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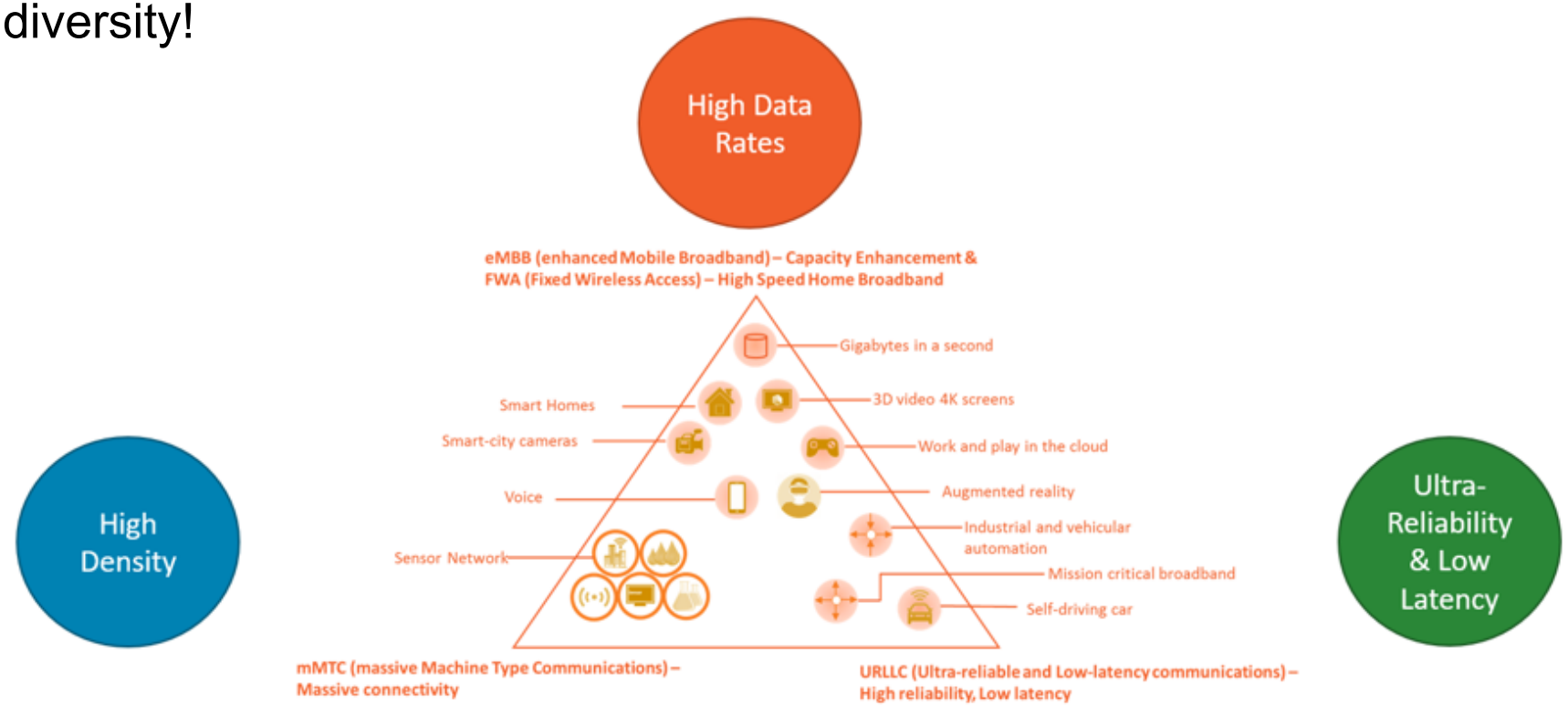
TACKLING NETWORK DENSIFICATION CHALLENGES FOR 5G

5G NR USE CASES

Unlike previous generation it must support a wide variety of use cases

- Too much diversity!



