GISC2020
Global ICT Standards Conference

뉴노멀시대 선도를 위한
ICT 표준의 역할

5G 기반 ITS 기술 표준화 현황

삼성전자 강현정

- Use Cases and Service Requirements
- R14/R15/R16 V2X Features
- 5G V2X Scenarios and Architecture
- R16 NR V2X
- R17 Standards for V2X service

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선도를 위한
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역할

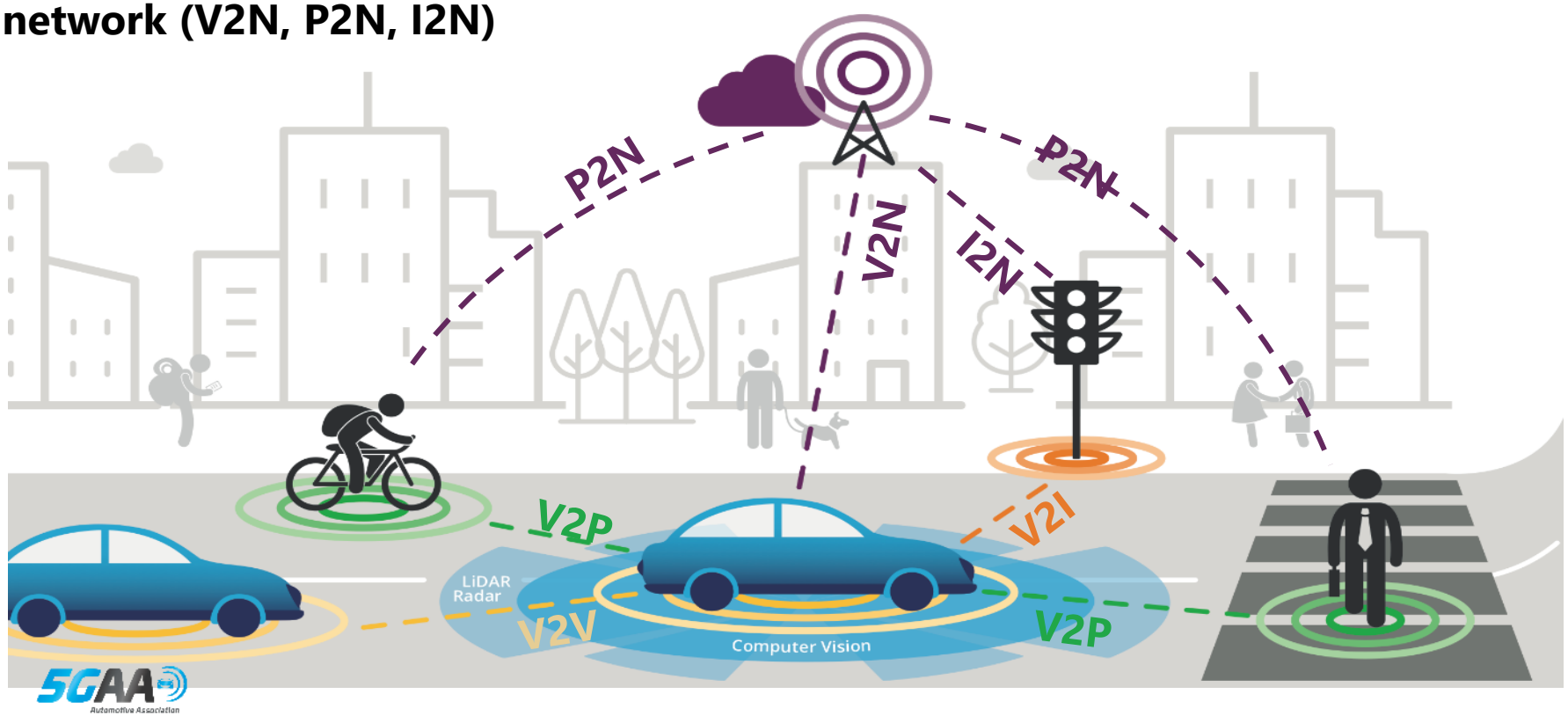
Cellular-Vehicle to Everything

Vehicles to **communicate** with

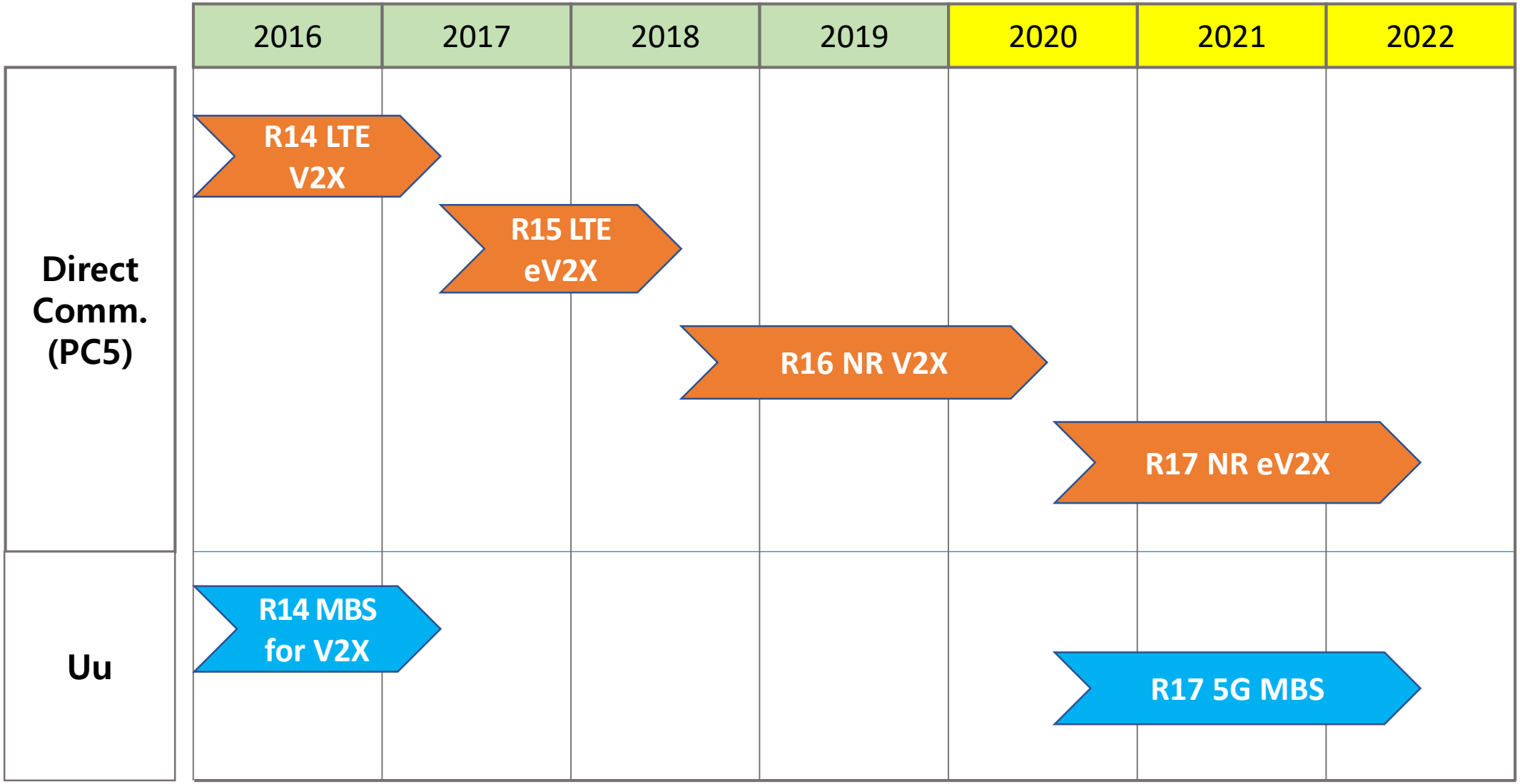
- **Other vehicles (V2V),**
- **Pedestrians and Cyclists via smartphones (V2P),**
- **Road Infrastructure (V2I)**

supported by the

- **Mobile network (V2N, P2N, I2N)**



3GPP Timeline for V2X Standards



MBS: Multicast and Broadcast

Key Use Cases

Rel-14 LTE V2X

Basic Safety Message (BSM), Cooperative Awareness Message (CAM)/Decentralized Environmental Notification Message (DENM)

- **BSM**
  - Longitude, latitude, elevation
  - Speed and heading
  - Brake system status
  - Vehicle size (length, width)

  …
- **CAM/DENM**
  - Speed limits notification
  - Emergency vehicle warning
  - Slow vehicle indication
  - Intersection collision warning
  - Motorcycle approaching indication
  - Collision risk warning
  - Emergency electronic brake light

  …

Rel-15 LTE eV2X, Rel-16 NR V2X

Advanced Use Cases *(Platooning, Advanced driving, Remote driving, Extended sensor)*

- **Platooning**
  - Enabling vehicles to dynamically form a platoon travelling together
- **Advanced driving**
  - Enabling semi-automated or full-automated driving
- **Remote driving**
  - Enabling a remote driver to operate a remote vehicle
- **Extended sensor**
  - Enabling the exchange of data gathered through local sensors or live video messages among vehicles, road site unites, devices of pedestrians

