

5G mmWave Summit

Thursday 29th September

MWC Las Vegas 2022

5G mmWave Summit

Peter Jarich

Head of GSMA Intelligence

5G mmWave Summit

Alex Sinclair

CTO, GSMA



5G and 5G mmWave
A Global Perspective
Alex Sinclair, CTO

A long-exposure photograph of a road at dusk. The road curves from the bottom left towards the center right. Light trails from cars are visible, with a prominent bright yellow and white trail in the distance. The sky is a deep blue with scattered clouds, and several colorful light trails (pink, orange, and white) arc across the upper portion of the frame. The overall mood is futuristic and dynamic.

5G's Unprecedented Momentum




GSMA™ Supporting 5G



**“GSMA Announces
Formation of 5G mmWave
Accelerator Initiative as
part of Continued 5G
Global Support”**

(November 2021)



**Deployment
Best Practices**

5G mmWave Summit

Peter Jarich

Head of GSMA Intelligence

5G mmWave Summit @ MWC Las Vegas

The “Why” of mmWave 5G

...and why it’s a global “when” not “if” discussion

DATE

SEPT 2022

AUTHOR

P. Jarich

The “Broad Perspective” on mmWave 5G

and they say the last speaker has it tough!

5G Adoption Trends / Status

GSMA Support for mmWave 5G

What Have You Heard?

The “Broad Perspective” on mmWave 5G

and they say the last speaker has it tough!

5G Adoption Trends / Status

GSMA Support for mmWave 5G

Monetization and Adoption Momentum

Ecosystem Development Momentum

Operator Views and Insights

What Have You Heard?

What Will You Hear?

The “Broad Perspective” on mmWave 5G

and they say the last speaker has it tough!

5G Adoption Trends / Status

GSMA Support for mmWave 5G

Monetization and Adoption Momentum

Ecosystem Development Momentum

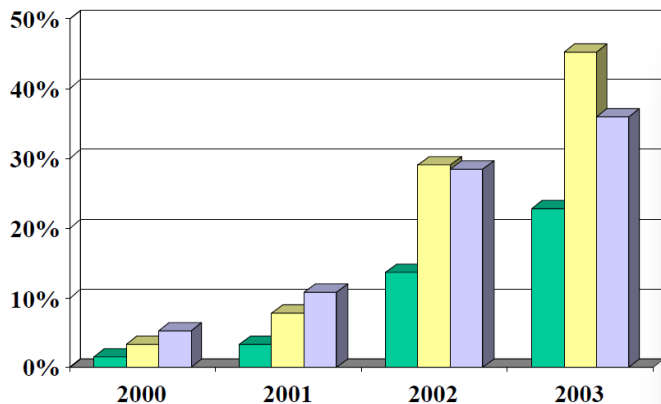
Operator Views and Insights

What Have You Heard?

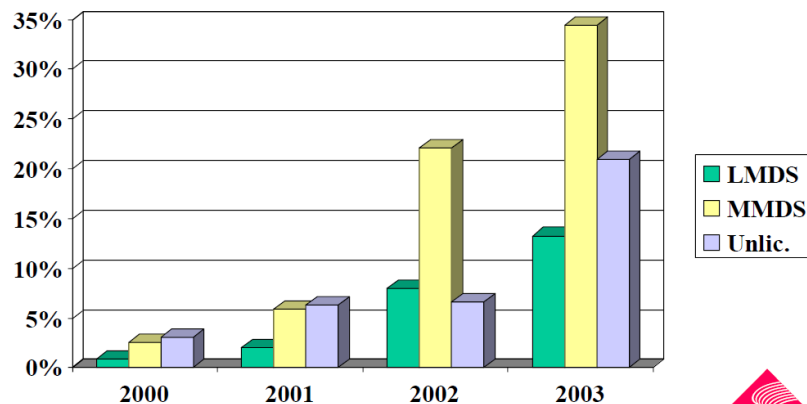
What Will You Hear?

WHAT ELSE COULD I POSSIBLY TELL YOU?

Network Coverage - Business



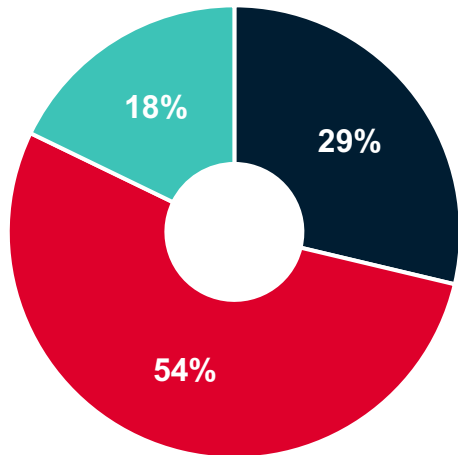
Network Coverage (Households)



mmWave Challenges: Yet Still New(ish)

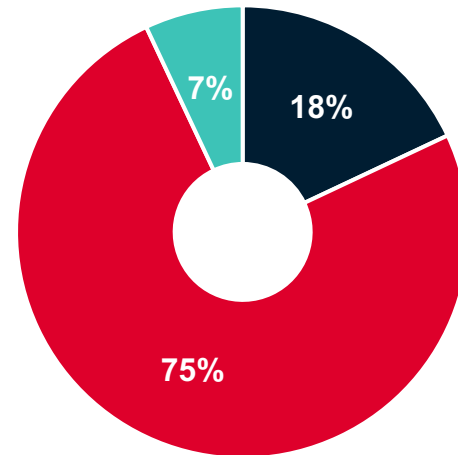
despite a long history, mmWave is still a (relative) 5G outlier across the globe

5G Spectrum Assignments: Mid-2022



■ < 1 GHz ■ 1 to 7 GHz ■ > 24 GHz

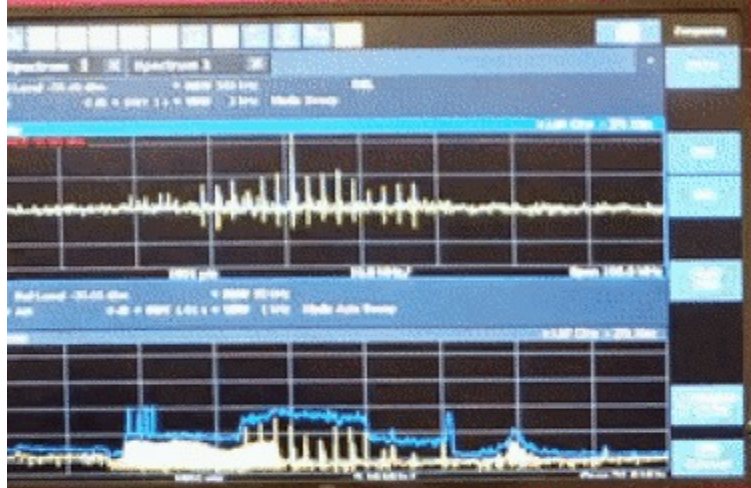
5G Spectrum Launches: Mid-2022



■ < 1 GHz ■ 1 to 7 GHz ■ > 24 GHz

mmWave Challenges: Myopic Marketing

we know where mmWave can fall short, and the market (incl. operators) has played this up