Release 15 just focused on eMBB with forward compatibility in mind to support other uses cases in the future

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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 ANSWERS TO DENSIFICATION CHALLENGES

A new architectural approach

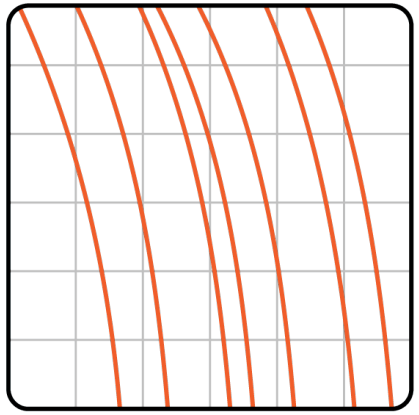
- Inherent split gNB
  - Already a distributed RAN architecture makes densification easier by centralizing (CU) control between different radios (DUs)
- Centralized control and multiple coordinated Tx/RX approach
- Wider and more distributed bands
  - Limit co-channel deployments without loosing efficiency

5G NETWORK CAPACITY GROWTH

The main pillars for wireless capacity increase

More Spectrum

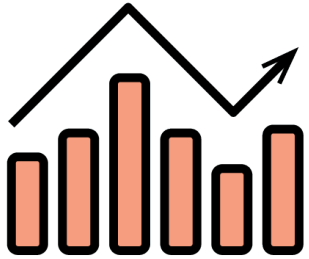
x



Higher Spectral Efficiency

x

=



Substantially More Capacity

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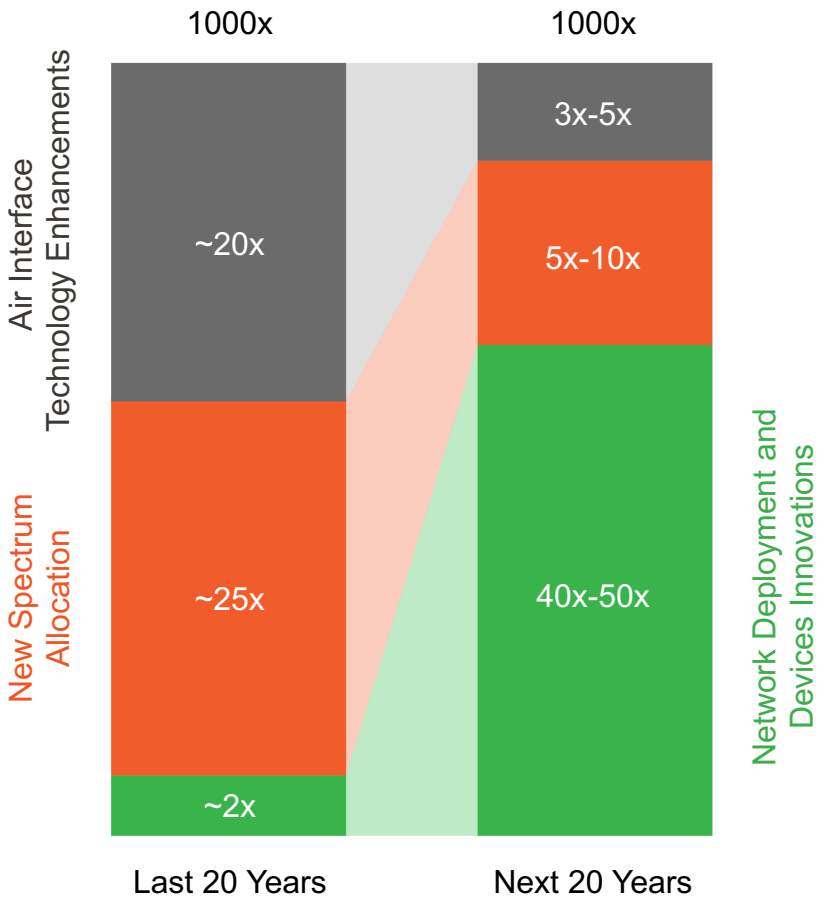
THE TRENDS OF NETWORK CAPACITY GROWTH

Air Interface Technologies and available Spectrums are reaching their limits



Reference: IEEE Vehicular Technology Magazine March 2014

- Coordinated Multipoint Tx/Rx
- Massive MIMO
- New Modulation and Coding Schemes

- Extended Licensed/Unlicensed Spectrum, mmWave
- Licensed/Unlicensed Share Access

- Cell Densification
- Integrated MultiRAT Operation
- WLAN Offloading
- Device-to-Device

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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
  - 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

