6G Common Requirements

Infra Tech

6G-IOWN promotion department

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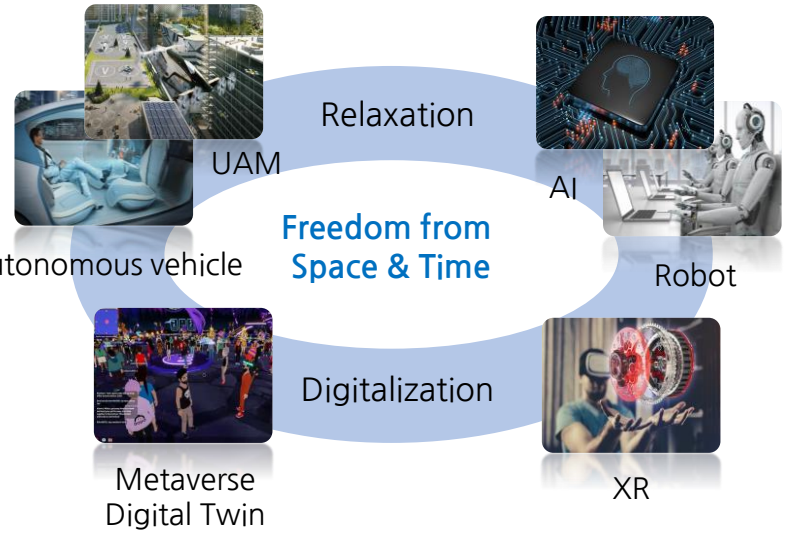
Requirements for Consideration

○ **Innovative services and devices are crucial factors for successful 6G**

- e.g., immersive media/XR, UAM, smart logistics, in-plant devices, 100% coverage



○ **Investigate different data rate requirements and usage scenarios for different frequency (e.g., FR1, 2, ⋯ 5)**

○ **Take balance between flexibility and complexity with supporting various deployment options**

- Flexible rollout plan cause various deployment options in 5G spec. but few options used in practice
- Careful investigations are needed to avoid complex and many (unnecessary) parameters/options in 6G

○ **Need coverage and device related requirements**

- 6G investment availability through coverage extension technology
- Enhancing battery consumption and heating of devices

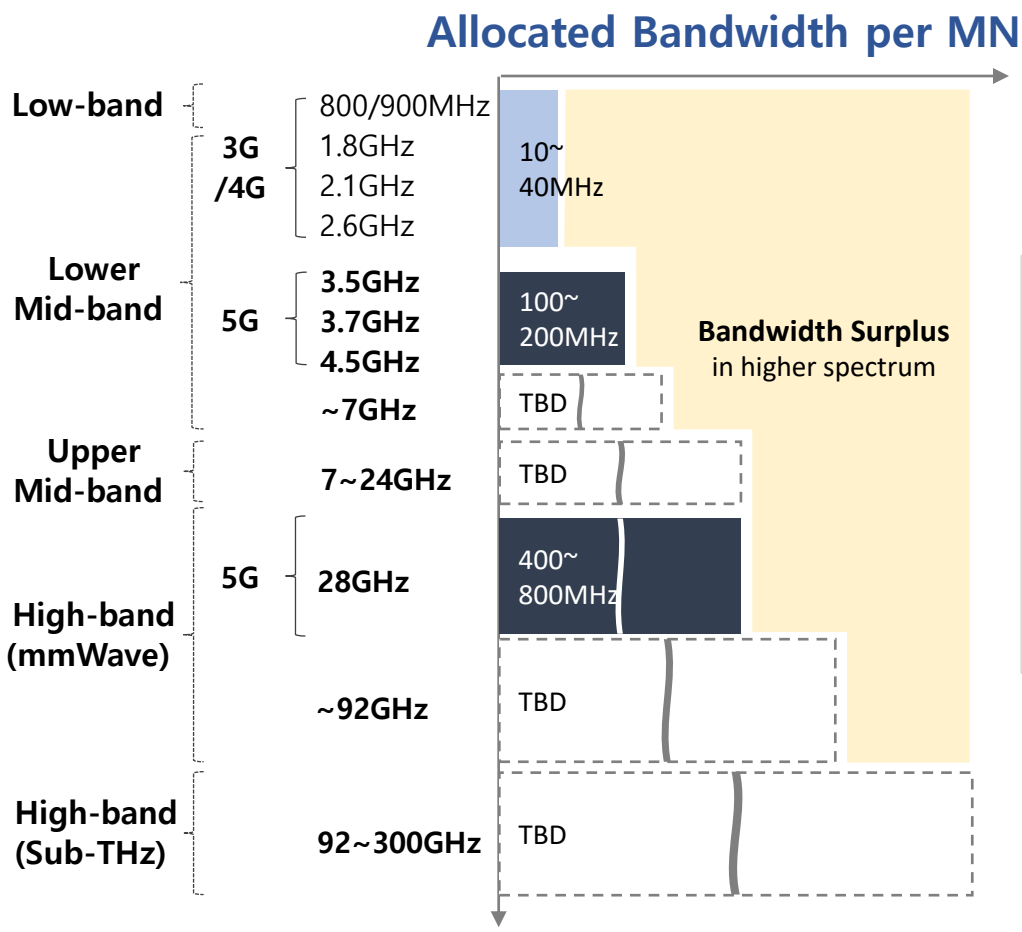
○ **Open RAN should be available by default**

