

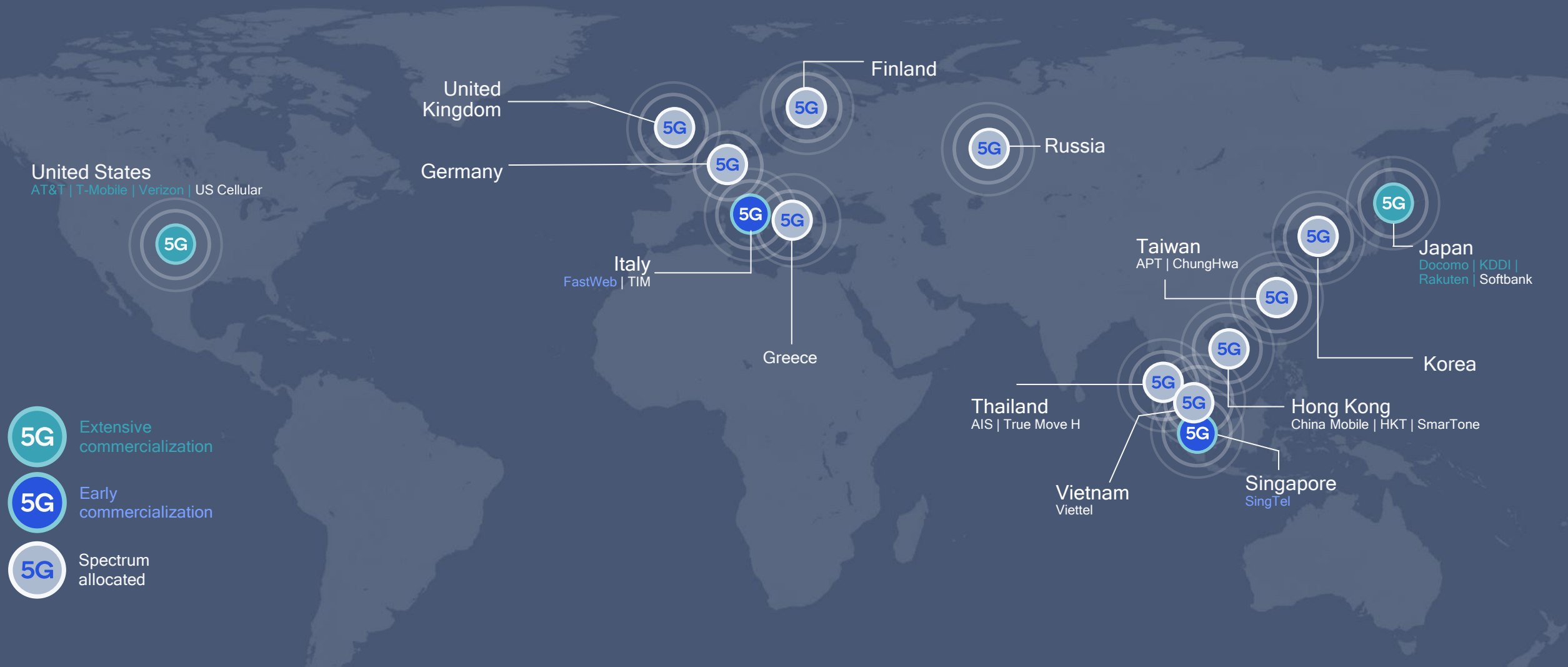
5Gミリ波の現状と展望

城田 雅一

クアルコムジャパン 標準化本部長

5G
mmwave

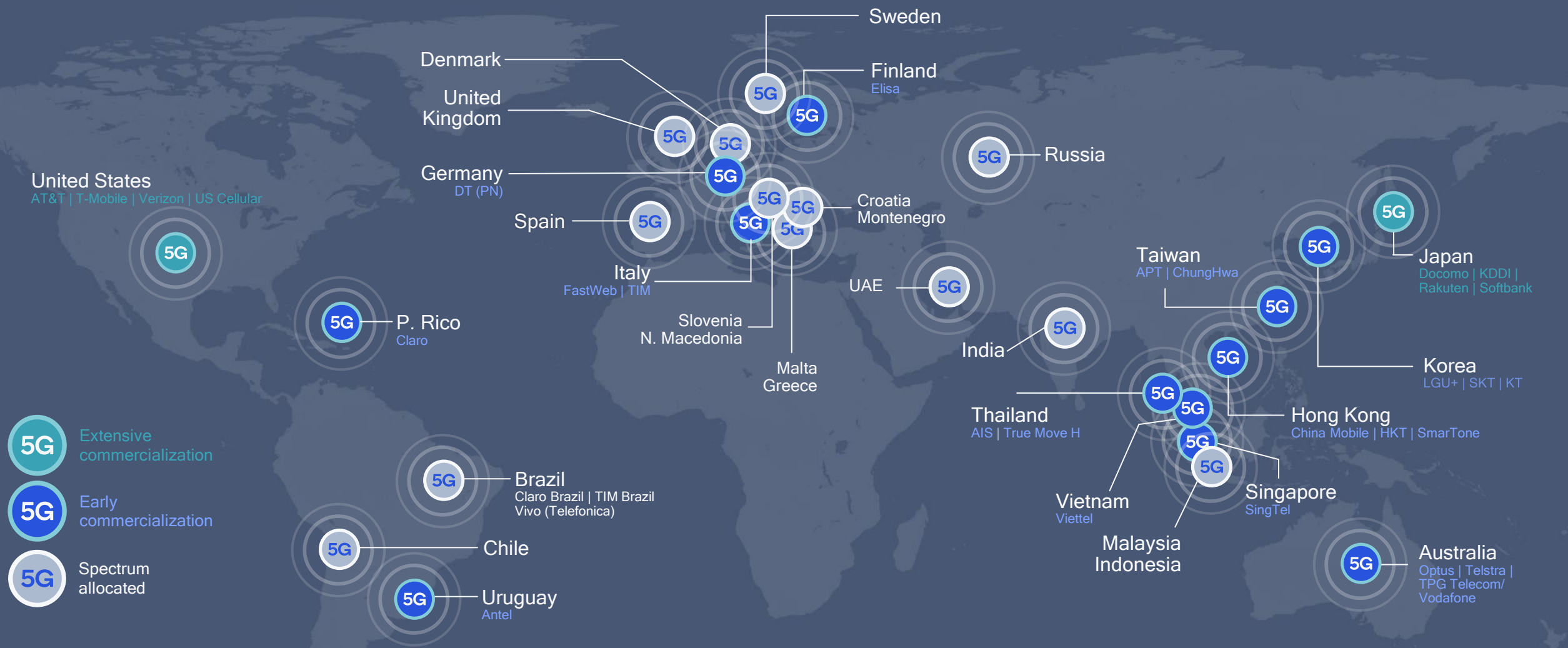
1. 現在（国内外の動向）
2. 必要性
3. 製品



5G mmWave commercialization and spectrum (Dec 2020)

Commercialization - 8 operators

Spectrum available - 14 countries and regions*



* Current or expected by end of 2022

5G mmWave commercialization and spectrum (Nov 2022)