600 MHz holds strong

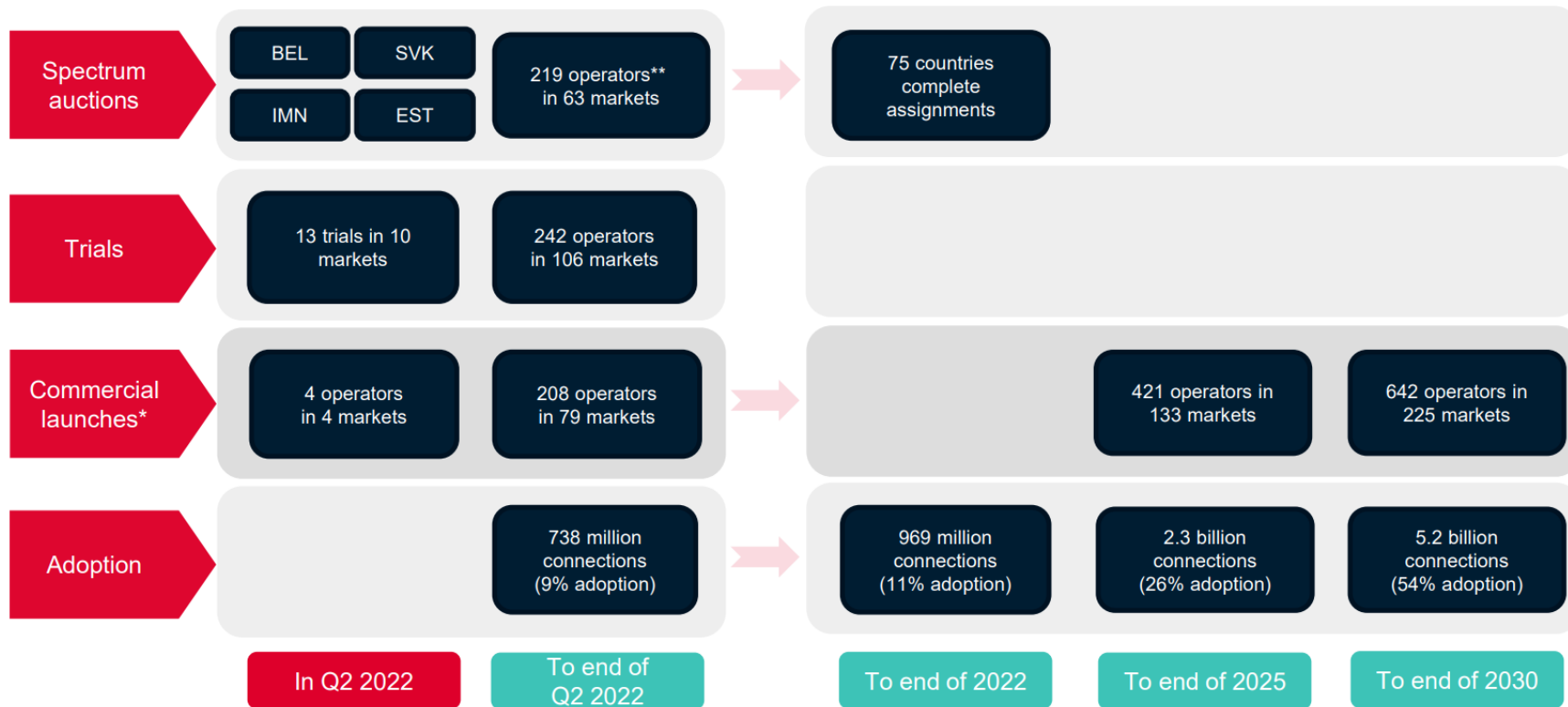


**mmWave
blocked by door**



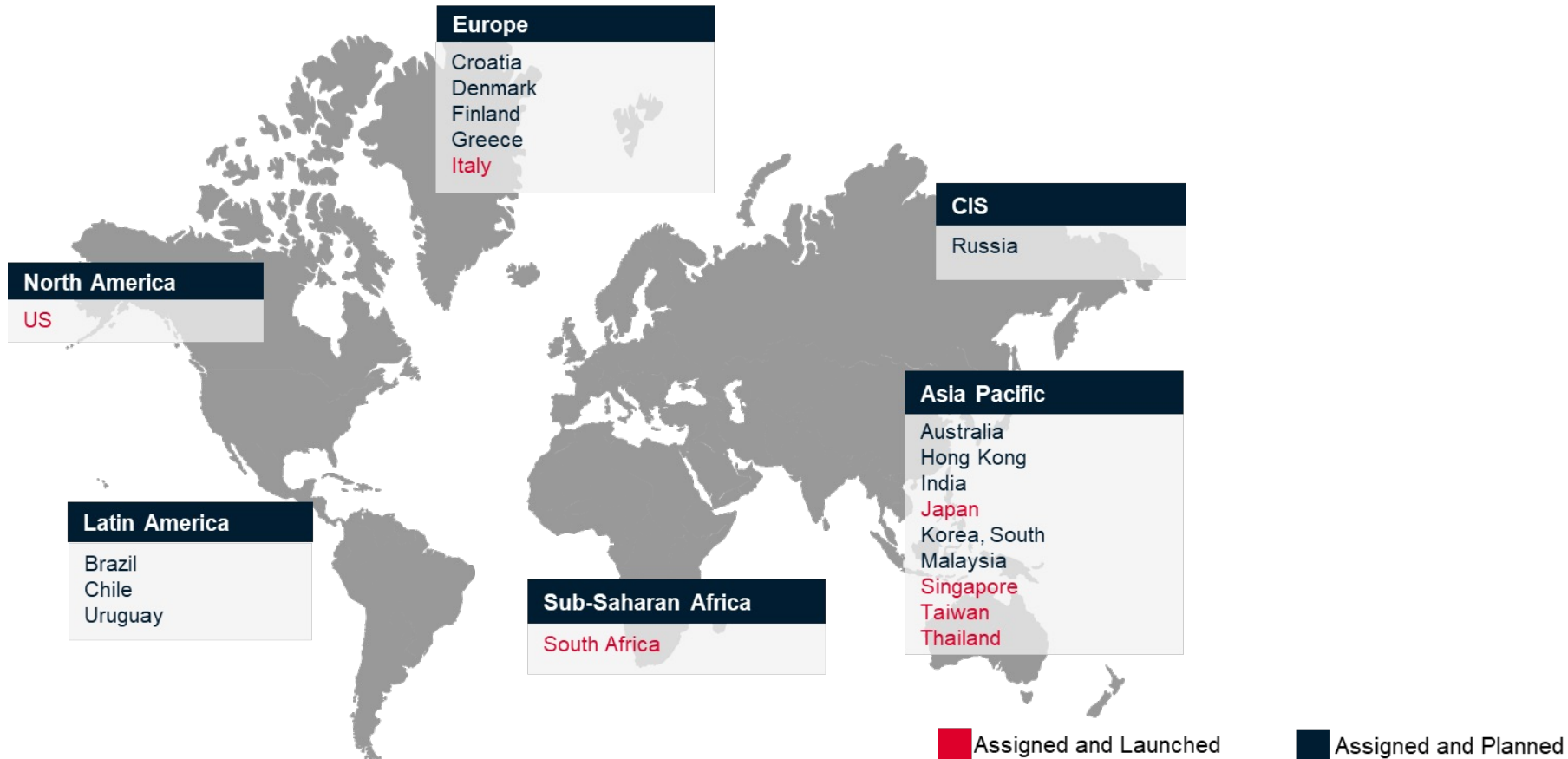
mmWave Opportunities: 5G is Here

we're no longer waiting for the 5G Era to arrive

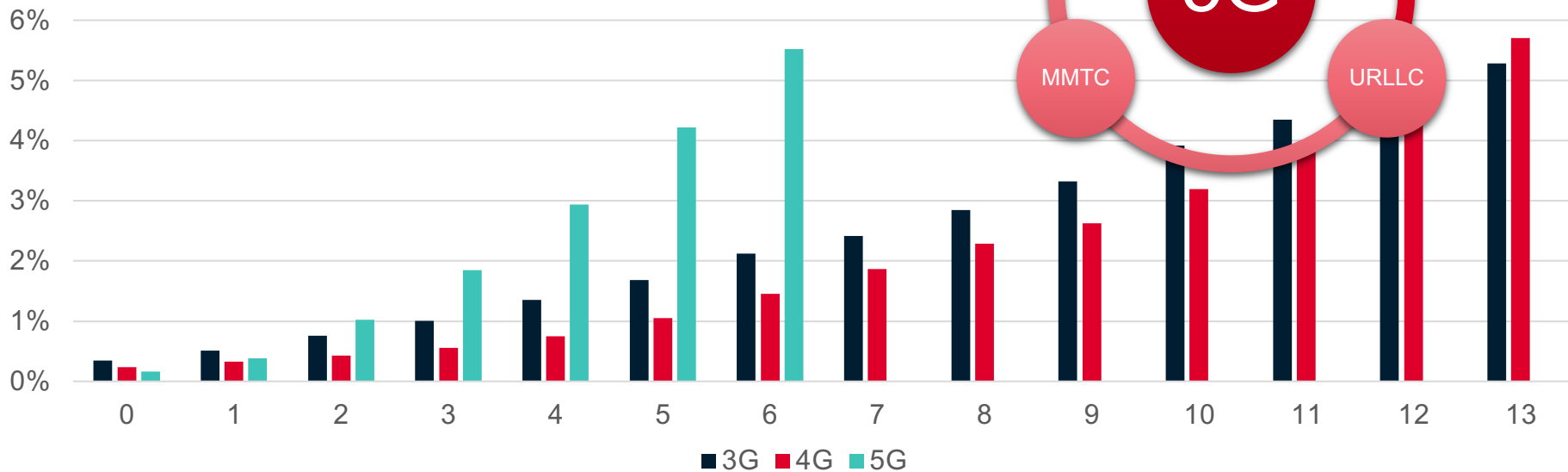


mmWave Opportunity: 5G mmWave is Here

we're no longer waiting for the 5G mmWave to prove itself



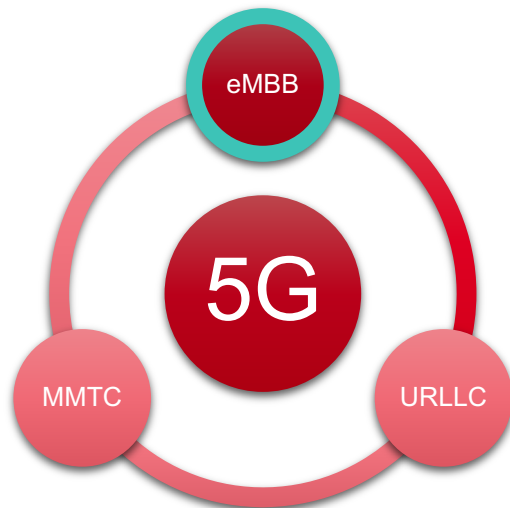
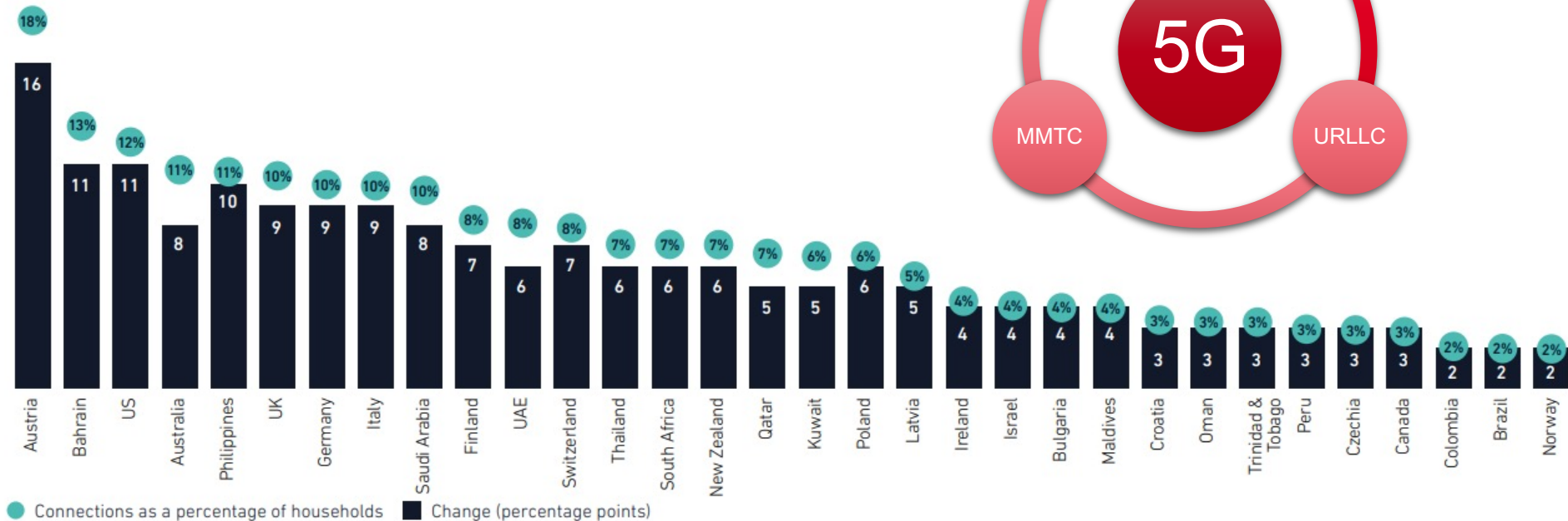
Share of Mobile Connections by Generation (by Q, post 0.25% achievement)



mmWave Opportunity: Use Case Execution

FWA is finally taking off, and mmWave is a big part of the explanation

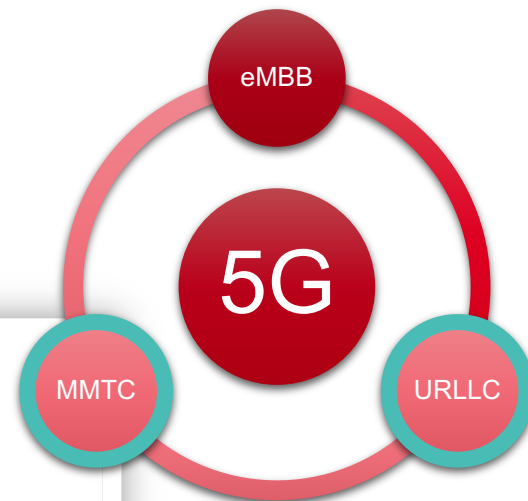
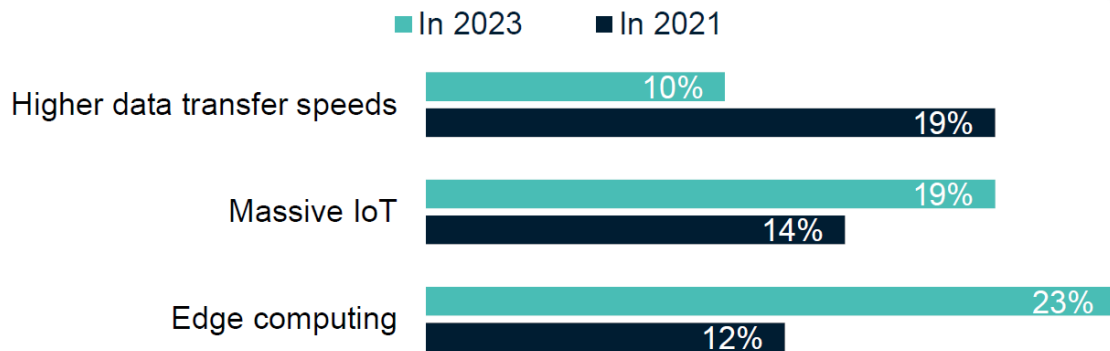
FWA Connections: 2021 to 2025 (% of households / delta)



mmWave Opportunity: Use Case Execution

operators understand that the enterprise opportunity is about speeds...and more

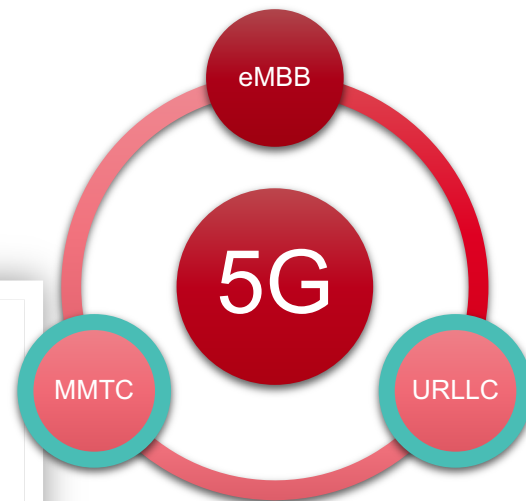
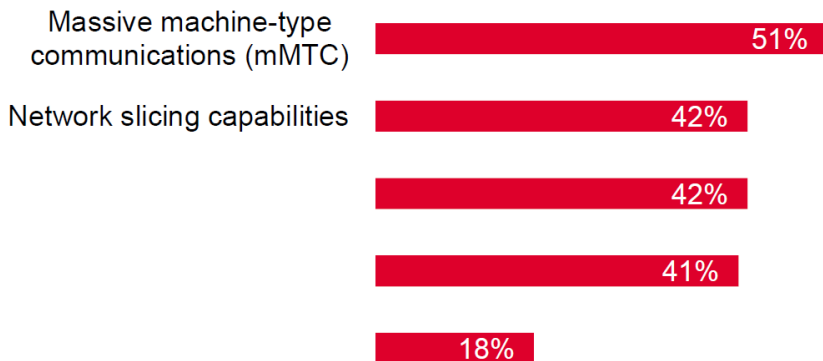
What is the primary 5G value proposition you are marketing to enterprises now and expect to market within two years?



mmWave Opportunity: Use Case Execution

operators understand that the enterprise opportunity is about speeds...and more

Rank the following benefits of deploying standalone 5G in your network
(ranking score %)

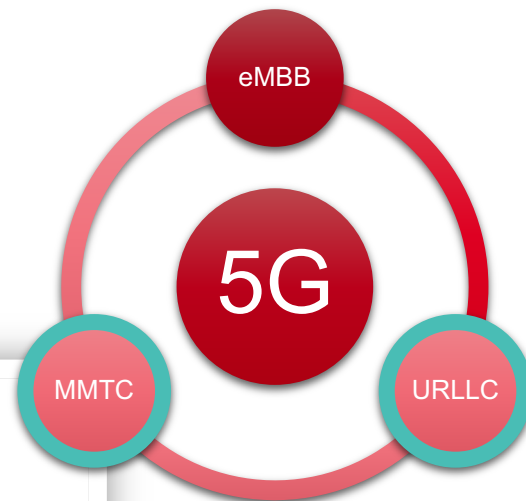
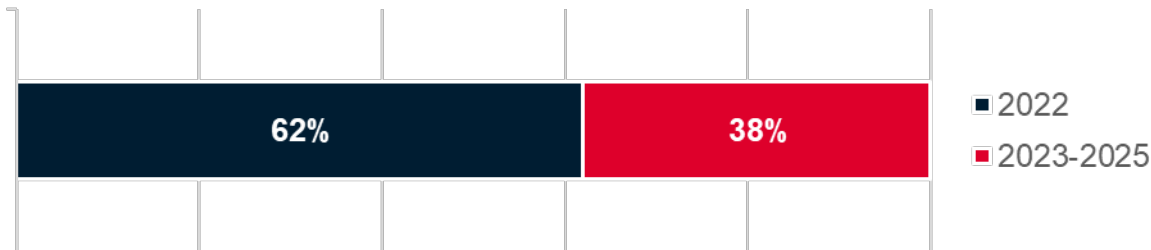


mmWave Opportunity: Use Case Execution

FWA is finally taking off, and mmWave is a big part of the explanation

What technologies are you using for private wireless network deployments?

% of operator respondents choosing 5G



mmWave Opportunity: Data Trajectory

nobody is using less data going forward

Operators will need a variety of spectrum bands (and plenty of them) to meet demands.

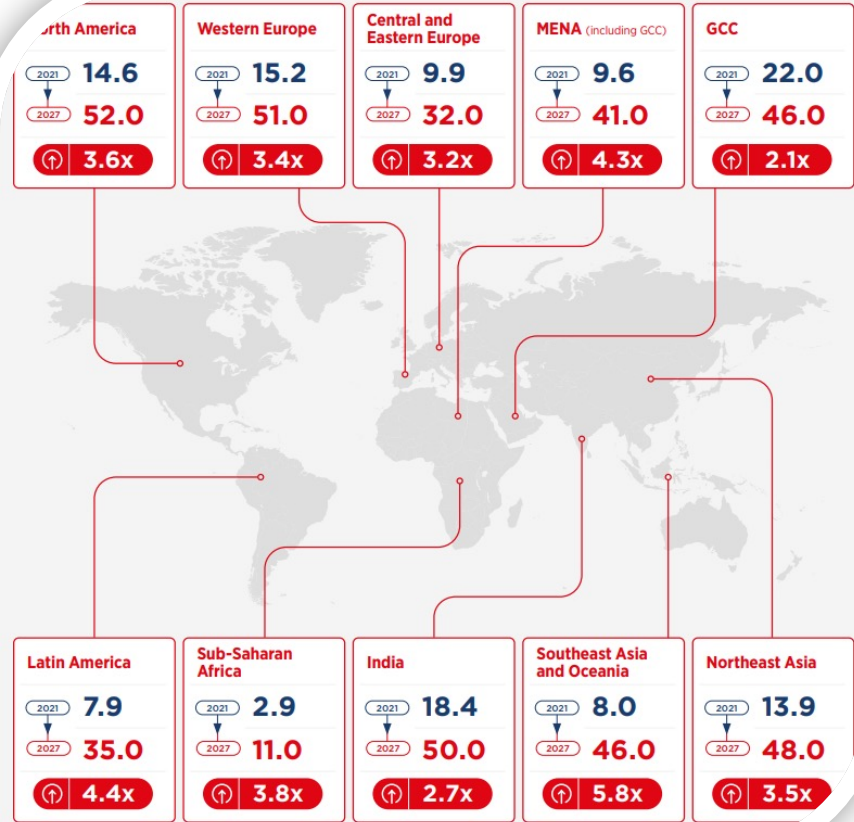


Global average

11.4
2021

41.0
2027

3.6x



The mmWave Context: eMBB, FWA, B2B

the key 5G use cases can be much better supported (more profitably) with mmWave



eMBB

Ultra-fast, high-capacity hotspots in dense urban areas.

35% Savings

(vs. 3.5 GHz alone)



FWA

Fiber-like speeds for residential connectivity and competition.

34% Savings

(vs. 3.5 GHz)



Enterprise Networks

Deployment to support Industry 4.0 with high-bandwidth, low-latency apps.

27% Savings

(vs. 3.5 GHz alone)

The mmWave Context: eMBB, FWA, B2B

meeting use case demands will require more mmWave spectrum to be allocated



eMBB

Ultra-fast, high-capacity hotspots in dense urban areas.

4.5 GHz



FWA

Fiber-like speeds for residential connectivity and competition.

350 MHz



Enterprise Networks

Deployment to support Industry 4.0 with high-bandwidth, low-latency apps.

150 MHz

EXPECTED AMOUNT OF mmWAVE SPECTRUM NEEDED PER MARKET BY 2030

mmWave Has Proven Itself

- *focus on key use cases / scenarios*
- *delivering real value today*
- *deployments and allocations...even if work remains*

5G Dynamics Drive mmWave Value

- *FWA, eMBB, enterprise comms*
- *un-ending data demands*
- *un-ending profit demands*
- *societal demands*

Industry Support Still Needed

- *more spectrum*
- *more spectrum flexibility*
- *more (fact-based) faith and development*
- *more launches*

**The 5G Promise Rests on Data Demands and Key Use Cases.
Delivering on the Promise Requires mmWave 5G.**



THANKS!

