5G Beyond Mobile Broadband

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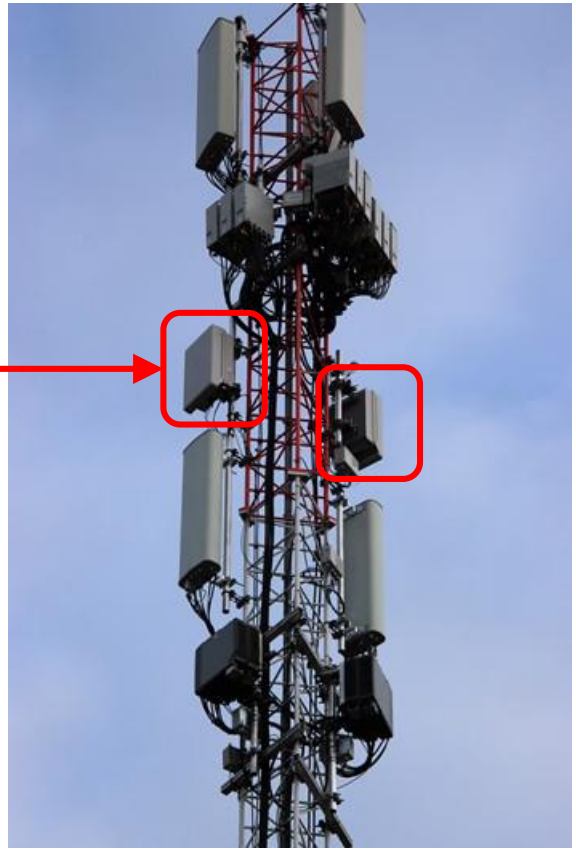
NOKIA 5G TNF

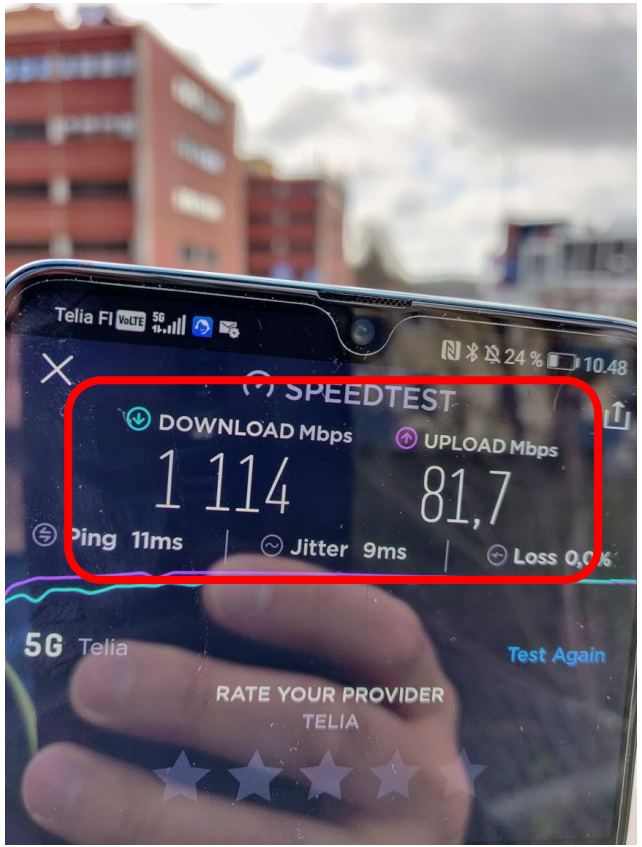
5G Today – Great for Mobile Broadband (and Fixed Wireless as well)

5G + 100 MHz bandwidth + massive MIMO antenna gives great capacity

Nokia 5G massive MIMO antenna in Helsinki
“Small in size – massive in performance”

“Tuhatta ja sataa 5G:lla”





