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Dimensioning the Anyhaul network for 5G

Impact of 5G on IP transport networks

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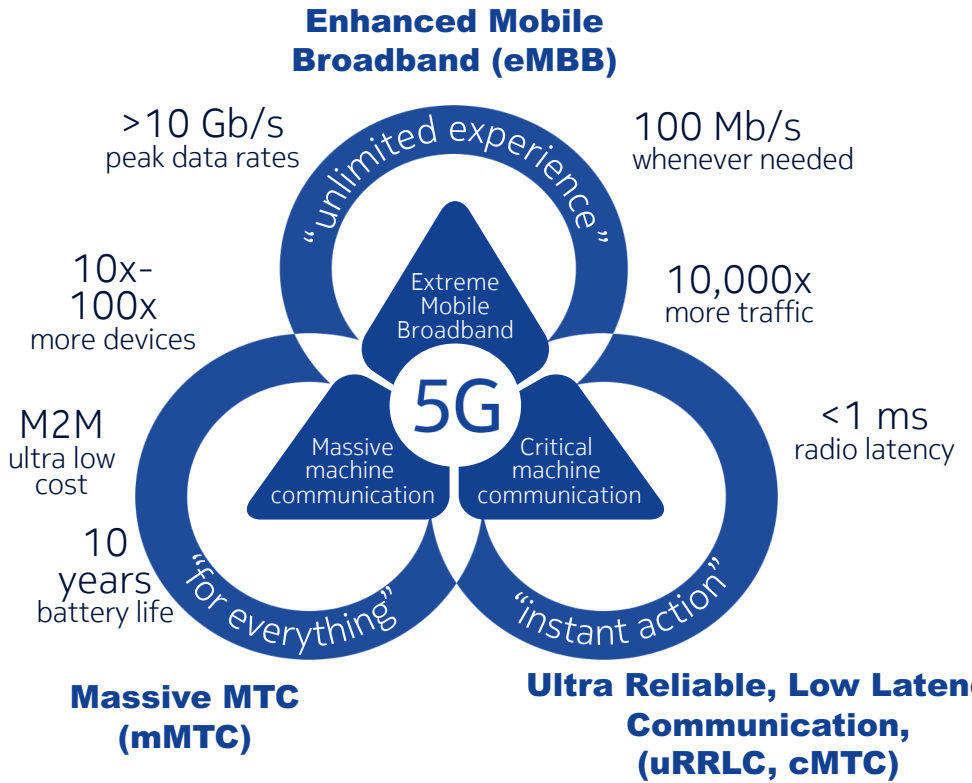
- 2019

5G: Built to address new requirements



Changes vs LTE	*Targets*
10x data rates	20 Gb/s
10x lower latency	<1 ms
10x lower IoT power	<10 µWh per tx
5x energy efficiency	<1 kWh/TB
3x spectral efficiency	>10 bps/cell/Hz

MTC = Machine Type Communication

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What makes 5G different ? (1)

New Spectrum

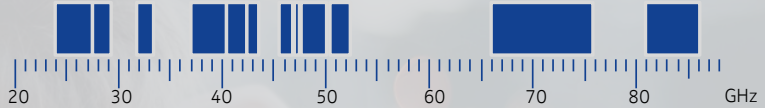
mmWave
local area
(e.g. 70-90 GHz)

cmWave
solid area
(< 30 GHz)

Below 6GHz
wide area
(<6.5GHz)
LTE-M

Wider Spectrum Allocations

From 10s of MHz to 100s of MHz (even GHz)

