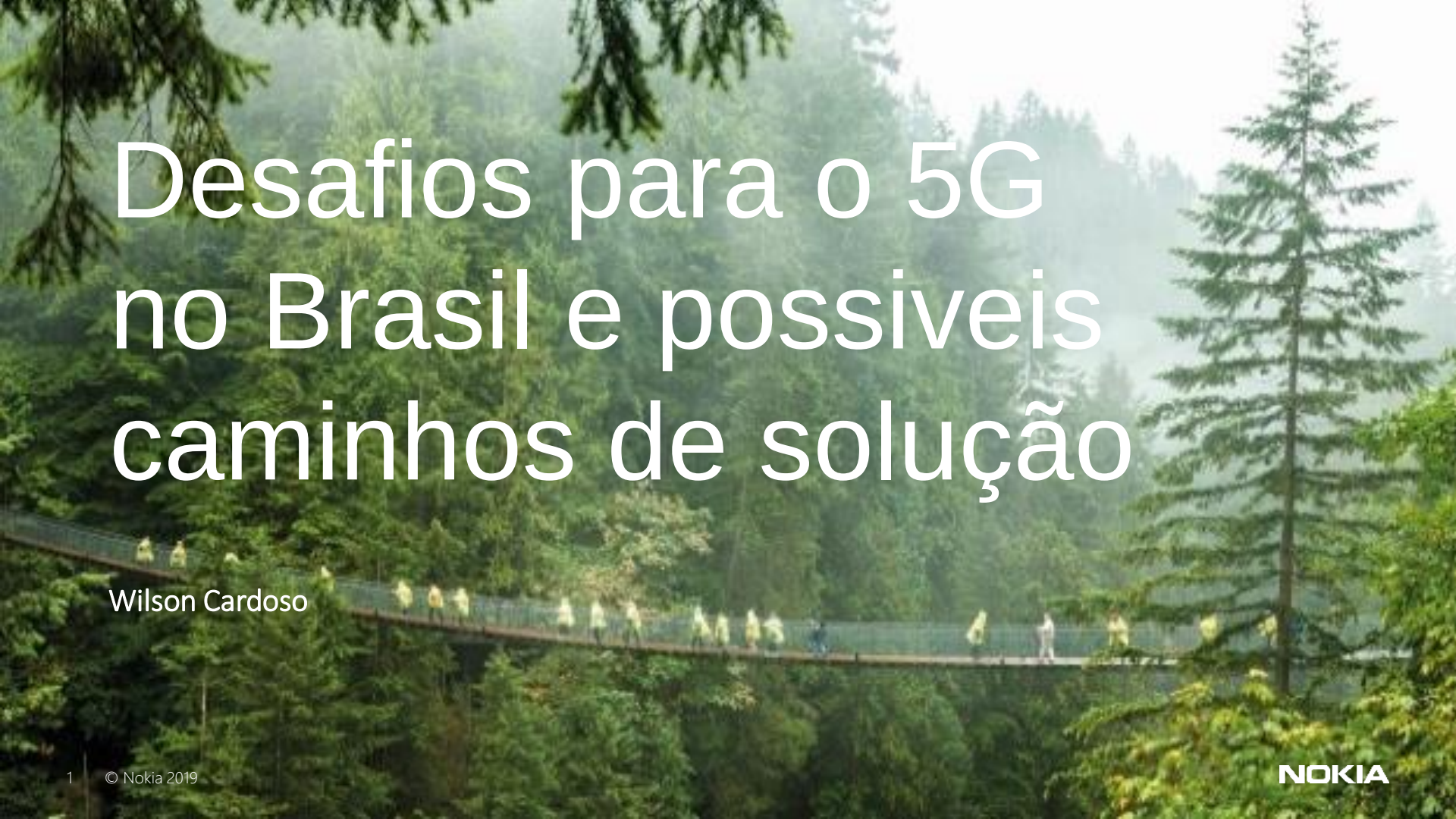

Desafios para o 5G no Brasil e possiveis caminhos de solução

Wilson Cardoso

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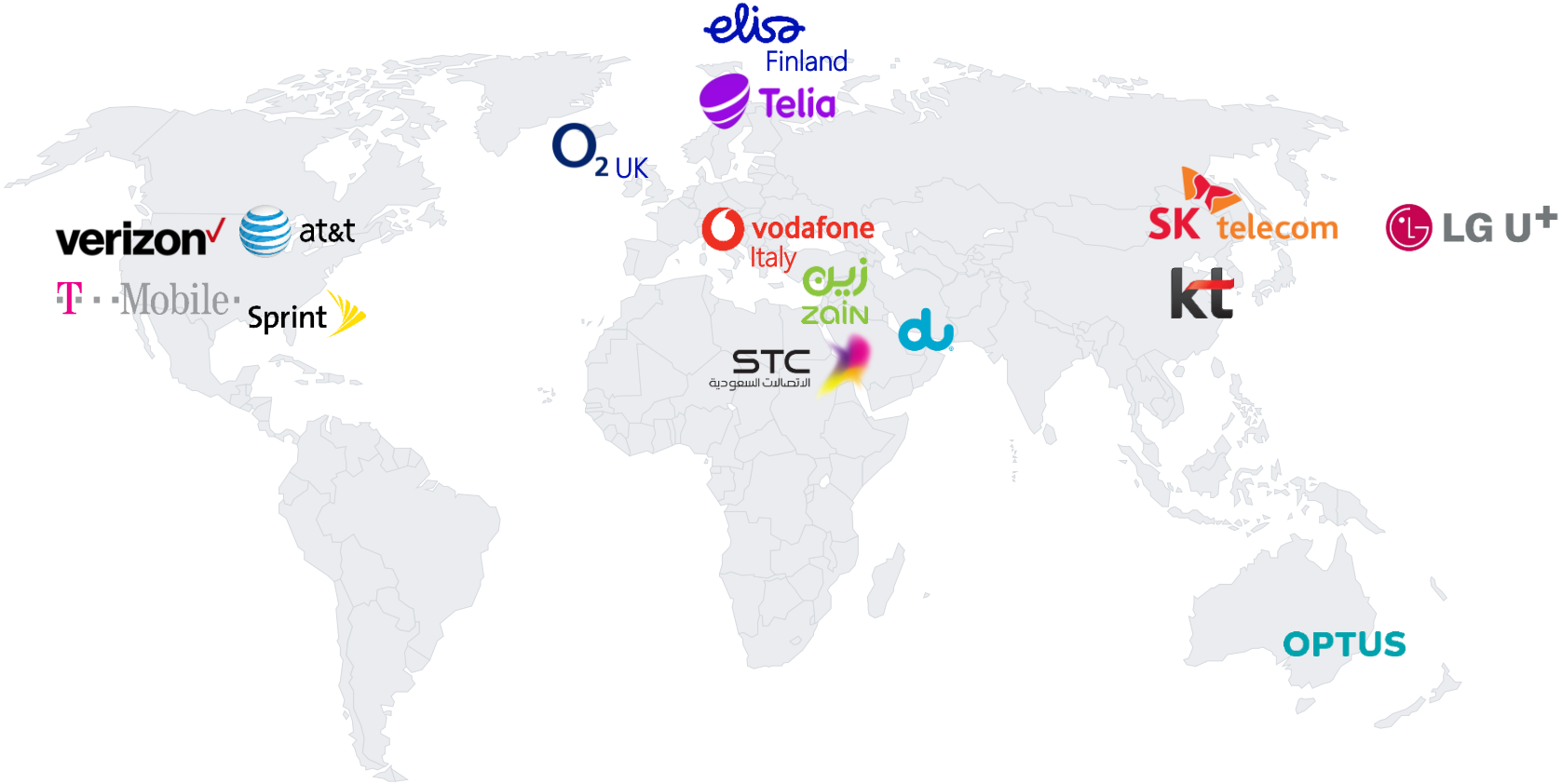
15 live Nokia 5G references - **What have learned this far?**



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5G Use Cases launched
Sprint uses 5G to power Fortnite and Hatch live tournament

5G launch event included Hatch races on phones and Fortnite on PCs – "It's faster than my internet at home," said Fortnite star Wes Johnson

Sprint includes Hatch cloud gaming free for three months on all 5G phones ($7.99 after)

Hatch is a collection of more than 100 mobile games, that can be launched "instantly" with Sprint 5G connectivity without downloads or updates – they're played on servers run by Hatch, via the cloud."

