

**RWS-150052**

**3GPP RAN Workshop on 5G, Phoenix, USA, Sep. 17 - 18, 2015**



# **Vision, Standardization, and Technologies for 5G**

**LG Electronics, Inc.**

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# Outlines

## ❑ 5G Vision: Main Use Cases & KPIs

## ❑ 5G Standardization Approach

- 5G technology definition
- 3GPP 5G standardization timeline
- Below 6GHz radio access technology
- Above 6GHz radio access technology

## ❑ 5G Standardization Items

- Phase-1 (Rel-14/-15) standardization technologies
- Potential phase-1 standardization items

# 5G Main Use Cases & KPIs

## 5G Drivers

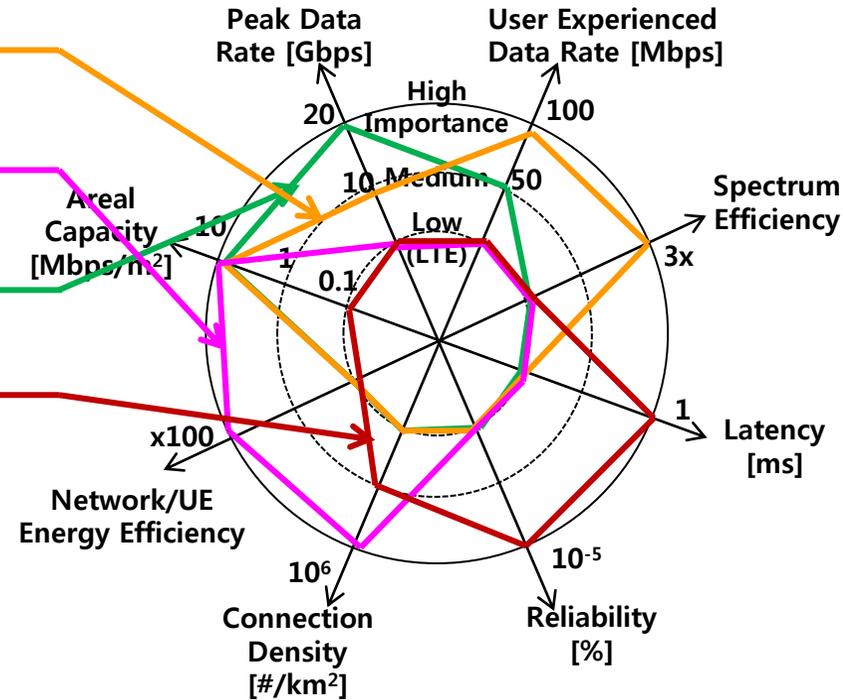
- Rapid growth of mobile data traffic
- Huge number of connected devices
- Advent of immersive multimedia
- New IoT requiring low latency & ultra reliability



## 5G Use Cases

- Enhanced Radio Capacity
- Massive Device Connection
- Ultra Mobile Broadband
- Mission-critical IoT

## 5G Main KPIs



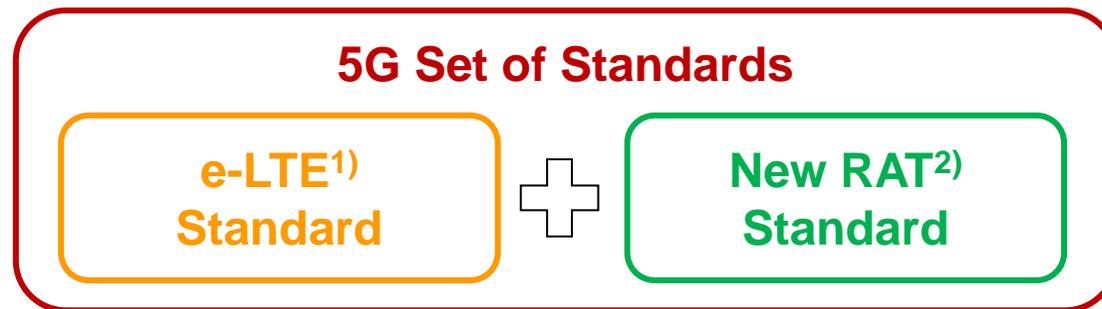
- Optimized carrier/resource utilization for diverse user traffic