Peter Jarich

Head of GSMA Intelligence

pjarich@gsma.com

5G mmWave Summit

Michael Sherwood

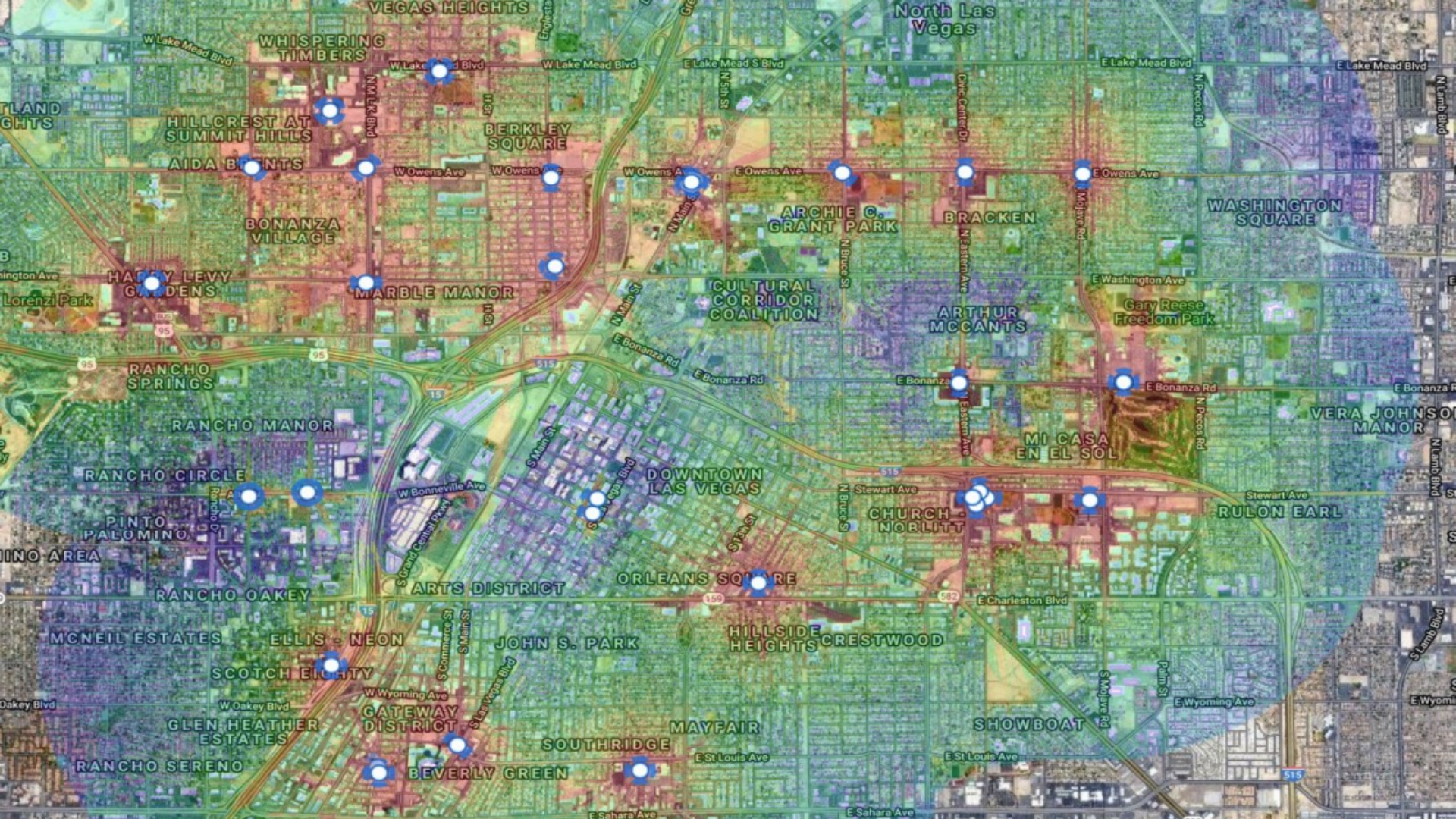
CITO, City of Las Vegas

**City of Las Vegas
International Innovation District
5G mmWave Summit**











Pole # 3

Pole # 2

Pole # 7

Pole # 4

60 GHz Client Node

Pole # 1

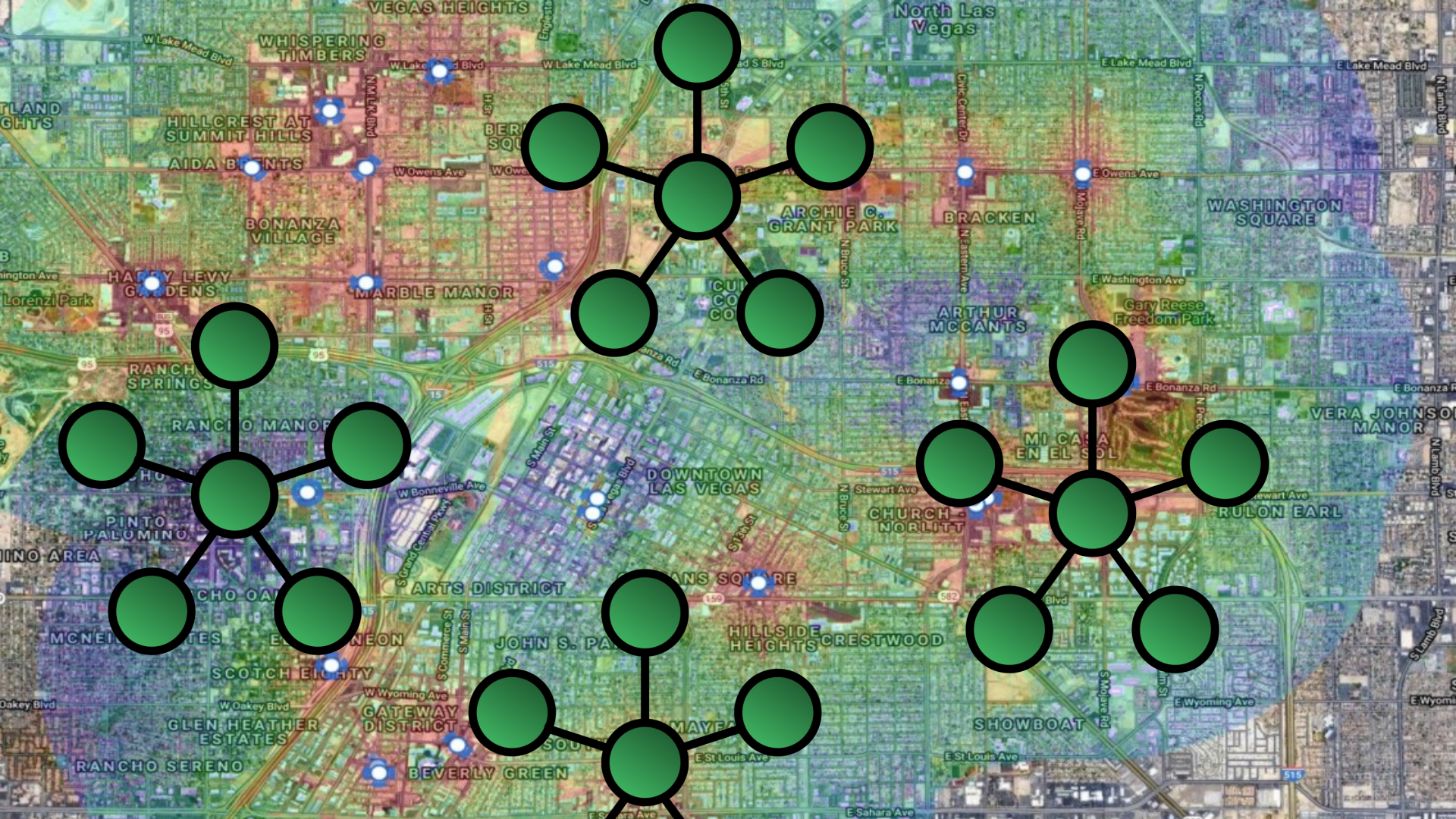
60 GHz Root Node

60 GHz Seminar

Baker Park

Pole # 5

Pole # 6





5G mmWave Summit

Narothum Saxena

VP, Technology Strategy & Architecture, UScellular



Role of mmWave in 5G FWA

Narothum Saxena
VP Technology Strategy and Architecture



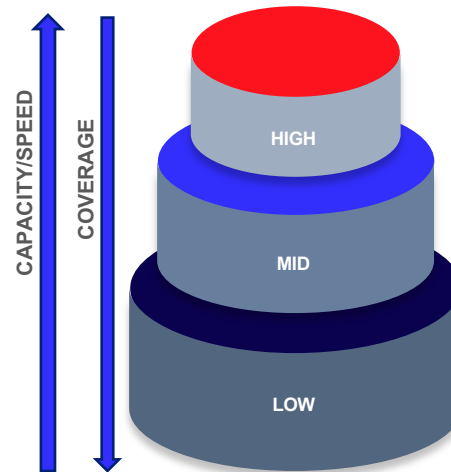
Spectrum Strategy

Three-layer approach: All three layers of spectrum are needed (low-band, mid-band, and mmWave) to provide the best customer experience in terms of coverage, capacity, and speed.

HIGH-BAND: Ultra high-speed layer for concentrated areas with high usage and demanding use cases such as FWA.

MID-BAND: High-speed wide-area layer providing competitive speeds across the footprint.

LOW-BAND: Ubiquitous and reliable connectivity layer.



mmWave plays a key role providing high speeds, FWA offering and capacity offload for mid-band as part of a comprehensive multi-layer 5G network.

mmWave in 5G FWA

DEPLOYMENT MODELS

- **Sub-6 5G FWA**
 - Fast coverage, agile deployment, high peak rates
 - Capacity for ~5-20% take rate
- **mmWave Sub-6 offload**
 - Deploy on existing LTE sites / grid
 - Sub-6 for coverage, mmWave for capacity
 - Boost capacity by ~ x8 (50 → 400 MHz)
- **Dense mmWave**
 - Full fiber equivalence
 - Dense network of small cells
- **Long reach mmWave**
 - Rural (+ new use cases: MDU,)



Delivering capacity + new use cases

mmWave Gaining Traction Worldwide



Source: Qualcomm, GSMA and Nokia research

mmWave Extended Range Trials

Benefits of Extending mmWave range

- Reduces deployments costs and covers more households for Fixed Wireless Access (FWA)
- Bridges digital divide for rural customers

mmWave Extended Range trials

- Increased range achieved through software improvements on RAN and use of high-powered CPE devices
- Collaboration with industry partners (RAN, device and chipset providers) is needed for innovation and moving the industry forward



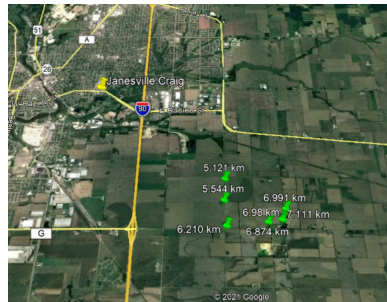
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ERICSSON Apr 2021 (Janesville, WI)

~1Gbps @ 7km

- 28GHz with 400MHz bandwidth
- Radio installed at 88 ft, rural geography, flat terrain
- Inseego high power CPE and Qualcomm high power CPE/MTP
- Line-of-sight (LOS) and Non-line-of-sight (NLOS)



inseego

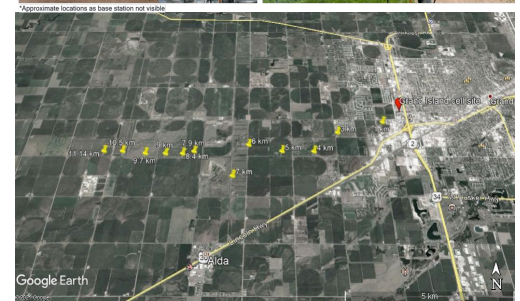
NOKIA

Qualcomm

May 2021 (Grand Island, NE)

~1Gbps @ ~10km

- 28GHz with 400MHz bandwidth
- Radio installed at 298 ft, rural geography, flat terrain
- Qualcomm high power CPE/MTP
- Line-of-sight (LOS) and Non-line-of-sight (NLOS)



mmWave Technology Demonstrations

Nov 2021 – Kingwood, WV

- 28GHz with 400MHz bandwidth
- Qualcomm High Power CPE MTP and Inseego High Power CPE commercial Wavemaker device
- Demonstrated 800+ Mbps DL / 60+ Mbps UL throughput 1.5km from site, achieved range of 5.5km during trial
- Established Teams Video call connecting Senators to WV constituents



Senator Joe Manchin  @Sen_JoeManchin · Nov 9, 2021 ...
Look up! Thanks to the Bipartisan Infrastructure Bill, you'll be seeing more 5G wireless tower upgrades to connect West Virginians to broadband. Thrilled to join @UScellular CEO Laurent Therivel in Kingwood today to see this transformative technology in action.



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Aug 2022 – Beggs, OK

- 28GHz with 400MHz bandwidth
- Inseego High Power commercial Wavemaker CPE
- Demonstrated video download and Teams Video call connecting State Senator to OK constituents
- Heavy rainfall occurred during Teams call that did not affect network performance

“



"This is a true life-changing option for getting broadband to people. What you guys are doing is great, even when it's raining!"

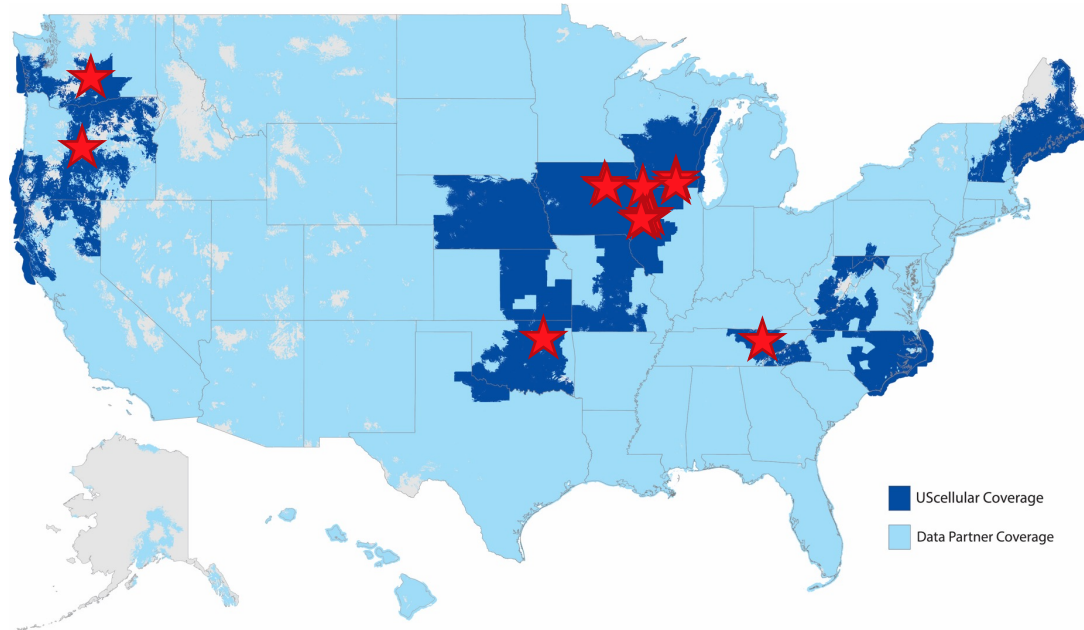
Oklahoma State Senator Roger Thompson

”



5G Home Internet Launch on mmWave

Bringing Broadband to the Heartland



High Speed Internet using mmWave FWA

- Up to 300Mbps downlink speeds, 10-15x LTE speeds
- Deployed using 28GHz and 39GHz mmWave
- Inseego Wavemaker™ FW2010 outdoor 5G CPE

10 cities launched in April 2022

- Beloit and Janesville, WI
- East Moline and Rock Island, IL
- Bettendorf, Cedar Falls, Davenport, Dubuque, and Waterloo, IA
- Yakima, WA

Increased to 30 cities in September 2022 incl.

- Medford, OR
- Tulsa, OK
- Des Moines, IA
- Madison, WI
- Knoxville, TN

Mid-band FWA to be launched in 2023

- 3.45 GHz and C-band spectrum to accelerate high-speed Internet FWA deployment

Thank You!



5G mmWave Summit

Philippe Poggianti

VP, Business Development – Qualcomm France S.A.R.L.

5G mmWave monetization and global adoption

Philippe Poggianti

VP, Business Development - Qualcomm France S.A.R.L.