Pricing Plans: SKT – Volume based 5G pricing

Higher ARPU through new plans

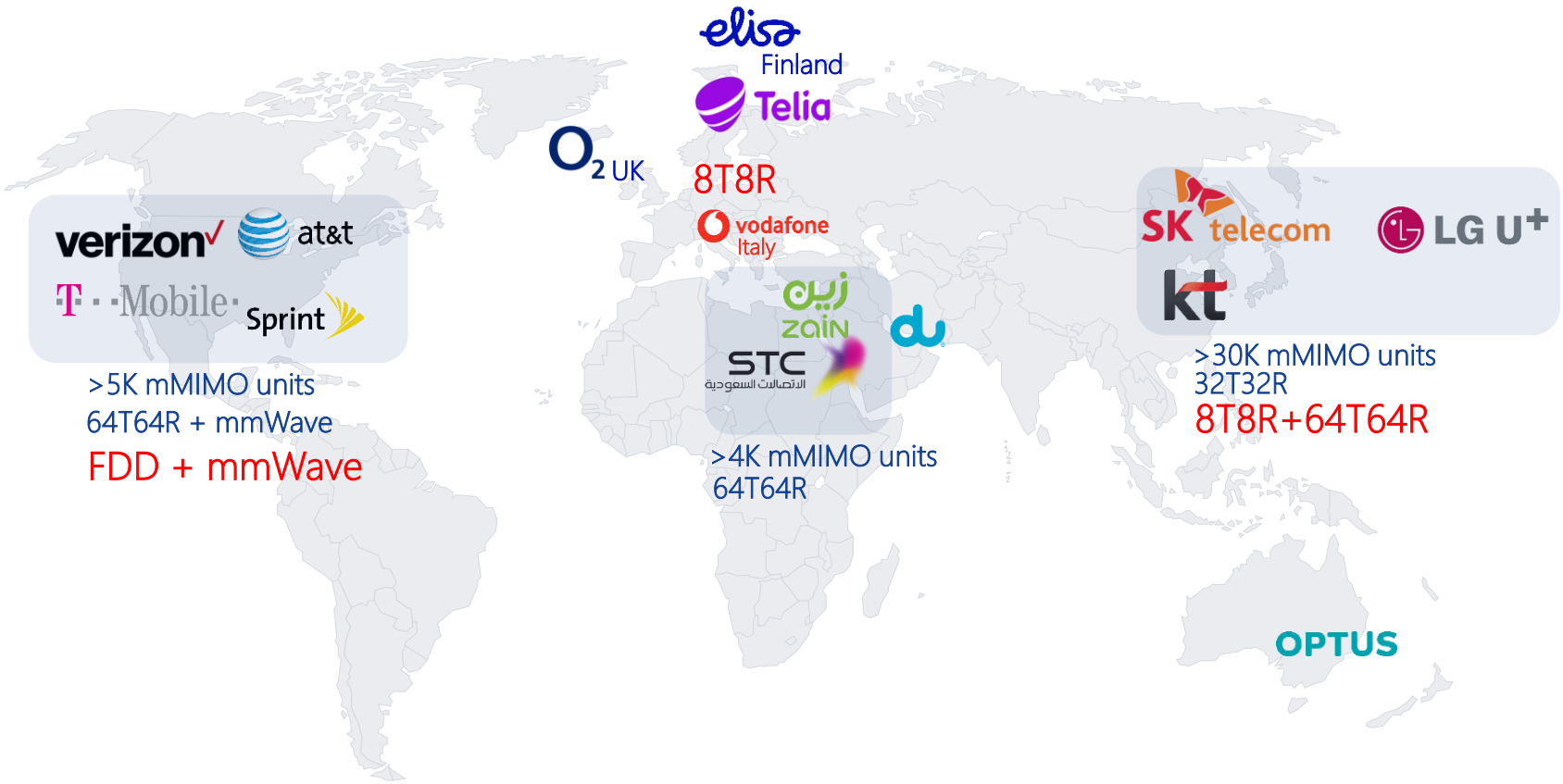
LTE	$28	$42		$67	$85	
	1.5 GB 4G LTE	4GB 4G LTE Unlimited, 1mbps cap thereafter		150GB 4G LTE Unlimited, 5mbps cap thereafter	Unlimited 4G LTE No cap, Tethering 30Gb, 40Gb Family sharing	
5G			$47	$64	$81	$107
			9GB 5G Limited volume	150GB 5G Unlimited 5Mbps cap thereafter. Tethering limit 20Gb.	200GB 5G Unlimited, 10Mbps cap thereafter. Tethering limit 30Gb. 1 other device. Free terminal insurance & VIP benefits. No data cap promotion 2019.	300GB 5G 10Mbps cap thereafter. Tethering limit 50Gb. 2 Other devices. Free terminal insurance & VIP benefits. No data cap promotion 2019.

- Faster speeds with 5G
- New services enabled with 5G
- Goal to reduce number of entry level LTE only plans and more top end 5G plans

"SK Telecom and Microsoft partnership … ensure they are delivering the **best experience** to all the customers. To this end, the two companies will start public preview for **Project xCloud** in Korea in October 2019 **for selected SK Telecom's 5G/LTE subscribers**."

