5G・ミリ波の利活用促進に向けたご提案
〜５G・ミリ波の成功を６Gへ〜

Qualcomm Japan

政策渉外本部長
篠澤康夫

Physical world

Digital world

Virtual world

Digitization

Spatial computing

Metaverse

Ubiquitous, low-power sensing and monitoring with near real-time actions

Immersive interactions take human augmentation to the next level

空間の融合
がもたらす新たなインタフェース出現の機会

新たな
ヒューマン
インタフェース

Transportation

Manufacturing

Industrial

Retail
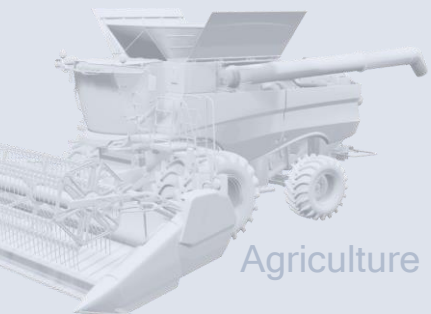
Energy

あらゆる産業でのデジタルトランスフォーメーションを牽引

5Gは2035年に世界で13.1兆ドルの販売活動を可能に
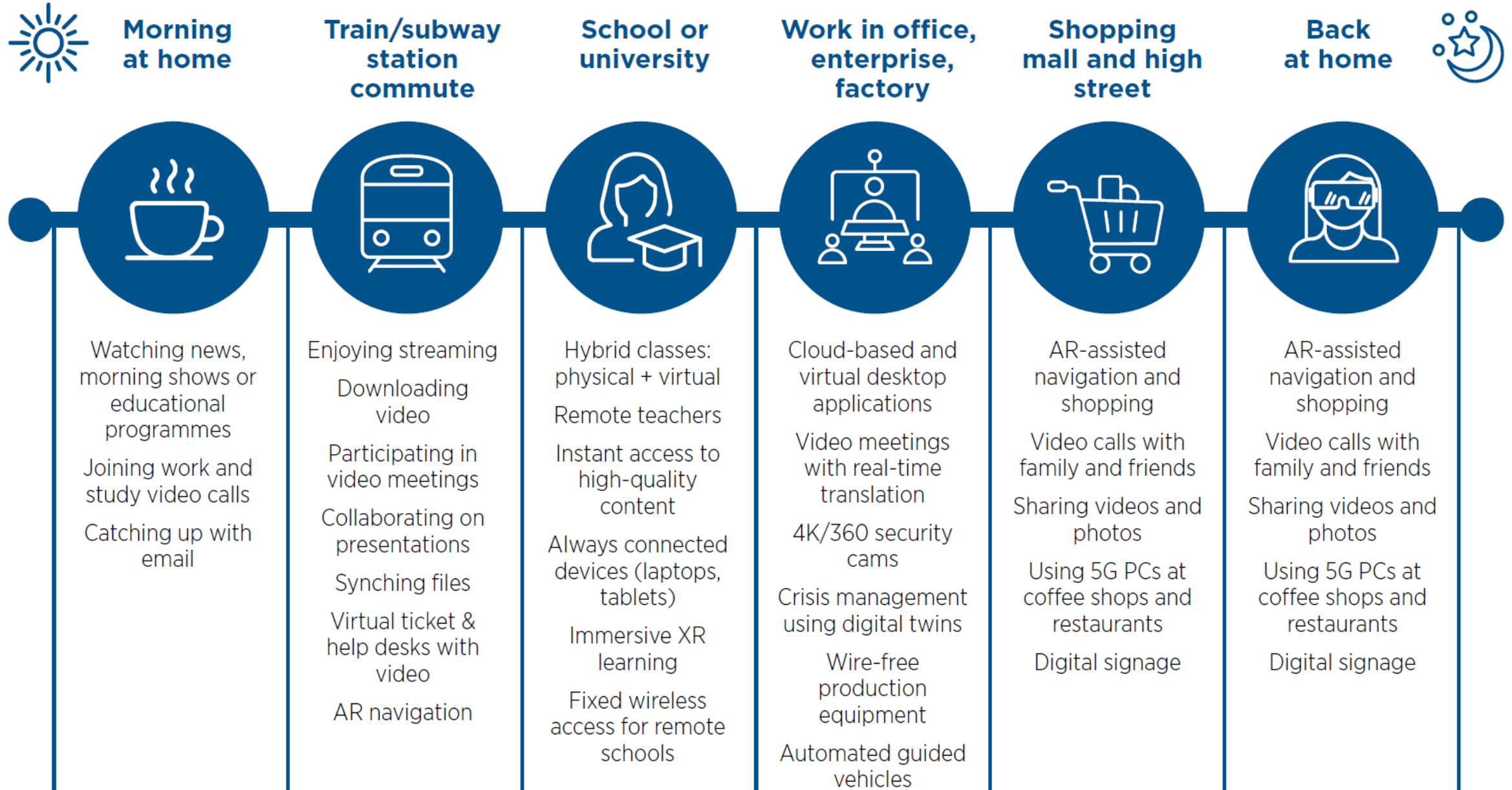
Agriculture

Public safety

Smart cities

Healthcare

Entertainment

5G mmWave による 5Gのフルポテンシャルの発揮

Morning at home
- Watching news, morning shows or educational programmes
- Joining work and study video calls
- Catching up with email

Train/subway station commute
- Enjoying streaming
- Downloading video
- Participating in video meetings
- Collaborating on presentations
- Synching files
- Virtual ticket & help desks with video
- AR navigation

School or university
- Hybrid classes: physical + virtual
- Remote teachers
- Instant access to high-quality content
- Always connected devices (laptops, tablets)
- Immersive XR learning
- Fixed wireless access for remote schools

Work in office, enterprise, factory
- Cloud-based and virtual desktop applications
- Video meetings with real-time translation
- 4K/360 security cams
- Crisis management using digital twins
- Wire-free production equipment
- Automated guided vehicles

Shopping mall and high street
- AR-assisted navigation and shopping
- Video calls with family and friends
- Sharing videos and photos
- Using 5G PCs at coffee shops and restaurants
- Digital signage

Back at home
- AR-assisted navigation and shopping
- Video calls with family and friends
- Sharing videos and photos
- Using 5G PCs at coffee shops and restaurants
- Digital signage

5G mmWave - Unlocking the Full Potential of 5G (GSMA)
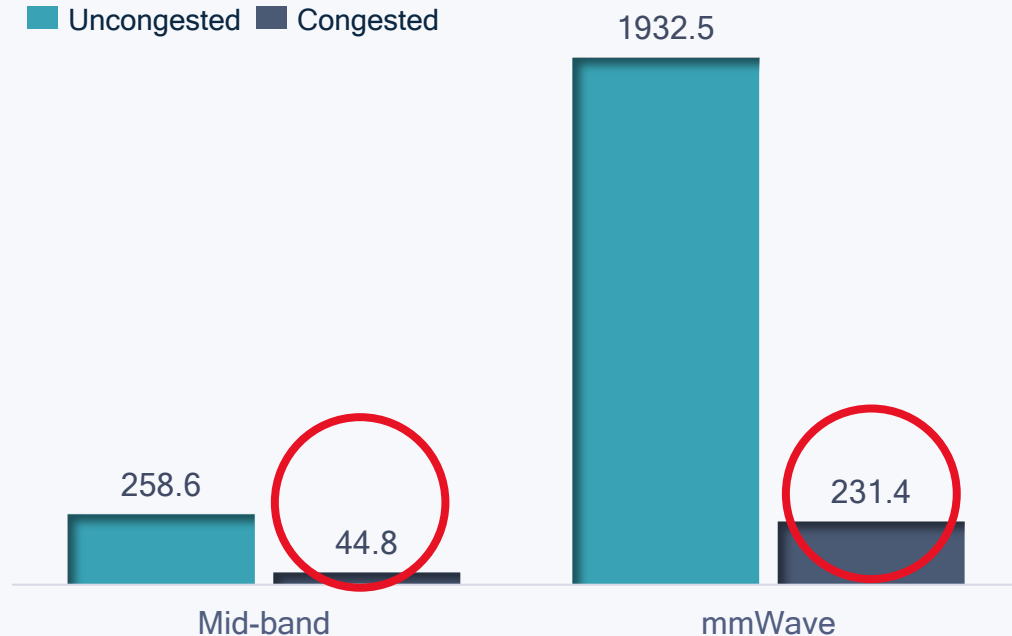
5G mmWave + mid-band = 最高の QoE (Quality of Experience) を提供

Median download throughput (Mbps)

■ Uncongested ■ Congested

1932.5

258.6

44.8

231.4

Mid-band

mmWave

- RootMetrics の調査で、5G mmWaveは混雑した NWであっても 均質なユーザー体験 を提供できることを確認
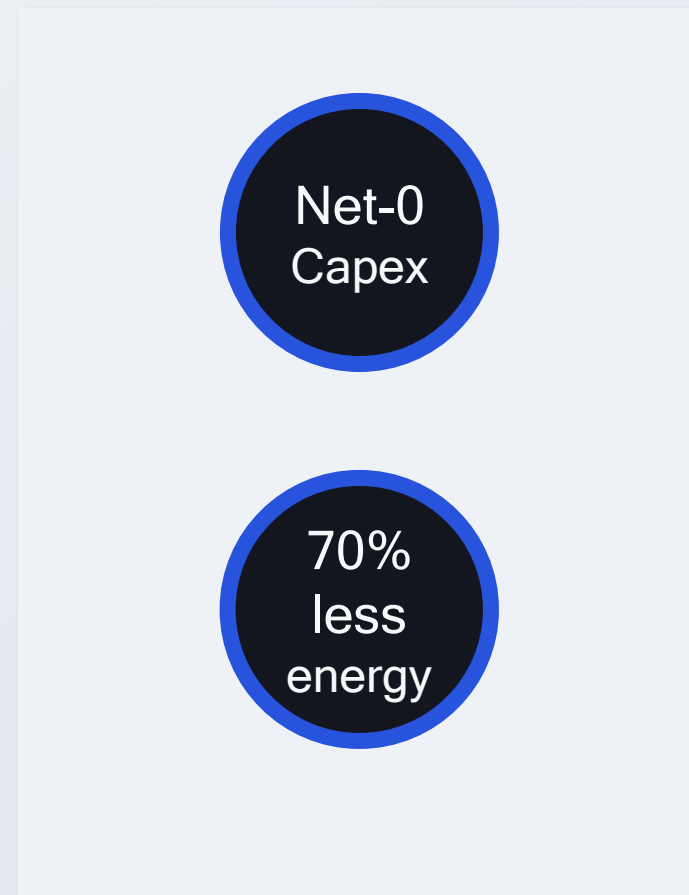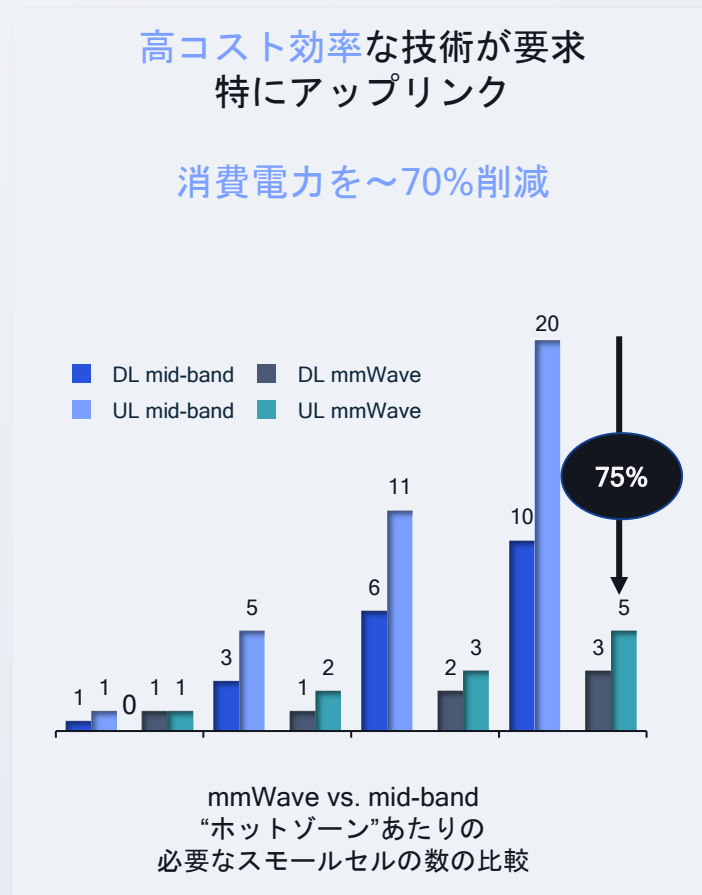
- 5G mmWaveは、ネットワークの負荷が高い場合でも、大容量・高速サービスを保証

スタジアム　　鉄道駅　　屋内モール　　屋外ホットスポット

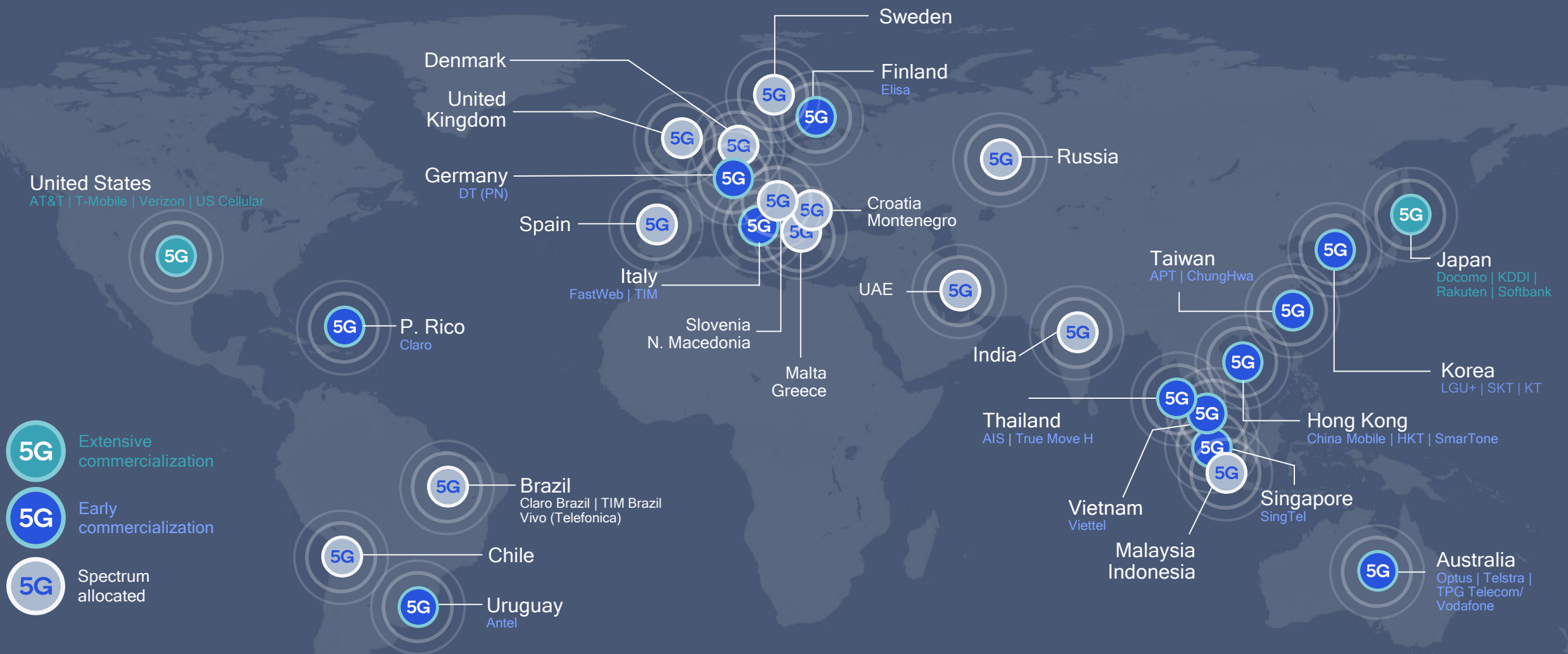# 5G mmWaveは大容量が必要なエリアでも高品質なサービスを高いコスト効率で実現