- Operators and vendors must start considering future standardization of open RAN at an early timing

Peak Data Rate for Each Spectrum

Estimate reasonable target peak data rate considering the available frequency bandwidth for each spectrum

【 Spectrum vs. Bandwidth 】

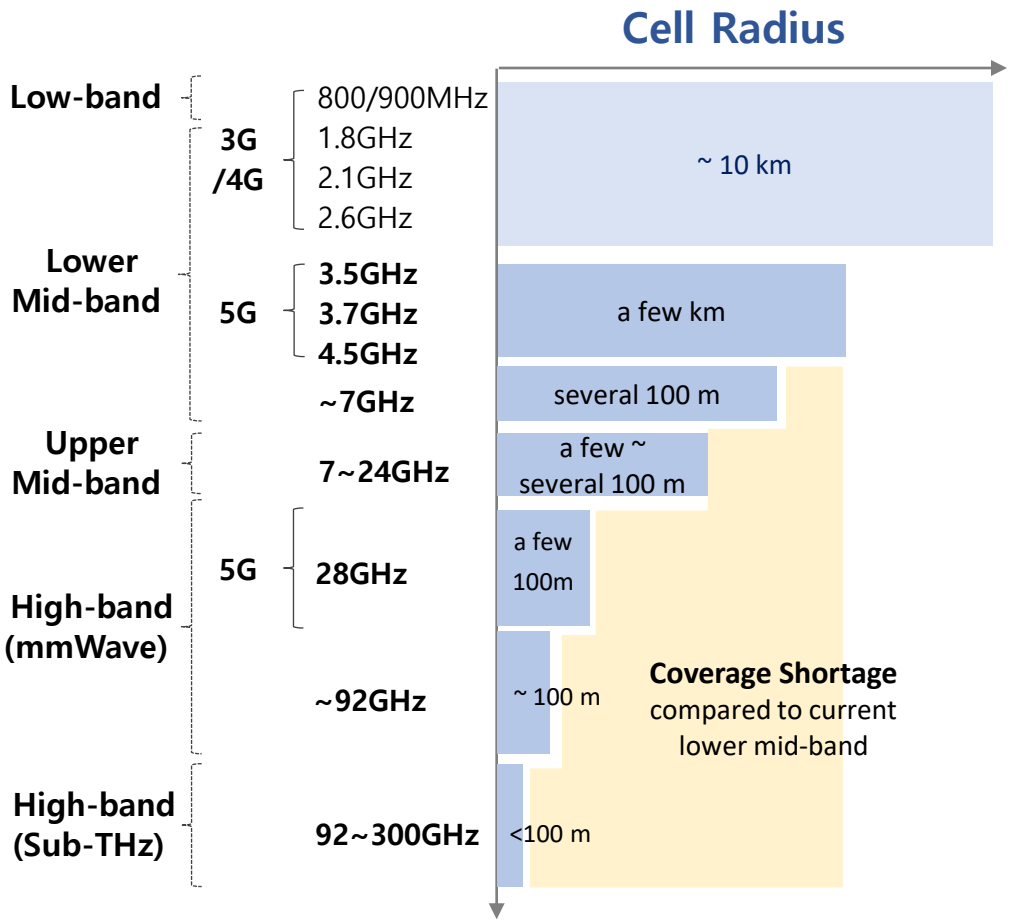


- ○ **Lower Mid-band** — Below 100Gbps
  - There might be several 100MHz bandwidth in new spectrum (above 3.5GHz)
  - Should consider “Spectrum Refarming”
- ○ **Upper Mid-band** — Below 100Gbps
  - There might be several 100MHz and more bandwidth
- ○ **mmWave** — Up to 100Gbps
  - There might be a few GHz and more bandwidth
- ○ **Sub-THz** — Up to 1Tbps
  - There might be several GHz and more bandwidth
  - Should develop the RF technology of Sub-THz

