Activities of Technology Working Group

Technology Working Group,
White Paper Subcommittee, B5GPC

February 16, 2022

Technology Working Group

White Paper Subcommittee

Chair: Mr. Nakamura (NTT DOCOMO)

Vision Working Group

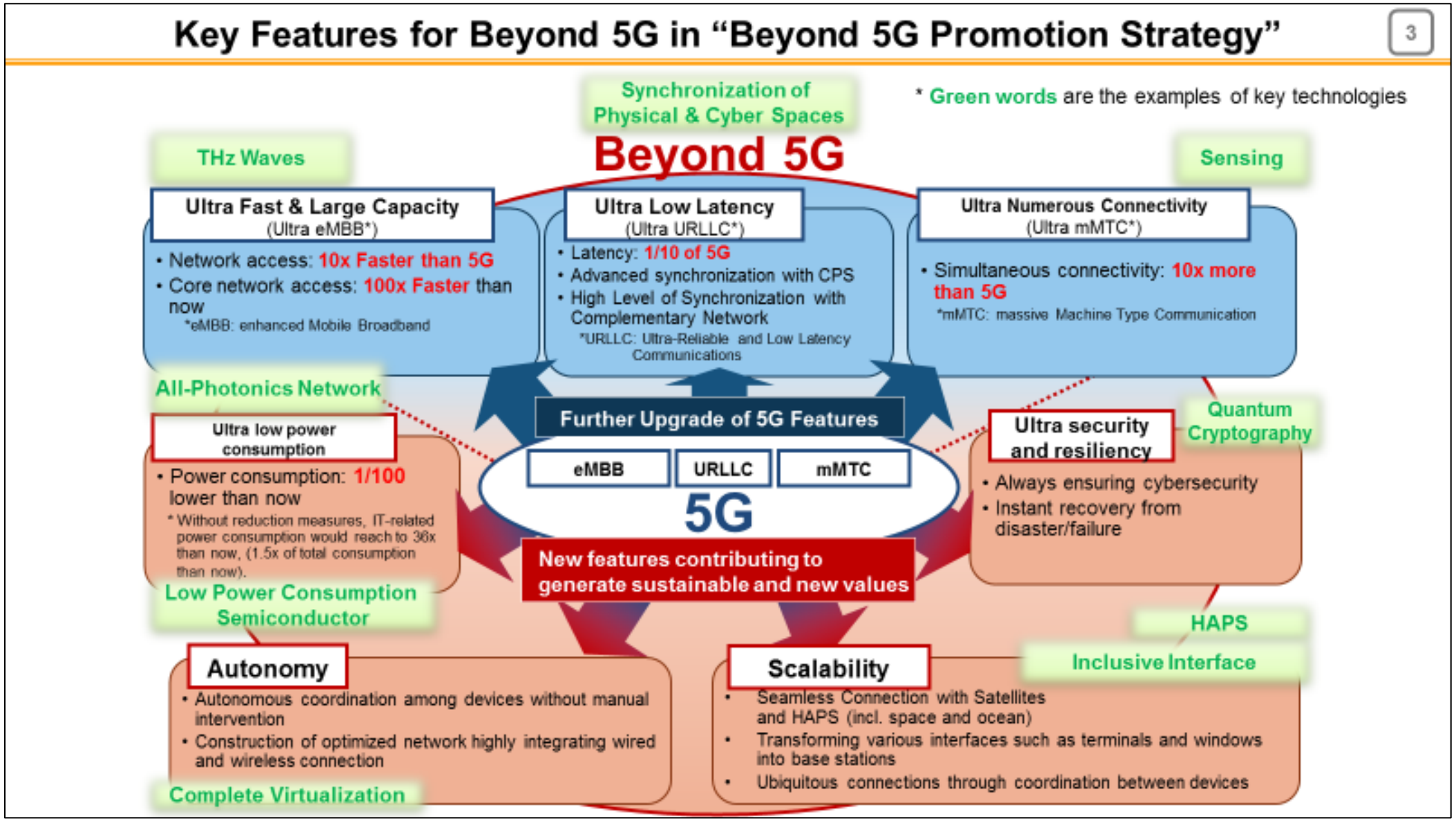
Leader: Dr. Konishi (KDDI),
Sub-leader: Dr. Nagata (NTT docomo)

Technology Working Group

Leader: Mr. Nakamura (Fujitsu),
Sub-leader: Dr. Shimonishi (NEC)