Commercialization - 8 → 28 operators*

Spectrum available - 14 → 31 countries and regions*

Expanding breadth, availability of 5G mmWave devices

150+

5G mmWave devices launched or announced by 50+ vendors

5G smartphones



PCs



Hotspots



Modules



CPEs

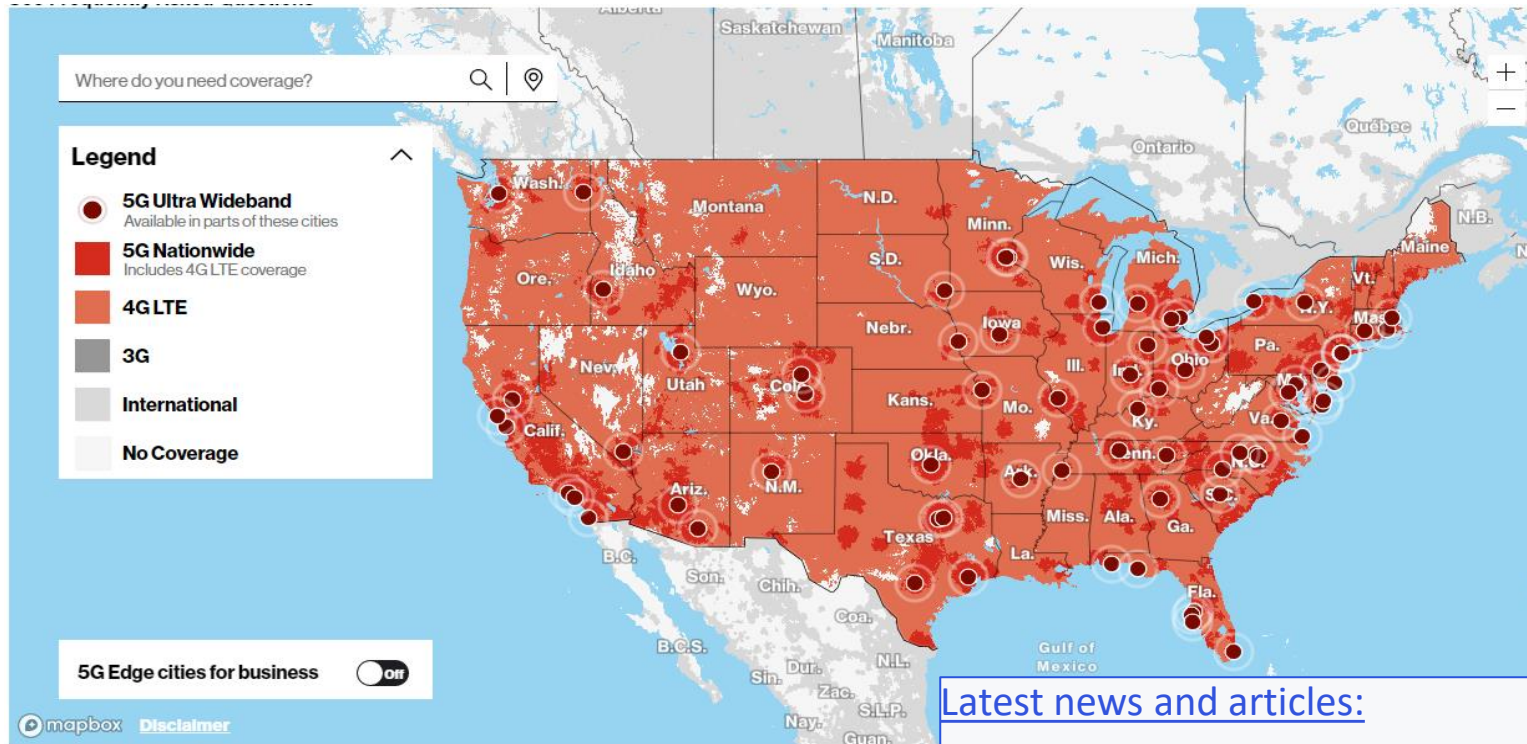


Source: GSA, Feb. 2022

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:

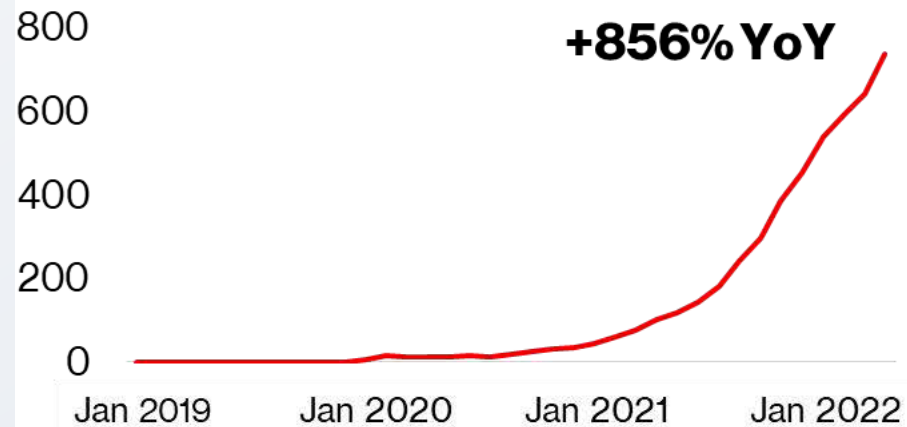
- [Verizon in a millimeter wave groove, CTO Malady says | FierceWireless](#)
- [Testing Verizon's 5G at the Jersey Shore | PCMag](#)
- [Verizon launches private 5G for enterprise, public sector | FierceWireless](#)

5G Nationwide and 5G Ultra Wideband coverage services apply to postpaid and prepaid. For additional coverage details on 4G and 3G, click [here](#)

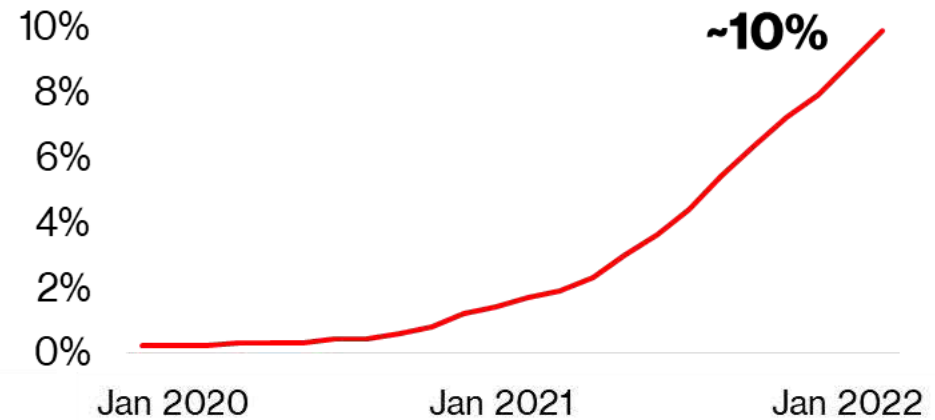
Verizon mmWave Traffic

mmWave Usage is Growing Fast

mmWave Usage Growth
Avg. daily usage (TB)



mmWave Usage in Deployed Footprint
Percentage usage on mmWave



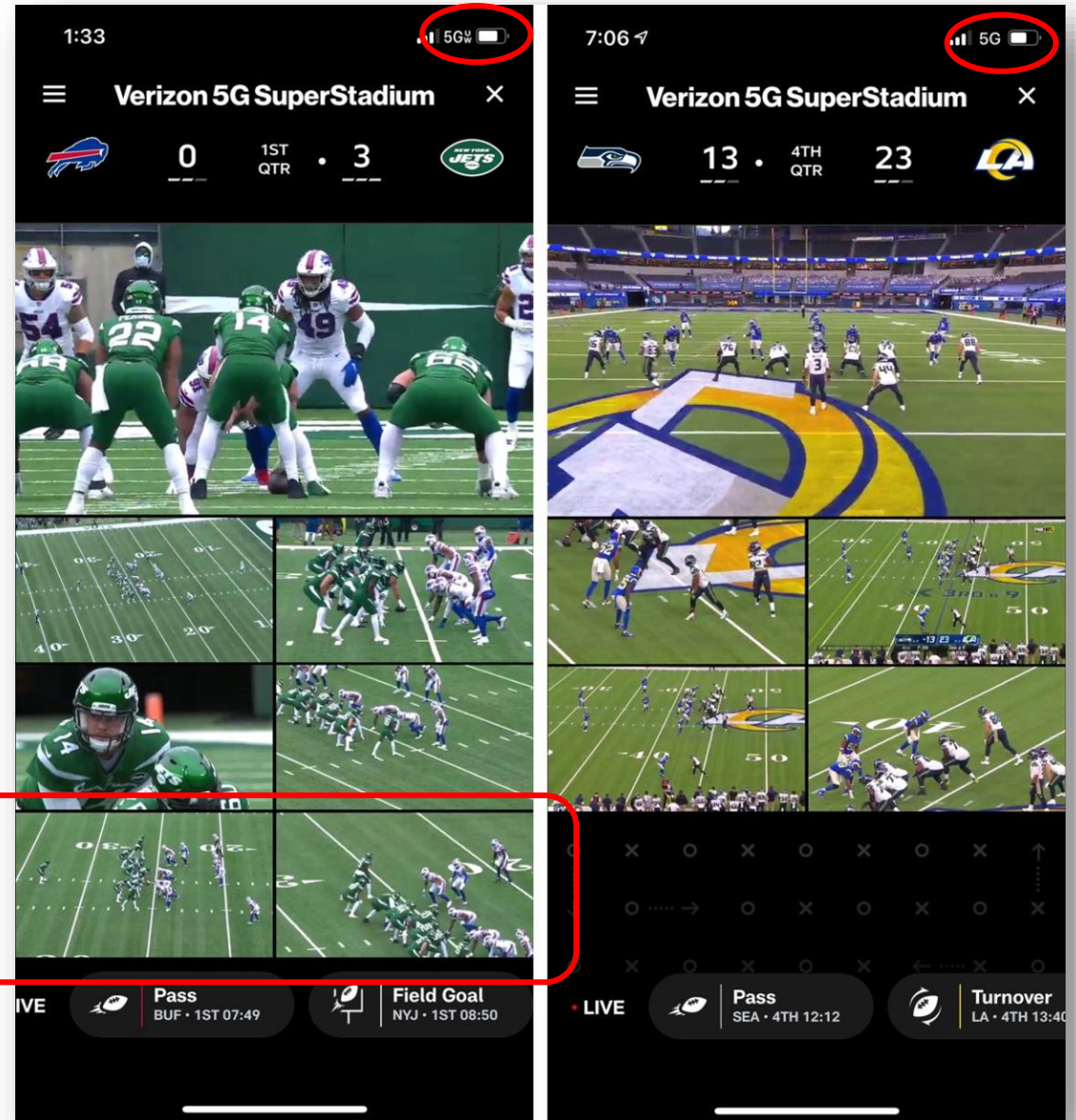
mmWave is Vital to 5G Plan to Support and Scale Usage in Dense Areas

