

# 3GPP ProSe/D2D and its proposed extensions to other topics such as V2X, wearable devices

## Systems Aspects

Shubhranshu

# 3GPP ProSe/D2D and its proposed extensions to other topics such as V2X, Wearable devices

## RAN Aspects

蔡華龍

ITRI – ICL/V100

2016/03/29

# 3GPP ProSe/D2D and its proposed extensions to other topics such as V2X, wearable devices

## Systems Aspects

**Shubhranshu**

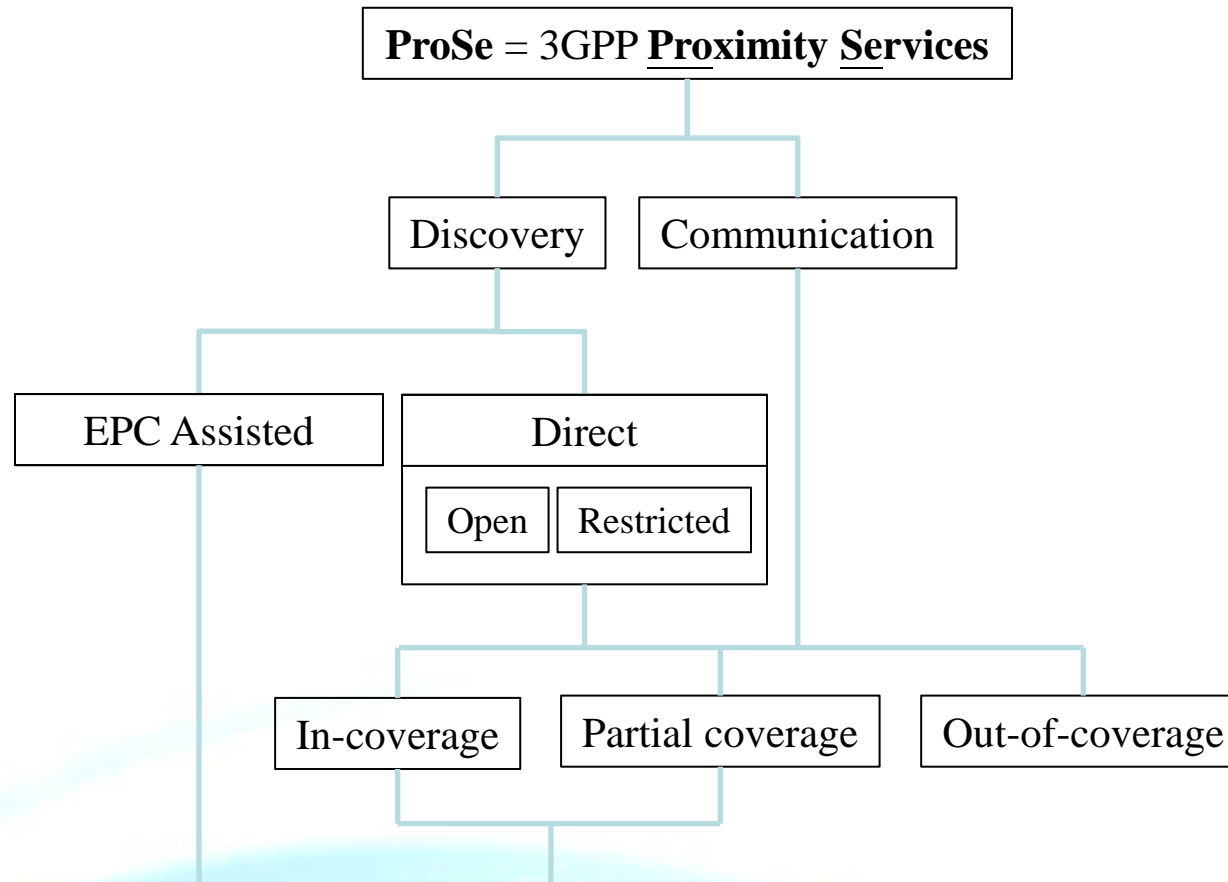
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2016/03/29

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- **Introduction**
  - ◆ 3GPP D2D/ProSe, Terminologies, 3GPP Releases & Timeline
- **Reference Architecture Model and Concepts**
  - ◆ ProSe Function, D2D interface, etc
- **ProSe Discovery**
- **EPC support for WLAN direct discovery and communication**
- **LTE-based V2X Services**
  - ◆ Terminologies, Types of Services
  - ◆ Reference Architecture

# Introduction (1)



## Major contributors in 3GPP:

Qualcomm, Intel, ITRI, ALU, Ericsson, Telecom Italia, Huawei, Samsung, Nokia Networks, .....

## Definitions from 3GPP SA2 TS 23.303

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- **ProSe Direct Communication**: A communication between two or more UEs in proximity that are ProSe-enabled, by means of user plane transmission using E-UTRA technology via a path not traversing any network node.
- **ProSe Discovery**: A process that identifies that a UE that is ProSe-enabled is in proximity of another, using E-UTRA or EPC.
- **ProSe Direct Discovery**: A procedure employed by a ProSe-enabled UE to discover other ProSe-enabled UEs in its vicinity by using only the capabilities of the two UEs with E-UTRA technology.
- **EPC-level ProSe Discovery**: A ProSe Discovery procedure by which the EPC determines the proximity of two ProSe-enabled UEs and informs them of their proximity.

## Definitions from 3GPP SA1 TS 22.278

- **Open ProSe Discovery**: is ProSe Discovery without explicit permission from the ProSe-enabled UE being discovered.
- **Restricted ProSe Discovery**: ProSe Discovery that only takes place with explicit permission from the ProSe-enabled UE being discovered.

## ProSe, why?

- Enables LTE to become a competitive (cost efficient) broadband communication technology (e.g. PS networks)
- The close location of nodes allows for high data rates at low latency and low energy consumption (proximity-gain);
- Reuse of transmission resources within the same cell by cellular as well as D2D links is possible, thereby increasing the reuse factor (reuse-gain);
- Only one direct link is required, compared to up- and downlink in cellular communication; less resources are used in overall (hop-gain);
- Switching from infrastructure to direct path offloads cellular traffic, alleviating congestion, and thus benefitting other non-D2D UEs as well.
- .....

# Introduction (4)

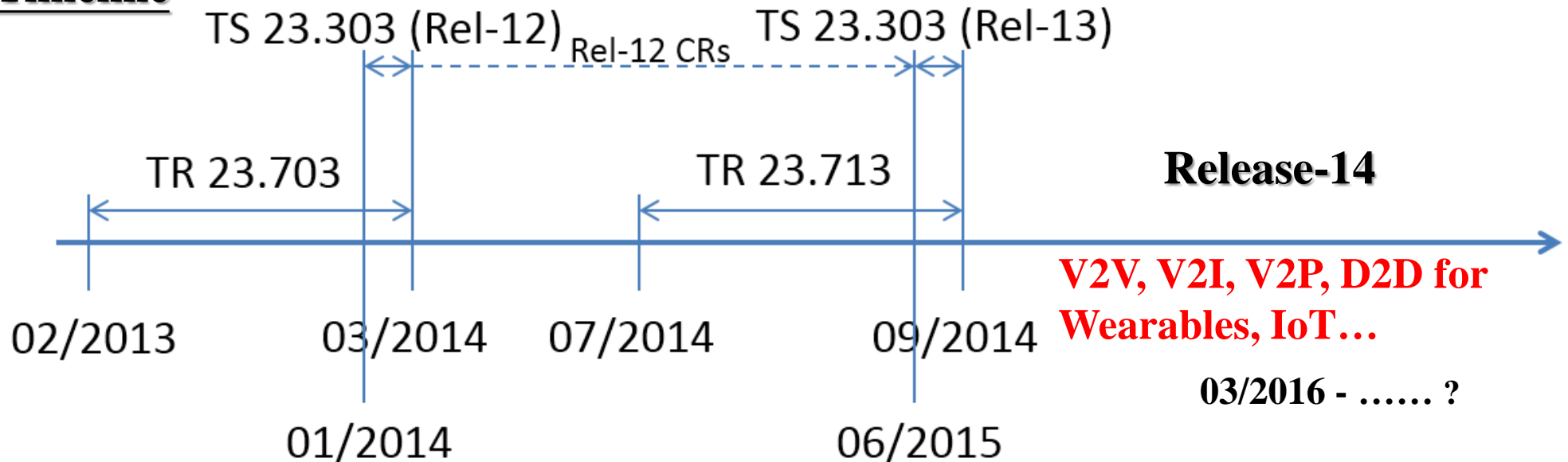
## Release 12

- TR 23.703: Study on architecture enhancements to support Proximity-based Services ProSe
- TS 23.303: Proximity-based services (ProSe); Stage 2;

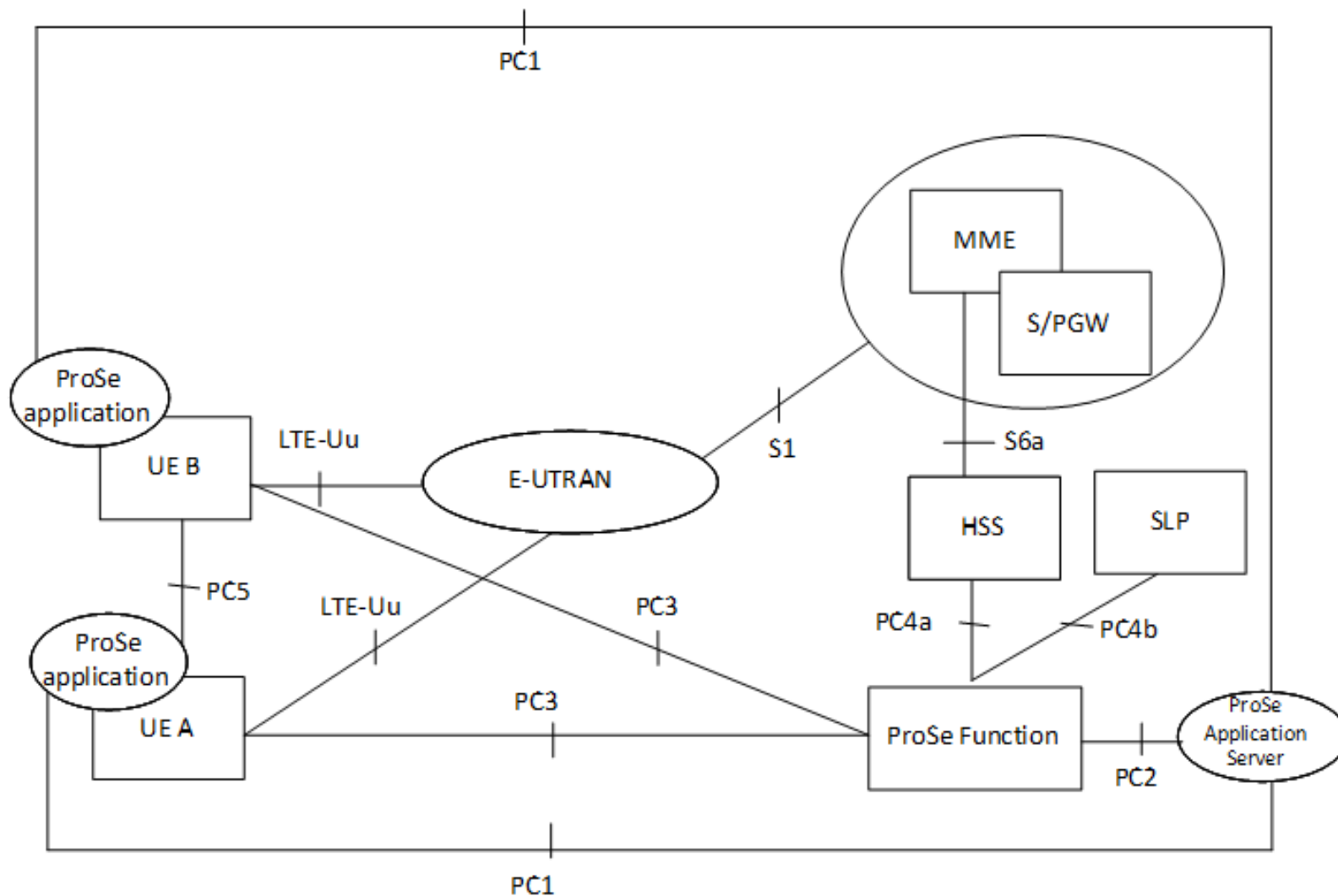
## Release 13

- TR 23.713: Study on extended architecture support for proximity services;
- TS 23.303: Proximity-based services (ProSe); Stage 2.