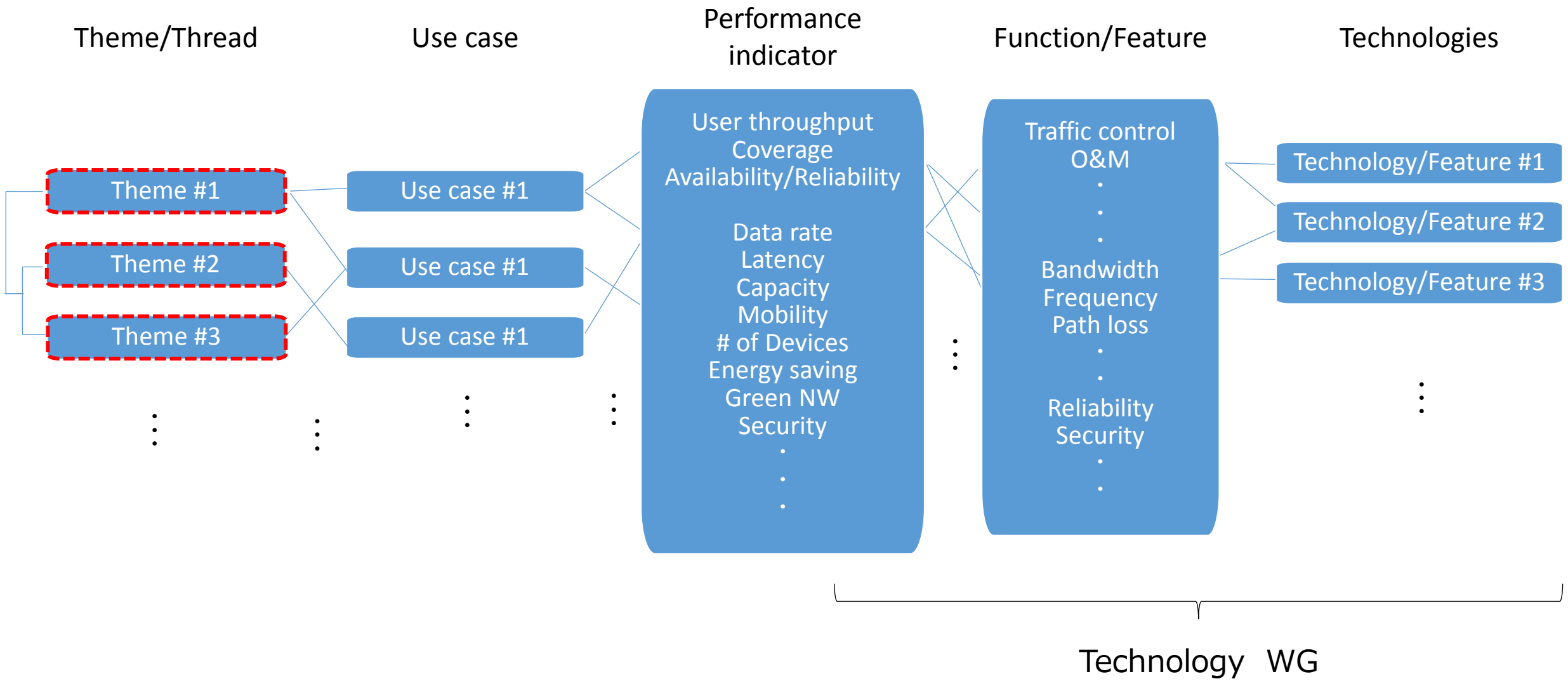
Technology trends of Beyond 5G which realize the use cases and the requirements for Beyond 5G

Key Features for Beyond 5G



"Beyond 5G Promotion Strategy", Ministry of Internal Affairs and Communications (June 2020)

Use Case to Technology Mapping



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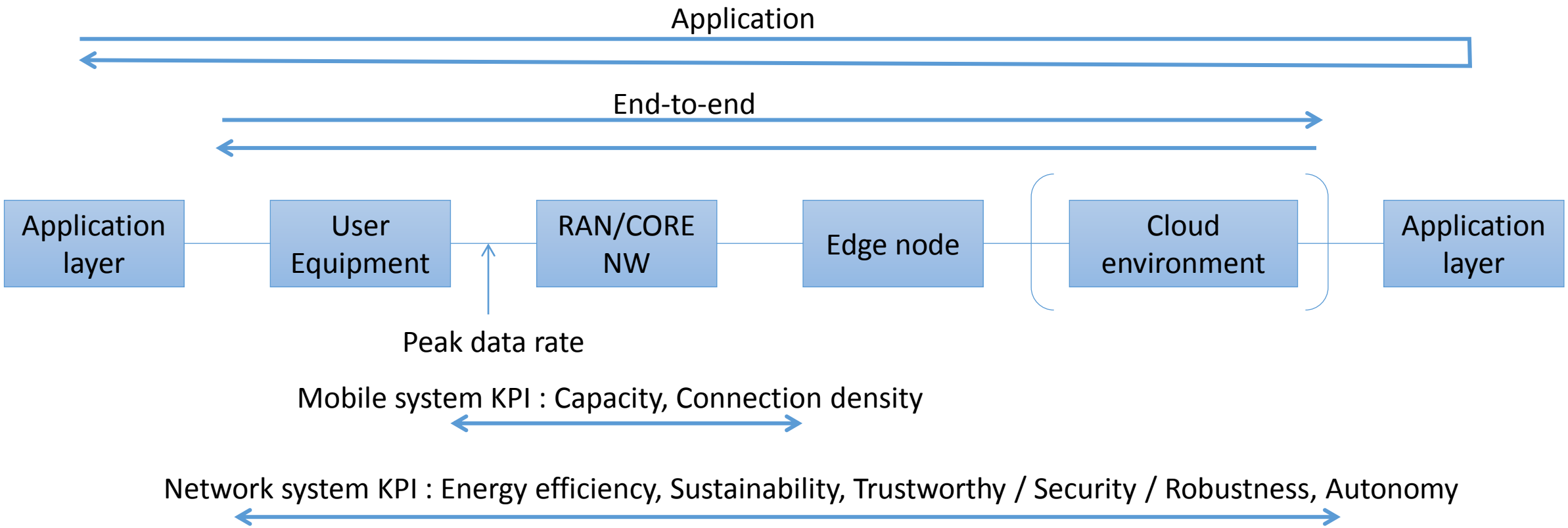
5.2章 KPI スコープ

User experienced KPI (end-to-end): Data rate, Latency/Jitter, Reliability, Coverage, Mobility, Position accuracy



