Toward 5G Deployment in 2020 and Beyond

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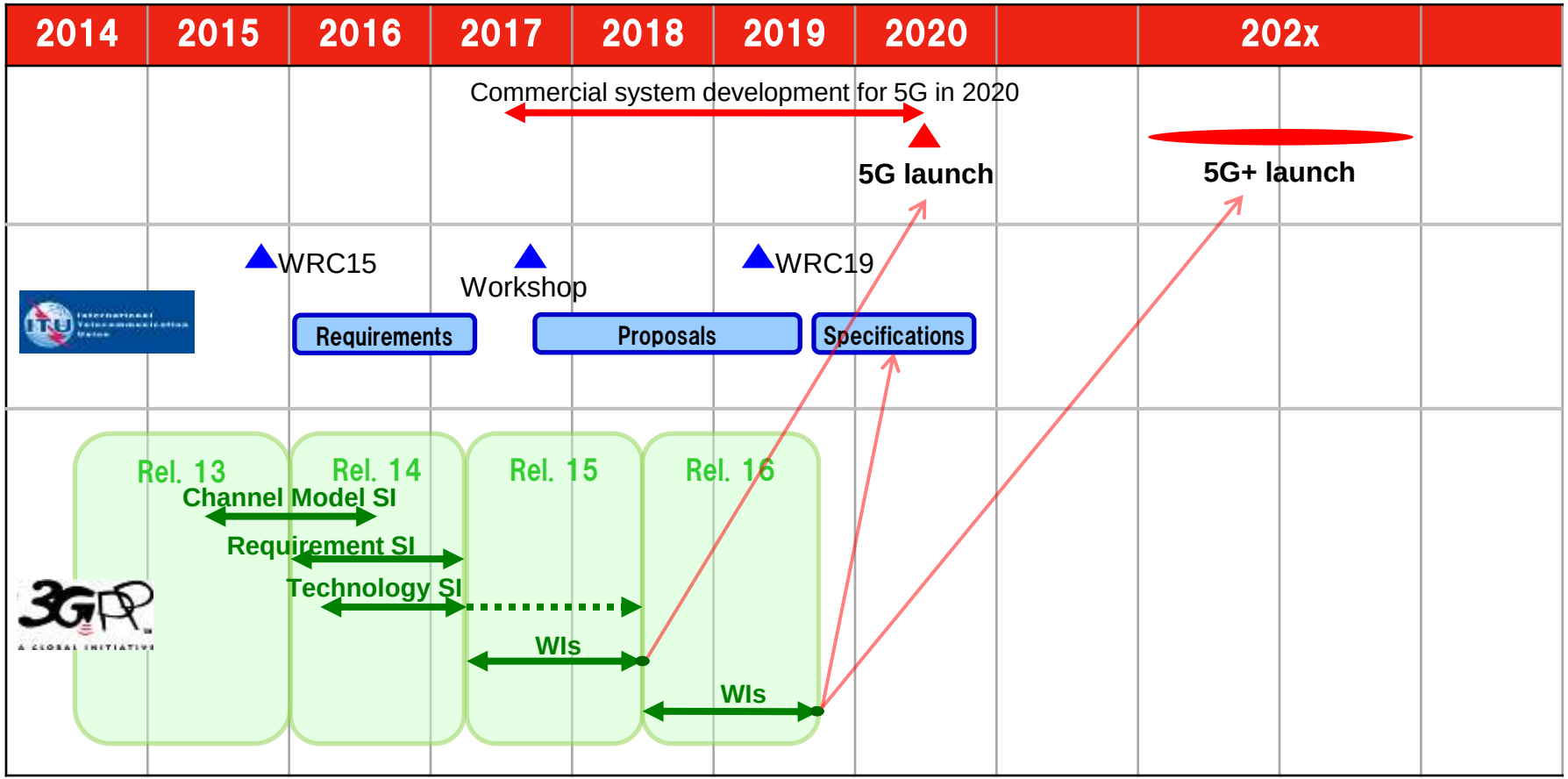
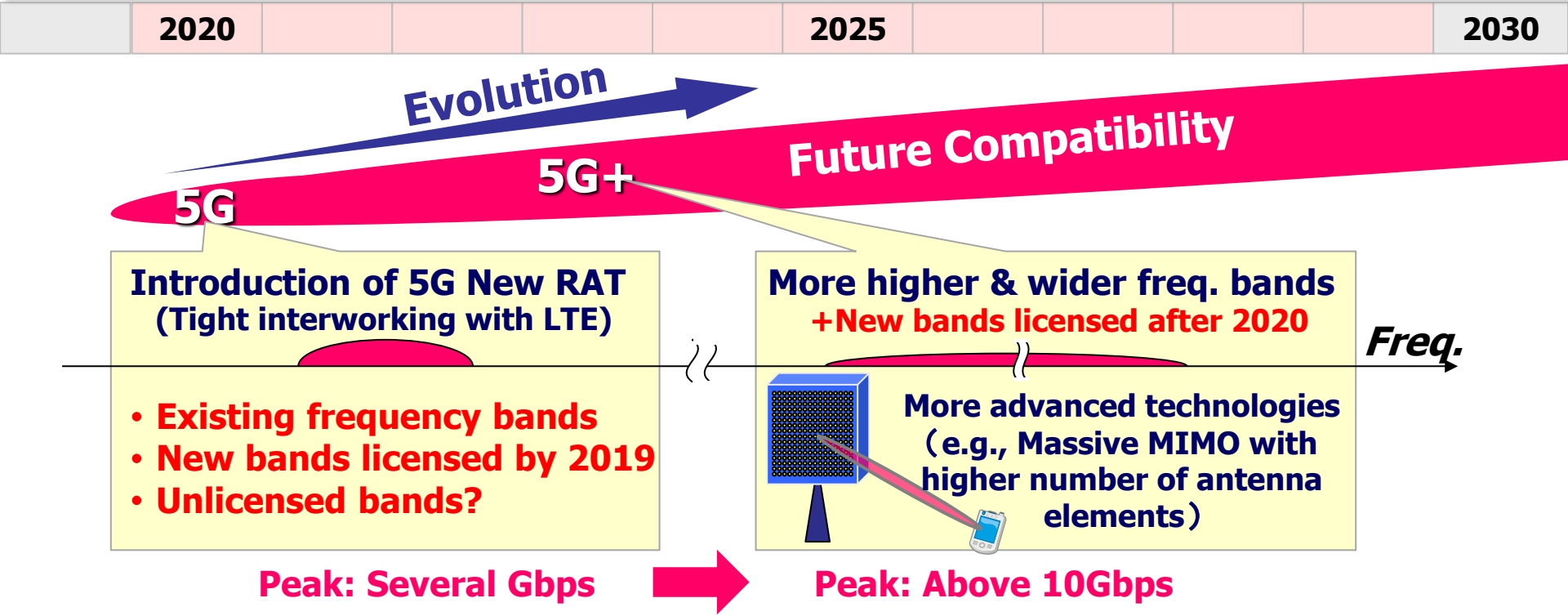
Time Plan for 5G and 5G+