スタジアム

鉄道駅

インドア
モール

屋外
高密度エリア

5G mmWave
ホットゾーン**

2000

ユーザの日常的
な利用率%

24%

高コスト効率な技術が要求
特にアップリンク

消費電力を～70%削減

- DL mid-band
- UL mid-band
- DL mmWave
- UL mmWave

75%

20

11

10

6

5

5

5

3

3

3

2

2

1 1

1 1

0

1

mmWave vs. mid-band
"ホットゾーン"あたりの
必要なスモールセルの数の比較

Net-0
Capex

70%
less
energy

5G mmWave 周波数割当と商用化の状況 (Nov 2022)

商用サービス – 8 → 28 事業者*

周波数が利用可能 – 14 → 31 国・地域*

mmWave の普及が 各国で進行中

- 50か国・地域の195事業者が5G mmWaveへ投資（テスト、トライアル、計画、ライセンス取得、開発あるいはNWを運用）
  - 26/28 GHz
  - 37-40 GHz
  - 47-48 GHz
  - 66-76 GHz and 81-86 GHzのトライアルも進行中
- 25か国・地域の118事業者が26/28GHz、37-40GHz、47-48GHzのいずれかのmmWave 導入ライセンスを取得
- 31か国・地域の28事業者が5G mmWaveを展開中/開始

Count and status of operator mmWave investments

■ Testing/Trialling/Planning ■ Licensed ■ Deploying/Launched
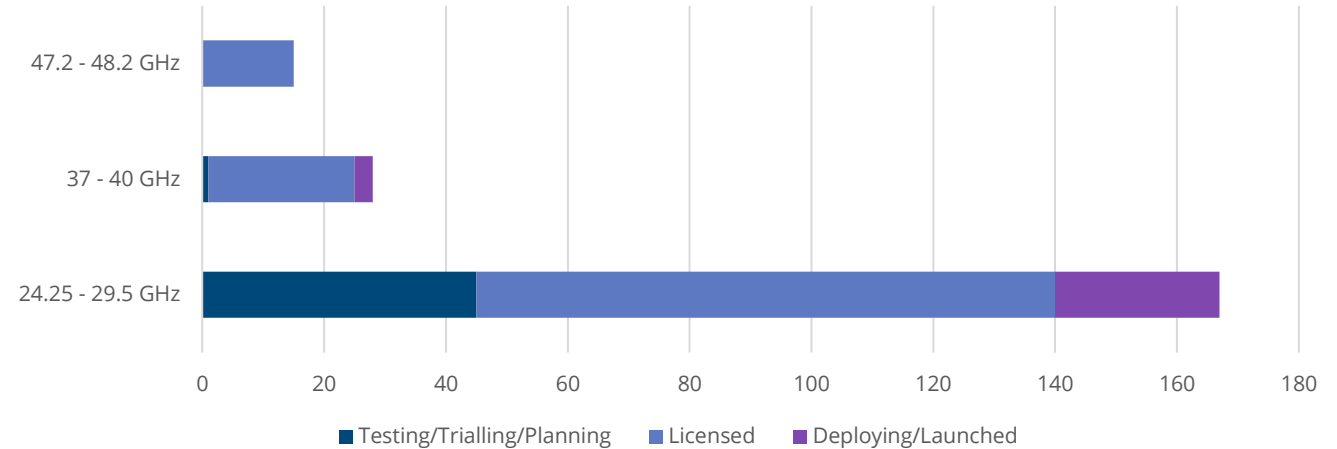
Use of 5G spectrum between 24.25 GHz and 29.5 GHz

■ Testing/Planning ■ Deploying ■ Licensed ■ Deployed

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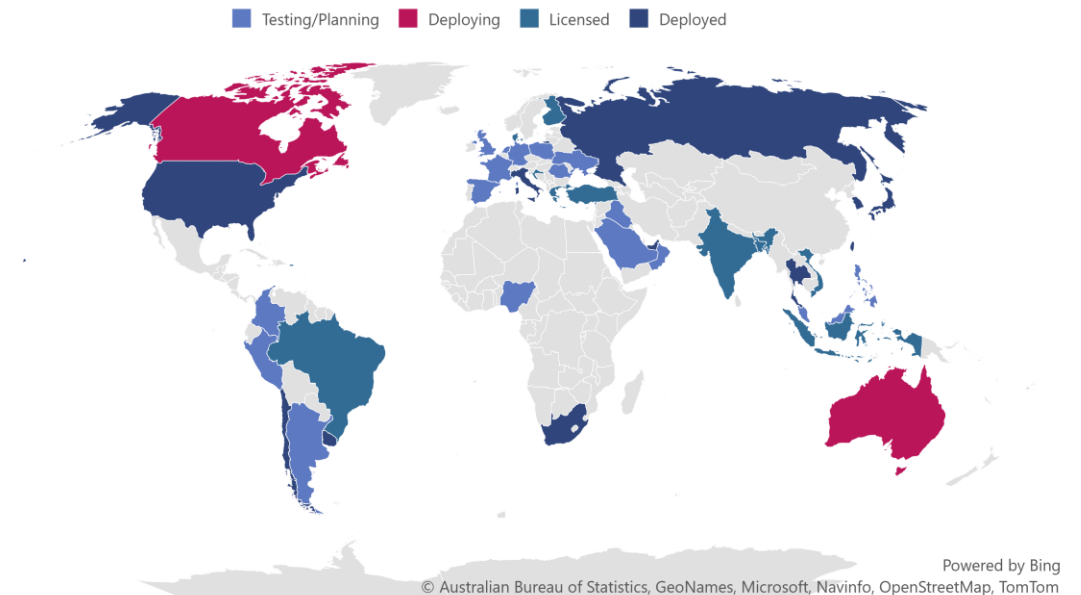
5G mmWave機器の多様な展開

170+

世界65以上のベンダーから
5G mmWave 機器が
発売・発表

5G smartphones
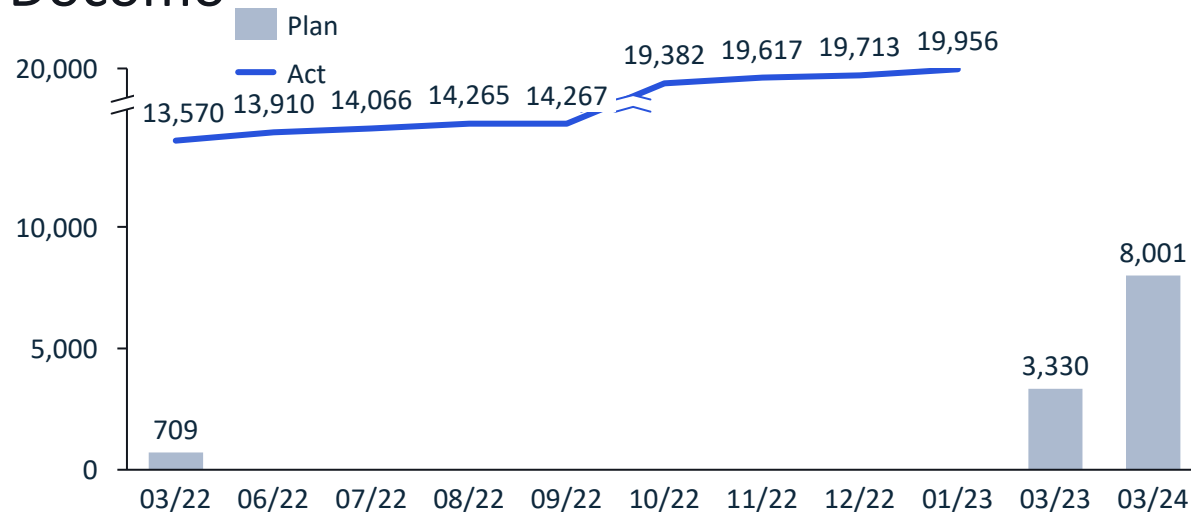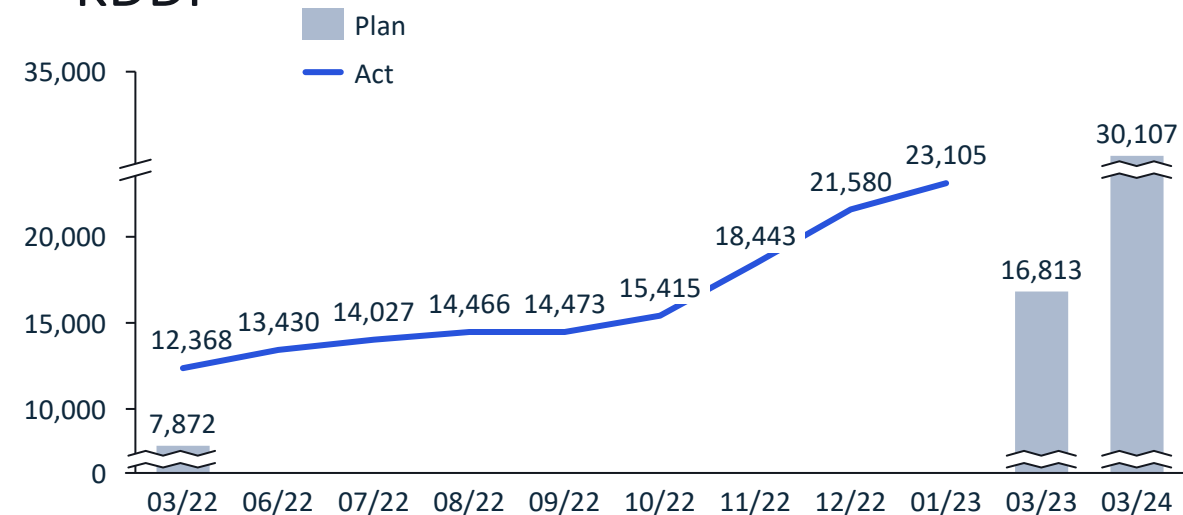
PCs

Hotspots & IoT

IP camera

Modules

CPEs

Sub-6 NW 展開状況* （Qualcomm社調査。2022年１月27日）

*: counted based on # of license application of gNB. If gNB is not deployed within 6 months, license application will be canceled.
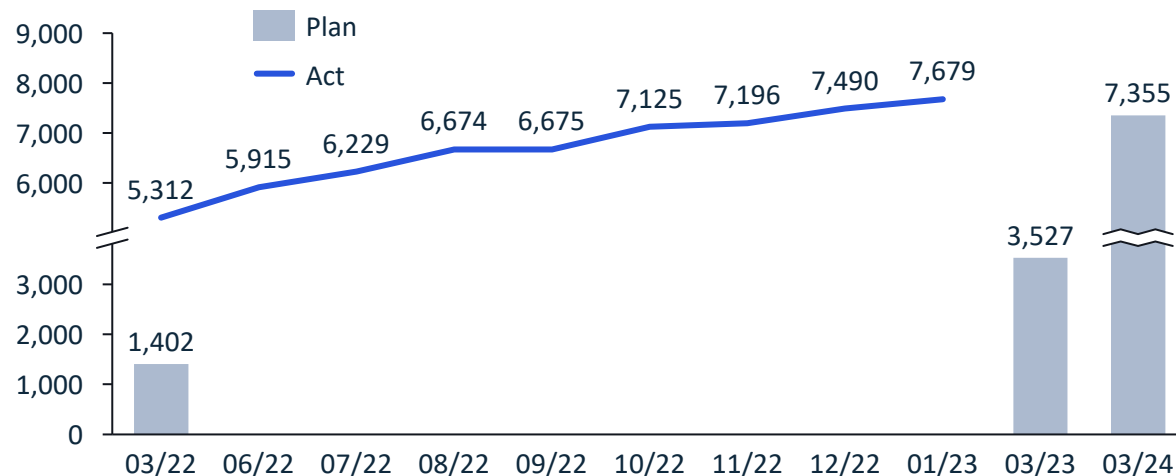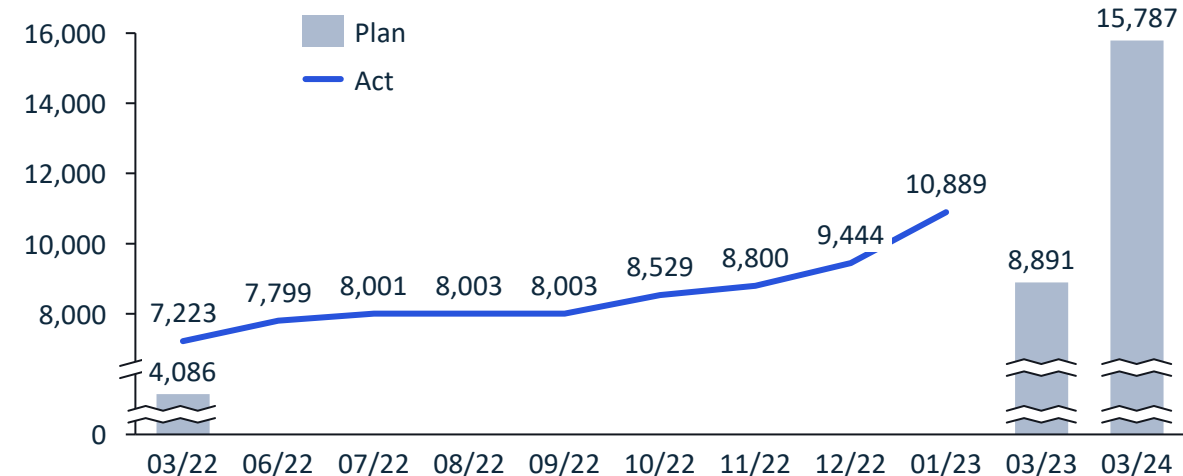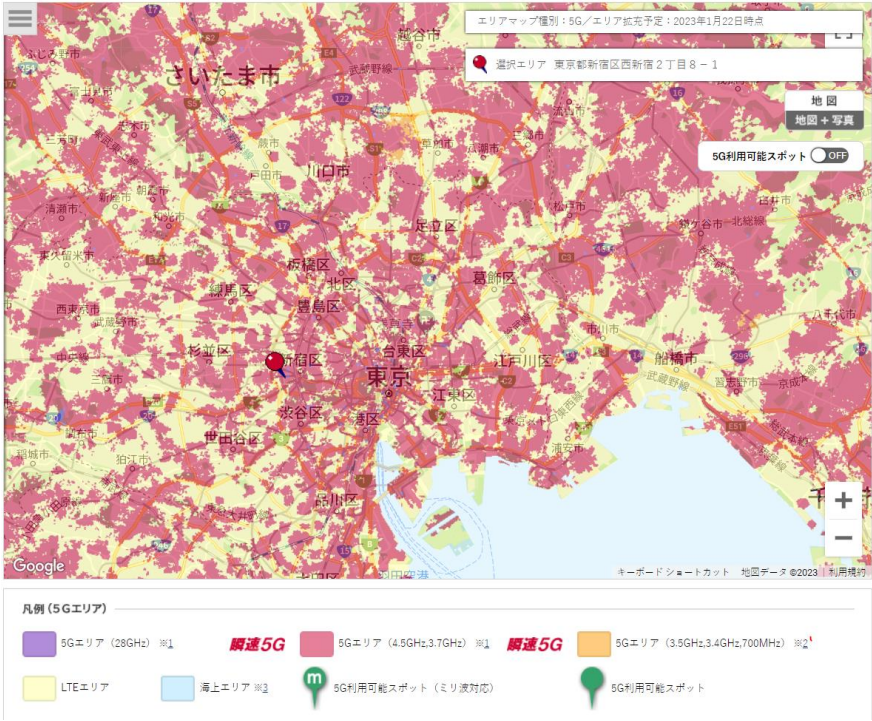
• Docomo