## Timeline



# ProSe Architectural Reference Model



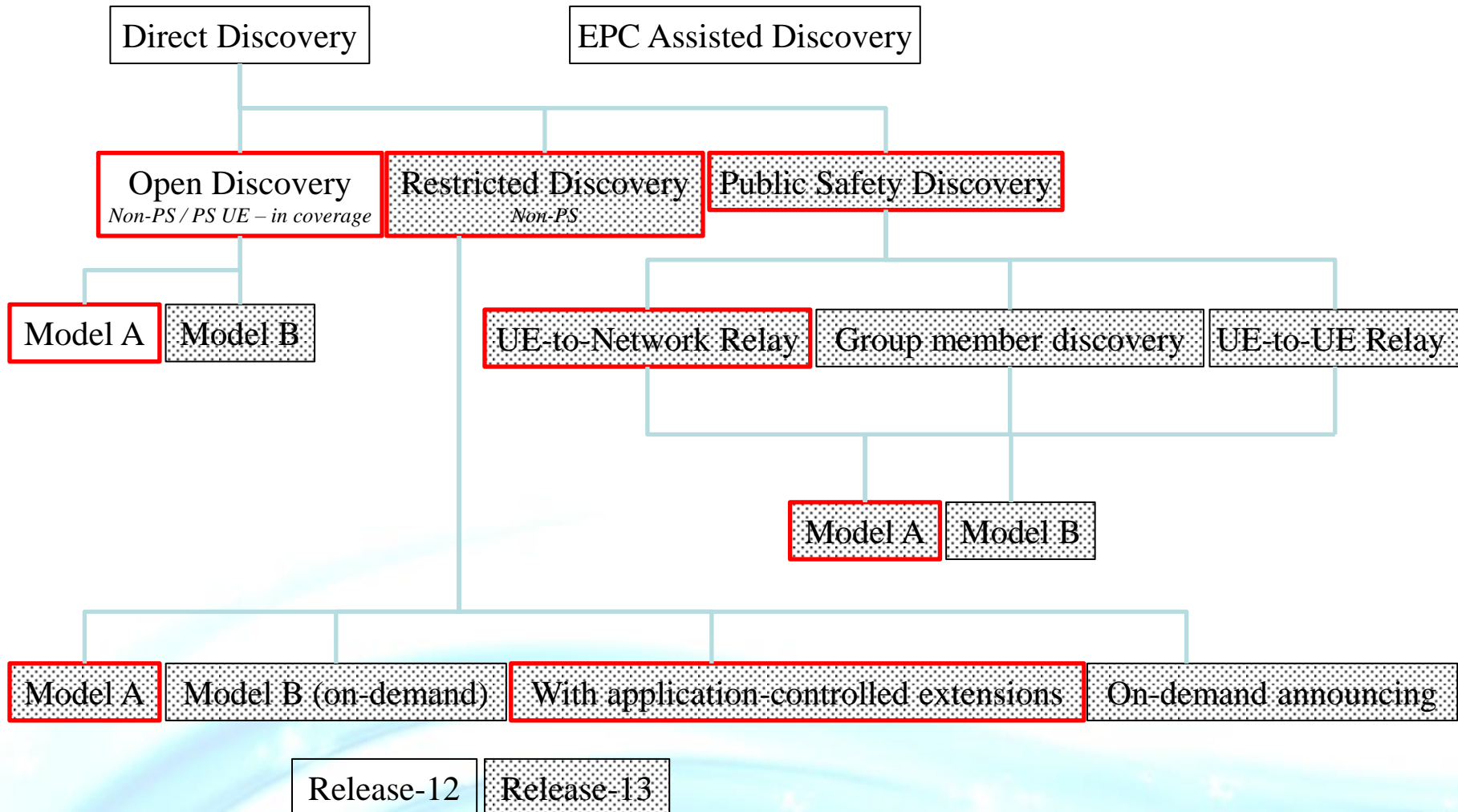
## Non-Roaming Reference Architecture



# ProSe Function

- Provision of the UE with necessary parameters in order to use ProSe Direct Discovery and ProSe Direct Communication;
- To allocate and process the mapping of ProSe Application IDs and ProSe Application Codes used in open ProSe Direct Discovery;
- Authorization of discovery requests;
- Provision of security material to UEs in order to protect discovery messages transmitted over the air;
- Provides the necessary charging and security functionality for usage of ProSe;
- ....

# ProSe Discovery - Overview



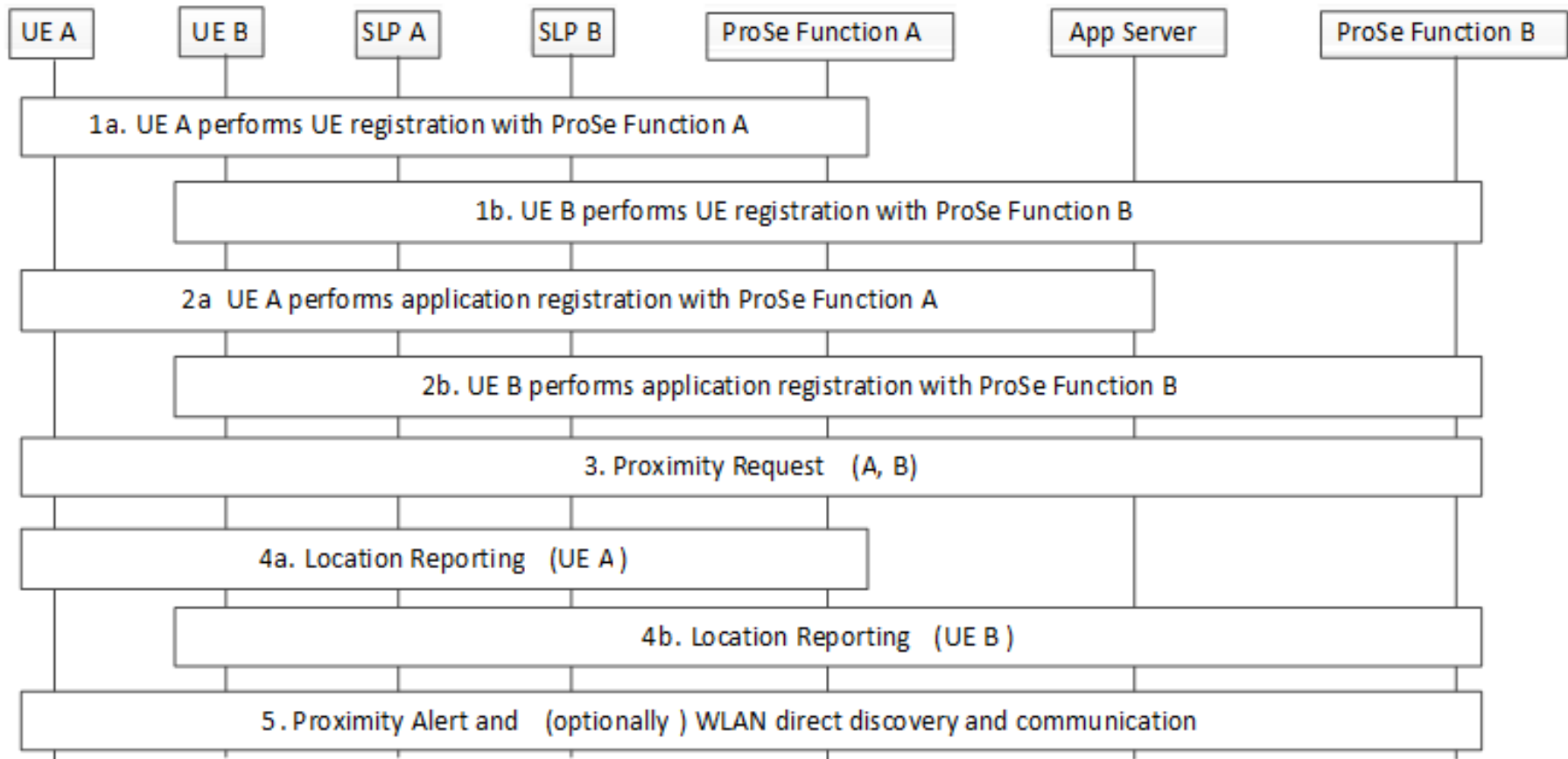
## Model A: involves one UE announcing "I am here"

- This model defines two roles for the ProSe-enabled UEs that are participating in ProSe Direct Discovery.
  - ◆ **Announcing UE**: The UE announces certain information that could be used by UEs in proximity that have permission to discover.
  - ◆ **Monitoring UE**: The UE that monitors certain information of interest in proximity of announcing UEs.

