Parallel WIRELESS

FUTURE 5G DENSE URBAN DEPLOYMENTS

5G DENSIFICATION CHALLENGES IN LEGACY NETWORKS

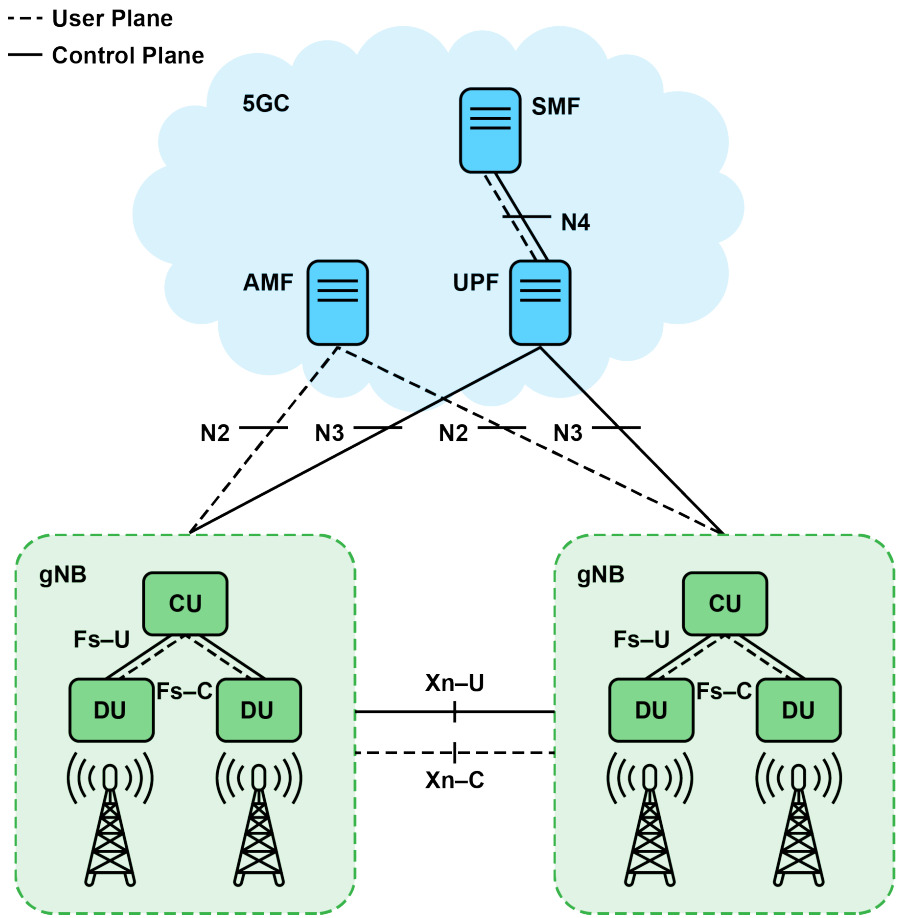
Monolithic and hierarchical architecture is not densification friendly

- The legacy mobile networks were focused on single-tier deployment
- Mainly macro layers with occasional co-channel underlays
- 5G pushes the limit for smaller cell deployment to the extreme
  - Combination of co-channel and different channel overlay/underlay in massive numbers
  - Increase in channel and bandwidth sizes creates a multi-tier network deployments, enhancing densification options

5G DISTRIBUTED ARCHITECTURE

Basic Architecture

- 3GPP considered the split concept (DU and CU) for NR from the beginning
  - Simplify multi-tier densification
- Single CU and multiple DUs at different frequency bands



5G ANSWERS TO Ddensification CHALLENGES

A New Architectural Approach

- Inherent split gNB
  - Already a distributed RAN architecture makes densification easier by centralizing (CU) control between different radios (DUs)
- Centralized control and multiple coordinated Tx/RX approach
- Wider and more distributed bands
  - Limit co-channel deployments without loosing efficiency