Verizon 5G UWBのスタジアム事例



スタジアムのシートの下に設置された5Gミリ波のsmallセル

5G Ultra Widebandのユーザは視聴できるストリーム数が多い



[At Super Bowl LV, 5G Will Change the Game | PCMag](#)

日本のミリ波モデル (スマートフォンのみ. 公開情報から弊社調べ)

Legend

sub-6/mmW

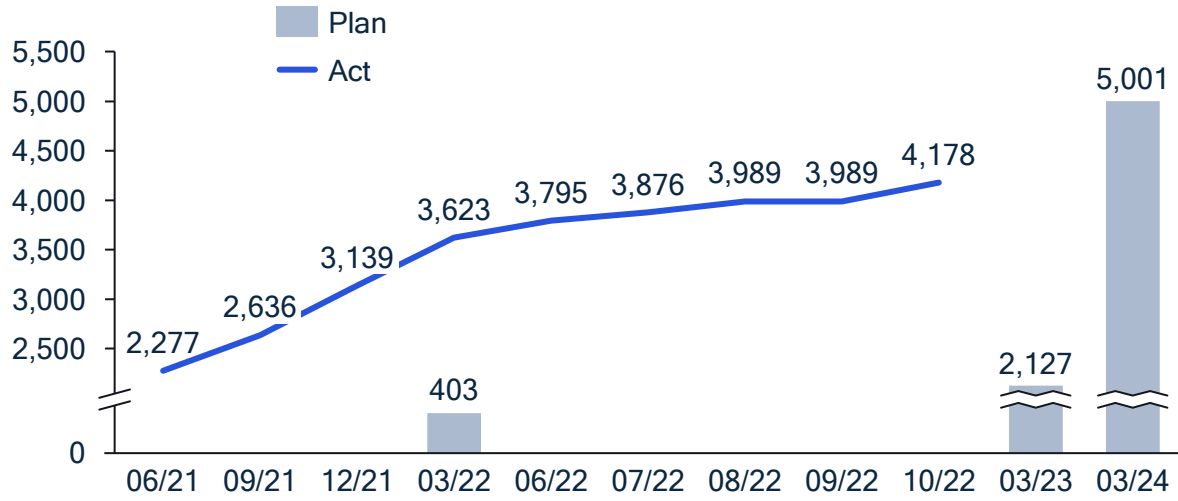
sub-6

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

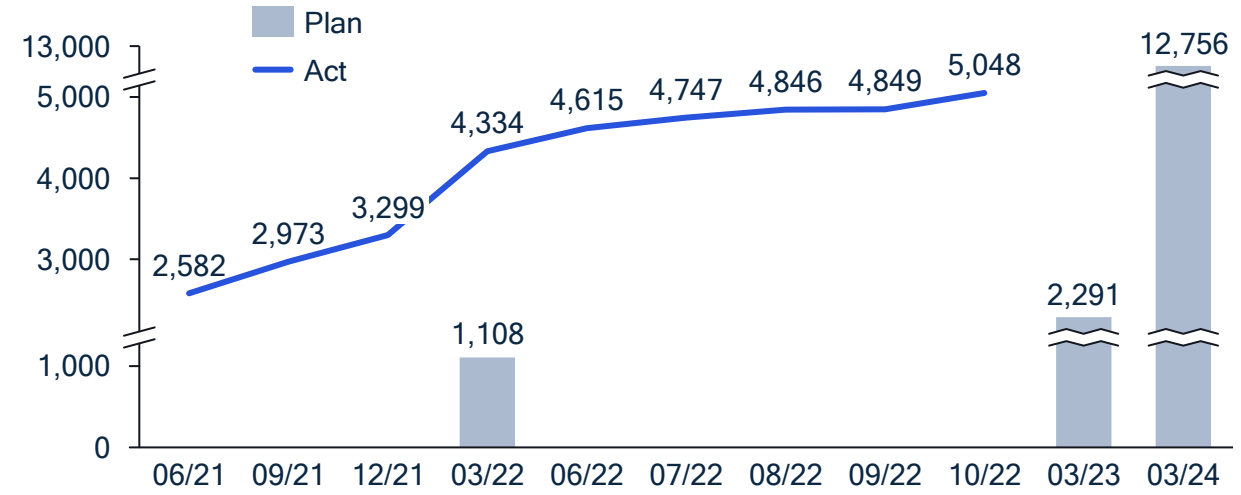
Model	'20 Summer		'20 Winter		'21 Summer		'21 Winter		'22 Summer		'22 Winter	
mmW models	4 models		3 models		5 models		5 models		9 models		8 models	
 Flagship/Prem Mid	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM
	Samsung: GS20+	Sony: Xperia 1 II	Samsung: Note20 Ultra	Sony: Xperia 5 II	Samsung: GS21 Ultra	Sony: Xperia 1 III	Samsung: Z Fold	Sony: Xperia 5 III	Samsung: GS22 Ultra	Sony: Xperia 1 IV	Samsung: Z Fold 4	Sony: Xperia 5 IV
	Samsung: GS20	Sharp: Aquos R5G	Samsung: A51	FCNT: Arrows NX9	Samsung: GS21	Sharp: Aquos R6	Samsung: Z Flip3		Samsung: GS22	Sharp: AQUOS R7	Samsung: Z Flip 4	
	LG: LG V60 ThinQ	FCNT: Arrows 5G	LG: Velvet L-52A	Sharp: Aquos sense5G	Samsung: A52	Sony: Xperia 10 III		Sharp: Aquos Sense6	Samsung: A53	Sony: Xperia 10 IV		Sony/ Sharp: TBD
 Tomorrow, Together	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM
	Samsung: GS21 Ultra	Sony: Xperia 1 II	Samsung: Z Fold2	Sony: Xperia 5 II	Samsung: GS21+	Sony: Xperia 1 III	Samsung: Z Fold	Sony: Xperia 5 III	Samsung: GS22 Ultra	Sony: Xperia 1 IV	Samsung: Z Fold 4	Sony: Xperia 5 IV
	Samsung: GS20+	Sharp: Aquos R5G	Samsung: Note20 Ultra		Samsung: GS21	Kyocera: TORQUE	Google: Pixel 6	Sharp: Aquos zero6	Samsung: GS22	Sony: Xperia 10 IV	Samsung: Z Flip 4	Sony: TBD
	Oppo: Find X2 Pro		Google: Pixel 5	Sharp: Aquos Sense	Oppo: Find X3 Pro	Sony: Xperia 10 III		Sharp: Aquos sense6	Google: Pixel 6a	Sharp: Aquos sense6s	Google: Pixel 7 Pro	Sharp: TBD
	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM	Global OEM	JP OEM
	LG: LG V60 ThinQ			Sony: Xperia 5 II	Moto: razr 5G	Sony: Xperia 1 III	Google: Pixel 6 Pro	Sony: Xperia 5 III		Sony: Xperia 1 IV		Sony: Xperia 5 IV
	ZTE Axon 10 Pro 5G	Sharp: Aquos R5G	Google: Pixel 5	Sharp: Aquos zero 5G	Google: Pixel 5a (5G)	Sharp: Aquos R6	Google: Pixel 6	Sharp: Aquos zero6		Sharp: AQUOS R7	Google: Pixel 7 Pro	Sharp: LEITZ PHONE
	OPPO: Reno3 5G		Google: Pixel 4a (5G)	Sharp: Aquos sense5G		Sharp: LEICA LEITZ		Kyocera: BALMUDA	Google: Pixel 6a	Sony: Xperia 10 IV	Google: Pixel 7	Sharp: sense 7
			Global OEM		Global OEM			JP OEM			Global OEM	
			ZTE: Rakuten BIG ZR01		Coolpad: Rakuten BIG S			Sharp: Aquos zero6			Samsung: Z Flip 4	

ミリ波基地局の免許申請数(総務省電波利用ホームページより弊社調べ)