--Microsoft press release

15 live Nokia 5G references – **What have we learned this far?**



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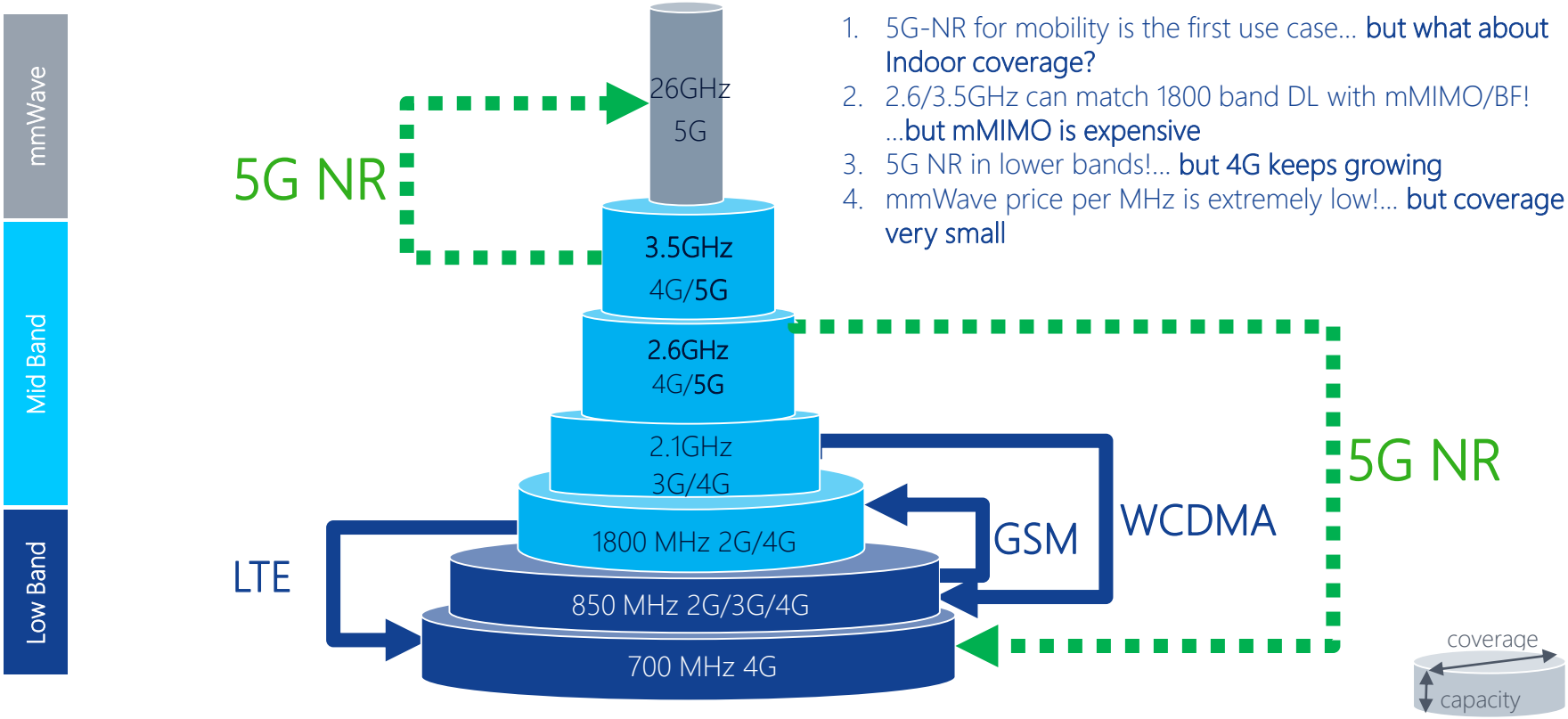
CTO thoughts after launching 5G…

Operator Spectrum – CTO's most precious assets and doubts



1. 5G-NR for mobility is the first use case… **but what about Indoor coverage?**
2. 2.6/3.5GHz can match 1800 band DL with mMIMO/BF! **…but mMIMO is expensive**
3. 5G NR in lower bands!… **but 4G keeps growing**
4. mmWave price per MHz is extremely low!… **but coverage is very small**

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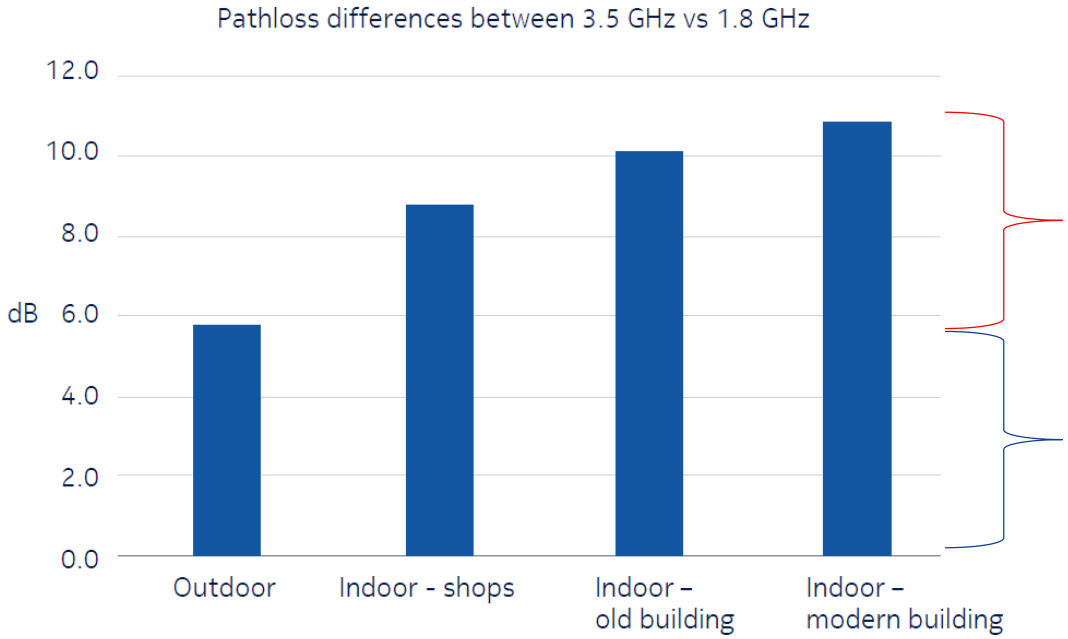
5G NR Mobility is great… But what about Indoor coverage?

5G NR (in mid band) vs. Walls' Pathloss

Managing the challenge of implementing mid band over a 1.8GHz grid



Indoor scenarios are not compensated with mMIMO, and the coverage challenges we see already in mid band with 1.8GHz is more evident with 2.6/3.5 GHz.

mMIMO improves 6-7dB's and compensate Outdoor coverage, however struggles with Indoor coverage

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AirScale Indoor Radio System (ASiR)

5G Ready indoor solution, with low OPEX, fast installation, ability to leverage IBS installed base and deliver an enhanced end-user experience

CAPEX savings

- Supports 2G, 3G, 4G and 5G
- Leverage existing IBS installed base via RFC
- Graceful 5G insertion via chaining

OPEX Savings

- 100% Macro software parity, no extra testing
- Single Frequency Network for FAST and EASY planning

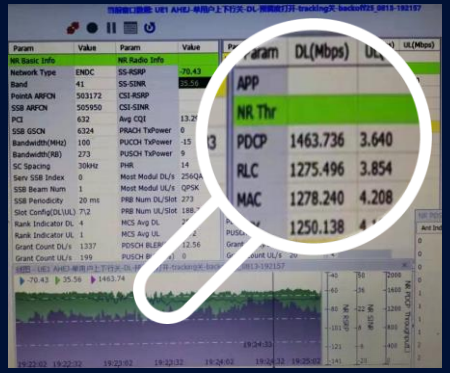
User Experience

- Distributed MIMO, CA, 256 QAM

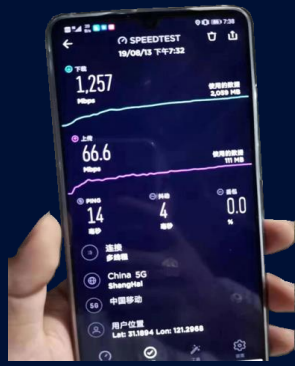
China Mobile Shanghai @ China International Import Expo (CIIE)