5G Deployment Scenarios

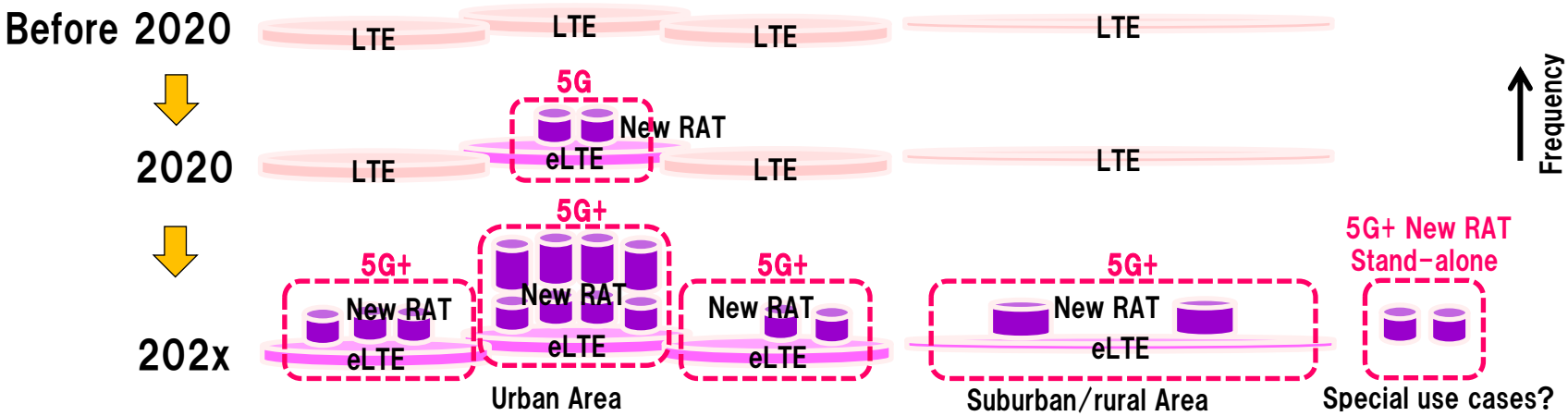
5G Phased Realization

5G will evolve by incorporating new freq. bands and technologies
➔ Future compatibility is key for system design to continue evolution