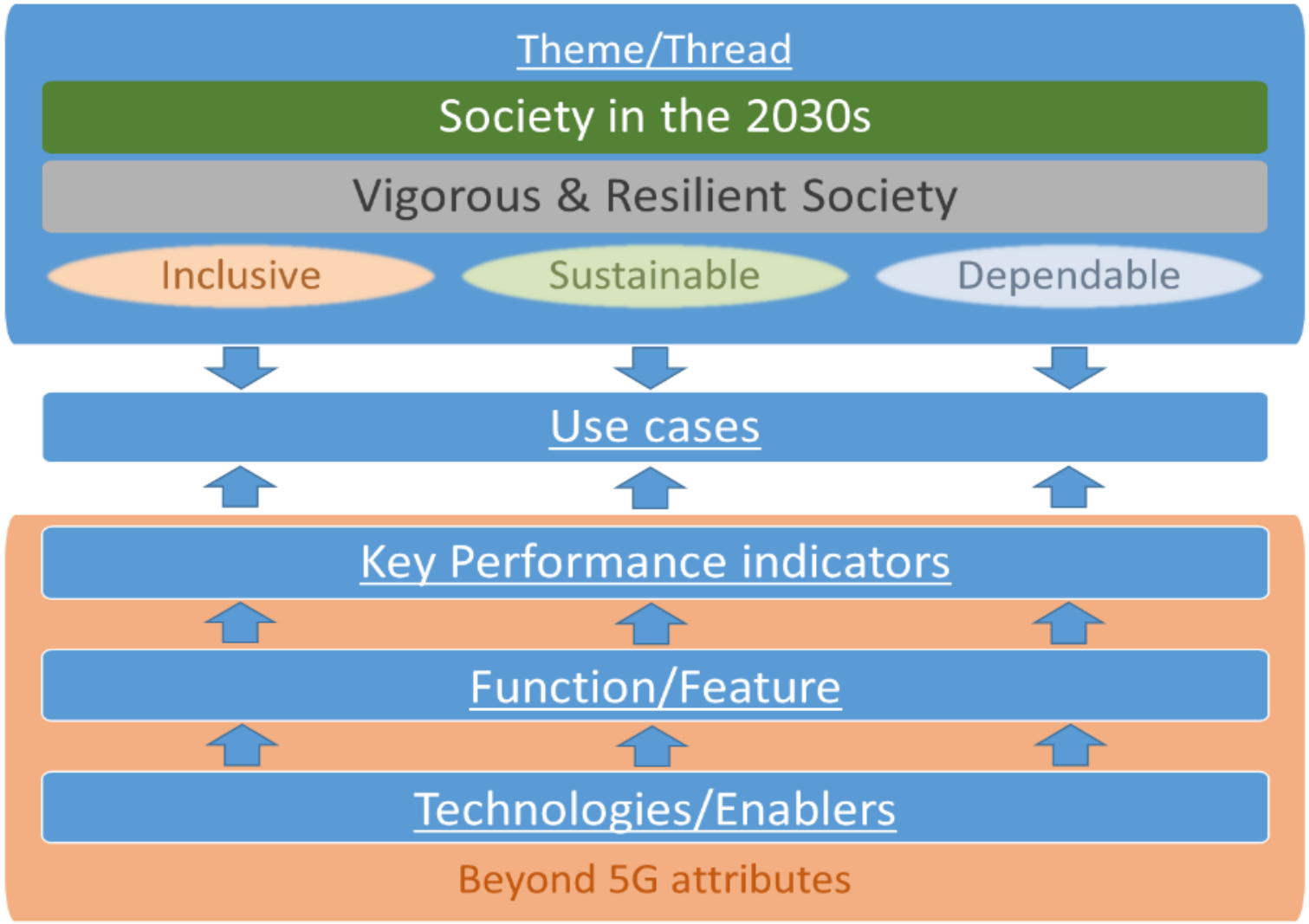
5.2章 KPI

カテゴリ	定量的要求条件	Beyond 5G推進コンソーシアム（案）
定量的要求条件	User experienced data rate (DL/UL)	10-100Gbps typical and 1Gbps everywhere
	Peak data rate (DL/UL)	100Gbps 以上
	Capacity	100 times of IMT-2020
	Latency	1msec for general use case, 0.1msec for localized communication use case (one-way)
	Jitter	1msec or less
	Response	100msec round trip application response (including expected application dependent processing delay)
	Reliability	10^{-6} -10^{-7} (RAN)
	Positioning accuracy	Order of cm
	Connection density	10^{6} - 10^{7} devices /km^2
	Energy efficiency	100 times of IMT-2020
	Mobility	1000 km/h
	Area coverage	陸上/海上/空/宇宙をカバー 面積カバレッジ 陸上100%
	Area coverage/HAPS	Horizontal : 半径数10-100km Vertical : 数km