Boosting 5G In-building with AirScale Indoor Radio & Micro RRH

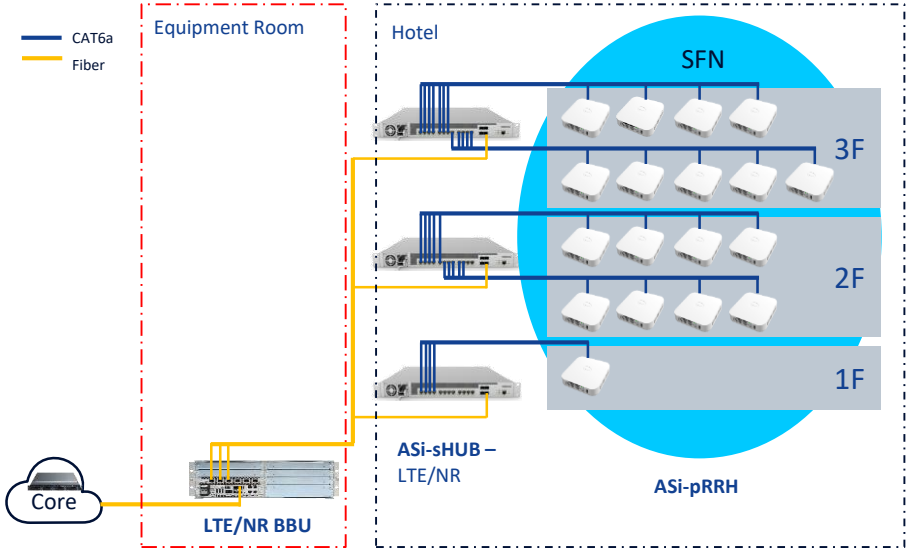
1463Mbps
FTP Max DL speed



1257Mbps
SPEEDTEST Max DL



NR Carrier: 1x100MHz @n41 (4layers 256QAM – 1240Mbps)
LTE Anchor Carrier: 1x20MHz @B3 (2layers 256QAM – 223Mbps)

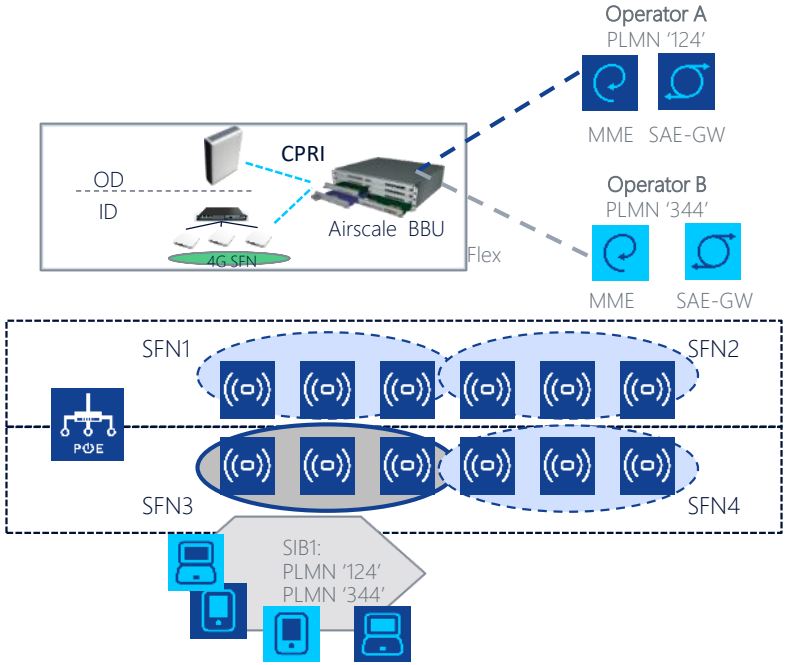


2G/3G/4G Availability:	Q4'19
5G availability:	5G19A (C5 P1'20)
Pilots Done:	DU UAE
Pilots Q4:	STC, Zain, Mobily, Maroc Telecom, Vodacom RSA

LTE Network Sharing

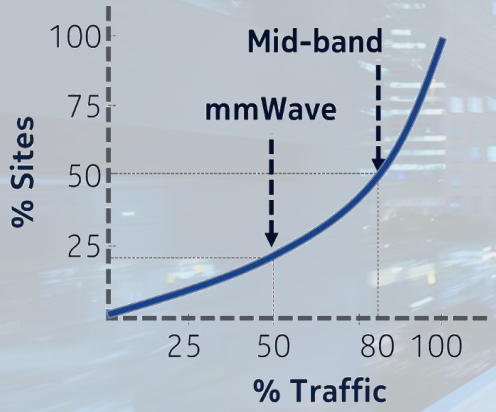
MOCN/MORAN available on AirScale Indoor

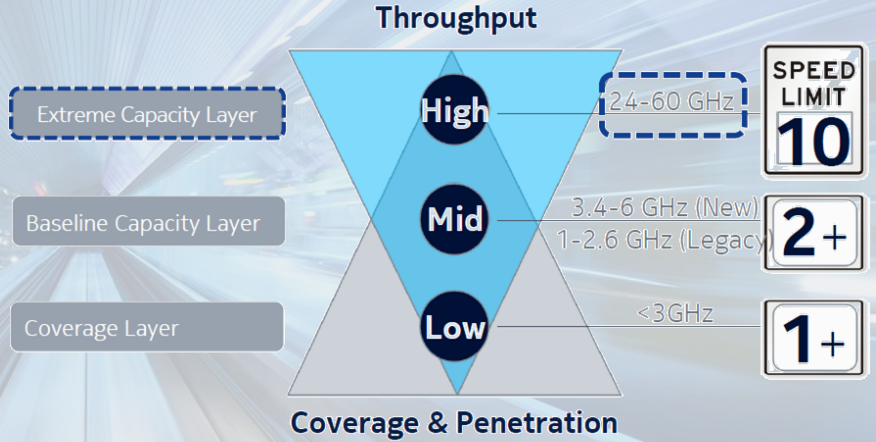
- Multi-operator Core Network (**MOCN**) enables network sharing among operators **with shared spectrum**
- Mobile Operator Radio Access Network (**MORAN**) enables sharing among operators **with dedicated spectrum**
- Available with macro parity
- Support to up 6 operators
- Supported with both stand-alone micro/pico as well as under Flexi Zone Controller
- Each operator sharing the network has its own EPC
- Same LTE functionality / feature set
- All core network related functions transparent for LTE (e.g. Billing, Policy Control) not affected by MOCN



A vital role for small cells in 5G

Small **Cells** Forum predicts that 5G or multimode small cells deployments will grow strongly after 2020*





- **Mid-band (3.5 GHz)**

provide nationwide 5G coverage and capacity for main urban areas and some industrial applications

- **mmWave**

bands such as 28 GHz and 39 GHz will deliver extreme capacity for very high density areas and demanding industrial needs

*Source: https://5g.co.uk/guides/small-cells-hetnets-5g/

2.6/3.5 can match 1800 DL with mMIMO/BF...

but mMIMO is expensive?