Rel-17 NR enhanced SL

Commercial, Public Safety (Mission critical Communication), eV2X

- **Commercial**
  - Network controlled interactive services (NCIS), e.g., AR/VR
  - Enhanced relays to support healthcare, container, wagon

  …
- **Pubic Safety**
  - 5G ProSe (Proximity-based Service)
  - Railway communications

  …
- **eV2X**
  - V2X communication with power efficiency (e.g., support of pedestrian UEs)

Service Requirements

	R14 LTE V2X	R15 LTE eV2X, R16 NR V2X			
	Basic safety services	Platooning	Advanced Driving	Remote Driving	Extended Sensor
					
Latency	≤ 20ms	≤ 10ms	≤ 3ms	≤ 20ms	≤ 3ms
Reliability	95%	99.99%	99.999%	99.999%	99.999%
Data rate	≤ 74 Mbps	65 Mbps	53 Mbps	25 Mbps	**1 Gbps**

V2X Features

Release 14

LTE/EPC 기반 V2X Arch
1. V2X 단말 Configuration
2. PC5/Uu/MBMS 기반 V2X 통신

- **Architecture**
  - LTE PC5/Uu 기반 V2X 통신 구조
  - V2X CF 정의 : 단말에 V2X 설정 제공
- **UE Authorization, Provisioning**
  - V2X CF – UE 간 UP 기반 설정
- **PC5 Support**
  - D2D Broadcast통신
  - PSID, ITS-AID별 Layer2 ID/PPPP 매핑 (패킷별 처리)
- **MBS Support (MBMS, SC-PTM)**

Release 15

LTE/EPC 기반 V2X Arch Enh.
1. Tx Profile 관련 사항 추가
2. QoS 관련 신규 Parameter 추가

- **Sidelink carrier aggregation, 64 QAM, Packet duplication**
- **Tx Profile**
  - V2X Packet의 AS 전송 방식 지시 (Rel-14 V2X, Rel-15 V2X)
  - Mapping Service types to Tx Profile
- **QoS update for PC5**
  - PPPP외 PPPR (신뢰성) 추가

Release 16

NR/5GC 기반 V2X Arch
1. LTE/NR 통합 V2X 단말 설정
2. PC5 Unicast/Groupcast 추가

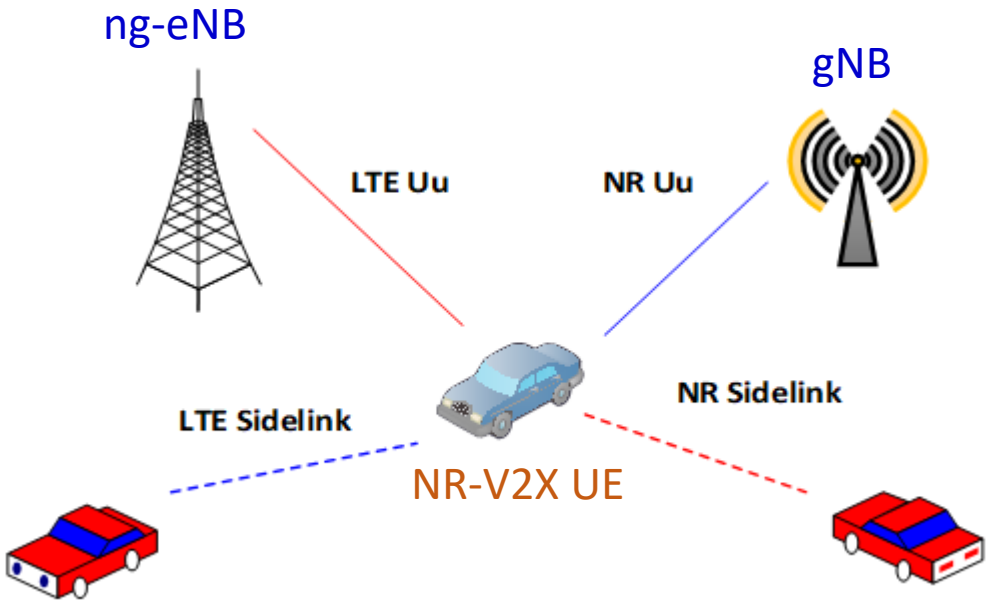
- **Architecture**
  - NR/LTE PC5/Uu 기반 V2X 통신 구조
  - PCF에서 V2X CF 기능 통합
- **UE Authorization, Provisioning**
  - PCF-UE 간 CP 기반 설정
  - LTE/NR RAT selection, Resource 관리
- **PC5 Support**
  - D2D Broadcast + Unicast/Groupcast
  - PQI(5QI for PC5) 기반 QoS (플로우별 처리)
  - Cross-RAT scheduling
- **Uu Support**
  - V2X Slice 정의, V2X용 5QI 정의
  - Alternative QoS profile 기능
- **MBS 기능 미지원**