5G mmWave

A mature ecosystem

1. Abundant spectrum available
2. Adoption in all key markets
3. Proven technology
4. A mature device ecosystem
5. Use cases for today and the future
6. Substantive growth and returns

mmWave
ROI
for mobile use



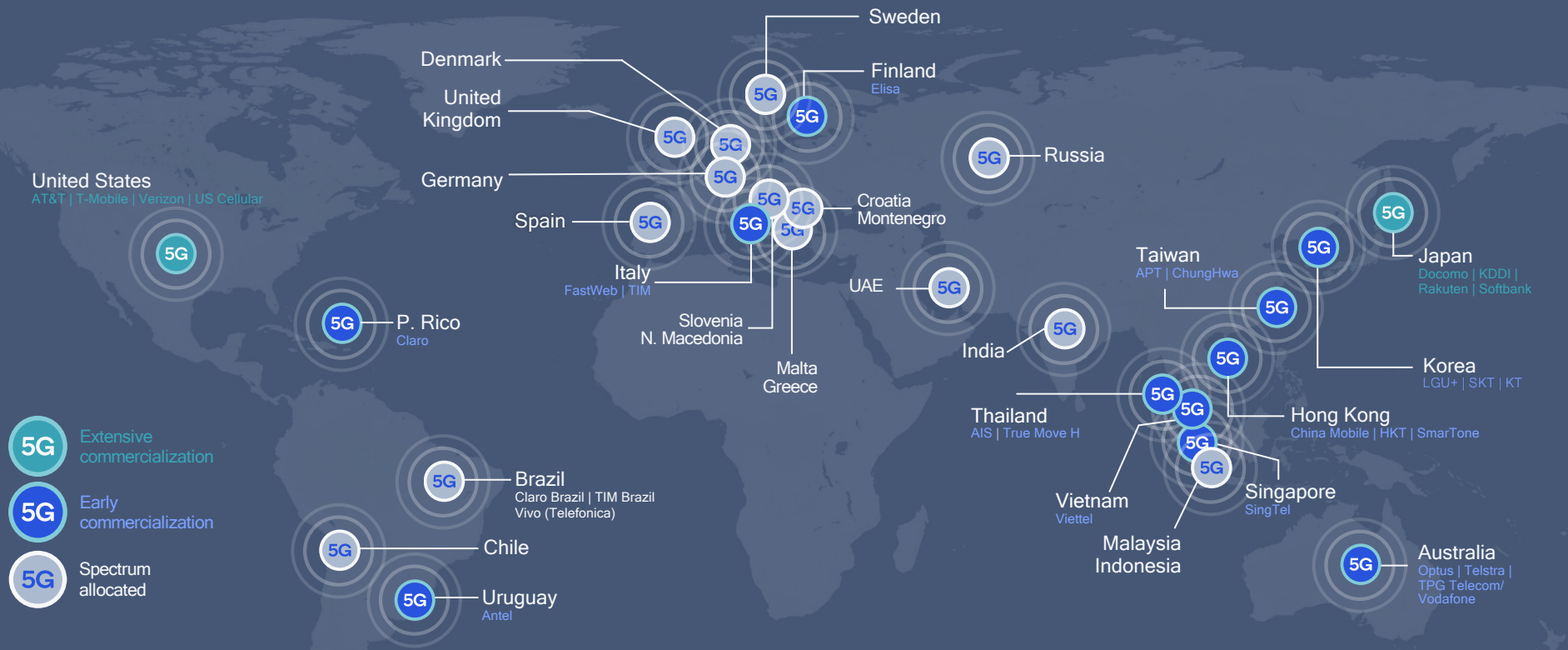
With
2000
mmWave
hot zones*



24%
Subscribers
daily reach*



4.8 years
Payback period*



* Current or expected by end of 2022

5G mmWave commercialization and spectrum

Commercialization - 28 operators*

Spectrum available - 31 countries and regions*

Expanding breadth, availability of 5G mmWave devices

150

5G mmWave devices launched or announced by 50+ vendors

Source: GSA, Feb. 2022

5G smartphones



PCs



Hotspots



Modules



CPEs



What are consumers willing to pay for an enhanced 5G service enabled by 5G mmWave?

Results from global consumer survey conducted by Qualcomm Technologies, Inc. (July 2022)

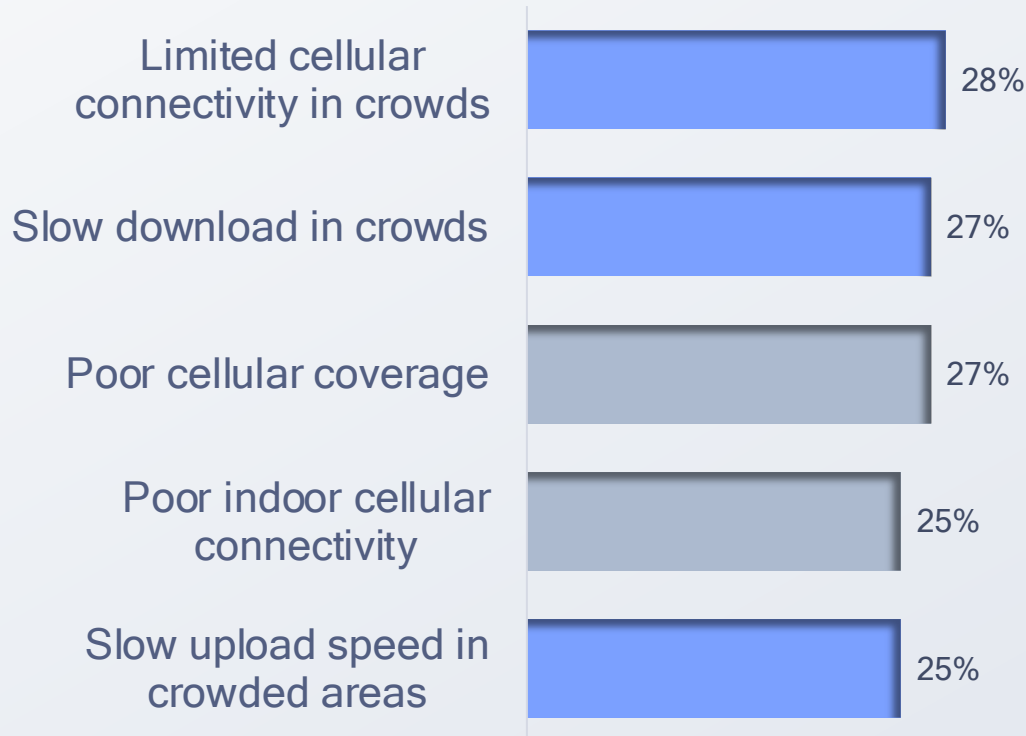




5G Enhanced Service provides next-generation cellular connectivity with fast download and upload speeds, instant cloud access, and smooth high-quality video streaming and gaming, especially in dense, crowded areas.

This 5G Enhanced Service can achieve up to 5X faster speeds than current 5G service and 10X faster than 4G/LTE, significantly improving user experiences.

3 out 5 top connectivity pain points related to crowded areas



Pain points drive interest in 5G mmWave Service

Connectivity Issues
At least weekly in crowded areas



Will pay a premium for 5G Enhanced Service

76%

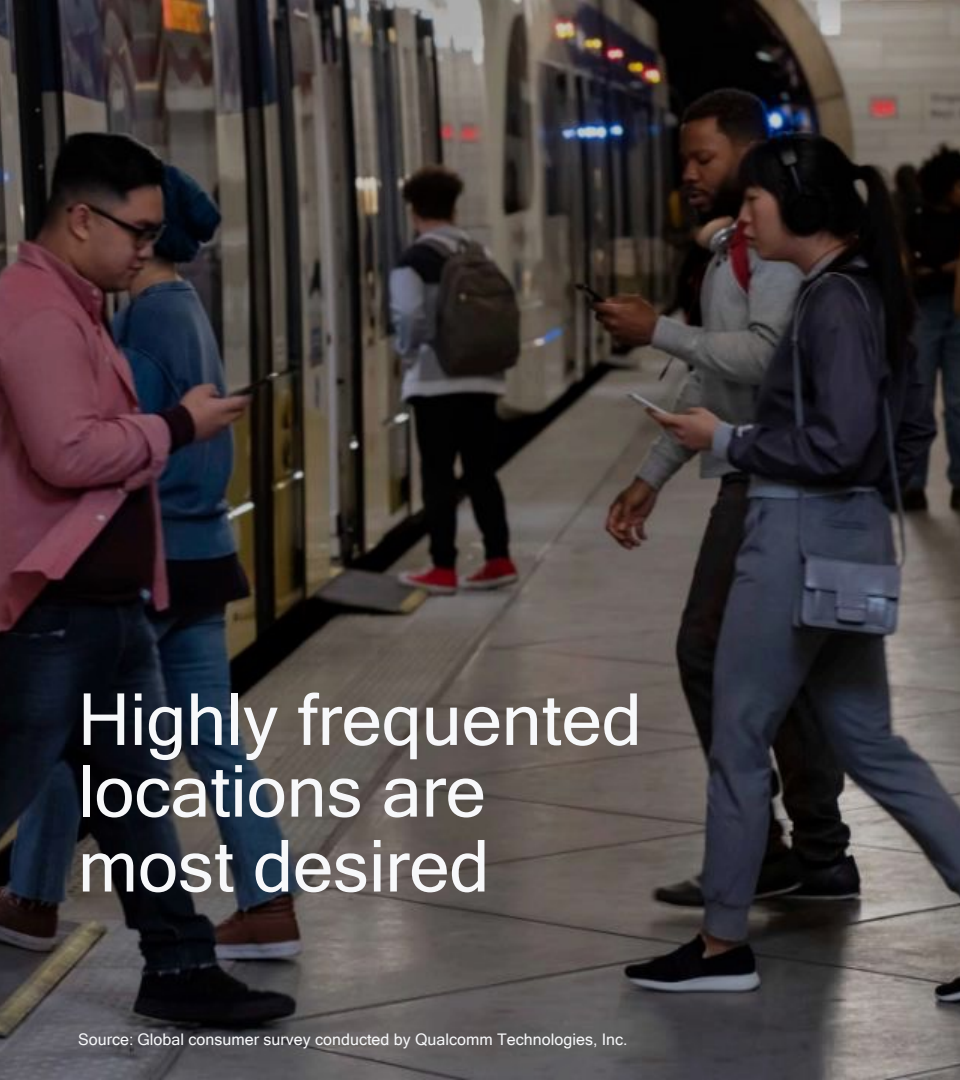
Screening Requirements:

Min 50% experience cellular issues at least a few times a year

Monthly options garner highest interest & premiums

Those willing pay extra for service option

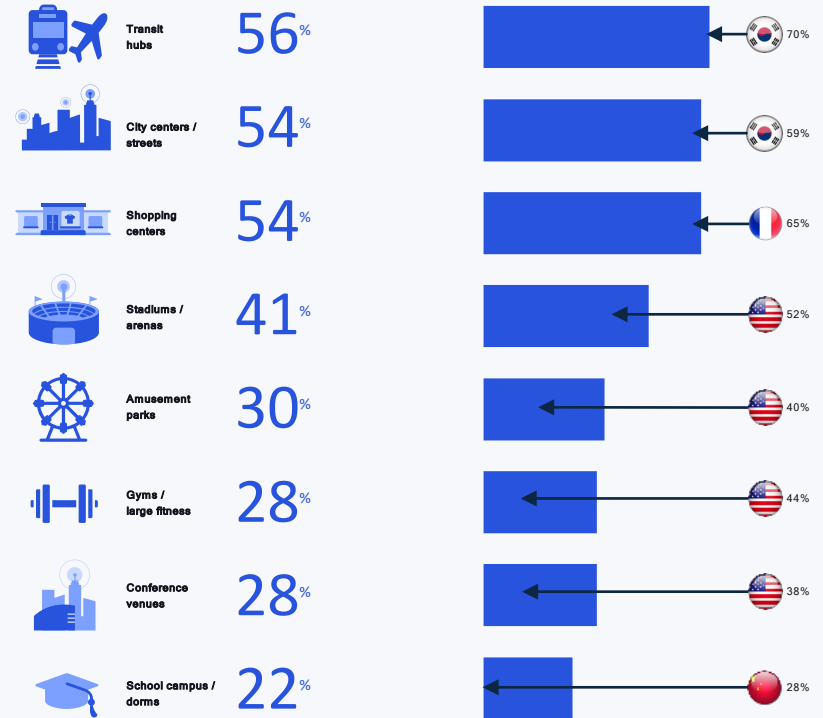




Highly frequented locations are most desired

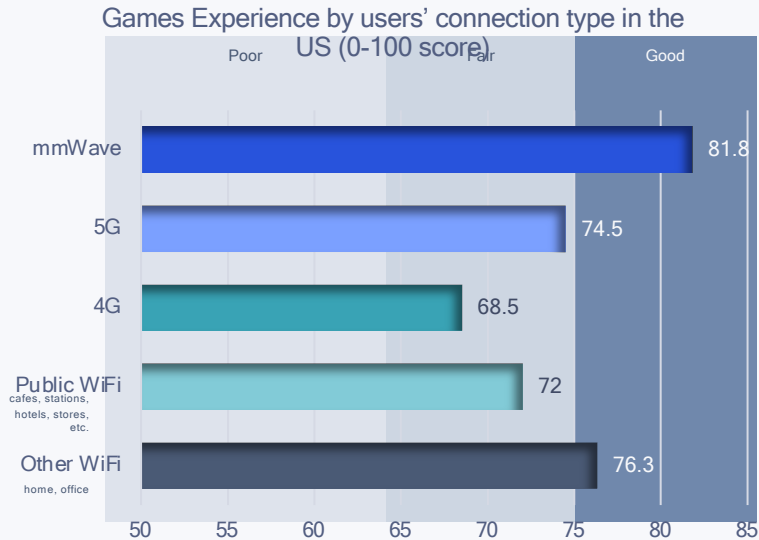
Source: Global consumer survey conducted by Qualcomm Technologies, Inc.

Most Desired Use Locations

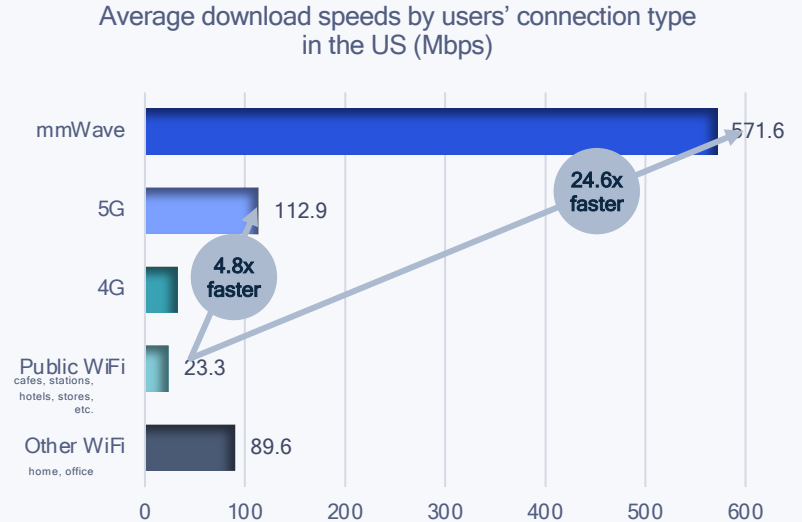


Mobile gaming benefits from 5G mmWave speed and capacity

For real-time multiplayer gaming using smartphones, 5G is a better experience than public WiFi



Users' average 5G download speeds are 4.8 times faster than Public WiFi, and mmWave is over 24 times faster

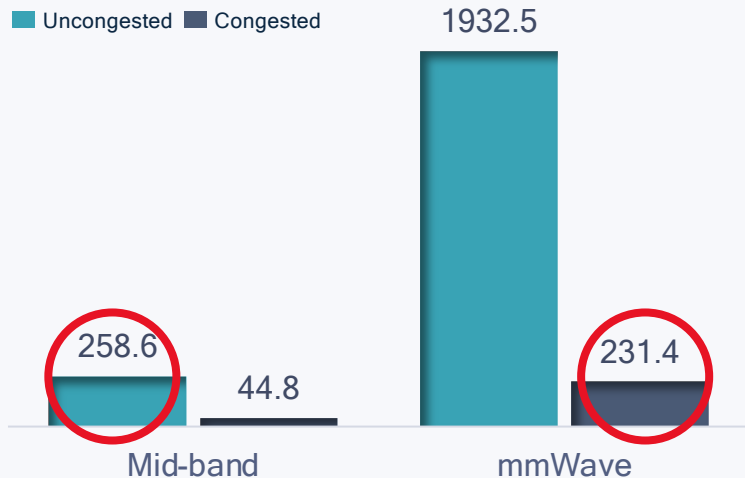


How to monetize
an enhanced 5G service
enabled by 5G mmWave?