Plan
Act

	03/22	06/22	07/22	08/22	09/22	10/22	11/22	12/22	01/23	03/23	03/24
Act	13,570	13,910	14,066	14,265	14,267	19,382	19,617	19,713	19,956		
Plan	709									3,330	8,001

Y-axis: 0, 5,000, 10,000, 20,000

• KDDI

Plan
Act

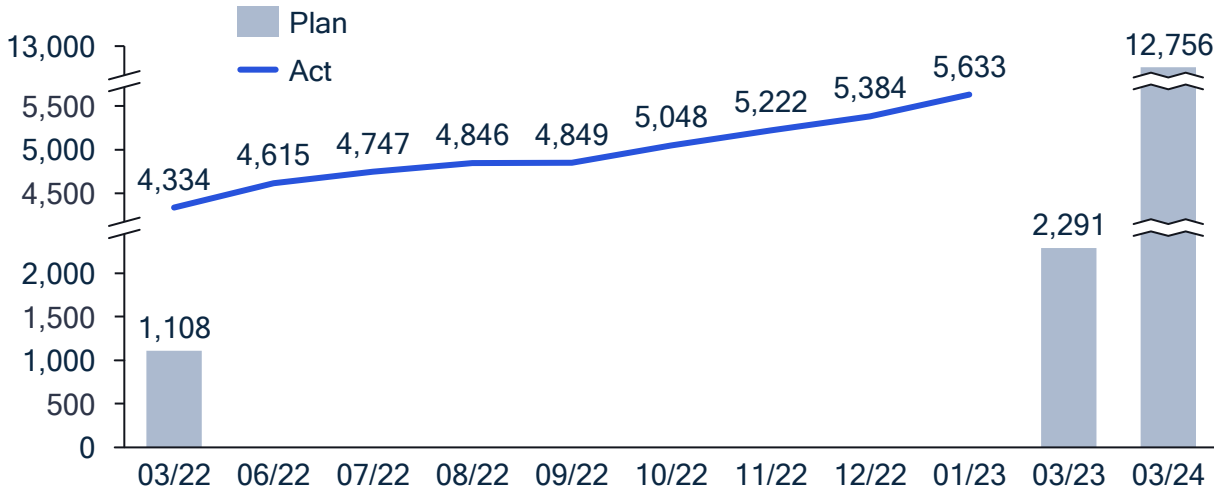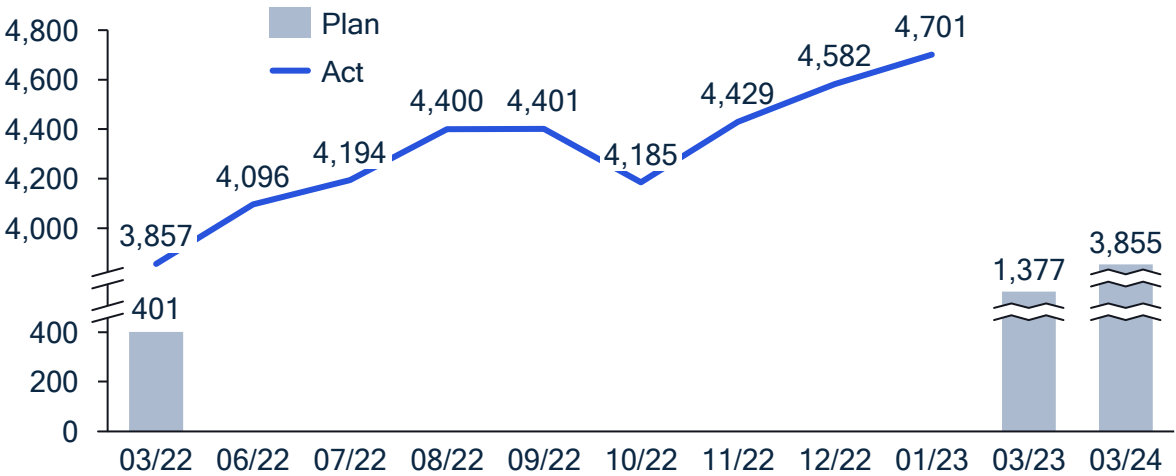|	03/22	06/22	07/22	08/22	09/22	10/22	11/22	12/22	01/23	03/23	03/24
Act	12,368	13,430	14,027	14,466	14,473	15,415	18,443	21,580	23,105		
Plan	7,872									16,813	30,107

Y-axis: 0, 10,000, 15,000, 20,000, 35,000

• Softbank

Plan
Act

	03/22	06/22	07/22	08/22	09/22	10/22	11/22	12/22	01/23	03/23	03/24
Act	5,312	5,915	6,229	6,674	6,675	7,125	7,196	7,490	7,679		
Plan	1,402									3,527	7,355

Y-axis: 0, 1,000, 2,000, 3,000, 6,000, 7,000, 8,000, 9,000

• Rakuten

Plan
Act

	03/22	06/22	07/22	08/22	09/22	10/22	11/22	12/22	01/23	03/23	03/24
Act	7,223	7,799	8,001	8,003	8,003	8,529	8,800	9,444	10,889		
Plan	4,086									8,891	15,787

Y-axis: 0, 8,000, 10,000, 12,000, 14,000, 16,000

Sub-6 NW 展開状況（東京） （Qualcomm社2022年2月調査）

Docomo

KDDI（au）

5G ミリ波

5G sub6

5G NR化

4G LTE

4G LTE 海上エリア

もっと詳しく

凡例（5Gエリア）

5Gエリア（28GHz）※1　　**爆速5G** 5Gエリア（4.5GHz,3.7GHz）※1　**爆速5G** 5Gエリア（3.5GHz,3.4GHz,700MHz）※2

LTEエリア　　海上エリア※3　　m 5G利用可能スポット（ミリ波対応）　　5G利用可能スポット

Rakuten

4G LTE　　　　5G

市区町村名や住所を入力

楽天回線 5G ミリ波エリア　楽天回線 5G Sub6エリア　楽天回線 4G LTEエリア　パートナー回線エリア

Softbank

地図縮尺：

5 km

SoftBank 5G　SoftBank 5G予定

〈凡例〉　SoftBank 5G〈28GHz〉※1（2022年12月末時点）　　SoftBank 4G／4G LTE（2022年10月末時点）
　　　　SoftBank 5G〈3.7GHz〉※1（2022年12月末時点）　　SoftBank 3G（2022年10月末時点）
　　　　SoftBank 5G〈700MHz 1.7GHz 3.4GHz〉※2（2022　　海上・水上でおおよそ利用可能
　　　　年12月末時点）
　　　　※1　高速大容量通信エリア
　　　　※2　5G表示となりますが通信速度はSoftBank 4Gまた
　　　　はSoftBank 4G LTE同等になります

現在地

Confidential - Qualcomm

mmWave NW展開状況* （Qualcomm社調査。2022年１月27日）

*: counted based on # of license application of gNB. If gNB is not deployed within 6 months, license application will be canceled.
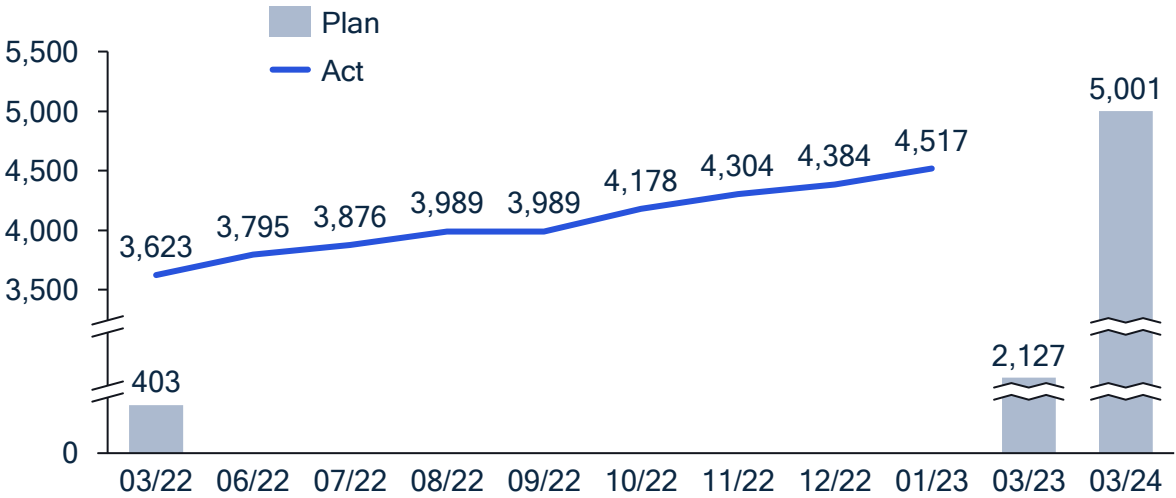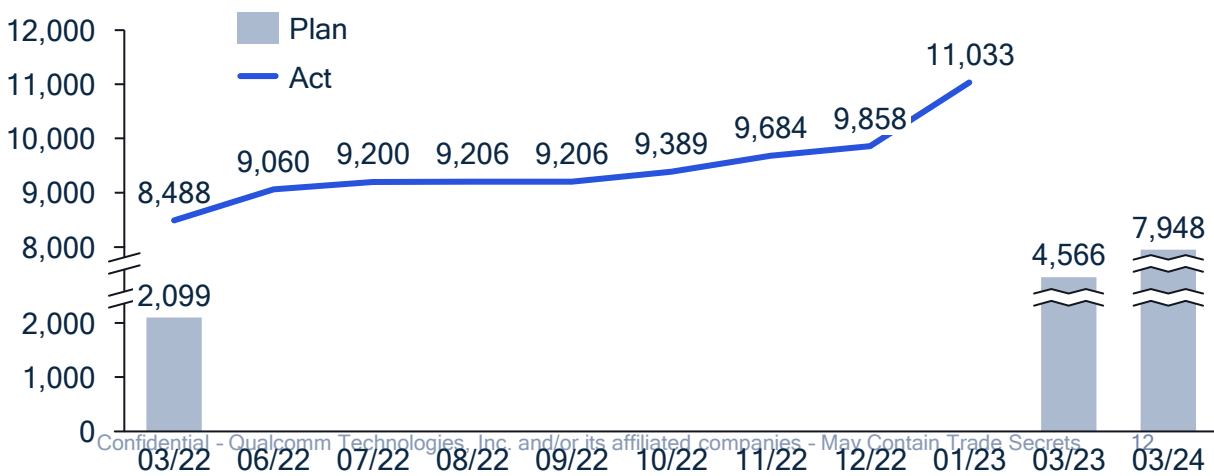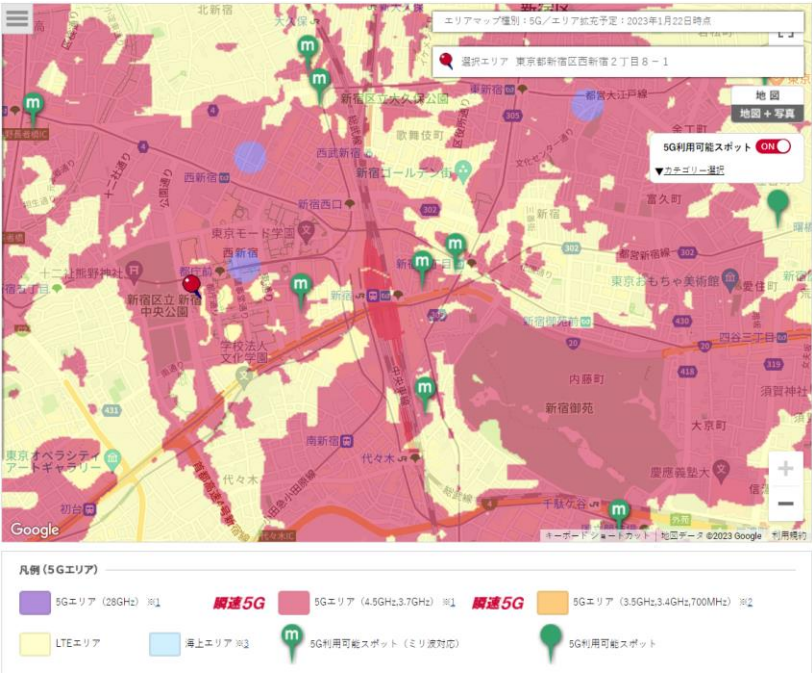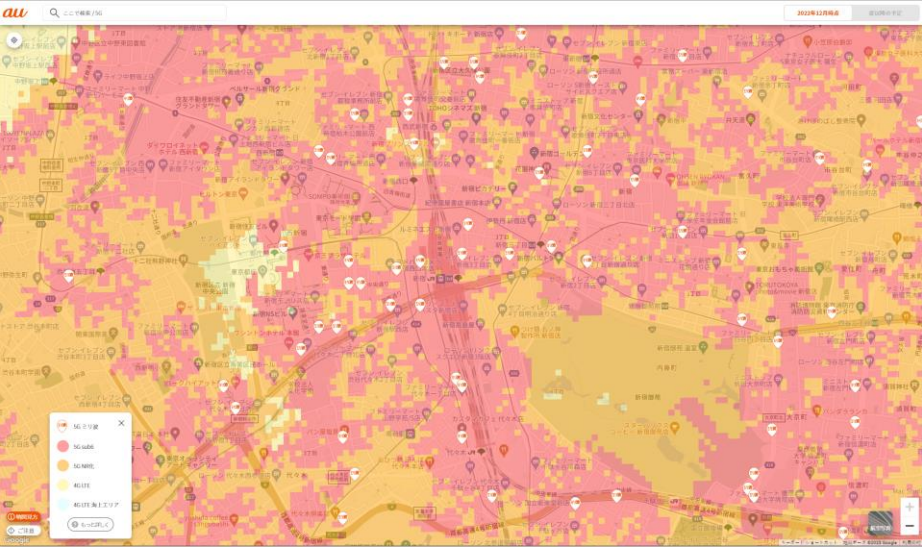
- Docomo

