

A network diagram consisting of a cluster of interconnected nodes and lines, resembling a molecular structure or a network topology, located in the upper left corner of the slide.

The Future Connected World

The Samsung logo, which consists of the word "SAMSUNG" in white capital letters inside a blue oval.

SAMSUNG

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Intro to Samsung R&D in the UK

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- Samsung Electronics has made the UK its base for European 5G research & Short Range Connectivity silicon development

SRUK

- Established in 1991 in the UK
- ~200 staff
- Based in Staines-on-Thames, branch in Netherlands
- Samsung Hub for European 5G research
- Founding member of the 5GIC

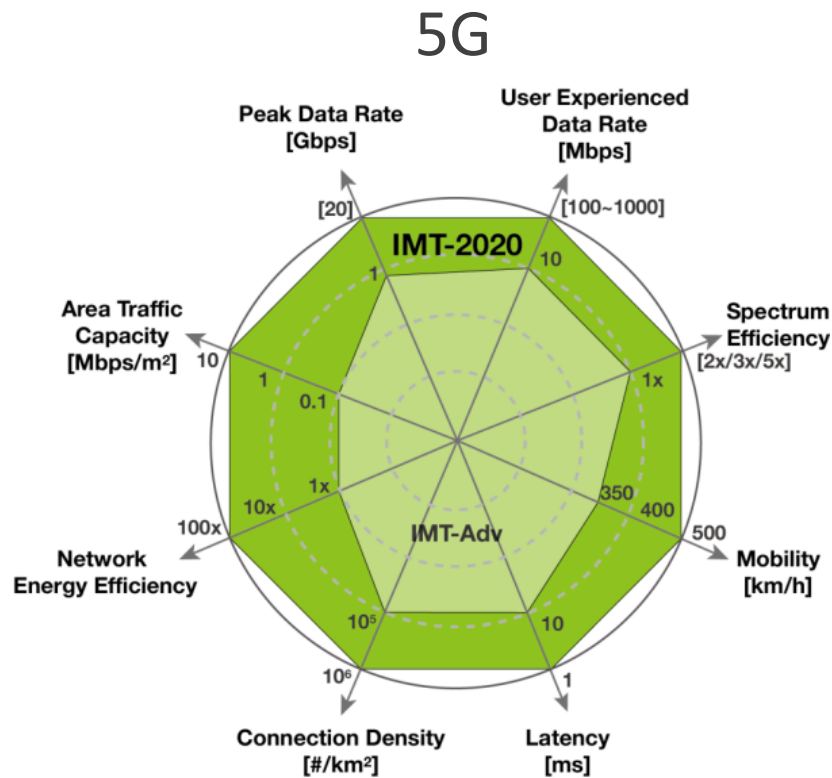


SCSC

- Established in 2012
- Formed from acquisition of CSR team
- ~180 staff
- Based in Cambridge, branch in Aalborg
- Hub for devt of BT and Wi-Fi silicon IP and SW
- Active in BT SIG, WFA, IEEE

Comparing 5G & 11ax Technical Requirements

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802.11ax

- <6GHz Frequency
- Low mobility (<=pedestrian)
- AVG Throughput Increase: 5-10x
- Increased spectral efficiency in dense STA environments
- Increased spectral re-use in overlapping networks
- Increased robustness in outdoor propagation environments

802.11b	802.11g	802.11n	802.11ac	802.11ad	802.11ax	802.11ay
11Mbps	54Mbps	600Mbps	6.9Gbps	7Gbps	8.4Gbps	20Gbps

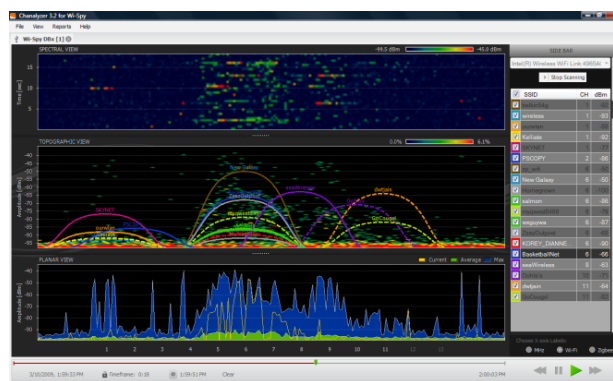
ITU-R WP5D, TEMP/548-E

Specific Challenges of Wi-Fi compared to Cellular

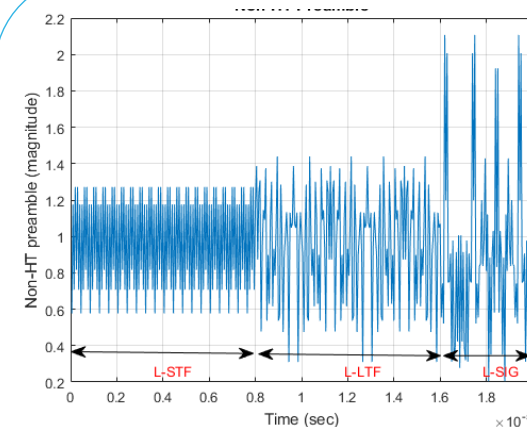
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Noisy Unlicensed Spectrum