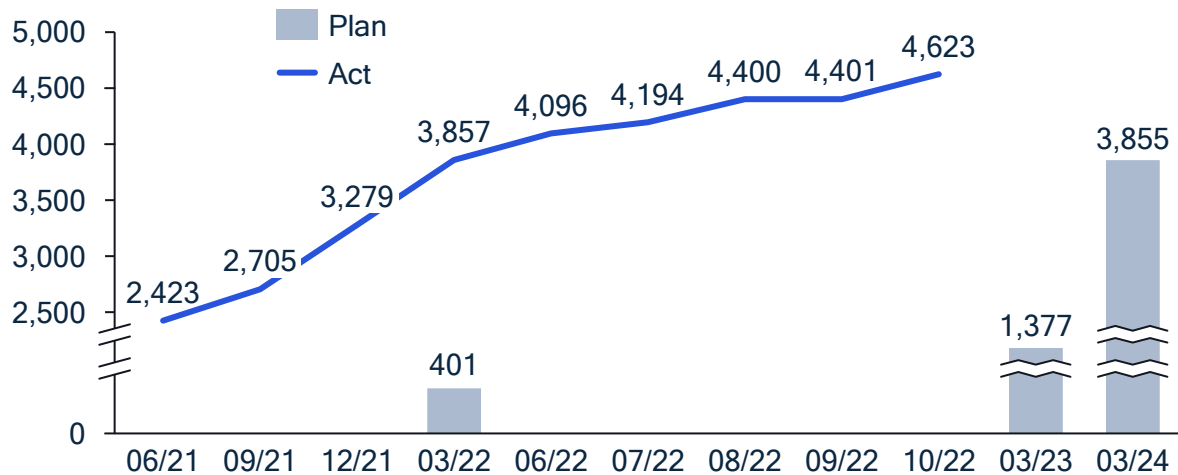
• Docomo



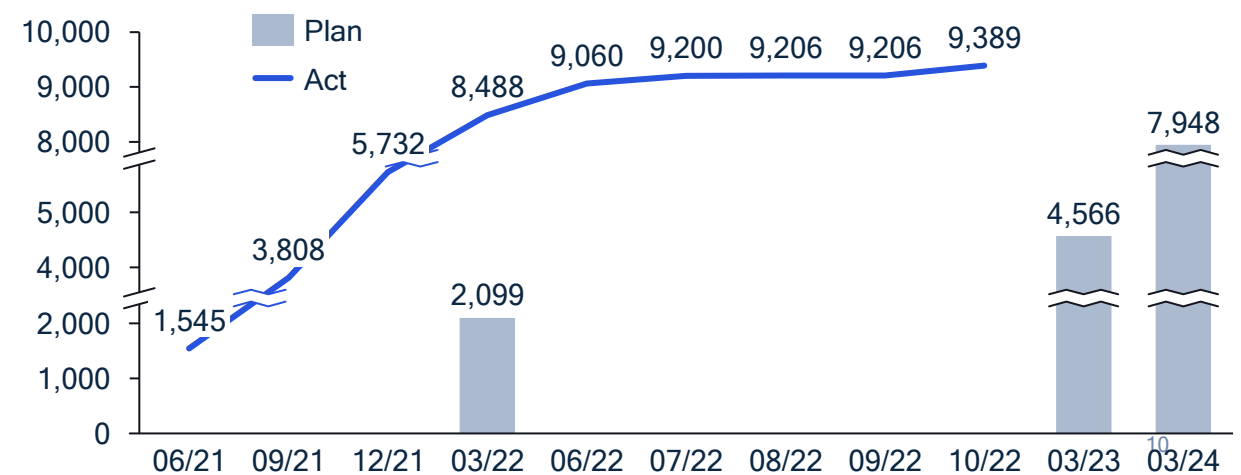
• KDDI



• Softbank

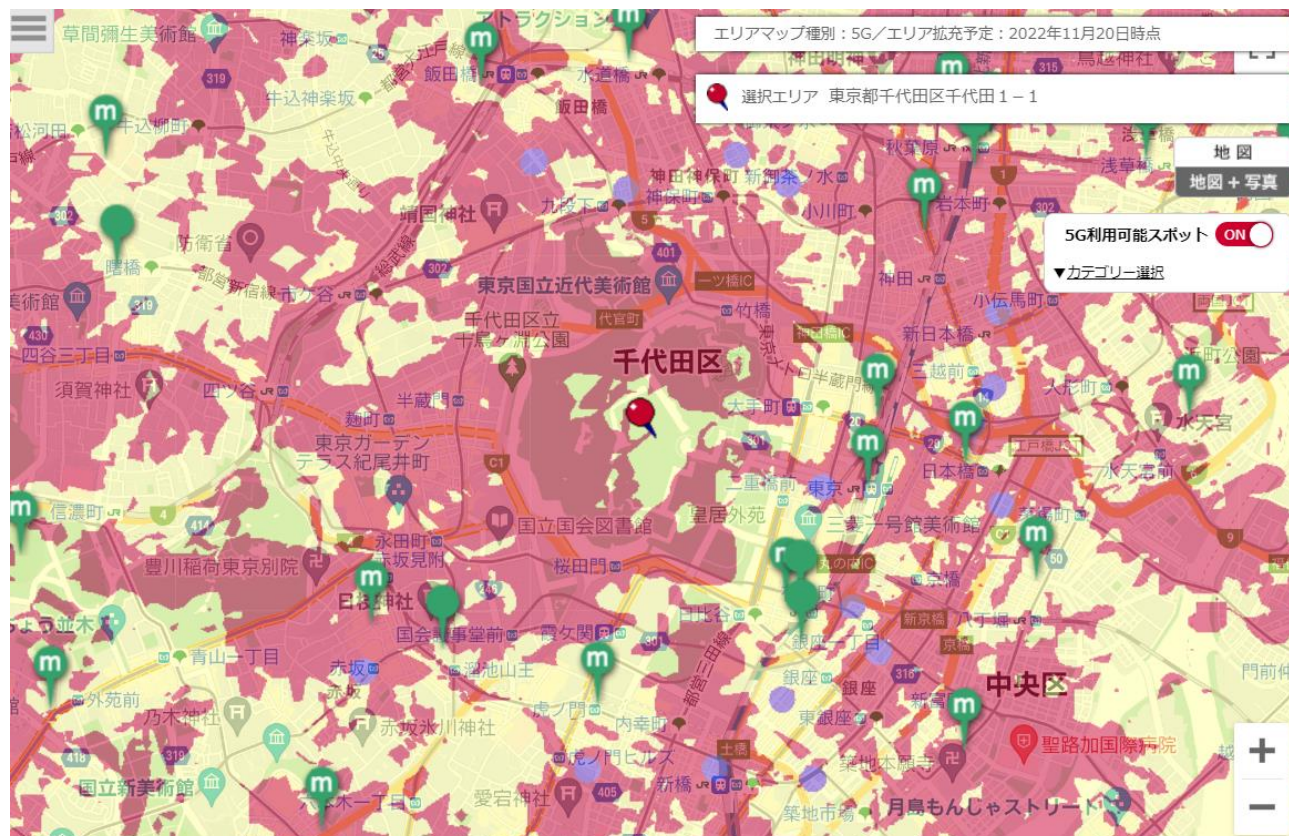


• Rakuten



エリア整備状況（東京都中心部）

NTTドコモ

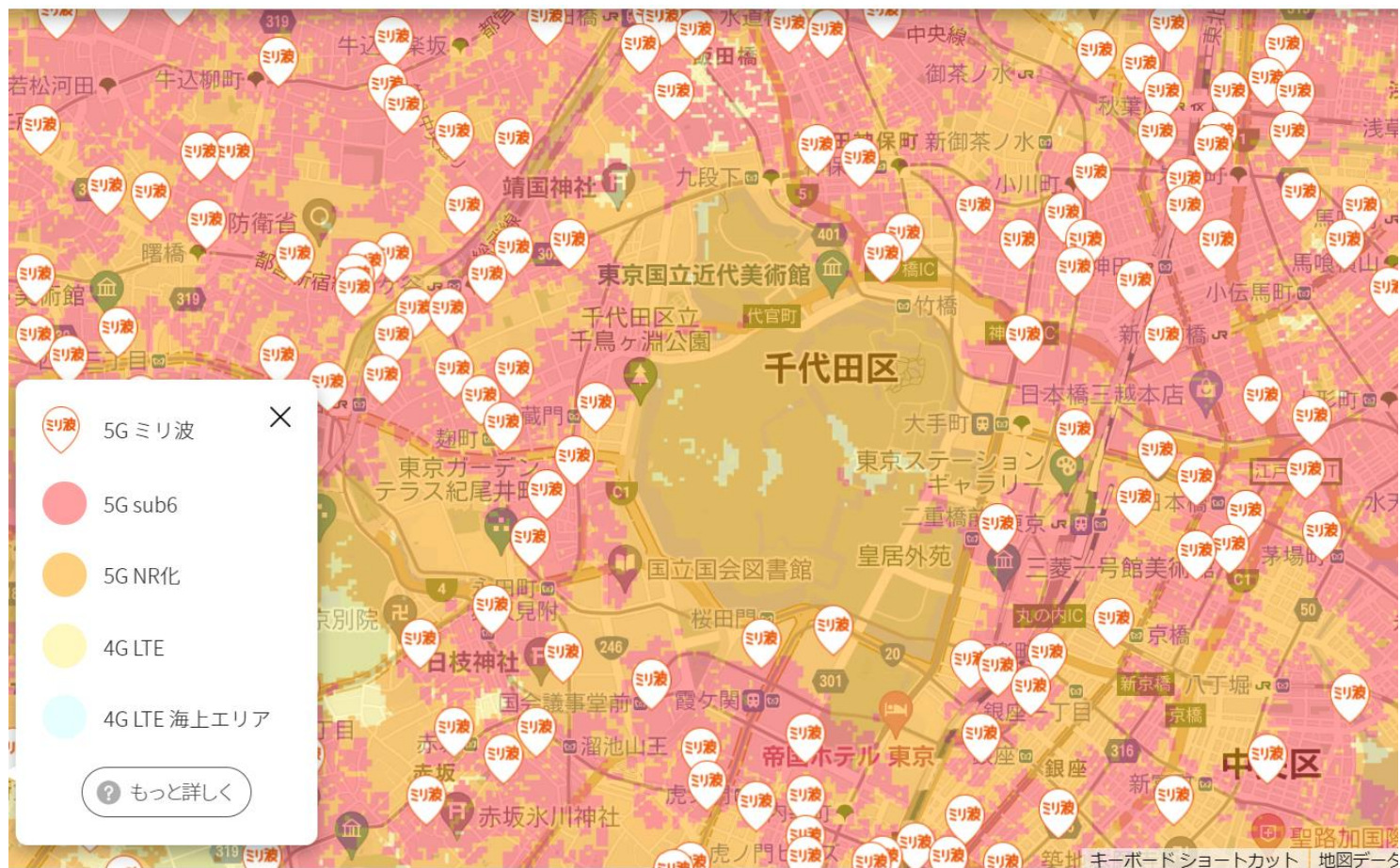


凡例（5Gエリア）

- 5Gエリア（28GHz）※1 **超速5G**
- 5Gエリア（4.5GHz, 3.7GHz）※1 **超速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