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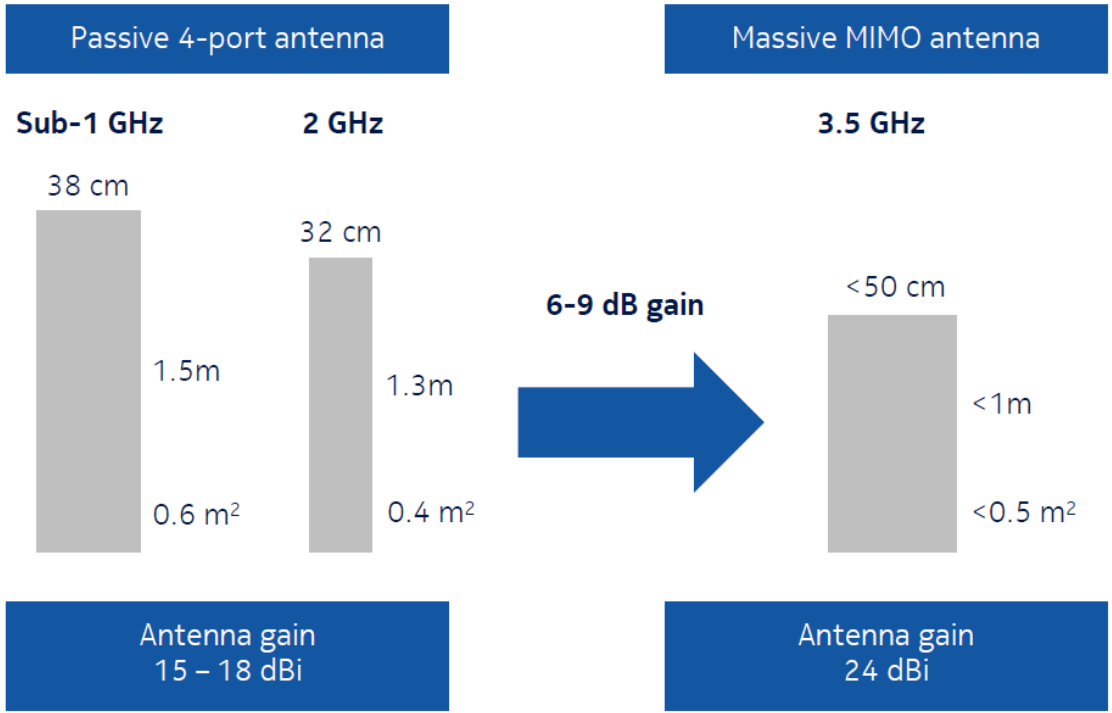
mMIMO impact in a network

Positive and negative points



- mMIMO compensates DL differences with lower mid-bands
- mMIMO provides great capacity gains
- 5G NR subscribers will grow faster than LTE
- mMIMO has a huge impact in site solution as it's being deployed mainly with 64T64R units that increase tower load

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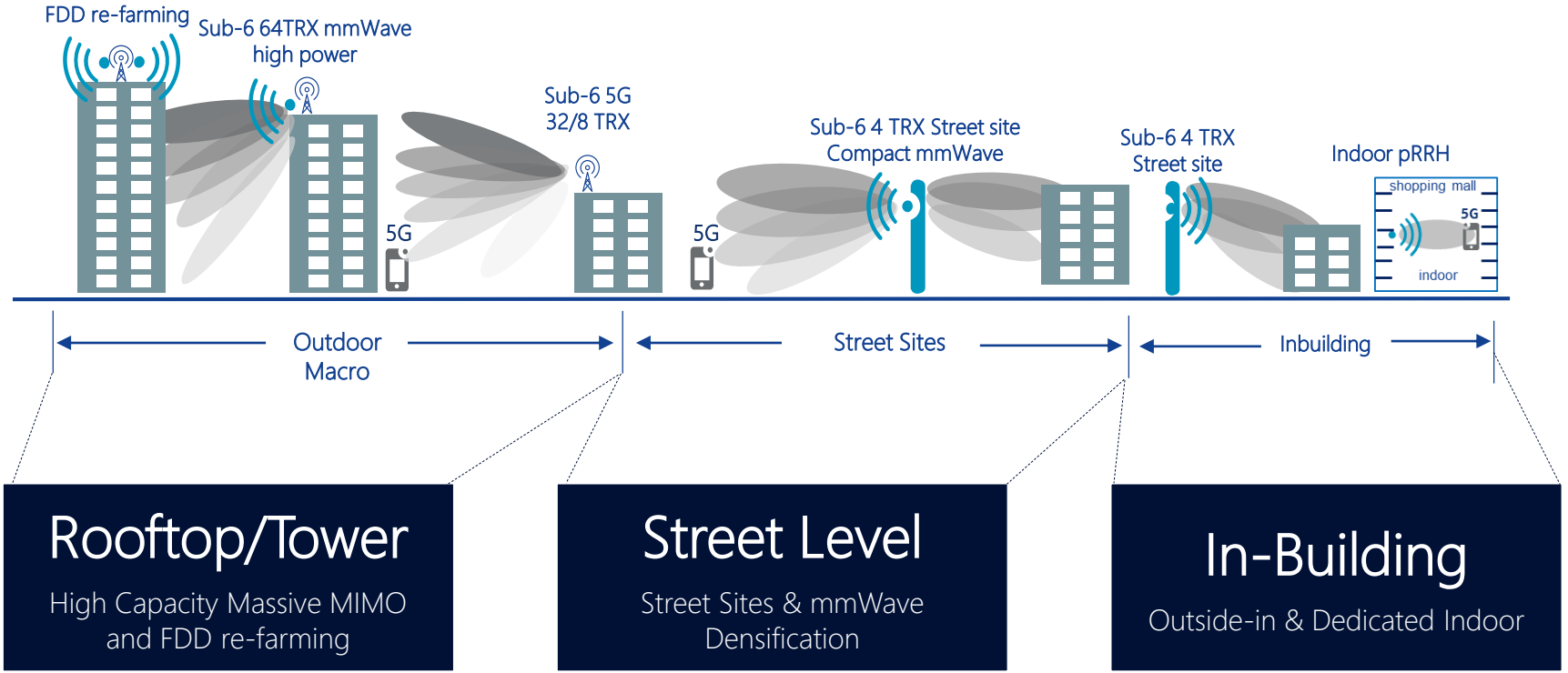
Commercial 5G implementation goes beyond 64T64R



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5G in lower bands...
but 4G keeps growing