- MBMS: Multimedia Broadcast/Multicast Service
- PCF: Policy Control Function
- PPPP: ProSe Per-Packet Priority
- PPPR: ProSe Per-Packet Reliability
- V2X CF: V2X Control Function
- 5QI: 5G QoS Identifier

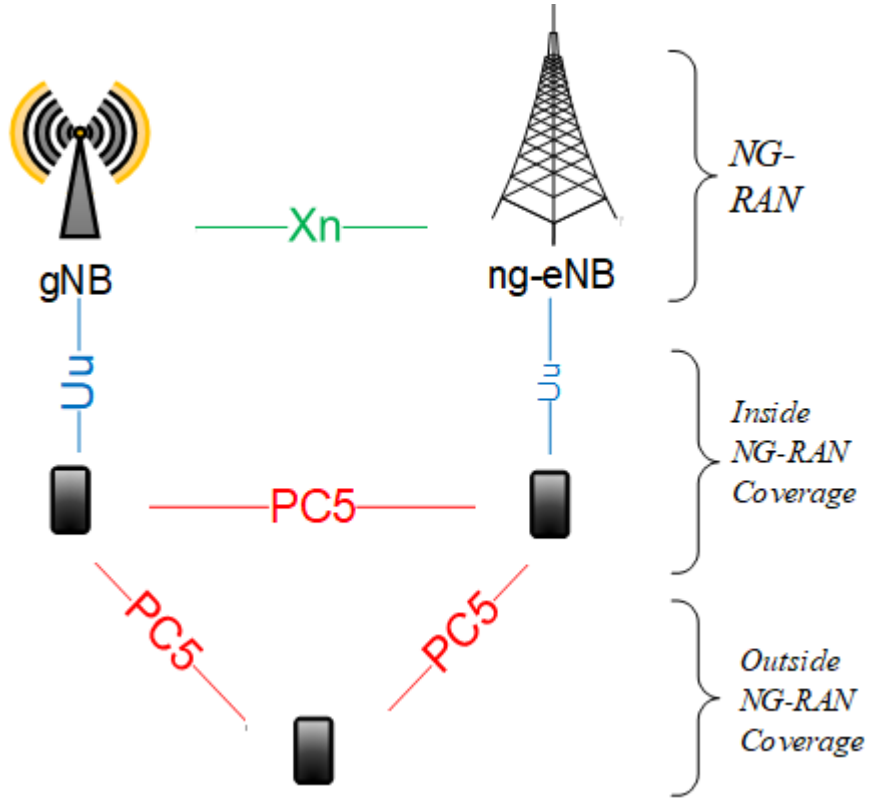
5G V2X Scenario and Architecture

Supported scenarios

- LTE Uu + LTE Sidelink (Rel-14, Rel-15)
- LTE Uu + NR Sidelink (Rel-16)
- NR Uu + LTE Sidelink (Rel-14, Rel-15)
- NR Uu + NR Sidelink (Rel-16)

