3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 - July 2, 2021

RWS-210009

NR Sidelink Evolution & Use Case Expansion

for Rel-18

AI: 4.2

Qualcomm

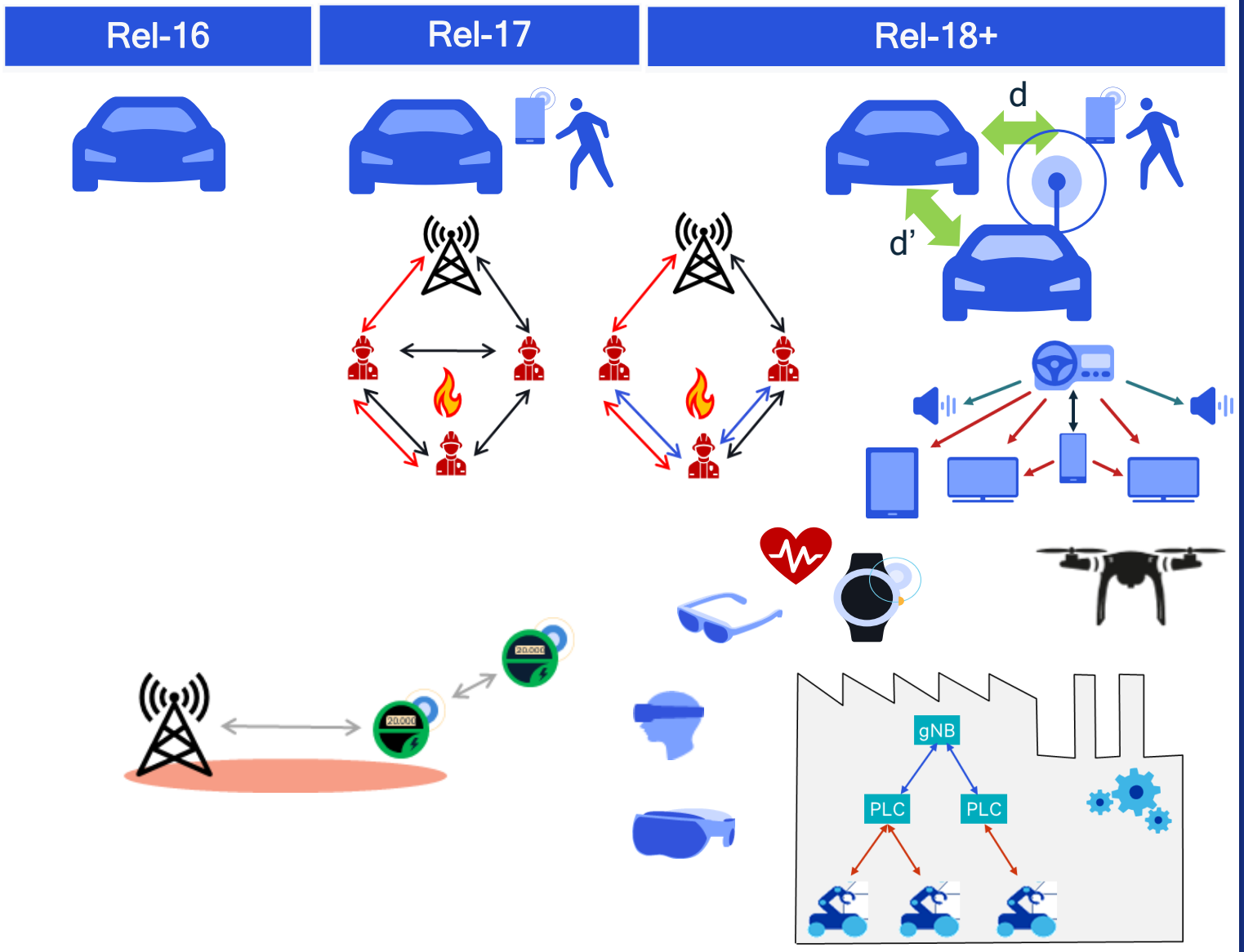
5G

Background

- Rel-16 introduced sidelink (SL) operation for NR
  - SL slot structure with new PHY channels: PSSCH, PSBCH, PSCCH & PSFCH
  - Resource pool concept and management
  - Designed for V2X advanced use cases while envisioned to support other services in the future
  - Optimized for ITS spectrum
- Rel-17 evolving NR sidelink operation to improve V2X and addressing PubS use cases
  - Introduces power savings (DRX) on sidelink and enhances Mode 2 operation for improved reliability & latency (inter-UE coordination[1])
  - Introduces sidelink relays for UE-to-NW communication
- From Rel-18: it is important to continue evolving sidelink operations
  - Balancing evolution of Auto while expanding to new use cases
  - Sharing same foundational features while understanding nuanced requirements of different use cases

(1): Actual outcome TBD.