## 5G Technology Definition

### 5G Technology Configuration



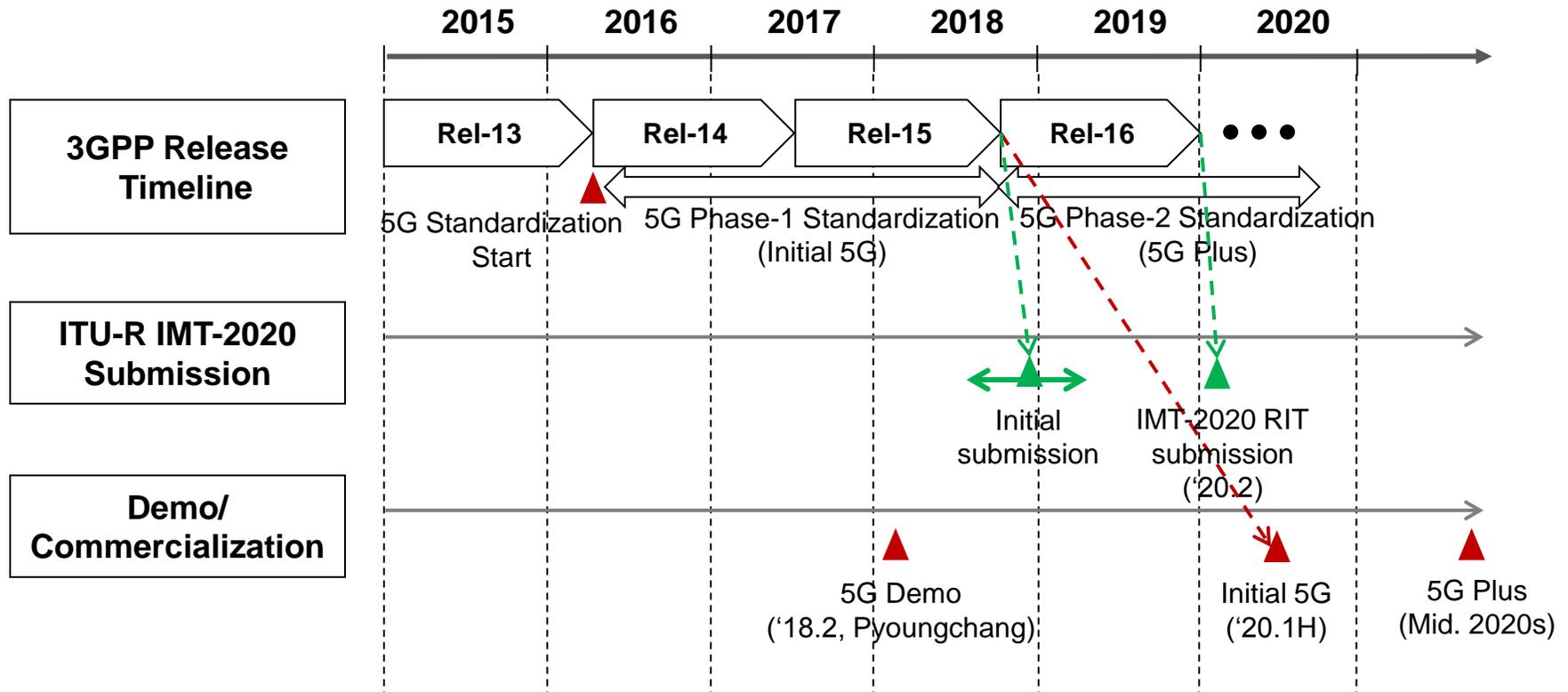
### 5G Standard Composition



**3GPP’s IMT-2020 RIT is composed of a set of RITs for e-LTE and new RAT.**

1) Evolved LTE/LTE-A RAT    2) Radio access technology

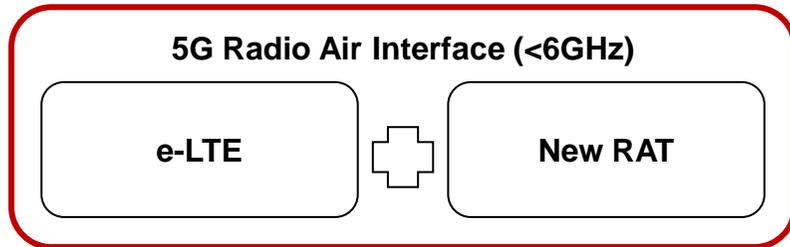
## 3GPP Standardization Timeline for 5G



- When considering the tight time budget of total 30 months for 5G Phase-1 standardization, a careful RAN work load management is essential.
- Therefore, technical items applied to initial 5G commercialization should be prioritized to complete a normative spec in time.