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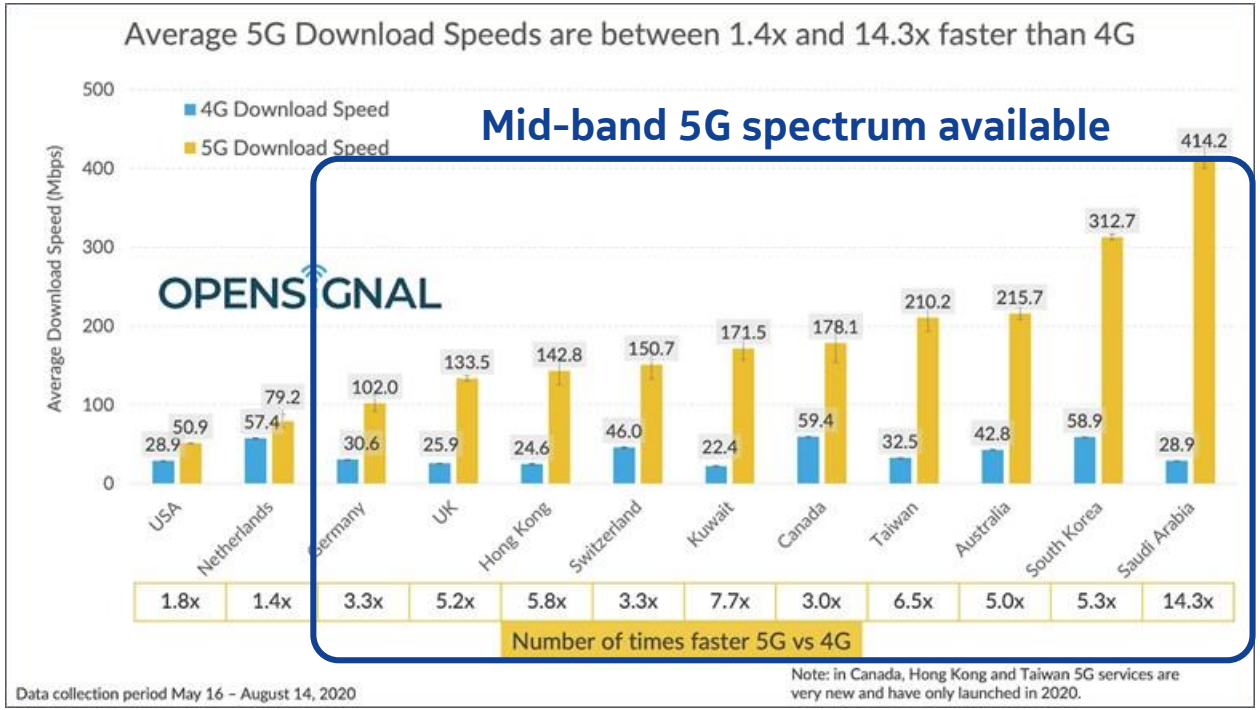
5G on Average 6x Faster than 4G if Mid-band Spectrum is Available
OpenSignal Study May – August 2020



- 5G data rate is 3.3 – 14x faster than 4G in those markets where 2.6/3.5 GHz band is available
- 5G on average 6x faster than 4G

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5G Next Phase – New Services

	5G Phase 1 = Mobile broadband	5G Phase 2 = Critical services & slicing
Solution	• 4G core network • Non-standalone (NSA) • Existing base station sites • 3.5 GHz band	• 5G core network • Standalone (SA) • Distributed edge • Low band 5G or mmWave
Benefits	• 5-10x capacity • 5-10x data rate	• Low millisecond latency • High reliability 99.999%

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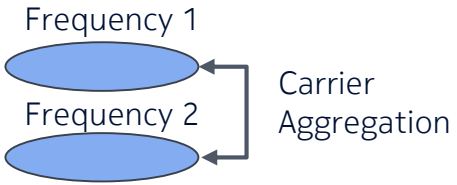
5G Components: FDD Bands + SA Architecture + Carrier Aggregation

5G coverage		5G services		5G data rates
5G FDD Optional Dynamic spectrum sharing	+	5G SA 5G core network	+	5G CA Carrier aggregation
RF sharing is a great solution for seamless migration of 5G FDD into LTE bands		5G FDD in low band needed with 5G SA for wide area access to new 5G core services		5G CA is needed to boost 5G data rates (LTE dual connectivity not available in SA)