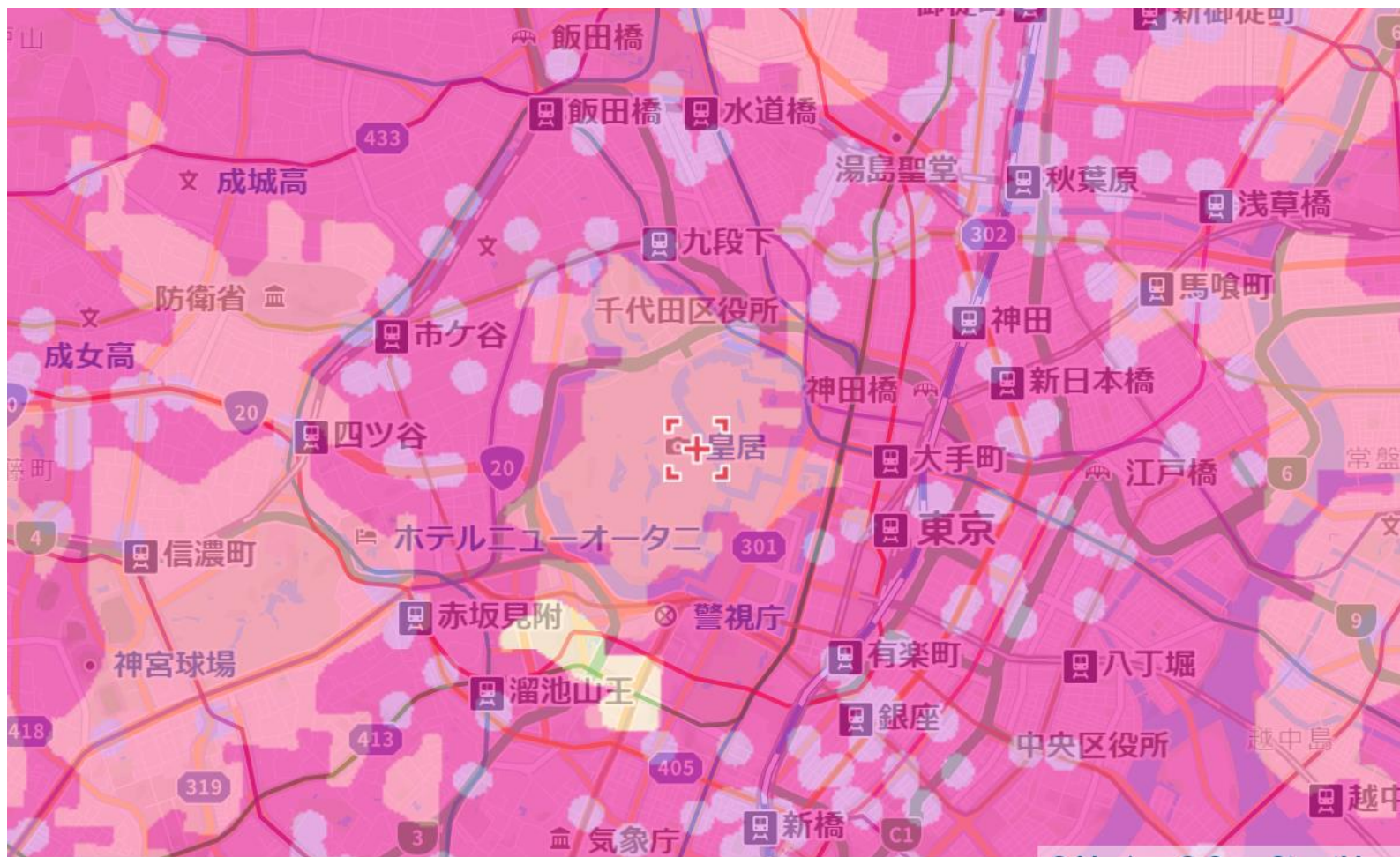
エリア整備状況（東京都中心部）

KDDI



エリア整備状況（東京都中心部）

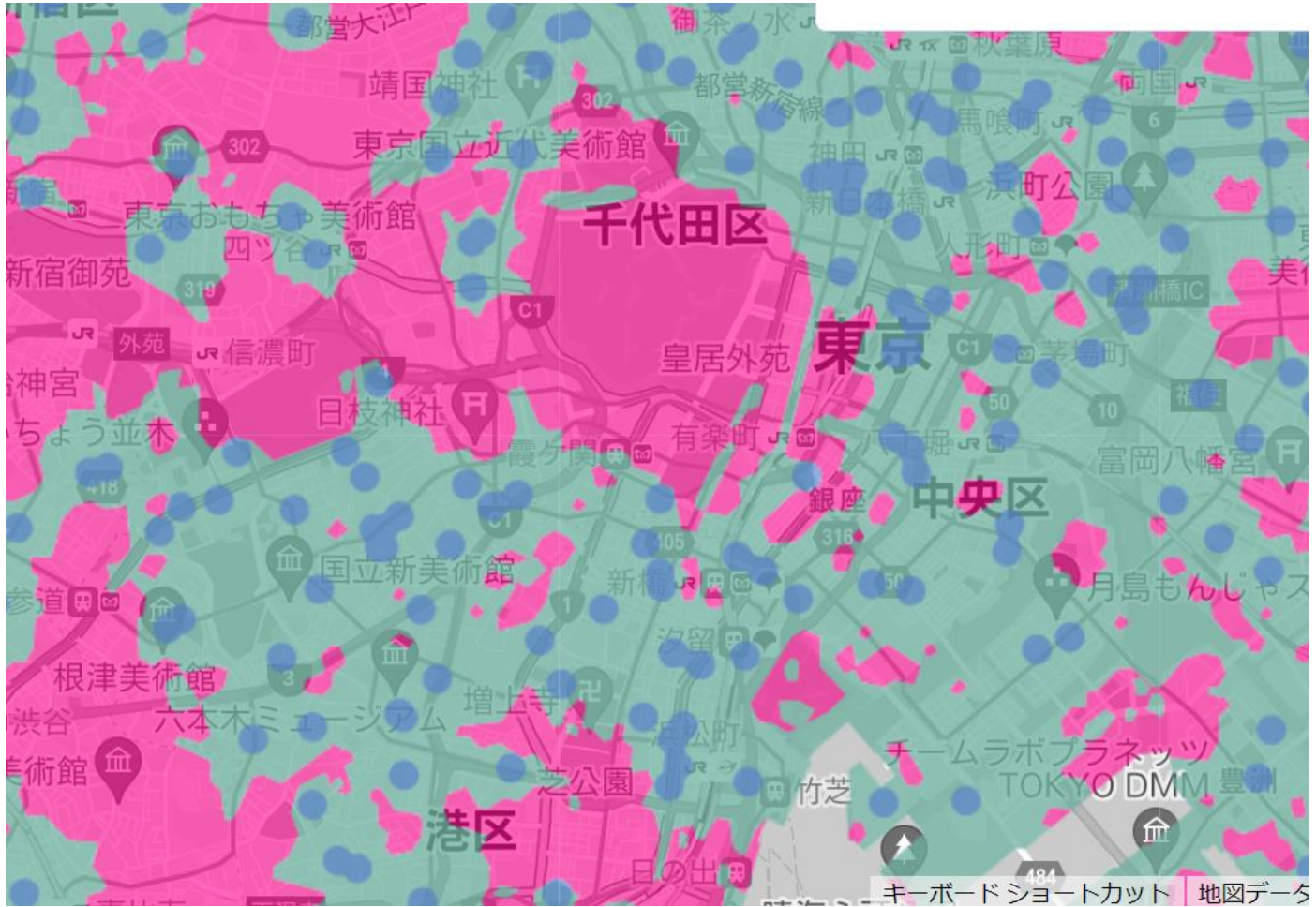
Softbank



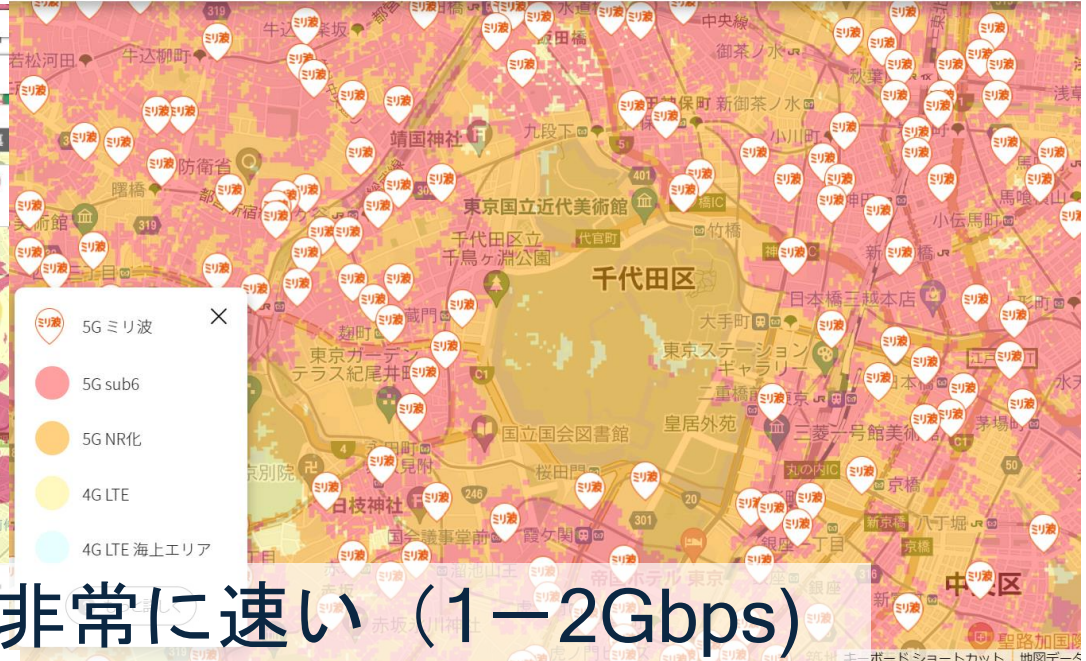
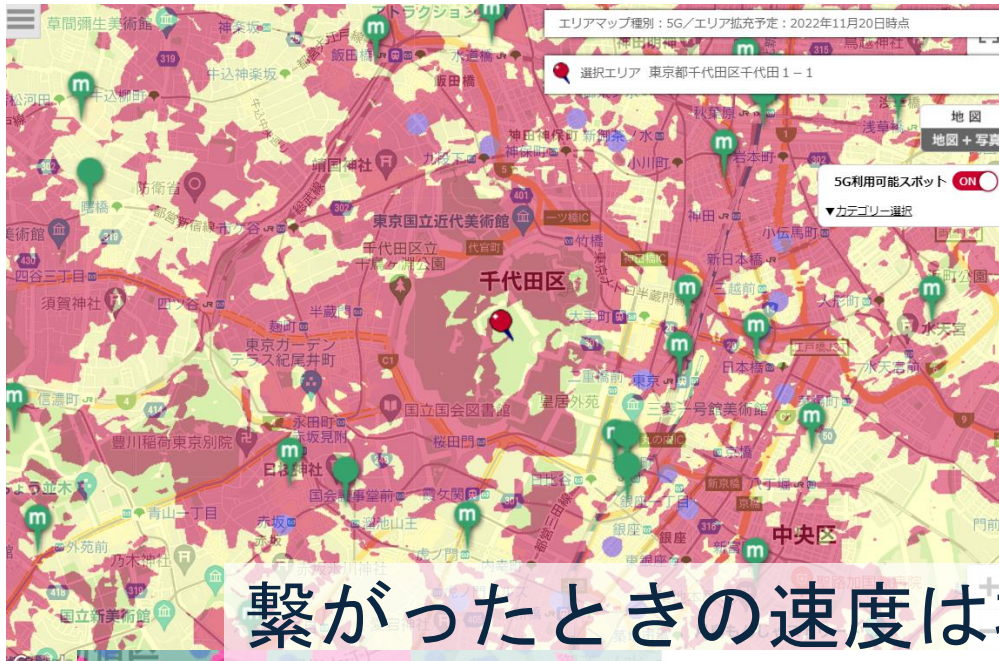
- 〈凡例〉
- SoftBank 5G<28GHz>※1 (2022年10月末時点)
 - SoftBank 5G<3.7GHz>※1 (2022年10月末時点)