## Model B: involves one UE asking "who is there" and/or "are you there"

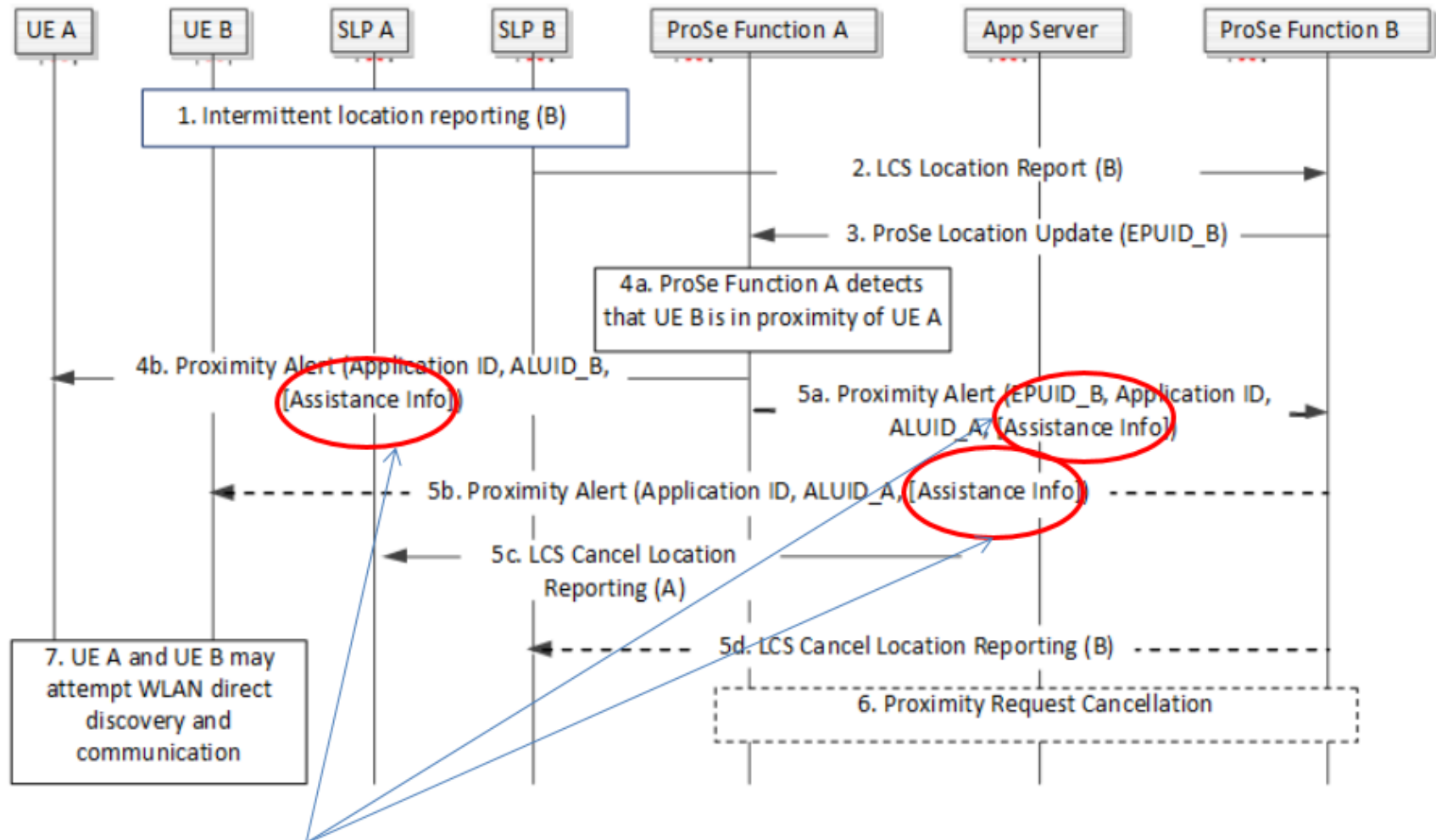
- This model defines two roles for the ProSe-enabled UEs that are participating in ProSe Direct Discovery.
  - ◆ **Discoverer UE**: The UE transmits a request containing certain information about what it is interested to discover.
  - ◆ **Discoveree UE**: The UE that receives the request message can respond with some information related to the discoverer's request.

# EPC-level ProSe Discovery procedures



**Contributing Companies in SA2: Intel, ITRI, ALU, .....**

# Proximity Alert



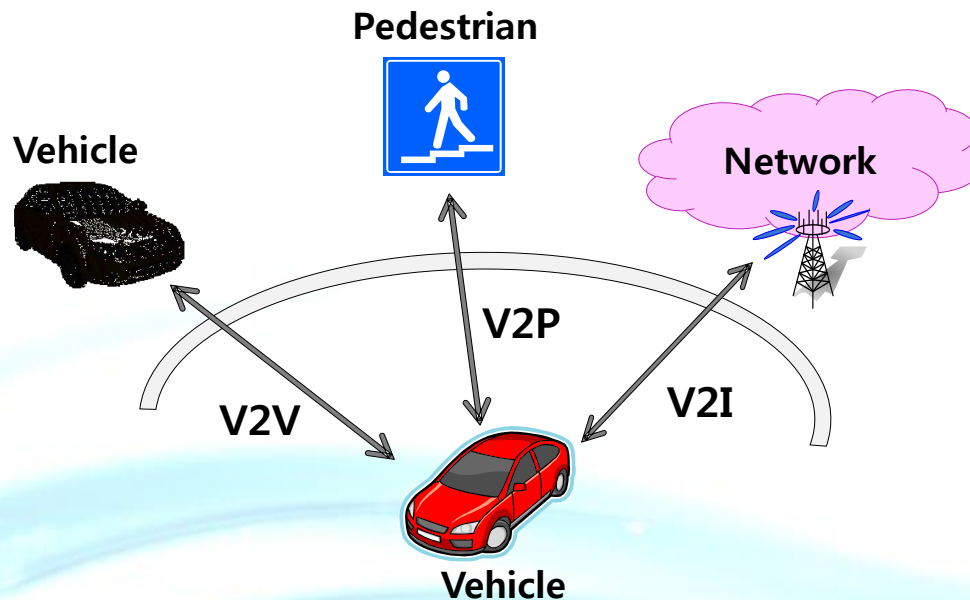
The message includes Assistance Information for WLAN direct discovery and communication with UE A.

The WLAN interface in the UE need not be turned on before step 7.

The assistance information is designed to expedite WLAN direct discovery and communication. The content of the assistance information depends on the technology used on the WLAN direct link.

## Types of V2X

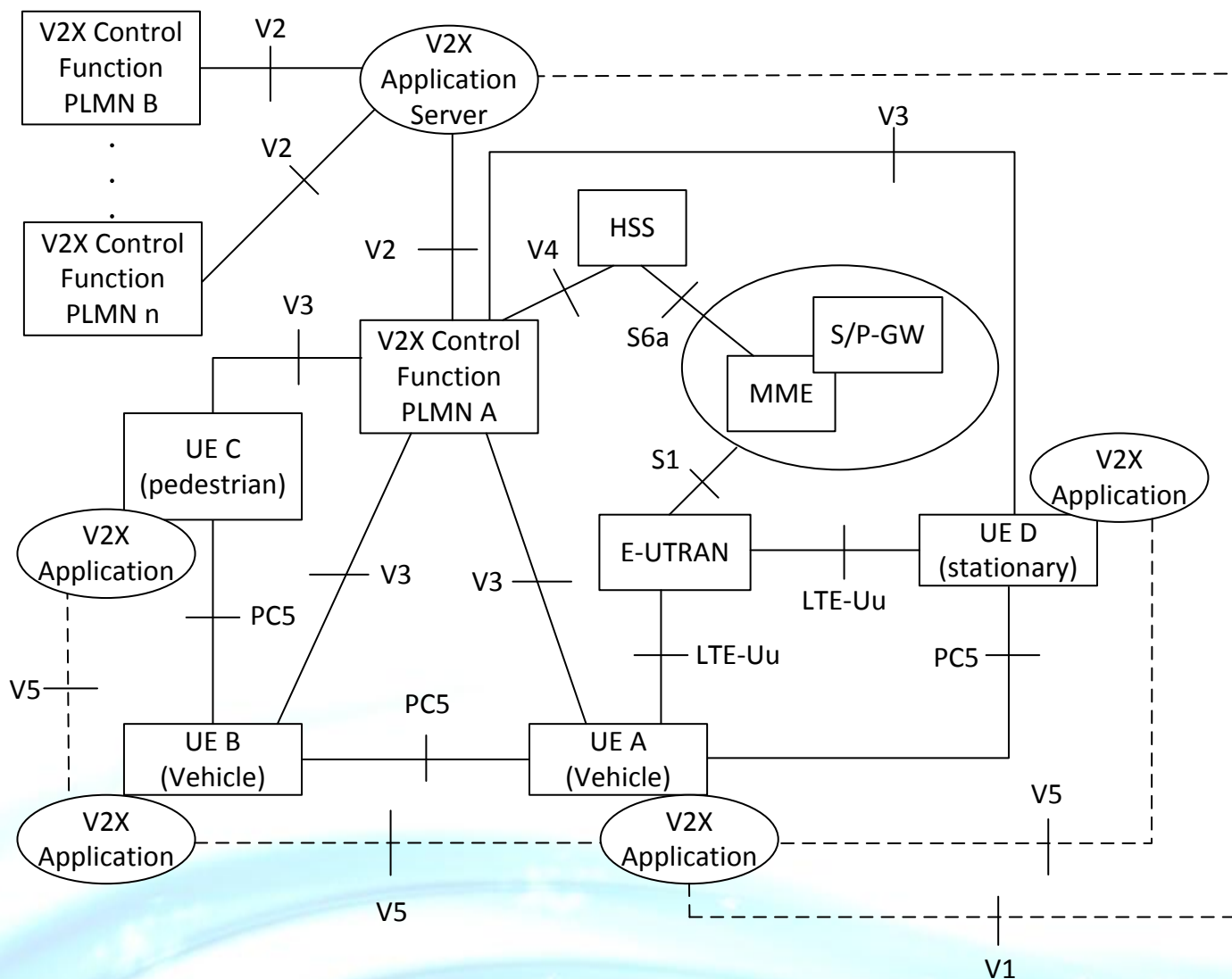
- **Vehicle-to-Vehicle (V2V) Communications**
- **Vehicle-to-Infrastructure (V2I) Communications**
- **Vehicle-to-Pedestrian (V2P) Communications**





- **Road Side Unit:** an entity supporting V2I Service that can transmit to, and receive from a UE using V2X application. RSU is implemented in an eNodeB or a stationary UE.
- **V2I Service:** a type of V2X Service, where one party is a UE equipped on a vehicle and the other party is an RSU.
- **V2N Service:** a type of V2X Service, where one party is a UE equipped on a vehicle and the other party is an application server (e.g. traffic safety server).
- **V2P Service:** a type of V2X Service, where one party is a UE equipped on a vehicle and the other party is a UE which is carried by an individual (e.g. handheld terminal carried by a pedestrian, cyclist, driver or passenger).
- **V2V Service:** a type of V2X Service, where both parties of the communication are UEs equipped on different vehicles

**Major companies involved in 3GPP: LG Electronics, Qualcomm, Huawei, Ericsson, Nokia Networks, Alcatel-Lucent**



## Reference architecture for V2X -- D2D/PC5 based



# 3GPP ProSe/D2D and its proposed extensions to other topics such as V2X, Wearable devices

## RAN Aspects

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- **Rel-13 eD2D (WID)**
- **Rel-13 LTE-based V2X Services (SID)**
- **3GPP ProSe /D2D proposal in Rel-14**