FDD = Frequency Division Duplex (low bands)
SA = StandAlone
CA = Carrier Aggregation

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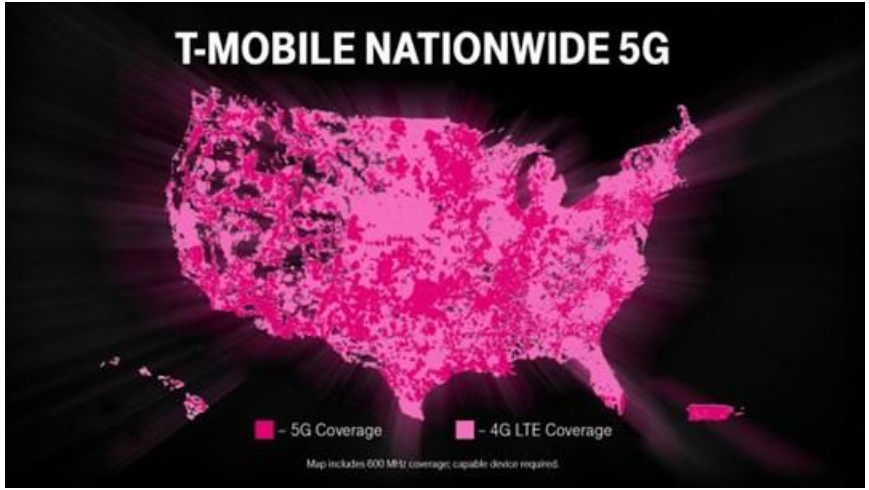
T-Mobile Launched Nationwide 5G at 600 MHz in December 2019



600 MHz spectrum and RF shared between LTE and 5G for great 5G coverage

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T-Mobile Launched Nationwide SA Network in August 2020

NETWORK

T-Mobile Launches World's First Nationwide Standalone 5G Network

August 04, 2020

Standalone 5G allows the Un-carrier to massively expand its 5G footprint, bringing next-gen connectivity to more places while paving the way for future groundbreaking applications

- Coverage +30% because no need for mid-band LTE anchoring
- Setup time improved by 90% because no need for LTE signalling
- Handover latency reduced by 60% because no need for LTE mobility
- Nokia radio network and Nokia core network

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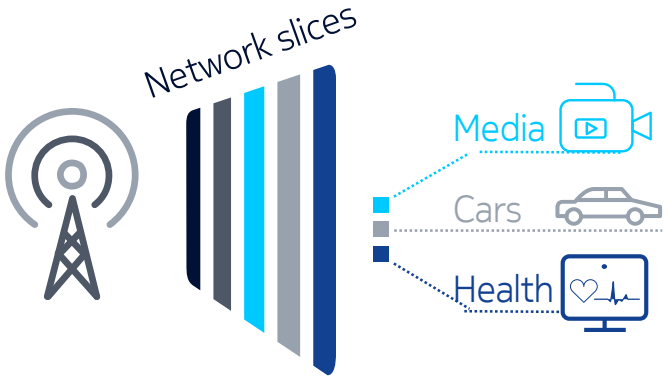
Two Options for Ultra Reliable Low Latency Communication (URLLC)

Option 1: Public networks with slicing

- Guaranteed quality with slicing
- Slice allows different security levels
- Example cases: public safety, remote control of machinery



Option 2: Dedicated local network

- Dedicated local network
- Customized security
- Example case: private LTE at Helsinki airport or Rio Tinto mine

Konecranes, Nokia and Ukkoverkot to operate - smart cranes depart on the 5G journey

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High Interest for Private 5G Licenses in Germany

67 local licences in 10 months

Bosch applies for private 5G licences for Industry 4.0

26 NOVEMBER 2019

Industrial IoT

Siemens applies for private 5G spectrum licences

Volkswagen to build private 5G networks from 2020; invites tenders from kit vendors

Nokia and Hitachi Kokusai Electric bring local 5G and private LTE networks to Japanese enterprises

"Private campus networks offer a maximum of security and independence"
"5G speeds up industrial manufacturing processes. By establishing local 5G networks, we will be able to take a significant leap forward in our ambitions to create the factory of the future"

Rolf Najork, the Bosch management board member responsible for industrial technology.