 - SoftBank 5G<700MHz 1.7GHz 3.4GHz>※2 (2022年10月末時点)
 - SoftBank 4G / 4G LTE (2022年3月末時点)
 - SoftBank 3G (2022年3月末時点)
 - 海上・水上でおおよそ利用可能

エリア整備状況（東京都中心部）

Rakuten



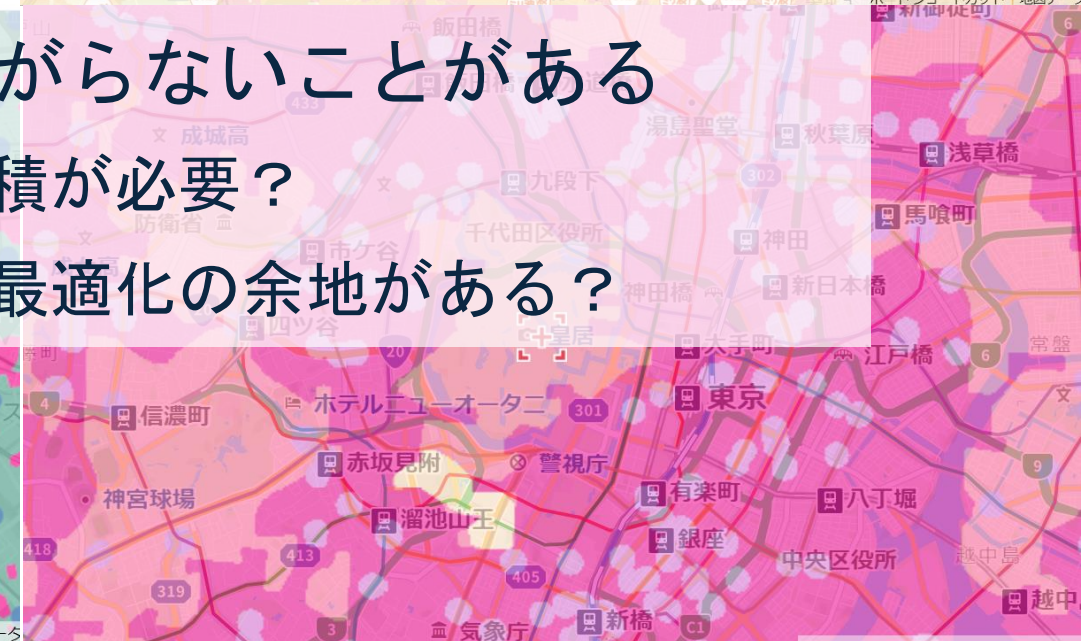
- 楽天回線 5G ミリ波エリア
- 楽天回線 5G sub6エリア
- 楽天回線 4G LTEエリア
- パートナー回線エリア