## Enhanced LTE Device to Device Proximity Services

### ● New WI: Enhanced Device to Device ProSe (RP-142311)

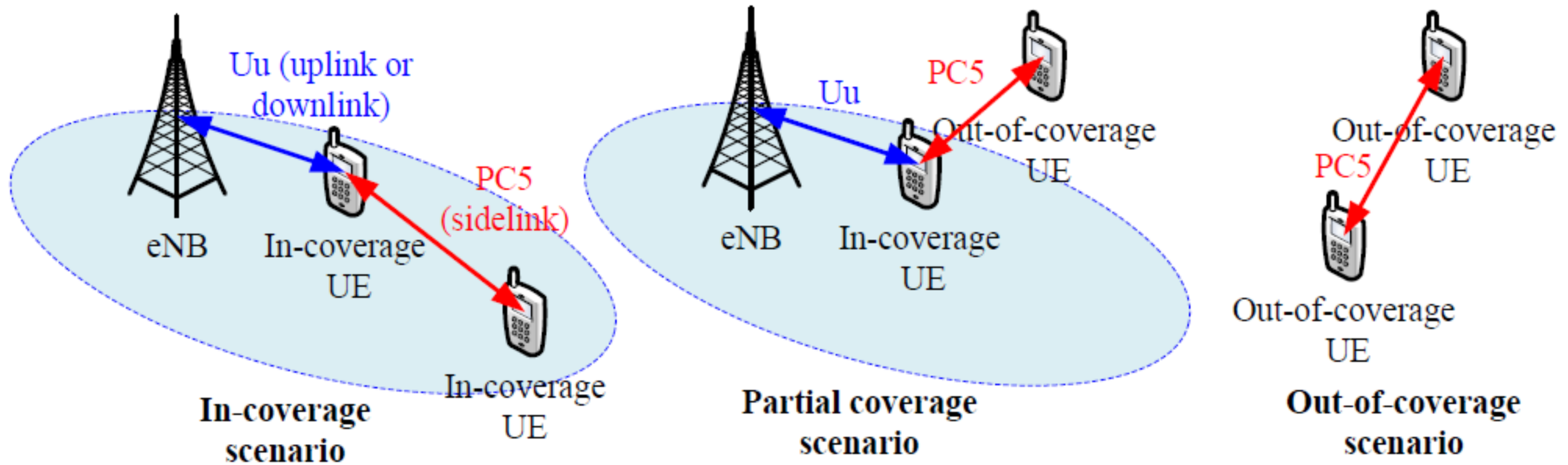
- ◆ Dec. 2014, RAN#66
- ◆ RAN2 leads this working item (Qualcomm)
- ◆ Objective:
  - ▶ **Type 1 discovery** for the **partial** and **outside network coverage scenarios** targeting public safety use
  - ▶ Support the **extension of network coverage** using **UE-to-Network Relays**, including service continuity (if needed), based on Release 12 D2D communication, considering applicability to voice, video.
  - ▶ Enhance D2D discovery support in the presence of **multiple carriers and PLMNs**
  - ▶ Interference Issues



# 韓國 D2D 系統佈建資訊

- **Korean government decided to use LTE technologies for Public Safety to build nationwide Public Safety Broadband Network (PSBN) on July 2014. Based on the Information Strategy Planning (ISP) of the Ministry of Public Safety and Security (MPSS), Korea will initiate the establishment of trial Public Safety Broadband Network (PSBN) in Pyeong-Chang City in 2015 which will host the 2018 Winter Olympic Games. This Public Safety Broadband Network (PSBN) will be expanded to 8 other major cities in 2016 and finally deployed nationwide by 2017**
- **SAMSUNG disclose 2016 LTE products support Rel.12/13 LTE D2D**

# D2D ProSe support three scenarios





# Classification



PS Case	In coverage	Partial	Out-Of-Coverage
Discovery	R12 (Inter-cell, intra-cell) R13 (inter-carrier, inter-PLMN)	R13 (type1)	R13 (type1)
Communication	R12 (Inter-cell, intra-cell)	R12	R12
	R13 (UE-to-Network Relay, Group priority communications)		

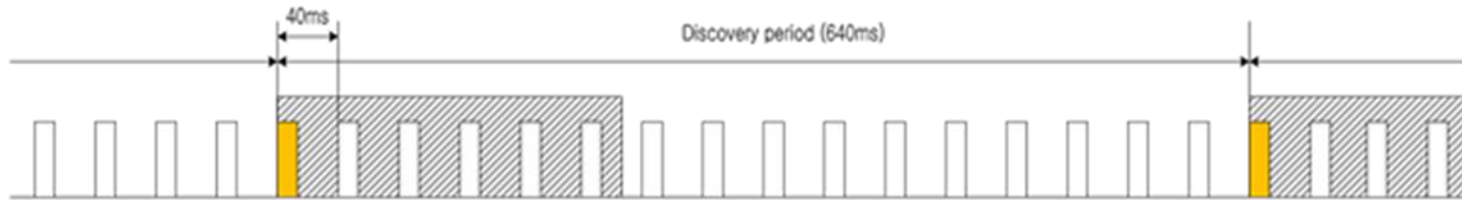
Non- PS Case	In coverage	Partial	Out-Of-Coverage
Discovery	R12 (Inter-cell, intra-cell) R13 (inter-carrier , inter-PLMN)	X	X
Communication	X	X	X

# Major Feature Of D2D ProSe In Rel-12 & 13

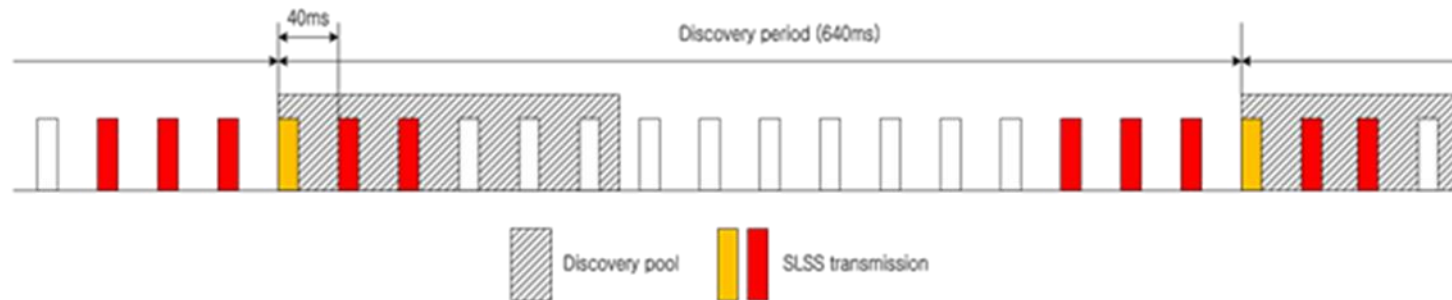
Features	Release 12	Release 13
Discovery	Only supported in in-coverage	Supported in-coverage, partial-coverage, and out-of-coverage. UE-to-Network relay for discovery is supported.
Purposes of discovery	Public safety	Public safety and non-public safety for in-coverage, public safety for partial-coverage and out-of-coverage
Synchronization to facilitate discovery	Achieved by eNBs	Additional mechanisms are needed
Communications	Broadcast (without feedback channels) for in-coverage, partial-coverage, and out-of-coverage	Broadcast with Layer 3 relay for partial-coverage
Synchronization to facilitate Communications	Achieved by eNBs for in-coverage, ns while additional mechanisms are needed for partial-coverage and out-of-coverage	Reuse the mechanisms in Release 12

# Type 1 discovery for partial & outside network coverage

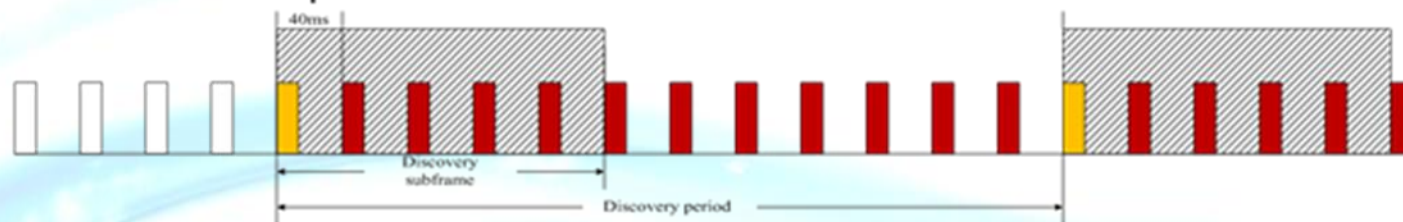
- Behavior 1 (Rel-12 behavior)



