ERICSSON

ERICSSON CLOUD RAN

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Jan 2017

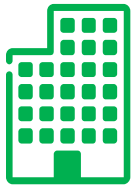
AGENDA

1. RAN evolution to Cloud RAN
2. Ericsson Cloud RAN Components
3. 5G & Cloud RAN

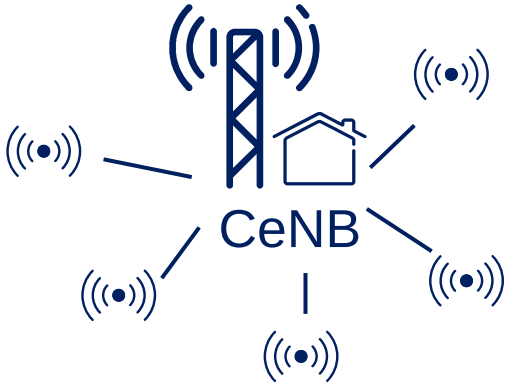
RAN DRIVERS

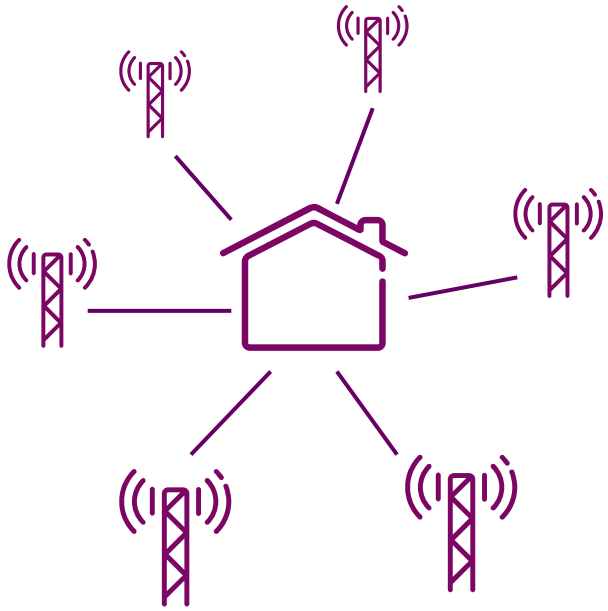
- LTE – agreed technology
  - Flat architecture
  - IP Based
  - Distributed topology
  - Coordination via X2
- Growing Traffic Demand
  - More applications and services
  - Networks become increasingly heterogeneous
  - Multiple standards, bands and layers
- Increased coordination
- 5G requirements
- Distributed RAN + other topologies

HOW TO CATCH A CLOUD



Baseband Hotel



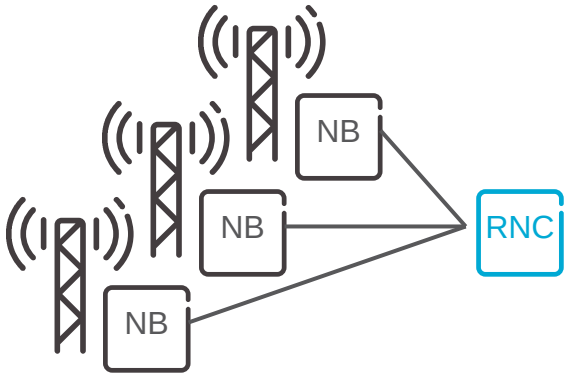


Centralized RAN

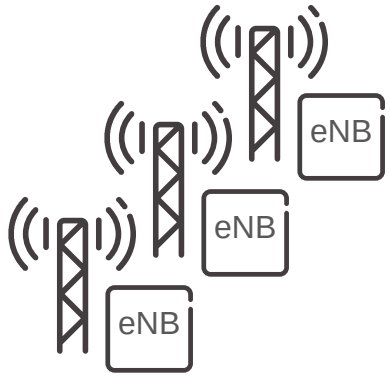
Virtualization

GPP

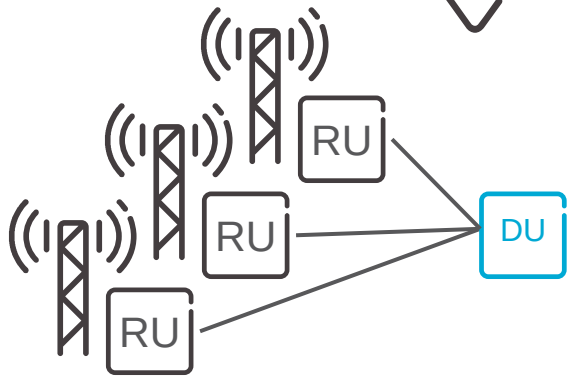
DÉJÀ VU?



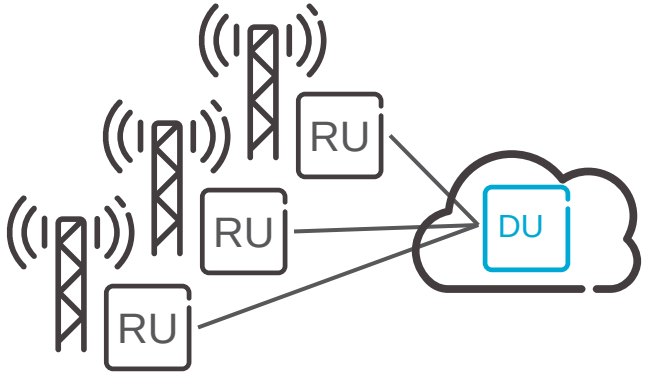
Distributed and Flat



Centralization



Cloud



ERICSSON CLOUD RAN

Distributed RAN

Improved interworking between sites and layers

Centralized RAN

Colocation of resources and maximum performance in traffic hotspots

Elastic RAN

Optimal coordination across the network for D-RAN and C-RAN

Virtualized RAN

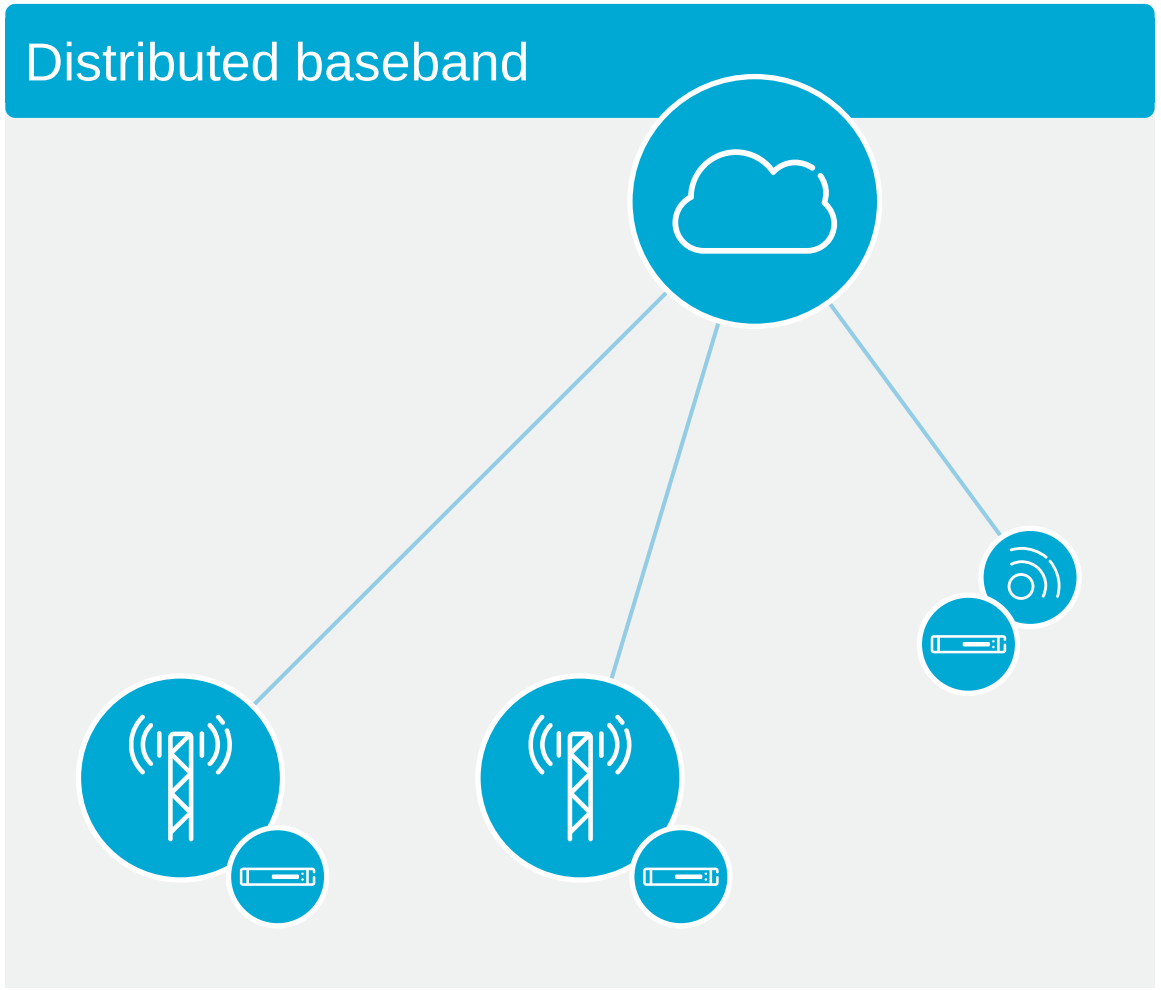
Introducing split architecture for full flexibility on the road to 5G

Coordination

Maximized spectrum efficiency and end-user experience

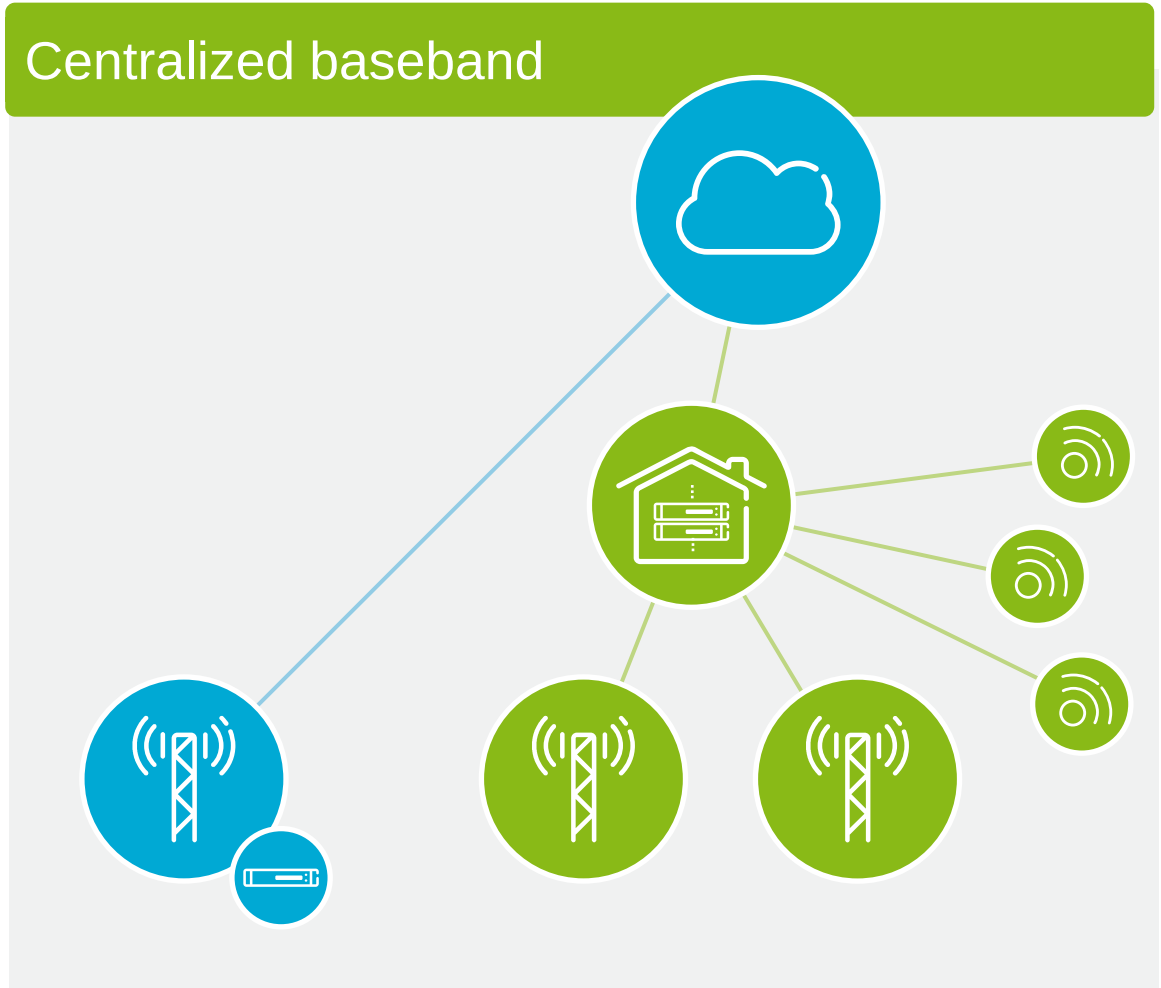
DRIVERS FOR DE-CENTRALIZATION

- Fewer node types
- Simple flat architecture
- Fully integrated solution
- Relaxed backhaul