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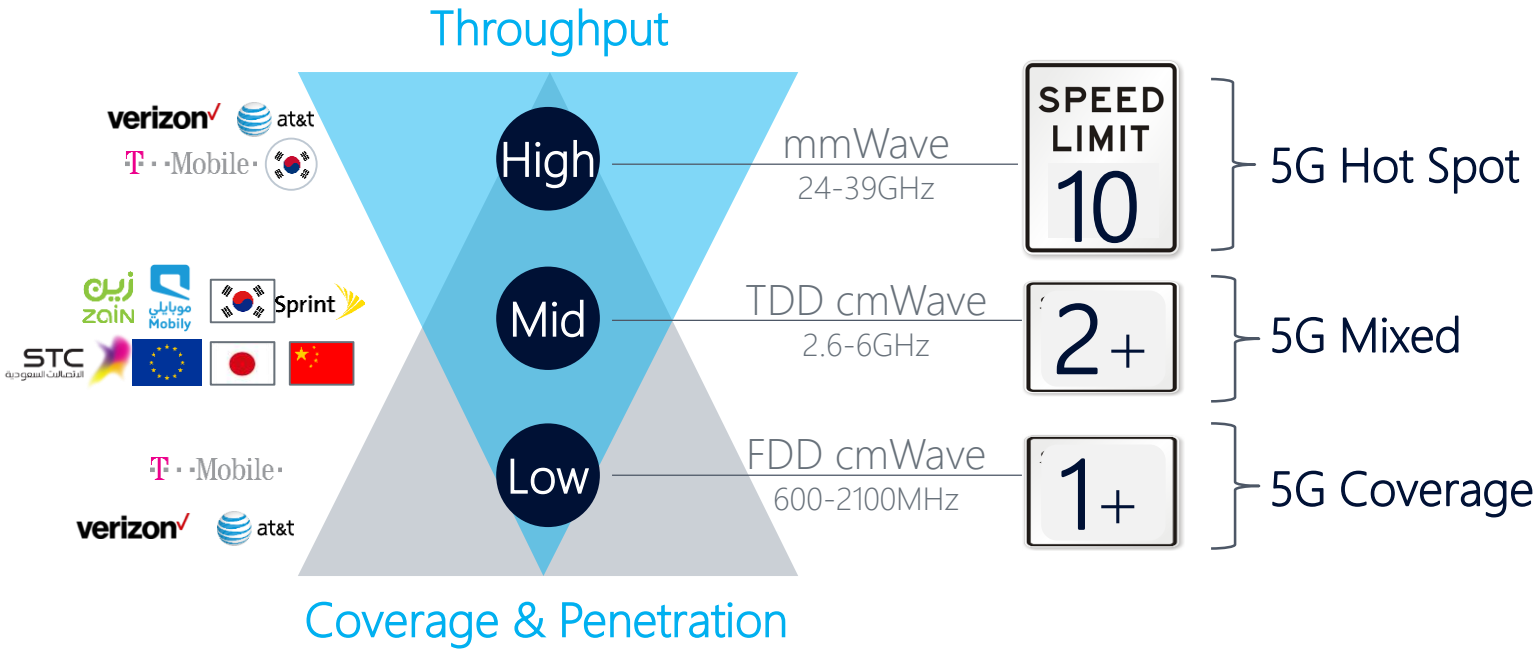
5G Network strategies…



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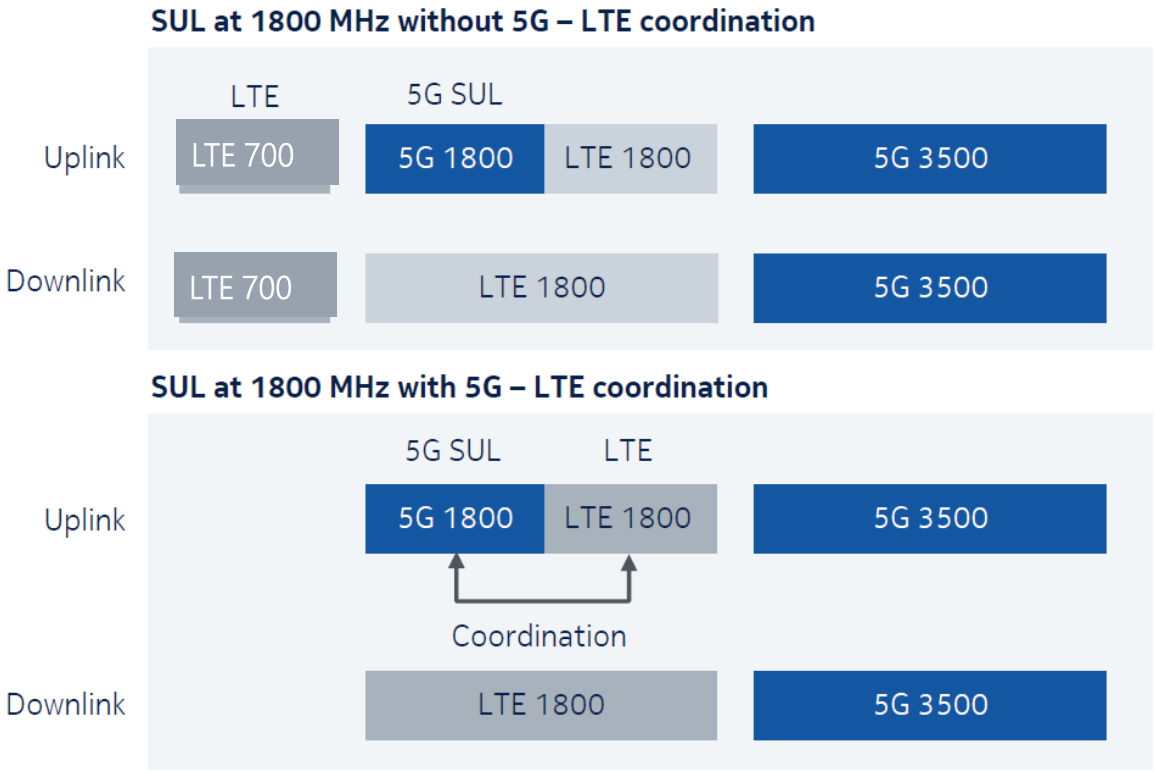
The truth about Supplementary Uplink

Concept will be very important in the future



- SUL can potentially compensate 5G coverage
- SUL can be implemented with minimal effect in 4G UL
- SUL requires handsets support
- SUL requires actual 5G implementation in the lower band

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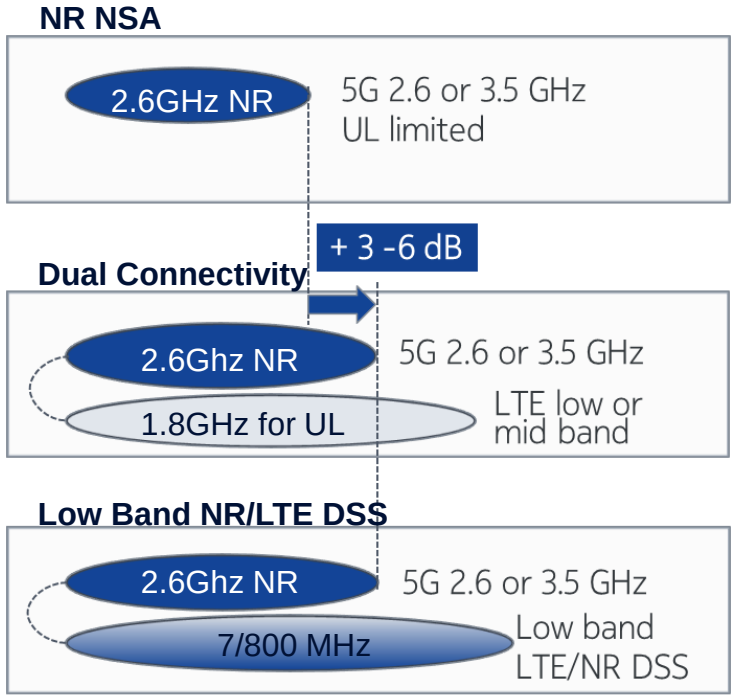
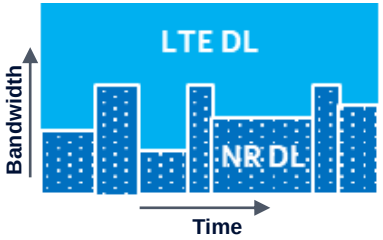
Extend 5G through low band FDD NR
Sprint / TMO Example



- Allows nationwide 5G coverage
- Better Uplink performance
- Dynamic Spectrum Sharing (DSS) to gradually turn LTE carriers into NR
- FDD NR also suitable for Low-latency services



Dynamic Spectrum Sharing (DSS)