- Behavior 2 (X=3, Y=2) – Option 1



- Behavior 2– Option 2

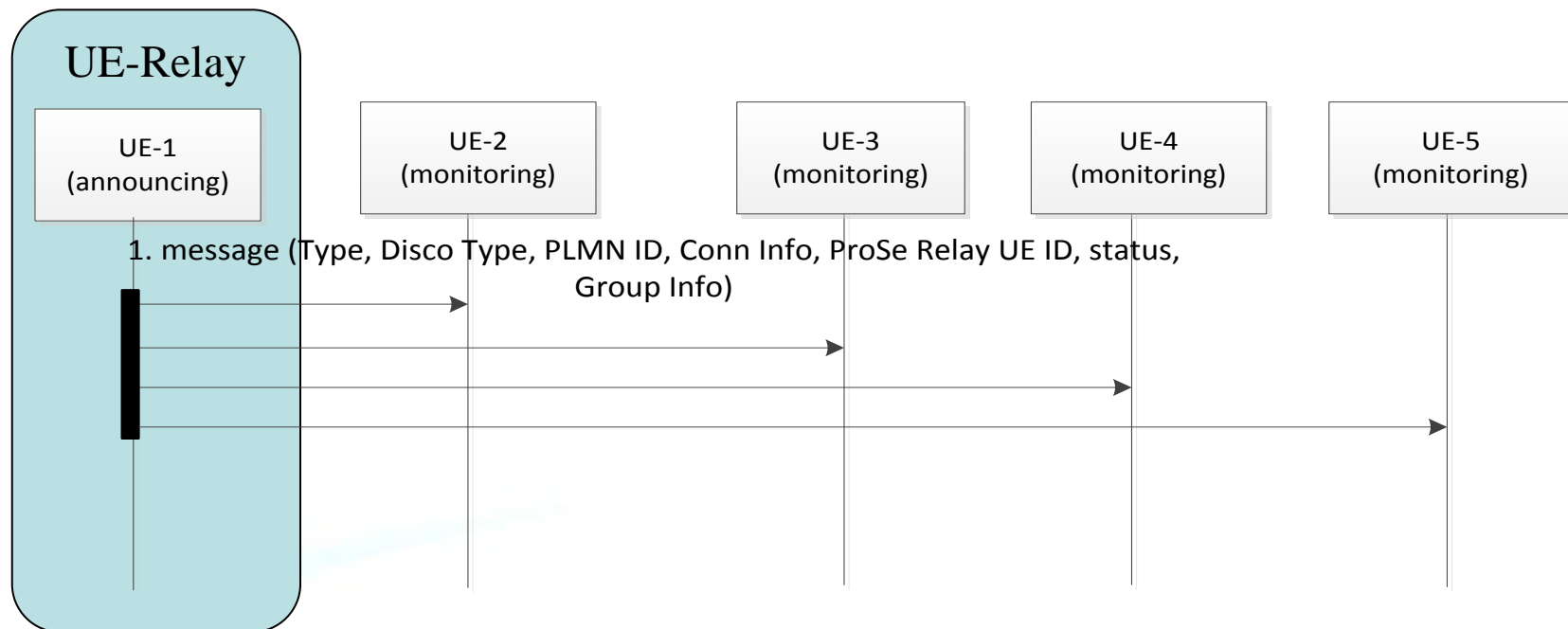




# UE-Network Relay Overview (1)

## □ UE-Network Relay Model (3GPP TR 23.713)

### ➤ Model A

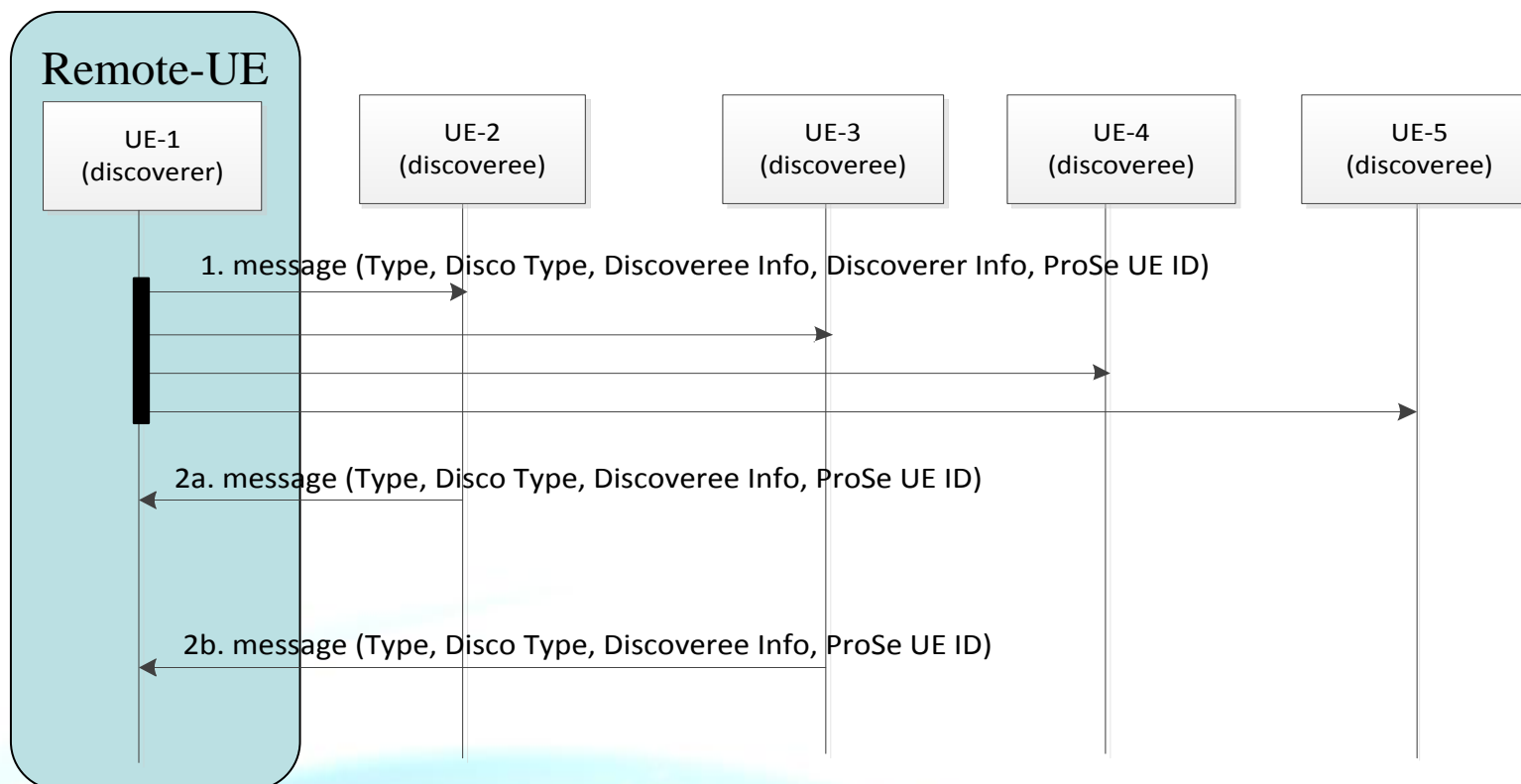


\* SA: scheduling assignment

# UE-Network Relay Overview (2)

## □ UE-Network Relay Model (3GPP TR 23.713)

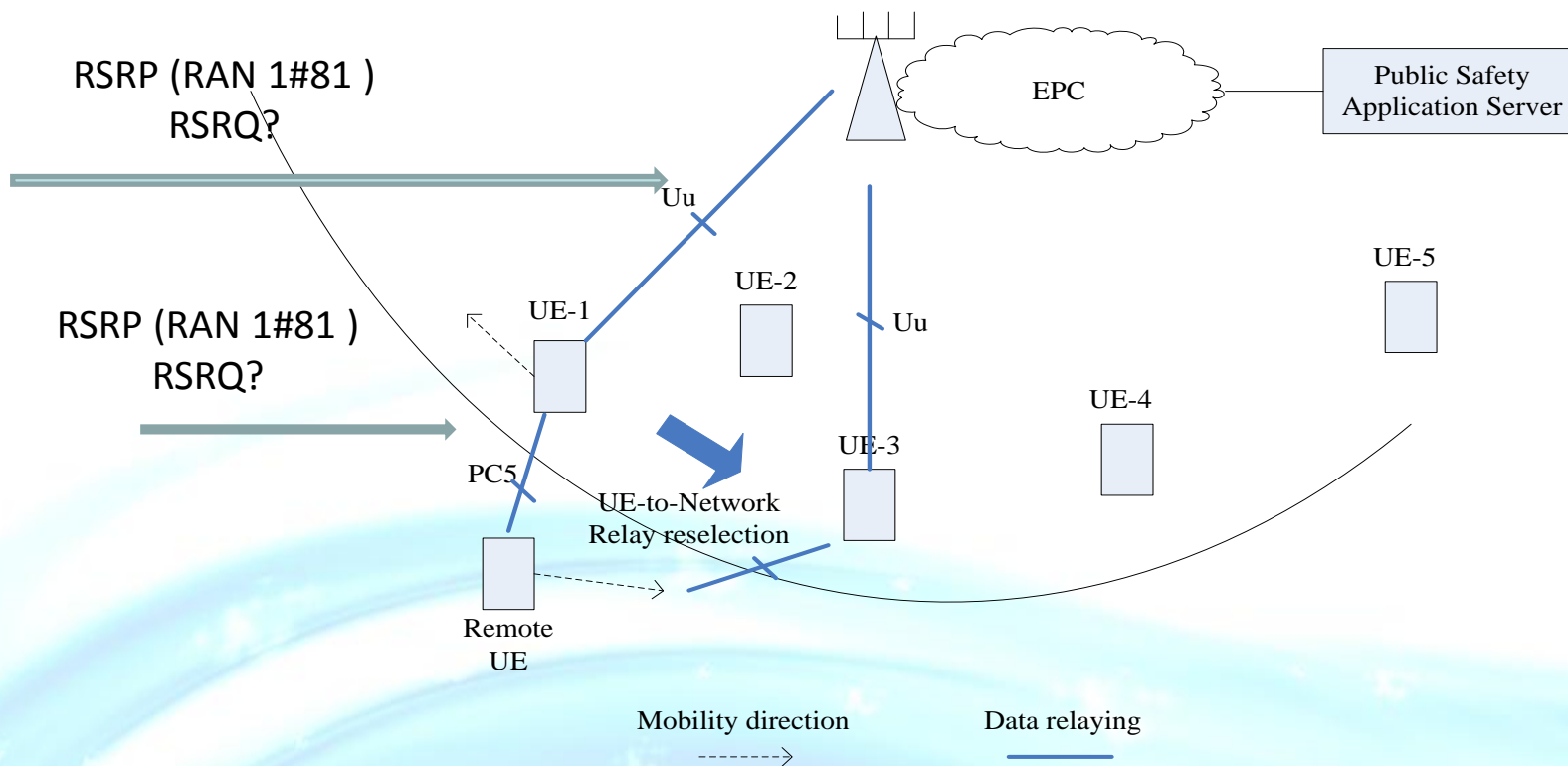
### ➤ Model B



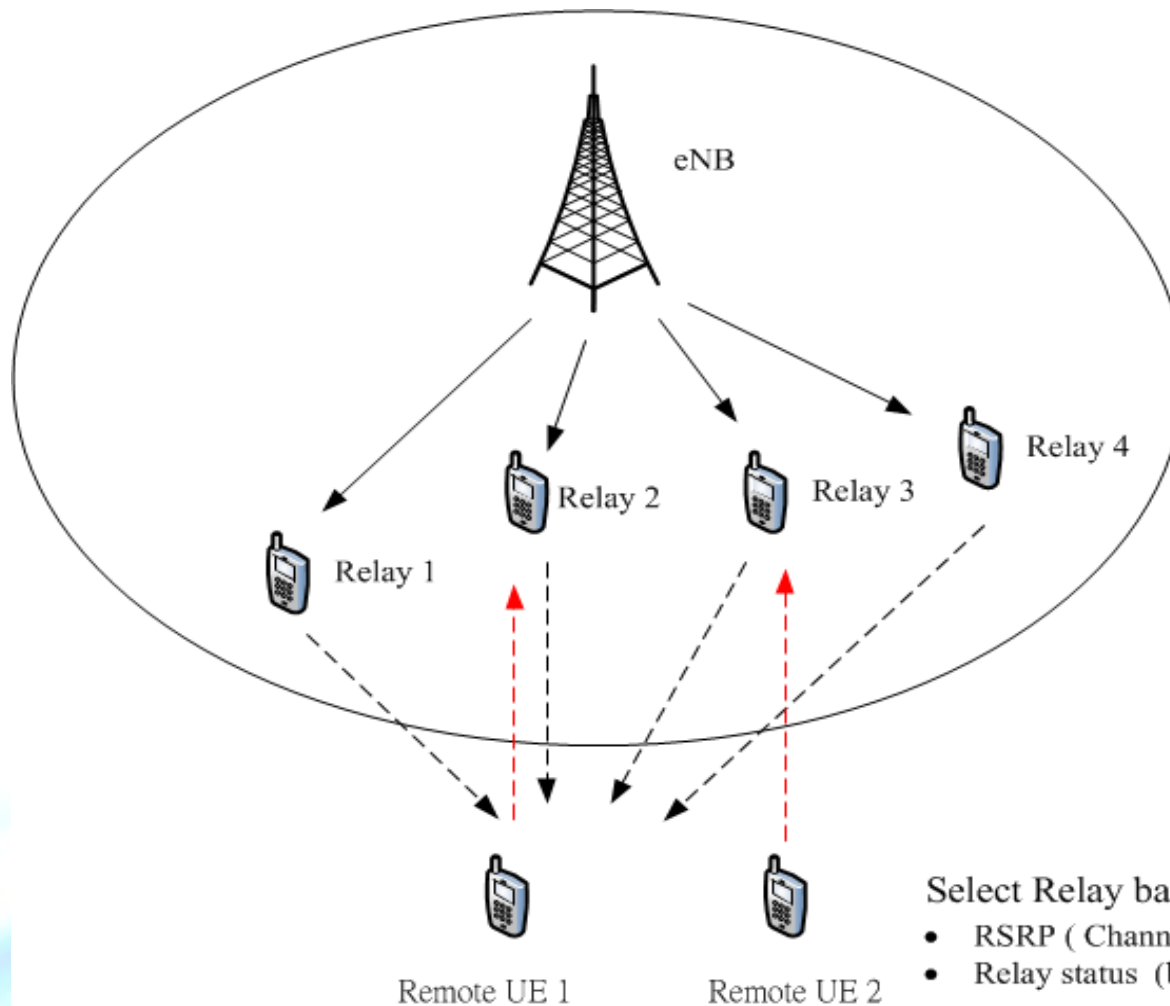
\* SA: scheduling assignment

# UE-NW Relaying

- ◆ Support the **extension of network coverage** using L3-based UE-to-Network Relays, including **service continuity** (if needed), based on Release 12 D2D communication, considering applicability to voice, video.