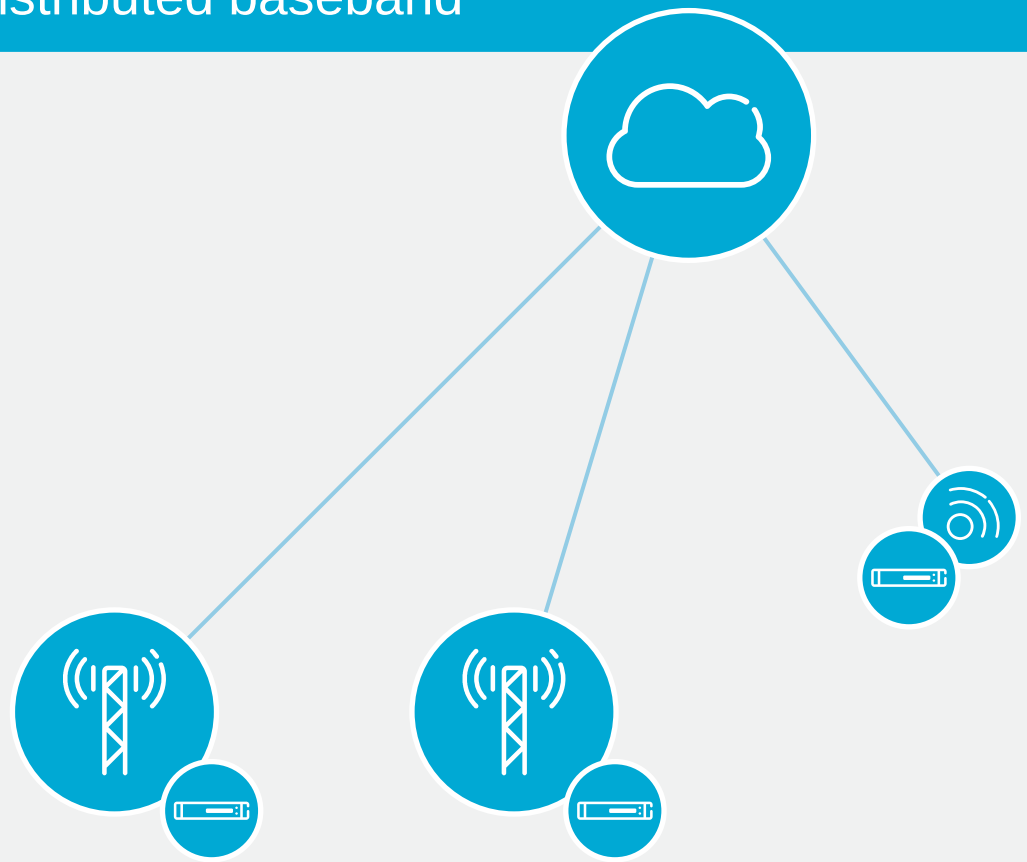
DRIVERS FOR CENTRALIZATION

- Fewer site visits
- Hardware pooling
- Network performance
  - Improved carrier aggregation
  - L1 CoMP
  - Improved mobility

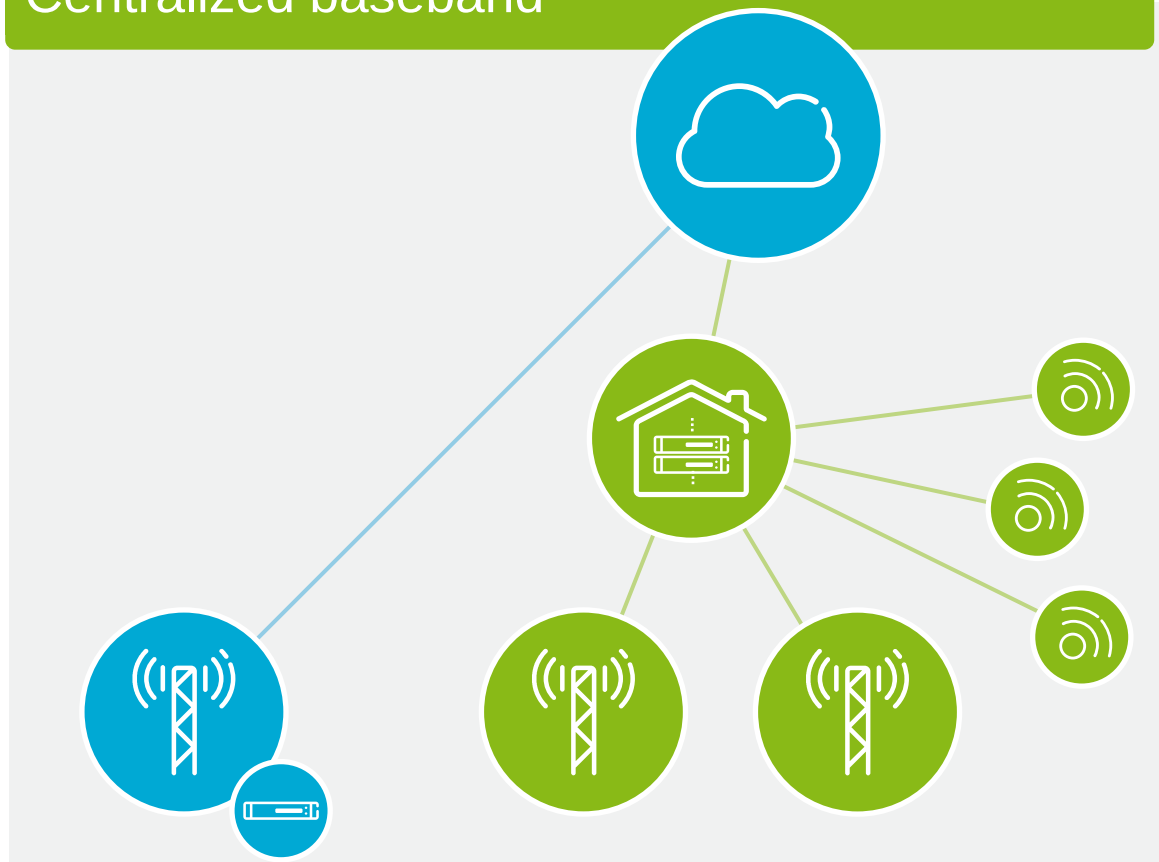


TOPOLOGIES TODAY

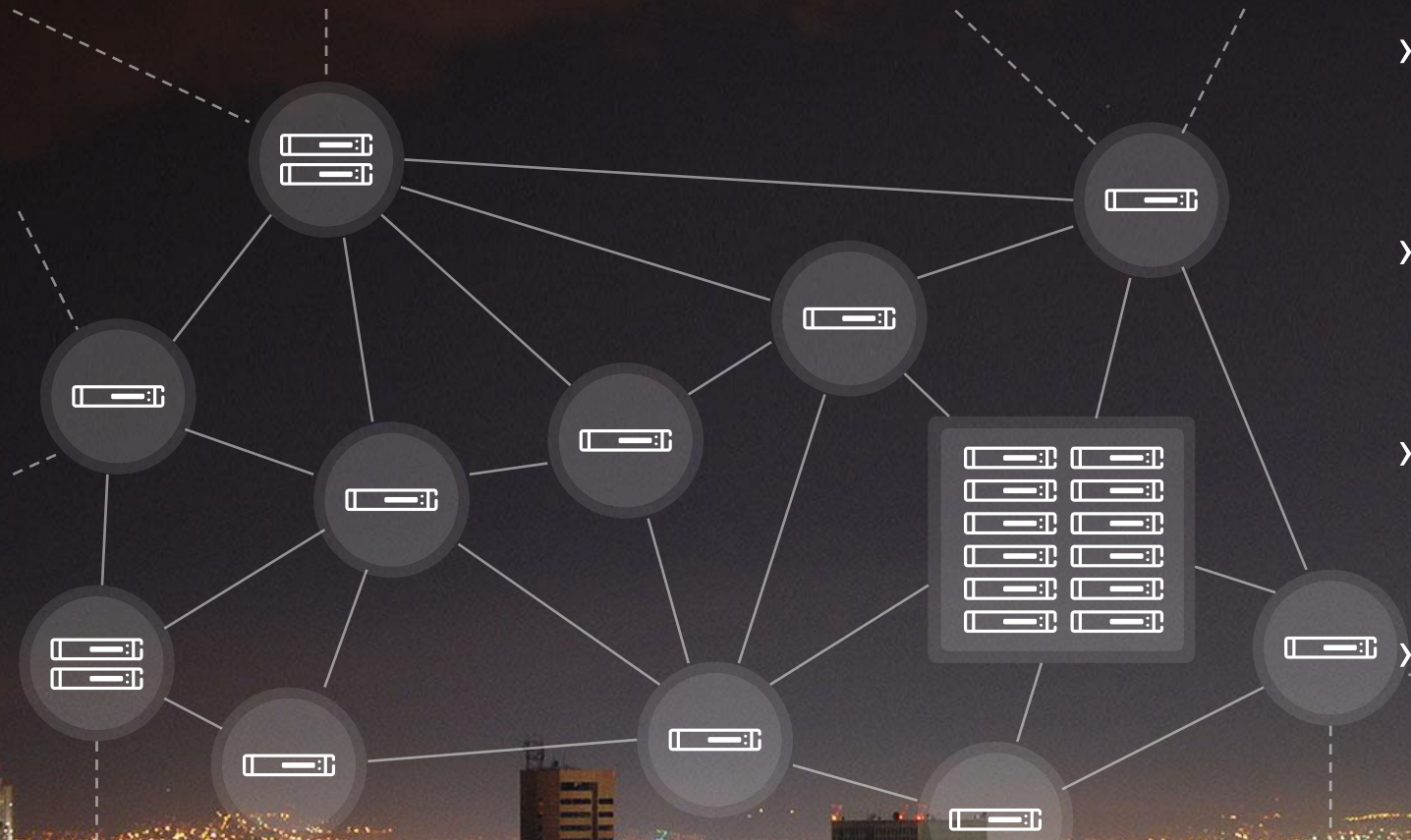
Distributed baseband



Centralized baseband



ELASTIC RAN: OVERVIEW



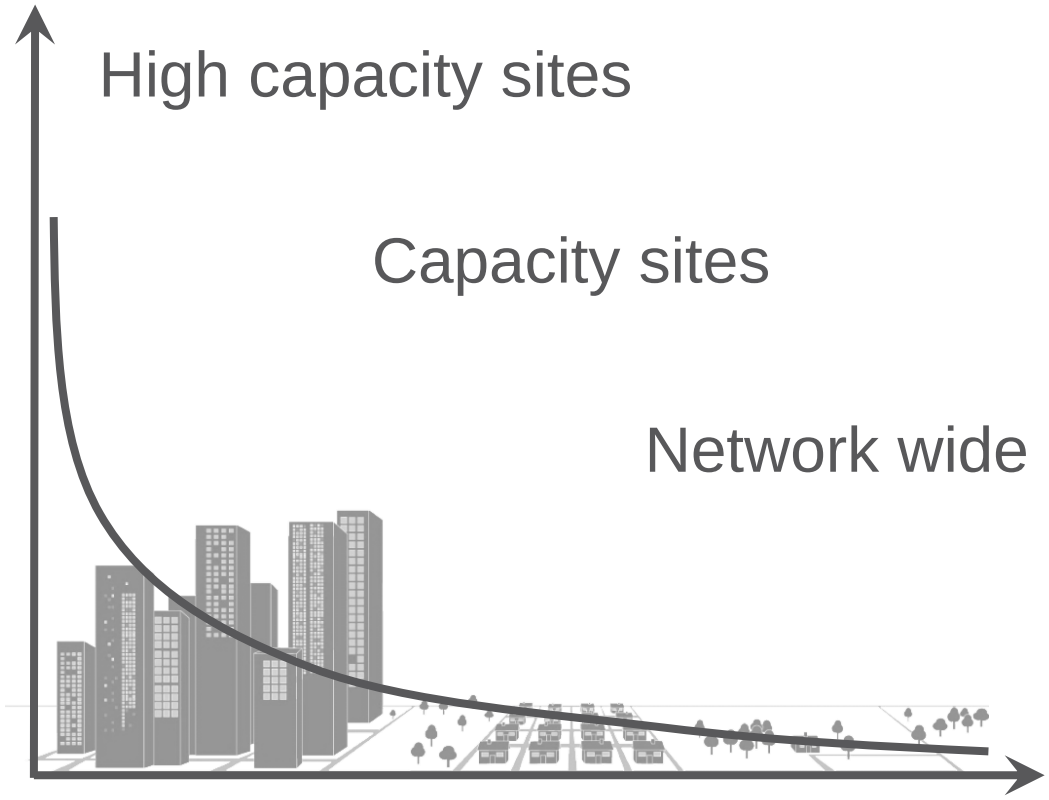
- Borderless coordination across entire network via inter-DU connectivity: L2 switching over fiber
- Support all deployment scenarios: CRAN, DRAN (with fiber to sites), or any mix
- Optimal carrier aggregation and CoMP performance with or without centralized baseband
- Resilient solution (restart domain no more than single DU)