NR Sidelink - comprehensive view



- **Rel-16**: foundational SL focusing on C-V2X for advanced use cases
- **Rel-17**: PowS (PubS, V2P/P2V), SL Relays (UE-to-NW)
- **Rel-18+**: Expansion to more use cases:
  - Auto new advanced use cases: Vehicle-mounted relays, positioning/ranging
  - Coverage extension: SL relays enh. (UE-to-UE)
  - Wearables: Low-tier (e.g. RedCap) and high-tier (e.g., XR, NCIS) devices
  - Drones
  - I-IOT with wireless PLC
  - In-vehicle wireless network

Treating sidelink as a building block for multiple projects

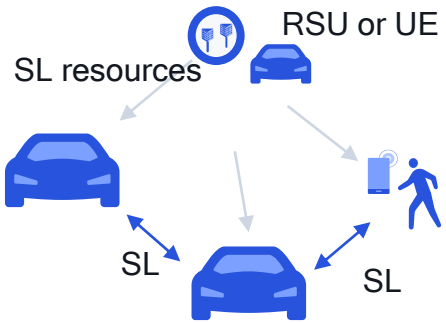
Sidelink Technology Areas vs. NR Releases

Feature	Rel-16	Rel-17	Rel-18+ Proposals
Baseline FR support	FR1 ITS & licensed FR2 (not optimized)	Same as Rel-16	FR1 licensed FR2/FR2x optimizations (multi-beam) FR1/FR2x unlicensed
Spectrum Aggregation	NA	NA	NR/LTE co-channel coex (ITS spectrum UE/EU) Carrier Aggregation (FR1+FR1, FR1+FR2/FR2x) Uu/PC5 aggregation & coex enh.
Latency / scheduling	Slot-based sched.	Same as Rel-16	“Mini-slot” scheduling
Power and reliability optimizations	NA	DRX on SL	SL WUS/GTS, BWP adaptation, SL-assisted sched. (incl. Indication of Tx/Rx resources and UE scheduling another UE)
MIMO support	CSI, 2-layers	Same as Rel-16	Multi-beam support Enhanced CSI, MU-MIMO
Relaying operation	NA	UE-to-NW relay	SL Relay enhancements (incl. UE-to-UE)
Positioning	NA	NA	SL positioning relative & absolute Positioning enh. via SL
Coding	NA	NA	Network coding Re-Tx by Relay UE
Discovery & UE Identif.	Higher layers	Same as Rel-16	Discovery enhancements ID broadcast & remote identification

Many of the techniques are common to all use cases while some are specific to particular use cases.

NR Sidelink Evolution - V2X

Areas for Rel-18+ work to enable applications requiring higher throughput and reliability



- UE Scheduling another UE over Sidelink
  - Improves PRR in congested areas for out of coverage UEs and UEs without Uu.
  - Includes leader selection and reselection, group management, and scheduling mechanism
- Carrier Aggregation (multi-carrier)
  - Enables improved performance where V2X spectrum is fragmented, e.g., the European Union
    - In Europe, ITS spectrum up to 20MHz channels may be allowed. In order to have the capability to deploy NR V2X over 40MHz, multi-carrier capabilities may be required
  - Support contiguous and non-contiguous carriers across multiple bands with capability exchange for unicast connections
- UE to UE Relay
  - Support relaying for connection-less traffic

NR Sidelink Evolution – Commercial & PubS

Areas for Rel-18+ work to enable power efficient, high throughput & low-latency applications

- **Increased data rates & reduced latency**
  [high-end wearables, NCIS, vehicular relays]
  - More spectrum for SL operation: FR1/FR2x unlicensed, i.e., SL-U [in addition to FR1/FR2]
  - Spectrum aggregation: FR1+FR1 CA, FR1+FR2/FR2x CA, Uu/PC5 aggregation
  - Enhanced MIMO support for improved resource efficiency
    - More layers and improved CSI feedback, MU-MIMO
    - Multi-beam support for FR2/FR2x
  - “Mini-slot” scheduling over Sidelink
  - In-car sidelink for in-vehicle networking use cases

- **Improved UE power consumption & Uu/PC5 joint operation**
  [high/low-end wearables, PubS, vehicular relays]
  - SL WUS/GTS, BWP adaptation, SL-assisted scheduling (incl. indication of Tx/Rx resources and UE scheduling another UE)
  - Uu/PC5 improved coexistence (non-ITS SL)