Nokia has more than 100 private network contracts

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Main 5G Spectrum Blocks in Finland

700 MHz spectrum (2x10 MHz per operator) auctioned 2016

703/758 MHz DNA elisa Telia 733/862 MHz

DNA 10 MHz	Elisa 10 MHz	Telia 10 MHz

Coverge

3.5 GHz spectrum (130 MHz per operator) auctioned 2018

3410 MHz Telia 3540 MHz elisa 3670 MHz DNA 3800 MHz

Telia 130 MHz	Elisa 130 MHz	DNA 130 MHz

Capacity

Hot spot

26 GHz spectrum (800 MHz per operator) actioned in June 2020

24.25 GHz 25.1 GHz 25.9 GHz 26.7 GHz 27.5 GHz

850 MHz (local)	800 MHz	800 MHz	800 MHz

Local elisa Telia DNA

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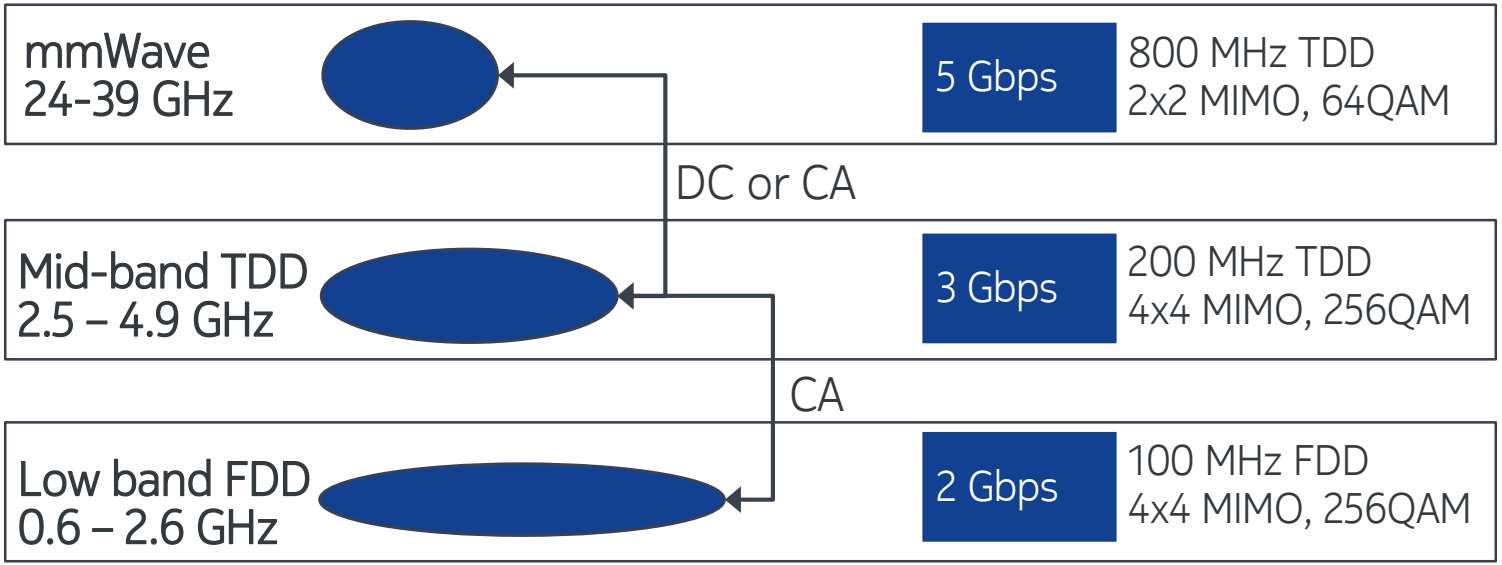
Multiband Integration: Dual Connectivity and Carrier Aggregation