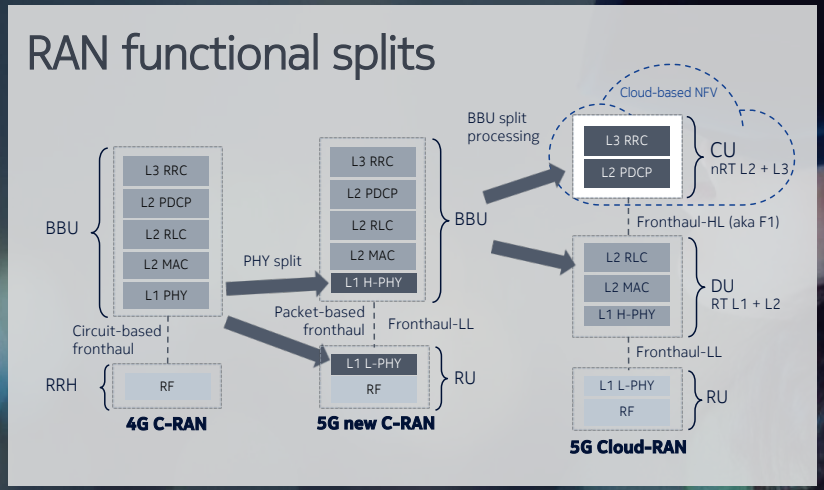


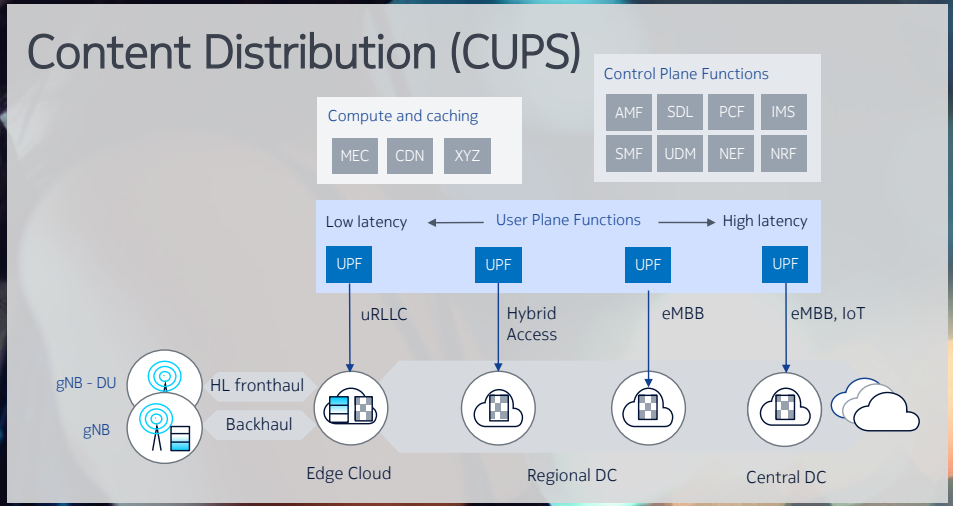
mMIMO

Massive MIMO

Beamforming

What makes 5G different ? (2)