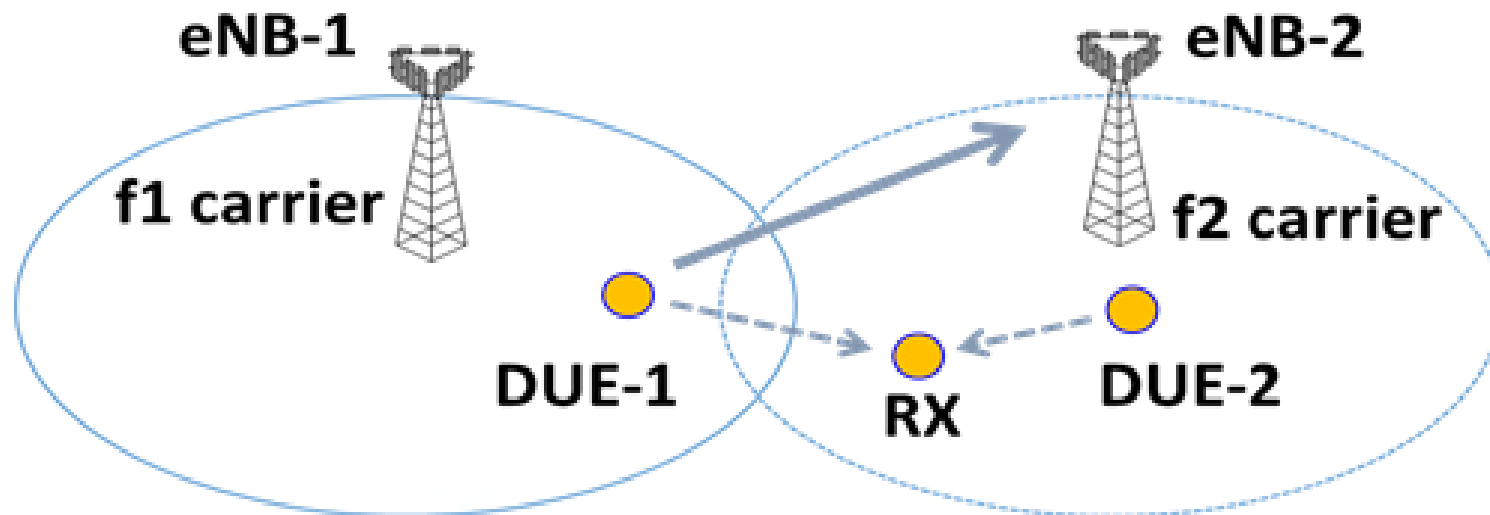


# UE-NW Relaying Selection



- Select Relay base on
- RSRP ( Channel condition )
  - Relay status ( battery, Capability )

# Enhance D2D discovery support in the presence of multiple carriers and PLMNs





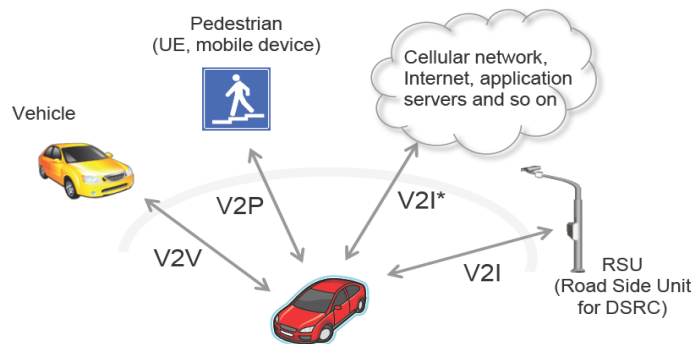
# Introduction V2X

- **China shows great interest in vehicular communications**
  - ◆ In 2014, CCSA has finished the feasible study for vehicle safety application based on TD-LTE
  - ◆ The series of industrial standard of communication based on LTE for vehicle application began
  - ◆ In 2015, the frequency study of V2X also started
  - ◆ National Regulatory Authority in China will allocate the frequency of connected vehicles
- **Vehicle manufacturers and cellular network operators also show strong interests in vehicle wireless communications for proximity safety services as well as commercial applications**
- **3GPP's goal is to *realize "connected car" via LTE***

\*CCSA (China Communications Standards Association) 中國通信標準化協會

## LTE-V2X activities in China

- ☞ National key project “Standardization and prototyping for LTE-V wireless transmission technology (2016-2017)” was released by MIIT
- ☞ Shanghai Intelligent Connected Vehicle Pilot Area” was approved by MIIT, China . Initial plan was disclosed by Shanghai International Automobile City
  - Phase 1 (present-2016.6): 40 connected vehicles (802.11p and LTE-V2X)
  - Phase 2 (2016.7-2017.12): 400 connected vehicles (802.11p and LTE-V2X)
  - Phase 3 (2018.1-2019.12): 1000 connected vehicles (LTE-V2X)



Major Companies	Focus Topics	Important Contributions @ RAN# 70
Huawei & L.G.	V2V services based on LTE sidelink	<ul style="list-style-type: none"> <li>- Enhancement to sidelink physical layer structure necessary for V2V</li> <li>- Enhancement to sidelink synchronization procedure necessary for V2V</li> <li>- Necessary sidelink resource allocation enhancement option(s) for V2V</li> </ul>



## Feasibility Study on LTE-based V2X Services

### ● New SI: Feasibility Study on LTE-based V2X Services (RP-151903)

- ◆ June. 2015, RAN#68
- ◆ RAN1 leads this working item (LG, Huawei, CATT)
- ◆ Objective:
  - ▶ To define the evaluation methodology for **LTE-based V2V, V2I and V2P services** to compare the performance of different technical options
  - ▶ For support of **PC5 transport** for **V2V** services (PC5 is specific for D2D )
  - ▶ For support of Uu transport for V2V, and Uu,PC5 transport for V2I and V2P services



## ● Road Side Unit

- ◆ an entity supporting V2I Service that can transmit to, and receive from a UE using V2I application. RSU is implemented in an eNodeB or a stationary UE.

## ● V2I Service (Vehicular-to-Infrastructure/Network)

- ◆ a type of V2X Service, where one party is a UE and the other party is an RSU both using V2I application.

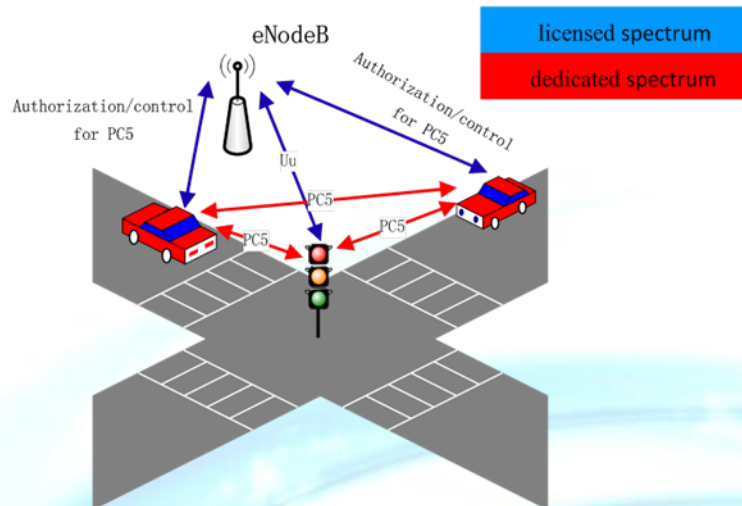
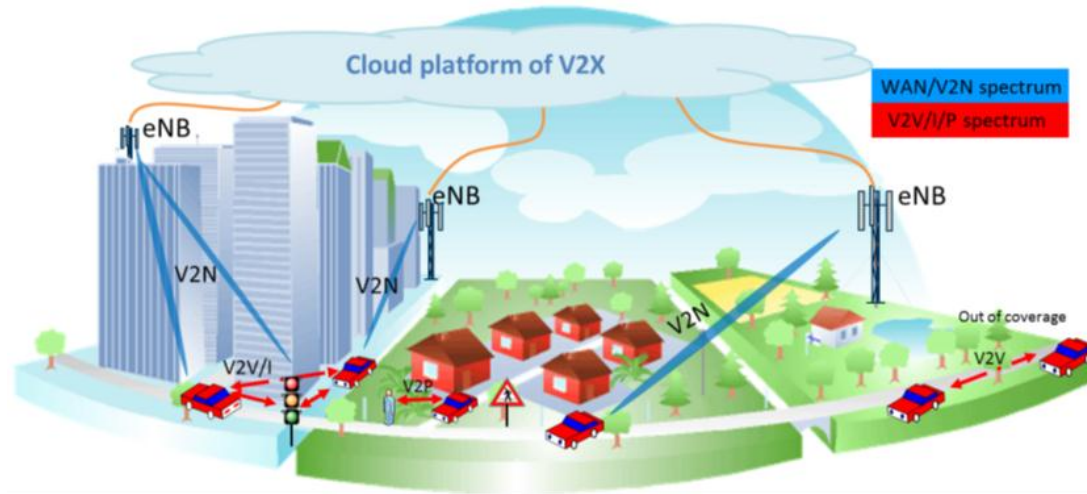
## ● V2P Service (Vehicular-to-Pedestrian)

- ◆ a type of V2X Service, where both parties of the communication are UEs using V2P application

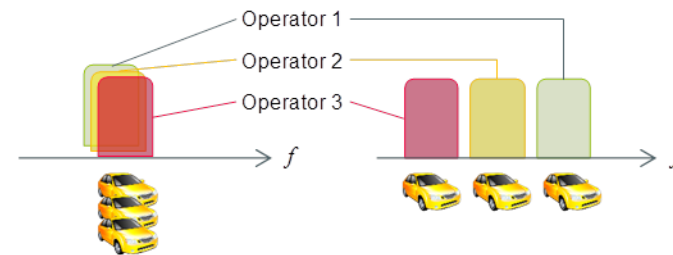
## ● V2V Service (Vehicular-to-Vehicular)

- ◆ a type of V2X Service, where both parties of the communication are UEs using V2V application