Multiple Overlapping Networks

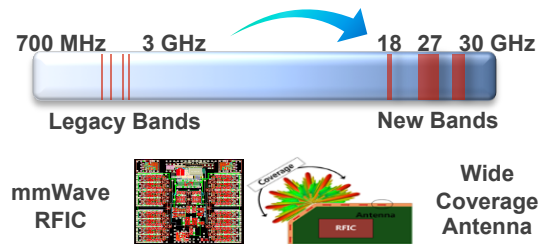


Multi-node Sync/AGC DSP

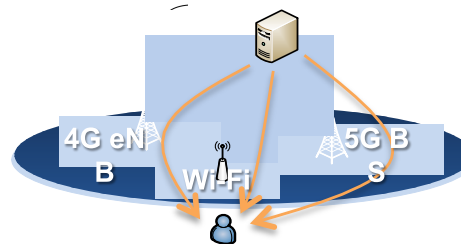
Key Enabling Technologies

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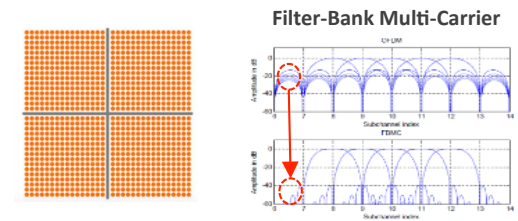
> 6 GHz System/RFIC/Ant.



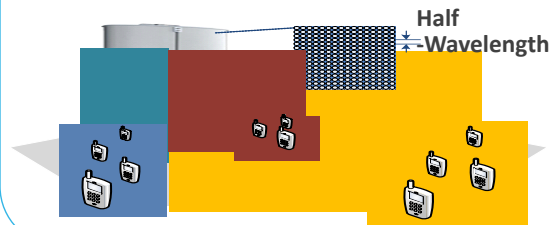
Multi-RAT Interworking



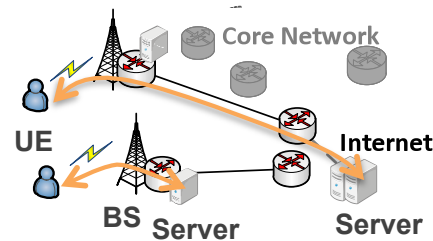
Complex Waveform Design



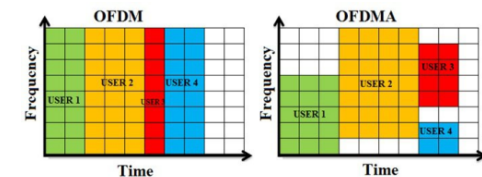
< 6 GHz Advanced MIMO



Enhanced Flat NW



Efficient Multi-User



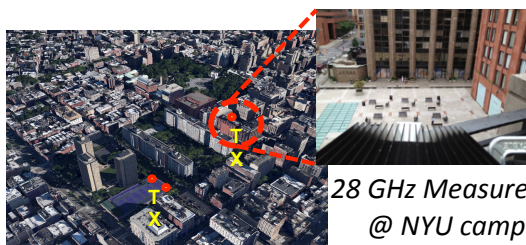
Recent R&D Results - Above 6 GHz Channel Modeling

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■ Ray-tracing Calibration based on Real Measurements in NYU Campus

■ After calibration, total 60610 Tx-Rx paired locations are used for channel modeling

Urban Micro Environment, New York

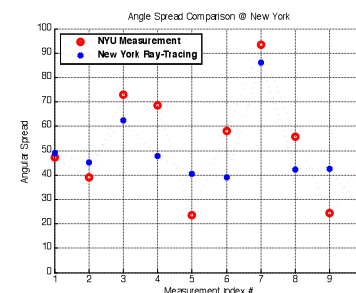


28 GHz Measurement
@ NYU campus

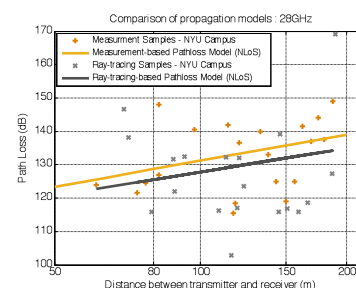
Ray-tracing Simulation @ New York City



Calibration on Ray-tracing



- Angle Spread Verification
- Good match between measurement and ray-tracing simulation



- Pathloss Model Verification
- Good match in average sense

Recent R&D Results - Above 6 GHz Channel Modeling

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Global Collaboration with Leading Universities/Research Centers

NYU [~15.1Q]

- Freq. : 28 (+ 38 GHz)
- Scenario : ① Dense Urban (NY)
② Sub-Urban (Austin)
- Method : ① Sounder (Horn)
- Model : ① Large Scale
② Small Scale

Samsung [~15.4Q]

- Freq. : 28 GHz
- Scenario : ① Dense Urban (Ottawa, Chicago, etc)
- Method : ① Ray-Tracing
- Model : ① Large Scale
② Small Scale

USC [~16.2Q]