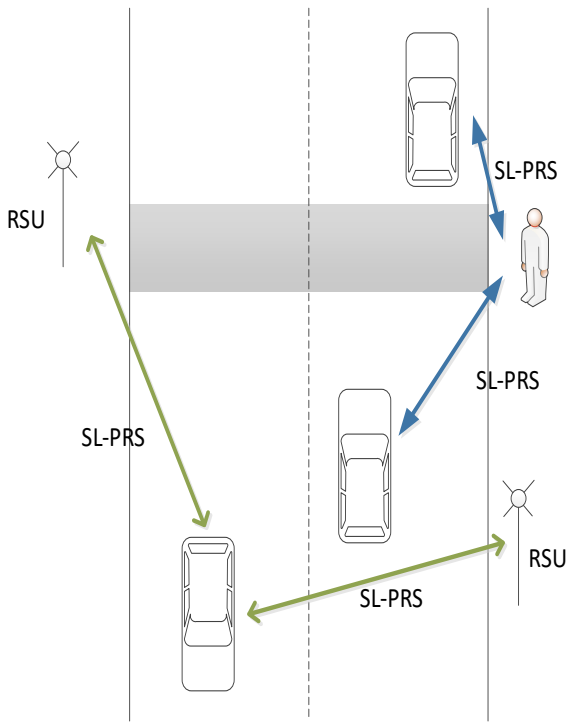
- **New connectivity topologies leveraging SL**
  [high/low-end wearables, IIOT, vehicular relays]
  - SL Relay enhancements enabling E2E 5G connectivity of remote UEs or wearables
  - TSN framework onto SL (IIOT)

- **Discovery enhancements**
  [commercial, UAVs]
  - Enable lower layer identification
  - ID broadcast and remote identification (UAVs)

- **Positioning over SL**
  [IOT, I-IOT]
  - Asset tracking (IOT)
  - High precision factory positioning (I-IOT)

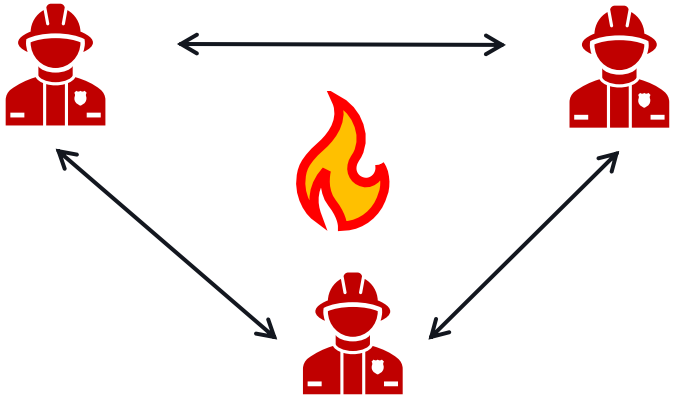
V2X & Auto – Sidelink positioning & ranging

Address advanced V2X, V2P & PubS use cases



- **V2X applications**
  - **"Vehicle to Infrastructure"**
    - Vehicle finds its absolute position on the basis of signals sent by an RSU
    - Autonomous vehicles require highly accurate positioning
  - **"Vehicle to Pedestrian":**
    - Use ranging signal between vehicle and pedestrian
    - Accurately estimate relative position between vehicle and pedestrian

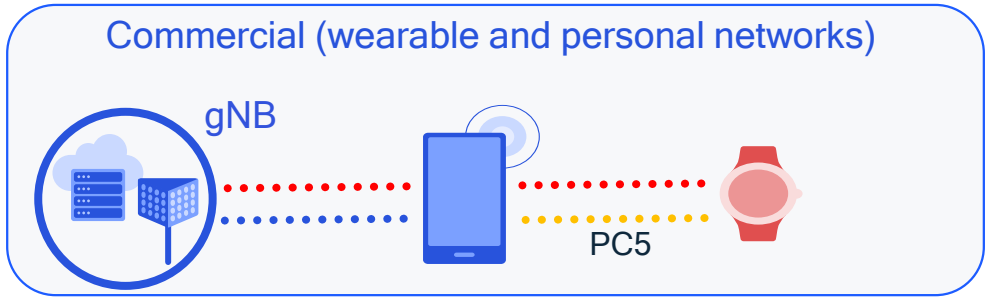
- **Public Safety**
  - Power efficient UE-UE positioning/ranging for public safety & other uses