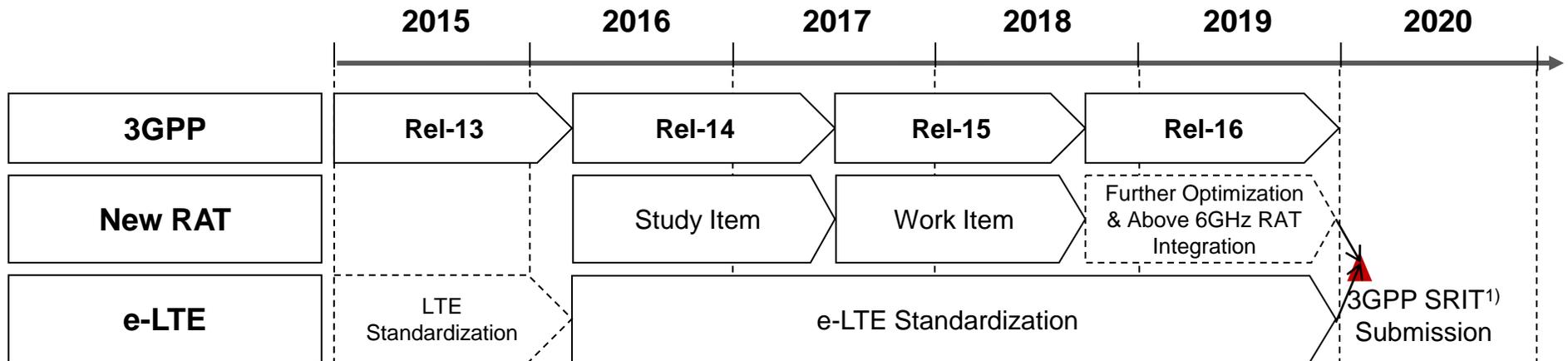
## Below 6GHz Radio Access Technology

### Baseline Approaches



- Tight integration of e-LTE and new RAT
- Main use case of new RAT: new spectrum, new service/application