- Freq. : 28 GHz
- Scenario : ① Dense Urban (Los Angeles, CA)
② Sub-urban
③ Campus
- Method : ① Sounder (Array)
- Model : ① Large Scale
② Small Scale

CATR/BUPT [~15.1Q]

- Freq. : 28 GHz
- Scenario : ① Indoor
② Urban
- Method : ① Sounder (Horn)
- Model : ① Large Scale
② Small Scale

Standards and Projects



KAIST [~15.3Q]

- Freq. : 28 GHz
- Scenario : ① In-building
② Campus
③ Urban
- Method : ① Sounder (Horn)
- Model : ① Large Scale
② Small Scale

Recent R&D Results - mmWave Testbed

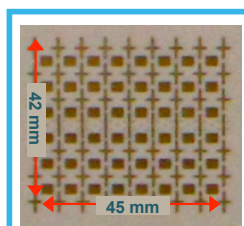
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World's mmWave Testbed and High Speed Mobility Test

1.2 Gbps (2013) → 7.5 Gbps (2014)

1.2 Gbps at 110 km/h (2014)

Base Station

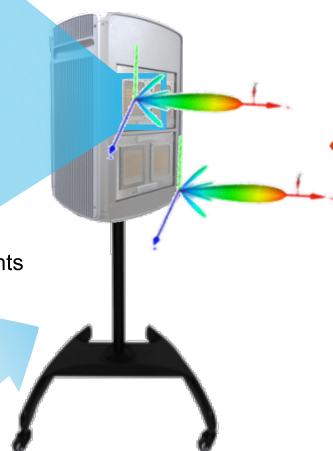


Array Antenna

8x6 (=48) Antenna Elements

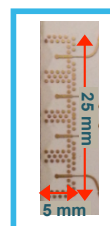


RF + Array Antenna



RF + Array Antenna

Mobile Station



Array Antenna

4x1 (=4) Antenna Elements



RF + Array Antenna



Baseband Modem

Mobility Test

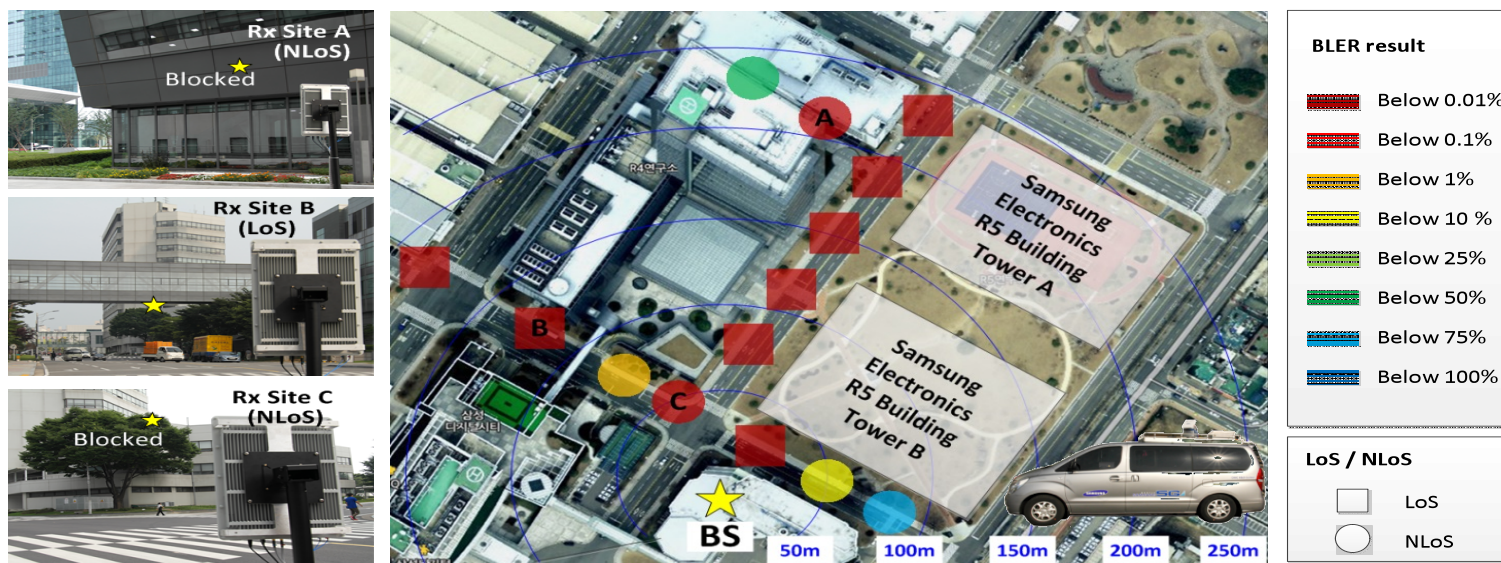


Recent R&D Results - mmWave Testbed)

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Outdoor Non Line-of-Sight (NLoS) Coverage Tests

Block error rate less than 0.01% up to NLoS 200m distance



Wonil Roh, et al., "Millimeter-Wave Beamforming as an Enabling Technology for 5G Cellular Communications: Theoretical Feasibility and Prototype Results," IEEE Communications Magazine, Feb. 2014.