NEXT 20 YEARS CAPACITY GROWTH

Balances Shift

- Air interface technology enhancements
  - Higher level modulations, advanced coding schemes, MIMO and all spatial and temporal multiplexing schemes almost reached their limits
- New spectrum allocation
  - Not much available at low and mid bands → utilizing m-MIMO techniques to utilize them more
  - mmWave needs new network deployment paradigm
- New network deployment methodologies
  - All the focus will be here for capacity increase in the near future

LAST 20 YEARS MOBILE NETWORK JOURNEY

Increasing System Capacity and User Throughput

- Air interface
  - Advanced modulations and coding schemes → from GMSK (2G) to 256 QAM (LTE-A)
  - Spatial multiplexing → MIMO and (e)CoMP
- Spectrum
  - From 25 MHz at 900 MHz band to more than 400 MHz at 40 different bands
- Network deployment techniques
  - Aggressive frequency reuse and cell splitting
  - Offloading

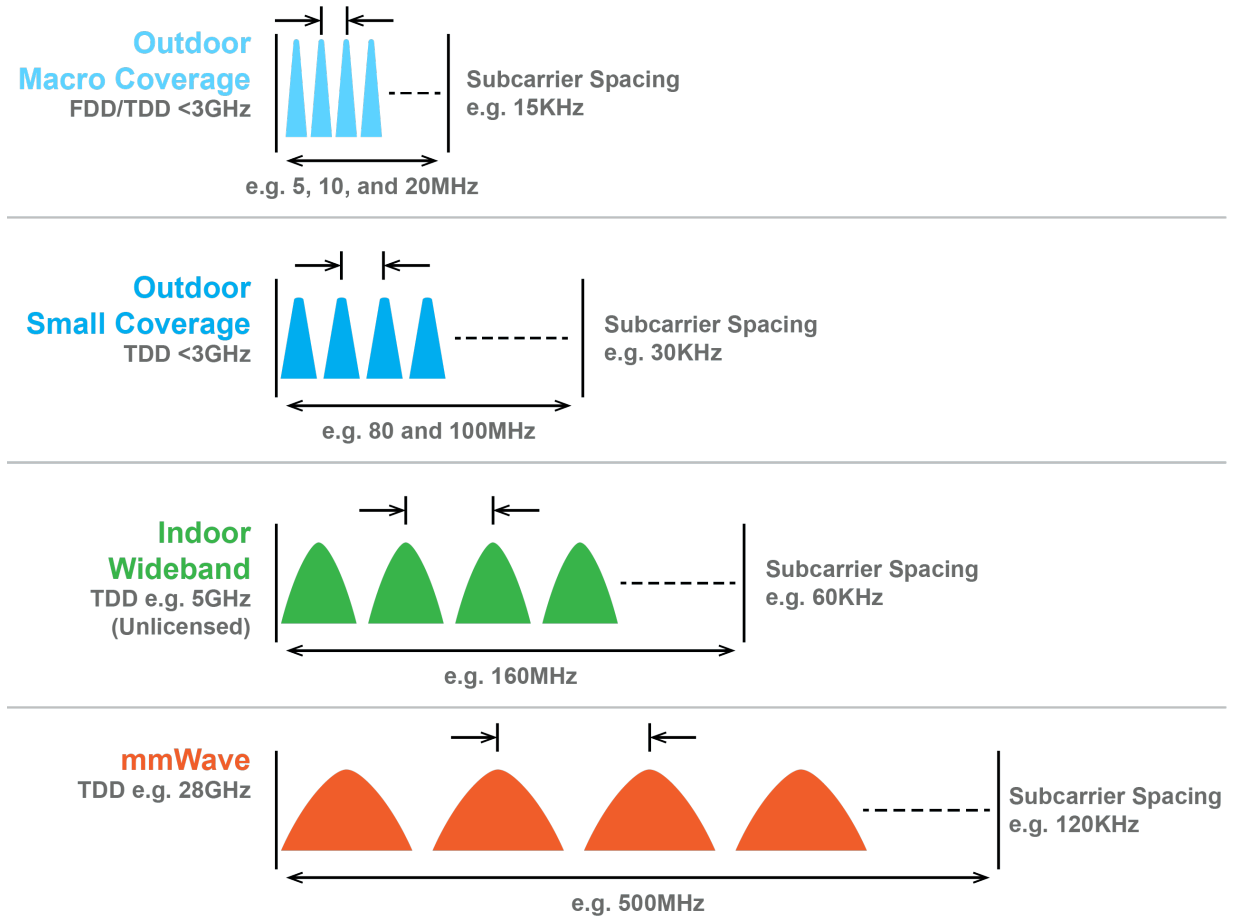
DENSIFICATION CHALLENGES

Simple in Theory, More Difficult Practically

- Densification concept for mobile network → main pillar of cellular technology
  - There is a practical limit to it
- Cost and ROI challenges
  - Legacy network solutions were not suitable for aggressive densification
- Maintaining QoS with legacy solutions for legacy services was not possible
  - Maintain acceptable call drop rate with 100 meter cell radius!

HETEROGENEOUS NETWORK DEPLOYMENT

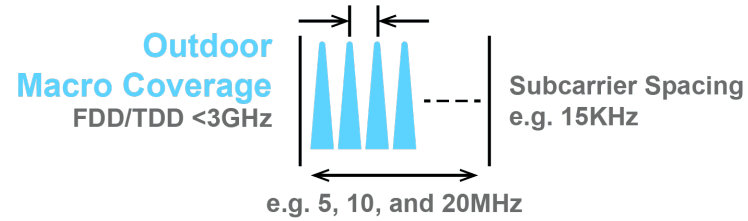
5G will rely heavily on "HetNet" deployment for densification



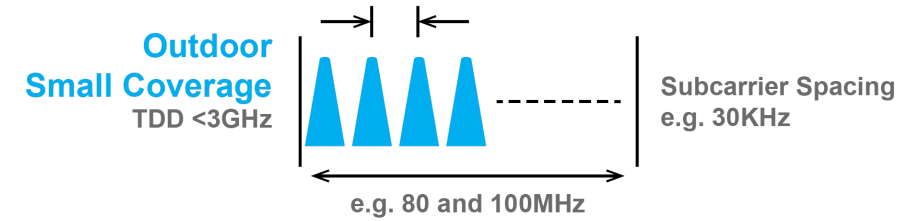
HETEROGENEOUS NETWORK DEPLOYMENT

5G will rely heavily on "HetNet" deployment for densification

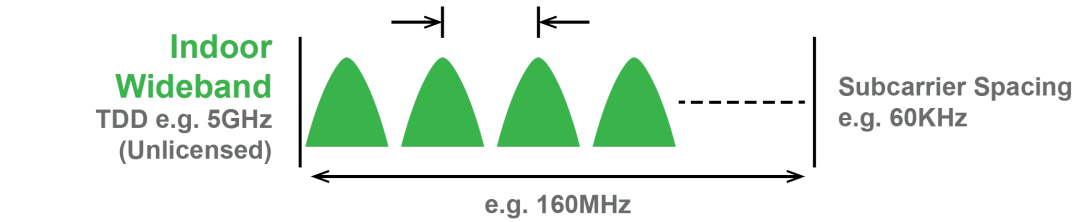
Overlay coverage
(All morphologies)



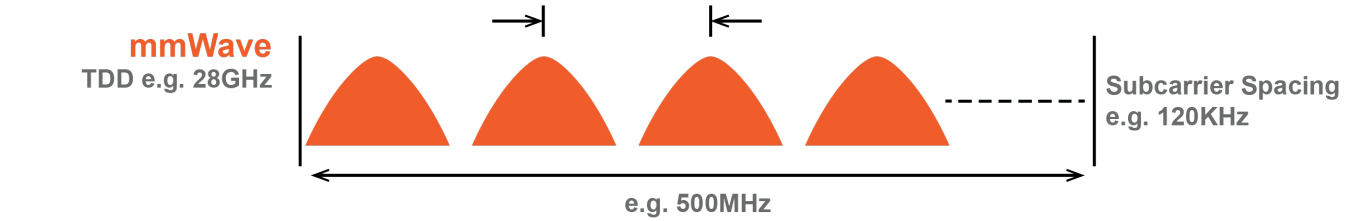
Underlay coverage
(Urban and dense Urban)



