3GPP TSG RAN Meeting #83
Shenzhen, China, 18-21 March 2019
Agenda item: 9.3.4
Document for: Discussion

RP-190347

Discussion on NR V2X WI Scope

Huawei, HiSilicon

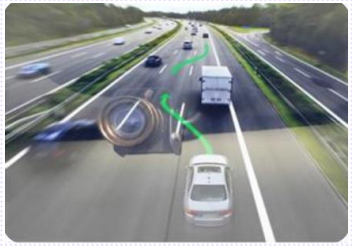
HUAWEI

www.huawei.com

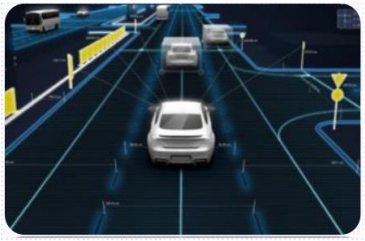
Applications and requirements for advanced V2X

Use cases for advanced V2X

Vehicle Platooning



Extended sensors



Advanced driving

Remote driving

NR-V2X needs to satisfy requirements as defined in TS 22.186 for 5G-V2X use cases.

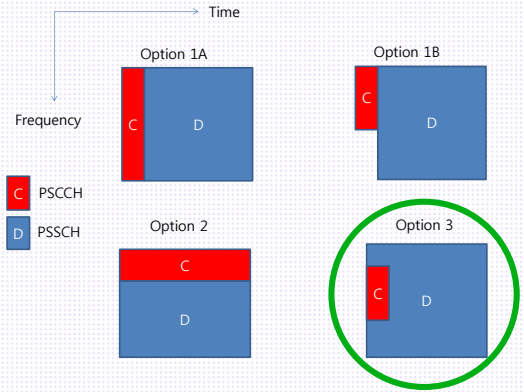
Use Cases	Shortest E2E latency	Highest Reliability	Highest Data rate
Platooning	10 ms	99.99%	65 Mbps
Advanced Driving	3 ms	99.999%	53 Mbps
Extended Sensors	3 ms	99.999%	1000 Mbps
Remote Driving	5 ms	99.999%	UL:25, DL:1 Mbps

Conclusion of NR V2X TR 38.885

- It is feasible to support advanced V2X services over the NR PC5 interface and the NR Uu interface
- In particular for the PC5 interface, it is **feasible to support unicast, groupcast, and broadcast operation in SL** and coexistence among them in a carrier is feasible, as well as the coexistence between sidelink and other cellular transmissions in a carrier
- In-coverage, partial coverage, and out-of-coverage operation are feasible
- It is feasible to support NR sidelink in both **FR1 and FR2 using a common design framework**
- It is recommended to specify for NR Uu interface, based on the descriptions in this TR, **support for multiple simultaneously active uplink configured grants**, and reporting of UE assistance information to gNB. QoS management for these services is also needed. It is feasible to deliver advanced V2X use cases in some scenarios over the LTE Uu interface. Some possible enhancements were studied but none are recommended.
- It is feasible to support **LTE Uu managing NR SL in resource allocation Modes 1 and 2, and NR Uu managing LTE SL in Modes 3 and 4**. Specification of the enhancements described to the respective Uu interfaces is recommended.
- Additional **enhancements have been identified for the network interfaces** to support V2X service authorization, UE SL aggregate maximum bit rate, F1 signalling for support of NR V2X mode 1 and mode 2, resource coordination, and possibly network slicing.
- It is recommended to **support RAT and interface selection** considering the outcome of related SA2 work.
- Based on the study from physical layer specification perspective, **in-device coexistence of LTE and NR sidelink is feasible for intra- and inter-band under the respective conditions**, and solutions for TX/TX, TX/RX, and RX/RX coexistence have been identified in this TR.

WI Scope: Basic PHY structures and procedures

- **Waveform**: CP-OFDM only
- **SCS & CP**: same as NR Uu – 15, 30, 60(+ECP) kHz in FR1; 60(+ECP), 120 kHz in FR2
- **Define similar PHY channels as LTE-V2X**: sidelink control, data, broadcast channels
  - Definition of HARQ and CSI feedback over sidelink
  - Addition of physical sidelink feedback channel, PSFCH
- **Sidelink synchronization** using updated designs of PSS/SSS
- **Sidelink control information (SCI)** and multiplexing with data
  - RAN1 still considering 1-stage and 2-stage SCI designs
  - Multiplexing Option 3 seems most reasonable to keep in-scope
- **Sidelink CSI reporting** – to enable link adaptation and high rates
- **Sidelink power control** – to protect Uu link vs. sidelink unicast and groupcast
- RAN1 slightly unclear on the extent of handling multiple antennas on a vehicle, but no sophisticated beam management