繋がったときの速度は非常に速い (1-2Gbps)

思うようにミリ波に繋がらないことがある

- ミリ波置局ノウハウの蓄積が必要？
- 置局後のチューニング・最適化の余地がある？



5G SA/NR-DC サービスの開始（NTTドコモ，2022年8月）

5G SA (Standalone) とは

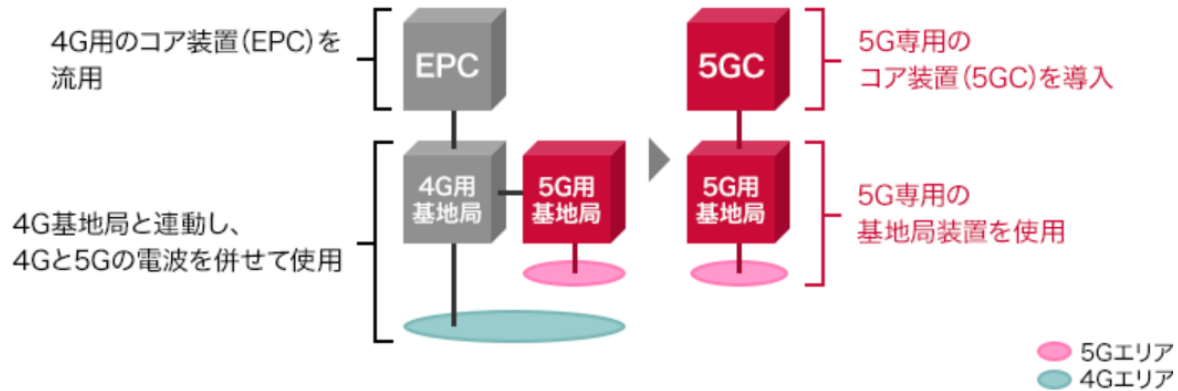
5G SAとは、5G専用のコアネットワーク設備である5GC（5G-Core）と、5G基地局を組み合わせて通信をする方式です。

上下ギガ超えの高速通信を実現！

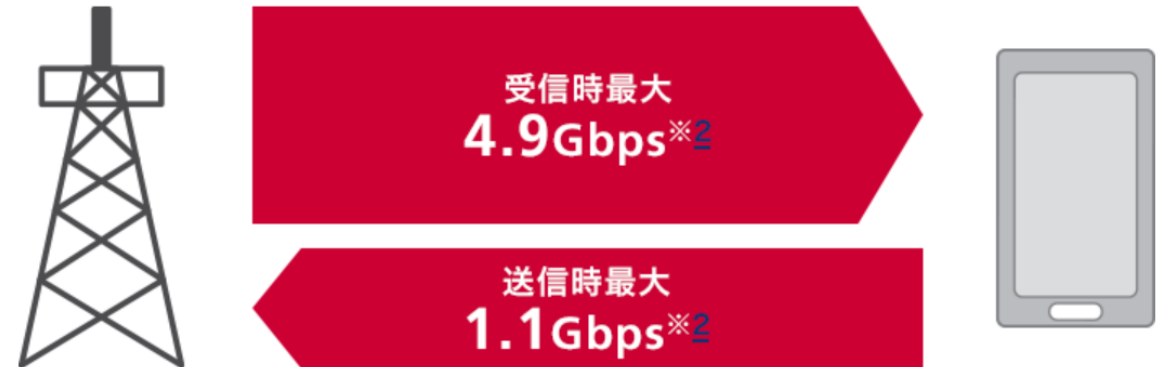
5G SAでは通常の5G（NSA）よりもさらなる高速通信をご利用になれます。受信時（下り）最大4.9Gbps※2 / 送信時（上り）最大1.1Gbps※2となり『上下ギガ超え』の通信速度を実現しています。

NSA (Non-standalone)

SA (Standalone)



ドコモの瞬速5Gは5G SAでさらに進化し、上下ギガ超えの高速通信を実現！



NTTドコモホームページより

1. 国内外の動向
2. 必要性
3. 製品

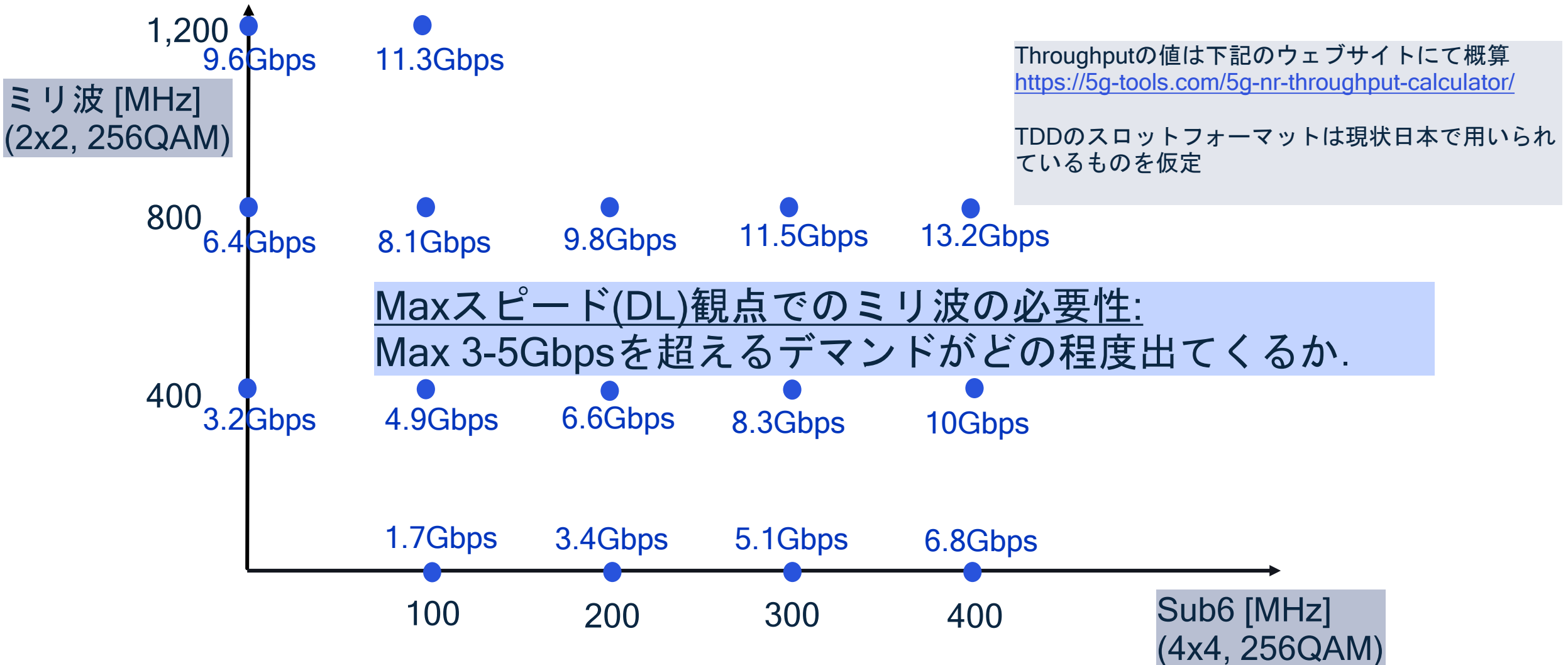
ミリ波の優位性とは？

- 大きな周波数帯域を確保しやすい
- ビームフォーミングを実現しやすい



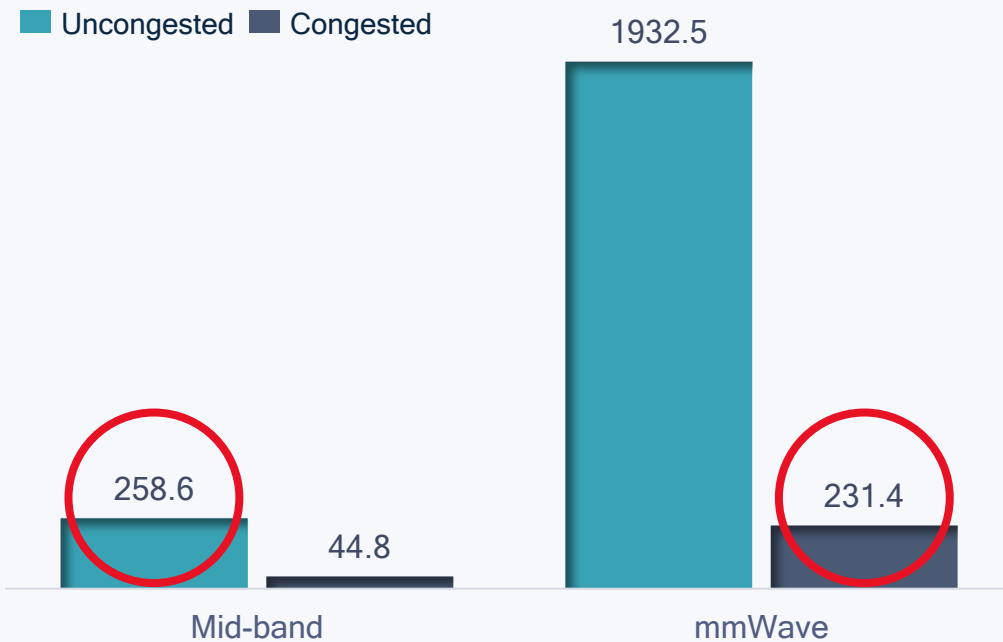
スピード、キャパシティ、低遅延、高精度測位、、、

5G NR サブ6、ミリ波のNRDCで達成する概算MAXスピード (Downlink)