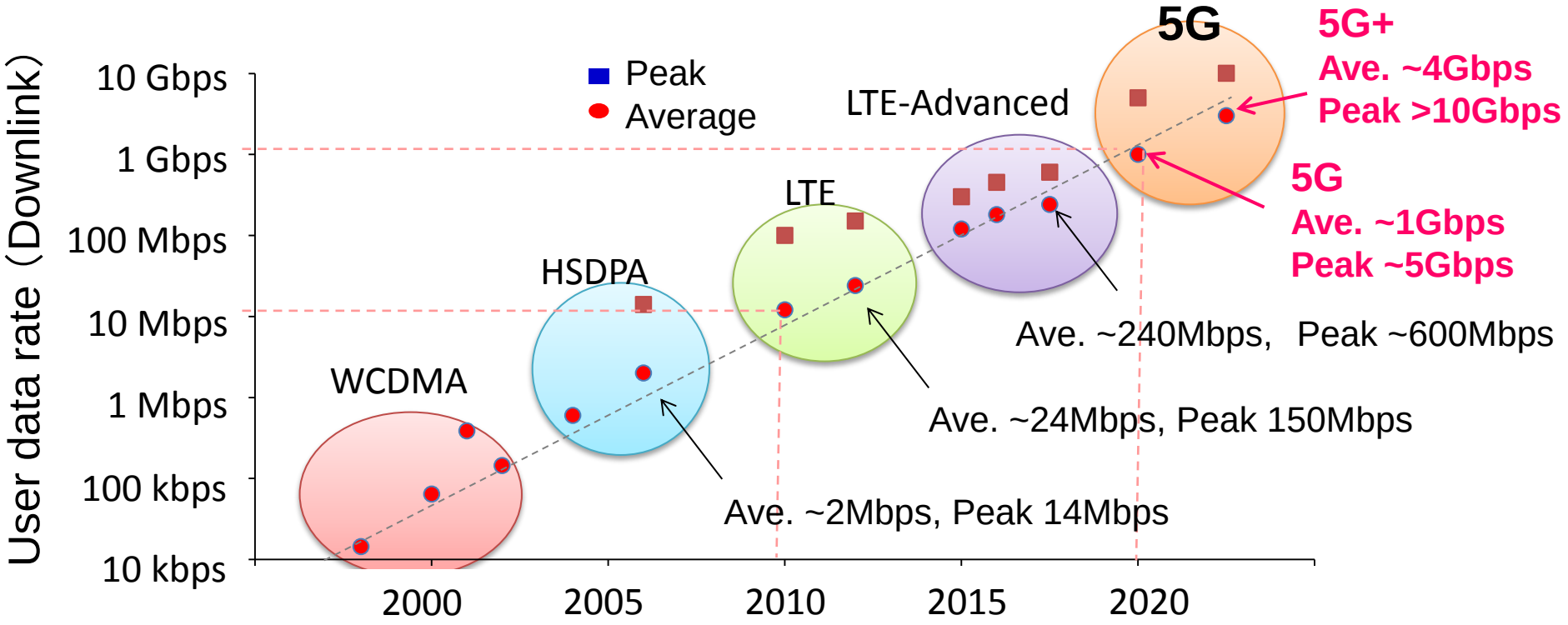
Deployment/Migration Scenarios

- In 2020, 5G will be launched initially from areas, where higher performance is required, e.g., dense urban area
  - Both new RAT (Phase I) and enhanced LTE (eLTE) RAT are introduced to realize tight interworking between lower and higher frequency bands
- In beyond 2020, deployment areas for 5G are gradually expanded while introducing additional technologies and frequency bands (= 5G+)
  - LTE (or LTE-Advanced) cell can be continuously used as eLTE cell for a long-time
    - Stand-alone new RAT might be deployed in the future