Indoor Coverage



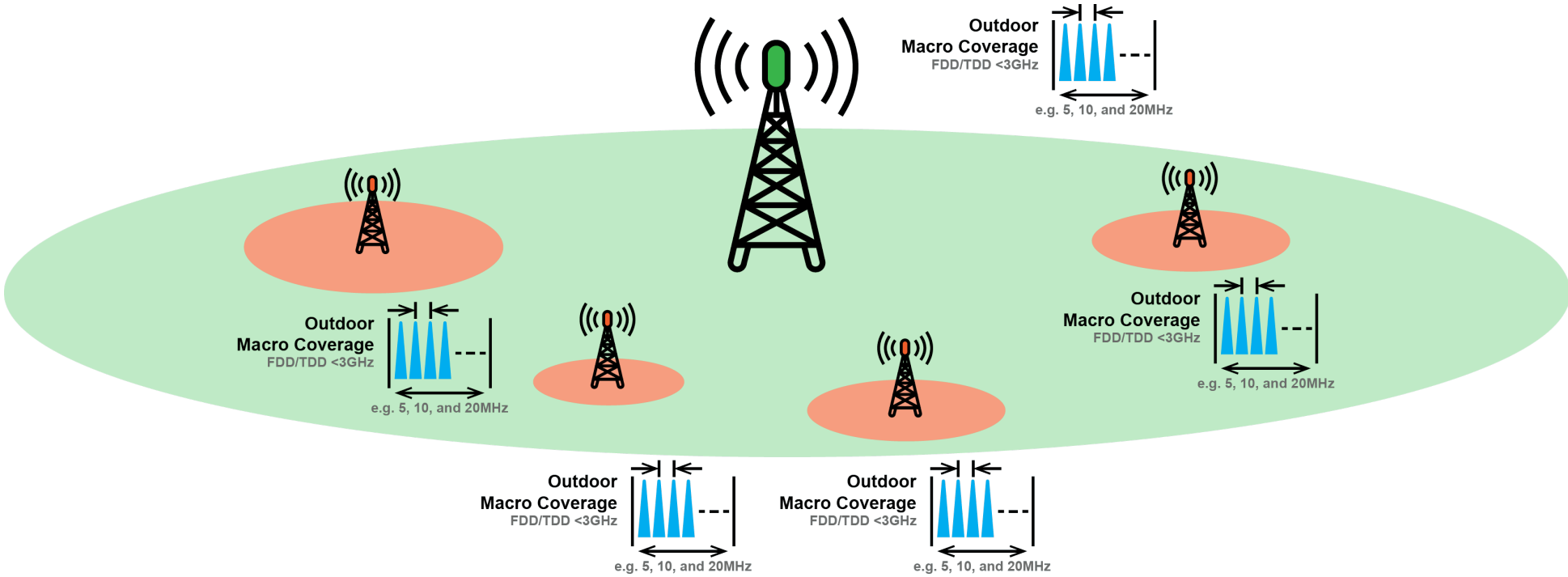
Underlay coverage
(Super dense urban/Indoor)