Deployment Scenario for Each Spectrum

Clarify the main deployment scenario for each spectrum considering characteristics of each spectrum

【 Spectrum vs. Coverage 】



○ **Lower Mid-band** — Common & Public IMT

- Can compromise coverage and capacity requirements

○ **Upper Mid-band** — Urban Extreme Capacity

- Can achieve capacity mainly in urban area

○ **mmWave** — Hotspot Capacity

- Can achieve high capacity in limited coverage area

○ **Sub-THz** — Sensing & Short range

- Can achieve highest capacity in very limited coverage area

Spectrum vs. Peak Data Rate / Deployment Scenario

Spectrum	Allocated Bandwidth per MNO	Peak Data Rate	Coverage / Deployment Scenario	Velocity / Technologies
Lower Mid-band (1GHz ~ 7GHz)	Several 100MHz → 400MHz	Below 100Gbps → 40Gbps (SE: 100bps/Hz)	Common & Public IMT	[For example] Velocity < 1000km/h, Full Duplex, Distributed / digital massive MIMO
Upper Mid-band (7GHz ~ 24GHz)	Several 100MHz and more → 800MHz	Below 100Gbps → 80Gbps (SE: 100bps/Hz)	Urban Extreme Capacity	Velocity < 500km/h, Full Duplex, Distributed massive MIMO
High-band [mmWave] (24GHz ~ 92GHz)	a few GHz and more → 1600MHz	Up to 100Gbps → 80Gbps (SE: 50bps/Hz)	Hotspot Capacity	Velocity < 300km/h, Distributed MIMO with hybrid BF
High-band [Sub-THz] (92GHz ~ 300GHz)	Several GHz and more → 10GHz (Max. 25GHz)	Up to 1Tbps → 200Gbps (SE: 20bps/Hz), Max. 1Tbps (SE: 40bps/Hz)	Sensing & Short range	Velocity < 40km/h, Analog BF, massive MIMO

6G Architecture and 6G Migration

6G architecture(s) and 6G migration should be simple

【 Lessons learned from 5G 】

○ **In 5G, several deployment options were introduced**

- Due to different rollout plans according to the needs of operators and coverage restrictions according to higher frequency compared to legacy 3G, 4G networks
- Very few options deployed in practice

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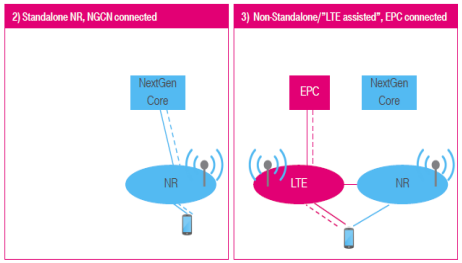

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○ **6G needs only minimum set of architecture and simple migration**

- Specifying highly probable architecture and migration
- 6G should reduce the number of deployment options/bearer types as less as possible

Coverage Extension and Device Problem

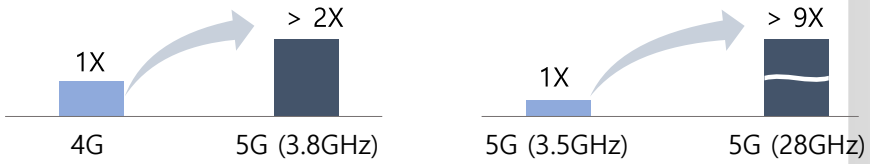
Under the current RF technology, high spectrum is a big challenge for coverage and user experience
Innovative radio technologies for RF components are essential

【 RF Technology immaturity 】

○ Shorter coverage resulted in more CAPEX/OPEX

- At least twice as many base stations to complete the nationwide coverage in 3.5GHz mid-band
- At 28GHz, it is difficult to estimate the number of base stations required (at least 9x than 3.5GHz)

[**# of cell site for nationwide coverage**, SKT estimation]