- KDDI

- Softbank
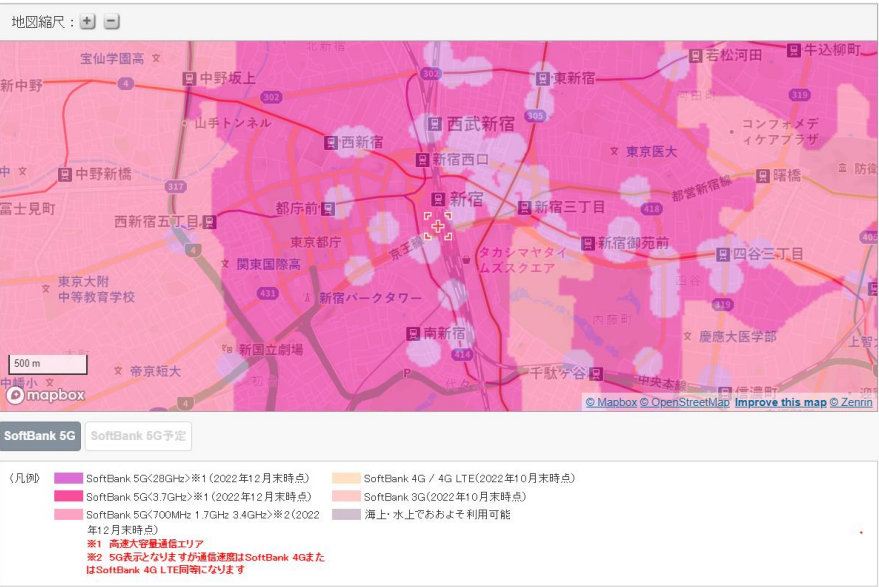

- Rakuten
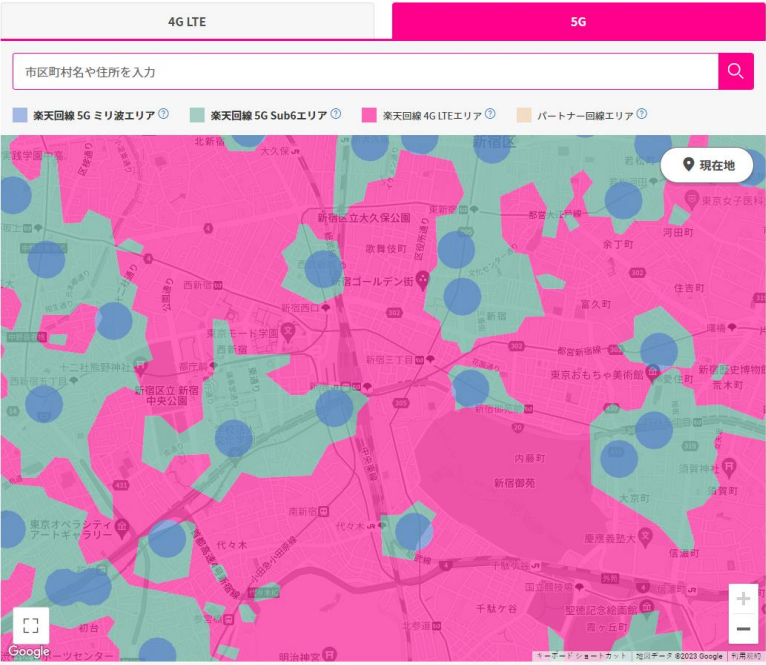
mmWave NW 展開状況（新宿エリア） （Qualcomm社2022年2月調査）

Docomo

凡例（5Gエリア）

- 5Gエリア（28GHz）※1
- 瞬速5G 5Gエリア（4.5GHz,3.7GHz）※1 瞬速5G
- 5Gエリア（3.5GHz,3.4GHz,700MHz）※2
- LTEエリア
- 海上エリア※3
- 5G利用可能スポット（ミリ波対応）
- 5G利用可能スポット

KDDI（au）

Softbank

〈凡例〉

- SoftBank 5G〈28GHz〉※1（2022年12月末時点）
- SoftBank 5G〈3.7GHz〉※1（2022年12月末時点）
- SoftBank 5G〈700MHz 1.7GHz 3.4GHz〉※2（2022年12月末時点）
- SoftBank 4G / 4G LTE（2022年10月末時点）
- SoftBank 3G（2022年10月末時点）
- 海上・水上でおおよそ利用可能

※1 高速大容量通信エリア
※2 5G表示となりますが通信速度はSoftBank 4Gまたは SoftBank 4G LTE同等になります

Rakuten

4G LTE | 5G

市区町村名や住所を入力

- 楽天回線 5G ミリ波エリア
- 楽天回線 5G Sub6エリア
- 楽天回線 4G LTEエリア
- パートナー回線エリア

Confidential - Qualcomm Tech

日本におけるミリ波対応スマートフォン（Qualcomm社調査）

凡例　[sub-6/mmW]　[sub-6]

(*) Rakuten's Sub-6 models were not listed here due to limited space

Model	'20 Summer	'20 Winter	'21 Summer	'21 Winter	'22 Summer	'22 Winter
mmW models	4 models	3 models	5 models	5 models	9 models	8 models

docomo (Flagship/Prem → Mid)

	'20 Summer	'20 Winter	'21 Summer	'21 Winter	'22 Summer	'22 Winter
Global OEM	Samsung: GS20+	Samsung: Note20 Ultra	Samsung: GS21 Ultra	Samsung: Z Fold	Samsung: GS22 Ultra	Samsung: Z Fold 4
	Samsung: GS20	Samsung: A51	Samsung: GS21	Samsung: Z Flip3	Samsung: GS22	Samsung: Z Flip 4
	LG: LG V60 ThinQ	LG: Velvet L-52A	Samsung: A52		Samsung: A53	
JP OEM	Sony: Xperia 1 II	Sony: Xperia 5 II	Sony: Xperia 1 III	Sony: Xperia 5 III	Sony: Xperia 1 IV	Sony: Xperia 5 IV
	Sharp: Aquos R5G	FCNT: Arrows NX9	Sharp: Aquos R6	Sharp: Aquos Sense6	Sharp: AQUOS R7	Sony/ Sharp: TBD
	FCNT: Arrows 5G	Sharp: Aquos sense5G	Sony: Xperia 10 III		Sony: Xperia 10 IV	

KDDI (Tomorrow, Together)

	'20 Summer	'20 Winter	'21 Summer	'21 Winter	'22 Summer	'22 Winter
Global OEM	Samsung: GS21 Ultra	Samsung: Z Fold2	Samsung: GS21+	Samsung: Z Fold	Samsung: GS22 Ultra	Samsung: Z Fold 4
	Samsung: GS20+	Samsung: Note20 Ultra	Samsung: GS21	Google: Pixel 6	Samsung: GS22	Samsung: Z Flip 4
	Oppo: Find X2 Pro	Google: Pixel 5	Oppo: Find X3 Pro		Google: Pixel 6a	Google: Pixel 7 Pro
JP OEM	Sony: Xperia 1 II	Sony: Xperia 5 II	Sony: Xperia 1 III	Sony: Xperia 5 III	Sony: Xperia 1 IV	Sony: Xperia 5 IV
	Sharp: Aquos R5G	Sharp: Aquos Sense	Kyocera: TORQUE	Sharp: Aquos zero6	Sony: Xperia 10 IV	Sony: TBD
			Sony: Xperia 10 III	Sharp: Aquos sense6	Sharp: Aquos sense6s	Sharp: TBD

SoftBank

	'20 Summer	'20 Winter	'21 Summer	'21 Winter	'22 Summer	'22 Winter
Global OEM	LG: LG V60 ThinQ	Google: Pixel 5	Moto: razr 5G	Google: Pixel 6 Pro		Samsung: Z Flip 4
	ZTE Axon 10 Pro 5G	Google: Pixel 4a (5G)	Google: Pixel 5a (5G)	Google: Pixel 6	Google: Pixel 7 Pro	Google: Pixel 7 Pro
	OPPO: Reno3 5G				Google: Pixel 6a	Google: Pixel 7
JP OEM	Sharp: Aquos R5G	Sony: Xperia 5 II	Sony: Xperia 1 III	Sony: Xperia 5 III	Sony: Xperia 1 IV	Sony: Xperia 5 IV
		Sharp: Aquos zero 5G	Sharp: Aquos R6	Sharp: Aquos zero6	Sharp: AQUOS R7	Sharp: LEITZ PHONE
		Sharp: Aquos sense5G	Sharp: LEICA LEITZ	Kyocera: BALMUDA	Sony: Xperia 10 IV	Sharp: sense 7

Rakuten Mobile (*)

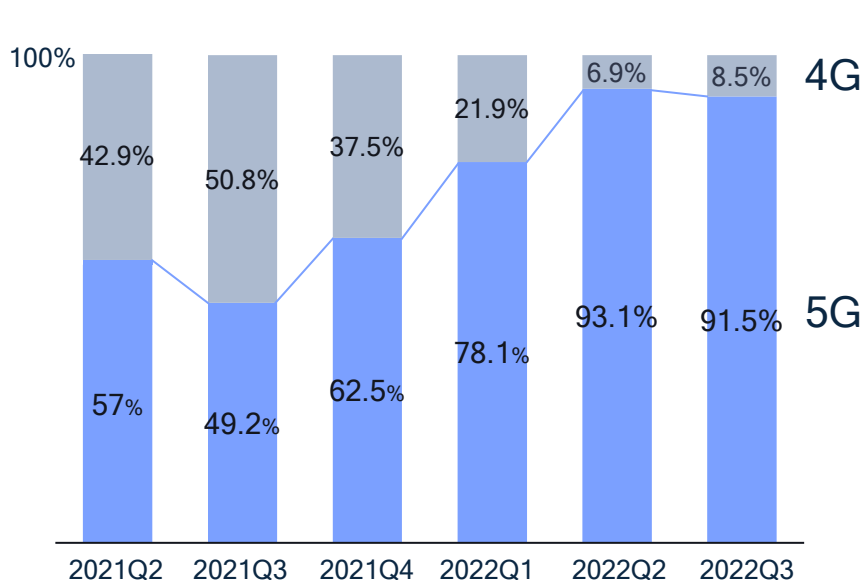|	'20 Summer	'20 Winter	'21 Summer	'21 Winter	'22 Summer	'22 Winter
Global OEM		ZTE: Rakuten BIG ZR01	Coolpad: Rakuten BIG S			Samsung: Z Flip 4
JP OEM				Sharp: Aquos zero6		

国内携帯電話市場における5G・ミリ波搭載端末

■5G対応端末
販売台数の割合の推移

- 5Gへの移行が順調に進展

■ミリ波搭載端末
販売台数の推移

- 2022年のミリ波搭載の販売台数は170万台を超える見込み
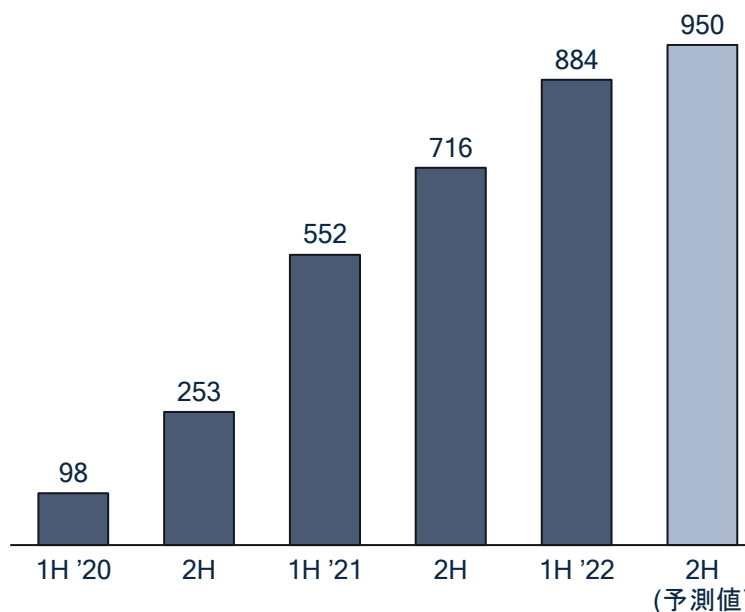
■ミリ波搭載端末
販売台数の割合

- ミリ波搭載端末は、2022年における携帯電話市場の販売台数の約5%相当と推定

5G対応端末販売台数の割合の推移（%）

	2021Q2	2021Q3	2021Q4	2022Q1	2022Q2	2022Q3
4G	42.9%	50.8%	37.5%	21.9%	6.9%	8.5%
5G	57%	49.2%	62.5%	78.1%	93.1%	91.5%

100%

ミリ波搭載端末販売台数（千台）

1H '20	2H	1H '21	2H	1H '22	2H (予測値)
98	253	552	716	884	950

2022年販売台数の割合（%）

- 4G/LTE: 15.1%
- 5G: ミリ波: 5.2%
- 5G: Sub-6: 79.7%

中心: 35.0（百万台）
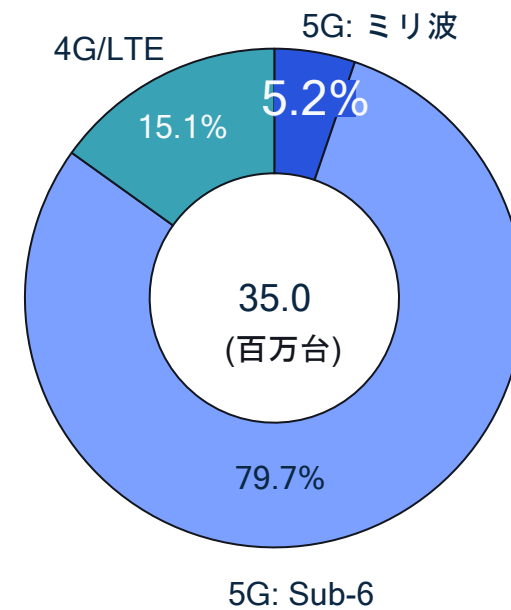
ミリ波を巡る現状と課題①

	現状	課題
基地局	• Sub-6 GHz の基地局は全国で約5万局 ミリ波の基地局は全国で約2.3万局 (2022年10月末時点、4事業者合計) • 各事業者は開設計画に対して前倒しで設置	• 都市部であってもミリ波のエリアへアクセスする機会は稀 ユーザーが5Gの真のポテンシャルによる利益を享受する機会が限定的に。
端末	• 対応端末の機種数は増加中: 　'20夏は4機種、'20冬は3機種 　'21夏は5機種、'21冬は5機種 　'22夏は9機種、'22冬は8機種 　(4事業者)	• ミリ波対応端末のシェアは５％程度 （米国の1/10以下）

日本	米国
Sales volume: 1.7 M (2022)	Sales volume: 90 M (2022)
5.2% of the total	57.3% of the total

ミリ波を巡る現状と課題②

	現状	課題
サービス & Local 5G	• ユーザーは追加料金なし（SAについては一部通信事業者において追加料金設定）でミリ波を利用可能 • "with COVID-19"で外出の機会が増えている状況下、XR/ARのような新たなサービスの登場が期待	• 5Gの真のポテンシャルを活かすことができるサービスの普及が不十分 • 多様な分野においてミリ波を利用するPoCは進められているものの、商用化には至っていないものが多い
国際動向	• 米国ではミリ波を利用したビジネスが着実に進展中 • 他各国・地域で順次ミリ波ラインセンスが付与 • 商用サービスはこれから本格化	• 韓国において、政府目標を達成していないため、MSITによりミリ波ライセンスがキャンセル • ミリ波の本格的な利活用がこれから、という状況にあって、日本の動向が世界から着目

ミリ波利活用促進に向けた取組のご提案

**〜日本が5Gのメリットを活かした
ビジネスデザインを世界に率先して行うために〜**

① 国家目標の設定

- 人口カバー率ではなく、定量的な基地局数に関する国家目標の設定
特にキャパシティ拡張のため、高トラフィックあるいは戦略的なエリア（例：空港、地下鉄、都市部、ショッピングセンター）
- 投資を促進するためのインセンティブの付与
- インセンティブと質の高いサービスの提供や他公共政策との連動

② 端末販売へのインセンティブ

- 新技術の普及や、事業者による創意工夫の促進
- ミリ波端末の普及目標の設定（現実的かつ最低限の値）
- 端末におけるミリ波関連アイコン表示の推奨

③ 産業政策

- 5G ミリ波へのアクセスにより新たな体験を得られるXR/ARのような先進的な技術やサービス開発の促進
- Local 5Gの長期的支援（バーティカルプレイヤー育成は時間を要する）
- 日本の先進的な技術のリーダーシップとしての強みの強化

5G・ミリ波ビジネスを成功させ、世界をリードする絶好の機会

端末販売へのインセンティブ設定等

[KPI案] (5% as of 2022)

ミリ波端末の割合を
2025年には50%以上
2030年には80%以上
（スマートフォンの台数ベース）

[Proposed policy 1]
- 2019年改正電気通信事業法に基づく端末購入に対する上限２万円規制を、ミリ波端末については上限を**引き上げ（４万円）**