MOTIVATION FOR ELASTIC RAN

- Rapid LTE carrier growth and small cell growth leading to increasingly large coordination clusters
- Existing multi-DU strategy constrained in terms of scalability and coordination capabilities
- Elastic RAN introduced to eliminate any fixed-sized coordination boundaries and scalability constraints, allowing for arbitrarily sized coordination zones with same performance as multi-DU configurations

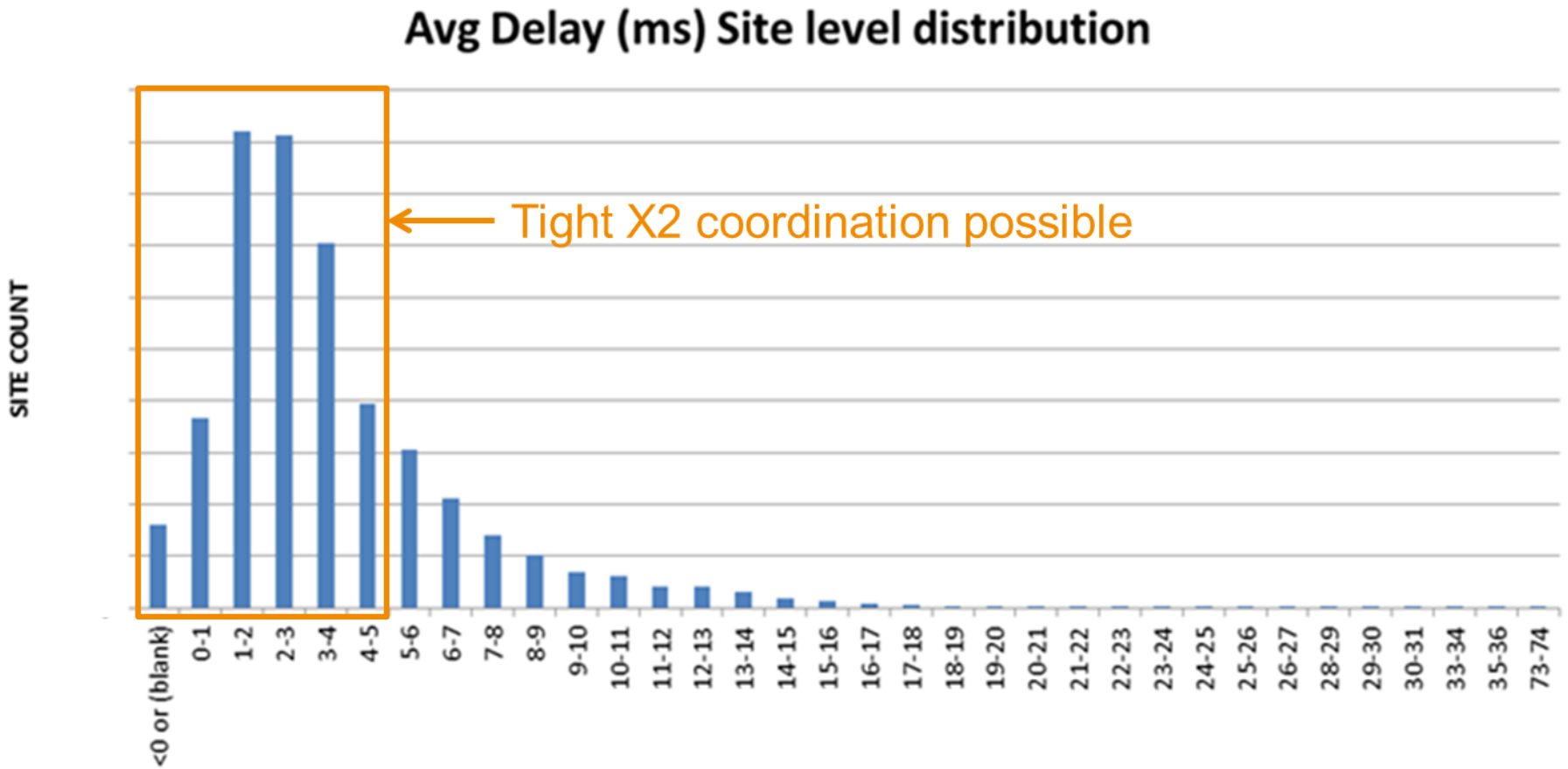
COORDINATION OPPORTUNITIES

	Latency	
Common baseband	≤ 0.1 ms	Carrier aggregation CoMP Combined Cell
Tight X2 coordination	≤ 5 ms	Inter-eNB Carrier aggregation Inter-eNB Uplink CoMP
X2 coordination	≤ 30 ms	Dual-connectivity X2 based ICIC RRC re-establishment Reduced HO oscillation ANR Load balancing



TYPICAL BACKHAUL LATENCIES

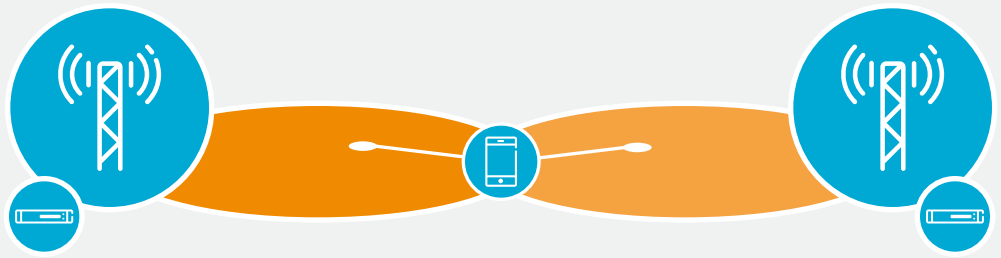
Better than expected



DISTRIBUTED COORDINATION

X2 latency < 5 ms enables tight coordination

Inter-eNB Uplink CoMP



2 dB improved VoLTE uplink coverage
higher uplink cell edge throughput

Inter-eNB Carrier Aggregation

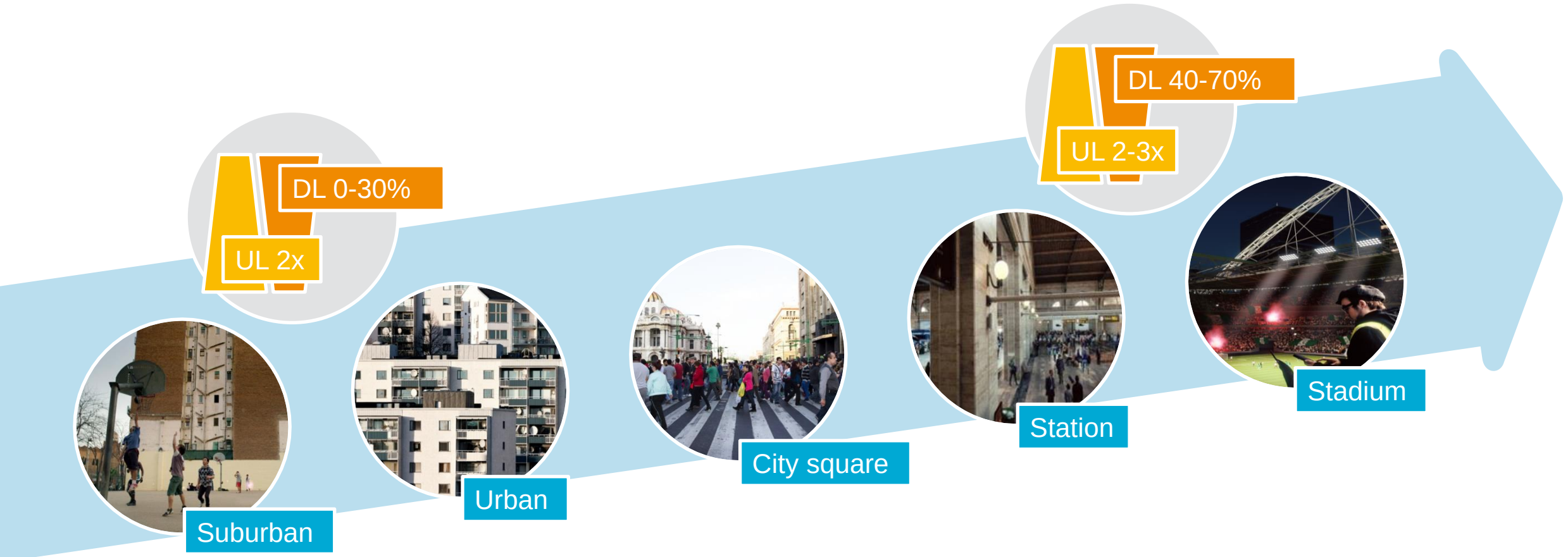
Aggregates downlink of two eNodeBs

Small cells, bands on different grids/nodes

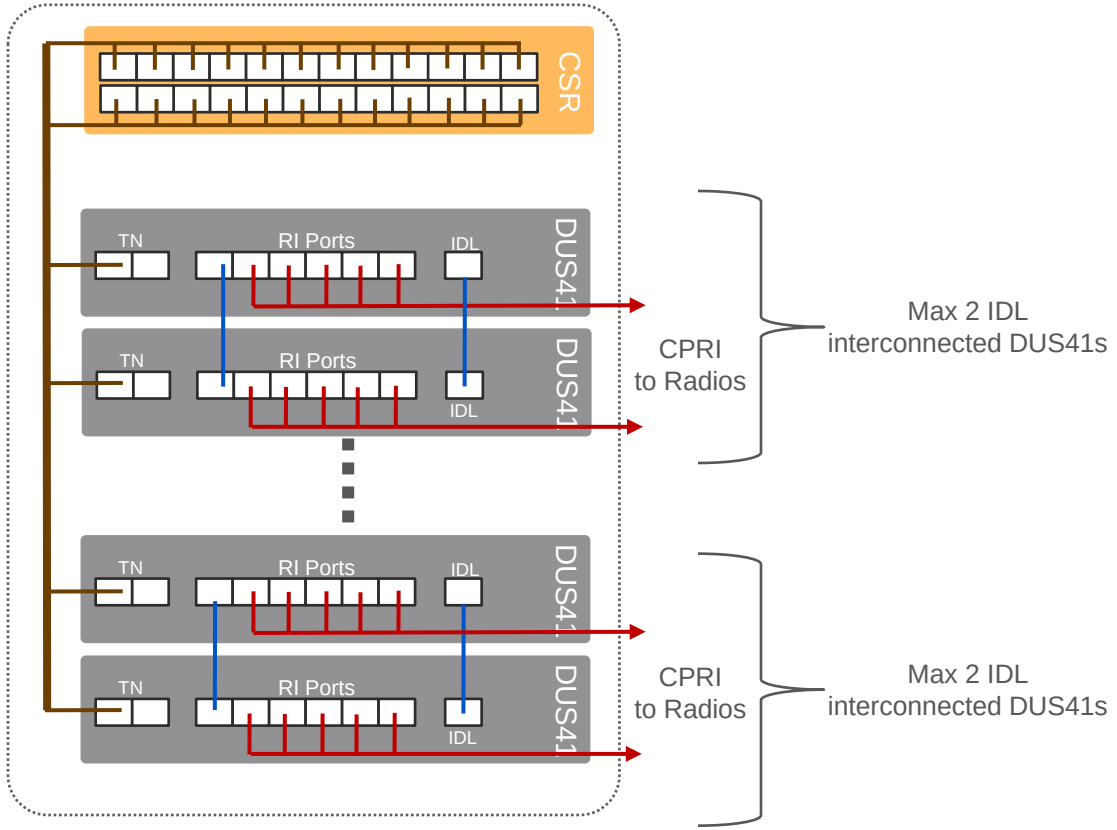
All Carrier Aggregation capable UEs supported