SPATIAL DENSIFICATION

Heterogeneous Networks Utilizing Same Frequency Band

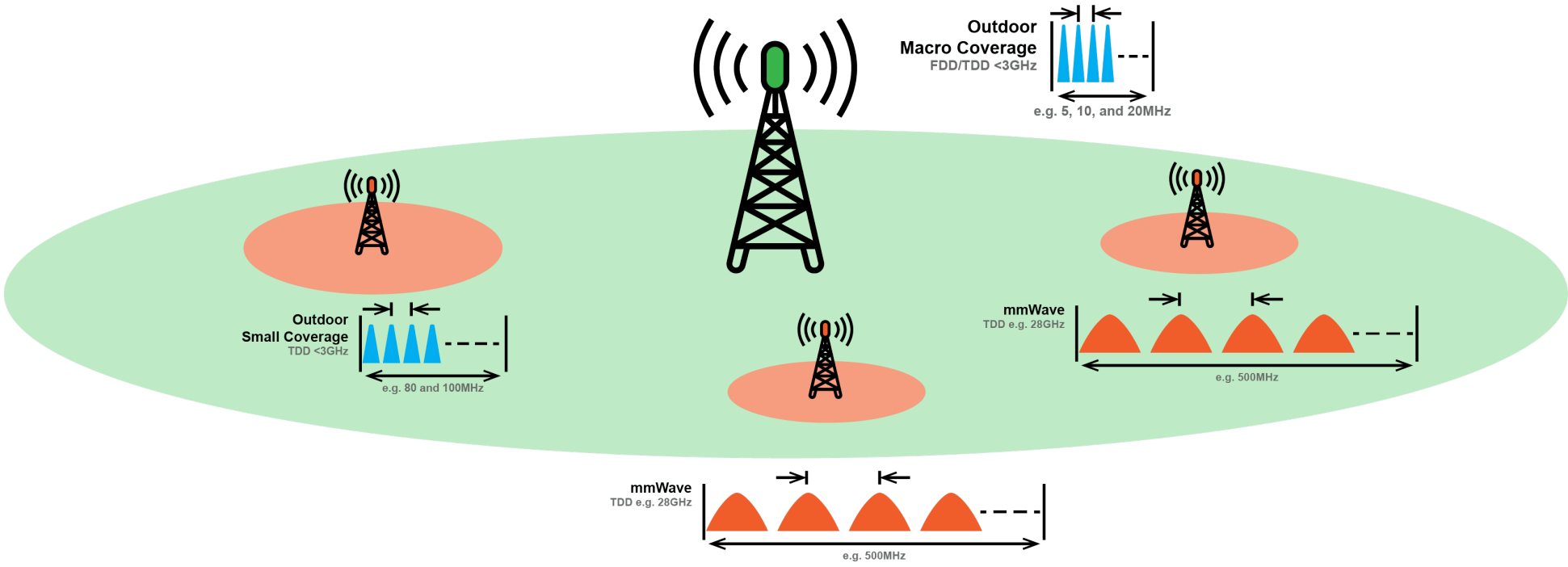
- High power macro base stations as umbrella cell for providing “coverage ”
- Low power cells for providing capacity utilizing same frequency band



VERTICAL DENSIFICATION

Heterogeneous Networks Utilizing Different Frequency Band

- High power macro base stations as umbrella cell for providing “coverage ”
- Low power cells for providing capacity in different bands



5G MAKES Ddensification MORE PRACTICAL

5G architecture can scale for aggressive densification

- Densification concept for mobile network → main pillar of cellular technology
  - There is a practical limit to it

→

- Distributes gNB (CU/DU) provides more central coordination

- Cost and ROI challenges
  - Legacy network solutions were not suitable for aggressive densification

→

- 5G DU/RRUs can reduce the cost dramatically compare to legacy network deployments

- Maintaining QoS with legacy solutions for legacy services was not possible
  - Maintain acceptable call drop rate with 100 meter cell radius!