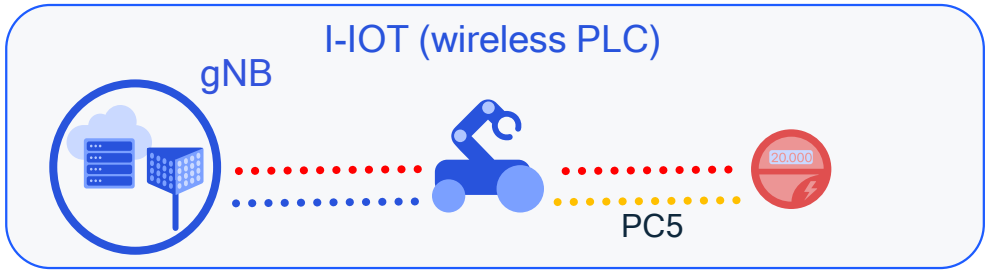
- **Solution should address automotive requirements & spectrum situation**
  - Needs to work independent of Uu (same as sidelink supporting "out of coverage")
  - Distributed coordination protocol that works over both LTE V2X & NR V2X
  - Send sidelink PRS in unlicensed spectrum
    - Accurate ranging requires wideband spectrum
    - Employing unlicensed address wideband spectrum access
    - No need to use ITS spectrum to send PRS
    - Will also allow deployment of positioning without disrupting current V2X deployments

Sidelink Relay Evolution

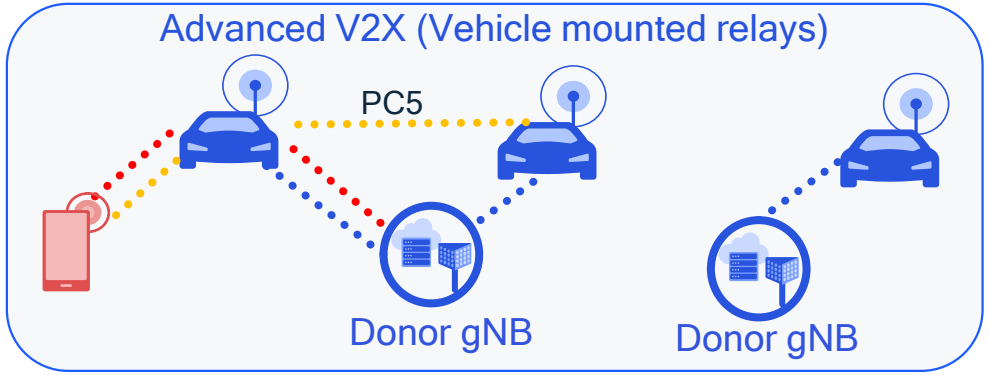
Extending PC5 support to advanced V2X as well as commercial and I-IOT use cases



- Reduced capability commercial devices



- Reduced capability IIOT devices
- Private networks
- TSN features
- Multi-hop support
- High reliability support via multi-path



- Vehicular relay mobility
- Group mobility for in-car UEs
- end-to-end service continuity during mobility of UEs and/or vehicular relays

Conclusions & Proposals

Sidelink use cases expanding in Rel-18 time-frame

- Many of the new use cases require higher capacity SL operation by way of:
  - Access to additional spectrum: unlicensed (FR1/FR2x)
  - Optimization of FR2/FR2x operation (multi-beam operation)
  - Carrier aggregation on SL; Uu/PC5 aggregation & enhanced coexistence
  - Other MIMO enhancements (CSI enhancements, MU-MIMO)
- Many of the new use cases require further Power savings for SL operation by way of:
  - WUS/GTS in SL and BWP adaptation
  - SL assisted sched for Mode 1 (Tx/Rx resource indication) & Mode 2 (UE scheduling another UE)
- Improved reliability, latency & coverage
  - SL relay enhancements incl. applicability to low-tier (eRedCap)/high-tier (e.g., XR,NCIS) devices, I-IOT & vehicle mounted relays
  - Mini-slot scheduling and SPS optimizations for SL. Path diversity techniques. SL reliability enhancements.
- Other techniques:
  - SL positioning (absolute & relative) and positioning enhancements via SL
  - Coding enhancements incl. applicability of network coding to sidelink relay operation
  - Discovery & identification enhancements

References

Sidelink applications for Rel-18 are discussed in more detail at the following contributions:

- [1] RWS-210007 “On 5G & IOT – A UE centric perspective”, Qualcomm.
- [2] RWS-210006 “On NR-LTE V2X Co-Channel Coex Perspectives for Rel-18”, Qualcomm.
- [3] RWS-210005, “On V2X evolution”, Qualcomm.
- [4] RWS-210008, “On Sidelink positioning ”, Qualcomm.
- [5] RWS-210014, “On Aerial Support in NR”, Qualcomm.
- [6] RWS-210016, “On NR for Wireless PLC and Other IIoT Services”, Qualcomm

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