COMMON BASEBAND

Increasing cell edge throughput

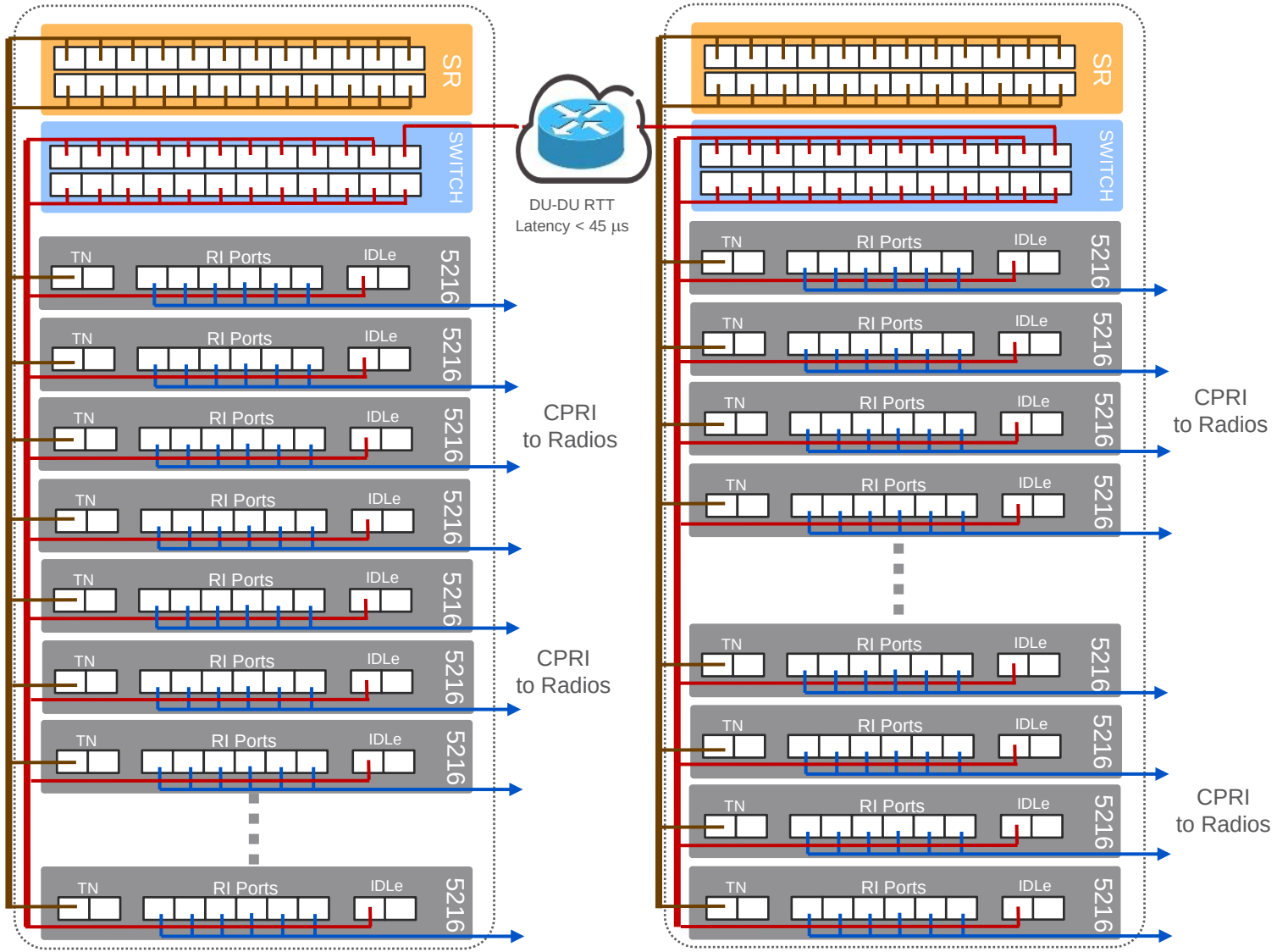


CURRENT ARCHITECTURE



- L16A - 2 IDL connected DUS41s
  - CA between DUs
  - DUs must be co-located
  - Max 18 cells
- L16B – non collocated DUs
  - Inter-eNB Carrier Aggregation
- L17A – First Elastic features
  - Elastic RAN with Carrier Aggregation
- L17B
  - Elastic RAN with Uplink CoMP

ELASTIC RAN ARCHITECTURE

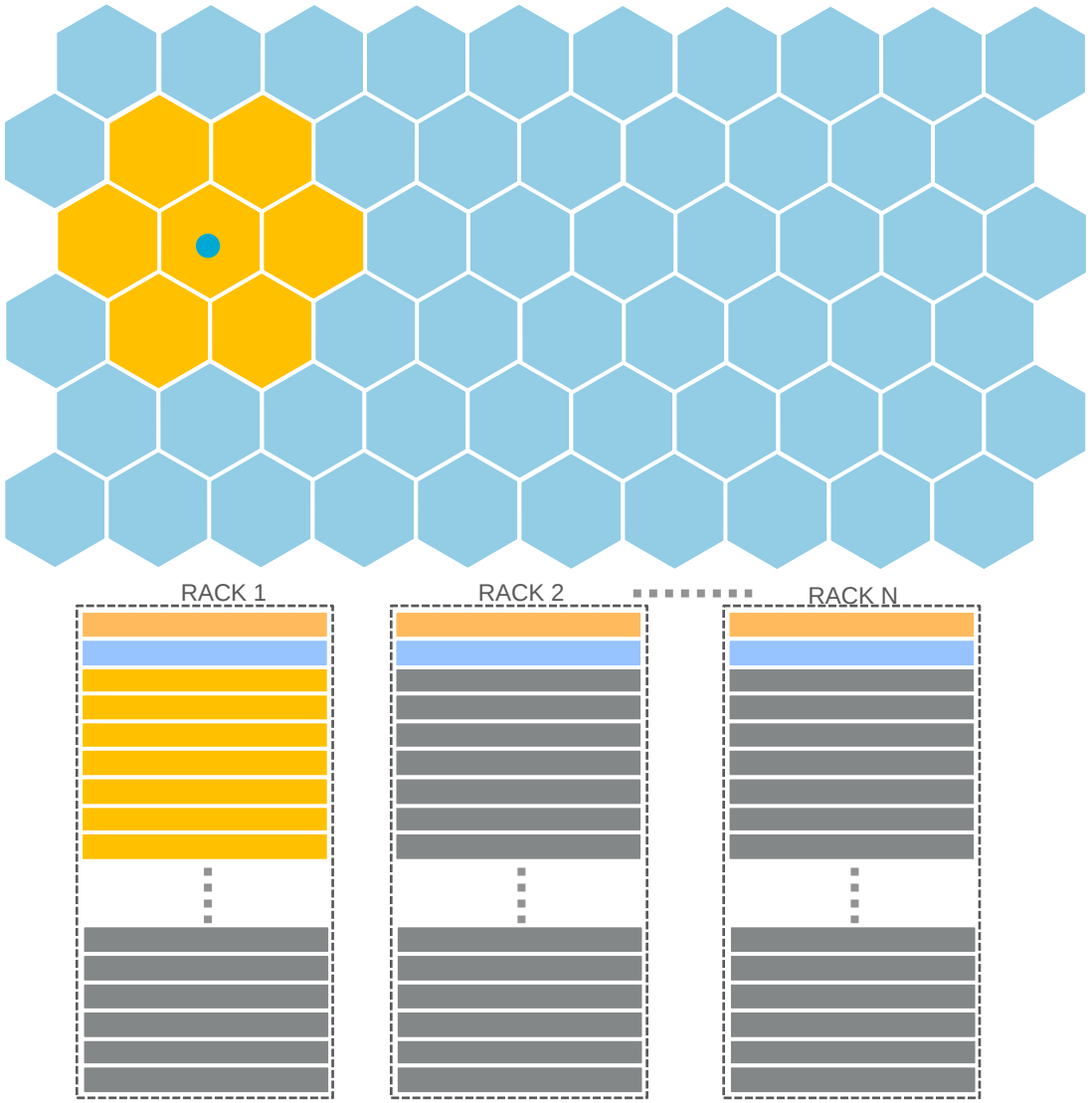


Cable connections simplified

- CPRI front haul uses CWDM or DWDM or direct fiber connections.
- All DUs are connected to the site router (SR) for backhaul connectivity
- All DUs* are connected to an L2 switch for IDLe connectivity
- The site router and L2 switch can be same or different physical units.
- Any 1 DU can be remotely configured to be co-ordinated with any 6 other DUs
- IDLe connectivity is possible between DUs located in different racks and/or different locations, provided RTT latency is <45us between the DUs

***Supported for baseband 52XX series and beyond due to IDLe requirement**

DYNAMIC CO-ORDINATION SETS



- Each eNB has 6 neighbor eNBs in its co-ordination set.
- It is possible to remotely configure co-ordination sets (no need for site visit)
- Co-ordination set follows the UE
- Inter-DU features are possible between any DUs within a co-ordination set
  - L1 UL COMP
  - Carrier Aggregation
  - Additional inter-DU features to be introduced as they are developed

One Macro site and underlying small cells configured on one BB5216

Example:

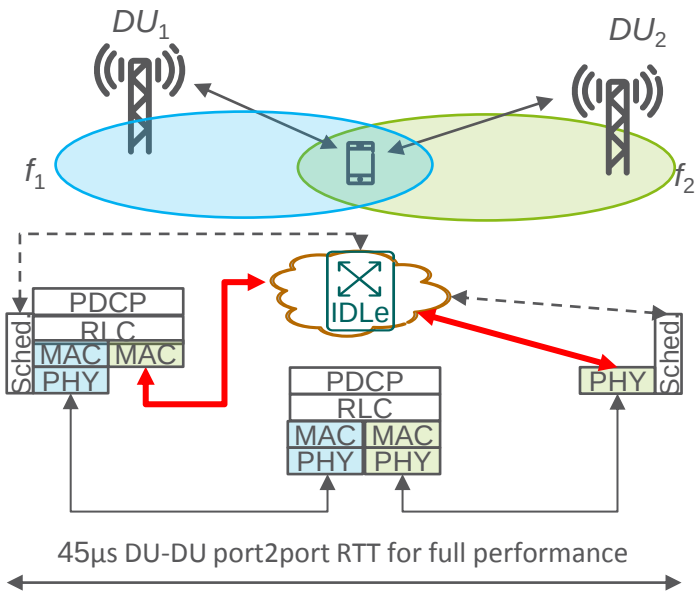
3 macro sectors, 3 bands

4 small cells, 2 bands

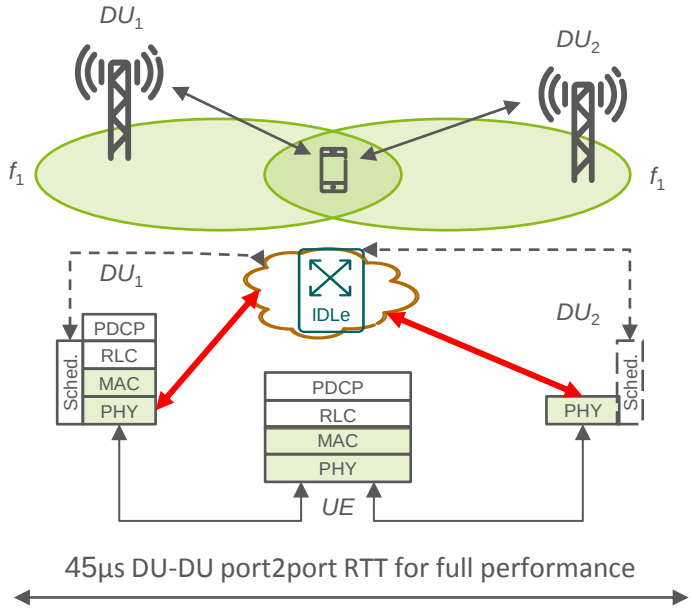
17 sector carriers

ELASTIC RAN FOR CA AND COMP

› Carrier Aggregation



› L1 UL CoMP

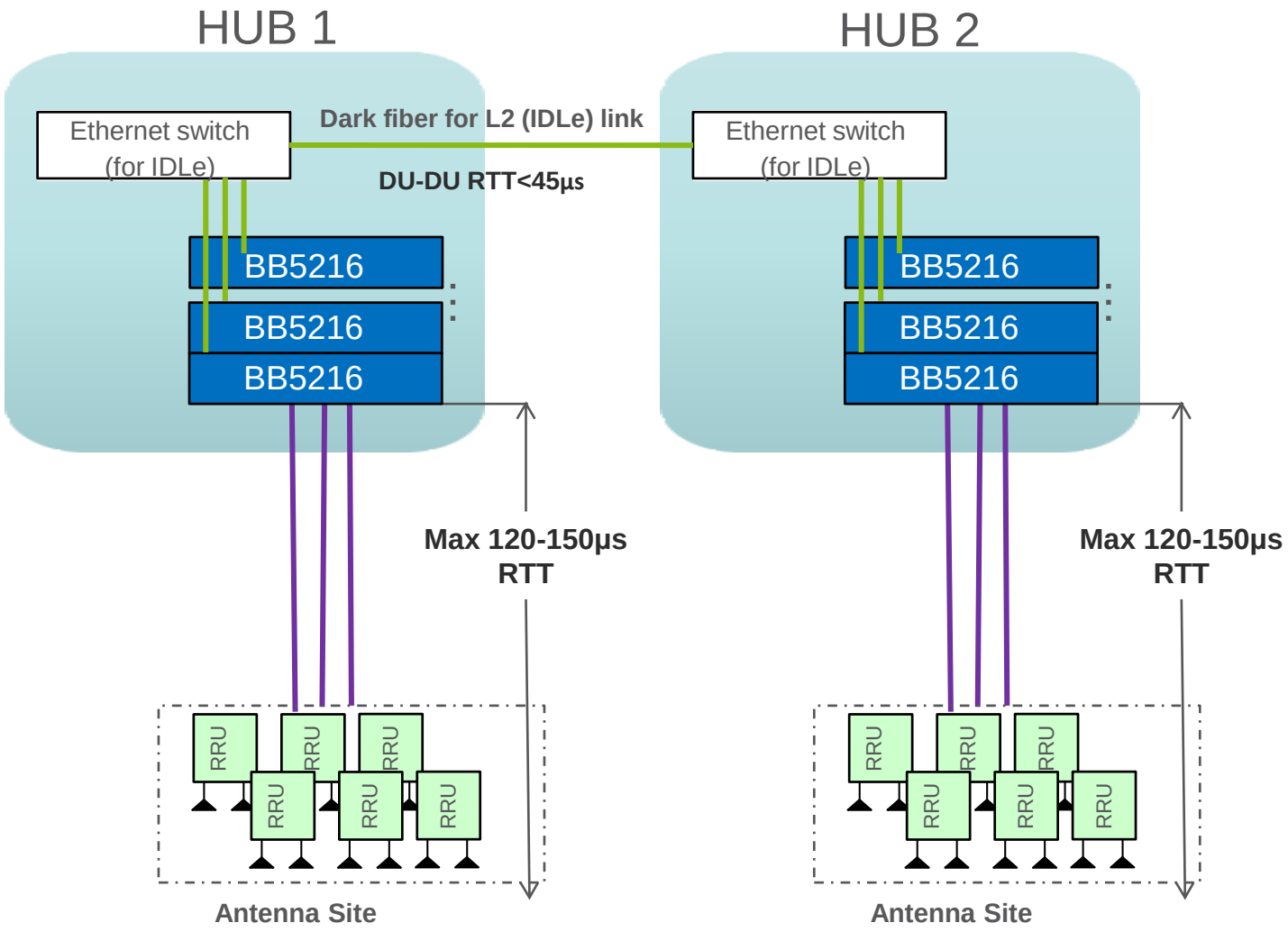


Notes:

1. Maximal DU-DU RTT: 45µs (further optimized in later releases)
2. Maximal fronthaul delay (CPRI + RF feeder): 120-150µs RTT

- L1 UL CoMP over IDLe is the next feature to be implemented
  - Evolution over future SW releases
- (Previously, L1 UL CoMP constrained within one DU)

LATENCY LIMITS



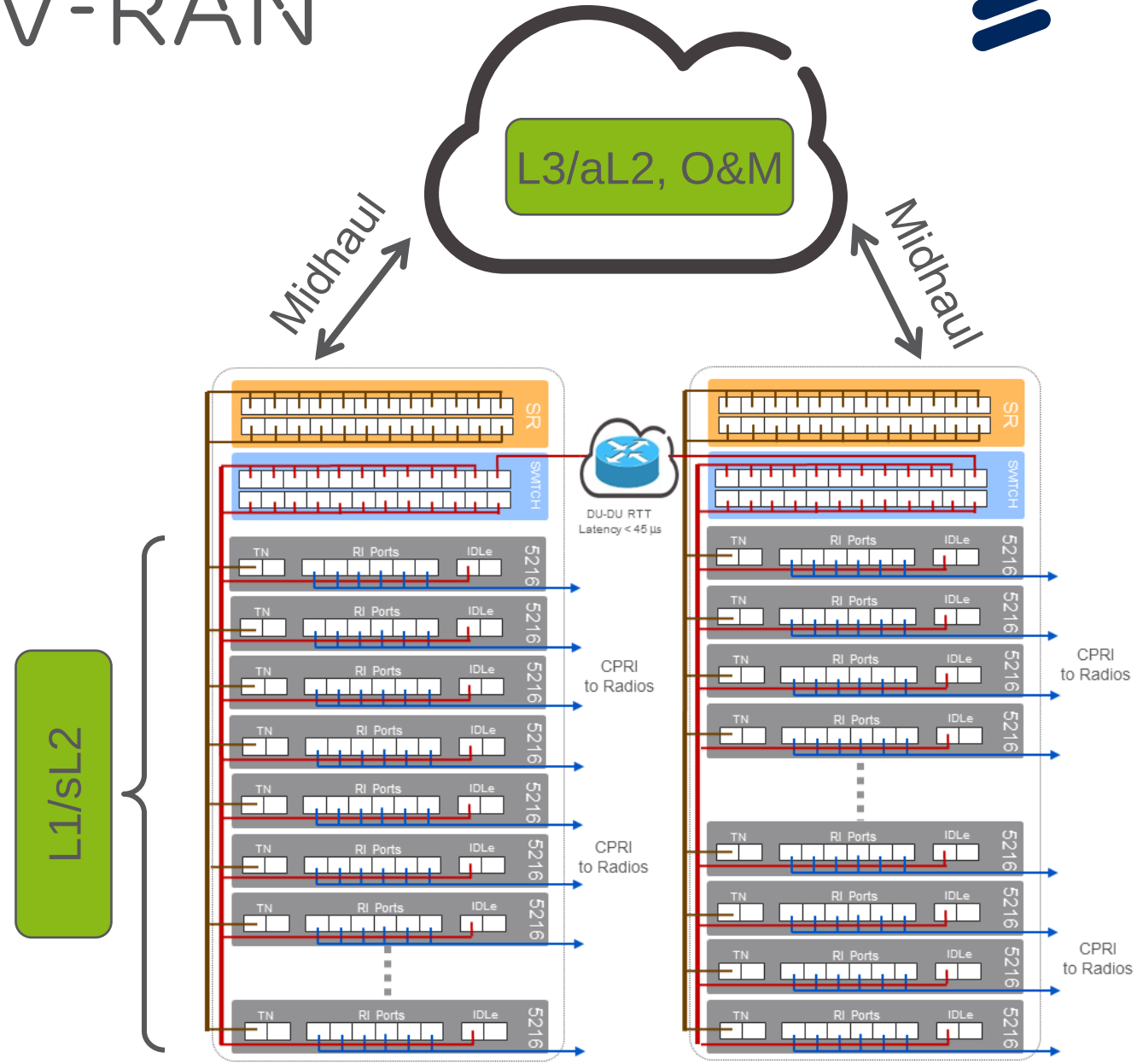
- Radio-to-DU Latency
  - 120-150 µs RTT on CPRI fronthaul
  - Translates to 12-15 km
- DU-to-DU Latency
  - 45 µs RTT over IDLe
  - Translates to max 4.5 km (minus switch delays)
  - Future possibility to improve the delays

Note: All DUs need to be synchronized

- GPS
- PTP is also an option

RELATIONSHIP TO V-RAN

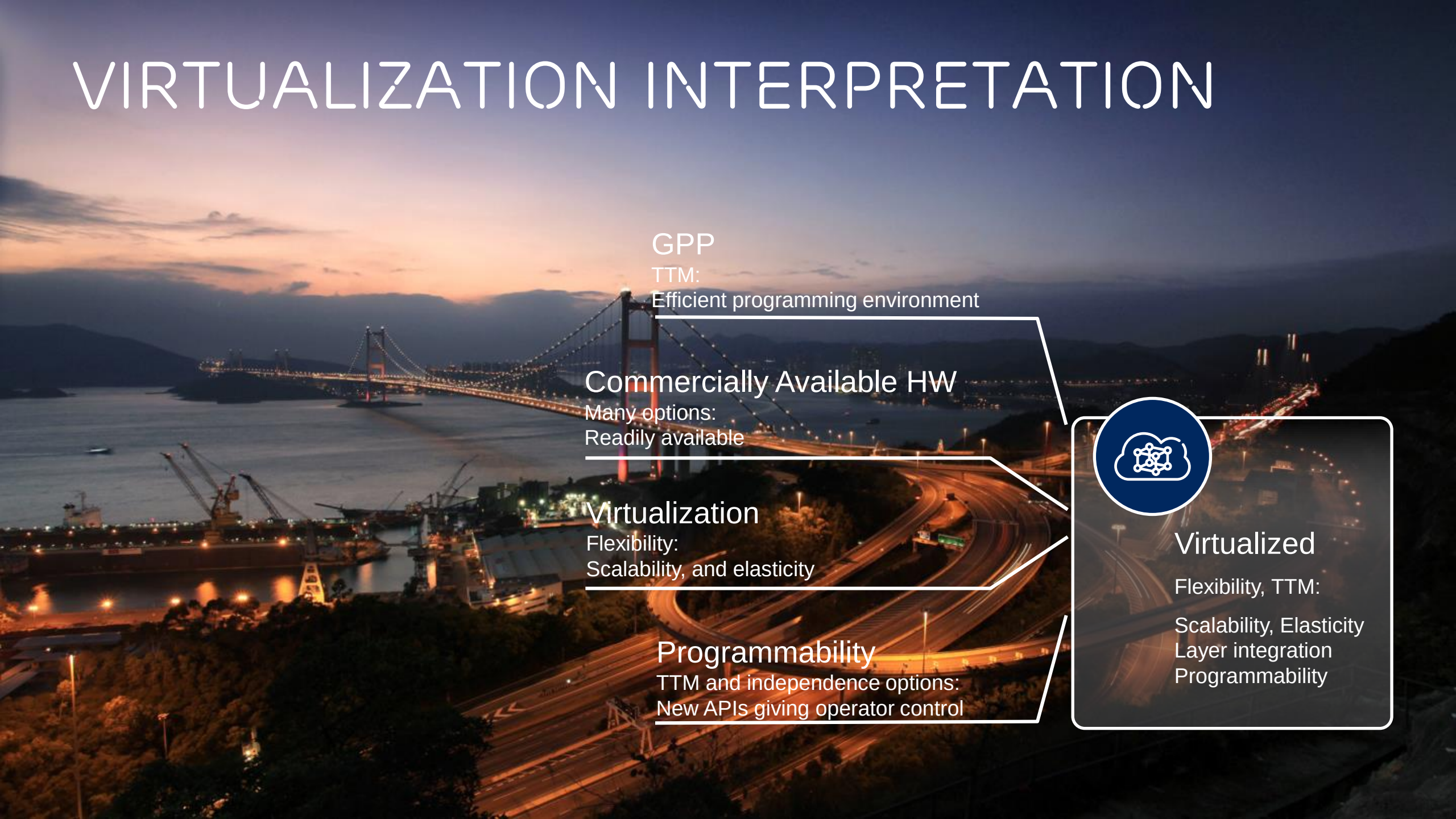
- Elastic-RAN is not a replacement for V-RAN
  - Elastic RAN is a replacement for multi-DU configurations
- V-RAN is fully compatible with Elastic RAN
  - Benefits of V-RAN still remain
  - e.g., RAN architecture split allows independent scaling of L3/aL2 and L1/sL2



BENEFITS OF ELASTIC RAN ARCHITECTURE

- Borderless co-ordination across the entire network
  - Via low latency high Bandwidth IDLe
    - Allows efficient inter-DU CA
    - Allows L1 CoMP between DUs over IDLe
- More configuration flexibility
    - Remote configuration of co-ordination sets
    - CA and CoMP between any co-ordinated DUs
    - No need for rewiring (site visits)
- COTS Ethernet switch based connectivity
- C-RAN architecture with greater scalability / flexibility
  - # of cells scales 1:1 with number of DUs
- Future proof design for inter-DU features in upcoming releases
- V-RAN compatible architecture: supports architecture split.