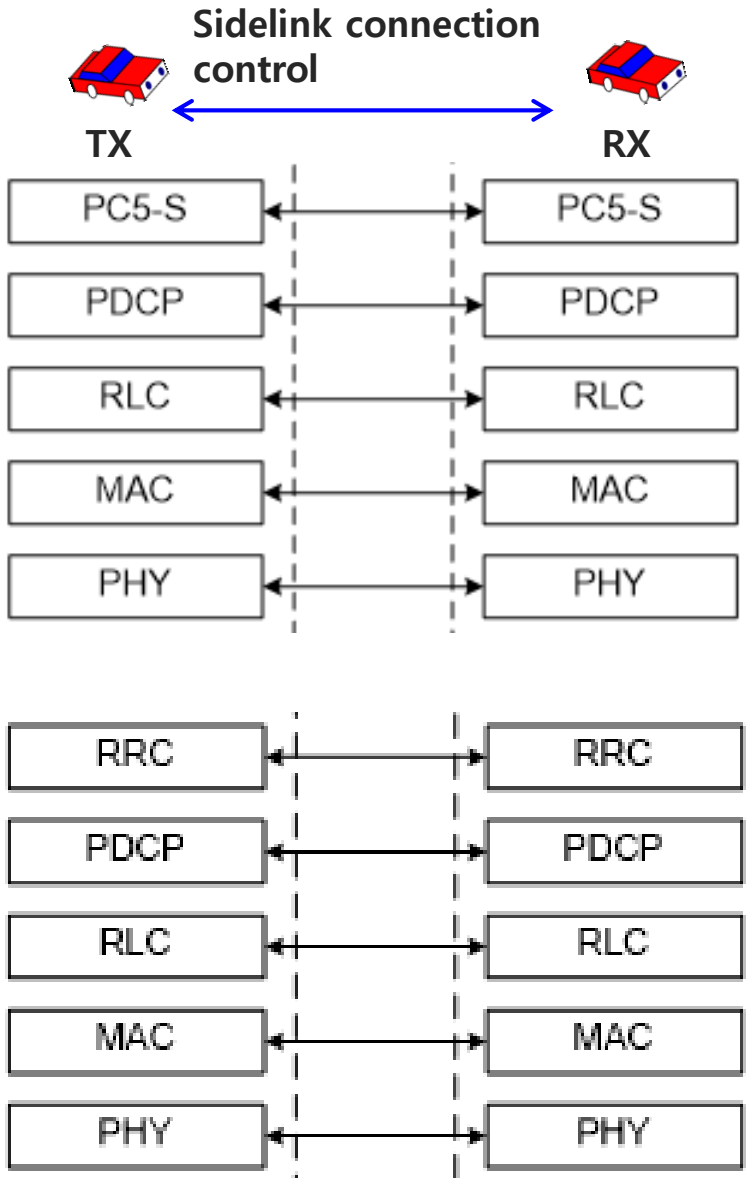


NG-RAN Architecture supporting NR PC5 interface



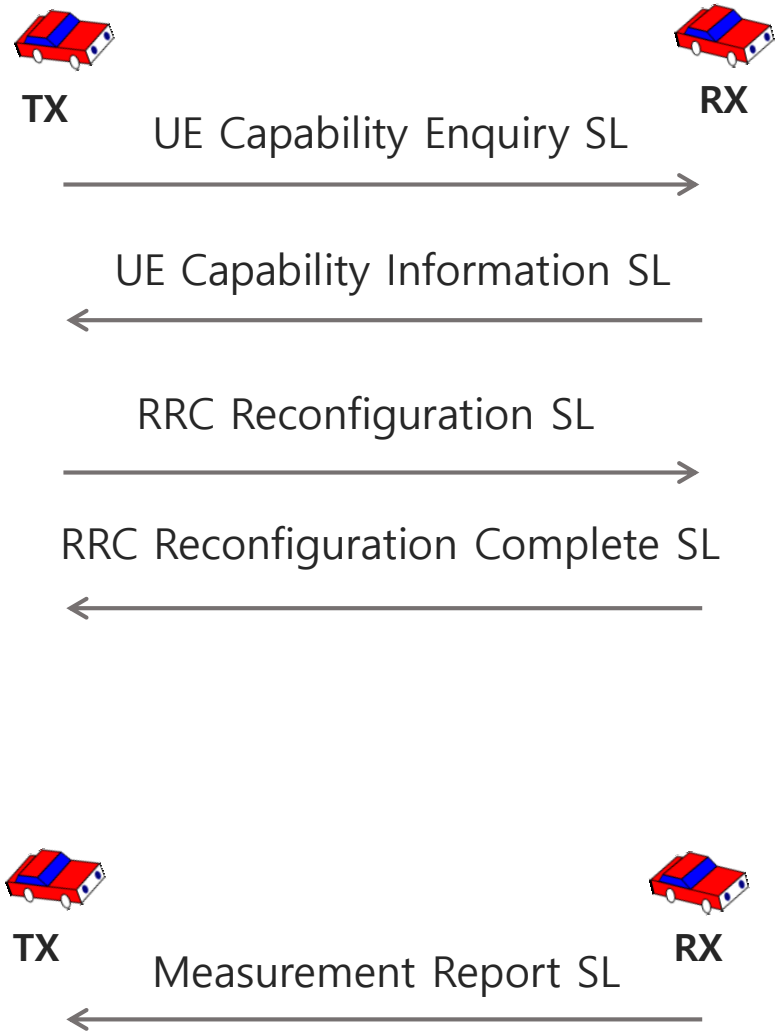
Rel.16 NR V2X Unicast

- **Unicast connection control on Two layers**
  - V2X layer (for PC5-S signaling message)
    - **Direct communication request**/accept
    - **Link identifier update** request/response/ack
    - **Disconnect request**/response
    - **Link modification** request/accept
    - **Keep-alive**/ack
  - PC5-RRC layer
    - **Unicast connection control**
    - **RLM/RRM**