[Reason for proposal]
- インセンティブを設定することで、ミリ波非対応端末に対してミリ波搭載を誘発。
- 差額が大きくなることで、転売対策としても効果が期待。

[Proposed policy 2]
- 利用者へのわかりやすい情報提供を行う観点から、ミリ波を受信していることを示すミリ波アイコンの表示の推奨

省庁横断的な取組推進

健康医療

情報通信

農林水産

産業振興

環境

日本の裾野の広い産業を活かす
省庁横断的な政策の推進

日本の裾野の広い産業構造をいかした5Gビジネスが普及・発展する
シナリオは大きな可能性を持っています。
そのためにも、複数の省庁が連携した取組を継続的に
推進していただくことが必要です。

科学技術・
イノベーション

資源・エネルギー

国土開発

教育

経済・財政

Thank you

参考資料

Meet users where they are
& maximize returns and cost-efficiency

The high throughput and network capacity of mmWave can lead to near-term cost-efficiency in key environments:

Homes & SOHO fixed access

Train Stations & Transit Hubs

Offices

Outdoor Hot Zones

Indoor Malls and Venues
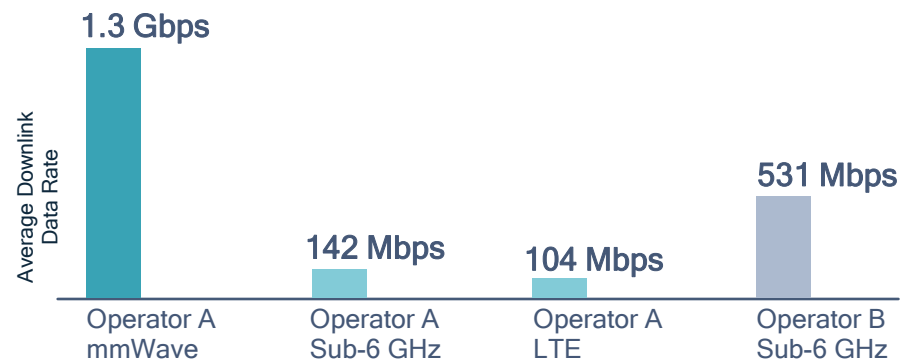
5G mmWave が ユーザー体験や システム容量を 大幅に拡張

米国シカゴでの商用ＮＷによる フィールドテスト

Operator A
mmWave NSA[1]: 各しきい値で65%[2]/85%[3] のカバレッジの達成とsub-6 GHz NSA (DSS)[4] や LTE[5]のサポート

Operator B
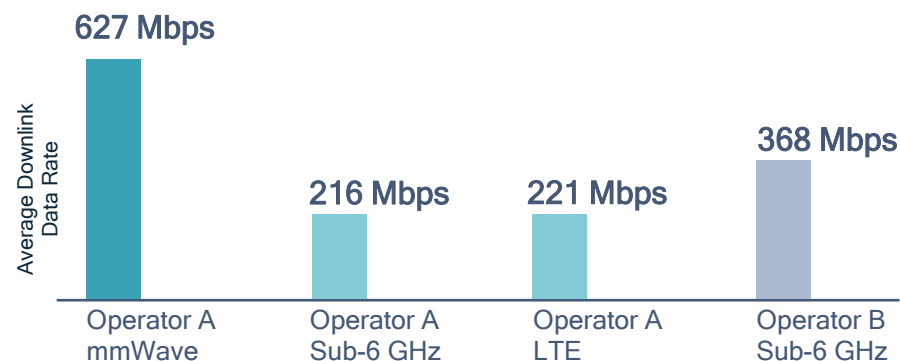Sub-6 GHz NSA[6]: 98%[7]のユビキタスカバ レッジの達成 や LTE[8]のサポート

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1 28 GHz band (n261) | 800 MHz TDD bandwidth
2 -105 dBm (typical threshold for adding 5G NR mmWave carriers)
3 -115 dBm (typical threshold for serving DL data ~100Mbps on mmWave carriers)
4 850 MHz band (n5) | 10 MHz FDD bandwidth
5 Up to 35 MHz FDD BW in stationary location, 75 MHz FDD BW in mobility route
6 2.5 GHz (n41) | 100 MHz TDD bandwidth
7 With 100 -dBm threshold
8 Up to 45 MHz FDD BW in stationary location and 90 MHz FDD BW in mobility route
9 Additional network configuration may have led to further throttling in non-mmWave test cases
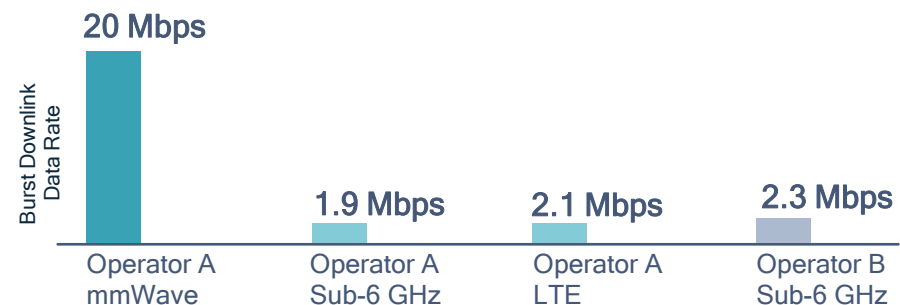
固定デバイスへのファイル転送

Average Downlink Data Rate

- Operator A mmWave: **1.3 Gbps**
- Operator A Sub-6 GHz: **142 Mbps**
- Operator A LTE: **104 Mbps**
- Operator B Sub-6 GHz: **531 Mbps**

5分間のテストで、Operator Aの mmWaveは、 sub-6 GHzの9倍、LTEの12 倍、Operator Bのsub-6 GHzの2.5倍の データを転送

移動デバイスへのファイル転送

Average Downlink Data Rate

- Operator A mmWave: **627 Mbps**
- Operator A Sub-6 GHz: **216 Mbps**
- Operator A LTE: **221 Mbps**
- Operator B Sub-6 GHz: **368 Mbps**

5分間のテストで、Operator Aの mmWaveは、sub-6 GHz/LTEの4倍、 Operator Bのsub-6 GHzの60%以上のデー タを転送

移動デバイス[9]へのビデオストリーミング

Burst Downlink Data Rate

- Operator A mmWave: **20 Mbps**
- Operator A Sub-6 GHz: **1.9 Mbps**
- Operator A LTE: **2.1 Mbps**
- Operator B Sub-6 GHz: **2.3 Mbps**

Operator AのmmWaveでは4Kビデオ品質、 sub-6 GHz/LTEではビデオ品質が低下

Based on analysis by Qualcomm Technologies, Inc.

mmWave licensing around the world – selected countries rollout commitments

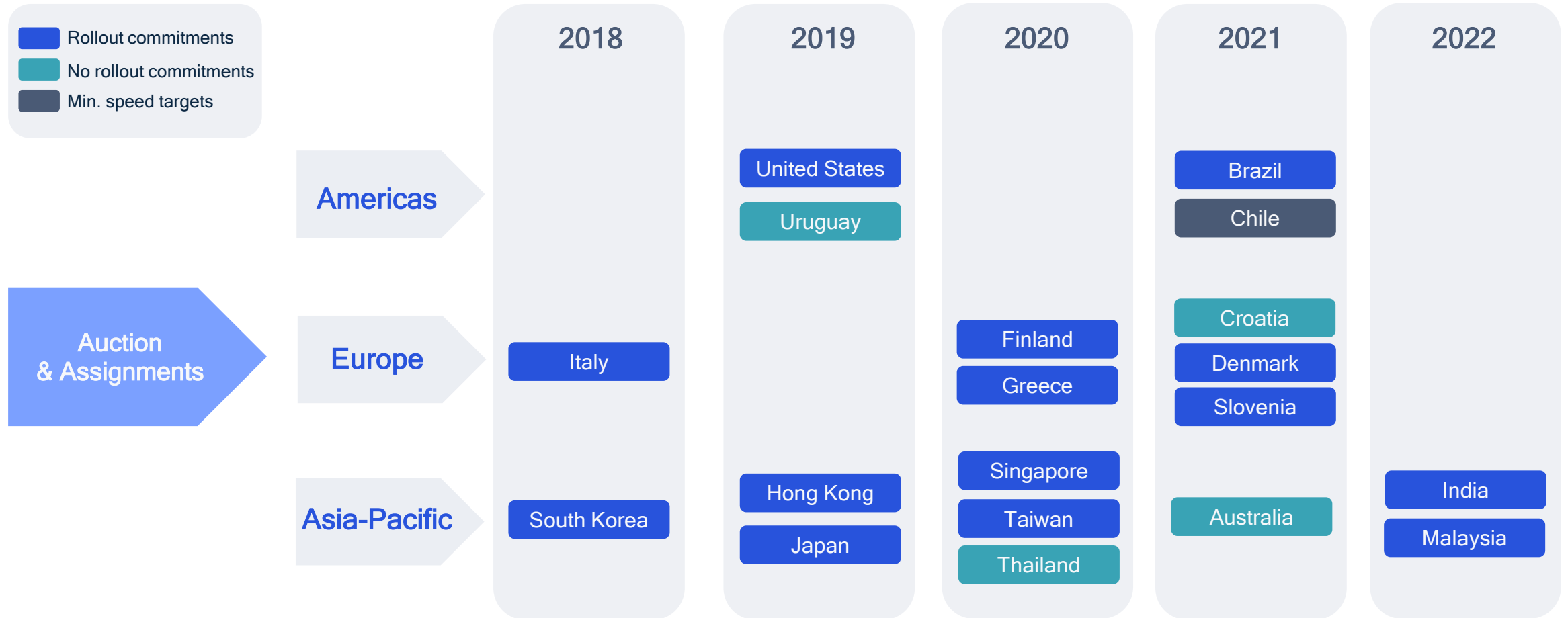|	**Licensees**	**Rollout Commitments**
United States	• AT&T Spectrum Frontiers LLC • T-Mobile License LLC • United States Cellular Corporation • Cellco Partnership d/b/a Verizon Wireless	• Verification of signal coverage and service to at least 40% of the population within the licensed service area. • Show prove of certain number of operating links (depends on population) and service provision to customers or for internal use.
Hong Kong	• Hong Kong Telecommunications • SmarTone Mobile Communications • China Mobile HongKong	• Deployment of a minimum amount of radio stations depending on amount of spectrum assigned (first 5 years following spectrum assignment).
India	• Adani Data Networks Ltd • Bharti Airtel Limited • Reliance Jio Infocomm Limited • Vodafone Idea Limited	• Within 1 year: launch commercial services and provide coverage to one town anywhere in the LSA • Within 3 years: deploy 240 Category A, 150 Category B, and 80 Category C sites. Cover a certain number of towns per category. • Within 5 years: deploy 660 sites in Category a LSAs, 560 in Category B LSAs, and 300 in Category C LSAs. Cover a certain number of towns per category.
Singapore	• SingTel • StarHub • M1 • TPG	• Provision of publicly available 5G services within a year and offer publicly available 5G services based on standalone network architecture, no later than 24 months from when the standalone ecosystem is ready.
South Korea	• Korea Telecom • SK Telecom • LG Uplus	• Target for each licensee: 100,000 28 GHz base stations within 5 years • Minimum for each licensee: 15,000 28 GHz base stations within 3 years
Taiwan	• Chungwa Telecom • Far EasTone Telecom • Taiwan Mobile • Asia Pacific Telecom	• Installation of 375 5G base stations for every 100 MHz obtained. For more than 800 MHz, the operator must install more than 3,000 base stations.

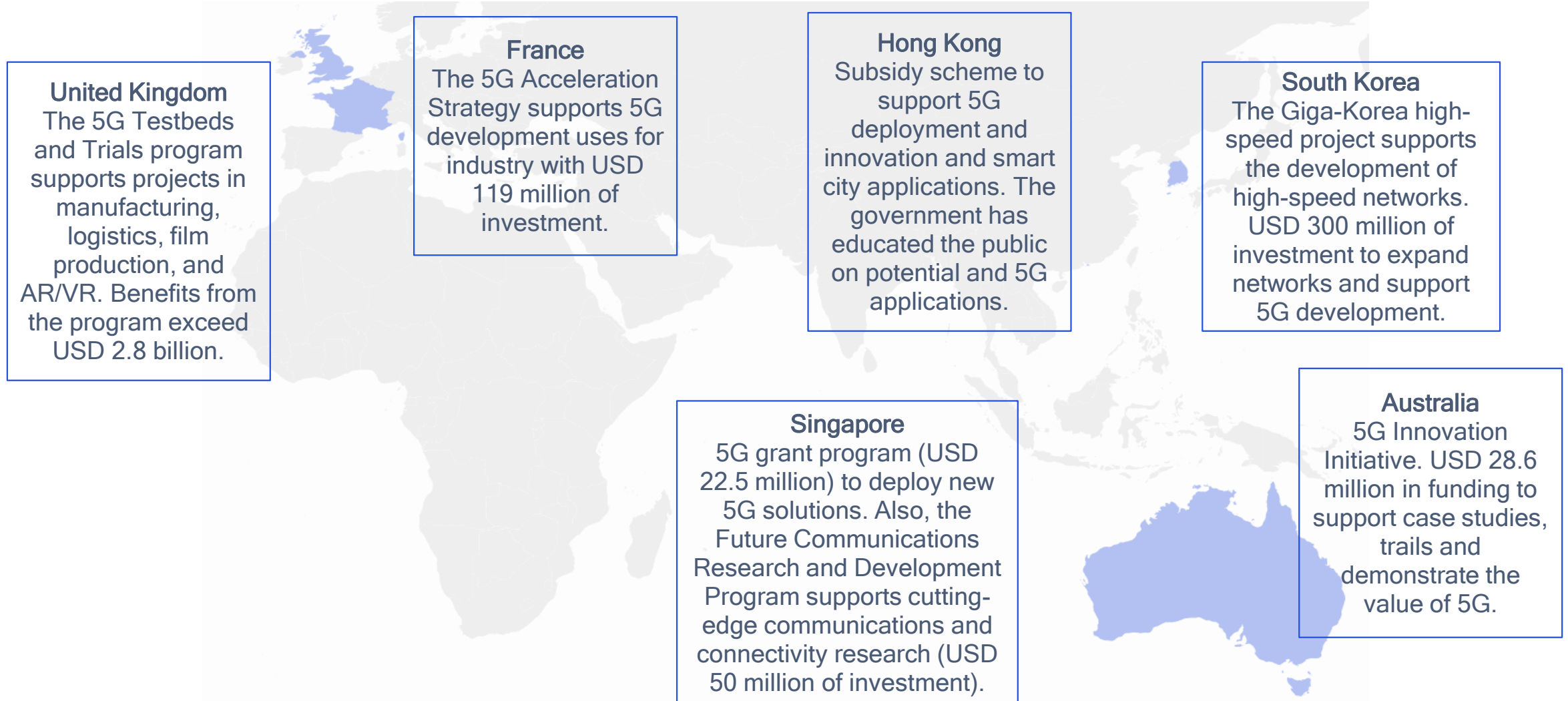# mmWave licensing around the world – selected countries rollout commitments

Licensees	Rollout Commitments
Denmark • TDC Net • 3 Denmark • TT-Network	• Install antennas and transmitting and receiving equipment within four years. • Equipment at mast positions must be connected to telecommunications infrastructure to allow the licensee to offer at least one electronic communications service to end users using 26 GHz spectrum.
Finland • Elisa Corporation • Telia Finland Oyj • DNA Plc	• Begin operations under the license within two years. • Advise subscribers on matters regarding the license terms and conditions (network coverage).
Greece • Cosmote • Vodafone • WindTre	• Submit network development and expansion reports to the Hellenic Telecommunications and Post Commission every 6 months.
Italy • Telecom Italia • Vodafone • WindTre • FastWeb • Iliad	• Install broadband or ultra-broadband radio network and use the assigned spectrum in all Italian provinces within 48 months. • Provide wholesale access to other contractors for 5G-type services and enable access to non-telcos (verticals).
Slovenia • A1 Slovenija • Telekom Slovenije • Telemach	• Offer commercially available communications services and begin using spectrum and offering services to end-users in at least one major city within five years and eventually expand services to all major cities
Chile • Claro • Wom • Entel	• Install a minimum number of base stations based on the type of commune licensees applied to. • Begin offering services within 12 months in type D communes and within 18 months in types A,B, and C.

mmWave licensing throughout the past years around the world

Legend:
- Rollout commitments
- No rollout commitments
- Min. speed targets

Auction & Assignments

	2018	2019	2020	2021	2022
Americas		United States Uruguay		Brazil Chile	
Europe	Italy		Finland Greece	Croatia Denmark Slovenia	
Asia-Pacific	South Korea	Hong Kong Japan	Singapore Taiwan Thailand	Australia	India Malaysia

Generating demand for 5G services and applications

United Kingdom
The 5G Testbeds and Trials program supports projects in manufacturing, logistics, film production, and AR/VR. Benefits from the program exceed USD 2.8 billion.