# Deployment



2GHz  
6GHz



1 Tx chain and 1 Rx chain for PC5

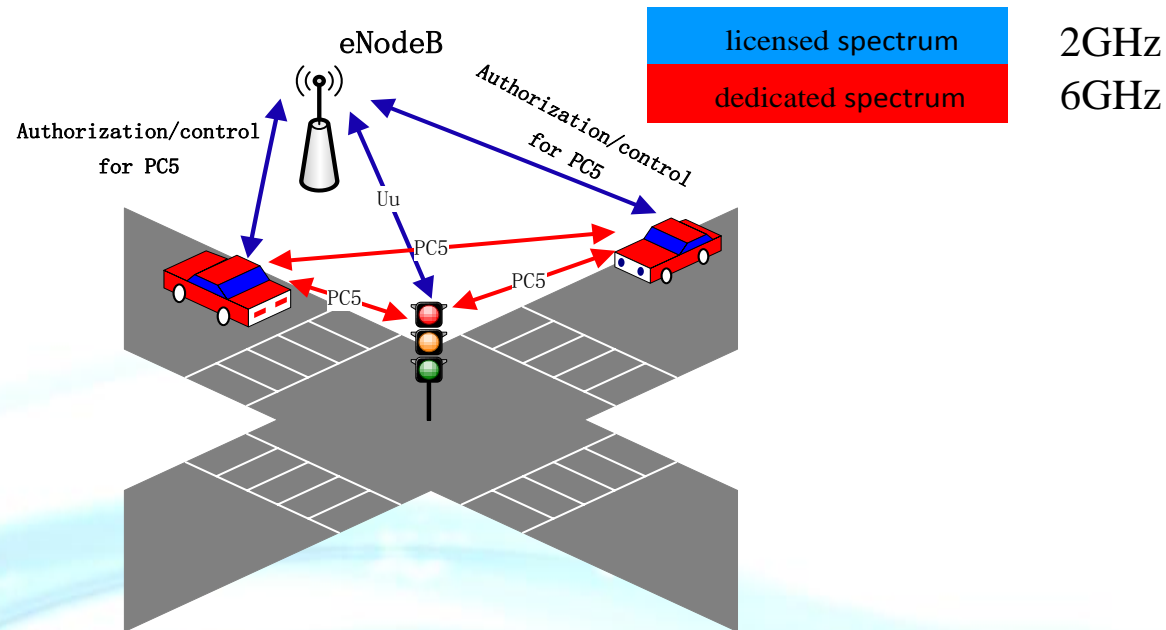
Case 1-1: Single dedicated V2x carrier is used regardless of the operator. This carrier is owned by single operator or shared by multiple operators.

1 Tx chain and 3 Rx chain for PC5

Case 1-2: Multiple operators have each dedicated V2x carriers and UE is equipped with multiple Rx chain to monitor all the V2x carriers.

# V2X –Spectrum (1)

- **PC5 transport uses a dedicated carrier**
- **Uu transport and authorization/control for PC5 transport could use a licensed carrier which is also used for LTE network coverage.**



\* SA: scheduling assignment

## Evaluation Assumption (1)

<i>Parameter</i>	<i>Possible model</i>
Carrier frequency for PC5-based V2V	6 GHz, 2 GHz. Capture in TR "Note that the system should work for all the bands up to 6 GHz, including 5.9 GHz. This study is not intended to make any implication for the study on channel above 6 GHz."
Bandwidth	10 MHz
Number of carriers	1 (baseline), other numbers can be evaluated based on inter-carrier interference model from the existing UE-UE link ACLR ( FFS ).
Mobility	If UE mobility is explicitly modeled, UE position is updated in every X (FFS) ms based on the details on the channel model below.
Synchronization	Time and frequency error should be considered in system and link level simulations. Companies should explain the assumed error model and the method to achieve the error range. Continue discussion during the week on the possible error range. (Wait RAN4 reply)



# Evaluation Assumption

## Urban case



<i>Urban case</i>	
Pathloss (UE-UE) including LOS/NLOS	WINNER+ B1 Manhattan grid layout (note that the antenna height should be set to 1.5 m.). Further check the offset.  <a href="#">FFS: How to model close distance</a>
Shadow fading distribution	Log-normal
Shadowing standard deviation	3 dB for LOS, 4 dB for NLOS
Shadowing decorrelation distance	<del>FFS depending on the conclusion on the shadowing correlation: 10 m for LOS, 13 m for NLOS</del> <a href="#">FFS</a>
Shadowing spatial cross-correlation	<del>Continue discussion between IID and an alternative model such as the one in Appendix A of R1-154287</del> <a href="#">FFS</a>
Shadowing spatial auto-correlation	<del>Continue discussion between IID and an alternative model such as the one in Appendix A of R1-154287</del> <a href="#">FFS</a>
Fading	For baseline, continue discussion between Umi with dual mobility (simplified model in TR36.843) and EVA or EPA with dual mobility (details needed). ETU can be an optional selection.
Number of lane in each direction	2 (4 lanes in total in each street)
Lane width	3.5 m
Road grid size determined by the distance between intersections.	3 m is reserved for sidewalk per direction (no vehicle or building in this space). Select one among the following options: Option 1: 600 * 600 m Option 2: 150 * 150 m Option 3: 288 * 166 m Option 4: 200 * 150 m Option 5: 480 * 413 m Option 6: 433 * 250 m



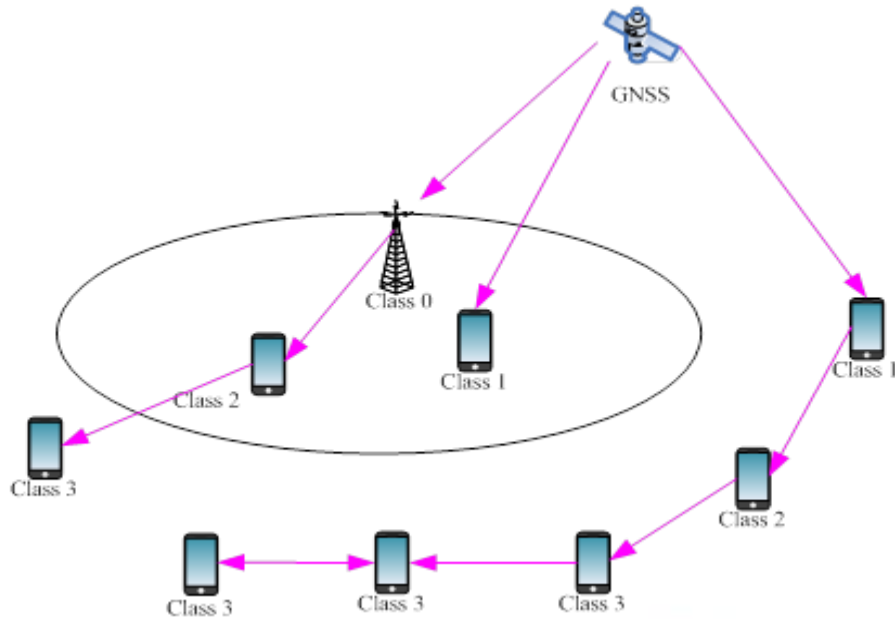
## Freeway case

<i>Freeway case</i>	
Pathloss (UE-UE) including LOS/NLOS	LOS in WINNER+ B1 (note that the antenna height should be set to 1.5 m.)
Shadow fading distribution	Log-normal
Shadowing standard deviation	FFS
Shadowing spatial cross-correlation	FFS
Shadowing spatial auto-correlation	FFS
Fading	FFS
Number of lane in each direction	3 (6 lanes in total in the freeway)
Lane width	4m
Simulation area size	freeway length $\geq$ 2000 m. Wrap around should be applied to the simulation area.
Vehicle density	Average inter-vehicle distance in the same lane is 2.5 sec * absolute vehicle speed. Baseline: The same density/speed in all the lanes in one simulation.
Vehicle speed	140, 70 km/h (Capture this in TR: The intention is to capture the sparse and medium cases in ETSI TR 101 612)
Vehicle drop	Spatial Poisson process

# V2X Synchronization scenario & procedure

Synchronization source priority list:

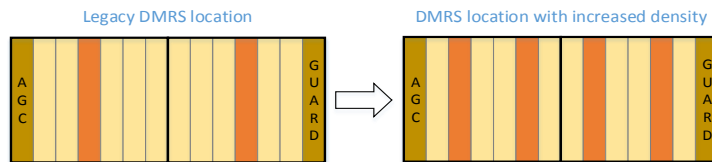
- eNBs are synchronized to GNSS
- UEs are synchronized to GNSS
- UEs are synchronized to eNB with GNSS or synch level-1 UE
- All other cases to UE
- If all UEs within coverage do not use GNSS, eNB without GNSS can be used as synchronization source as that in D2D
- The priority ranking of the synchronization grade is: 0, 1, 2, 3  
Furthermore, if above list is applied, transmission timing and receiving timing need to be redefined according to GNSS unified scheme.



Source : LG

# Enhance DMRS in high Doppler case

- Maximum Doppler frequency is about 1.5kHz (for 6GHz carrier frequency and 280km/hr vehicle speed)
- Maximum carrier frequency is about 6kHz (for 6GHz carrier frequency and 1ppm mismatch, carrier spacing is 15kHz)
- Enhanced DMRS design
  - ✓ Increase DMRS density



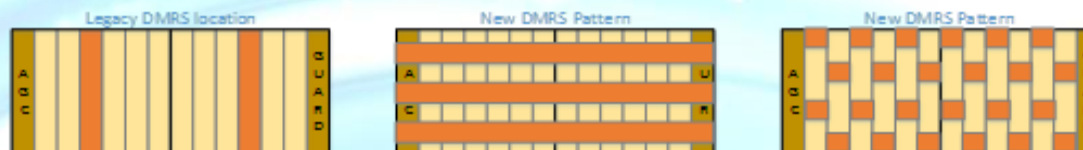
Each DMRS contains 6PRBs  
→ 144REs to 288REs