### Standardization Plan

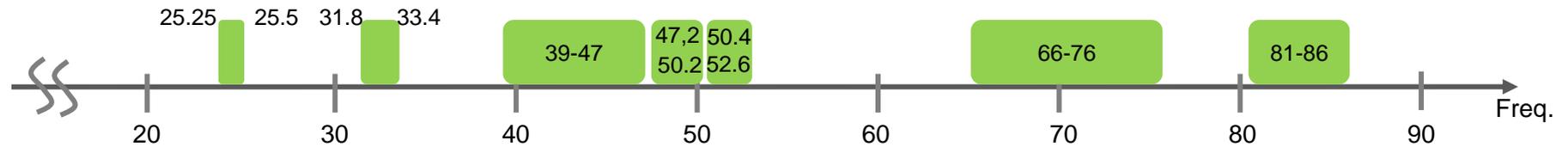


1) Set of RIT: New radio & LTE evolution

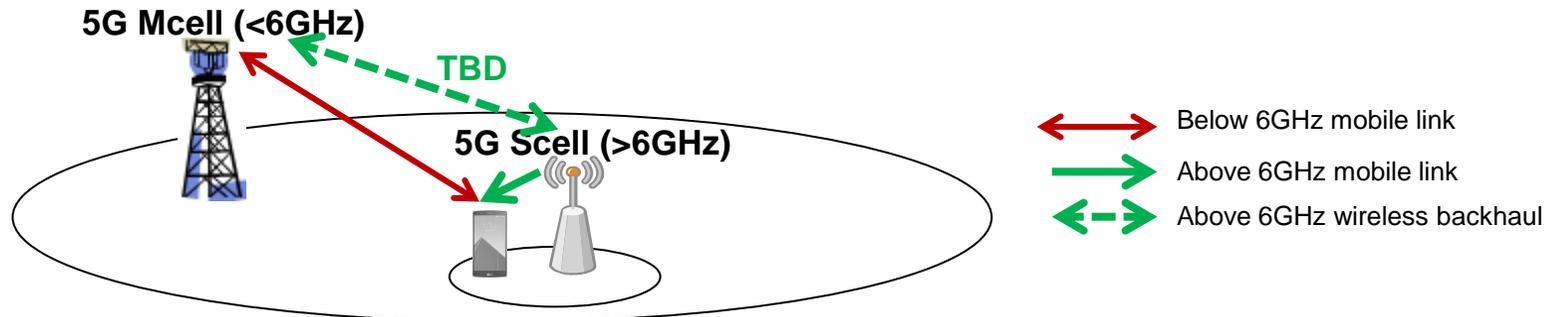
## Above 6GHz Radio Access Technology

### >6GHz IMT Band Candidates

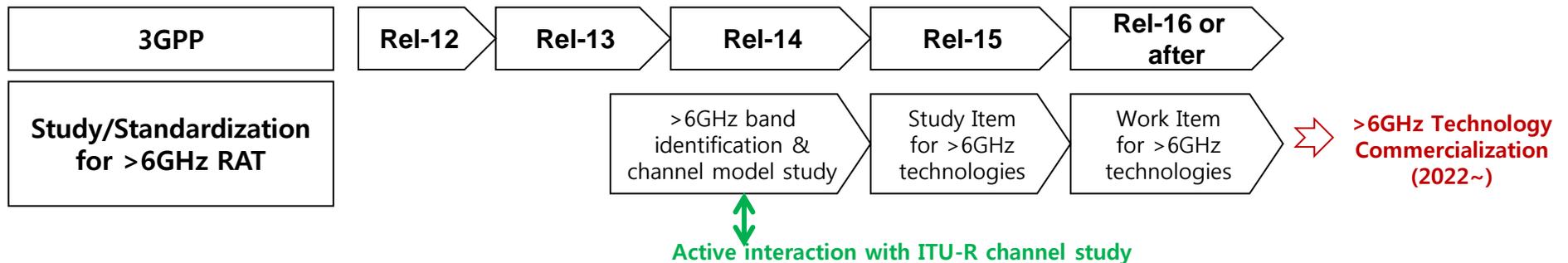
Ref) APG15-5/OUT-40, 31 July 2015



### Baseline Application Scenario

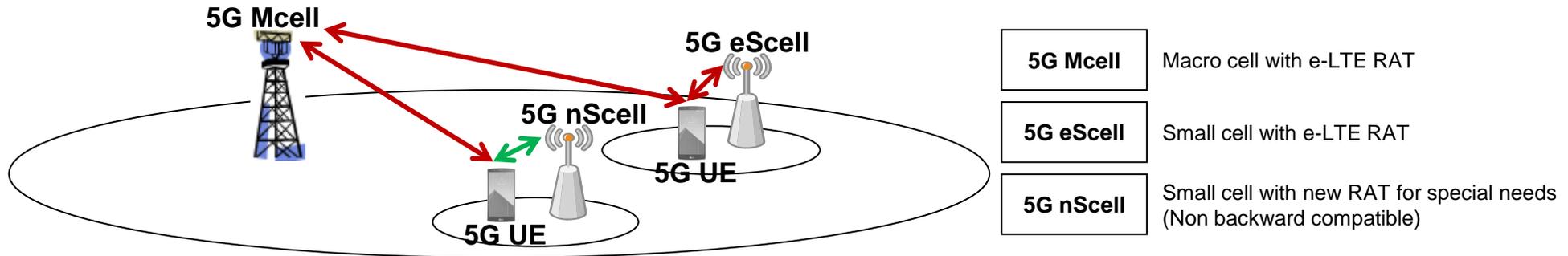


### Standardization Plan

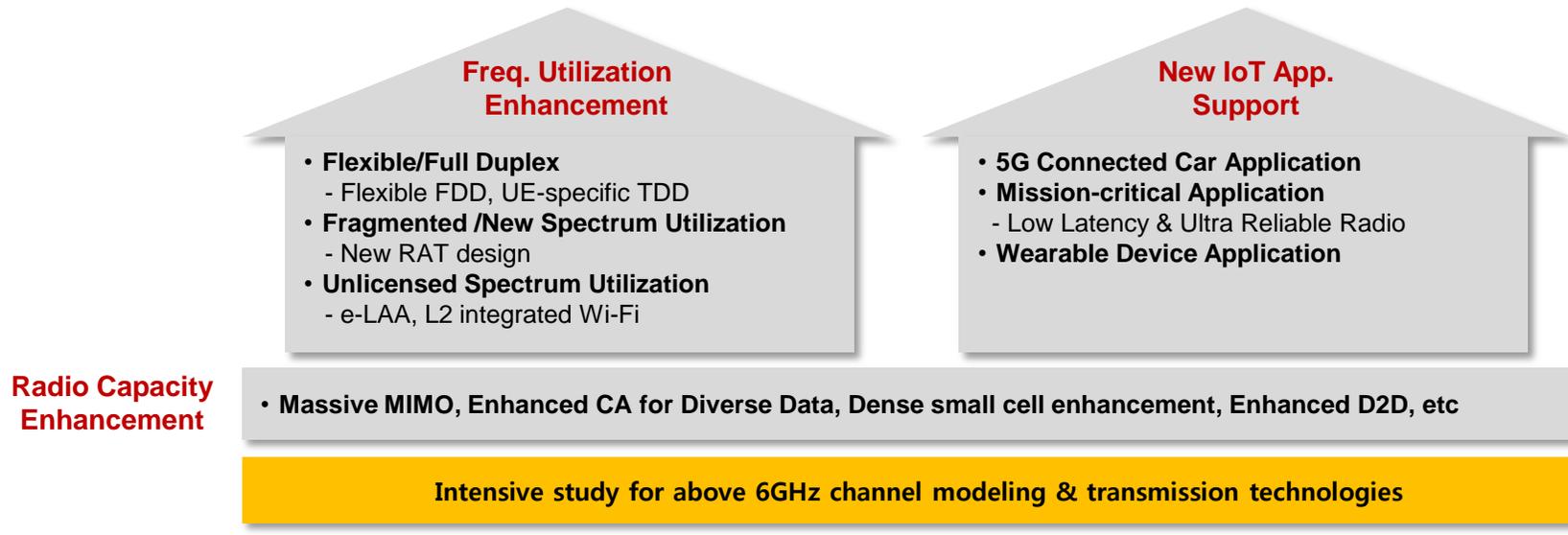


## Phase-1 (Rel-14/-15) Standardization Technologies

### 5G Reference Scenario



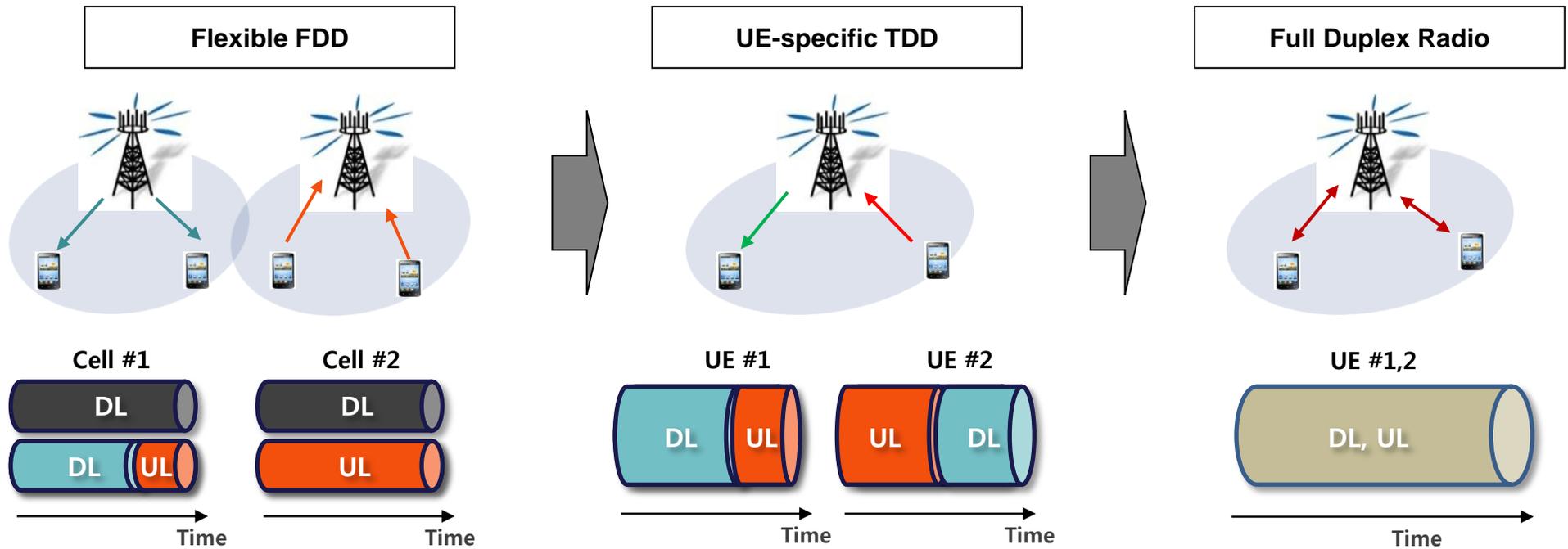