France
The 5G Acceleration Strategy supports 5G development uses for industry with USD 119 million of investment.

Hong Kong
Subsidy scheme to support 5G deployment and innovation and smart city applications. The government has educated the public on potential and 5G applications.

South Korea
The Giga-Korea high-speed project supports the development of high-speed networks. USD 300 million of investment to expand networks and support 5G development.

Singapore
5G grant program (USD 22.5 million) to deploy new 5G solutions. Also, the Future Communications Research and Development Program supports cutting-edge communications and connectivity research (USD 50 million of investment).

Australia
5G Innovation Initiative. USD 28.6 million in funding to support case studies, trails and demonstrate the value of 5G.

Verizon offering 5G Ultra Wideband (C-band + mmWave) to premium users only

- Verizon is offering two types of 5G services
  - **5G Nationwide** runs alongside 4G LTE (DSS) and uses low band spectrum (700/850 MHz)
  - **5G Ultra Wideband (UW)** is the premium services utilizing C-band and mmWave

- Driving network densification with the help of mmWave and C-band spectrums
  - Densely populated areas (e.g., venues, airports, city centers, etc.)
  - Offload capacity from congested cell sites and/or clusters
  - Fixed wireless access coverage

- 5G mmWave device penetration
  - Customers adopting 5G at a rapid rate, with 47% of Consumer Postpaid base now on 5G
  - 5G smartphone phone penetration will be over 60% by 2023 and 80% by 2025
  - Introduced mmWave laptops (Lenovo ThinkPad X13s 5G, Lenovo Flex 5G)
  - Dedicated 5G Gaming devices coming in Q1 '23 (Razer Edge 5G)

- 5G UW is available in 1700+ cities
  - 135 million POPs covered with a goal to cover 250 million POPs by 2024
  - 80+ Stadium and arenas
  - 2 million Business internet customers
  - By 2025 will reach 50M Households with FWA
  - 40K+ cell sites

| ◎ 5G Edge | ⓘ | ● 5G Ultra Wideband | ⓘ | ■ All Coverage | ⓘ | ☐ No Coverage |
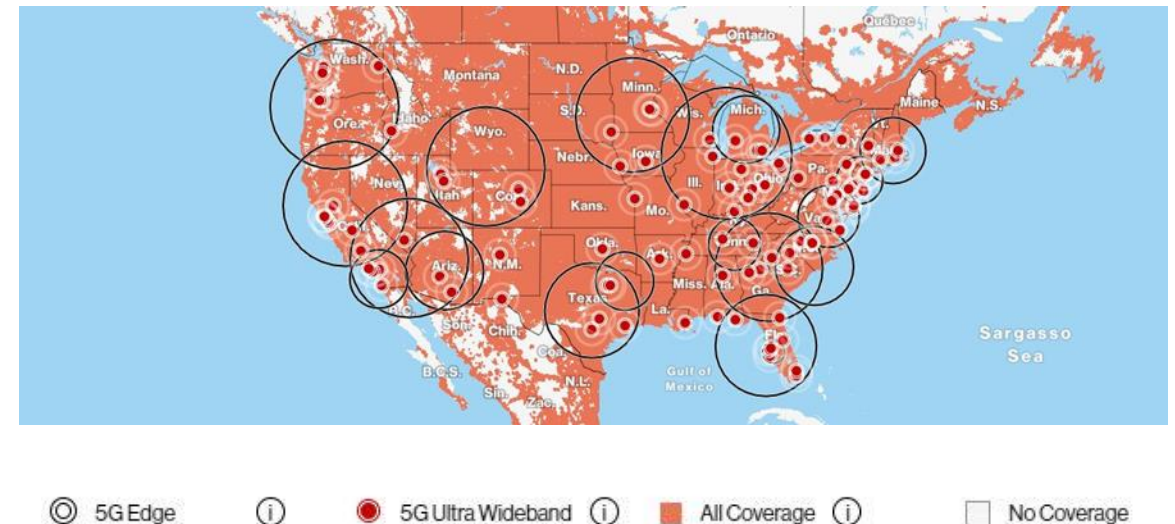
Enterprise mmWave @ Verizon

- **Private Networks**
  - Fully managed, monitored and maintained all-inclusive solution
  - Custom QoS requirement-ready

- **Enterprise Grade FWA Internet**
  - Massive capacity
  - Enhanced security
  - Over 200K units sold since introduction in Nov '20

- **5G Edge**
  - Drives efficiencies, optimizes costs and improves customer experiences
  - Use cases include
    - Quality Assurance for Production & Warehouse,
    - Crowd Analytics
    - Automated Guided Vehicle Management
    - Accelerated Access,
    - Cashier less Checkout
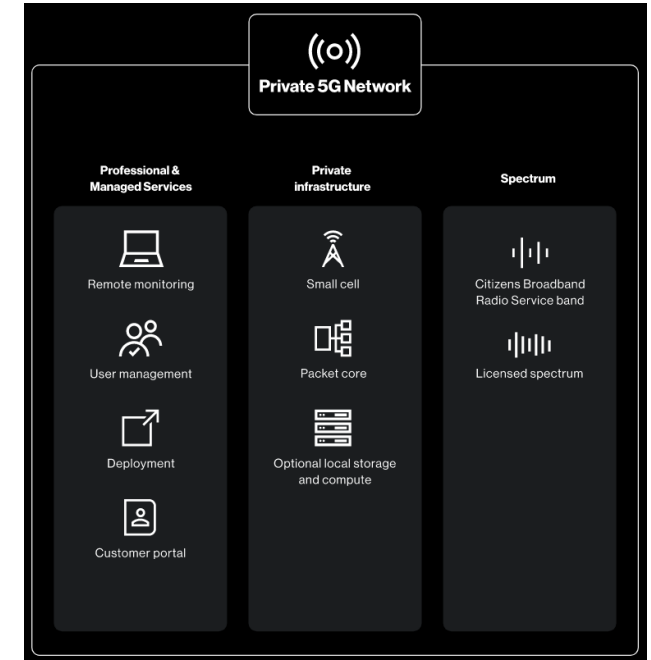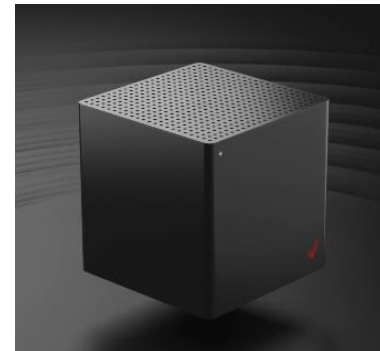
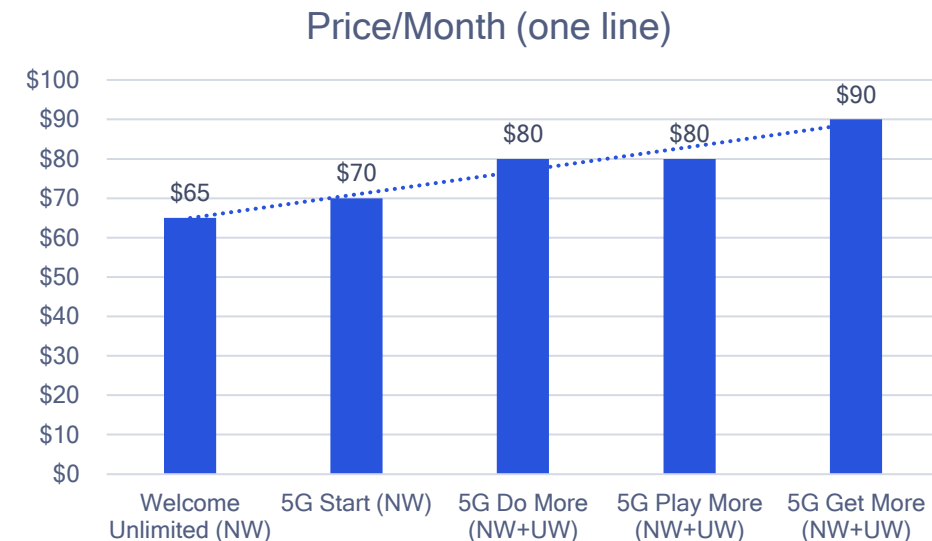# Verizon is extensively bundling OTT video, music and gaming to differentiate its plans and from competition.

- **5G Monetization levers**
  - Unlimited UW premium access
  - Mobile hotspot limits
  - No throttling during congestion
  - OTT bunding (Streaming, Gaming, Cloud etc..)
  - Number of lines
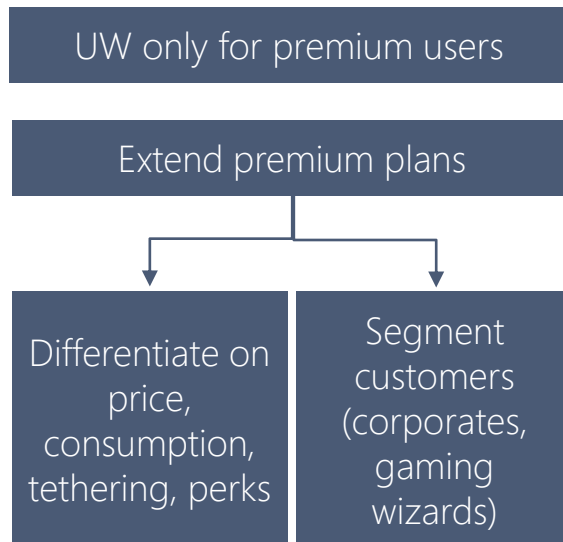
- **5G plan differentiated based on pricing, total lines, features and perks**
  - Additional perks are being offered with each plan: Disney, ESPN+, Arcade, Google Play Pass, Cloud storage etc.
  - FWA (Home internet) starting from $25/month
  - mmWave PCs plans starting from $25/month

UW only for premium users

Extend premium plans

Differentiate on price, consumption, tethering, perks

Segment customers (corporates, gaming wizards)

Price/Month (one line)

Plan	Price
Welcome Unlimited (NW)	$65
5G Start (NW)	$70
5G Do More (NW+UW)	$80
5G Play More (NW+UW)	$80
5G Get More (NW+UW)	$90

Verizon- offering new wireless innovation for enterprise and consumers

Lenovo ThinkPad X13s 5G mmWave launched in July '22

- Enterprise-ready solution
- Extended battery life
- AI-enhanced videoconferencing, noise cancellation
- Offers seamless roaming and mobility support for mobile workers

Strategic Value :

- ACPCs offers path to diversification and growth
- Diversify connected device offerings for enterprise and consumers
- Enhance customer acquisition and retention strategy
- Broad customer influence, reduce Churn rate and increase ARPA

Price Plan:

- Aggressive Price Plan starting from $25/month

ACPCs solving complex connectivity challenges for remote and hybrid workforce


Redefining mobile computing

Multi-day battery life*
Premium performance
Lightning-fast 5G/4G speeds
Enterprise-grade security
Connected standby / Instant on
AI accelerated experiences
Thin, quiet and cool
Modern Device Management/ Cloud Integration
Windows 11
chromebook

Snapdragon
Defining the Always On, Always Connected PC

* Battery life varies significantly based on device, settings, usage, and other factors.

Verizon 5G mmW network deployment status

mmWave
- **82 cities** and **60 stadiums/arenas** with mmWave UWB and **57 5G Home (FWA) cities**
- 14K+ additional small cells in '21, **30K+ in total by Y/E '21**
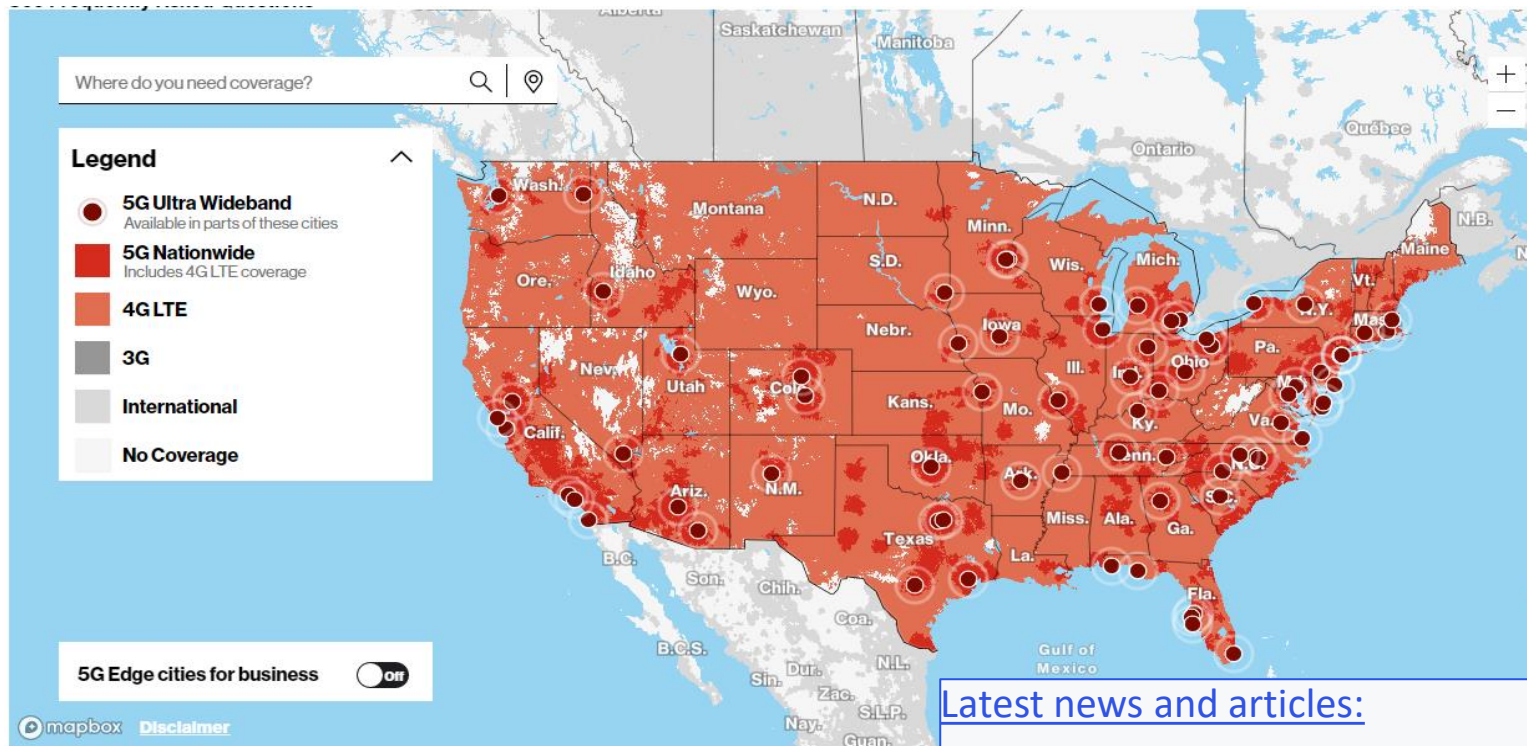
Latest news and articles:

- Verizon in a millimeter wave groove, CTO Malady says | FierceWireless
- Testing Verizon's 5G at the Jersey Shore | PCMag
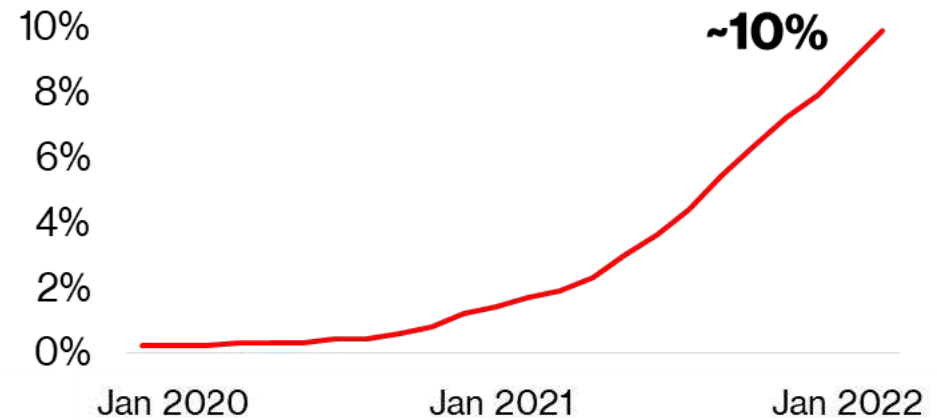- Verizon launches private 5G for enterprise, public sector | FierceWireless

Verizon mmWave Traffic

mmWave Usage is Growing Fast

mmWave Usage Growth
Avg. daily usage (TB)

+856% YoY

800
600
400
200
0

Jan 2019   Jan 2020   Jan 2021   Jan 2022
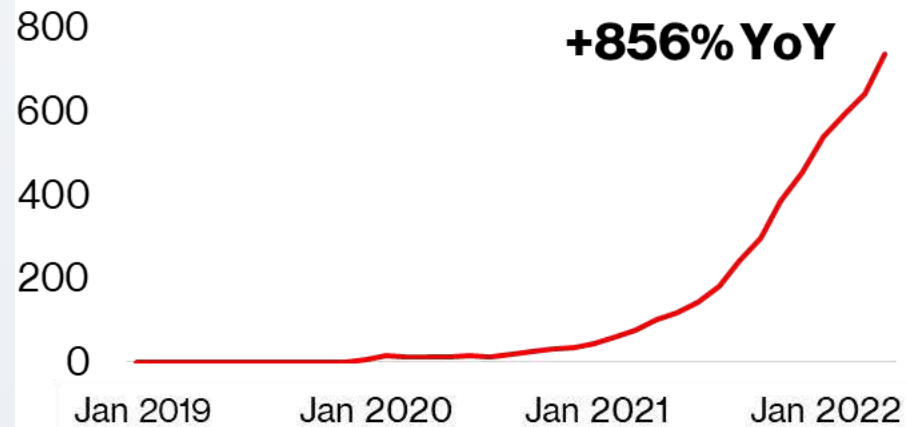
mmWave Usage in Deployed Footprint
Percentage usage on mmWave

~10%

10%
8%
6%
4%
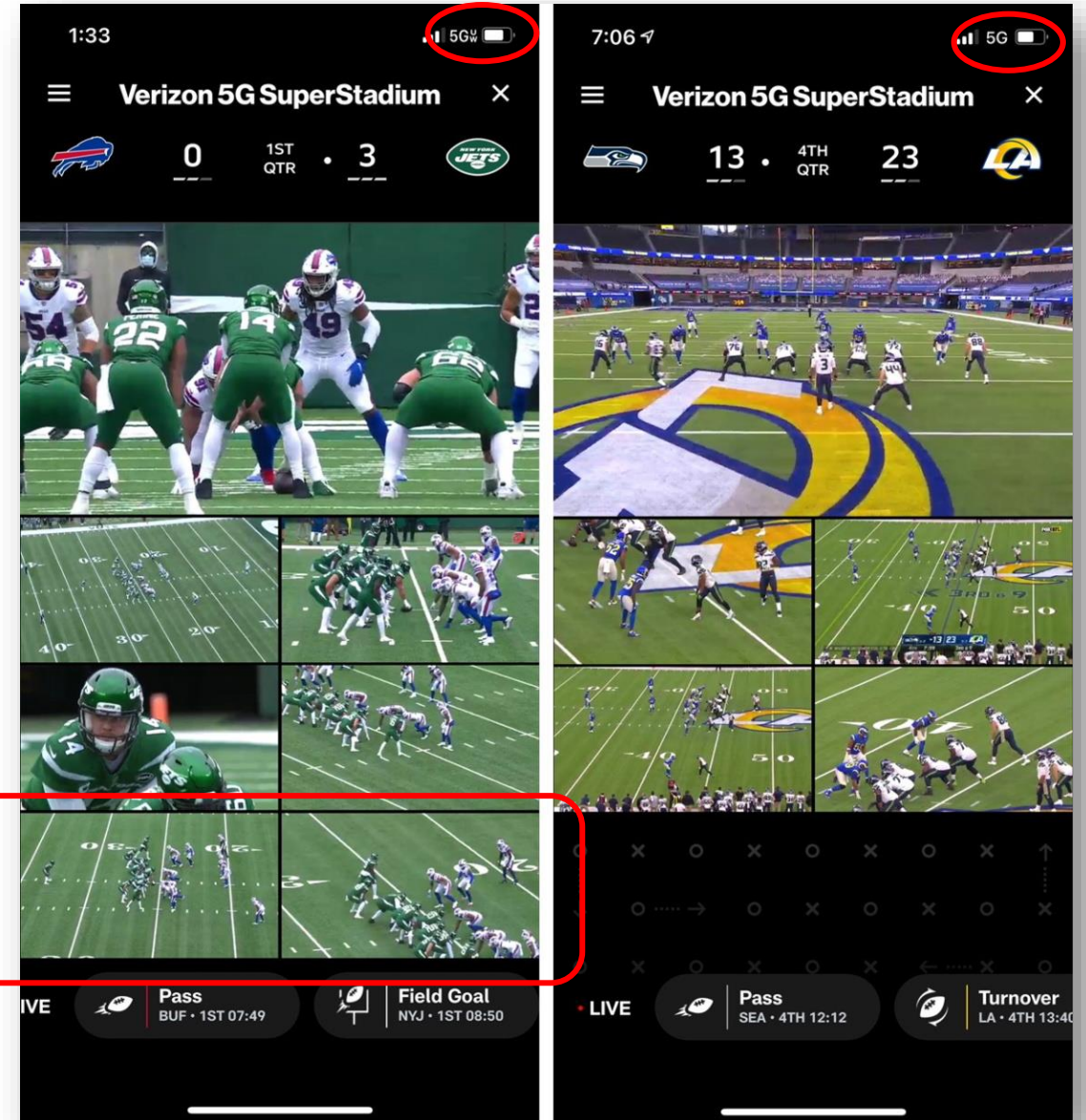2%
0%

Jan 2020   Jan 2021   Jan 2022

mmWave is Vital to 5G Plan to Support and Scale Usage in Dense Areas

Verizon 5G UWB in Stadium, USA

スタジアムのシートの下に設置された5Gミリ波のスモールセル

5G Ultra Widebandのユーザは視聴できるストリーム数が多い

Qualcomm

Stadiums

5G mmWave powers successful Super Bowl 56 and 60 other stadiums in the U.S.

Verizon, AT&T and T-Mobile leveraged multi-band 5G mmWave and mid-band to offer seamless coverage and capacity to 70k fans during Super Bowl 56 in Los Angeles

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5G mmWave Solution

- 5G mmWave and mid-band network providing connectivity to 70k fans
- Use of Mobile Edge Computing (MEC) to enable ultra low latency
- Merge computer-aided motion analysis, player and ball tracking, and shot tracking

- Partners: ShotTracker (Verizon Ventures portfolio company), NOAH Shooting System, SIMI Reality Motion System

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Impact

- 100% 5G mmWave coverage on all levels
- Excellent network performance
- 3+ Gbps Downlink peak throughput
- 170+ Mbps Uplink peak throughput
- 10 ms average ping latency

> **Hans Vestberg Retweeted**
> **Cristiano R. Amon** @cristianoamon · 18h
> Watching the @SuperBowl here at @SoFiStadium with my dear friend and real #5G leader @hansvestberg. The 5G UWB mmWave speed from @Verizon is incredible! The future of wireless broadband performance in venues is here! 👏
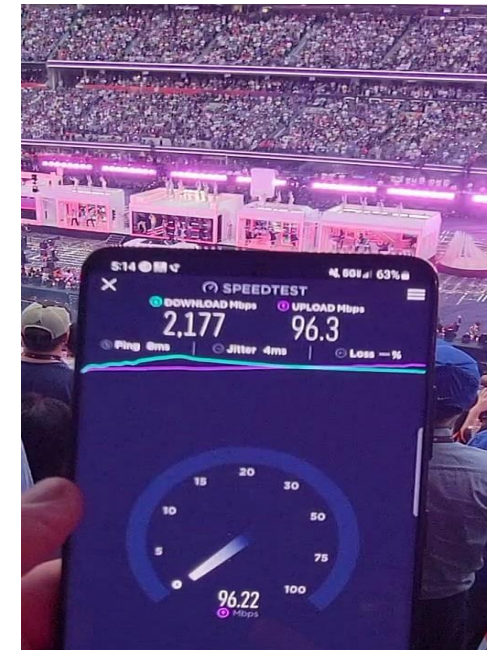
Consistent 2Gbps+ DL throughput in the bowl

Case study: French network infrastructure investments
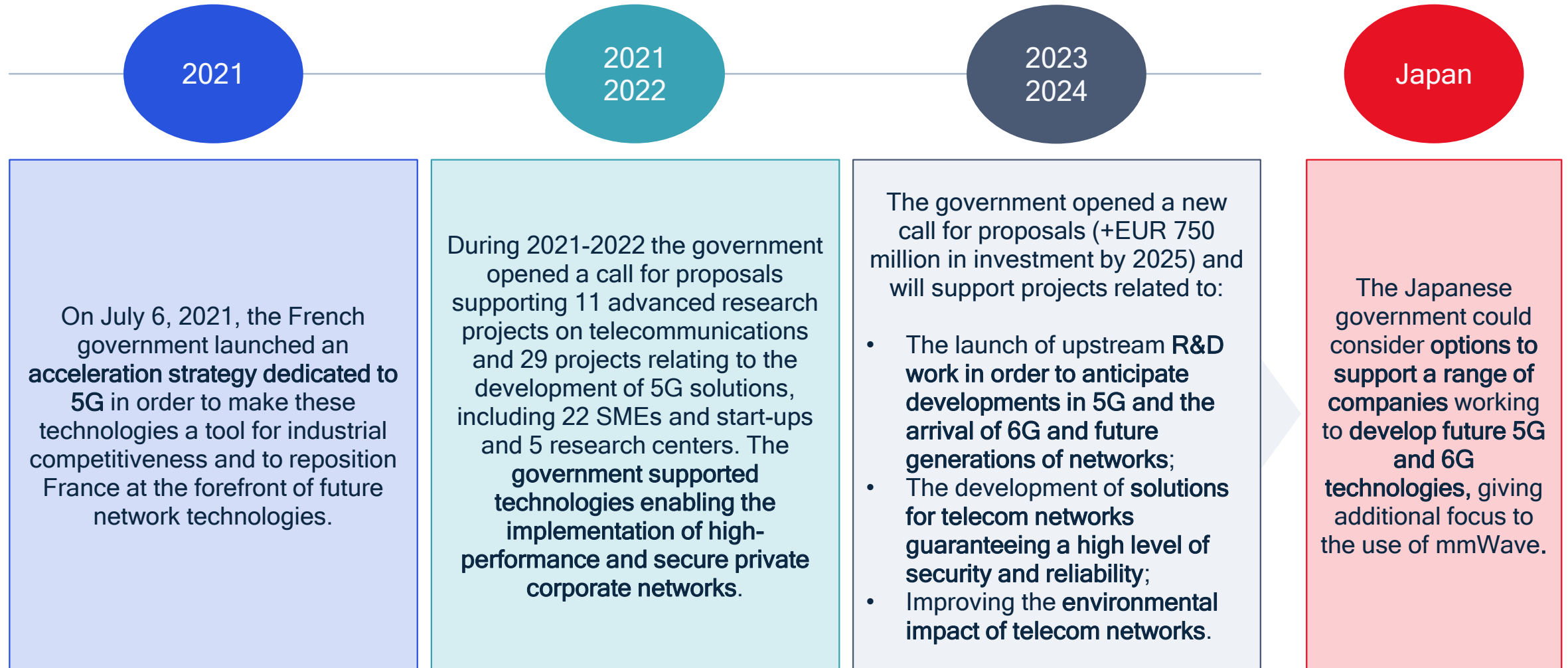
France 2030 - 5G and 6G Sovereign Solutions Acceleration Strategy is a good practice that Japan could consider

2021

2021 2022

2023 2024

Japan

On July 6, 2021, the French government launched an **acceleration strategy dedicated to 5G** in order to make these technologies a tool for industrial competitiveness and to reposition France at the forefront of future network technologies.

During 2021-2022 the government opened a call for proposals supporting 11 advanced research projects on telecommunications and 29 projects relating to the development of 5G solutions, including 22 SMEs and start-ups and 5 research centers. The **government supported technologies enabling the implementation of high-performance and secure private corporate networks.**

The government opened a new call for proposals (+EUR 750 million in investment by 2025) and will support projects related to:

- The launch of upstream **R&D work in order to anticipate developments in 5G and the arrival of 6G and future generations of networks;**
- The development of **solutions for telecom networks guaranteeing a high level of security and reliability;**
- Improving the **environmental impact of telecom networks.**

The Japanese government could consider **options to support a range of companies** working to **develop future 5G and 6G technologies,** giving additional focus to the use of mmWave.

Generating demand for 5G - South Korea government connectivity

5G Government Network Pilot Project

The government announced plan to introduce 5G Government Network

- Total project estimate: KRW 18.1 billion (USD 15 million)
- Funded by: Ministry of Interior and Safety (MOIS)
- Timeline: Installation by Dec 2022. Operation from 2022 - 2027

	Participating agency	Number of 5G users
1 Project Group	MSIT	800
	Korea Intellectual Property Office (KIPO)	720
2 Project Group	Ministry of Foreign Affairs (MOFA)	900
	Ministry of Personnel Management (MPM)	510

Spectrum will be both sub-6 and mmWave: MSIT, KIPO, MOFA for both sub-6 & mmWave and KIPO for sub-6 only.

RFPs were released for 5G Government Network Pilot Projects in four government agencies.

Expansion plan
- Expansion to all four government complexes by 2025
- Total project estimate: KRW 157 billion for infra building, KRW 175 billion for subscription.