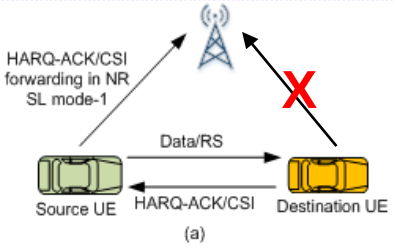


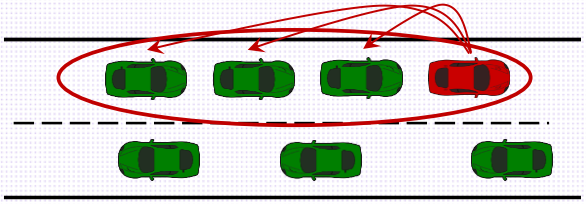
WI Scope: Sidelink resource allocation

- Mode 1 – **fully gNB controlled resources**
  - Dynamic sidelink grant from gNB
  - Grant-free Type-1 (RRC only) and Type 2 (RRC + activating DCI)
  - Details for WI: SR/BSR and grant procedures; configuration details
- Mode 2 – **UE selects** resources within configured/pre-configured set
  - Design broadly converging to sensing- and measurement-based selection of resources by UE
  - Similar to LTE-V2X mode 4, resources are based on repetition transmission for low latency, high reliability, and reduction of half-duplex constraints
  - Details for WI: definition of resources in sensing procedures; measurements for selection
- One in-coverage UE can transfer gNB resource configuration to other UEs in its group, via higher-layer signalling
- Support simultaneous configuration of UE with Mode 1 and Mode 2

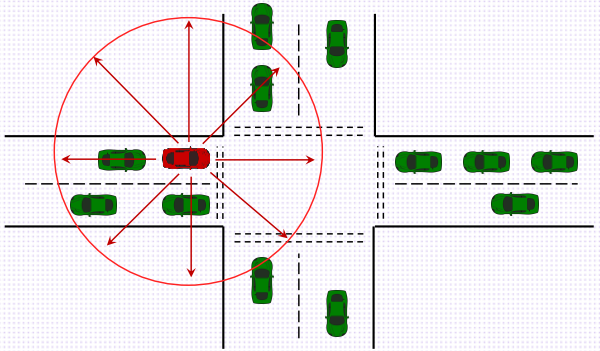
WI Scope: Sidelink HARQ

- Needed for reliability and link adaptation of high data rate on sidelink
- Support transferring sidelink feedback to gNB from TX UE only
  - No need to keep RAN1 FFS on using also RX UE
- Two flavors of sidelink groupcast are adding complexity to the design:
  1. Groupcast with a group leader, e.g. platoons, where all UEs send HARQ ACK/NACK
  2. Groupcast with no group structure, e.g. ?, where only some UEs send HARQ feedback, or some send only NACK feedback without possibility of ACK'ing the transmission
- WI details should focus on groupcast for platooning cases which need consistent QoS within a group and throughout the service duration
  - Other cases could be treated as much simpler sidelink broadcast





Groupcast for platooning



Broadcast for extended sensors

WI Scope: Sidelink synchronization

- Very basic agreements during SI on SLSS + SS block design
  - Start from NR PSS/SSS sequence types and SSB-based design
  - Identified 4 design combinations for sidelink SSB resource and sequence lengths:

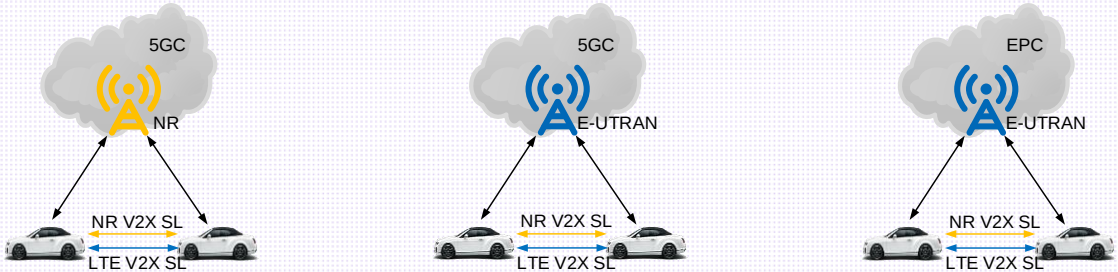
Combination #	Number of S-PSS symbols	S-PSS length	Number of S-SSS symbols	S-SSS length	Number of RBs	Bandwidth containing S-SSB (MHz)			
						15 kHz	30 kHz	60 kHz	120 kHz SCS
1	2	127	2	127	11 or 12	2.5	5	10	20
2	2	127	2	127	20	5	10	20	40
3	1	127	1	127	20	5	10	20	40
4	1	255	1	255	24	5	10	20	40