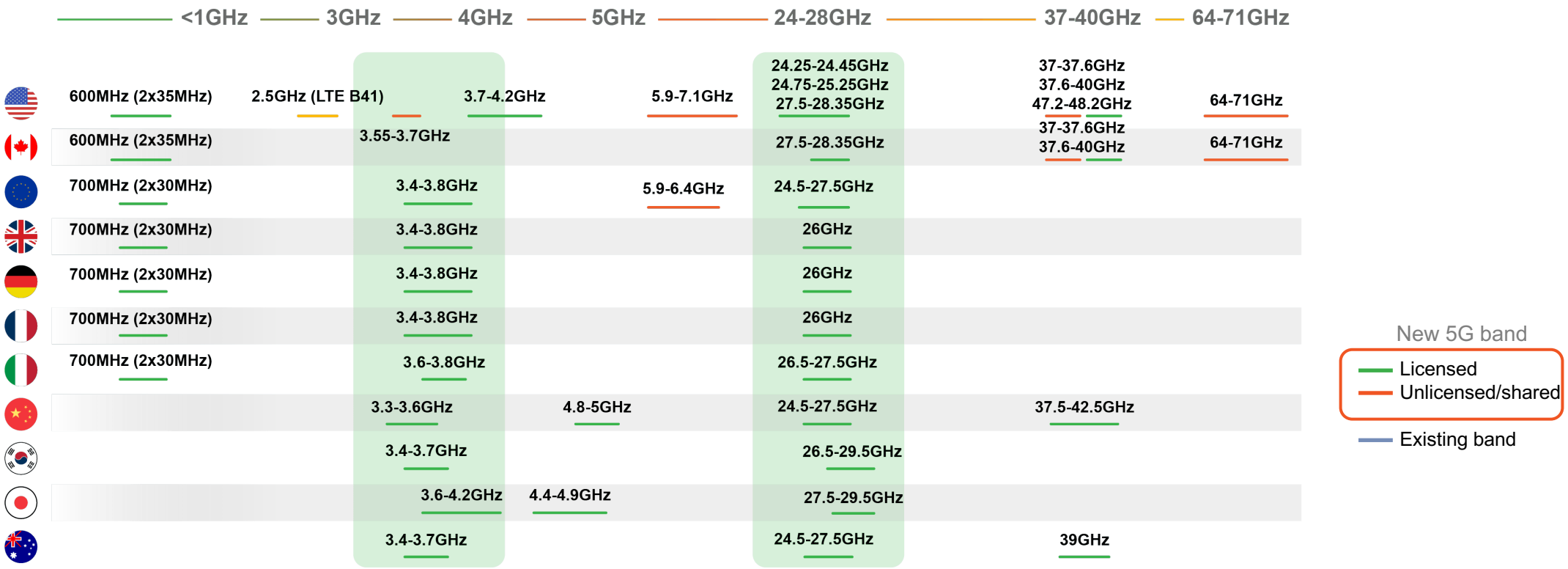
Increasing system capacity and user throughput

- 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

THE NEXT 1000-FOLD CAPACITY INCREASE (SPECTRUM)

Old tricks do not work anymore

- Governments have already done their best to allocate as much spectrum as they can
  - Mid-band (3.5 GHz – 4.2 GHz) is crucial for 5G deployment



Reference: everything RF website

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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!

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
- 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!

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

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

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

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DENSIFICATION AND MOBILITY

Smaller cells means more mobility related signaling and handoffs

- Smaller cells increase number of HOs and related signaling
  - Horizontal intra frequency HOs due to mobility
  - Vertical inter frequency HOs due to mobility

- Explosive growth of small cells and HetNet deployments require new approaches to mobility management

AGGRESSIVE DENSIFICATION FOR 5G

There is going to be a limit for "real estate" and infrastructure

- There is a limit for available physical location, backhaul/fronthaul and power in prime locations
  - Can not have 100 RRU per operator per square miles!
- Traffic fluctuations impacting smaller cells more than macros
  - Smaller cells utilization can be minimum in certain time