### Focus Radio Technologies



# Flexible/Full Duplex

## Motivation

- Service-specific & time-variant DL/UL data traffic asymmetry
  - ✓ Wide range of DL/UL traffic ratios ( $\approx 9:1$  [1]) due to online video streaming, web browsing, file downloading, etc.
- A demand of enhanced spectrum utilization efficiency
- Resolution of half-duplex restriction for unpaired spectrum utilization cases



[1] RP-140419, NTT DoCoMo et al.

## New RAT Design

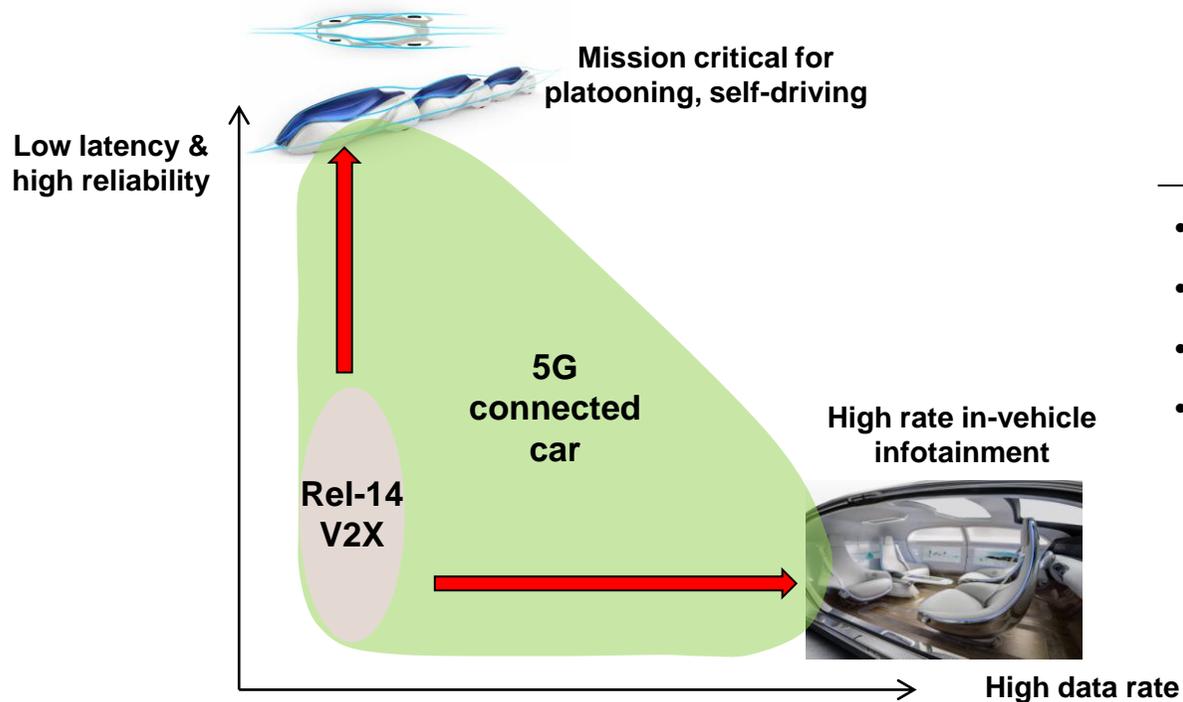
Categorization	New RAT Design in Below 6GHz	
	New Numerology Based RAT	New Filtered Multi-carrier Based RAT
Potential Motivation	Optimal processing and performance for wider system bandwidth	<ul style="list-style-type: none"> <li>• Low out-of-band emission</li> <li>• Robust asynchronous multi-user signal reception</li> </ul>
Main Target Spectrum	Above 3.4GHz new spectrum	Fragmented spectrum, Newly defined spectrum
Considering Waveform Type	OFDM waveform (with extended subcarrier spacing)	New filtered multi-carrier

A careful investigation for gain-complexity tradeoff in comparison with existing solutions is essentially required.  
 - e.g. legacy OFDM with sharpened RF filter, massive CA, etc.