5.2章 KPI

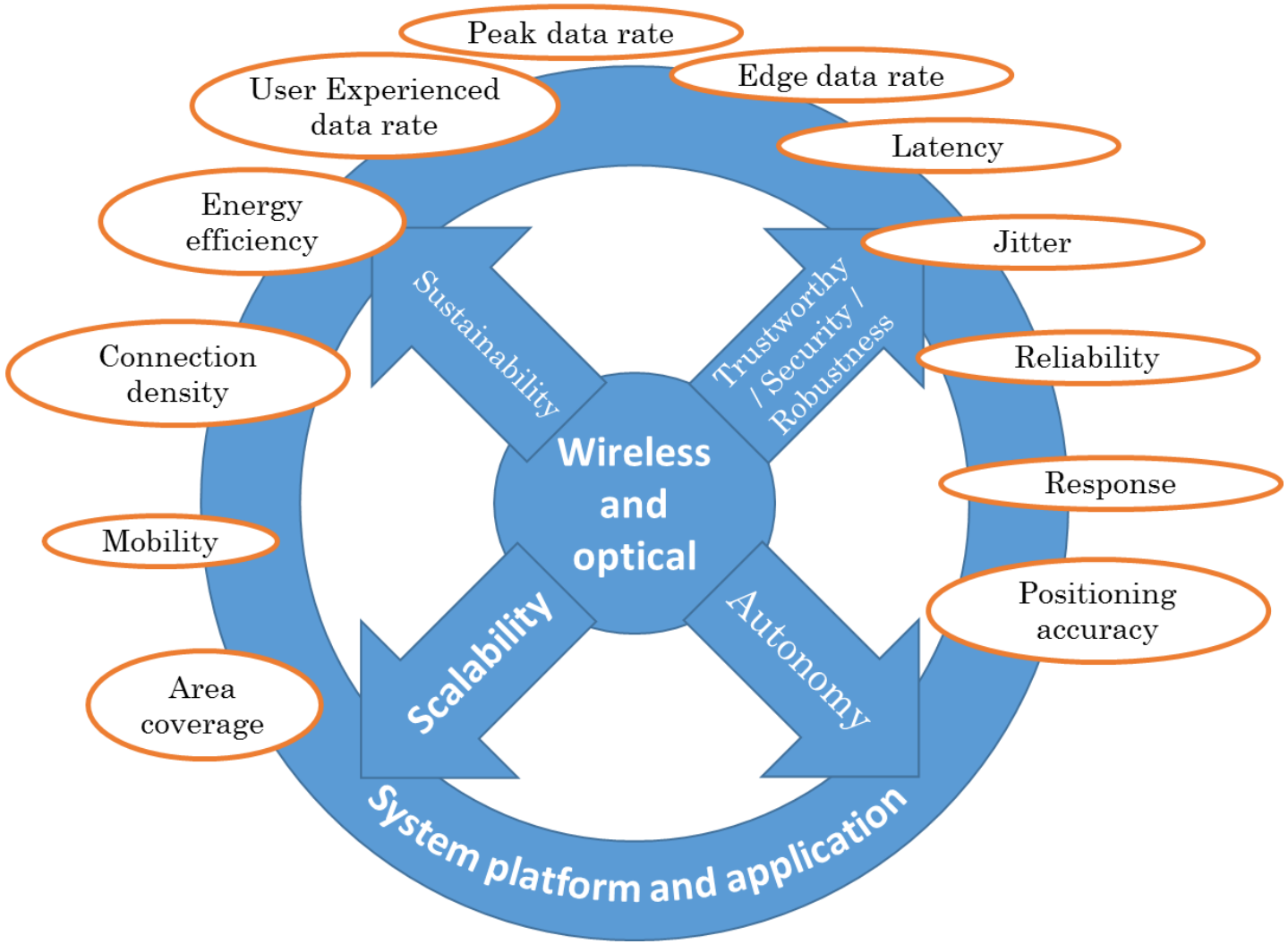
カテゴリ	定量的要求条件	Beyond 5G推進コンソーシアム（案）
定性的要求条件	Sustainability	• 機器の低環境負荷化(環境対応材料の使用、再利用性向上) • 機器の長寿命化(ソフトウェア拡張性やHWのモジュール構造化) • カーボンニュートラル(再生可能電源の利用)
	Trustworthy / Security / Robustness	• Peak data rateを超える暗号処理速度(100Gbps以上) • 量子コンピュータ時代でも耐えられる256bit鍵長への対応 • 災害や障害からの瞬時復旧
	Autonomy (自律性)	• ゼロタッチで機器が自律的に連携、有線・無線を超えた最適なネットワークの構築 • 構築から運用まで全てのワークフローにあたって、省力性・柔軟性・迅速性を同時に満たす完全自動化の達成
	Scalability (拡張性)	• 衛星やHAPSとのシームレスな接続 • 端末や窓など様々なものを基地局化 • 機器の相互連携によるあらゆる場所での通信 • オープンインターフェイス(Network API, application API)

6.1.1 Market demands [1/2]



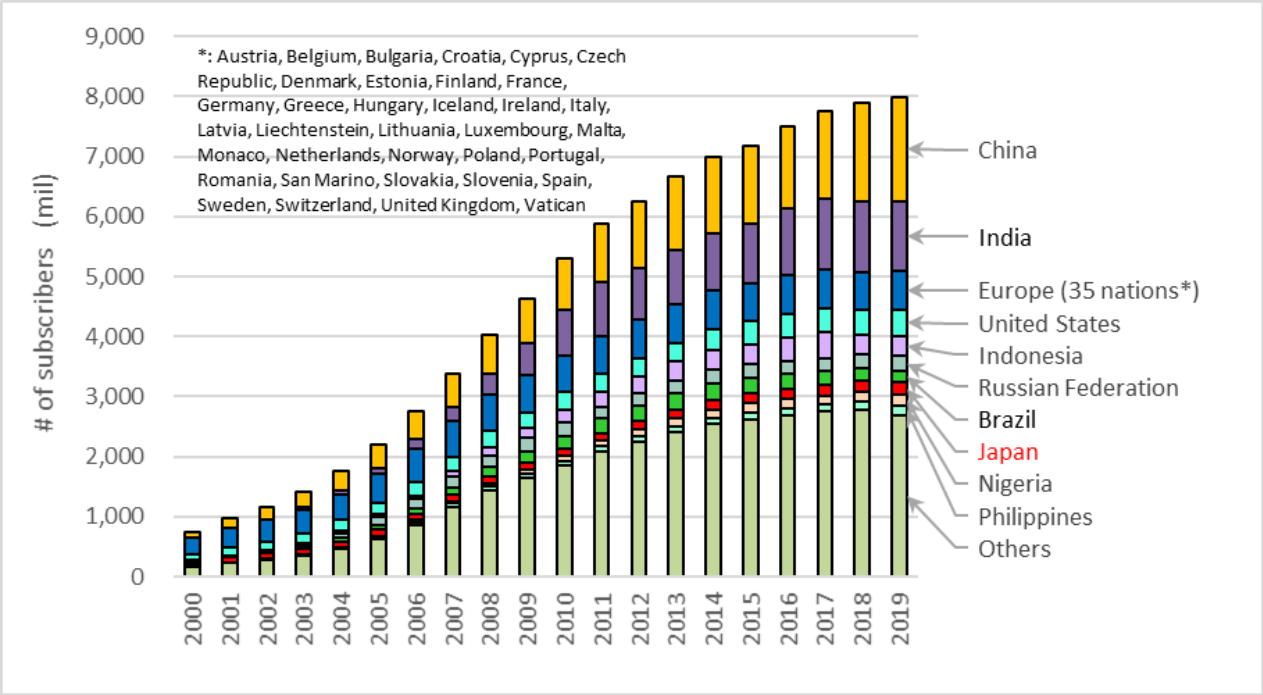
Technologies supporting Target Key Performance Indicators