VIRTUALIZATION INTERPRETATION



GPP

TTM:
Efficient programming environment

Commercially Available HW

Many options:
Readily available

Virtualization

Flexibility:
Scalability, and elasticity

Programmability

TTM and independence options:
New APIs giving operator control

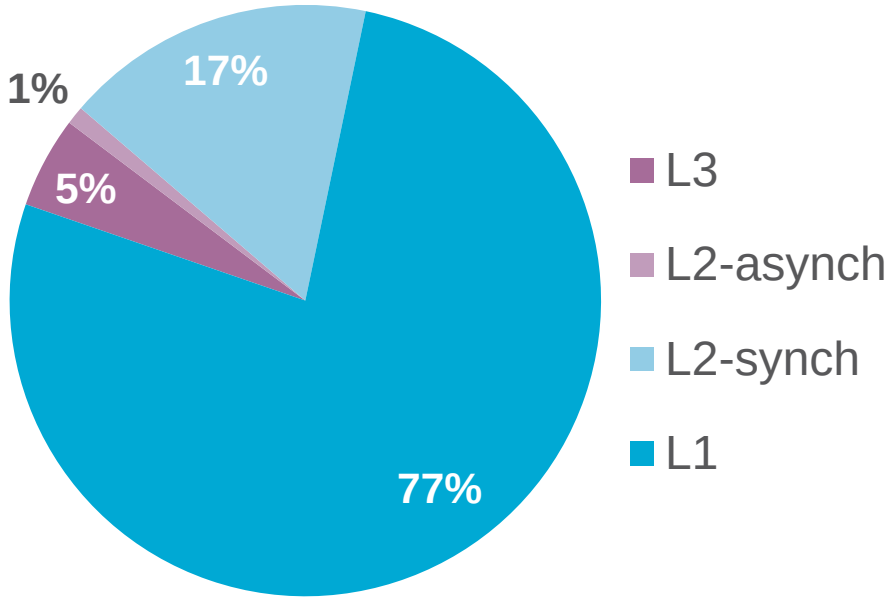
Virtualized

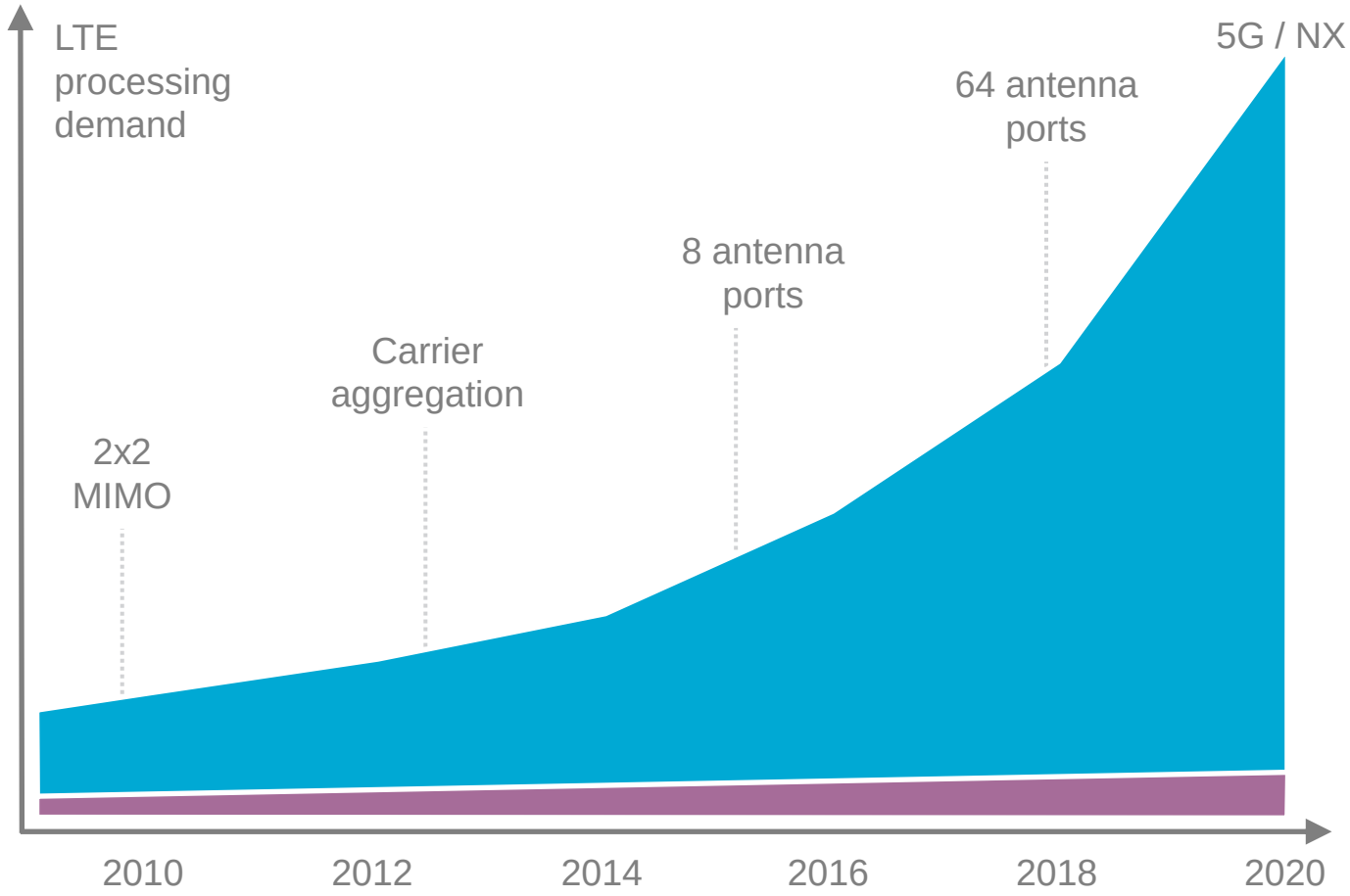
Flexibility, TTM:

Scalability, Elasticity
Layer integration
Programmability

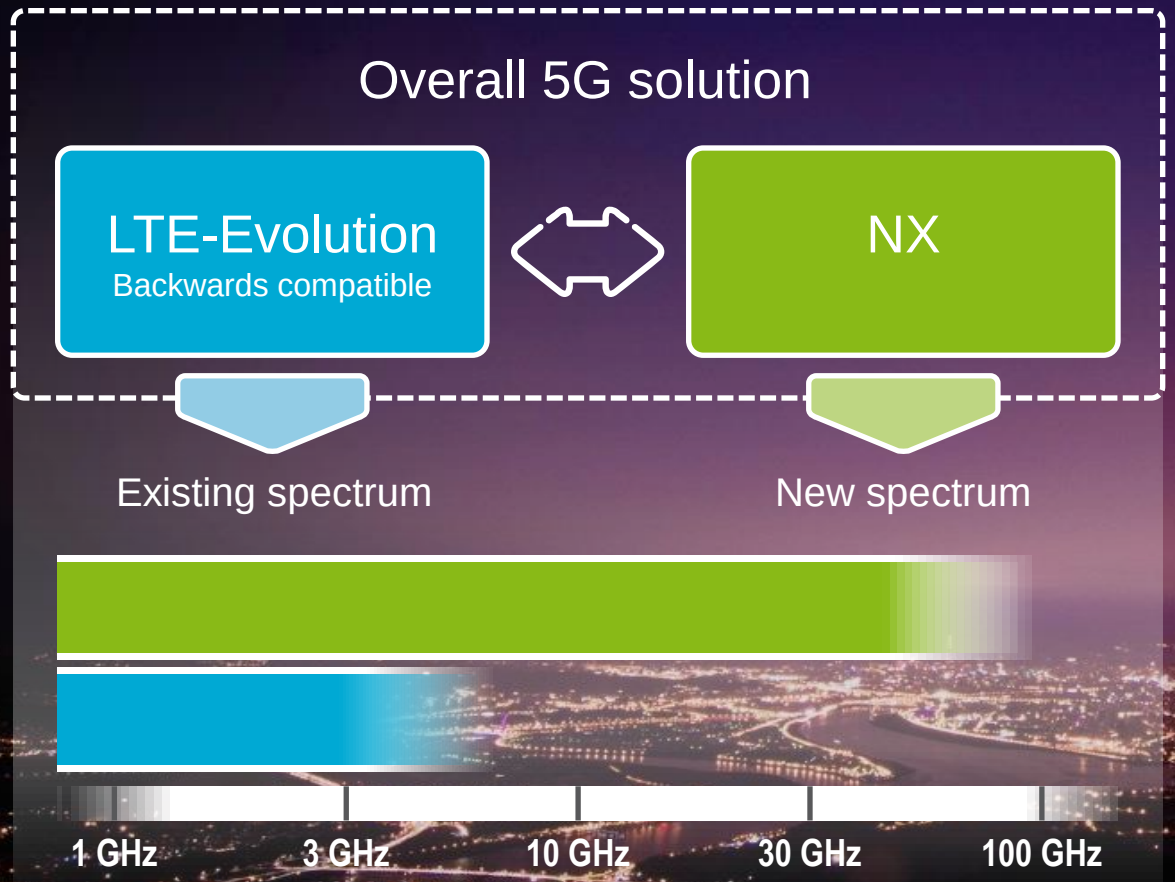
COMPUTATIONAL REQUIREMENTS

Current Distribution and Future Evolution





5G RADIO ACCESS: LTE-E AND NX



› Evolution of existing technology adding new RAN technology

› LTE+ and NX combined allows rapid switching based on radio conditions

› Gradual migration of NX into existing spectrum

› Ericsson principles fully agreed for 3GPP Rel 15

5G REALITIES

New high bands

NX ~30GHz

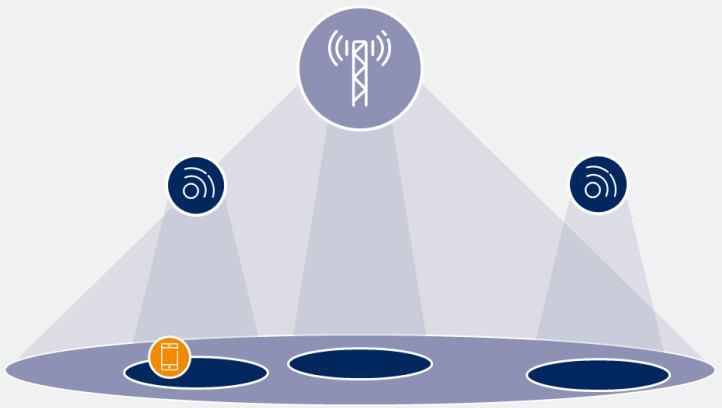
NX ~10GHz

LTE high bands

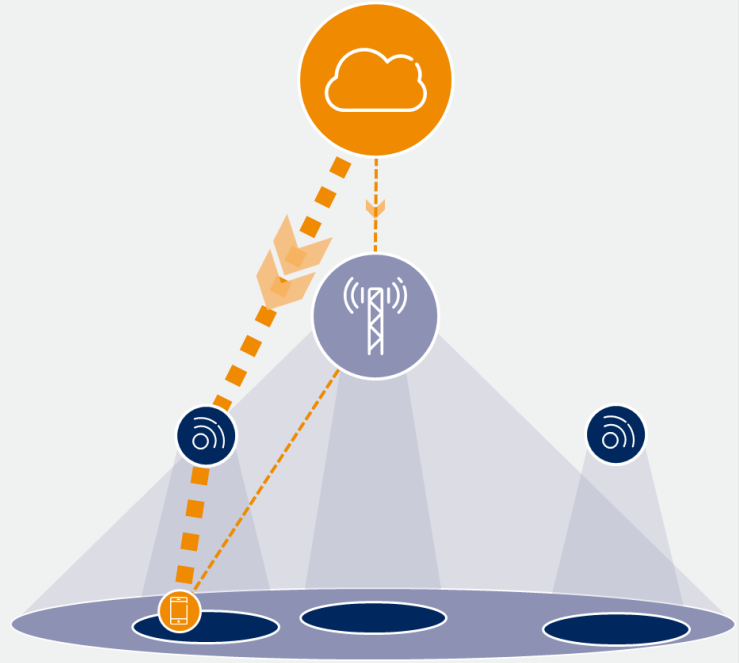
LTE low bands

Asymmetries

Coverage

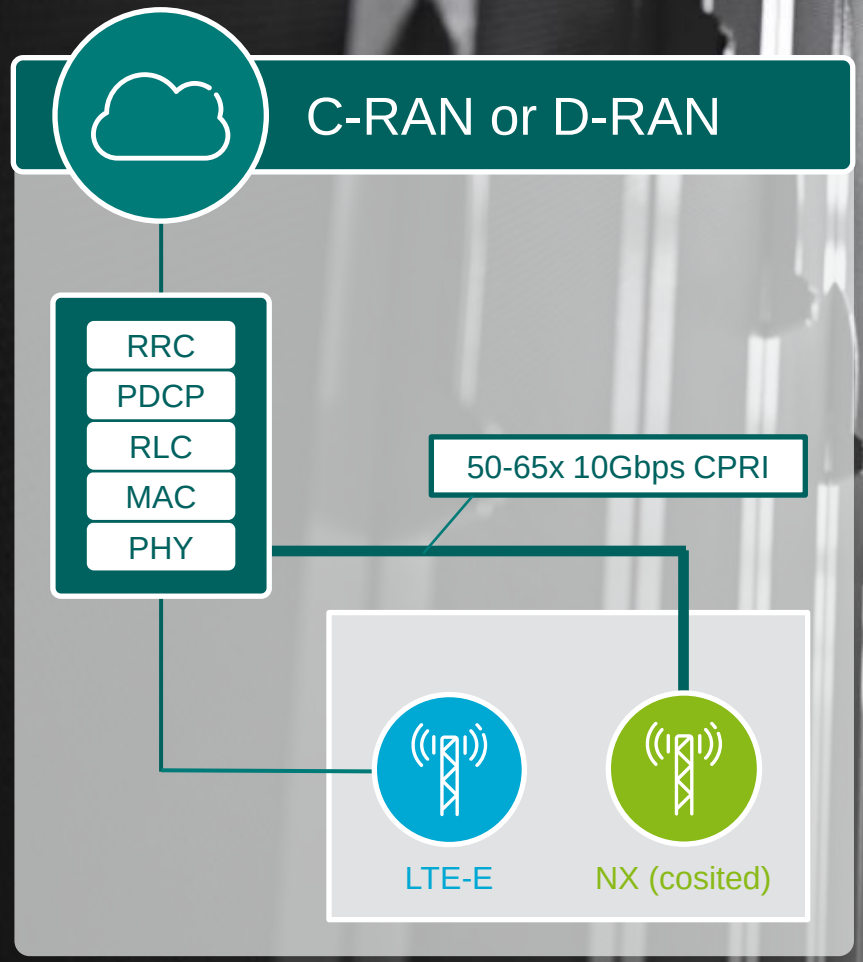


Data Volume



TOPOLOGY FOR BEAMFORMING

With NX co-located



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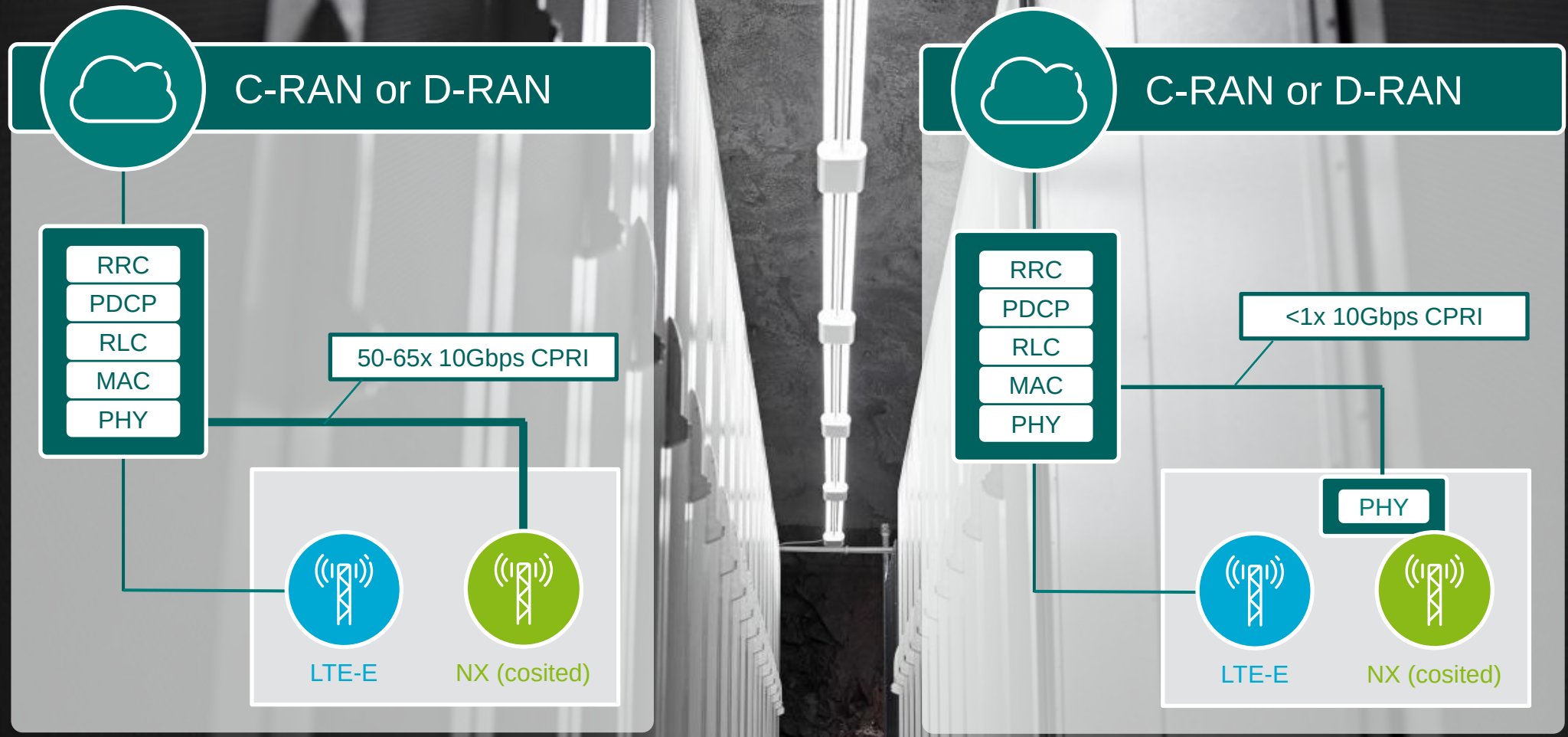
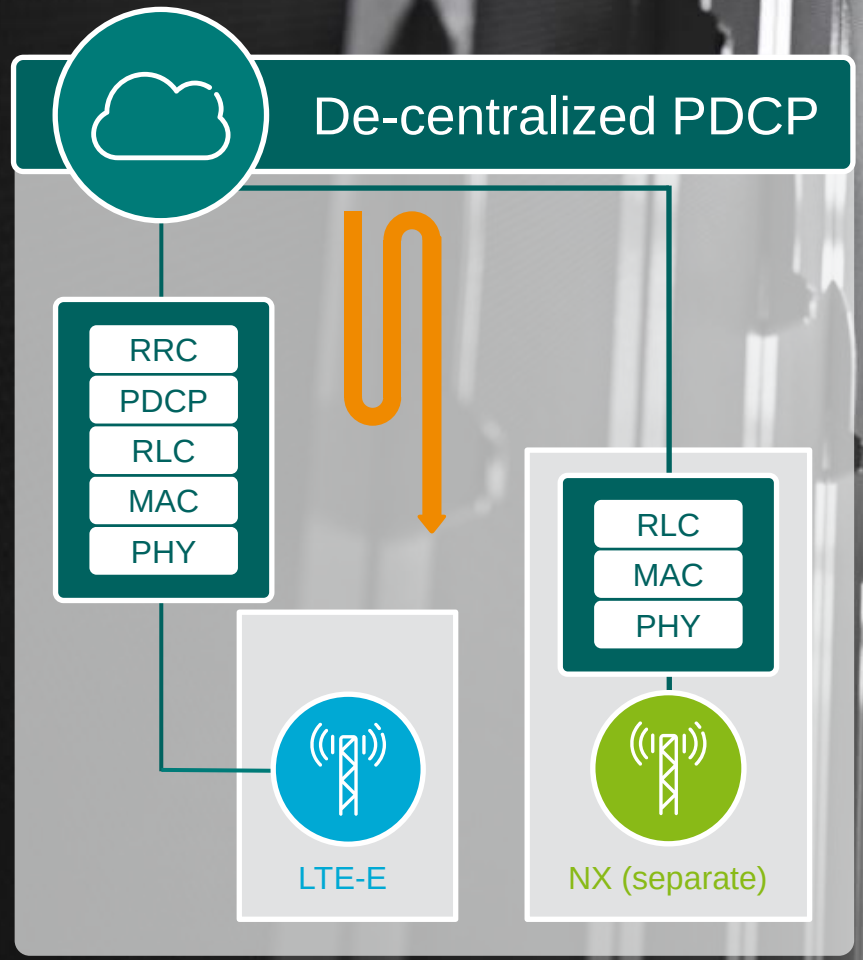


FUNCTIONAL SPLIT FOR LTE/NX

With NX on different grid



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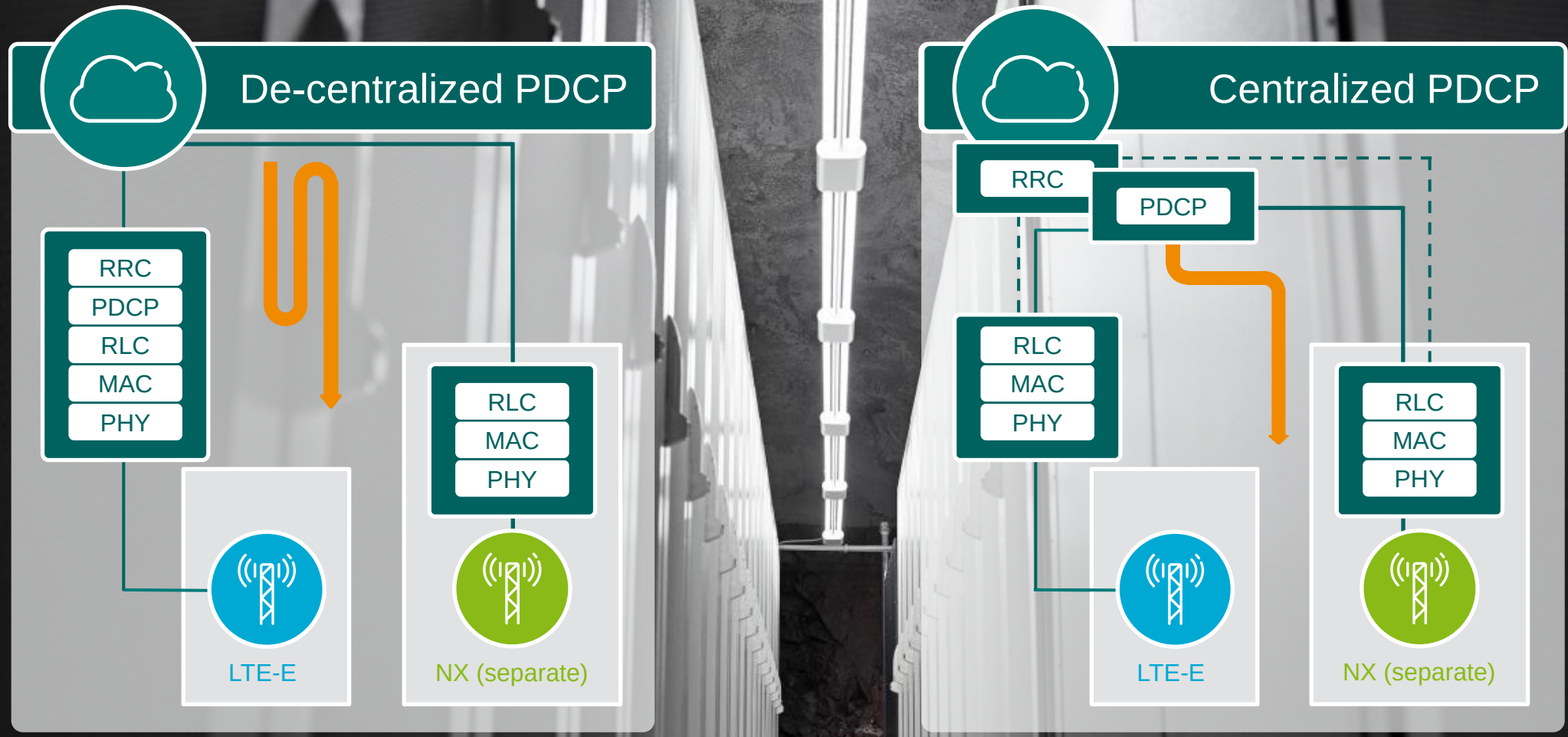
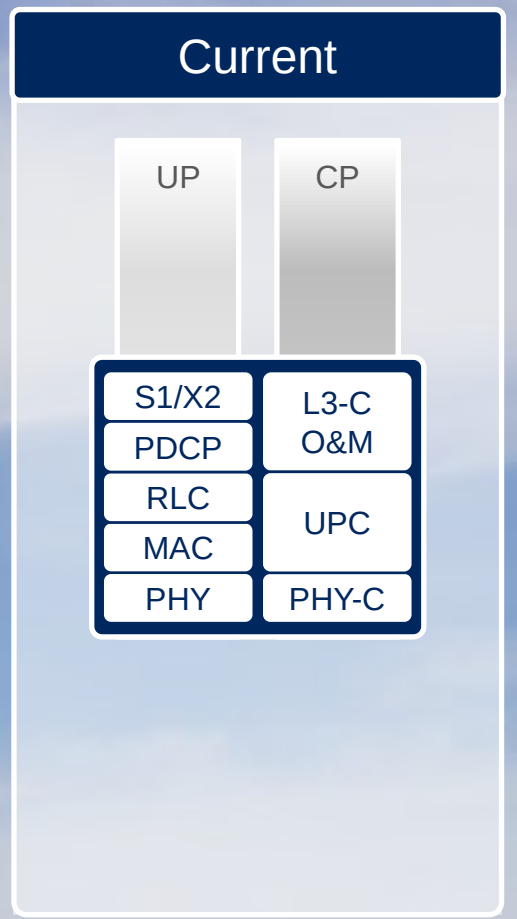
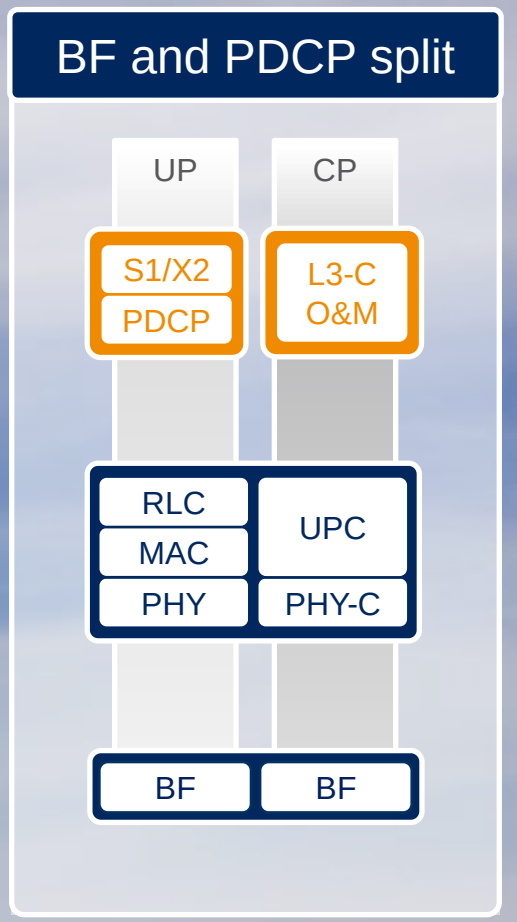