# 5G Connected Car

## Motivation

- A car will be connected with other cars, hand-held devices, and infrastructure by Rel-14 LTE-based V2X.
- Enhancements should continue for 5G connected car.
- Vehicles have more rooms for advanced technology.
  - ✓ Less battery limitation, more processing power, more antennas, more predictability



## Enabling Technology Candidates

- Full-duplex radio for D2D
- Vehicle multi-antenna transmission
- Mobility-aware transmission
- Enhanced mobility management

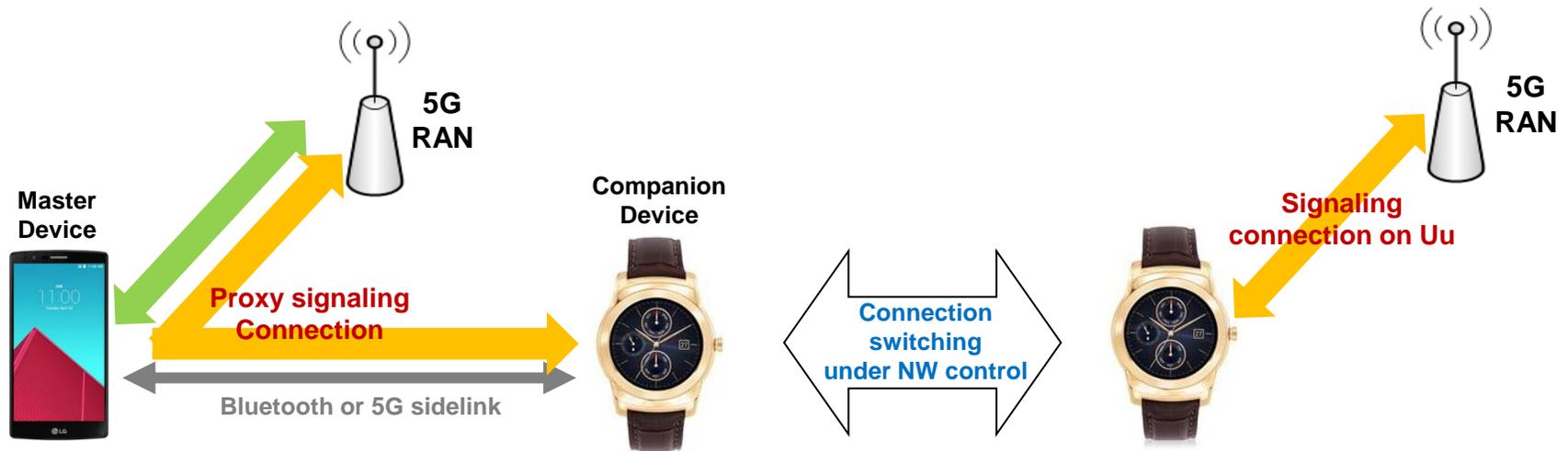
# Enhanced connectivity for companion devices

## Motivation

- Operators need to control QoS provided for companion devices (e.g. wearable devices) connected to master devices.
- Wearable devices need to improve battery lifetime while not losing support of delay sensitive services.

## Main Technical Issue & Target

- Proxy connection via master device for control signaling as well as user traffic of companion device
- Switching between proxy connection and Uu connection under operators' control
- Support of proxy connection based on the existing technologies (e.g. Bluetooth) and potential enhancement of sidelink for short range and low energy on licensed/unlicensed spectrum