6.1.1 Market demands [2/2]

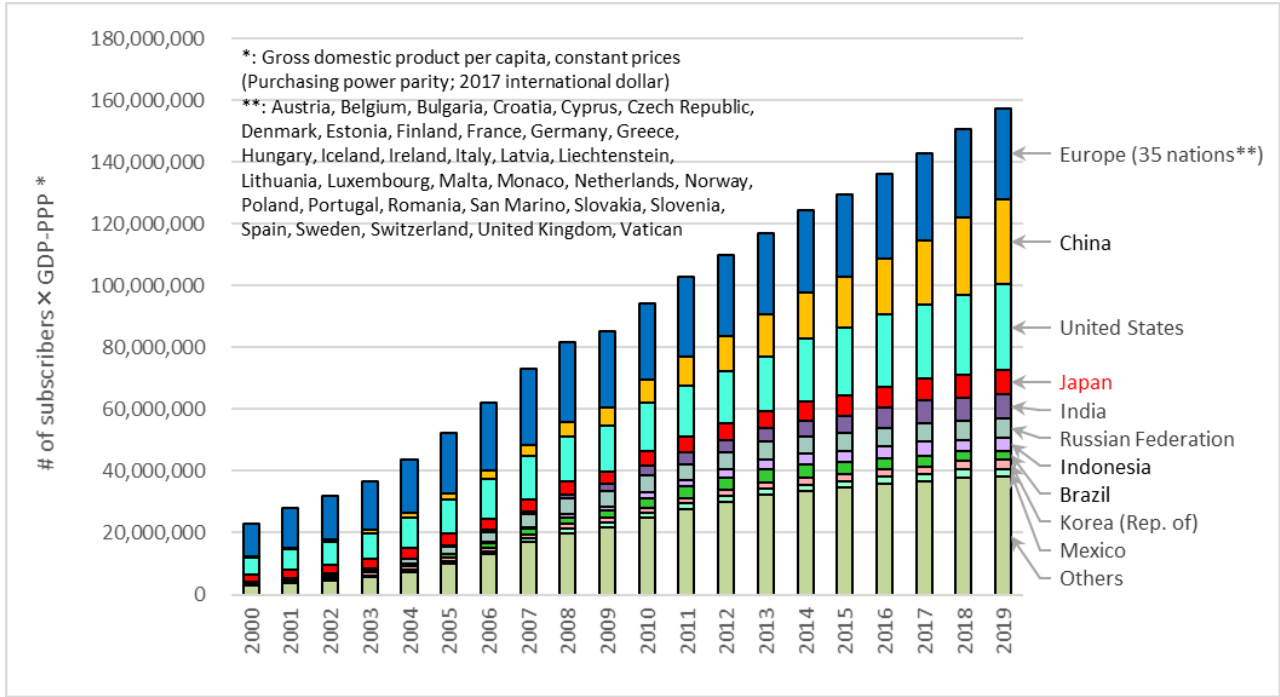


Technologies supporting Target Key Performance Indicators

6.1.2 Deployment aspect



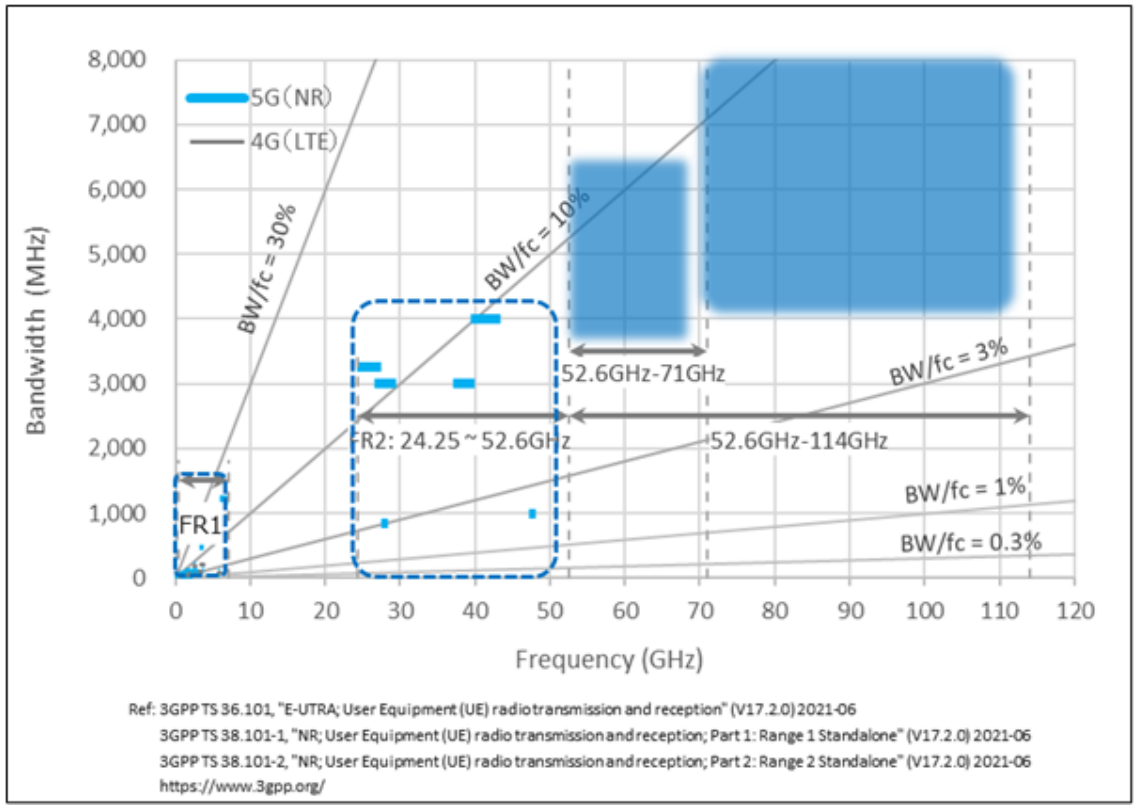
Number of mobile phone subscriptions worldwide [1]