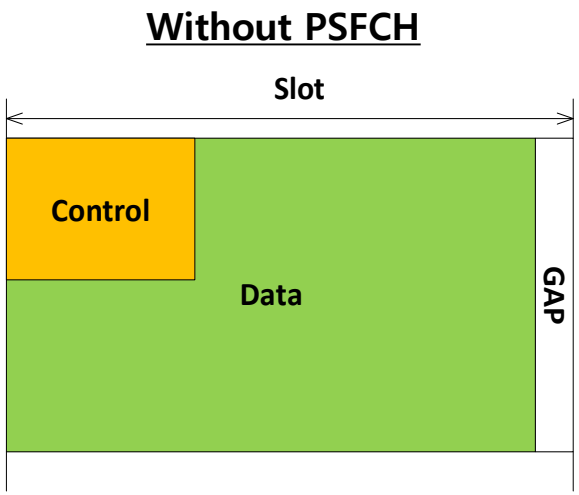
Rel.16 NR V2X RRC Procedures

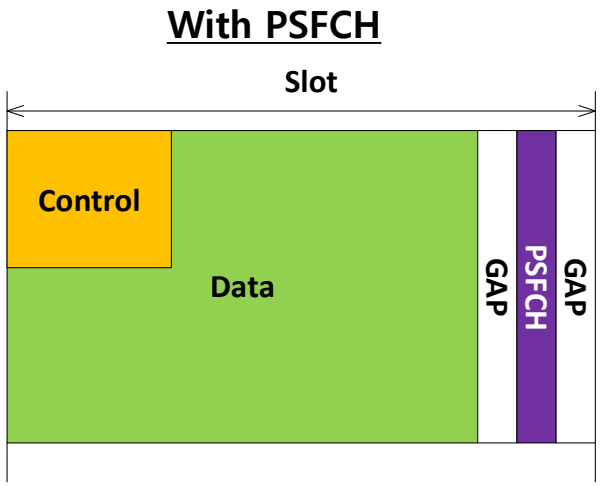
- **RC5-RRC procedures: connection control, RRM**
  - SL UE capability
    - UE's sidelink related capability exchange
  - SL RRC Reconfiguration
    - SL-DRB (data radio bearer) configuration
    - SDAP, PDCP, RLC, MAC, PHY layer parameter configuration
  - SL RLF (radio link failure)
    - Metrics: maximum RLC retransmission number, consecutive HARQ NAK
  - SL measurement/report
    - For SL open loop power control



Rel.16 NR V2X PHY Structures

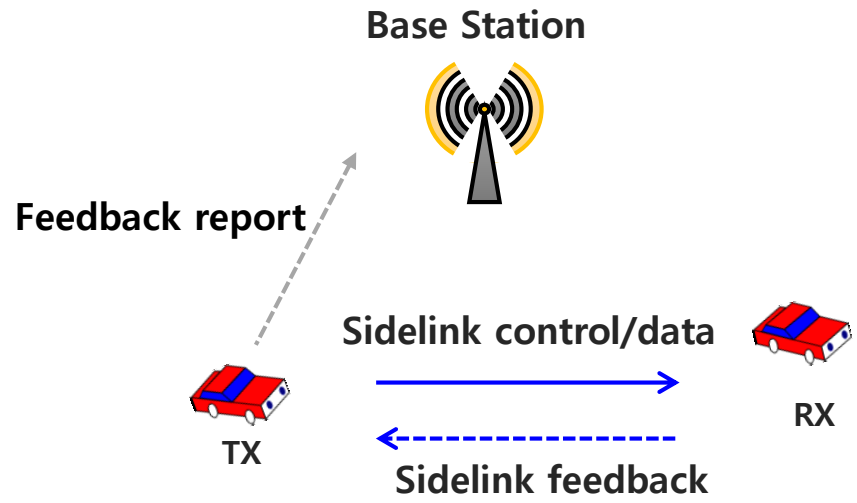
- **PHY structures**
  - PHY channels
    - PSBCH (physical sidelink broadcast channel)
      - To carry sidelink system information
    - PSCCH (physical sidelink control channel)
      - To carry sidelink control information
    - PSSCH (physical sidelink shared channel)
      - To carry data
    - **PSFCH** (physical sidelink feedback channel)
      - To carry sidelink HARQ-ACK information
  - Slot structure





Rel.16 NR V2X PHY Procedures

- **Sidelink HARQ feedback (unicast, groupcast)**
  - Enabling/disabling by RRC
  - RX UE reports ACK/NAK to TX UE
  - TX UE reports the received feedback to base station
  - For groupcast,
    - Member-based HARQ feedback (ACK/NAK)
    - Distance-based HARQ feedback (NAK only)