CA = Carrier Aggregation
DC = Dual Connectivity

=10 Gbps combined data rate

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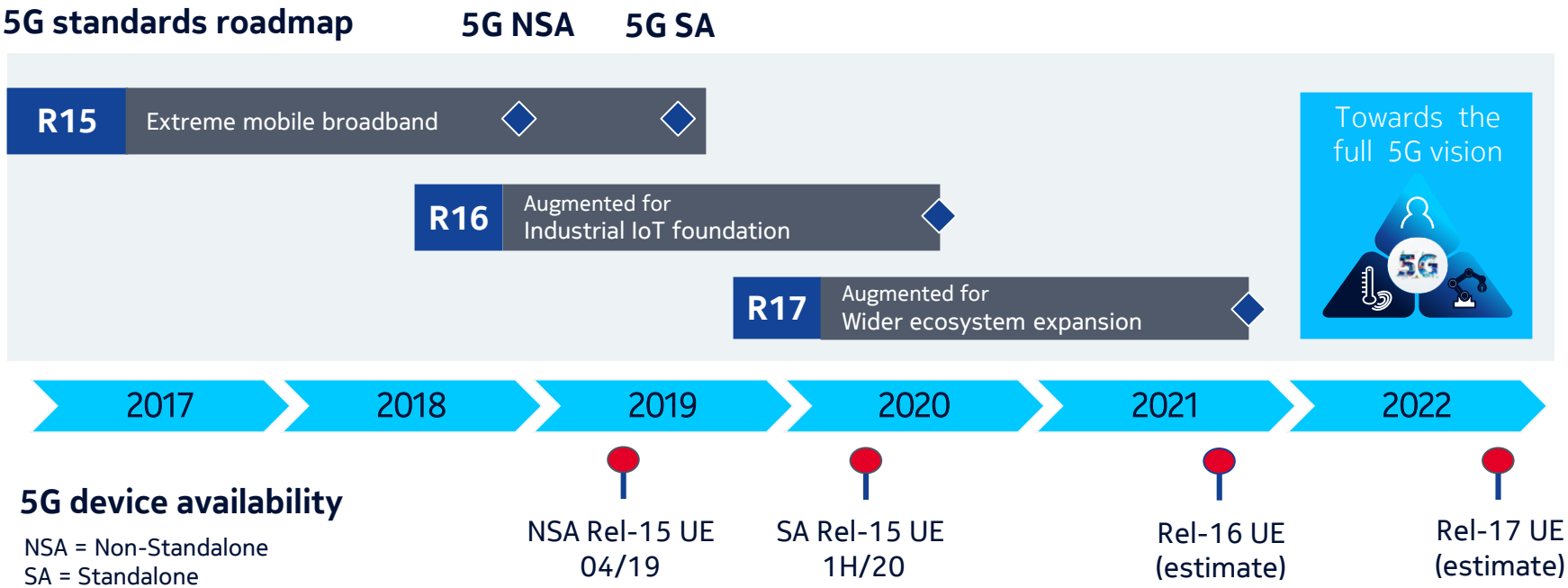
Realizing the full promise of 5G through 3GPP evolution