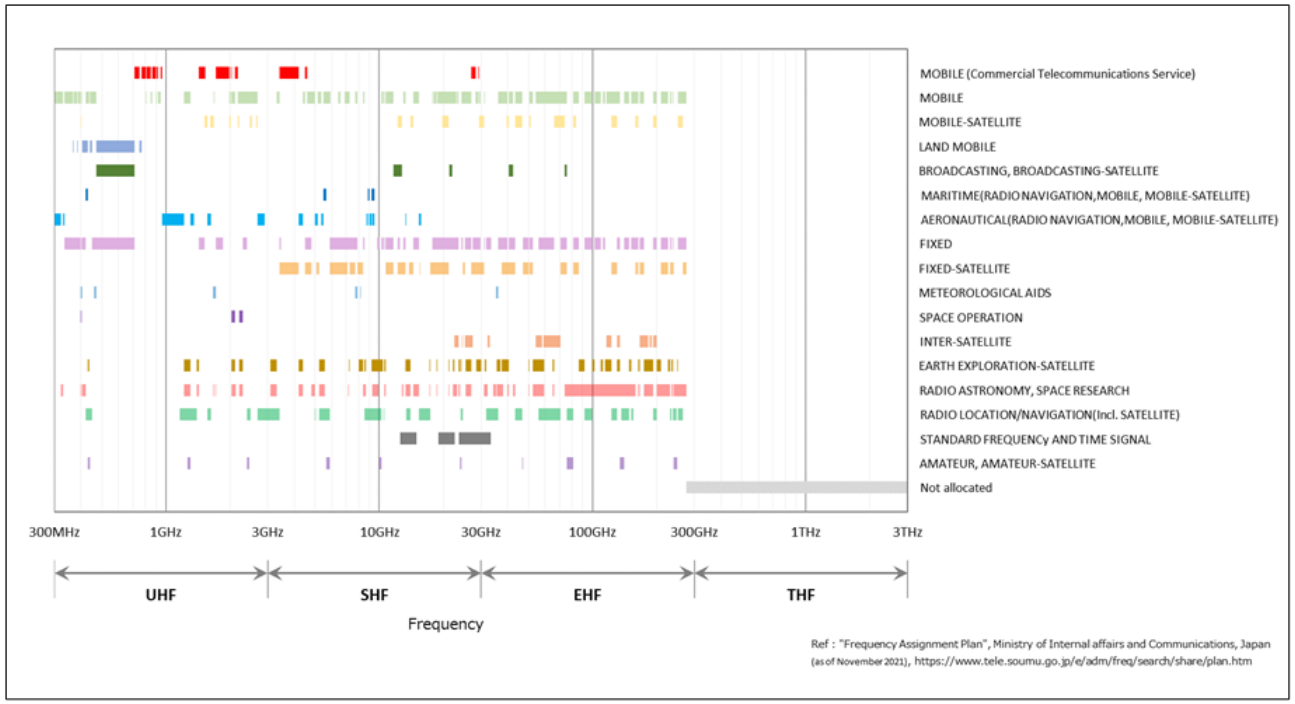
Number of subscribers multiplied by GDP-PPP [1][2]

[1] “Mobile-cellular subscriptions (excel)”, International Telecommunication Union, Telecommunication Development Sector (ITU-D), (November 2021).
[2] “World Economic Outlook Database”, International Monetary Fund, October 2021.