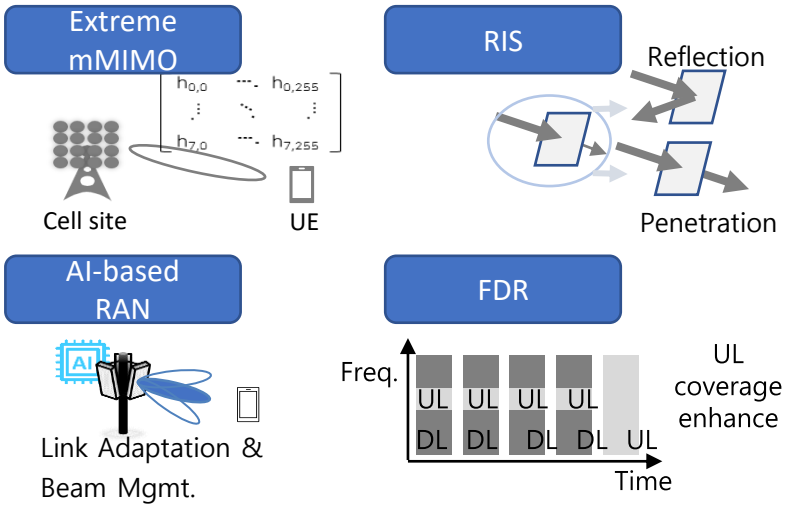


○ User experience problem in device

	Reference	After watching YouTube for 2 hours		
		3.5GHz (ⓐ)	28GHz (ⓑ)	Gap (ⓑ-ⓐ)
Heat*	30°C	36.9°C (+6.9°)	43.5°C (+13.5°)	+6.6° (x2)
Battery	100%	73% (△27%)	39% (△61%)	△34% (x2.2)

* Transitions to 4G when the device temperature rises over 43°C

○ Strong adoption of novel radio technology



○ RF components and device technology for high frequency bands

- Low power semiconductor & RFIC
- New material-based battery (e.g., All solid state)

Open RAN Architecture

Introduction of Open RAN architectures should be further facilitated

【 Lessons learned from 5G 】

○ **Introduction of open architecture in RAN is still limited**

- Open RAN is being actively promoted in Telco industry, but vendors are still having passive stances from the implementation perspective
- 3GPP focused on the high-layer split (CU - DU) only but does not define the standard interface for low-layer split (DU - RU), which is left for implementation, even when nearly all 5G deployments use separate DU and RU equipment.
- O-RAN ALLIANCE has defined the standard interface for low-layer split. However, its commercial implementation is achieved by a limited number of vendors so far.

○ **Open RAN should be available by default**

- In order to achieve benefits of open RAN, operators and vendors must cooperate now for deploying the open architecture and interfaces specified by the O-RAN ALLIANCE
- For 6G, in order to ensure that open RAN is available by default, operators and vendors must start considering future standardization of open RAN at an early timing

Cloud-native Architecture

Cloud-native should be refined in 5G Evolution and towards 6G

【 Lessons learned from 5G 】

○ **5GC is on the way towards cloud-native friendly**

- EPC can now be operated as virtualized network functions, and hardware and software can be procured/upgraded separately
- SBA was adopted in 5GC, and it uses cloud-native platform. It was expected that cloud-native platform for web service would be evolved for telecommunications for easy and flexible operation
- However, ETSI NFV and other activities have not yet specified a cloud-native platform for telecom

○ **6G network functions and platform should be designed cloud-native friendly**

- We assume that In the 6G era, ETSI NFV will have specified a cloud-native platform for telecom. And computing and network resources will be distributed in multiple different locations. Core/Edge will be deployed/connected/managed using the cloud-native platform
- 3GPP, ETSI NFV, etc. should collaborate with each other and they make and maintain the specification for cloud-native deployment
- We also expect NF vendors to provide 5GC/6GC Cloud-native Network Functions according to the specifications. (6GC should be based on eSBA)

Network Automation

Network automation should be extended in 5G Evolution and towards 6G

【 Lessons learned from 5G 】

○ **Partial network automation in life cycle management and wireless/network control is gradually being adopted**

- AI-based automation is being specified in 3GPP, ETSI ZSM, TM Forum, O-RAN ALLIANCE, etc.
- AI-Ops and ML-Ops are becoming a reality to automate part of the lifecycle from analysis results to prediction, countermeasures, and actions
- Network control can be determined automatically based on the results of analysis of the operating data

○ **The entire process will be automated with AI**

- It is expected that entire process will be automated eventually as the pile of partial network automation
- The entire automation prevent large-scale failures and enable early recovery
- In order to provide for user intent/SLAs, problems should be less likely to occur, and if they do occur, they should be able to be quickly recovered
- The network should be able to operate with less human-intervention
- It is necessary that the operator can explain why and what operation scenario was automatically done

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