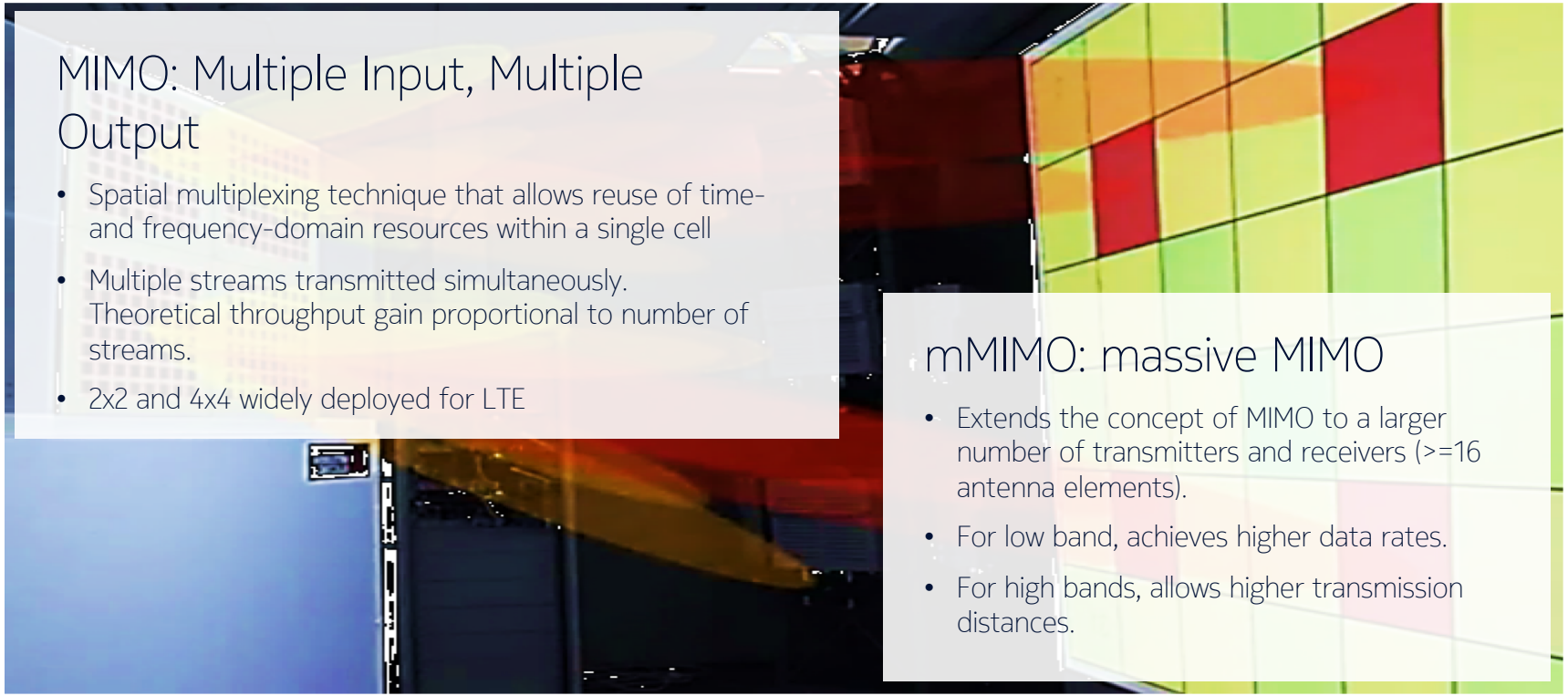


Different 5G spectrum ranges for different use cases

3 key spectrum ranges have emerged

	Spectrum range	Bands	Coverage	Peak Data rates	Bandwidth	Use Cases
Cell range / Data rate	**Low band** < 3 GHz	• 600 MHz (n71) • 700 MHz (n28) • 900 MHz (n81) • 1800 MHz (n80)	• Deep indoor • >1 km	~100 Mbps	FDD 2x10 MHz	• Deep indoor coverage for e.g. MTC • Supplementary UL eMBB coverage • Coverage layer for MBB
	Mid-band 3 – 6 GHz	• 3.4-3.6 GHz (n78) • 3.6-3.8 GHz (n77) • 4.5-4.9 GHz (n79)	• Same grid as LTE1800 • ~1 km	~1 Gbps	TDD <100 MHz	• 5G eMBB coverage on LTE grid • Major commercial 5G launches are expected in this spectrum range (JPN, KRN, CHN, EUR)
	mmWaves > 24 GHz	• 26 GHz (n257) • 28 GHz (n258) • 39 GHz (n260)	• Hot spots • Line of sight • 100 m	~10 Gbps	TDD <1 GHz	• Extreme data rates for e.g. VR in local areas like stadiums • Used in US due to lack of 3-6 GHz

Not just MIMO… massive MIMO



MIMO: Multiple Input, Multiple Output

- Spatial multiplexing technique that allows reuse of time- and frequency-domain resources within a single cell
- Multiple streams transmitted simultaneously. Theoretical throughput gain proportional to number of streams.
- 2x2 and 4x4 widely deployed for LTE

mMIMO: massive MIMO

- Extends the concept of MIMO to a larger number of transmitters and receivers (>=16 antenna elements).
- For low band, achieves higher data rates.
- For high bands, allows higher transmission distances.