Data Rate Improvements Toward 2020 and Beyond

Continuous improvement of user experienced throughput toward 5G/5G+



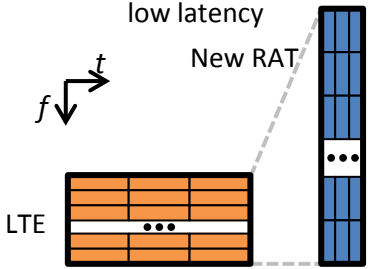
✓ Data rate increase will continue (approx. 100x per 10 years) (quasi-Moore law)

5G Key Technologies for 2020 Deployment

New RAT

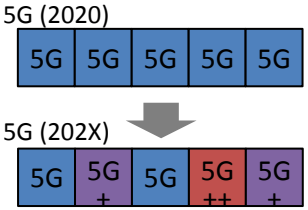
New numerology with shorter TTI

Wider bandwidth and low latency

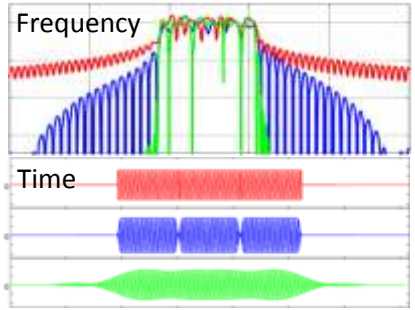


Lean radio frame

Less inter-cell interference, energy saving, good forward compatibility

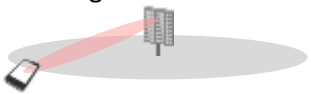


Well localized waveform

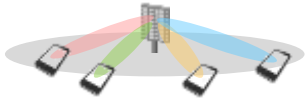


Massive MIMO/ beamforming

Cell range extension

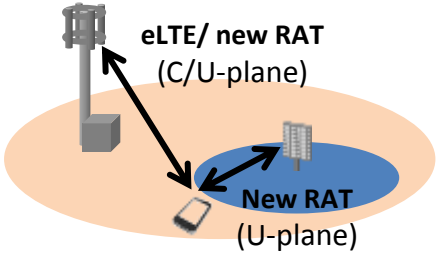


Improved spectral efficiency



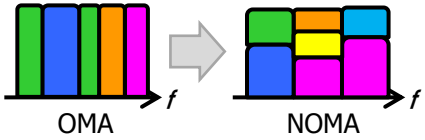
Tight LTE integration

C/U-plane split (dual connectivity, CA)



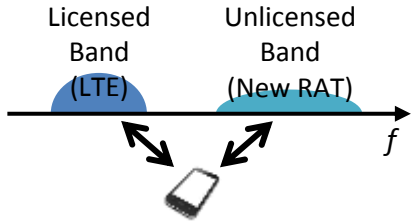
NOMA on LTE

Further cellular enhancement with massive connectivity



Intentional non-orthogonality

Flexible duplex with unlicensed spectrum (e.g. LTE-assisted access)