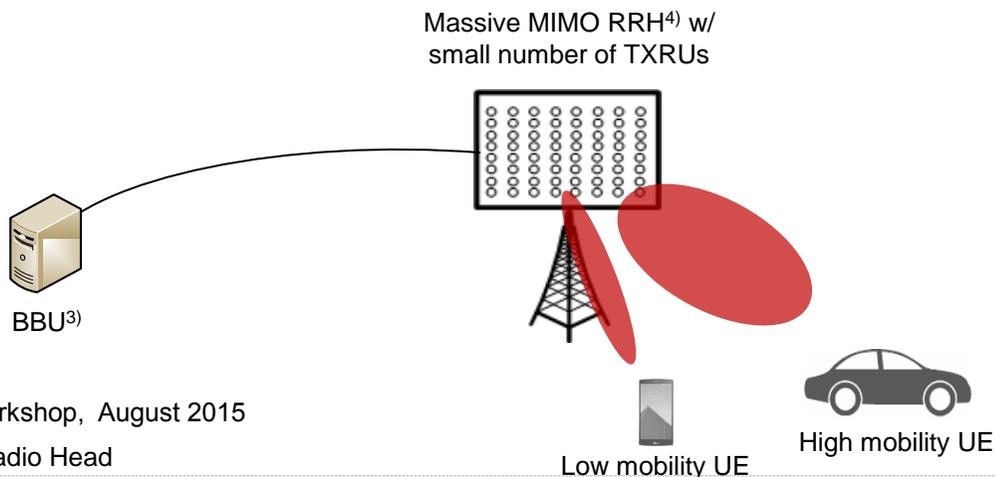
# Massive MIMO

## Motivation

- Key SE<sup>1)</sup> enhancement technology to achieve the 5G system capacity/ radio quality requirements

## Main Technical Issue & Target

- Limitation of maximum number of TXRUs<sup>2)</sup> due to front-haul capacity
  - ✓ Examples of required front-haul capacity [1]: 2.45Gbps (4TXRUs, 10MHz BW) vs. 196Gbps (32TXRUs, 100MHz BW)
- Beamforming to support various UE mobility
  - ✓ Narrow beamforming based operation may not be feasible for high/mid mobility users.
- Optimal MIMO transmission for the increased number of UE antennas
  - ✓ Large space for antennas (e.g. vehicles)
  - ✓ Higher frequency applications

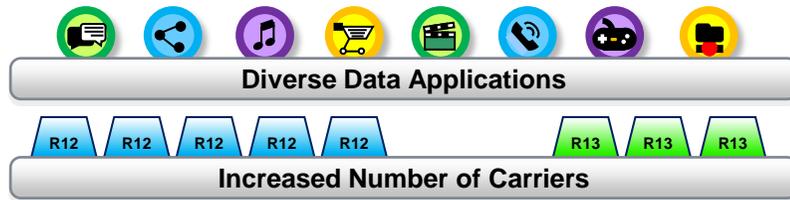


[1] SK Telecom, "Massive MIMO Technical Trend and Standardization", IEEK Workshop, August 2015

1) Spectral Efficiency 2) Transmit Radio Units 3) Baseband Unit 4) Remote Radio Head

# Enhanced CA for Diverse Data Applications

## Motivation

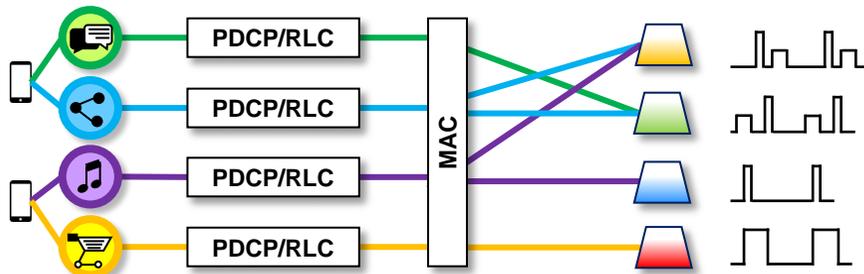


To serve diverse applications with different QoS on multiple cells with different characteristics, it is essential to support cell (group) specific operation in CA

### Functional limitation to support cell specific operation in CA

- All aggregated cells are assumed to have same or similar characteristics.
- UL grant differentiation based on e.g., cell quality or cell load, is not supported.
- Common DRX, common implicit deactivation, no support of SPS on SCell.

## Main Technical Issue & Target



- |                   |  |
|-------------------|--|
| <b>LCP</b>        | Per Cell (group) bearer mapping, UL grants differentiation                 |
| <b>DRX</b>        | Per Cell (group) DRX operation, Multiple DRX patterns                      |
| <b>Act/Deact.</b> | Per Cell (group) implicit deactivation, SCell activation at SCell addition |
| <b>SPS</b>        | Per Cell (group) SPS operation, Multiple SPS patterns                      |

LCP : Logical Channel Prioritization  
 DRX: Discontinuous Reception  
 SPS: Semi-Persistent Scheduling

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**Thank You!**