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

1. 国内外の動向
2. 必要性
3. 製品

Extending 5G Modem-RF leadership

1st Gen



- 3GPP Release 15
- Sub-6 and mmWave
- NSA, TDD
- Multi-SIM
- Qualcomm® 5G PowerSave
- Qualcomm® Smart Transmit
- Qualcomm® Signal Boost
- 10nm process

2nd Gen



- 3GPP Release 15
- Sub6 and mmWave
- NSA and SA
- TDD and FDD
- Qualcomm 5G PowerSave
- Qualcomm Smart Transmit
- Qualcomm Signal Boost
- Global multi-SIM
- Qualcomm® Wideband Envelope Tracking
- Dynamic Spectrum Sharing
- Integrated 5G to 2G
- 5G/4G carrier aggregation
- 7nm process

3rd Gen



- 3GPP Release 15
- Sub6, mmWave
- NSA, SA, TDD, FDD
- Sub-6 CA across TDD/FDD
- 3rd-gen mmWave antenna module (QTM535)
- Voice-over-NR
- Qualcomm 5G PowerSave
- Qualcomm Smart Transmit
- Qualcomm Signal Boost
- Global 5G multi-SIM
- Qualcomm Wideband Envelope Tracking
- Dynamic Spectrum Sharing
- Integrated 5G to 2G
- 5nm process

4th Gen



- 10 Gigabit 5G
- 3GPP Release 16
- Sub6, mmWave and mmWave-sub6 aggregation
- 4th-gen Qualcomm® 545 mmWave antenna module
- Qualcomm® 5G PowerSave 2.0
- Qualcomm® Smart Transmit™ 2.0
- Qualcomm® AI-based Signal Boost
- Global 5G multi-SIM
- Qualcomm® Wideband Envelope Tracking
- Dynamic Spectrum Sharing
- 4nm process
- NSA, SA, TDD, FDD
- FDD-TDD in 5G uplink CA

5th Gen



- Qualcomm® 5G AI Suite
- 10 Gigabit 5G
- 3.5 Gbps Uplink
- 5G mmWave standalone
- 4x Downlink Carrier Aggregation
- Uplink Carrier Aggregation
- Global 5G multi-SIM with Dual SIM Dual Active
- Qualcomm® 5G Ultra-Low Latency Suite
- Qualcomm® 5G PowerSave Gen 3
- Switched uplink support (TDD and FDD)
- FDD-TDD in 5G uplink CA
- Sub6, mmWave and mmWave-sub6 aggregation
- Qualcomm® Wideband Envelope Tracking
- 3GPP Release 16

First wave of devices

Second Wave

Raise performance bar

10 Gigabit 5G era

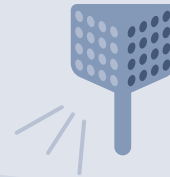
5G AI modem era

Qualcomm® 545 mmWave Antenna Module

Qualcomm Technologies' 4th-generation mmWave module for mobile

Extended range
compared to previous gen

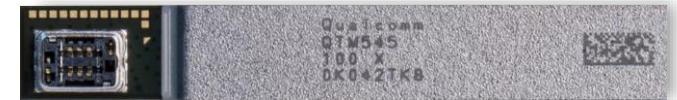
Added support for
41 GHz band (n259)



Snapdragon
X65 5G modem-RF



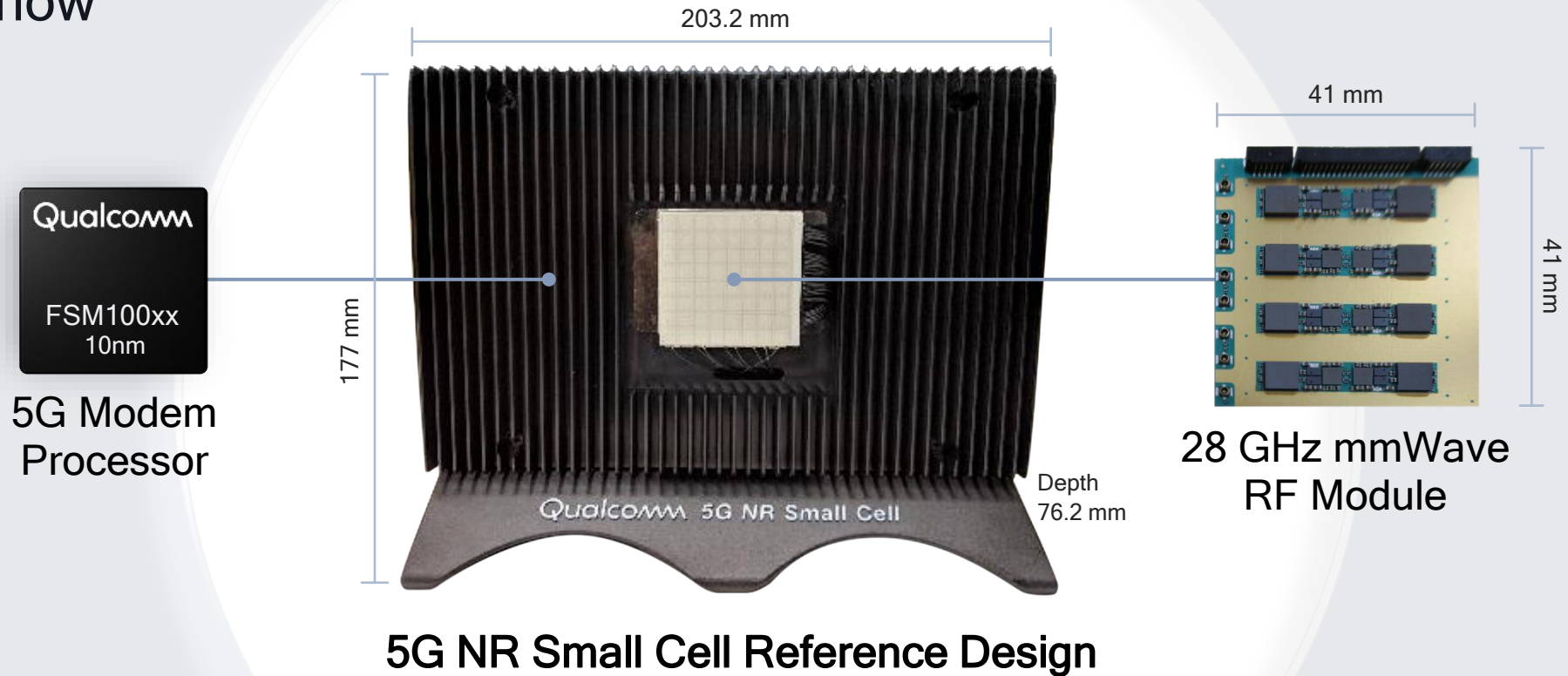
Snapdragon
X62 5G modem-RF



Global mmWave band support
26 GHz, 28 GHz, 39 GHz, 41 GHz
(North America, Korea, Japan, Europe, Australia, SEA)

Modemプロセッサとアンテナモジュールを提供

Sampling now



- 端末向けモデムRFの設計資産をレバレッジ
- SoC化・モジュール化により小型化，低価格化，低消費電力化を実現

まとめ

- グローバルでのミリ波の展開はここ2年で順調に進捗
- 国内のミリ波対応スマホ機種は順調に伸びている
 - 売れ筋機種や、ボリュームゾーンへの普及が課題
- ミリ波はキャパシティ確保に有効
 - トラフィック密度が高い場所でのユーザ体験の確保
- クアルコムミリ波アンテナモジュールは、異周波キャリアアグリゲーションの対応も見据える
- クアルコムスモールセルソリューションにて小型・低消費電力・低コストのミリ波基地局を実現可能
- 6Gではさらなる高周波帯の利用が検討されているが、5Gでのミリ波の経験をフィードバックすることが重要
 - 5Gミリ波の成功が将来への鍵

Thank you

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