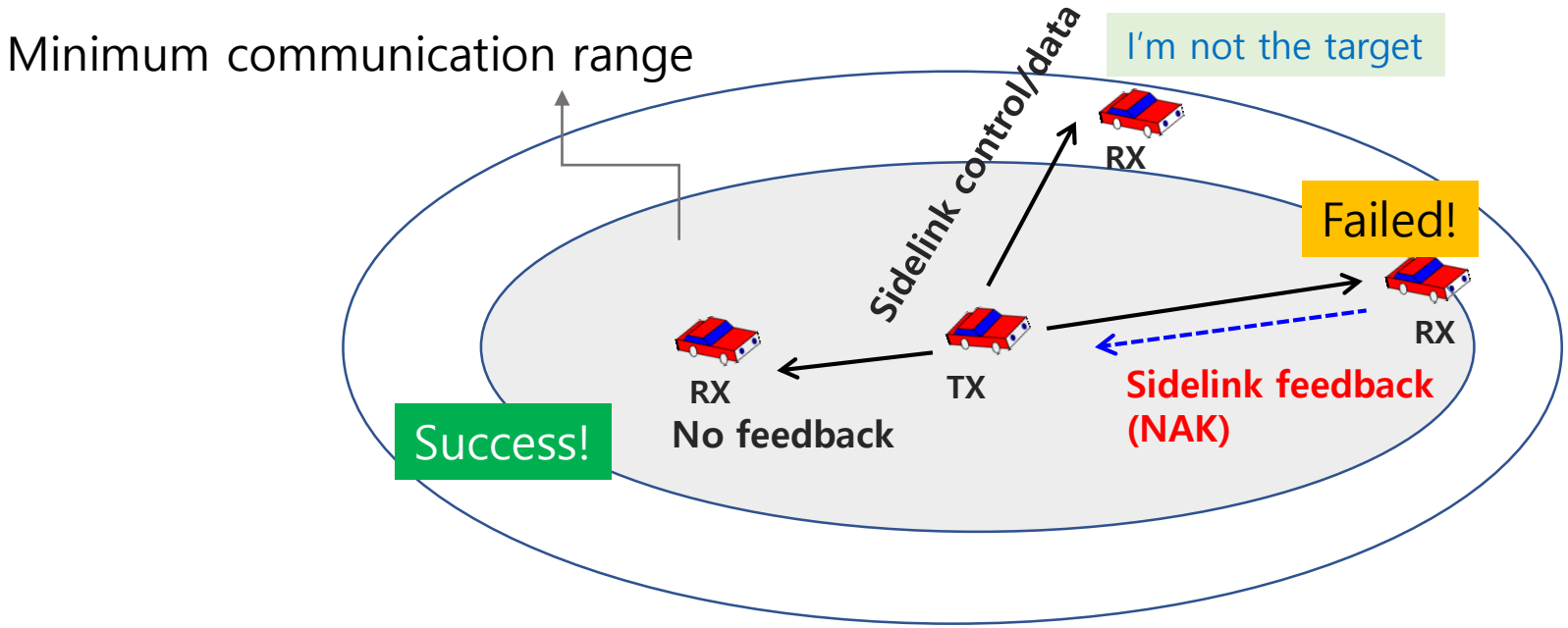


- **Sidelink CSI reporting (unicast)**
  - Aperiodic CSI reporting only using MAC CE
  - RS is confined into PSSCH (no standalone RS)

- **Sidelink power control**
  - Using DL pathloss only
  - Using SL pathloss only
  - Using both DL and SL pathloss

Groupcast distance-based HARQ feedback and retransmission

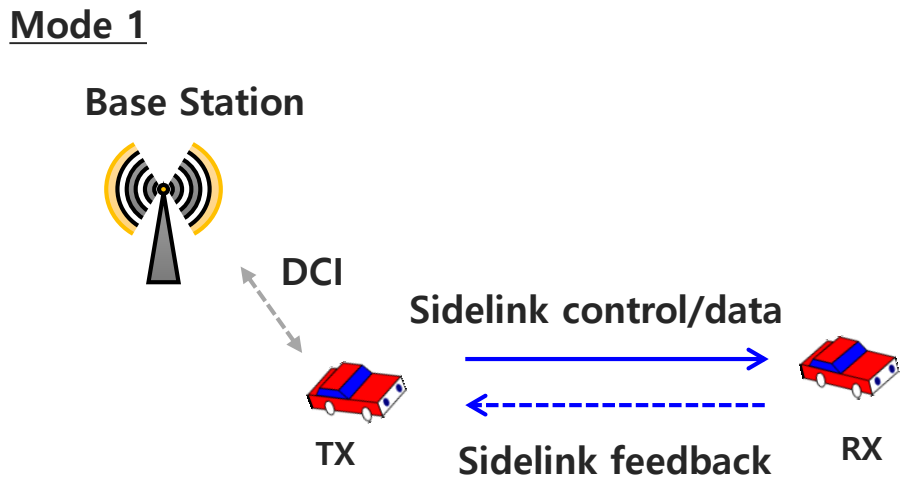
- To meet minimum communication range requirement of V2X service
- No need of explicit group formation
- RX determines the need of feedback based on distance.
  - Range requirement and TX location are signaled in sidelink control.
  - NAK based feedback
- TX retransmits data if NAK is detected on PSFCH.