Resources shared dynamically between LTE and 5G

Improved 5G Coverage with Low Band

Dynamic Spectrum Sharing rollout

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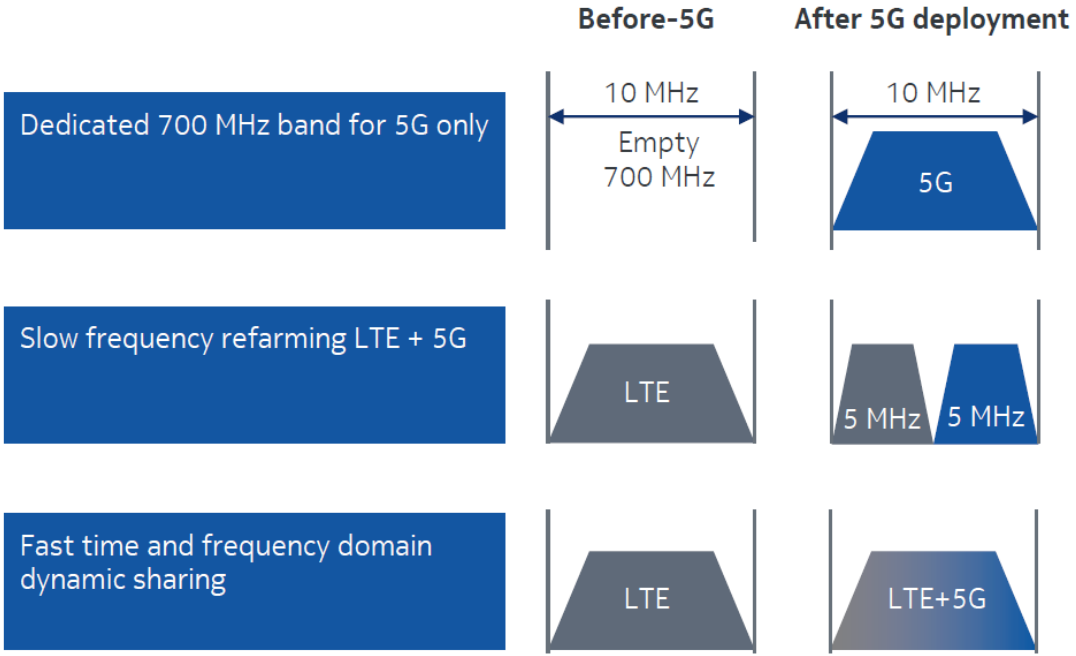
DSS for coverage expansion

FDD Dynamic Spectrum Sharing is used to enable DL 5G capacity in FDD



- DSS is a dynamic functionality that allows an **efficient use of the spectrum** capacity depending on the traffice
- DSS will be available **for FDD only in Q3'20**.

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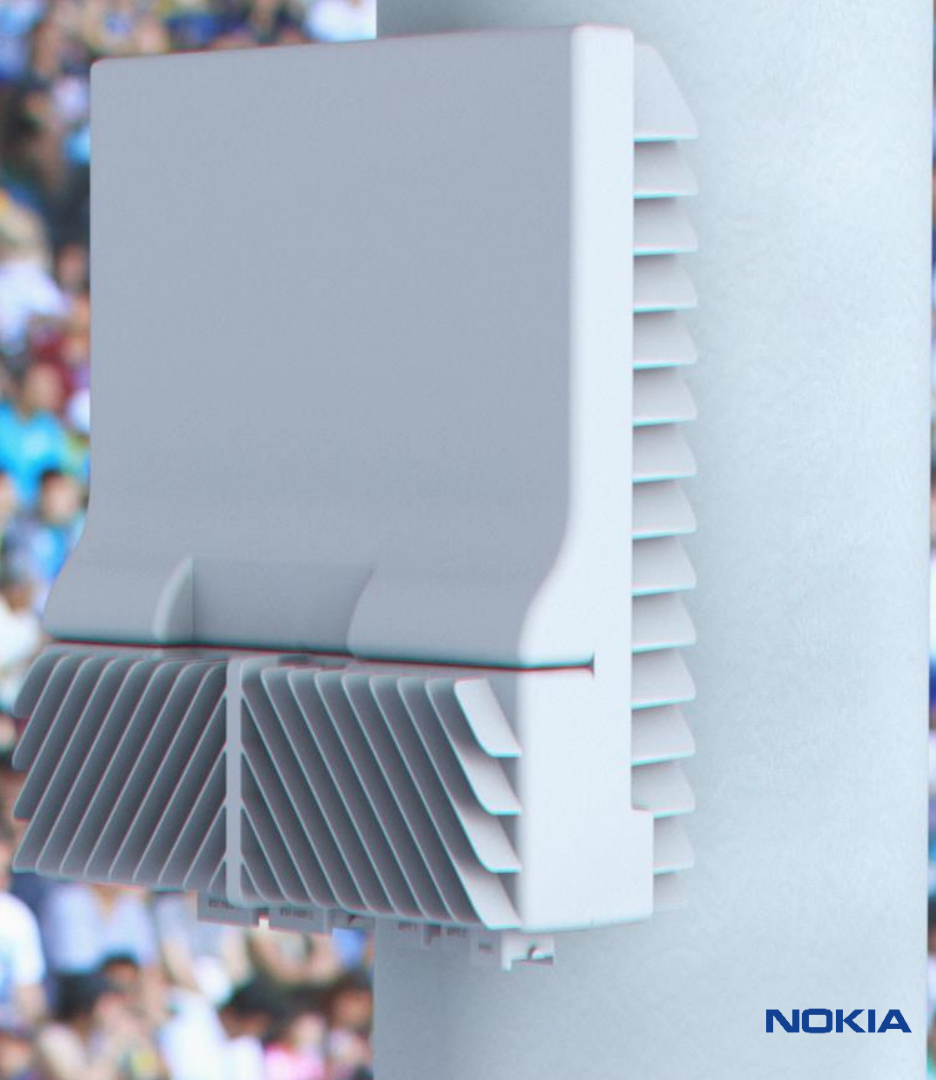
mmWave price is low... but coverage is very small

AirScale mmWave Radio

Versatile, enabling fast capacity roll-out

Integrated ”All-in-One” design for street level and hot zone deployments

- 26,5 - 29,5GHz (n257)
- IBW/OBW 1400MHz/800MHz
- EIRP: 55 dBm
- 128 AE (2T2R)
- <10litres, <10kg
- General Availability: Q4 2019