Impact of wider channels
Doing the numbers

Assumptions:

Configuration	Average Spectral Efficiency (bps/Hz)
Downlink 2x2 MIMO	3.69
Downlink 4x4 MIMO	6.00

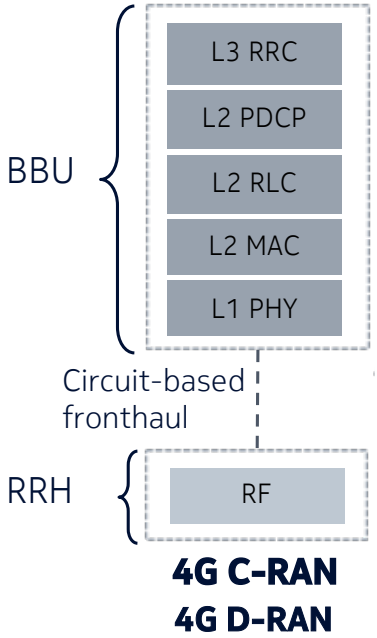
Downlink layers: 16

64T64R at base station

Example:

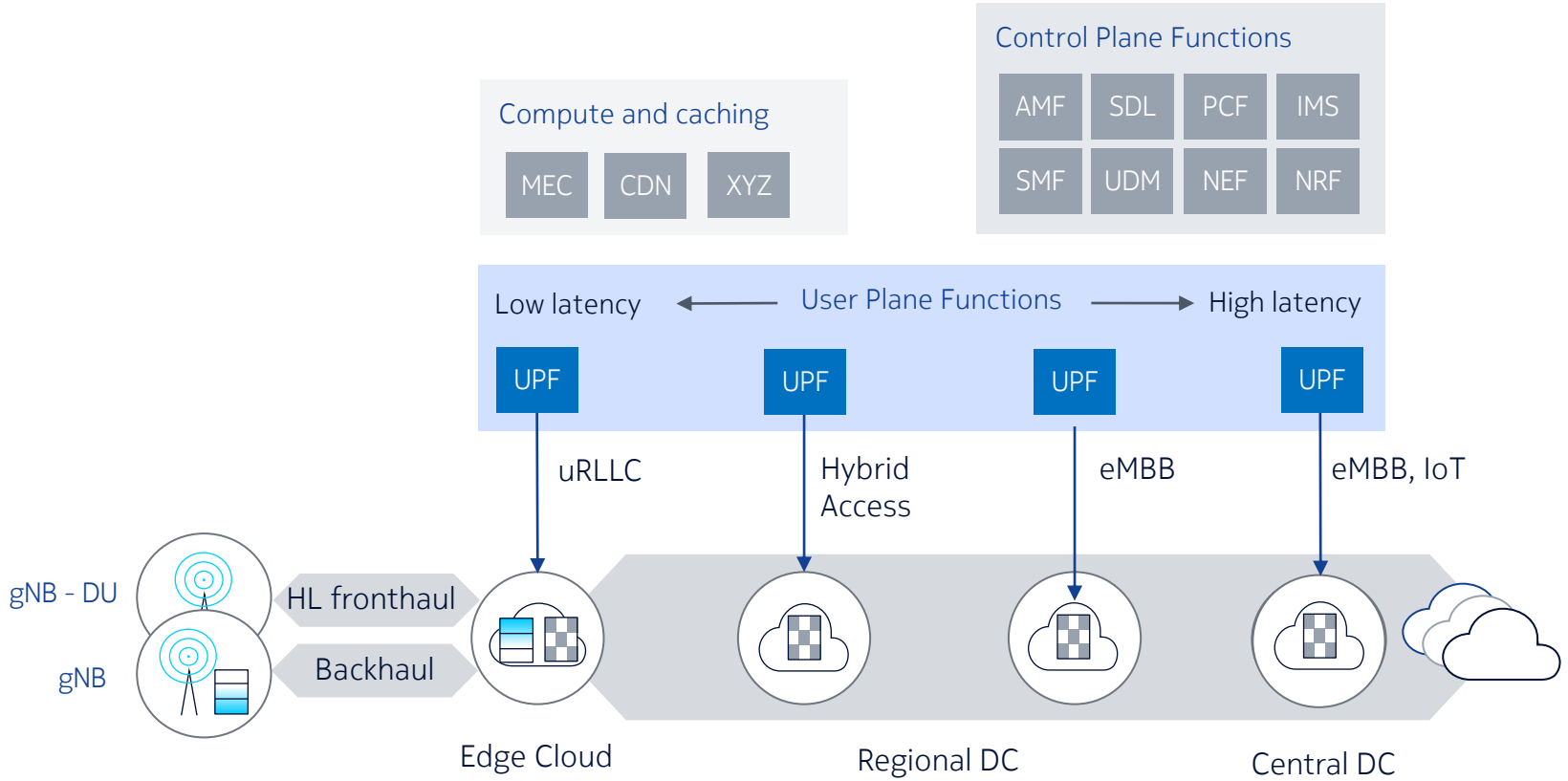
Frequency Range:	3.5GHz
Bandwidth:	100MHz
Average Sector Throughput (2x2):	369Mbps
Average Sector Throughput (4x4):	600Mbps
Peak DL Throughput (2x2)	4875Mbps
Peak DL Throughput (4x4)	9750Mbps