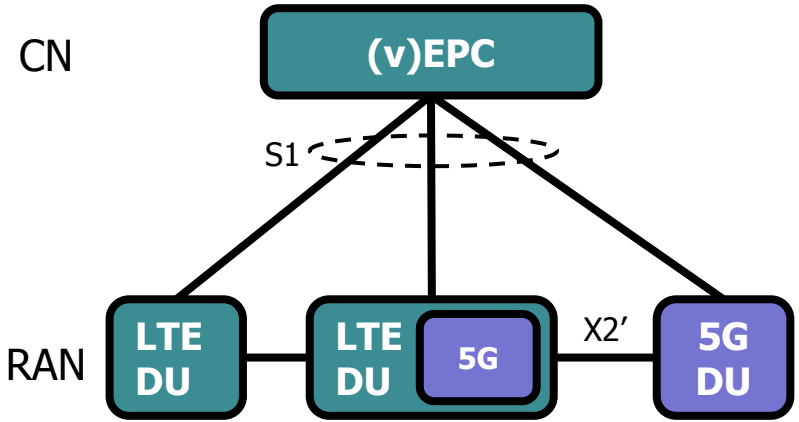
IoT related LTE enhancements

Low cost / Long battery life devices

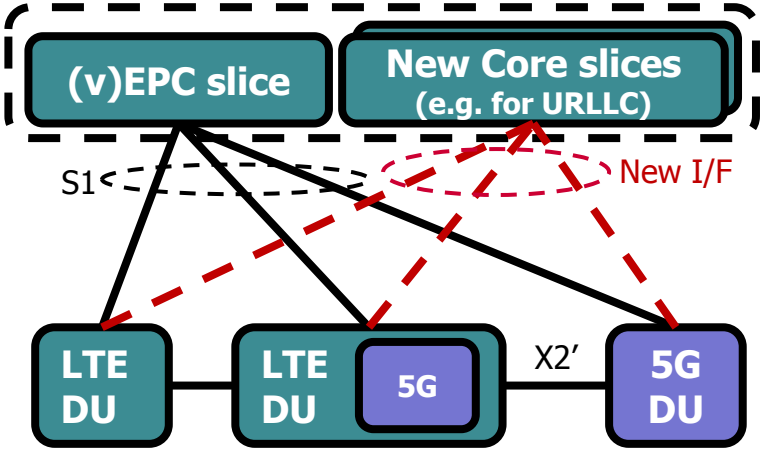
Core network for 5G

- EPC can host 5G RAN
  - EPC is well suited for eMBB and mMTC type traffic
  - Existing infrastructure can be used and also allows for early 5G introduction
- New Core can be defined if study proves it is beneficial
  - E.g. for support of new services like ultra-reliable and low-latency communications
  - But it should be supported in co-existence with (v)EPC in the form of NW slicing

➔ Should allow for independent evolution of RAN and CN



Initial phase (around 2020)



Later phase (around 202X?)

Lessons from WRC-15 and necessary actions

- It is becoming more difficult to achieve global/regional harmonization for frequency bands through the conventional ITU approach.
  - i.e., IMT identification in ITU first, which is followed by mobile market development in the world

- Alternative mechanisms such as bi-lateral/multi-lateral collaboration among regulators, in particular those who are mobile-friendly and/or those in major markets (e.g., KOR, US, JPN), are essential.
  - i.e., Mobile market development in major countries, which is followed by IMT identification in ITU and further market development in other countries.
  - ⇨ Mobile industry members should encourage those regulators to establish the collaboration towards early 5G development and implementation.

