



NGMN 5G Spectrum White Paper

by NGMN Alliance

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1 BACKGROUND

Since the publication of the original NGMN 5G¹ white paper in February 2015 the international 5G spectrum debate has advanced considerably, including the decisions taken at the WRC-15 on the bands for IMT that will be decided at the WRC-19 conference as well as global progress on 5G system developments and trials.

This white paper builds on the spectrum discussion in the original NGMN 5G White paper published in 2015 and sets out updated information on spectrum requirements and plans in relation to realization of 5G in key markets around the world.

2 INTRODUCTION

The detailed spectrum requirements for 5G may vary between countries and regions, for example based on timing of deployments, the availability of new spectrum bands and the ability to re-use spectrum already harmonized for previous generation mobile systems.

NGMN supports the principle of technology neutrality when authorizing spectrum use and the need for individual operators to have the necessary flexibility to re-farm their existing spectrum holdings to support 5G capabilities, for a smooth evolution from existing radio interfaces/technologies to new technologies. In fact, the envisaged 3GPP new 5G radio access technology specifications will support co-existence with the legacy IMT radio interfaces and flexible spectrum management for legacy IMT. Additionally, the new specifications will allow the new 5G radio system to use any spectrum band ranging at least up to 100 GHz to include new technologies. This enables 5G systems to utilize various operational bandwidths in different deployment scenarios.

The availability of new spectrum bands can be important to facilitate initial 5G deployments and a number of bands have emerged as the key bands for this purpose.

The bands to be considered at WRC-19 under its Agenda Item 1.13 are all above 24GHz and are generally seen to mainly fulfil the requirement of a very high speed short-range capability. Within the eleven bands identified for study, the NGMN operators have begun to evaluate priorities, and these initial preferences are described in this paper. In addition, noting that other frequency bands (e.g., the 28 GHz and certain bands in the frequency range 6-24 GHz) are also being studied or identified in some countries for potential 5G use even if not included in the WRC-19 process, NGMN supports the principle that consideration of such bands should not be precluded.

¹ The term 5G is elaborated in the NGMN 5G White Paper and the stated vision is that 5G is an end-to-end ecosystem to enable a fully mobile and connected society. It empowers value creation towards customers and partners, through existing and emerging use cases, delivered with consistent experience, and enabled by sustainable business models.

3 5G SPECTRUM

NGMN continues to place priority on the availability of exclusively licensed spectrum, made available on a technology-neutral basis, for delivery of 5G capabilities with assured quality and performance.

Licence-exempt spectrum is anticipated to play a complementary role and will support technologies that contribute to the delivery of 5G capabilities.

More spectrum is needed. For delivery of important new capabilities, such as the very highest peak and average data rates within a given area, 5G typically requires access to larger bandwidth channels than those of earlier generation technologies (carrier bandwidths of several 100MHz compared to 5MHz in 3G and 20MHz in 4G), which may only be available in new bands above 6GHz.

Also, in the very near term some other bands below 6GHz (e.g., the 600/700 MHz and C bands) may be considered for 5G to access wider bandwidths than are available today, potentially up to about 100 MHz, either on a standalone basis or with carrier aggregation. The total amount of downlink spectrum below 6 GHz designated as 3GPP IMT spectrum bands in Release 12 is 1285 MHz (overlapping band designations not double counted). However in any single market or jurisdiction, only a fraction of that might be currently made available for IMT.

Table 1 shows the sum of downlink spectrum allocations in 3GPP Release 12 by frequency range, and Figure 1 shows the bands ranked from largest to smallest allocation. Hence there will be limited opportunities to deploy bandwidth-intensive 5G applications (100 MHz or more) below 6 GHz, with Bands 41 (2.5 GHz), 42 (3.4 GHz) and 43 (3.6 GHz) being the only bands with more than 100 MHz downlink bandwidth capability.