5G RAN DENSIFICATION

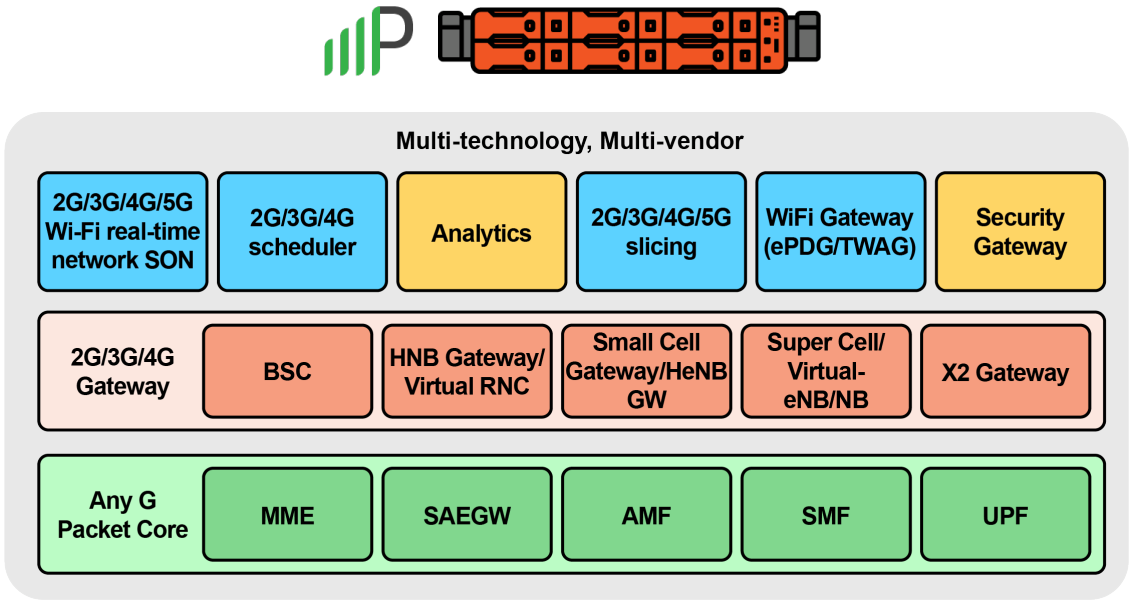
Number of e/gNBs will growth dramatically

- 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 Gateaway

- 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



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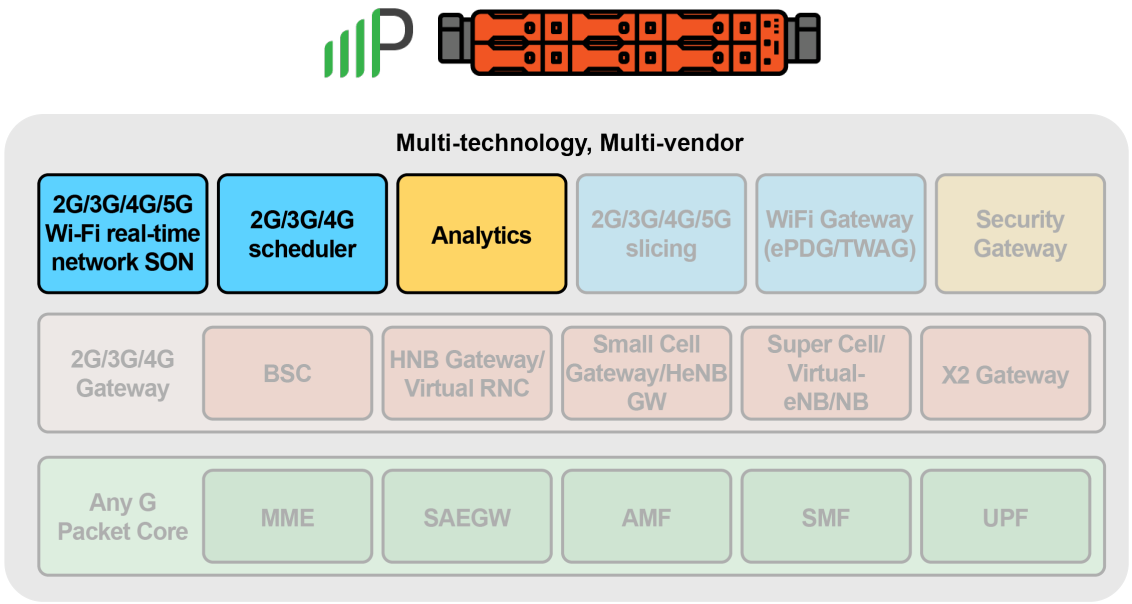
PARALLEL WIRELESS APPROACH TOWARD Ddensification

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



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