).
- For Sidelink over mmWave, the direct beam between two vehicles may be blocked by another vehicle.
- gNB cannot address OOC vehicles for V2X services.

Considerations:

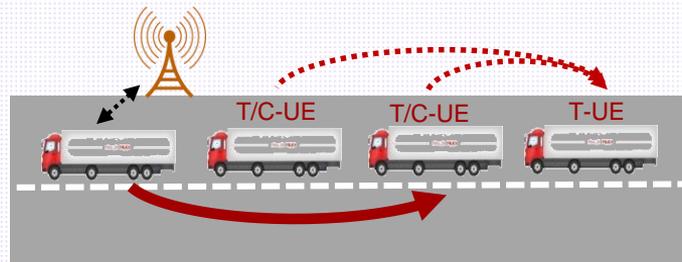
1. UE-to-UE relay and UE-to-Network relay for coverage extension
2. UE Cooperation to improve the reliability and coverage, for which two phases are included:
 - **Multicast Phase:** gNB/UE transmit data packets to the UE Cooperation group by UU/Sidelink multicast.
 - **Cooperation Phase:** C-UEs forward the cooperation information (data packets received during multicast phase) via Sidelink to T-UE to help the T-UE to decode the data packets.

T-UE (Target UE): Target of data packets delivery

C-UE (Cooperative UE): UE to cooperate with the T-UE for data packets reception



Scenario 1: Relay&UE Cooperation for OOC vehicles



Scenario 2: Relay&UE Cooperation in platoon

- Multicast link (UU/Sidelink)
- - -→ Cooperative Link

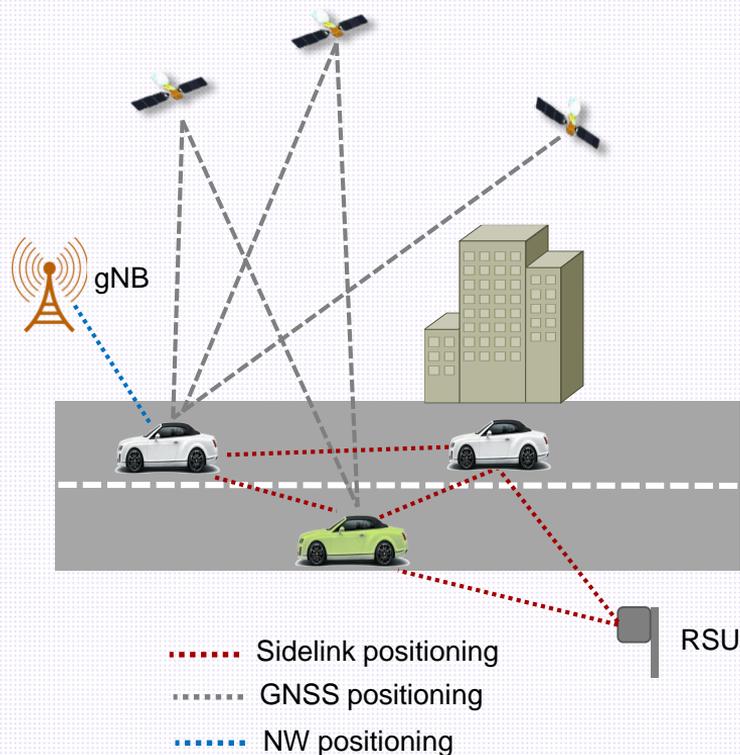
NR-V2X Positioning: Sidelink based Cooperative Positioning

Considerations :