Network Architecture options for 5G RAN



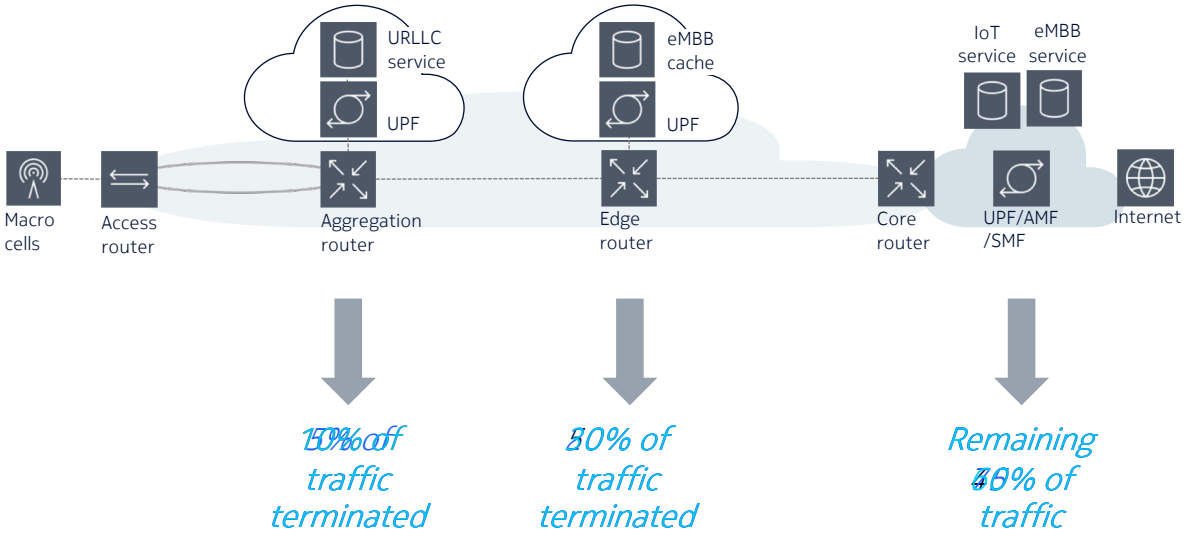
5G system architecture evolution

Cloud Native with Control and User Plane Separation

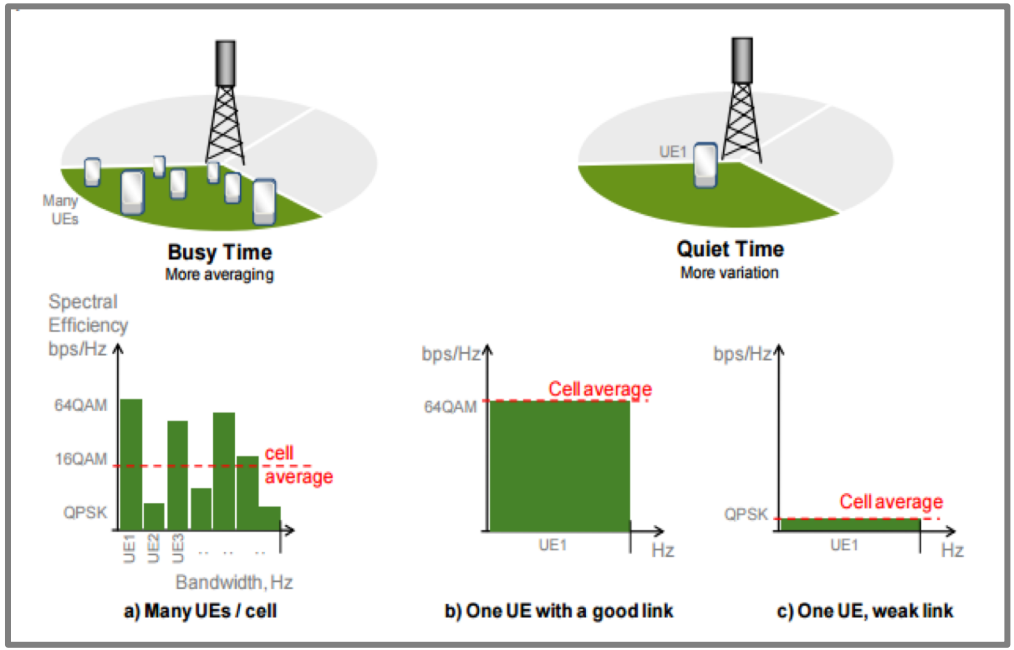


Distributed traffic injection

Traffic no longer needs to be carried all the way to the core and is increasingly terminated closer to users.



NGMN Dimensioning Guideline
Dimensioning Principles



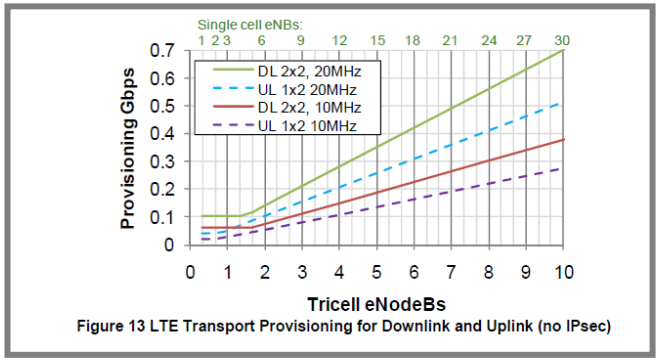
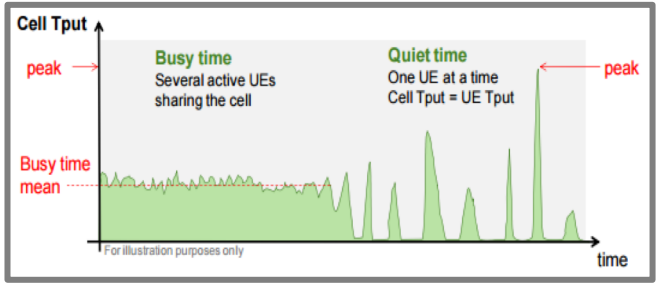


Figure 13 LTE Transport Provisioning for Downlink and Uplink (no IPsec)



Source: "Guidelines for LTE Backhaul Traffic Estimation" by NGMN Alliance
(https://www.ngmn.org/fileadmin/user_upload/NGMN_Whitepaper_Guideline_for_LTE_Backhaul_Traffic_Estimation.pdf)

NGMN Dimensioning Guideline
How do we then dimension ?

- Provisioning for a single cell:
  - should be based on the quiet time peak rate of that cell.
  - But, when provisioning for a multi-sector base station, it is unlikely that the quiet time peaks will co-incide. The busy time mean, however, will occur in all cells simultaneously
- Calculations are based on Peak and Busy Hour Mean values that are dependent on the type and amount of spectrum available.
- There are no absolute rules but heuristic rules can be selected and applied (depending on how peak and mean have been defined). Based on NGMN Alliance guidelines:

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Lower Bound for N cells = Max (Peak, N x Busy Hour Mean)
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(https://www.ngmn.org/fileadmin/user_upload/NGMN_Whitepaper_Guideline_for_LTE_Backhaul_Traffic_Estimation.pdf)

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