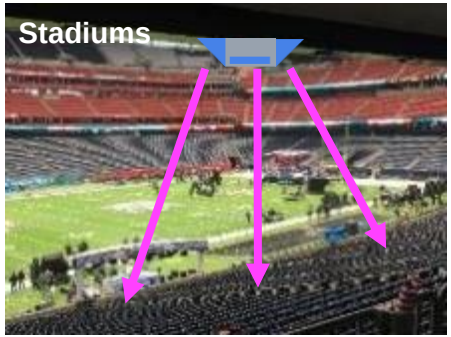
mmWave Use cases & challenges

Focus is on areas of extreme capacity

Fixed Wireless

Enhanced mobile broadband. Hot Spots

Stadiums, Airports



King Fahad International Stadium

Convention Centers

Riyadh Exhibition Center

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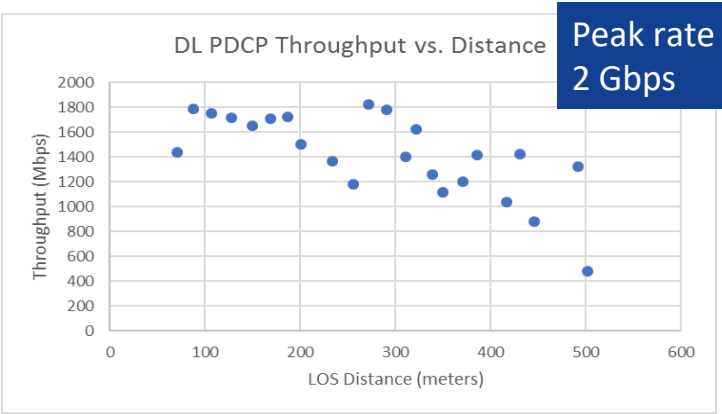
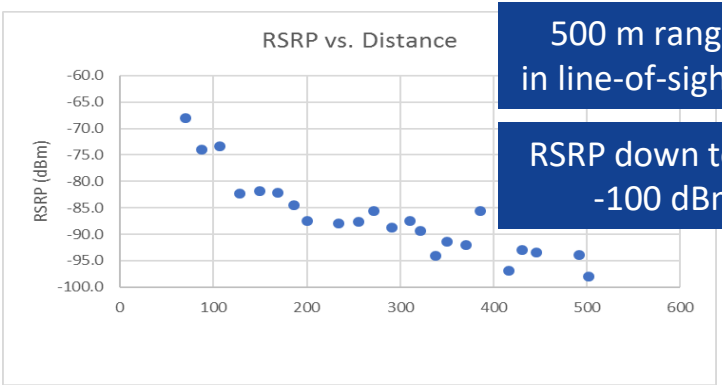
mmWave Field Performance: Manhattan Test Results 400MHz BW

Excellent Peak Speeds with coverage challenges

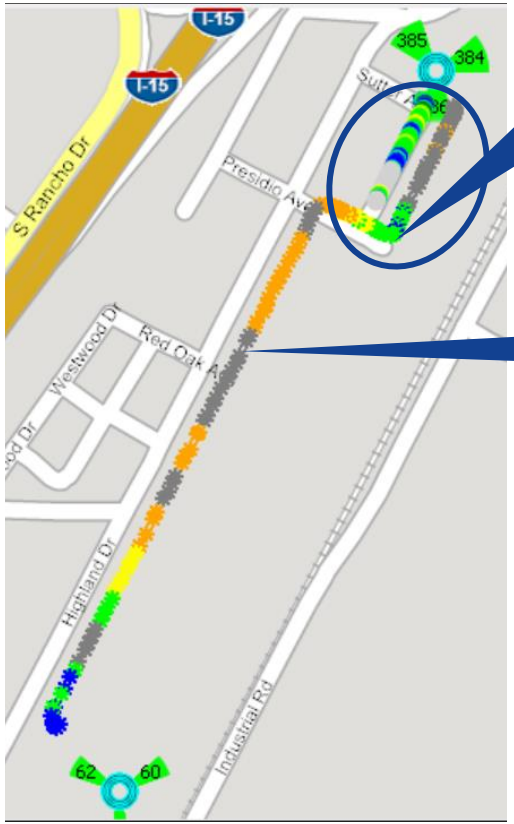


Peak rate
2 Gbps



500 m range
in line-of-sight

RSRP down to
-100 dBm



mmWave range
approx. 150 m
Cell edge
630mbps

UE connected to
LTE

Available now, depending on exact frequency availability

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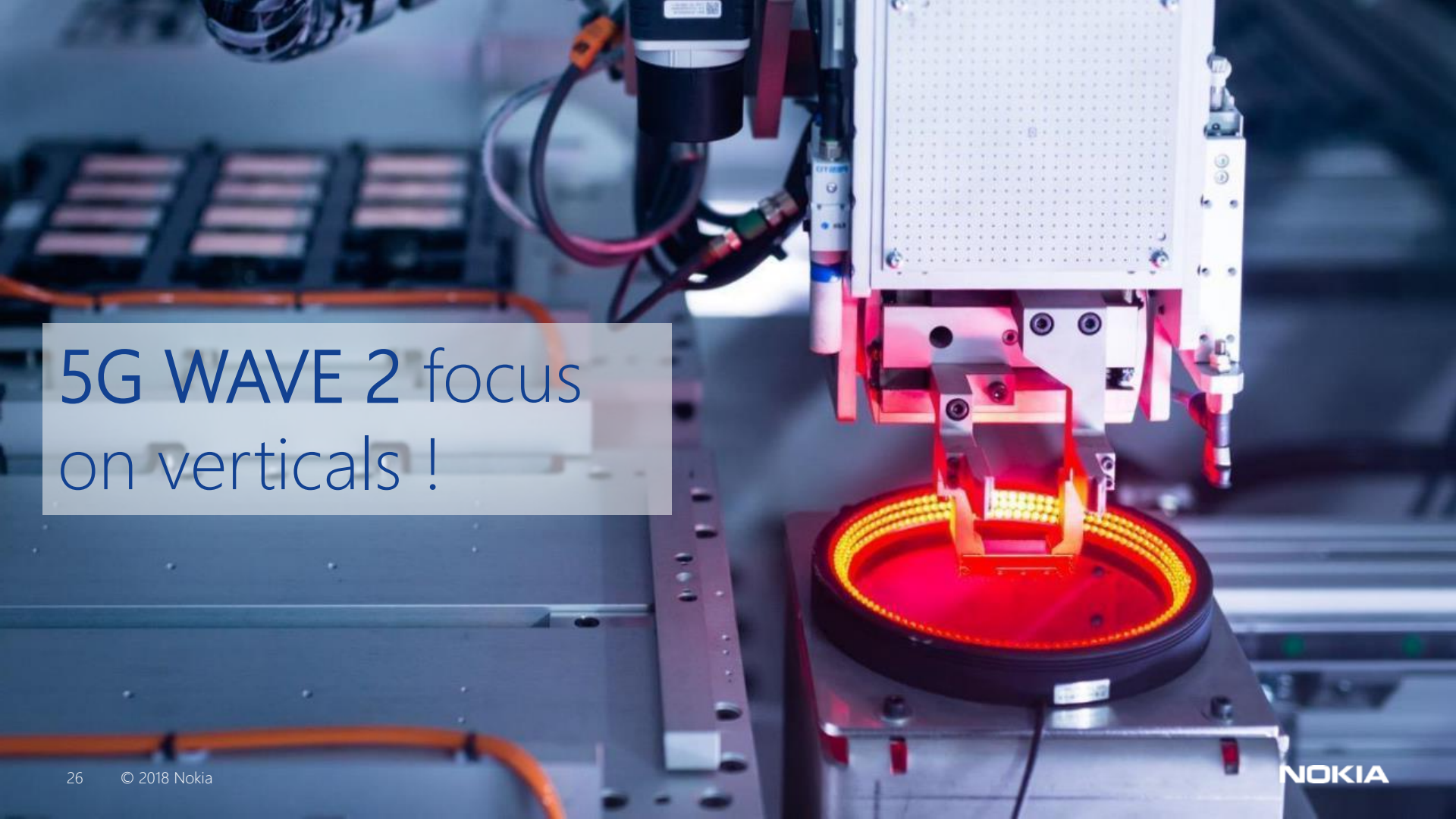

5G WAVE 2 focus on verticals !

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Obrigado

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