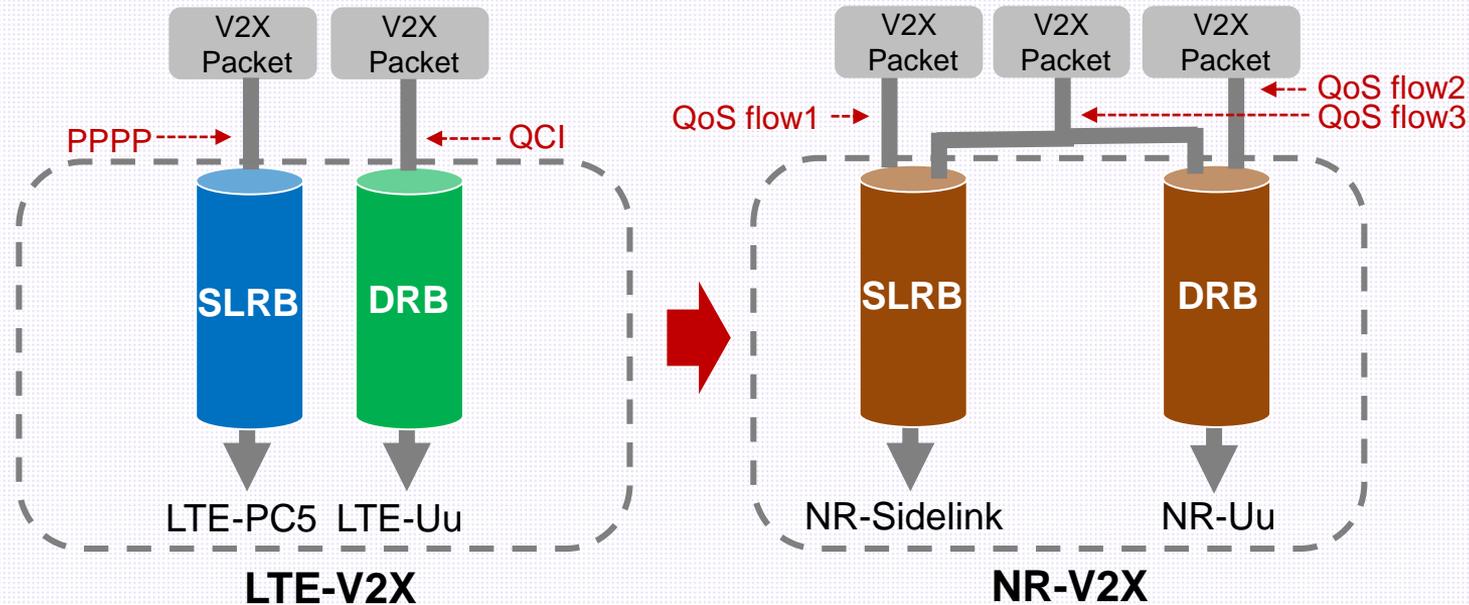
- Vehicles can determine the inter-vehicle distance with NR-sidelink measurement (e.g. ToA/RSTD), and then the relative position of vehicles in proximity can be determined based on the measurement results shared between vehicles.
- Absolute position of one vehicle can be determined based on the absolute position of gNB, RSU or other vehicles and the relative position from the vehicle to them.
- Vehicles can share the satellite/positioning data between them to increase the positioning accuracy.

Advantages:

- Improved positioning accuracy
- Available in tunnel and city canyon scenarios, complementary to GNSS positioning.



Unified QoS Framework



Considerations:

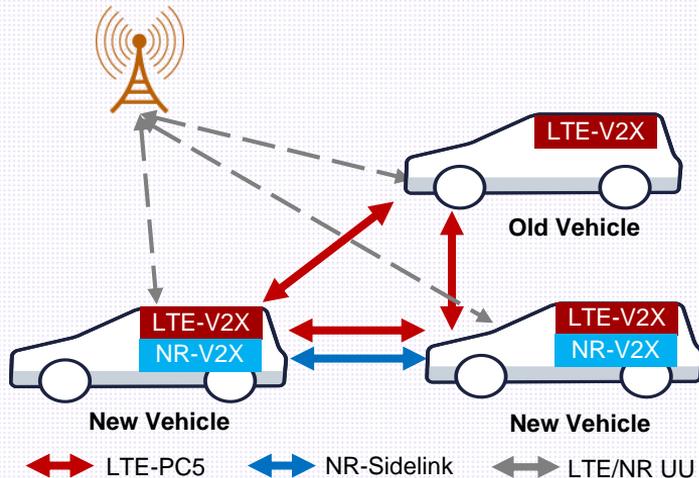
- A unified QoS-flow based framework can be used for NR-Uu and NR Sidelink.
- The QoS related parameters include Priority, Latency, Reliability and Data rate.
- E2E QoS Framework