6.1.3.1 Trend of radio frequency resource utilization

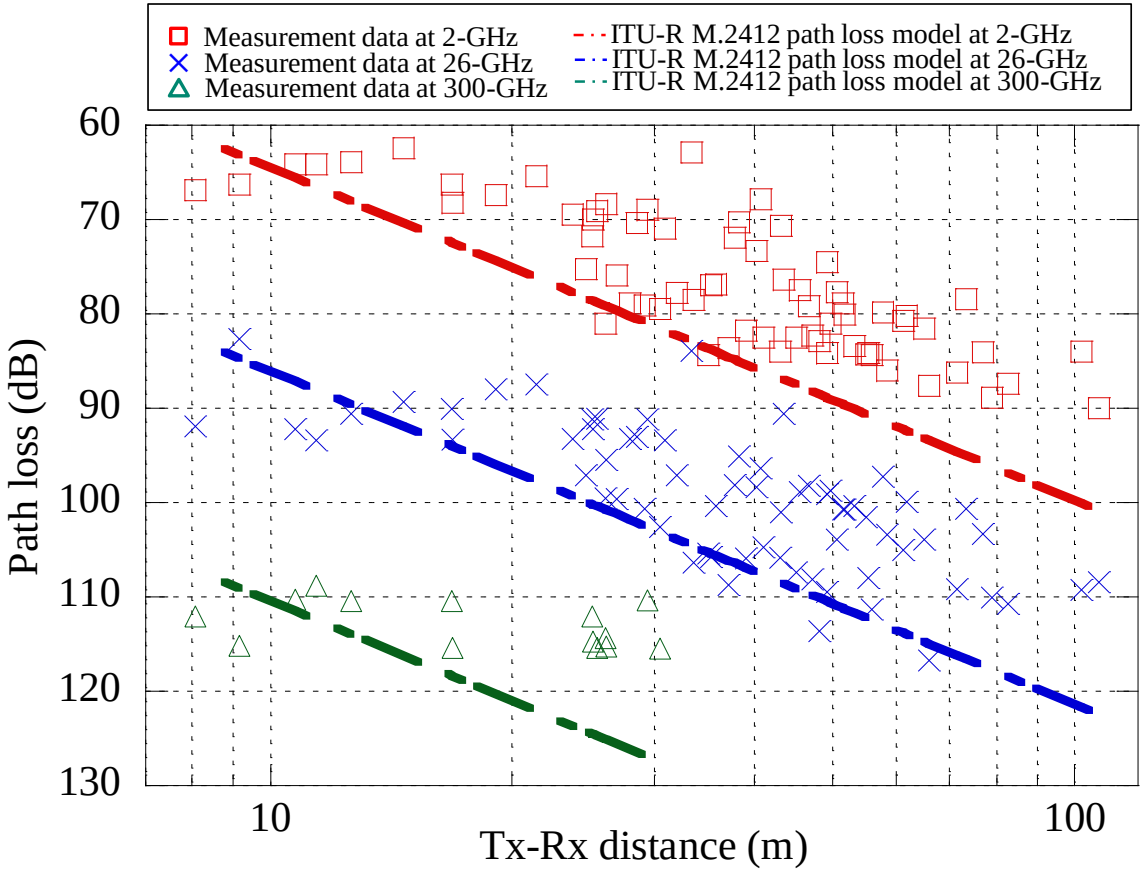


Frequency bands defined for 4G and 5G
in the 3GPP specifications

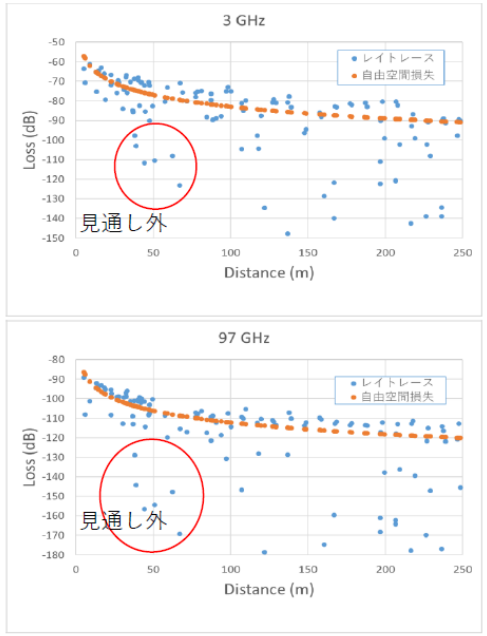


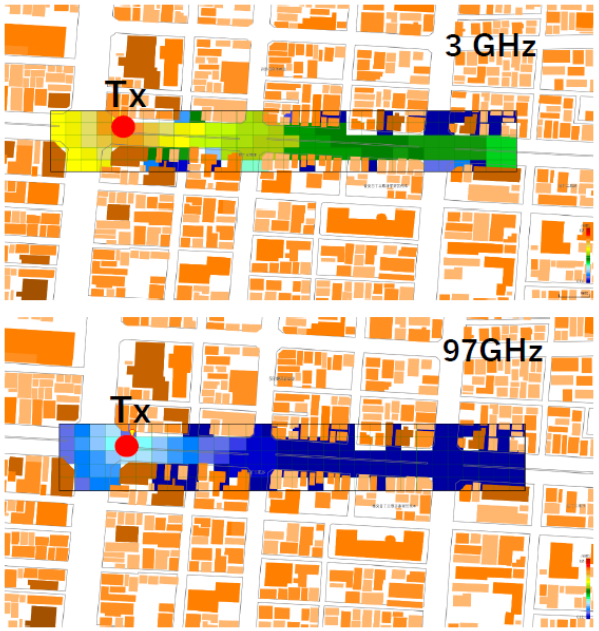
Frequency assignment in Japan

6.1.3.2 Radio Propagation related studies [1/2]



Measurement path loss characteristics





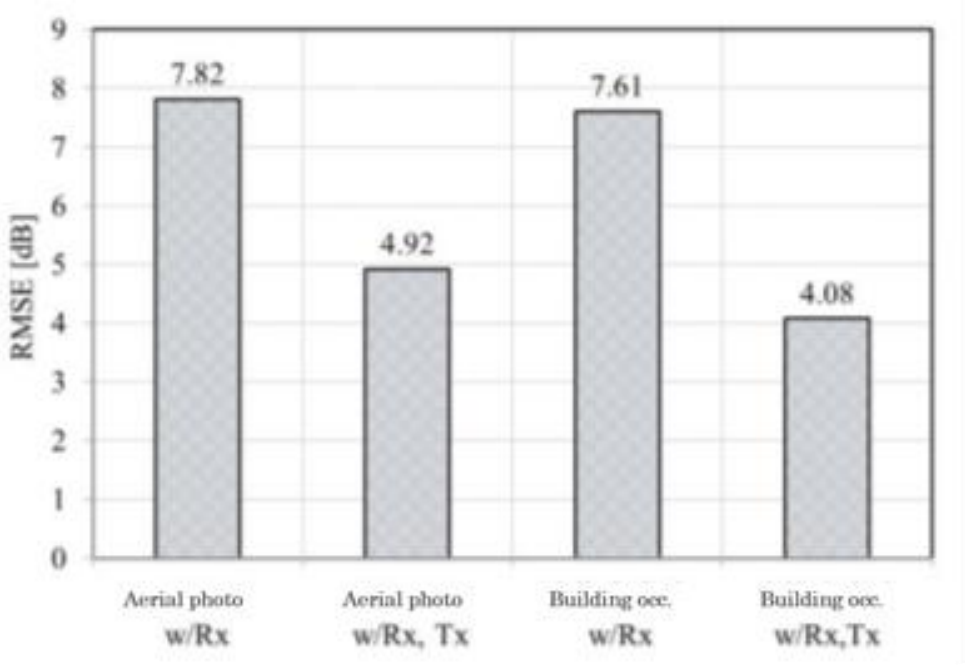
Ray-tracing and free-space propagation model comparison (Outdoor street canyon) propagation [3]

[1] M. Inomata et.al, "Radio Propagation Characteristics for Pioneering Terahertz Wave Bands in 6th Generation Mobile Communication Systems", IEICE Technical Report RCS2020-98(2020-10)

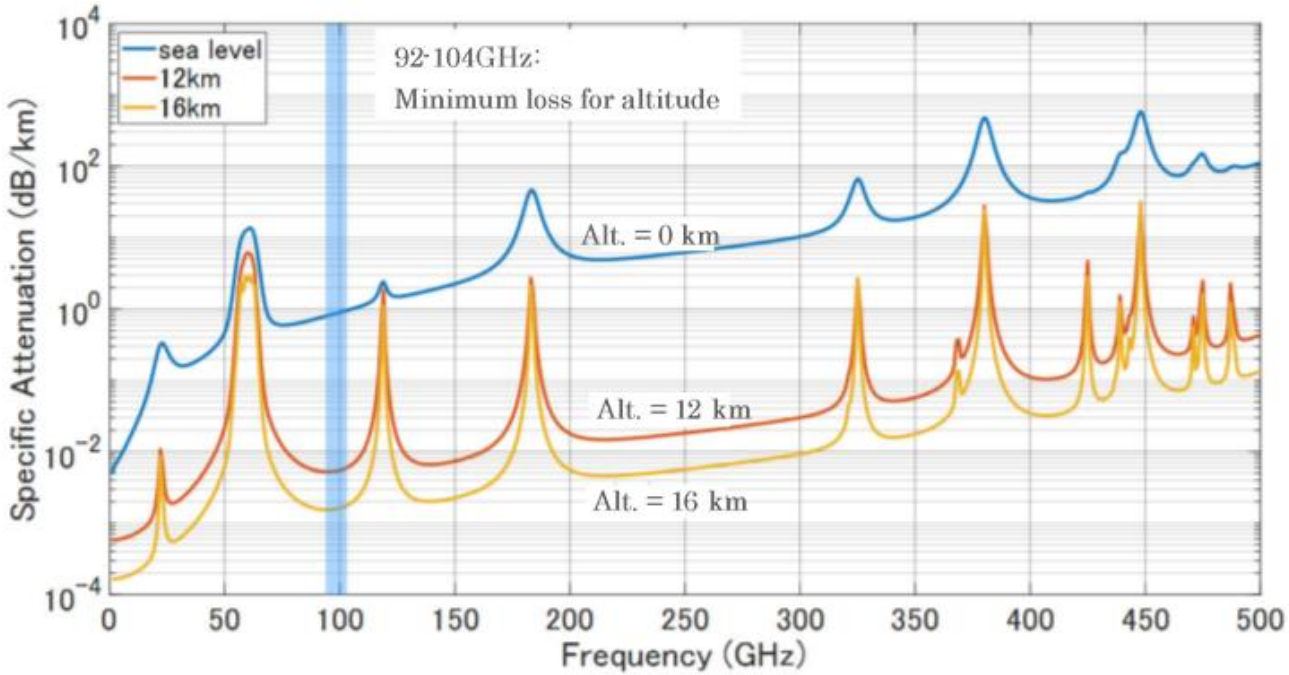
[2] M. Inomata et.al, "Path Loss Characteristics from 2 to 100 GHz Bands in Urban Microcell Environment for 6G", IEICE Technical Report, A・P2021-51 (2021-08)

[3] Y. Oda, "Technical study on radio wave propagation characteristics of Terahertz wave", Planning and Strategy Committee of the B5G Consortium, (in Japanese, Feb. 2021)

6.1.3.2 Radio Propagation related studies [2/2]



Comparison between path loss model derived by machine learning and measurement results



Propagation losses due to atmospheric gases and related effects [4][5]

[1] T. Hayashi, T. Nagao and S. Ito, "A study on the variety and size of input data for radio propagation prediction using a deep neural network," 202014th European Conference on Antennas and Propagation (EuCAP), 2020.

[2] T. Nagao and T. Hayashi, "Study on radio propagation prediction by machine learning using urban structure maps," 2020 14th European Conference on Antennas and Propagation (EuCAP), 2020.

[3] T. Nagao and T. Hayashi, "Geographical Clustering of Path Loss Modeling for Wireless Emulation in Various Environments," [Manuscript submitted for publication] 2022 15th European Conference on Antennas and Propagation (EuCAP), 2022.

[4] T. Kawanishi et.al, "THz communications for non-terrestrial-networks", [Manuscript submitted for publication] (in Japanese, Mar. 2022)

[5] Recommendation ITU-R P.676-12(2019), Attenuation by atmospheric gases and related effects.

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