- ✓ increase carrier spacing for DMRS



PAPR issue and Standard Impact

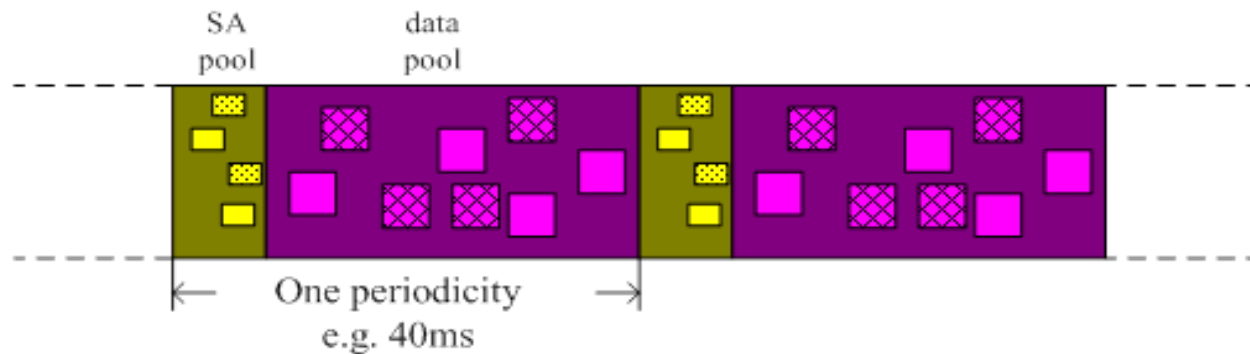
- ✓ New DMRS pattern



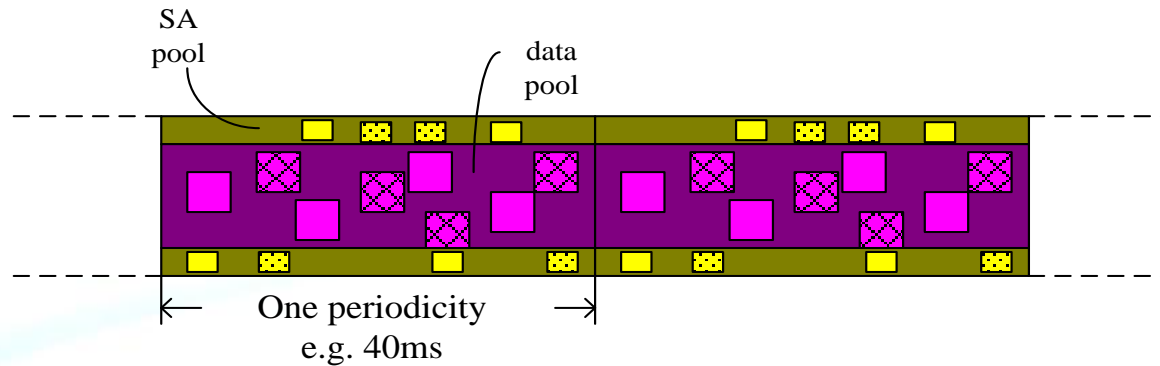


# PC5 enhancements for V2V (Resource Allocation)

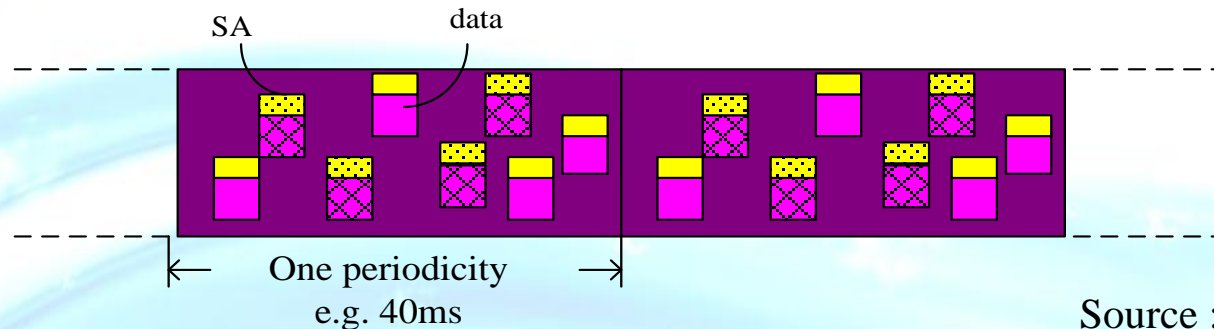
TDM  
(Rel. 12 D2D)



FDM

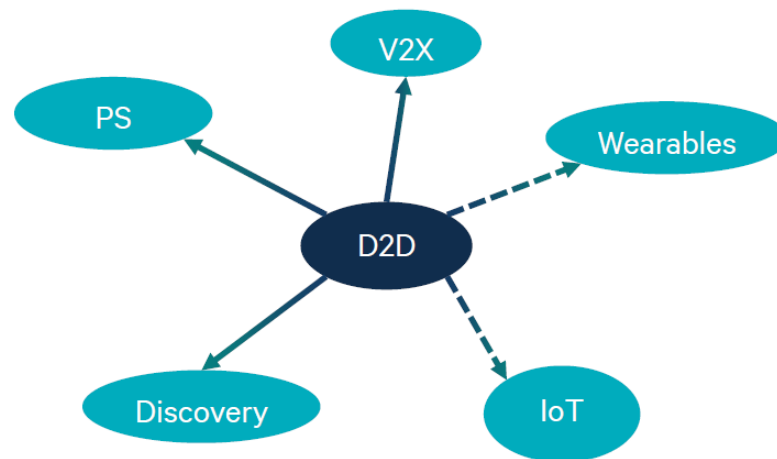


Hybrid TDM & FDM



Source : Huawei

# Enhancements to LTE D2D in Rel. 14



- **D2D first introduced in Release 12**

- ◆ D2D discovery for commercial & Public Safety use cases
- ◆ D2D group cast communication for Public Safety

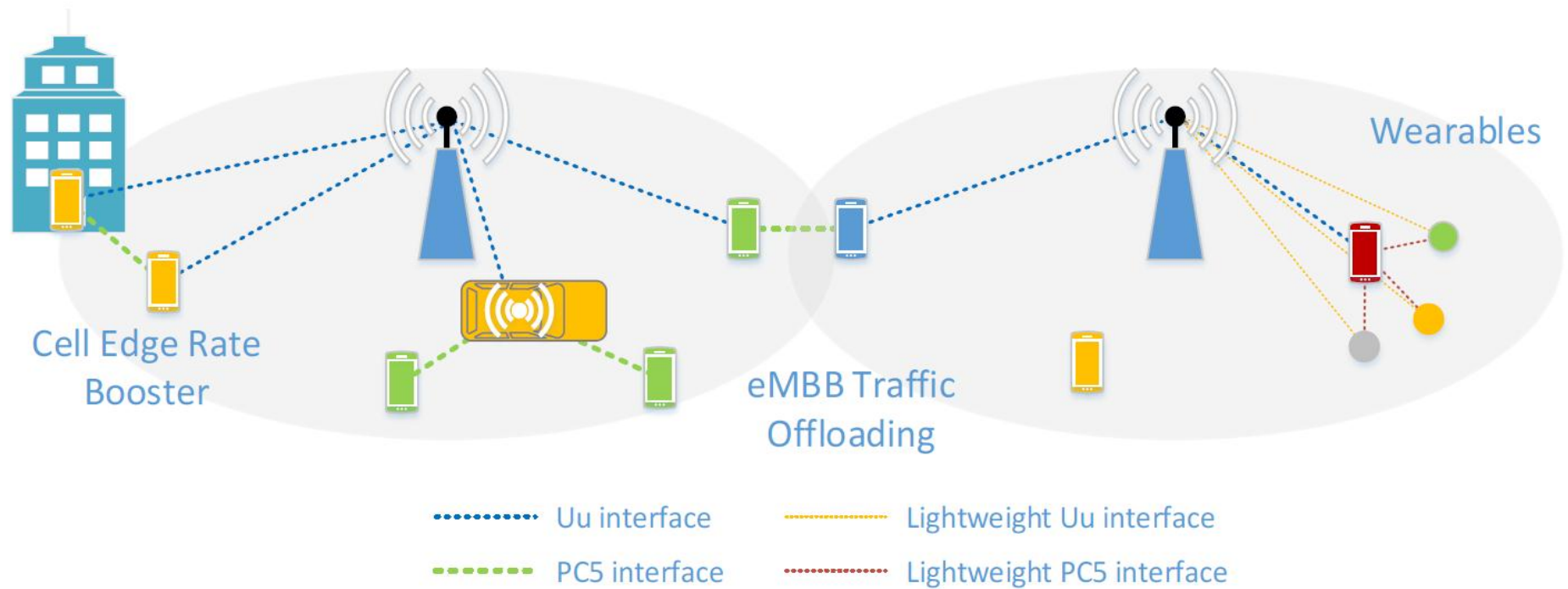
- **Enhancements to D2D continued in Release 13**

- ◆ D2D discovery enhancements to inter-frequency
- ◆ D2D based UE to Network relays

- **D2D based V2X being explored in Release 14**

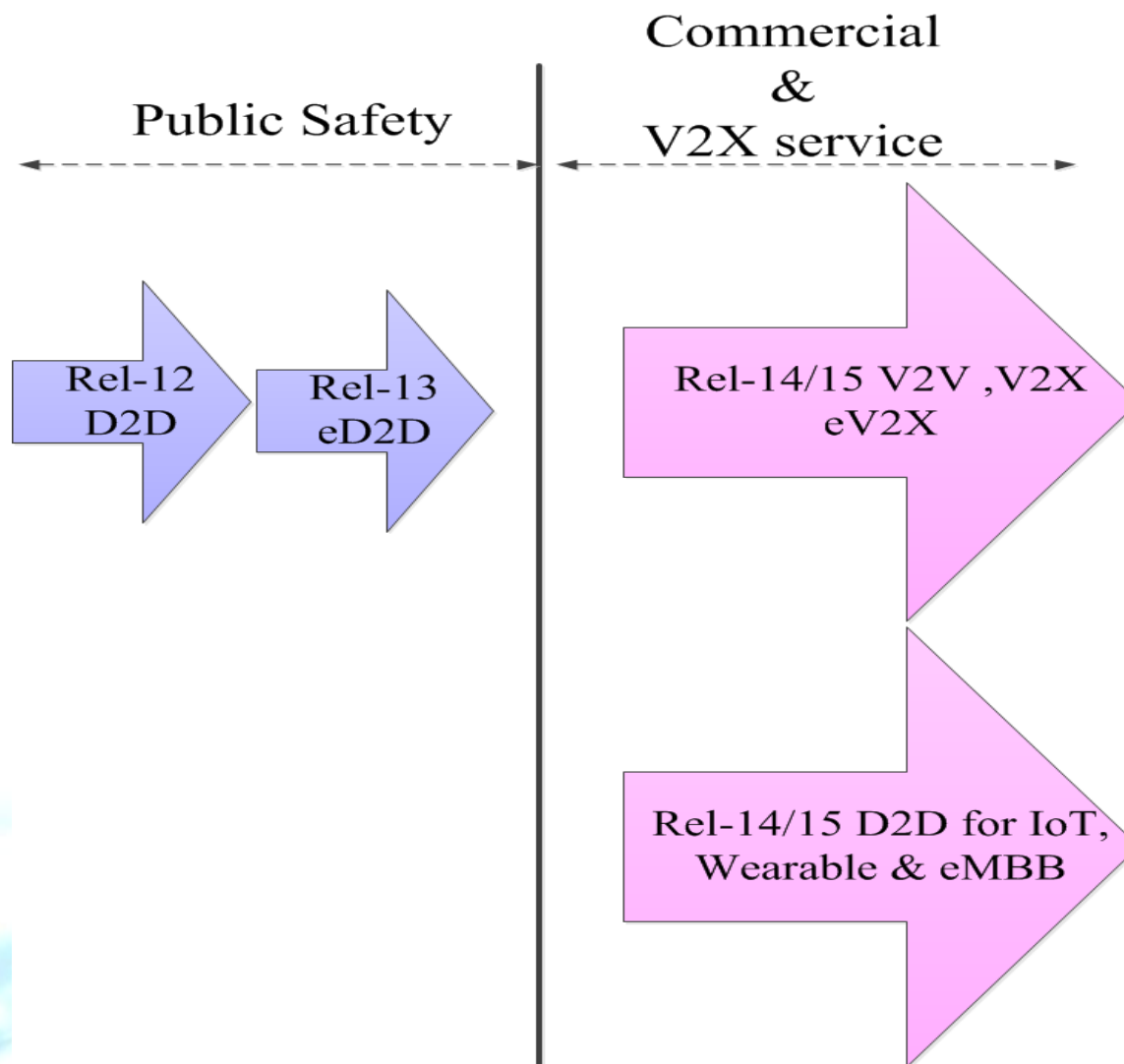
- **D2D also has applications to IoT and wearables that need to be explored**

# Enhancements Relay to LTE D2D in Rel. 14



Source : Intel

# 3GPP LTE Pro & 5G D2D Standardizations



# Thank You