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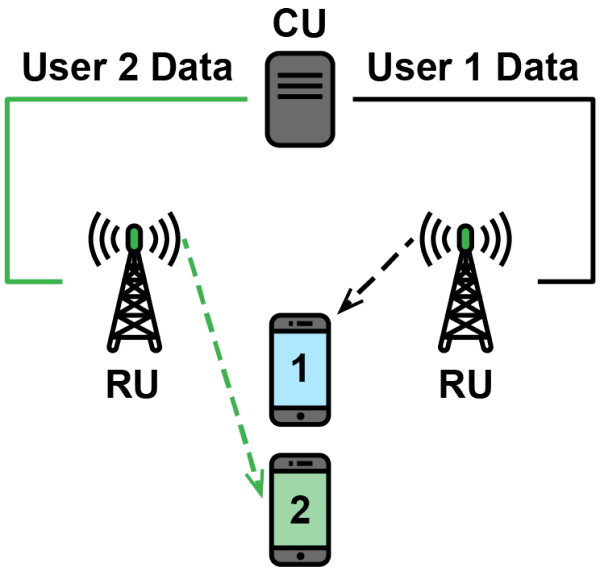
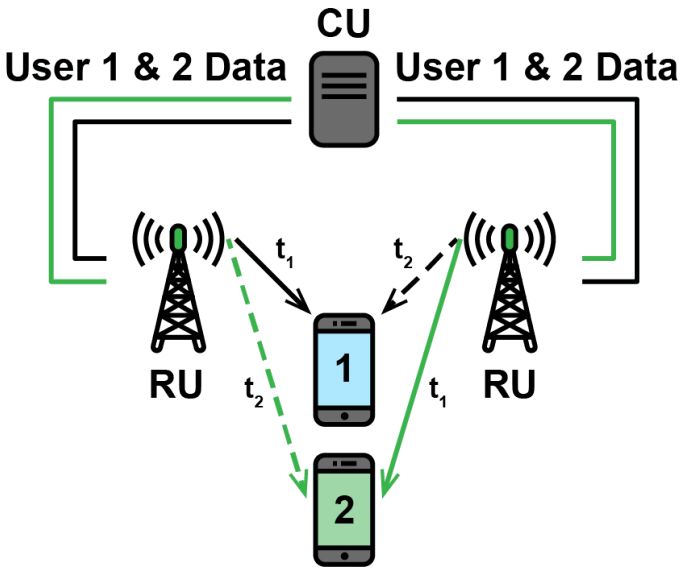
- Multi-band/multi-tier deployment in conjunction with overlay/underlay will guarantee QoS for different services

5G COMP (COOPERATIVE MIMO)

