4G & 5G Mobile Technology

5G Wave Technology

5G Wave Technology

	< 6GHz						> 6GHz		
	< 1 GHz	1 GHz	2 GHz	3 GHz	4 GHz	6-24 GHz	24-30 GHz	30 GHz	40 GHz
SPRINT			B41(2.6G)						
CTC			B41(2.6G)	B42(3.5G) 3.3-3.4	4.4-4.5 4.8-4.99				
AT&T								37.6-40 37-37.6	
DOCOMO				3.3-4.2	4.4-4.99		26.5-29.5 (24.25-29.5)		
KT	B8(900M)	B3(1.8G)	B1(2.1G) B40(2.3G)	3.4-3.7			26.5-29.5 24.25-27.5 (24.25-29.5)	31.8-33.4 37-40.5	
CMCC ERICSSON				B42(3.5G) SI on 3.3-4.99					
ORANGE	B20(800M) B28(700M)	B3(1.8G)	B1(2.1G) B7(2.6G)	B42(3.5G) B43(3.7G)		5.925-8.5	24.25-27.5	31.8-33.4	
DISH						12.2-12.7			
HUAWEI				3.3-(3.8-4.2)	4.4-4.99		24.25-27.5 26.5-29.5	37-40	40.5-43.5
ZTE				3.4-3.6			24.25-27.5 27.5-29.5		
SAMSUNG	[Ref] Discussion on defining "NR Band" in 3GPP RAN4			3.4-3.7			26.5-29.5 24.25-27.5	37.6-40 37-37.6	

5G Wave Technology

❖ mmWave System

- Huge bandwidth is available in the mmWave band (above 6 GHz) compared to the current LTE band
- mmWave Example
  - 2.2 Gbps data rate can be supported in the 28 GHz band using multi-cell and 500 MHz bandwidth transmission technology
- Supporting technologies
  - 28 GHz Polarization Interleaved Array
  - 60 GHz 360° Coverage, 16 Chain CMOS RFIC

5G Wave Technology

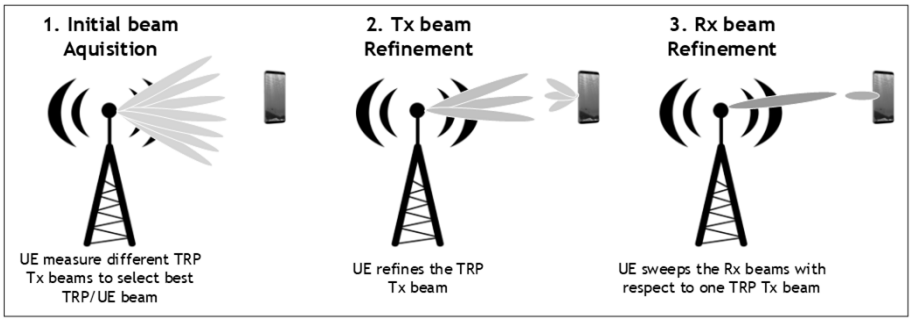
❖ mmWave System

- mmWave beamforming
  - Multiple beams need to provide coverage to the entire cell area
  - Beam management procedures to acquire and maintain best beam for each TRP/UE pair are applied

5G Wave Technology

❖ mmWave System

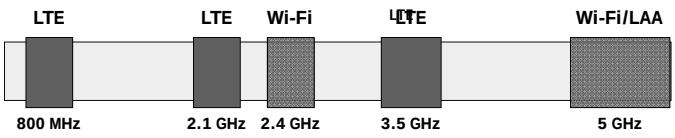
- mmWave beamforming
  - NR supports L1/L2 beam management procedures



5G Wave Technology

❖ Multi-RAT Internetworking

- UE/Network based Multi-RAT (Multi-Radio Access Technology) Coordination Technology
- Throughput and connection reliability enhancement using Unlicensed & Licensed spectrum coordination



LTE LAA (Licensed Assisted Access)

5G Wave Technology

❖ Multi-RAT Internetworking

- Interworking and integrating the 5G system with other RATs (e.g., 3G, 4G, Wi-Fi, Bluetooth, etc.)
- Multi-path transmission technology enables a device to use multiple transmission protocols (Cellular, WLAN, Bluetooth, etc.) simultaneously

5G Wave Technology

❖ Multi-RAT Internetworking

- Multi-path transmission enhances connection reliability and data transmission rates
- MPTCP (Multi-Path TCP) enables a device to configure several TCP sessions simultaneously by utilizing multiple network connections and addresses

5G Wave Technology

❖ Advanced MIMO

- Advantage of Diversity Mode
  - Time Diversity
    - Using different timeslots and channel coding
  - Frequency Diversity
    - Using different channels & modulation technologies
      - Spread spectrum, OFDM, OFDMA, MIMO, etc.
  - Space Diversity
    - MIMO uses antennas located in different positions
    - Uncorrelated radio paths are simultaneously used
    - Multiple antenna spacing & positioning is important

5G Wave Technology

❖ Multiple Access

- OMA (Orthogonal Multiple Access)
  - Each time/frequency resource block is exclusively assigned to one user (e.g., OFDMA)
- NOMA (Non-Orthogonal Multiple Access)
  - Allows multiple users to share the same time/frequency resource
  - Enhance the system capacity and accommodate massive connectivity

OFDMA: Orthogonal Frequency-Division Multiple Access

5G Wave Technology

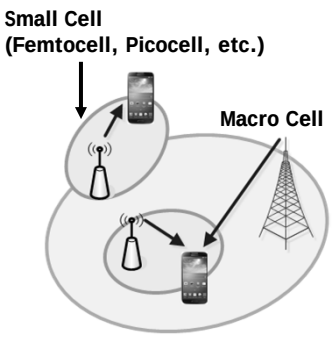
❖ Advanced D2D (Device to Device)

- Offloading data from the mobile network such that the load and cost of processing data and signaling is reduced
- MCPTT: Mission Critical PTT (Push-To-Talk)
- V2X (Vehicle-to-Anything) communication
  - IEEE 802.11p + IEEE1609.x Cooperative Computation
  - Efficient exchange of emergency signals between vehicles and RSUs (Road Side Units)

5G Wave Technology

❖ Advanced Small Cell

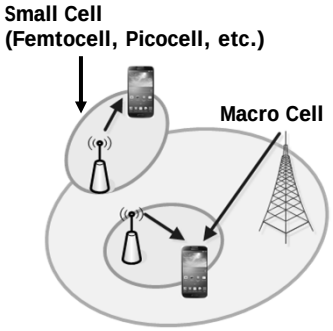
- Large number of small cells in a given area can provide significant throughput enhancements
- 5G system utilizes vast bandwidth in the mmWave band
  - High propagation loss of the mmWave makes it suitable for dense small cell deployment



5G Wave Technology

❖ Advanced Small Cell

- Distributed and self-configured network technology
  - Easy to deploy small cells



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