Korea's 5G Government Network Pilot Project

- Korean government announced to introduce <u>5G Government Network</u> in '22.
- RFPs were released for 5G Government Network Pilot Projects in four government agencies.
  - KT won the projects.
- Participating agencies and number of 5G users:
  - 1 Project Group: MSIT - 800, Korea Intellectual Property Office (KIPO) - 720
  - 2 Project Group: Ministry of Foreign Affairs (MOFA) - 900, Ministry of Personnel Management (MPM) - 510
    Total 2,930 users
- Spectrum will be both sub-6 and mmW: MSIT, KIPO, MOFA for both sub-6 & mmW and KIPO for sub-6 only.
- Total project estimate: KRW 18.1B ($15M)
- Project funded by Ministry of Interior and Safety (MOIS)
- Project Timeline: Installation by Dec. '22. Operation from '22-'27.
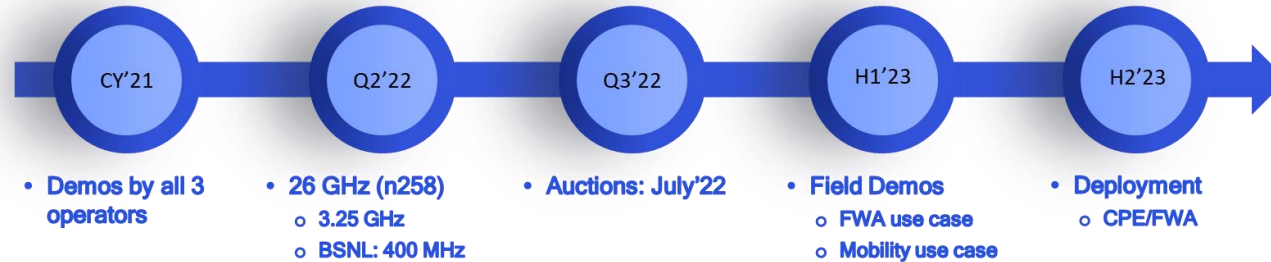- The mmWave products are expected to be dongles, routers, and small cells.

Expansion Plan of 5G Government Network

- By '25 MOIS is planning to expand 5G network to all the four government complexes (Sejong, Seoul, Gwacheon and Daejeon).
- Total project estimate: KRW 157 B for infra building, KRW 175B for subscription.

India poised for the fastest global rollout of 5G services (Sub-6 + mmWave)

Timeline:
- **CY'21** — Demos by all 3 operators
- **Q2'22** — 26 GHz (n258)
  - 3.25 GHz
  - BSNL: 400 MHz
- **Q3'22** — Auctions: July'22
- **H1'23** — Field Demos
  - FWA use case
  - Mobility use case
- **H2'23** — Deployment
  - CPE/FWA

5G mmWave band allocations

Operator	High Band/mmW (n258)
RJIO (SA)	1000 MHz (1Ghz) - Pan India
Airtel (NSA)	800 MHz - Pan India
BSNL (TBD)	400 MHz - Pan India
Vodafone (NSA)	200-800 MHz - In key markets
Adani -new entrant (5G PN)	400 MHz - In key markets of their operations

- Jio plans to reach nationwide coverage with 5G Sub-6 by December 2023
- Bharti Airtel aims to offer full 5G coverage across India by March 2024
- Preparing to add 5G Sub-6 5,000 to 6,000 sites per week (3500 sites per week as of now)
- Jio's 5G network targets to connect more than 100 million homes, tens of millions of small businesses, and tens of thousands of large enterprises with a fixed wireless access (FWA) service

China mmWave Update

2019.04
- Support WRC 19 RF testing
- 800MHz bandwidth verification
- Beam management

2020.07
- Infra and device verification
- EN-DC and RF performance
- DDDSU

2021.04
- mmWave SA testing
- CBW 200MHz@n258
- DDDSU/DSUUU
- NR-DC/NR-CA

2022.04
- FR2 SA only testing
- CBW 200MHz@n258
- DDDSU/DSUUU

2022.10
- URLLC basic function
- One way latency < 1ms

- All carriers, infra-vendors and chipset vendors actively involved in IMT2020 mmWave lab and field testing

- All mmWave key features are verified with multi-vendors inter-operation combination

- First B2B mmWave license in October 2022 to COMAC, Chinese aircraft manufacturer

- mmWave specific E2E use scenarios demonstrated, such as 8K+DSUUU , XR split rendering…

- Reached **7.1Gbps** Down Link peak rate, **2.1Gbps** Up Link peak rate, **3.6** milliseconds extreme low latency
  - FR2-only Stand Alone; Down Link DDDSU config, 200MHz*4, 256QAM; Up Link DSUUU config, 2*200MHz, 64QAM
  - https://www.qualcomm.com/news/releases/2022/11/qualcomm-achieves-critical-5g-standalone-mmwave-milestone-in-chi
  - Tests completed under guidance of China Academy of Information and Communications Technology (CAICT) and China's IMT-2020 (5G) Promotion Group

DSUUU – Uplink oriented frame structure (Downlink, Special, Uplink, Uplink, Uplink)
DDDSU – Downlink oriented frame structure (Downlink, Downlink, Downlink, Special, Uplink)
COMAC - Commercial Aircraft Corporation of China, Ltd

Australia

Technology readiness

- nbn set 5G long-range transmission records of 1 Gbps at 7+km in Feb 2021

- Telstra is first in world to achieve 5Gbps on a single device in the commercial network in Jan 2021

- Optus, Telstra and nbn continuing mmWave trials

Spectrum availability

- Operators used experimental licenses in 2020 to accelerate network build

- Auction completed in April 2021

- Incumbent operators secured the majority of n258 spectrum
  - TPG - 400 to 600Mhz
  - Optus - 800Mhz
  - Telstra - 1Ghz

- nbn secured 1GHz of n257 spectrum

Commercial rollout

- Telstra and Optus unveil expanding 5G mmWave in execution

- Telstra Netgear router, Google Pixel 6 commercially available

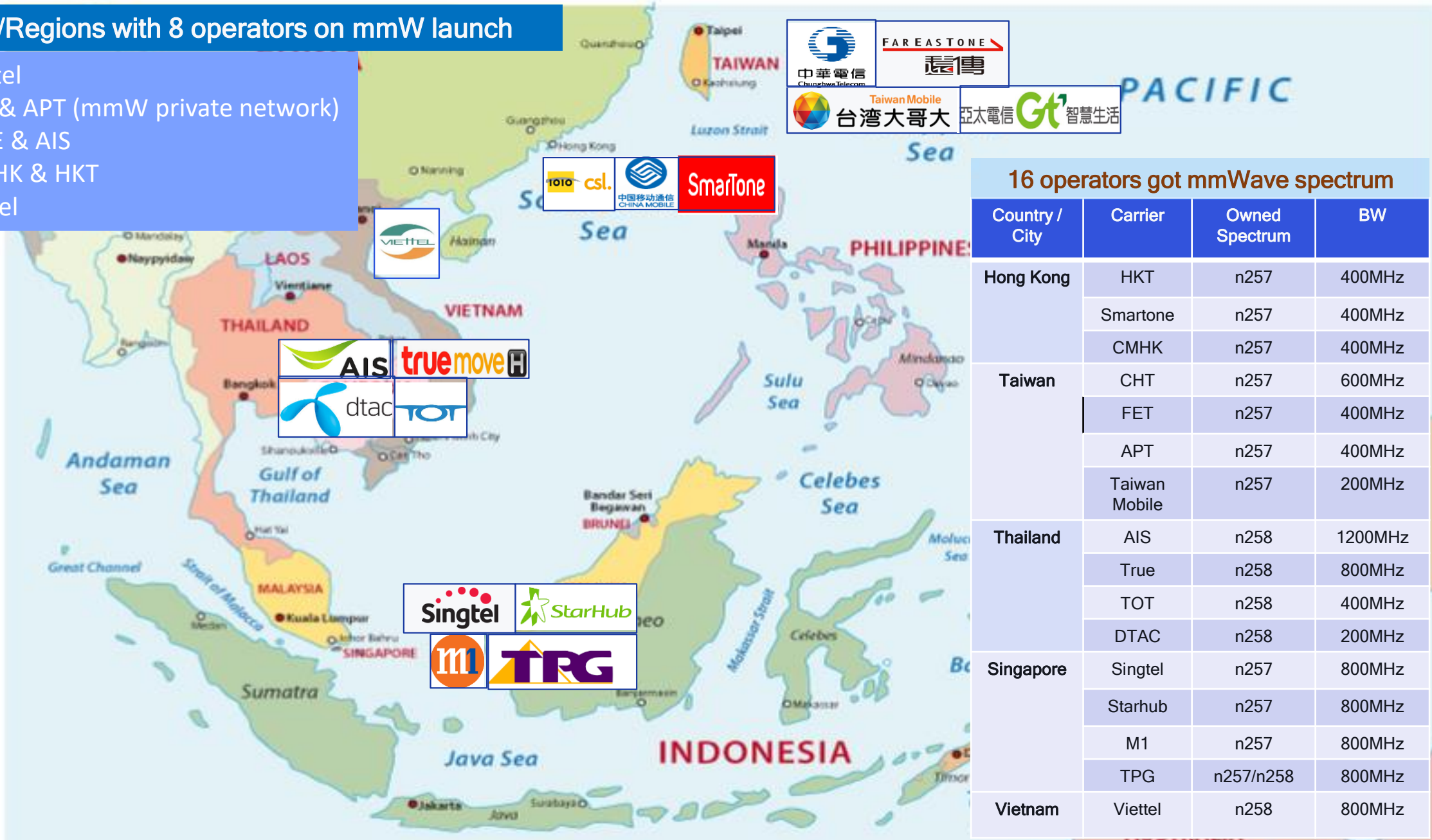- Telstra selected Casa Systems for mmWave FWA launch

South East Asia

Dec'20: Singtel
Dec'20: CHT & APT (mmW private network)
Feb'21: TRUE & AIS
May'21: CMHK & HKT
Sep'21: Viettel

16 operators got mmWave spectrum

Country / City	Carrier	Owned Spectrum	BW
Hong Kong	HKT	n257	400MHz
	Smartone	n257	400MHz
	CMHK	n257	400MHz
Taiwan	CHT	n257	600MHz
	FET	n257	400MHz
	APT	n257	400MHz
	Taiwan Mobile	n257	200MHz
Thailand	AIS	n258	1200MHz
	True	n258	800MHz
	TOT	n258	400MHz
	DTAC	n258	200MHz
Singapore	Singtel	n257	800MHz
	Starhub	n257	800MHz
	M1	n257	800MHz
	TPG	n257/n258	800MHz
Vietnam	Viettel	n258	800MHz

Government can support the development of **mmWave 5G services in <u>high-impact sectors</u>** such as industrial IoT and healthcare

Industrial IoT use case

Taiwan | ASE mmWave NR-DC SA smart factory

- In August 2022, Advanced Semiconductor Engineering, INC (ASE) unveiled plans for a 5G **mmWave** NR-DC SA smart factory.

- Focus is to enable digital transformation of factory processes including:
  - AI-enabled detection of abnormalities from the standard operating process
  - Data analysis of current and newly purchased equipment in operation to enhance productivity and yield
  - Real-time inventory forecasting to reduce production cycle time
  - Generating high-resolution AOI images in real-time to improve accuracy and efficiency of quality inspection
  - Network stability to improve connectivity and reduce set up time for machine re-layout
  - OT security technology to ensure reliability, security, and functionality of machines and tasks in digitized manufacturing environment

- Stakeholders
  - ASE, Industrial Development Bureau, Qualcomm, Institute for Information Technology, Asia Pacific Telecom, DEVCORE Security Consulting, and the National Cheng Kung University

France | 5G mmWave at the Le Havre seaport

- mmWave platform at the Le Havre seaport tested **26 GHz** applications in a port and industrial environment.

- Explored applications in the energy field, including smart grids and recharging electric vehicles.

- Also focused on logistical operations such as operating container terminals.

- Stakeholders
  - Siemens, Nokia, Electricité de France (EDF), and Grand Port Maritime du Havre

Healthcare use cases

France | 5G at the Rennes University Hospital

- Experiment at the Rennes University Hospital.
  - Part of the European 5G-TOURS research project
- Simulated surgical procedure in wireless operating room.
- Surgery performed on a patient simulator and followed remotely by a doctor in Athens, Greece.
- Ultrasound images and X-rays superimposed and retransmitted using a 5G AR application operating on an experimental **26 GHz network**.
- Stakeholders
  - AMA, b<>com, Nokia Bell Labs, Orange, and Philips

UK | Liverpool 5G Health and Social Care Testbed

- Project established a 5G **mmWave network** and supported health and social care products.
  - Ex: pain distraction VR headsets for palliative care, pharmacy video link to enable patients to take medication safely at home, dehydration device, etc.
- Stakeholders
  - 5G Testbeds and Trials Programme (5GTT) (part of the Department of Digital, Culture, Media & Sport), and the Liverpool 5G Consortium

Generating demand for 5G - Brazil educational connectivity

Connectivity in public schools of basic education

Carry out connectivity projects for public schools of basic education.

The projects should comply with the quality and speed necessary for the pedagogical use of ICTs in educational activities regulated by the Connected Education Innovation Policy.

The Monitoring Group for the Cost of School Connectivity Projects (GAPE) will coordinate the projects. It will include a representative from the National Telecommunications Agency (Anatel), Ministry of Communications, Ministry of Education, and a representative from each of the winning bidders for the 26 GHz band.

The projects may include any infrastructure, equipment and resources associated with achieving full connectivity in schools.

5G deployment status in Japan (MIC, End of FY2021)
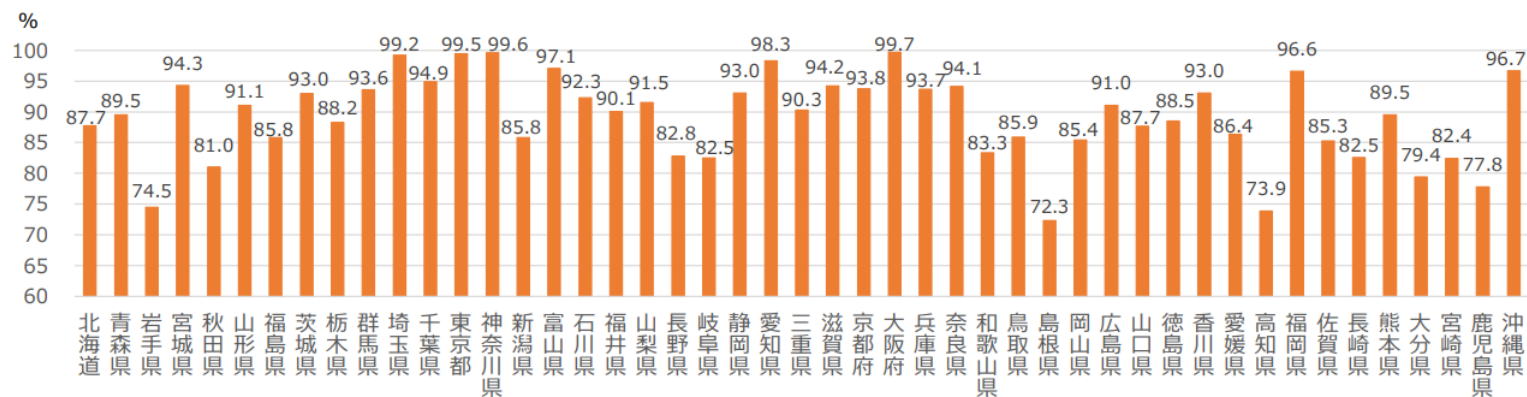
5G deployment status in Japan (as of March 2021)

- Nationwide 5G population coverage rate will reach 93.2% by March 2022

- Population coverage exceeded 70% in every prefectures

Trends and forecasts of capital investment amounts in operators

Capital investment planned by telecommunications operators' peaks in 2022
and gradually decline.