Flexible Selection Mechanism of LTE-V2X/NR-V2X

Basic Safety Application @5.9GHz by LTE-PC5

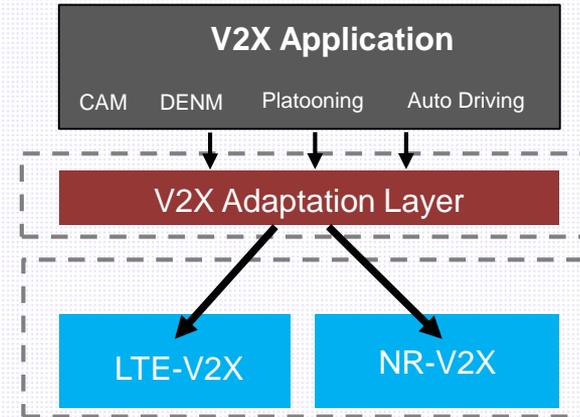
New vehicles deploy both LTE-V2X and NR-V2X to enable the inter-operability with old vehicles:

1. LTE-PC5: Basic safety applications
2. NR-Sidelink: Advanced autonomous driving applications



Flexible Selection between LTE-V2X/NR-V2X

Provide policies/criteria to the UE to assist the radio technology selection, according to e.g. V2X application type, QoS requirements etc



NR-Sidelink Frequency Band(s)

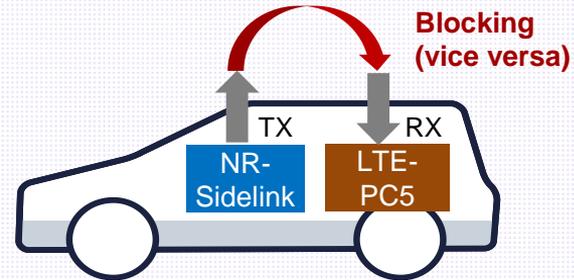
ITS spectrum in different countries/regions, IMT spectrum is another option

Country/Region	Current ITS spectrum
Europe	5875-5905MHz 5905-5925MHz(reserved) 63-64GHz
China	5905-5925MHz for LTE-V2X Trial
USA	5850-5925MHz
Japan	755.5-764.5MHz 5770-5850MHz (ETC)
Korea	5855-5925MHz

* Some mobile operators are also considering to use their IMT spectrum to provide value-added V2X services (over sidelink) in addition to basic safety services.

Coexistence of LTE-PC5 and NR-Sidelink when they are deployed in the same vehicle

Solution	Analysis
FDM	LTE-PC5 (5.9GHz) NR-Sidelink (New band to avoid mutual blocking with LTE-PC5. The required frequency separation is FFS)
TDM	Not preferred , because it will: 1) Increase NR-Sidelink latency 2) Reduce the available resource for both LTE-PC5 and NR-Sidelink



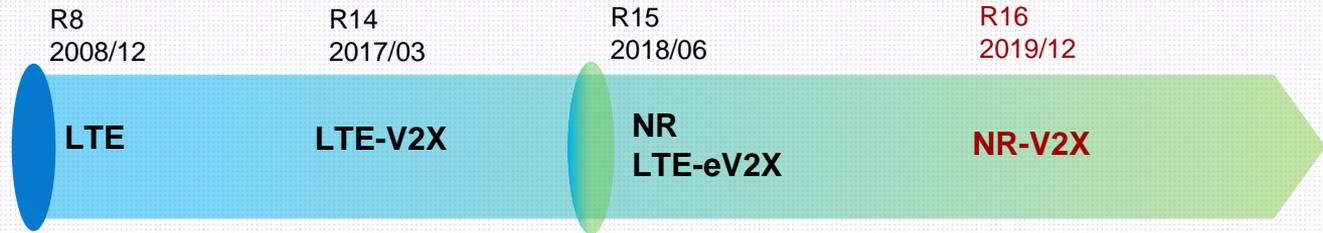
NR-V2X SI needs to identify the exact frequency band(s) for NR-Sidelink to facilitate the subsequent NR-V2X WI.

NR-V2X: Time plan



5GAA preference (LS to 3GPP in S-170179):

1. Specify NR-V2X as part of Rel-16 (including Sidelink, Uu interface and network slicing)
2. Ensure NR-Sidelink to complement LTE-PC5 and extends its capabilities



It is expected to:

1. Start the NR-V2X SI in June 2018
2. Complete the subsequent WI (with reasonable scope) within R16 timeframe



Thank you !

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