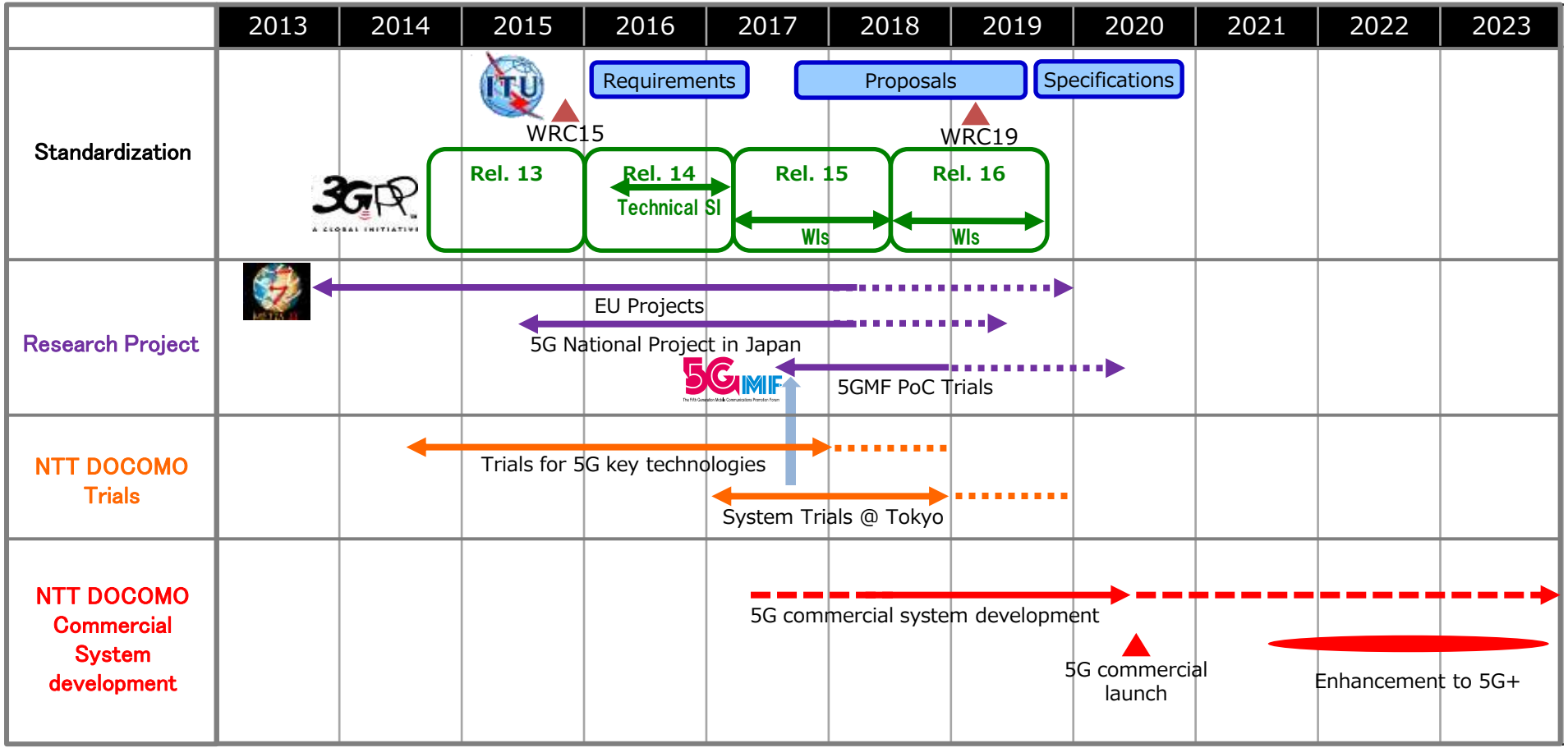
Study on 5G Frequency Band Candidates

	Frequency band	Bandwidth	For eMBB	Device availability	Spectrum availability				
					Europe	US	JPN	KOR	CHN
Below 6 GHz	3.4-3.8GHz	400MHz	😐	☺	☺	😐 3.4-3.7GHz only	😐 for 4G	☺	😐 3.3-3.6GHz only
	3.8-4.2GHz	400MHz	😐	☺	☹	☹	😐	?	☹
	4.4-4.99GHz	500MHz	😐	☺	☹	☹	☺	☹	😐 4.4-4.5, 4.8-4.99GHz only
	5.15-5.35GHz*	200MHz	😐	☺	😐 Indoor only	☺	😐 Indoor only	😐 Indoor only in 5.10-5.25GHz	😐 Indoor only
	5.47-5.85GHz*	380MHz	😐	☺	😐 Not available above 5.725GHz	☺	😐 Not available above 5.725GHz	☺	😐 Not available above 5.725GHz
Above 6 GHz									
	24.25-27.5GHz	3,250MHz	☺	?	☺?	☺? 24.25-24.45GHz, 25.05-25.25GHz	😐	☺ Unlicensed band >25GHz is used for V2V	☹ FSS
	27.5-29.5GHz	2,000MHz	☺	?	☹	☺ 27.5-28.35 GHz	😐	☺	☹

*Unlicensed frequency bands, which are mainly used for Wireless LAN now.