Rel.16 NR V2X Resource Allocation

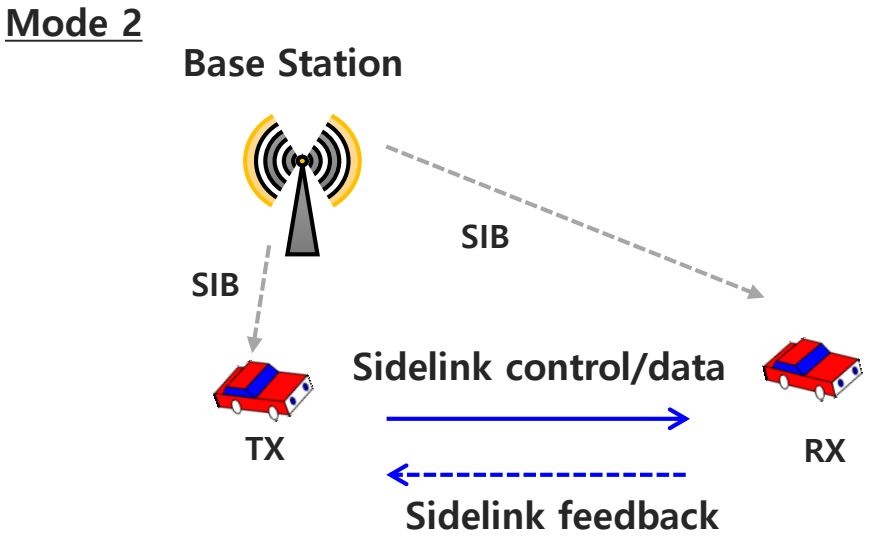
Resource allocation Mode 1

- Base station schedules sidelink resource to be used by UE for sidelink transmission.
  - TX UE should be in RRC connected
- ng-eNB scheduling for NR sidelink resource
  - RRC based configured grant (=CGType 2)
  - No DCI based scheduling



Resource allocation Mode 2

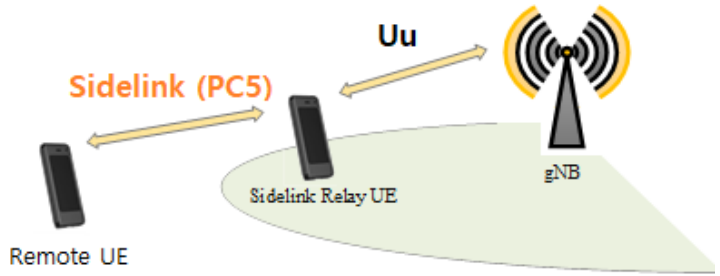
- UE determines sidelink transmission resource within sidelink resources configured by base station or pre-configured sidelink resources.
  - TX UE can be in RRC idle, RRC inactive or out of coverage.
  - A sensing operation is performed by TX UE.



Release 17 Standards

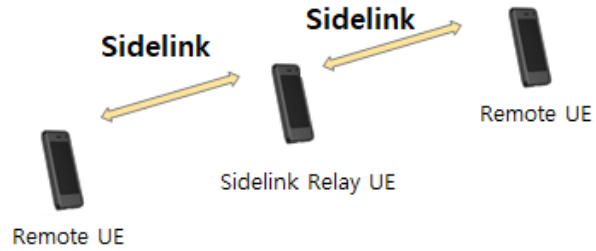
NR Sidelink enhancement

- **Sidelink DRX (discontinuous reception) function design**
- **Resource allocation enhancement to reduce power consumption, enhance reliability and reduce latency**



NR Sidelink relay (study item)

- **Relaying function on NR sidelink for device to device direct communication**
- **Use cases: V2X, public safety**



5G Multicast and broadcast

- **RAN function design (downlink only) for broadcast/multicast service in 5GC**
- **Use cases: V2X, public safety, IPTV, software delivery, IoT application**


감사합니다.