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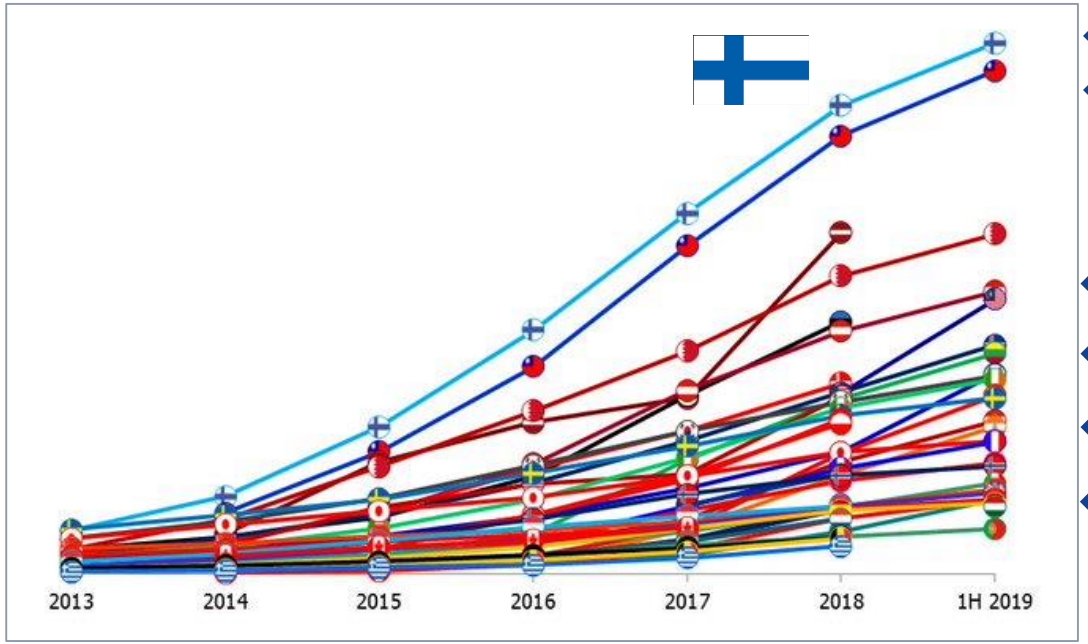
Finland Leading in Mobile Data Usage in GB per Person



Finland
Taiwan

USA
Korea
India
Germany

”Käytä dataa Suomen poika, ettei Taiwan meitä voita…”

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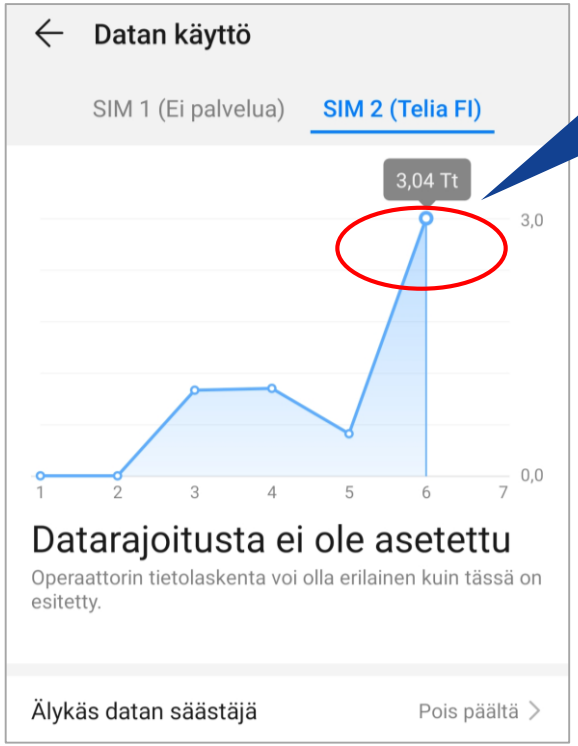
My mobile data usage = 3.0 TB/day. Single day. Single user. Single device.



My data usage 3.0 terabytes.

One day.
One user.
One device.

- That is roughly equal to mid-sized German town mobile data usage with 30.000 inhabitants.
- That is more mobile data than the average person has used in his entire life.

Serving Telia 5G BTS

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5G Book published!

5G Technology: 3GPP New Radio

Harri Holma, Antti Toskala, Takehiro Nakamura

- Contributors from Nokia Bell Labs, Nokia, NTT Docomo, Mediatek and Skyworks from nine different countries
- Specifications in 3GPP Releases 15-16 explained
- Performance and dimensioning discussed
- Devices RF and baseband design presented
- 5G millimeter wave measurements illustrated
- IoT evolution explained
- 500 pages

https://www.wiley.com/en-fi/5G+Technology:+3GPP+New+Radio-p-9781119236313

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Thank you