- Most evaluations assume NR Uu-length sequences of 127 for least re-design
  - Focus RAN1 work on 127-length PSS/SSS sequences and remaining resource details
  - Note that sidelink sync needs to fit in spectrum available in some ITS bands, e.g. 10 MHz
- WI details to handle GNSS, gNB/eNB, SLSS-based sync source priorities
  - Operation when NR / LTE sidelink UEs have different sync references
  - Multi-carrier synchronization procedures

WI Scope: ‘Cross-RAT’ control of sidelink

- Clear operator requests for:
  1. NR Uu to control LTE mode 3/4 sidelink
  2. LTE Uu to control NR mode 1/2 sidelink

  Both allow smooth evolution within 3GPP V2X as MNOs’ RAT availability, and automotive industry choices, develop over lifetime of vehicles
- SI phase decided that NW control is by higher layer signalling, with minor updates to LTE PHY procedures for mode 3
- The prioritized operation cases from RAN2 should be supported in Rel-16:



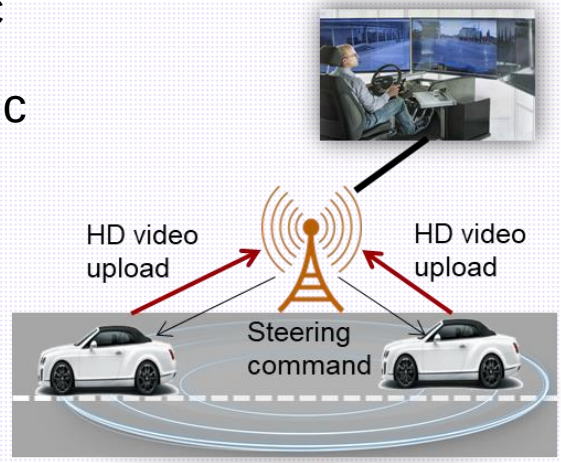
…and MR-DC equivalents under MN control of sidelink

WI Scope: In-device coexistence of LTE V2X and NR V2X

- Feasible by using TDM or inter-band/intra-band FDM between RATs, under certain conditions for handling TX/TX, TX/RX, or RX/RX collisions
  1. ‘Long-term’ TDM is relatively easy by configuring non-overlapped resources by implementation
  2. ‘Short-term’ TDM assumes within-UE coordination between RATs and low-enough traffic load, allowing UE to prioritize one of the RATs upon each collision
  3. Inter-band FDM is relatively easy when power allocation is static, simply by ensuring enough frequency separation to avoid interference between TX/RX chains
  4. Inter-/intra-band FDM with dynamic power allocation requires detailed alignment of RAT transmissions in time domain, and then prioritization of power allocation per RAT
- All 4 cases rely to a large extent on UE and/or NW implementation choices
  - WI scope to no RAN1/2 spec impact – leave all details to implementations
  - RAN4 to determine minimum frequency separation for inter-band FDM

WI Scope: V2X service delivery over NR Uu

- NR Uu is already flexible and can support many advanced V2X use cases, aided by URLLC support
  - Remote driving is a V2X use-case destined specifically for the Uu link
- RAN1 identified benefits by supporting multiple activated UL configured grants
  - Feature design depends on various (e)URLLC design issues
  - Joint work between V2X and URLLC WIs, but lead by URLLC
- Add definition of messages for reporting of V2X traffic characteristics to gNB from UE



WI Scope: Higher layers and QoS management

- Scope coming from RAN2 and RAN3 is generally stable
- RAN2 –
  - QoS management, sidelink Radio Bearers, etc. depending on SA2 work
  - Definition of PC5-RRC (not defined in LTE), for link management and configuration by unicast
  - Definition of RLC Acknowledged Mode on sidelink for ultra-reliable transmission
  - Simultaneous Mode 1 and Mode 2 configuration
  - RAT and interface selection
  - Signalling details of cross-RAT control
- RAN 3 –
  - Extensions to interfaces, e.g. F1, to manage configuration and scheduling of V2X resources
  - V2X service authorization, similar to LTE-V2X
  - Support of slicing, similar to NG-RAN

Summary

- V2X SI is complete, and can convert to Rel-16 WI, with broadly similar scope
- Limited amount of down-scoping necessary given well-understood SI designs
  - Focus groupcast on case with a group-leader for platooning; treat groupcast with no group structure as broadcast
  - Support only transmitter UE sends sidelink feedback to gNB, remove receiver UE
  - Assume length-127 sidelink PSS/SSS sequences for NR Uu re-use
  - Accept RAN2-prioritized operation scenarios for cross-RAT and MR-DC
  - In-device coexistence of NR and LTE can be left to UE/NW implementations
  - Multiple active UL configured grants can be joint with, but led by, eURLLC WI
- RAN to decide how much FR2 work scope is needed. RAN1 concluded "*a common design framework*" with FR1 is possible, with addition of PT-RS

Thank you !