5G mmWave + mid-band = Best possible QoE wherever you are

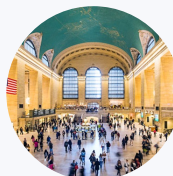
Median download throughput (Mbps)



- RootMetrics study shows 5G mmWave can deliver more **uniform user experiences** even in congested network
- 5G mmWave delivers on the promise of providing **extreme capacity** and blazing-fast speeds **under heavy network loads**



Stadiums



Train Stations



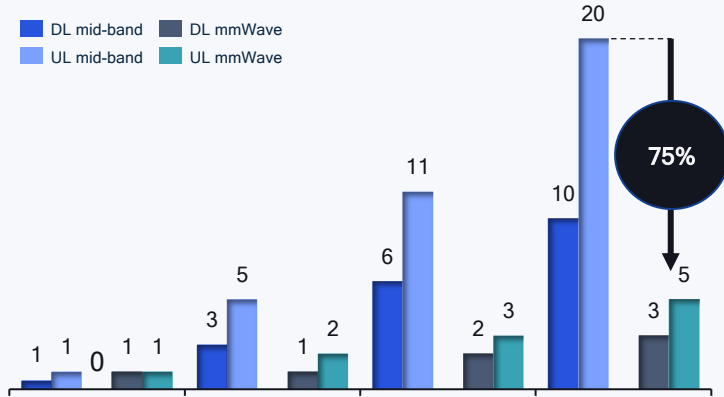
Indoor malls



Outdoor hot zones

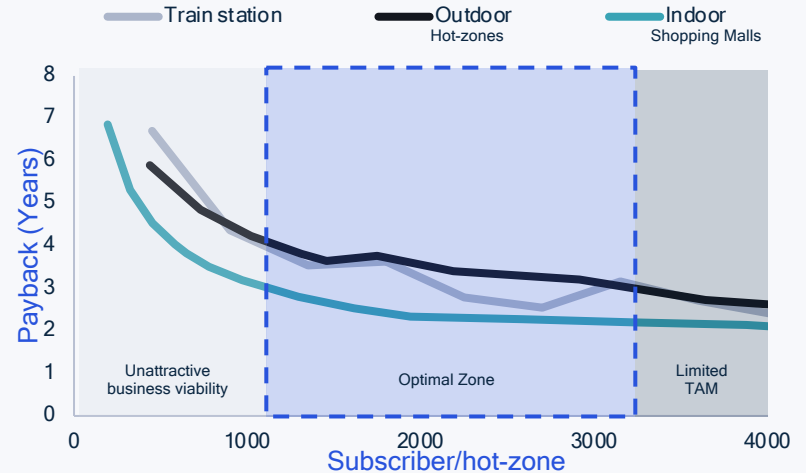
ROI study - 5G mmWave is cost-effective in congested hot-zones

Requires the most cost-efficient technology, esp. in Uplink.
Leads to up to 70% less power consumption



mmWave vs. mid-band number of small cells per "hot-zone"

Deployed at the 'right' places with optimal subscriber density to offer best QoE



Strategically scale 5G mmWave deployments considering zones of advantage of mmWave

5 approaches to be explored by operators to monetize mmWave

1

Location and event-based packages



Stadium package

Per event pricing:

- Exclusive content
- Multi-angle
- AR stats
- Immersive experience

2

Daily and Monthly instant boost



Daily and monthly pass

On location:

- Instant boost
- Zero-rating services

3

4

Enticing subscribers to higher bundles



mmWave service and benefits free for premium users

- Ultra speed tier (2+ Gbps) for premium users, among other exclusive benefits

Move next lower tier to premium plans

5

B2B Services



HD mobile video cameras

AGVs/Service bots

Ticketing booths

Workforce AR/VR

5G mmWave positions the operator as a quality leader

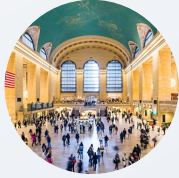
50
Stadiums



mmWave
Hot Zones**



100
Train Stations



250
Indoor malls



% Subs
daily reach*

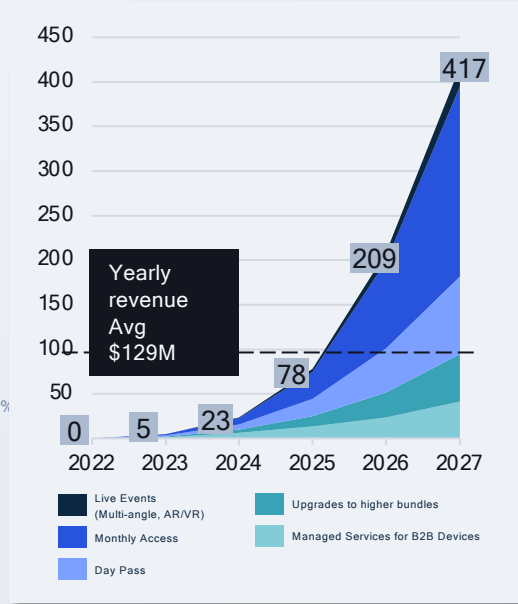


850
Outdoor hot
zones

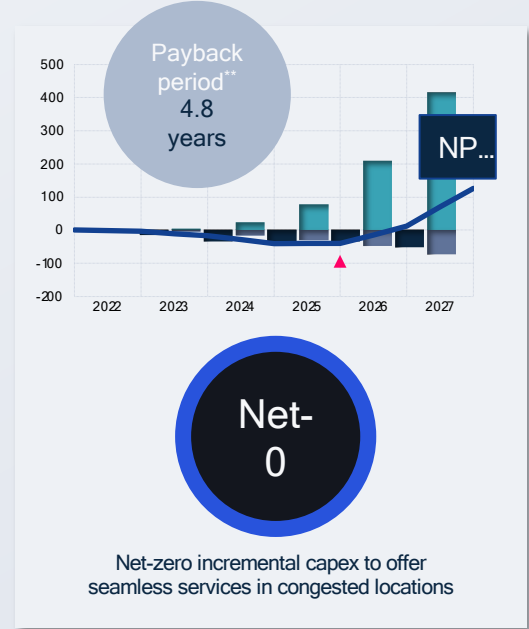


* Subscribers able to experience 5G mmWave in 50% of the time spent in the network
Source: Qualcomm Technologies and Bell Labs Consulting | ** 5G mmWave coverage available in 30% of the network

Annual revenue from difference streams



Business case for 5G mmWave rollout



Ongoing 5G mmWave technology enhancements

Uplink carrier aggregation (mmWave)

4 carrier component aggregation (4CC) helps increase critical uplink throughput and capacity

NR mmWave-sub6 Dual Connectivity (NR-DC)

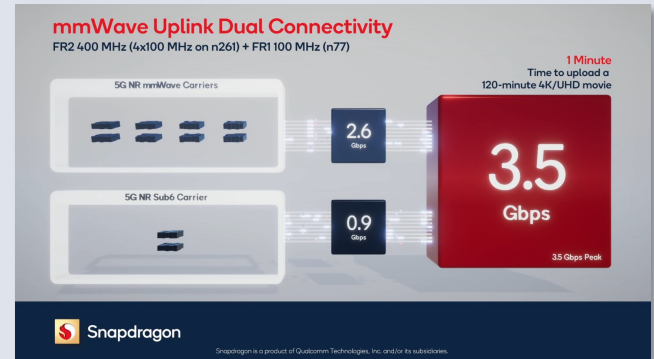
Aggregates 5G mid-band and mmWave spectrum on both downlink and uplink for increased data speeds, improved coverage, and better mobility into and out of mmWave coverage areas

Standalone mmWave (FR2-only deployments)

Allows the deployment of fixed-wireless access solutions and private networks using only mmWave spectrum

Nokia and Elisa achieve over 2 Gbps 5G uplink speeds on mmWave with Qualcomm solutions

Press Release



Qualcomm and NTT DOCOMO Unleash Next Generation 5G Speeds and Coverage Through World's First High-Speed 5G Standalone Service

Launch of NTT DOCOMO's 5G Standalone Service, Supported by Smartphones Powered by Snapdragon, Commercially Demonstrates High Speeds and 5G Seamless Coverage Enabled by Combining mmWave and sub-6 GHz Spectrum

SEP 7, 2022 | SAN DIEGO | Qualcomm products mentioned within this press release are offered by Qualcomm Technologies, Inc. and/or its subsidiaries.

Fastweb and Qualcomm Announce Collaboration to Commercialize 5G Standalone mmWave Services in Italy

Standalone FR2 Capabilities Powered by Qualcomm Technologies Can Enable Fastweb to Bring the Full Benefits of 5G mmWave Fixed Wireless Access to Italian Households and Businesses

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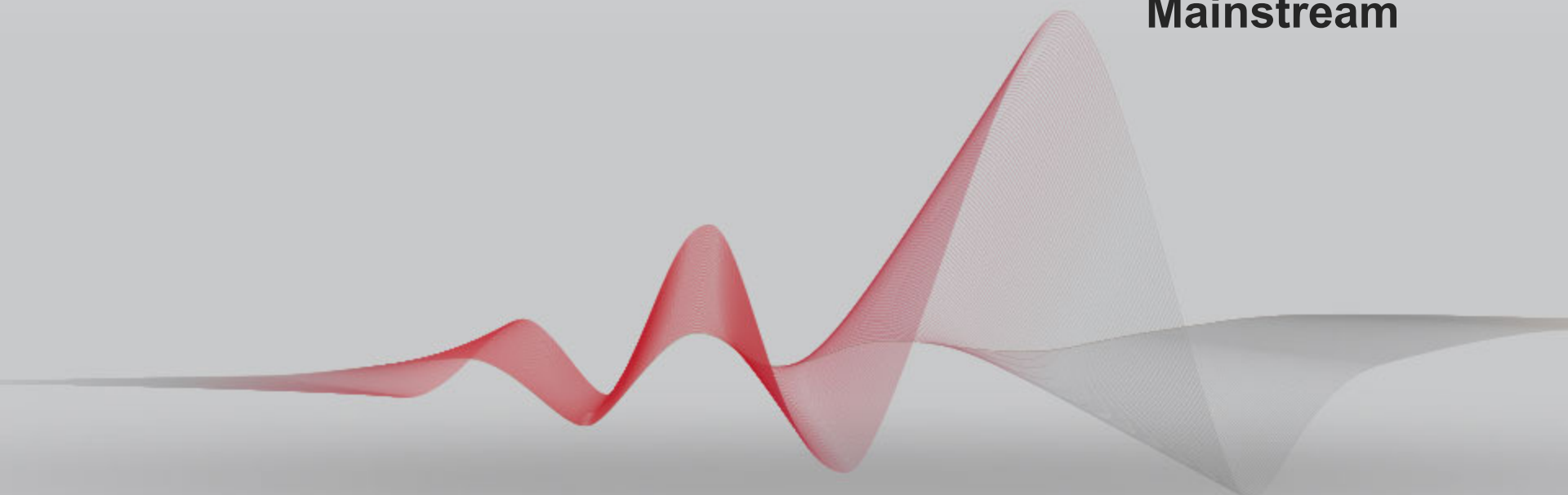
5G mmWave Summit

Neil Shah

VP, Research & Co-Founder, Counterpoint Research



5G mmWave : Ecosystem & Economics Ready to Go Mainstream



Company Overview

COUNTERPOINT PASSIONATE ABOUT TECHNOLOGY WITH DEEP EXPERIENCE



Counterpoint means '*usage of contrast or interplay of elements in a work*'.
At Counterpoint Research we always try to make our research **clear, comprehensive and precise.**

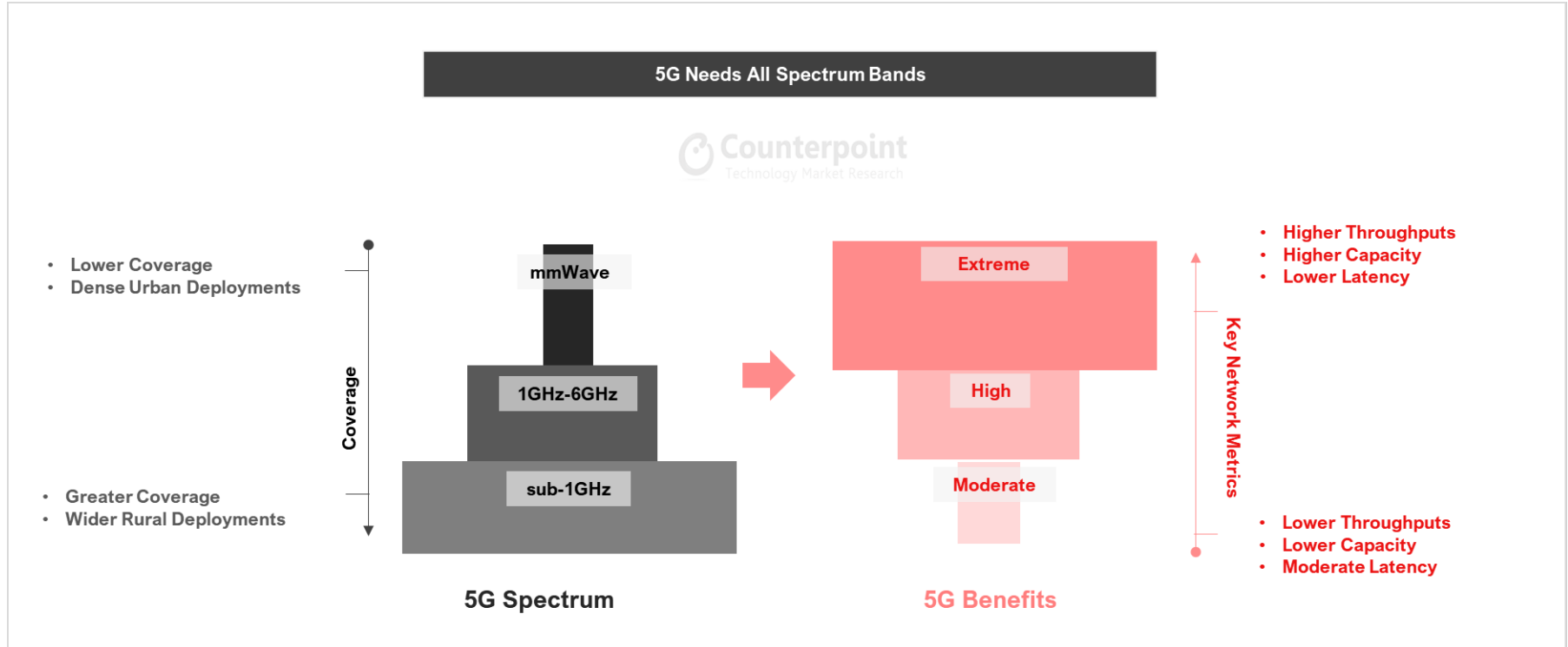
Mission

We help our partners make decisions with accurate data, delivered in timely manner.