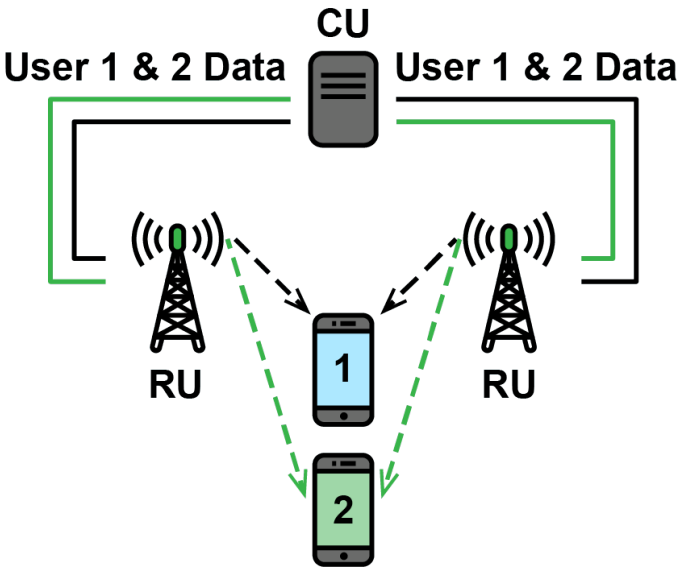
CoMP different flavors



Coordinated Scheduling/Beamforming



Dynamic Point Selection

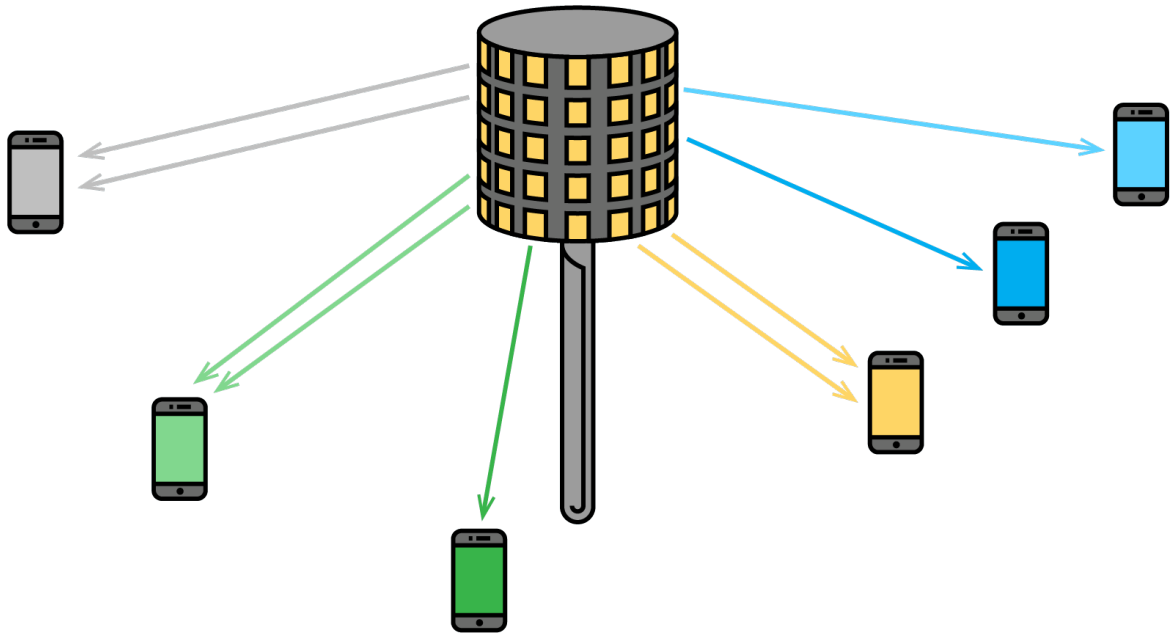


Joint Transmission (JT)

MASSIVE MIMO

Utilizing Low/Mid Spectrum Even More

- Base station antennas with hundreds of elements
  - An order of magnitude extra antennas compare to legacy systems
- Special multiplexing across the coverage area
- Large number of UEs utilize same time/frequency resources through special multiplexing