（敝社分析）

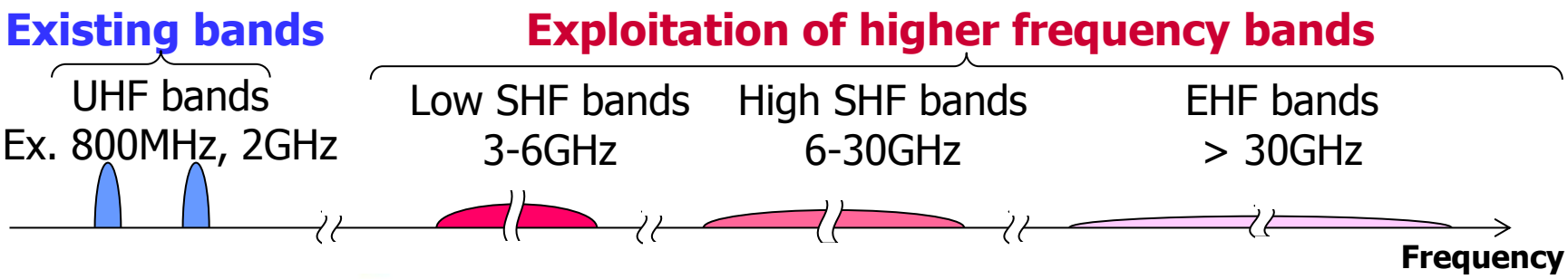
Time schedule for 5G deployment in 2020



5G Experiments

5G Experimental Trials【w/ 13 vendors】

5G experimental trials are being started since Q4 of 2014



HUAWEI FUJITSU NEC ERICSSON SAMSUNG MITSUBISHI ELECTRIC NOKIA Alcatel·Lucent

Key devices/Chip sets vendors

intel QUALCOMM MEDIATEK

System solution vendors

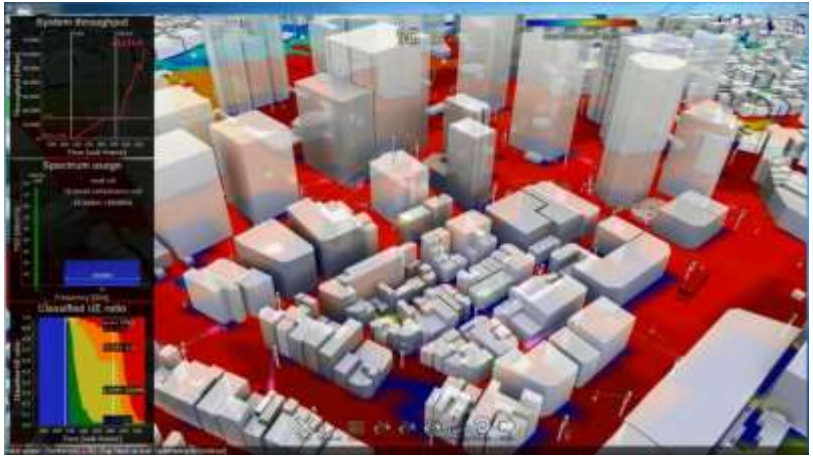
Panasonic

Measuring instruments vendors

KEYSIGHT TECHNOLOGIES ROHDE&SCHWARZ

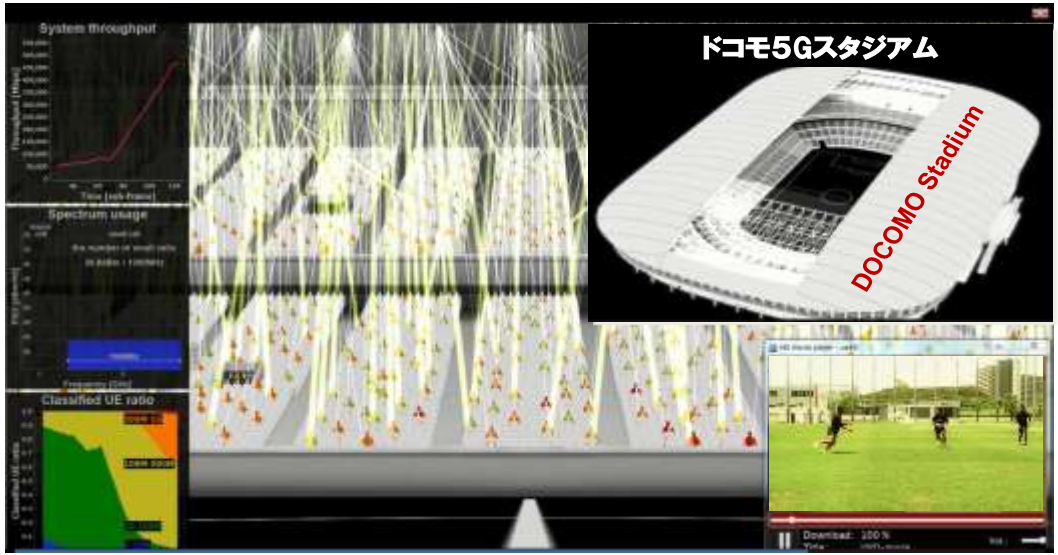
5G Real-Time Simulator

Real-Time Demonstration of 5G Performance and Its Enabling Technologies



◎Application of 5G at stadium as an example of a super dense deployment environment

- 5G can achieve several 100Mbps per user
- Simultaneous download and streaming of 4K high resolution movie by several users



＜DEMO＞

◎5G vs. 5G+:

Macro cell（3 sector/Macro cell, 20MHz@2GHz, 2×4MIMO）+Small cell（12 small cells/sector, 200MHz@5GHz, 128×4 Massive MIMO）

⇒ System throughput of 400x for 5G and beyond 1000x for 5G+

◎Real-time transmission and streaming of 4K high resolution movie

5G Real-Time Simulator