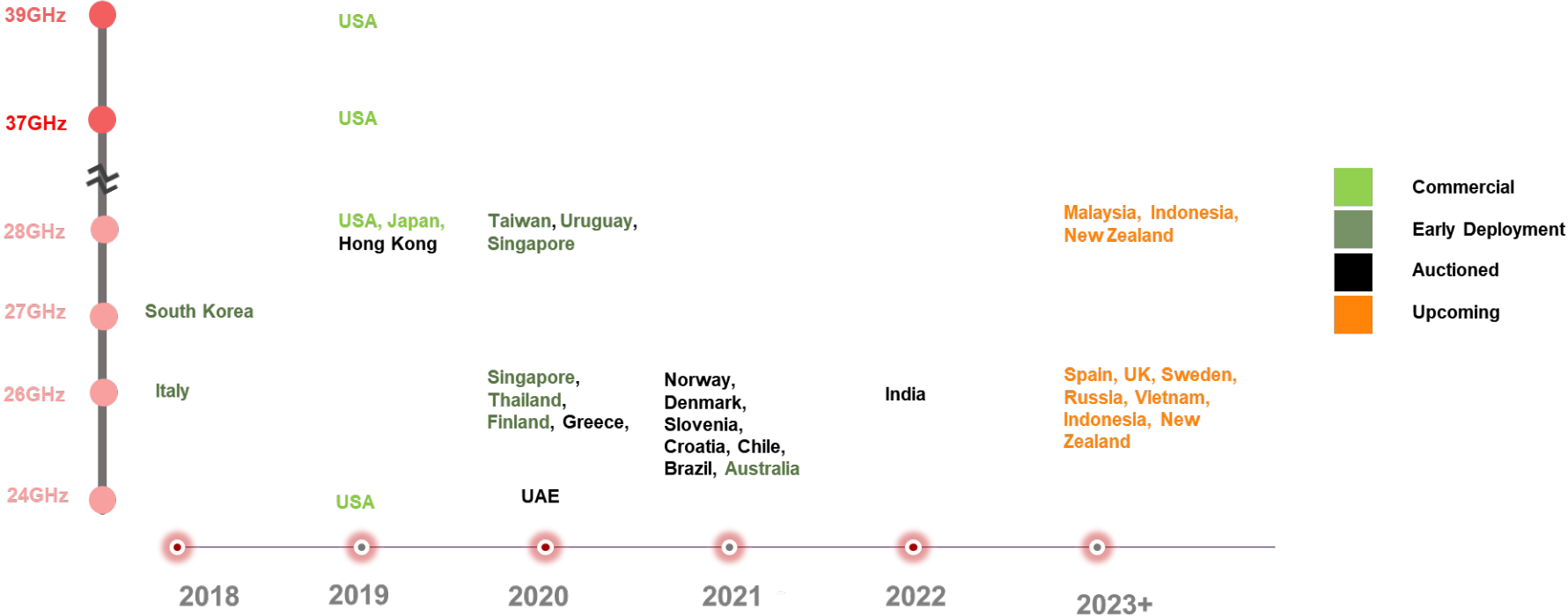
Research Activities in the High Tech Industry

Connected devices, digital consumer goods, software & applications and other adjacent topics
Emerging and disruptive technologies
Internet of Things (IoT)
Tailored research as well as syndicated reports
Seminars and workshops for companies and institutions
Consulting and customized project work on the above topics

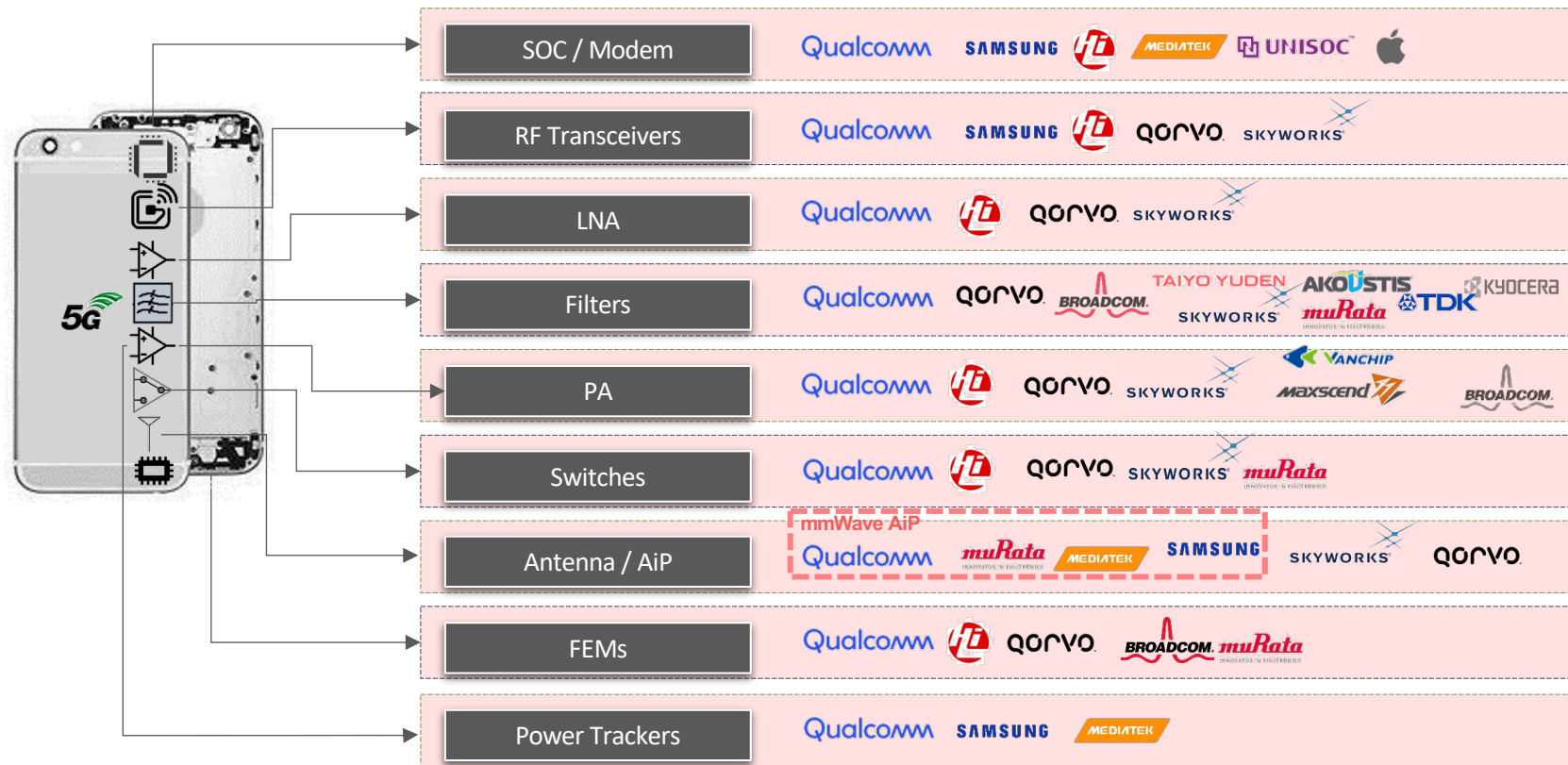
True 5G: The Inverted Cake



5G mmWave: Spectrum Allocated, 2024 an Inflection Point

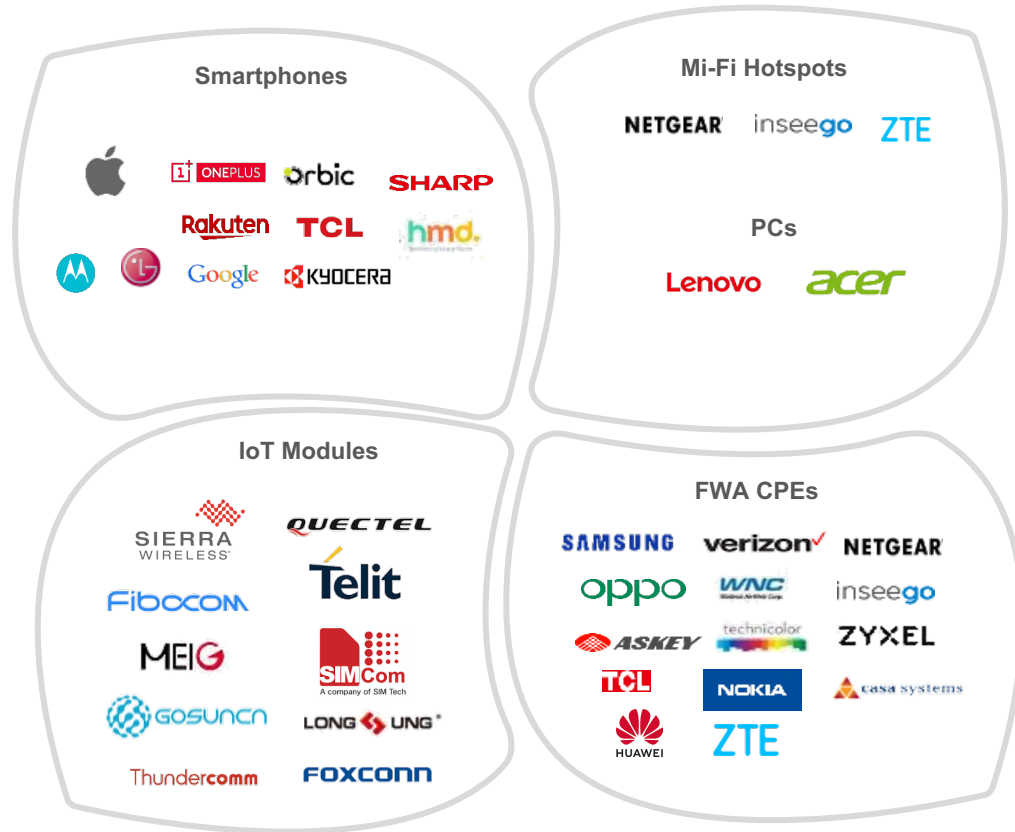


5G mmWave: Component Ecosystem Growing



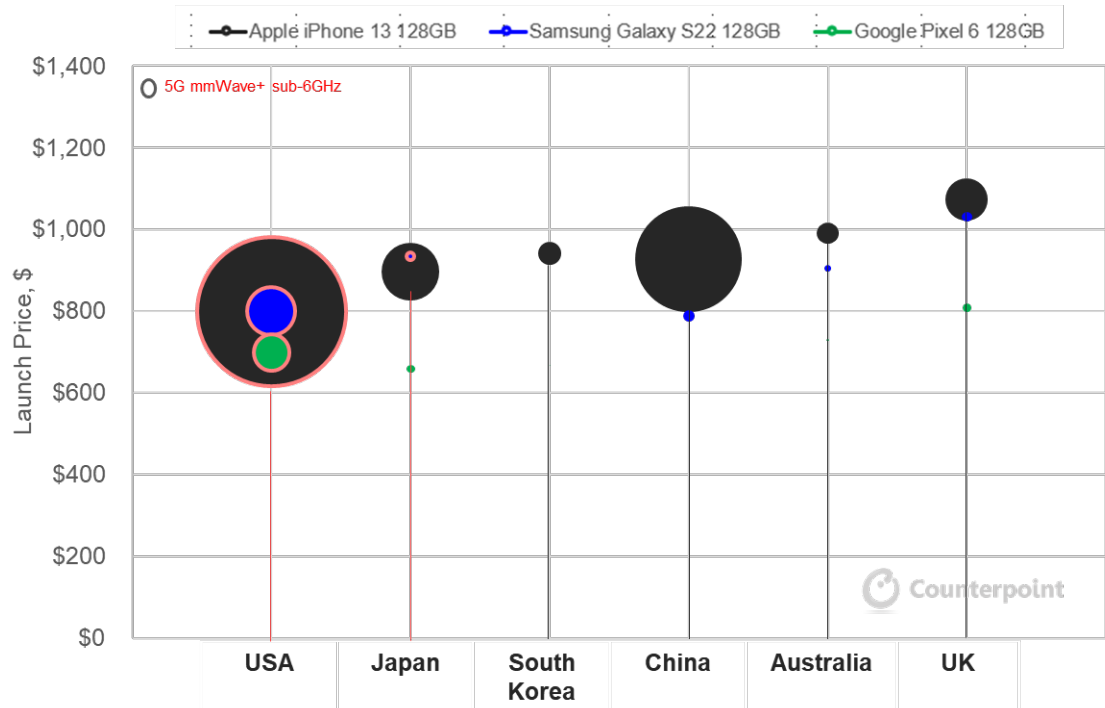
Source: Counterpoint Research Components Tracker, 2022

5G mmWave: Devices Ecosystem Growing



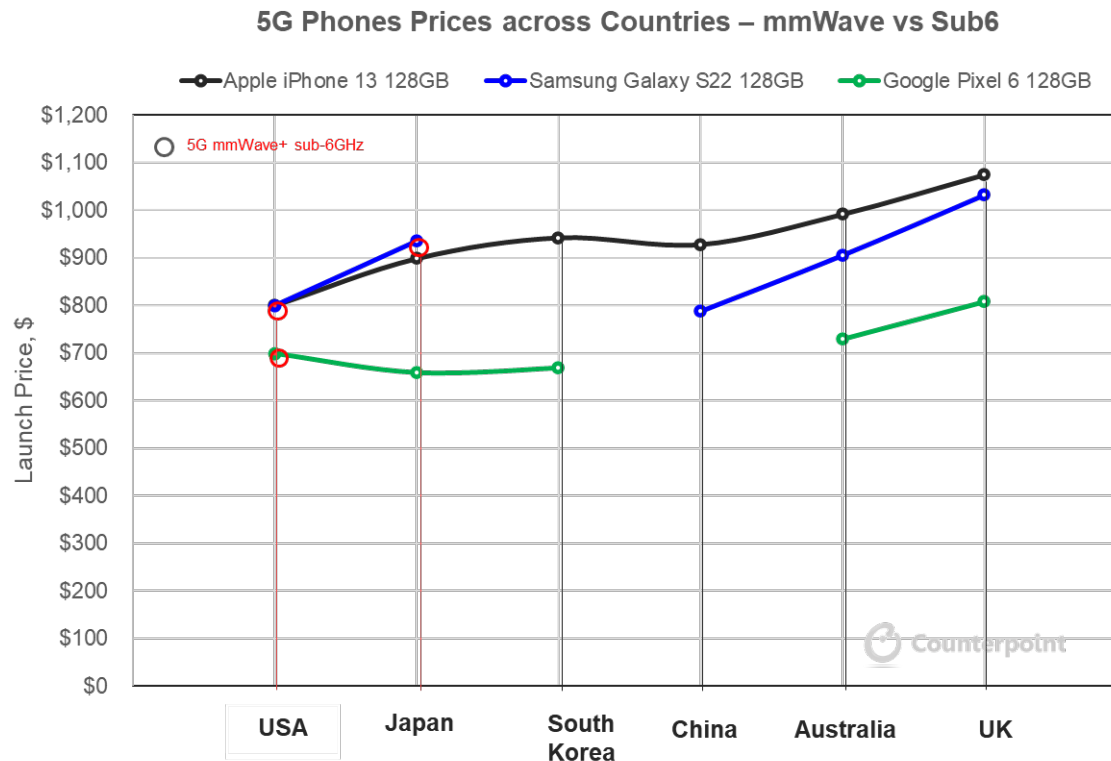
5G mmWave: No Correlation between sales & mmWave capability

5G Phones Prices vs Sales across Countries – mmWave vs Sub6



Bubble signifies sales units in H1 2022

5G mmWave: No Correlation between Sales & 5G mmWave/ sub-6GHz Pricing



5G mmWave: Consumer Awareness & Adoption Growing

Users who checked before purchase if the 5G Smartphone has 5G mmWave capability

60%

Users who in future prefer to avail 5G mmWave service & smartphone

43%

Counterpoint

N = 541 US Smartphone users

Top Reasons for buying a 5G mmWave smartphone

Bought to subscribe to the 5G mmWave data plan

1

44%

Unaware while making the smartphone purchase

2

29%

Default recommendation with the subscribed data plan

3

28%

Multiple Choice, Ranking

Top Reasons for buying a 5G mmWave data plan

More suitable for my smartphone usage

1

54%

Owned a mmWave 5G supporting device

2

47%

Was affordable special offers

3

44%

Multiple Choice, Ranking

5G mmWave: Smartphones Outlook

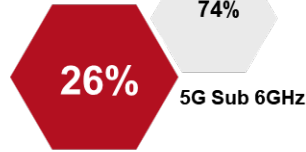


1 BILLION

5G mmWave Smartphones Shipments – 2019-2026

5G mmWave Smartphone

Global 5G mmWave smartphone shipments (cumulative) to cross 1 billion between 2019-2026.