5G RAN DENSIFICATION

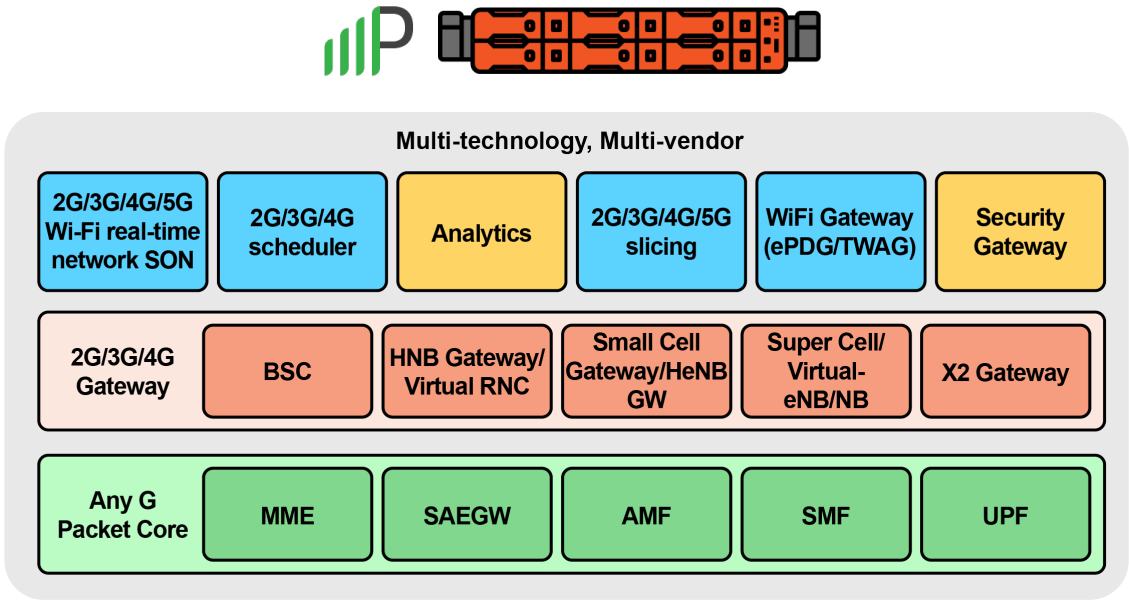
Number of e/gNBs Will Grow Dramatically

- Increase in number of RAN nodes are in different scale compare to previous generations
- Legacy approach to “own RAN” needs to change
  - Not practical deploying hundreds of e/gNBs per square miles
- Neutral hosts can be a viable solutions
  - Third party companies; e.g. tower companies, real estate owners, can fill the gap

PARALLEL WIRELESS APPROACH

OpenRAN Gateway

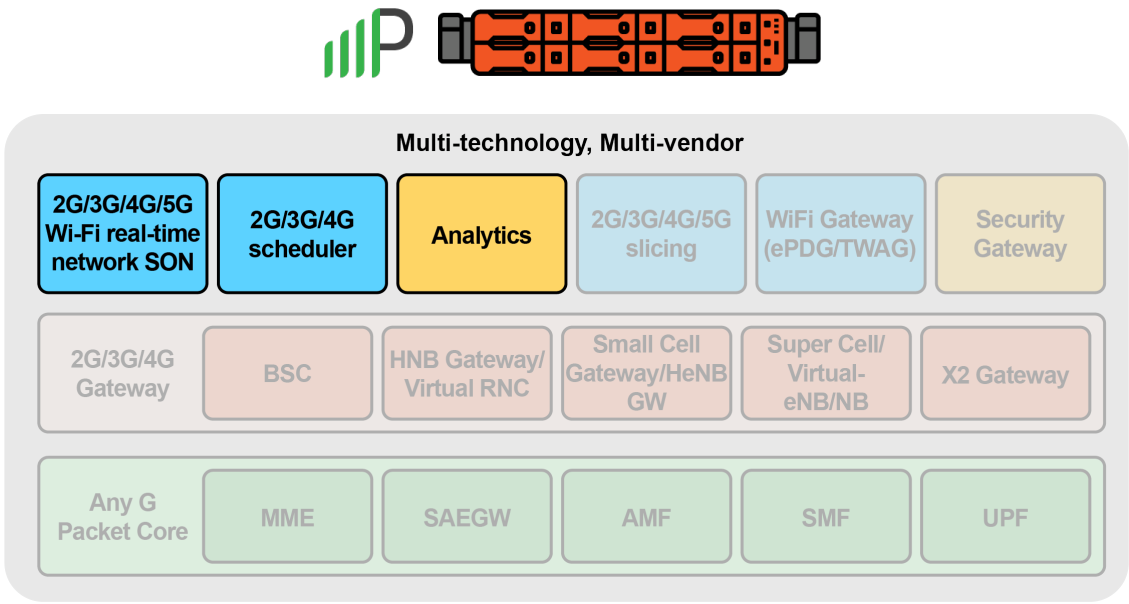
- Fully virtualized, standard compliant and cloud native ready
- 3GPP standard-compliant solution across different generations
- Scalable solution
- Co-located of all different functions at the same HNG instance
- Analytics, SON and Orchestration



PARALLEL WIRELESS APPROACH TOWARD Ddensification

OpenRAN Gateway

- Parallel Wireless OpenRAN Controller is positioned perfectly to address 5G densification challenges
- Utilizing our Analytics tool, it can coordinate the network accordingly and reducing interference
- Balancing the traffic across technologies and RAN



Reimagine Your Network. Reimagine Your Economics.