SPLIT ARCHITECTURE



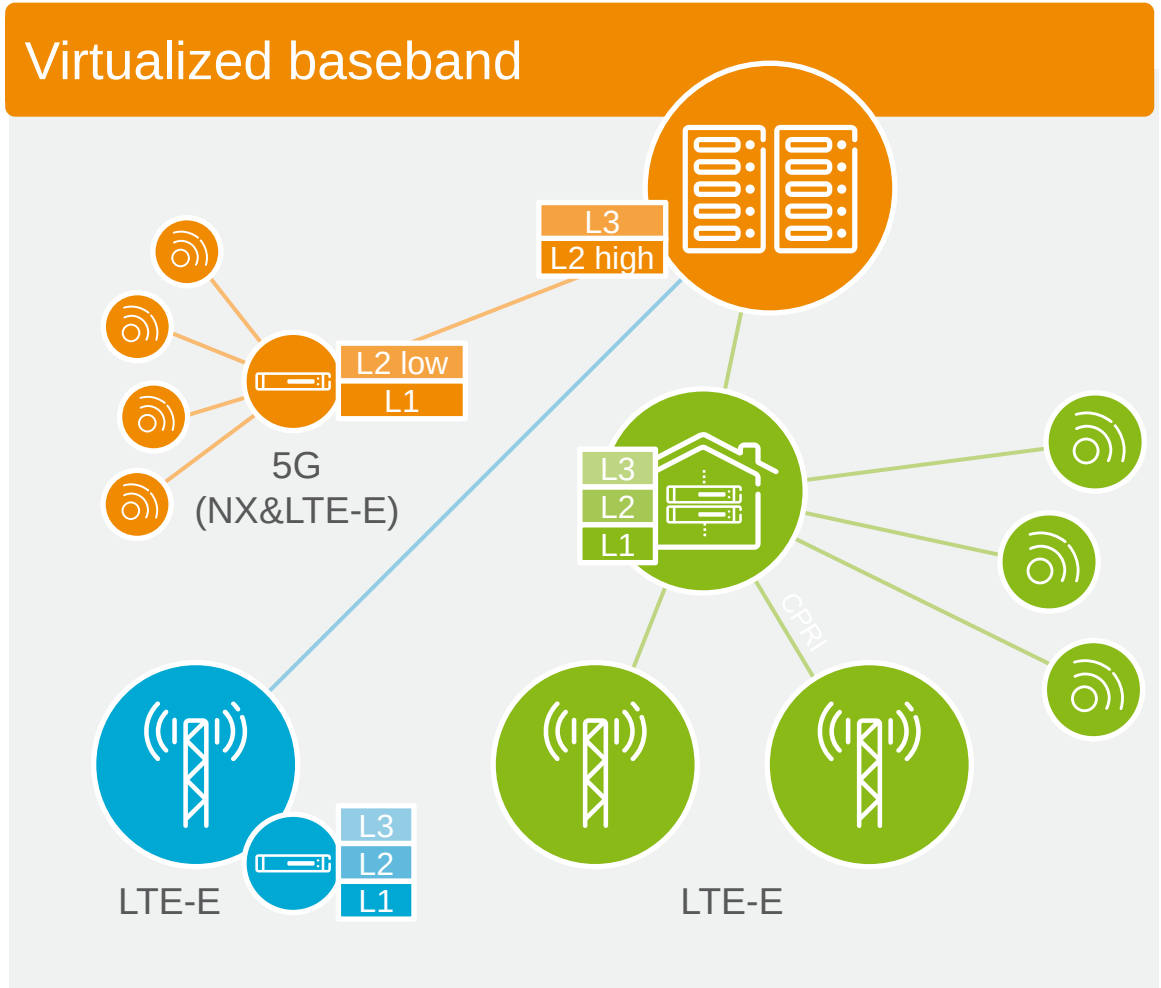
PDCP/RRC Separation

PHY Separation (Beamforming)



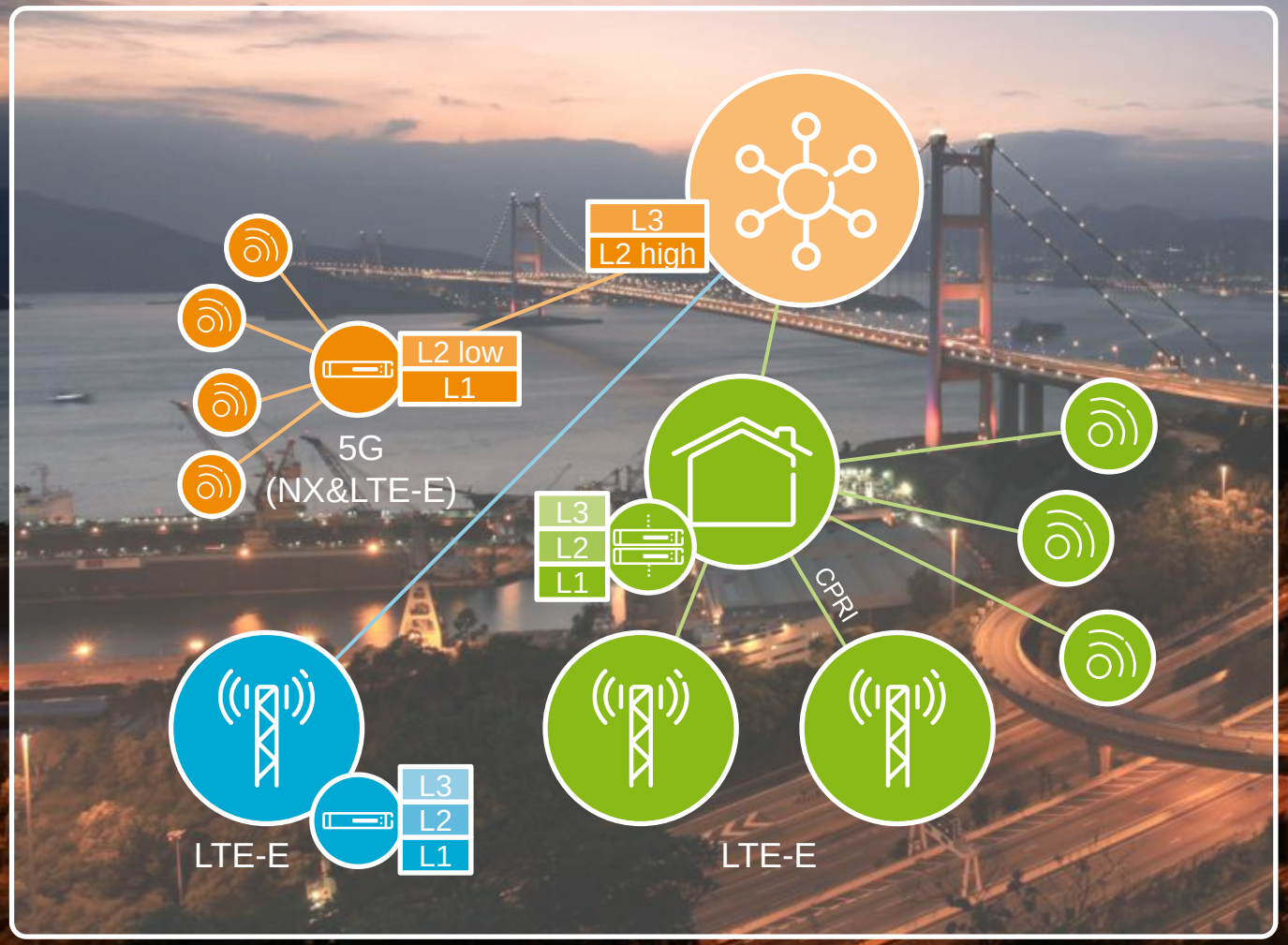
DRIVERS FOR VIRTUALIZATION

- Scalability and elasticity
- Efficient programming environment
- Commercially available hardware
- Flexibility and functionality at the right place



CLOUD RAN

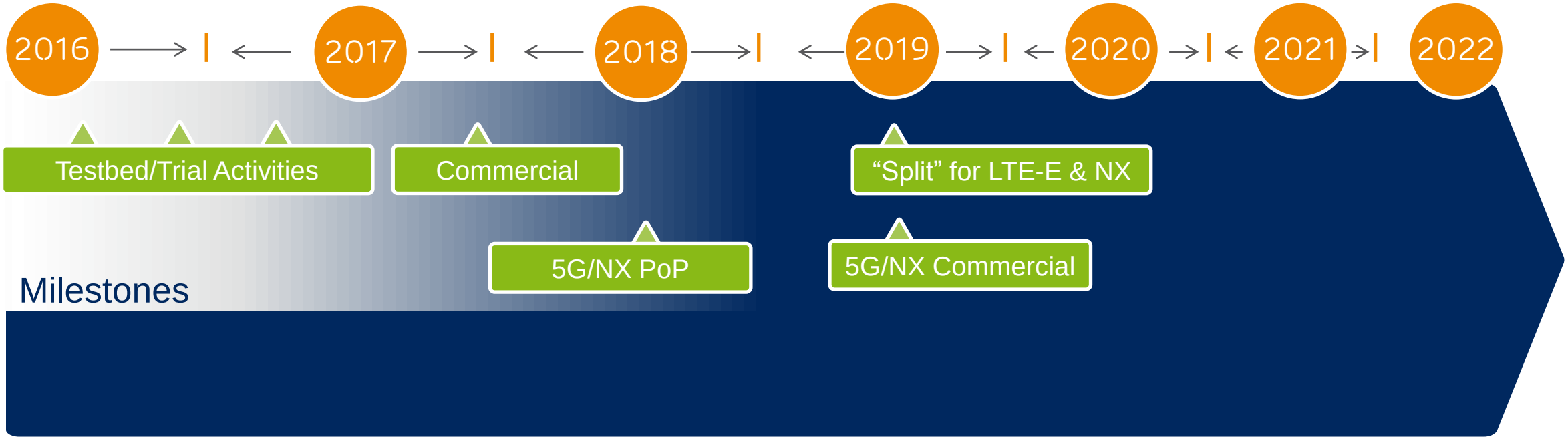
The architecture



- Coordination of all cells
- Heterogenous networks
- Distributed and selectively centralized
- Flexible function placement
- Proximity to core network and applications
- Enabling smooth migration
- Securing network investment

CLOUD RAN

CLOUD RAN ROADMAP



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