5G mmWave
5G mmWave Smartphone Penetration

5G mmWave smartphone penetration to reach 26% by 2026

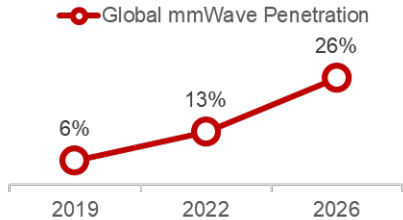


~\$10 to \$29

BoM Cost Delta

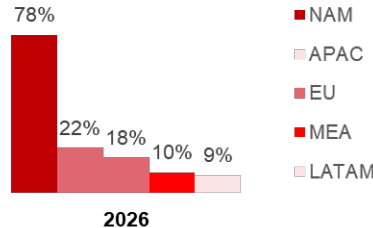
Price Delta Sub 6Ghz vs mmWave Smartphone

Price differentiation between sub-6GHz-only and mmWave smartphone has declined.



Global mmWave smartphone Penetration to Reach 26% by 2026

Spectrum is available across most countries + ASP are declining for the mmWave smartphones.



5G mmWave Penetration / 5G Smartphone by Region

By 2026 NAM will have the highest mmWave smartphone penetration followed by APAC and EU



~\$250

Cheapest mmWave smartphone in 2022

Key Smartphone Vendors for mmWave

Major tier-1 vendors have 5G mmWave smartphones in USA & trickling to mid end.

5G mmWave: Mobile Broadband CPEs Outlook

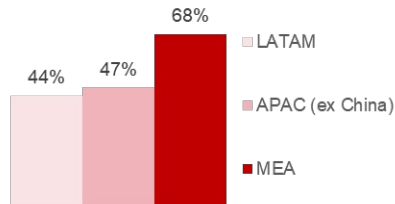


\$19 BILLION

5G CPE Revenue Opportunity

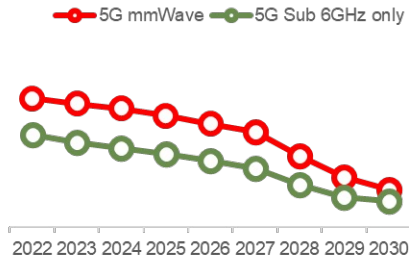
5G FWA CPE Revenues (mmWave)

Global FWA mmWave CPE cumulative revenues to reach \$19 billion between 2022-2030.



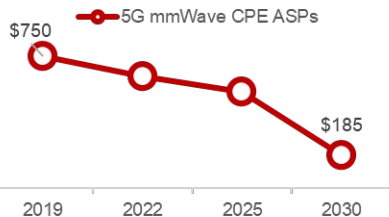
FWA Penetration/Fixed Broadband by Region

By 2030 Africa, India, and other South Asian countries (ex. China) have the most potential to drive the 5G FWA



5G FWA CPE ASP

ASP to taper after 2025, driving adoption even in low ARPU markets such as India and Africa



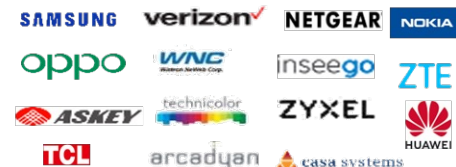
Global mmWave FWA CPE ASP reach sub-\$200 by 2030

Post-2025 will be an inflection point because of scale and mainstream adoption



Key Operators with 5G FWA Networks

Operators across USA, Italy, Australia etc. are already offering mmWave FWA services.

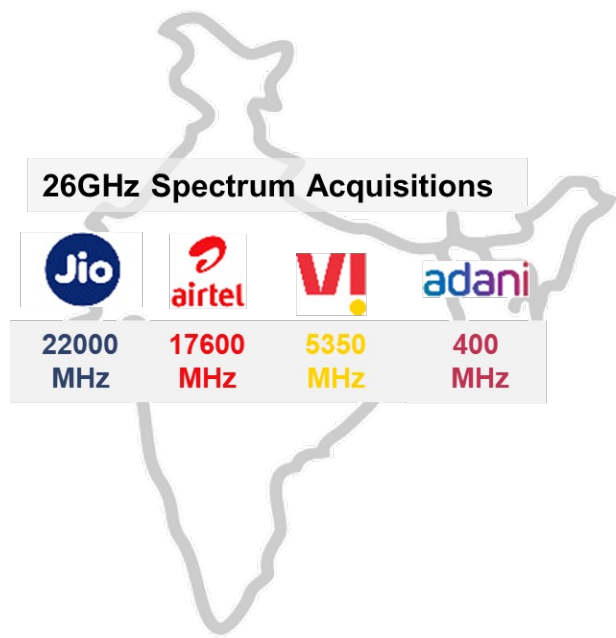


5G mmWave FWA Ecosystem is Growing

Several OEMs and ODMs are now offering mmWave CPEs

5G mmWave: India - the Wild Card

		2022	2026	2030
Population (Millions)		1237	1350	1415
Mobile Connections (Millions)		1.05	1.25	1.45
Smartphone Users (Millions)		620	870	1005
<hr/>				
5G Smartphone Shipments (Millions)		62	206	300
5G mmWave Smartphone Shipments (Millions)		0	20	125
<hr/>				
5G FWA Connections (Millions)		0	6	33
5G mmWave FWA Connections (Millions)		0	1	18



Global reach and our offices



5G mmWave Summit

Paul Challoner

VP, Network Product Solutions, Ericsson



mmWave

The hype 5G has been waiting for

Paul Challoner

VP Network Product Solutions Ericsson

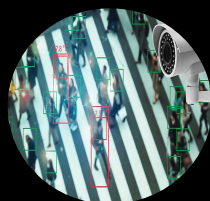
mmWave for businesses & consumers



Robotics



Warehouses



Video monitoring



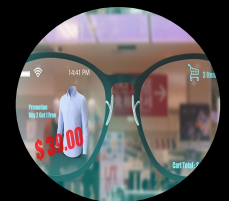
Digital twins



FWA WFH/LFH



Immersive gaming



AR assist



Enterprise

Lower latency



Consumer

Enhanced capacity

Office & campus



Ports



First responders



Crowds



Transit hubs



City Centers



Concerts

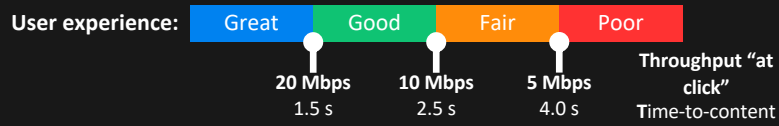
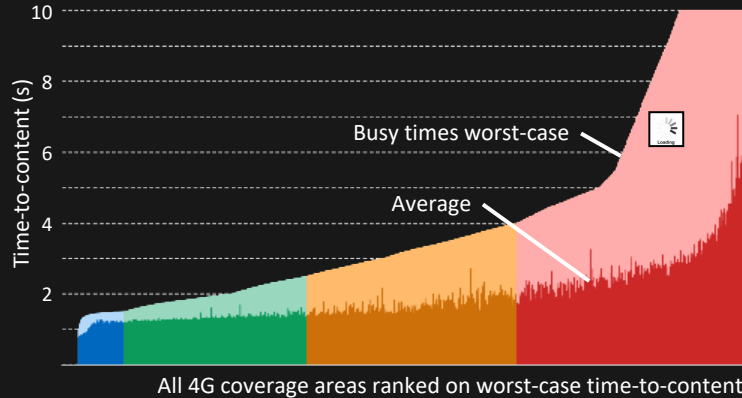


User experience challenged by congestion

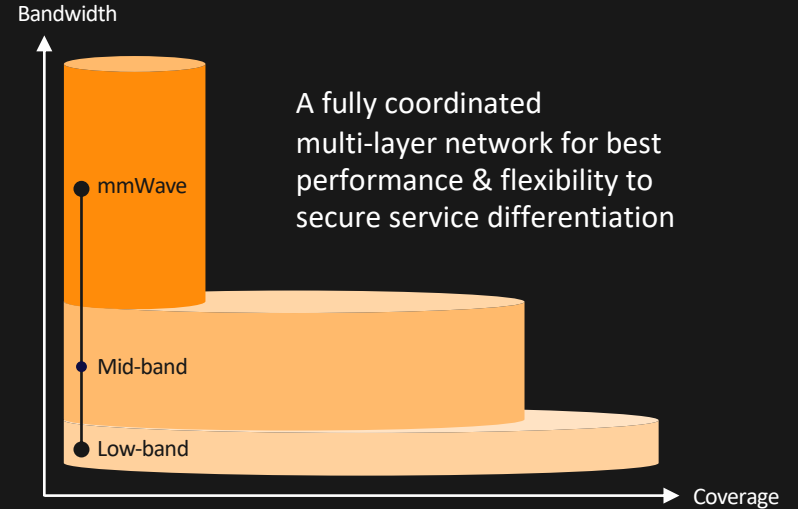


Time-to-content per 4G coverage area (gNB)
for a major European service provider

based on 800 million user activities measured 24/7 in week 45, 2021



A complete 5G network for all use cases



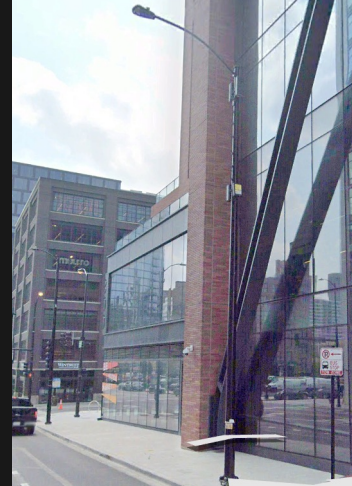
mmWave deployed where it matters to reach users



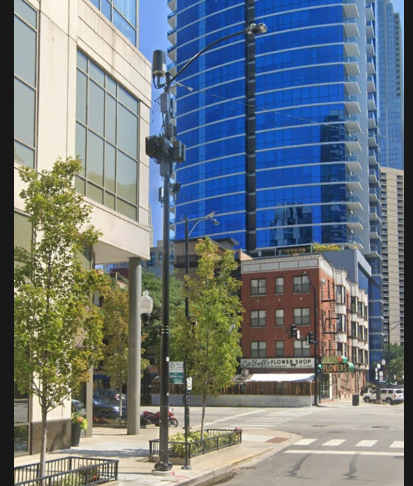
One sector stadium site



3 sector street site
with lower band
canister antenna



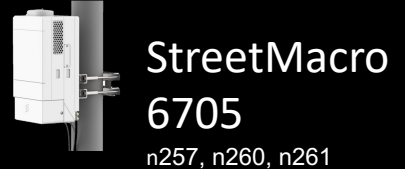
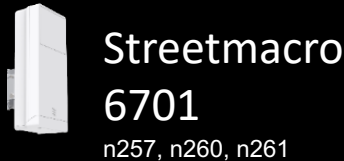
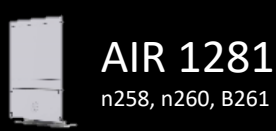
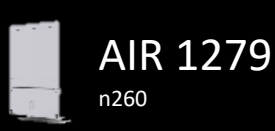
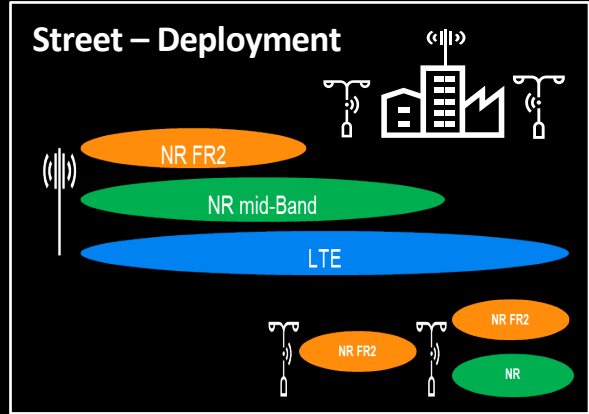
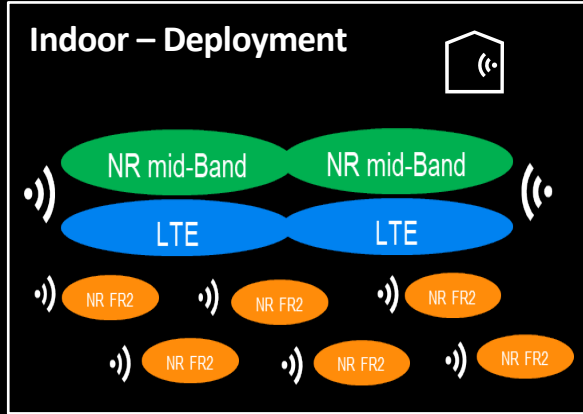
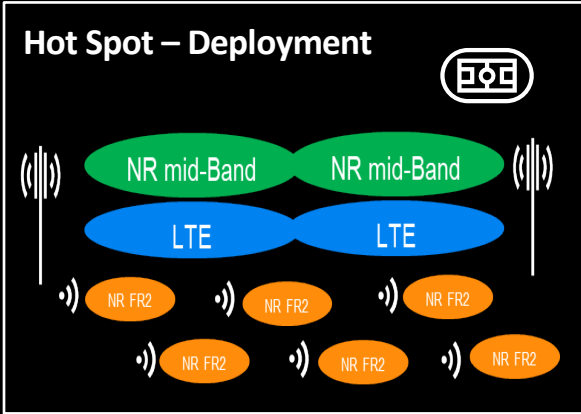
2 sector street site
mmWave only



2 sector street site
with lower band canister
antenna

Harnessing the power of highband to deliver demanding new 5G use cases in any deployment scenario

1,000x Higher data volumes	10-100x More connected devices
10-100x Higher typical user-data rates	5x Lower latency



Innovative beamforming solution, superior performance



Beamforming per UE:

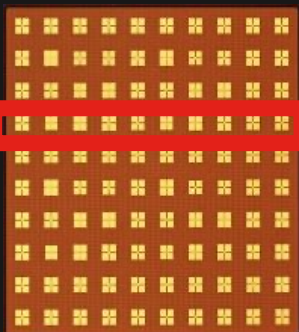
- Signal energy concentrated towards UE
- Strengthen signal & reduce interference spread

MIMO:

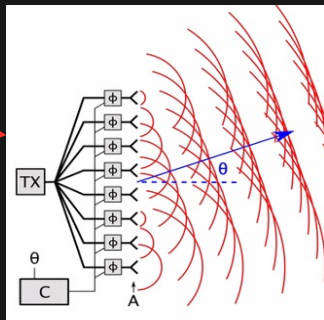
- Multiple data layers towards UE simultaneously
- Each layer beamformed separately

Cell Shaping:

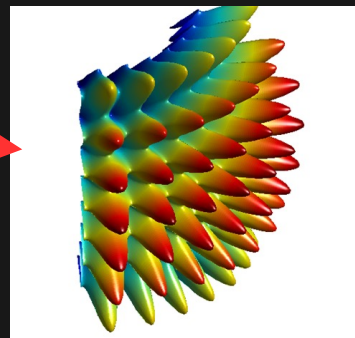
- Semi-static beamforming at cell level
- Optimize cell coverage to fit UE distribution



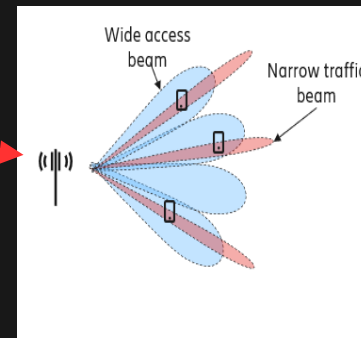
Antenna array



On-air combining



Set of possible beams



2 level beamforming

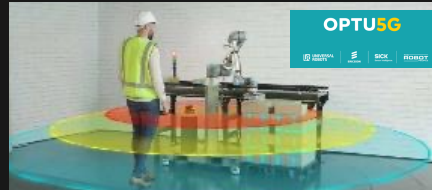
Ericsson's mmWave beamforming: Minimum overhead, latency and maximum beamforming gain!

MmWave enables new services and business



Early adoption: Industrial & Enterprise

- ✓ Reliable and secure replacement for wire and Wi-Fi
- ✓ Robotics and cloud control demands very high reliability at very low latency
- ✓ Flexible factory floor layout that allows mobile use with no interruptions
- ✓ UL heavy traffic for supervision
- ✓ Enhanced VR experience



5G mmWave URLLC capability for advanced automation
[Optus News](#)



5G mmWave exploration in production indoor and outdoor



5G mmWave in our own production



Enhanced VR experience in entertainment

mmWave unlocking the metaverse

A collaborative 5G solution to untethering immersive VR experiences



Traditional approaches to lack of mobility:

1. Shifting all computer power to headsets
2. Shifting computing power to a backpack
3. Using Wi-Fi

Innovative 5G mmWave solution:

- ✓ Cordless headsets powered by private network cell
Radio optimizations allow 6 VR players in a single cell
- ✓ Graphics remotely rendered and streamed
Photorealistic details & full-fidelity VR experience



[Full case study](#)



Qualcomm



Wevr



FWA geographic segments



The U.S. can be segmented into 6 morphologies based on household density

mmWave, mid-band and CBRS spectrum provide path to high speeds

Illustrative Morphologies						
	Downtown	Dense Urban	Urban	Suburban	Rural	Deep Rural
Household density (hh/sq-km)	> 1,600	800 – 1,600	400 – 800	120 – 400	10 – 120	< 10
Total Households (millions)	15	21	26	27	26	19
FWA Relevance	✗ Availability of numerous broadband alternatives discourage entry by FWA	✓ Sufficient household density combined with manageable levels of competition create opportunities for FWA to perform well technically and competitively	✓	✓	✓	✗ Low densities and long backhaul links create RF challenges

mmWave FWA performance (typical)

● LOS ● NLOS
28GHz



A world of limitless connectivity



Immersive applications

Fast

Unlock new business

Intelligent

Secure long-term evolution

Reliable

5G mmWave Summit

Maryam Rofougaran

Founder & CEO, Movandi



Maryam Rofougaran
CEO, Founder



5G mmWave Summit
September 29, 2022

**5G mmWave has the
ability to transform
every industry**



5G mmWave has the ability to transform every industry





Education



Healthcare



AR / VR



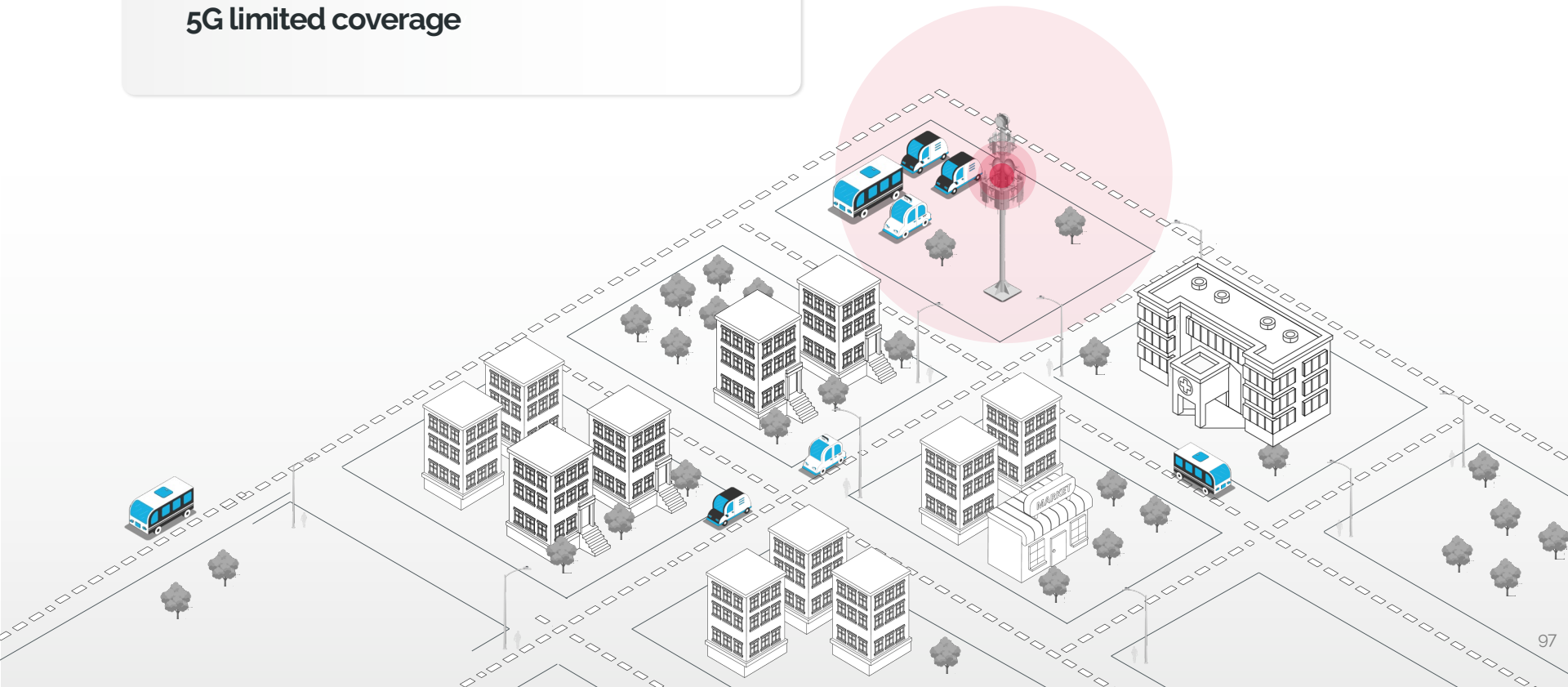
**Dense Urban Areas
& Venues**



**Automotive
& Smart City**

Connecting the Future with 5G mmWave

5G limited coverage

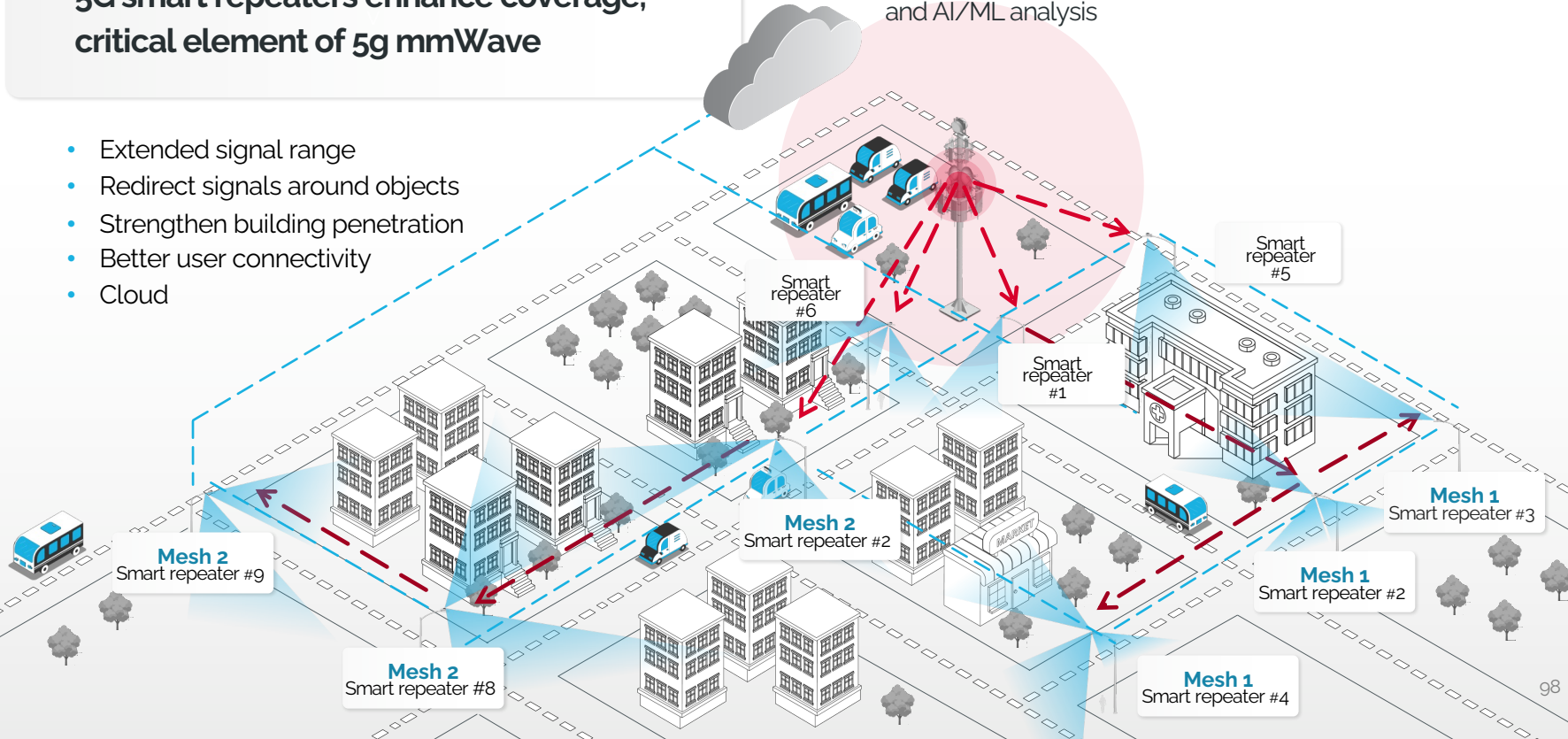


Connecting the Future with 5G mmWave

5G smart repeaters enhance coverage, critical element of 5g mmWave

Cloud APIs enable control, management and AI/ML analysis

- Extended signal range
- Redirect signals around objects
- Strengthen building penetration
- Better user connectivity
- Cloud



Repeaters Cut mmWave Costs by 80%

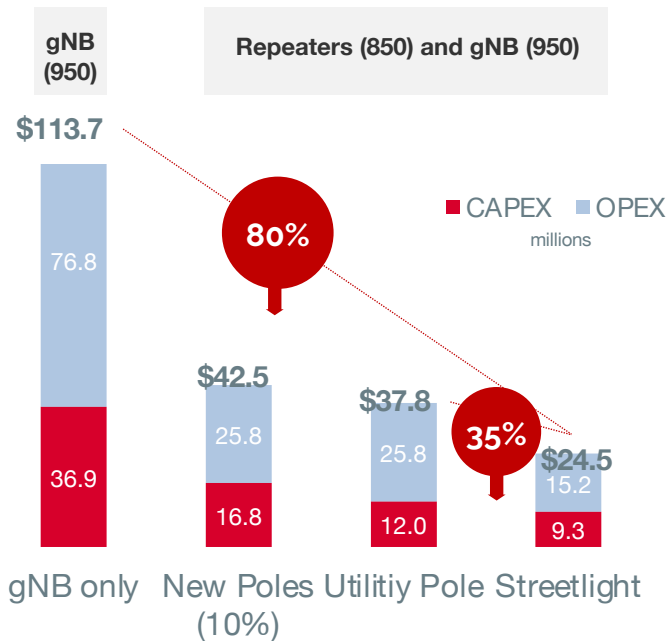
University park area. Dallas, Texas – 1.4 square miles



Source: Repeaters Cut 5G mmWave Costs in Half, Mobile Experts, August 2021



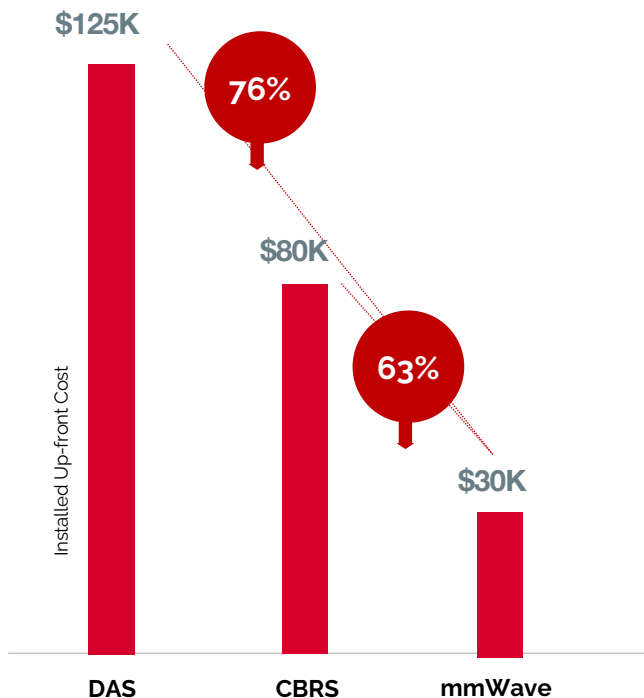
10 Year Total Cost of Ownership (TCO)



950 small cells

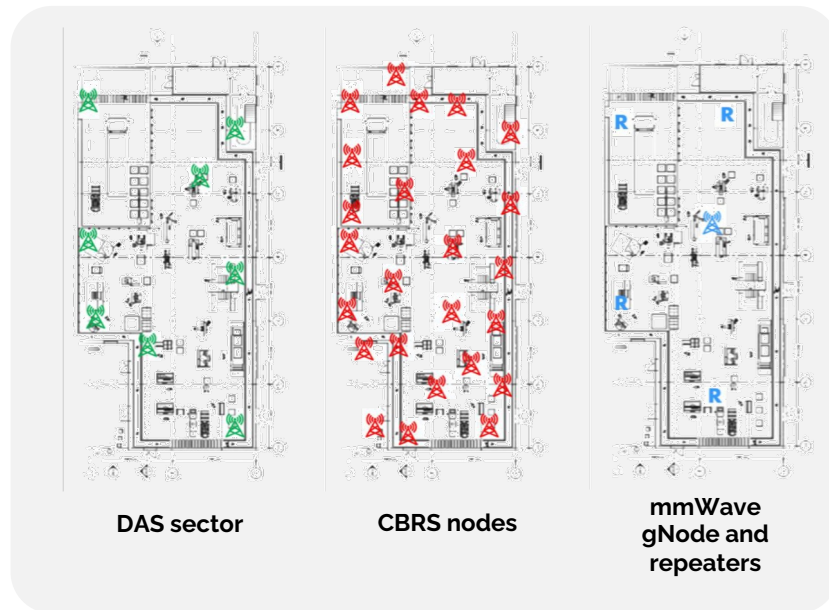
100 small cells + 850 smart repeaters

Making Private 5G Cost Effective



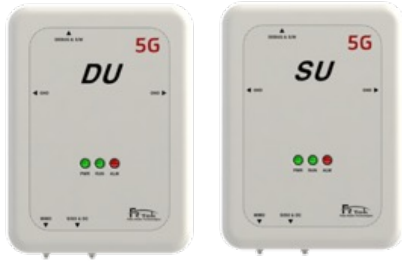
Deployment scenario:

- 30 robotic welding machines.
- Two 8k resolution video cameras per tool.
- Network requirement of 2.4 Gbps total capacity.



Smart Repeater Platforms

Network



Network extension, optionally solar-powered

- Outdoor coverage extension
- Outdoor to indoor

Indoor



For residences, businesses and enterprises, cost competitive with enterprise Wi-Fi

- Self-installation

Streetlight



Rapid installation on standard streetlights cuts deployment time / cost

5G mmWave smart repeater
deployments are here today





5G mmWave Summit
September 29, 2022

Thank You





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