Downlink frequency range (GHz)	Sum of 3GPP spectrum designations (MHz, DL)
0 – 1	205
1 – 2	286
2 – 3	394
3 – 6	400
TOTAL 0 – 6 GHz	1285

Table 1 – 3GPP IMT spectrum designations by frequency range

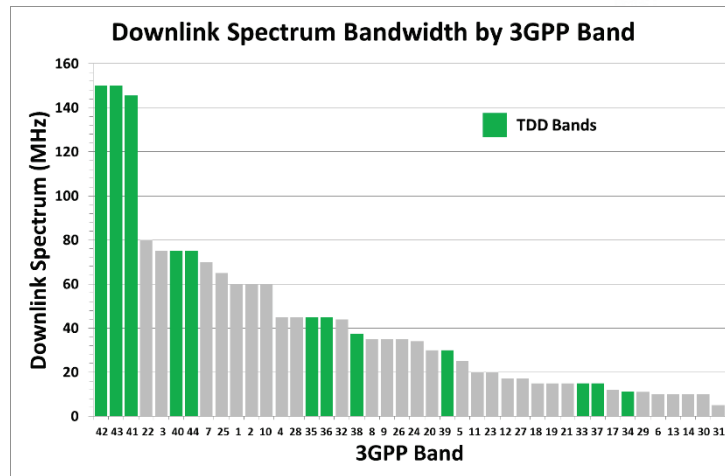


Figure 1 – 3GPP Rel 12 Band allocations below 6 GHz ranked by downlink bandwidth (TDD bands assumed to be 3:1 DL:UL)

There is a gap in spectrum availability between 6-24GHz that is not currently addressed in the ITU WRC-19 process and this needs to be addressed given the relative lack of large bandwidth allocations below 6 GHz. Considering the fact that it would be difficult to discuss these bands during the WRC-19, the entire industry should explore alternative options to create regional/multi-regional harmonization across bands. Possible example of such ranges could include 5.925-8.5 GHz and 10-10.6 GHz in Europe or 7.075 - 10.5 GHz and 15.35 - 17.3GHz in Africa, as they present a strong potential for 5G.

4 PRIORITY SPECTRUM BANDS

4.1 Initial deployments

The main interest among existing sub-6GHz global mobile bands for the first 5G deployments is for the global IMT bands at:

- Around 700MHz (for low-bandwidth, wide area applications)
- Around 2.5GHz² and 3.5GHz (for higher bandwidth, coverage and capacity)

These bands are currently designated in many markets for IMT use, hence present a practical and accessible opportunity for initial 5G deployments. In some cases 4G technologies has been, or might be, deployed in these bands with a plan to migrate partially or fully to 5G over time. The early availability of these bands will contribute to satisfying urgent requirements to deliver mobile network coverage and capacity and need not be linked to particular standardisation timetables. Thus, a regulatory embrace of technology neutrality is key to let the natural evolution from 4G to 5G.

A number of operators have indicated their intention of the first 5G deployments in the 28GHz band, including in the USA, where in 2016 the FCC has confirmed its use for 5G, and in the Republic of Korea where the 5G

² In some markets, depending on suitable operator assignments.



trial is planned in Feb. 2018 and where the government has also announced allocating 5G frequencies for commercial 5G service including 28 GHz band by 2018.

4.2 Further deployments

Based on changes in customer demand, including new applications and services, NGMN anticipates operators will also choose to re-farm existing mobile bands to transition to 5G technologies and will move to take advantage of new allocations in order to satisfy channel bandwidth requirements.

The WRC-19 bands are under evaluation by operators and other industry players together with national administrations. NGMN considers it important to carefully evaluate all options and has not ruled out any options at this stage. However it is important to develop and express views on the priorities as seen by operators and to begin to build consensus as early as possible on these preferences, with the intention to prepare for implementation as soon as decisions have been taken by the ITU Member States within the ITU process.

4.3 Consideration of the bands under study for WRC-19

The ITU-R WRC-19 will, under its Agenda Item 1.13, consider results of studies of the bands detailed in the Resolution 238 (WRC-15), namely:

- 24.25-27.5 GHz,
- 31.8-33.4 GHz,
- 37-40.5 GHz,
- 40.5-42.5 GHz,
- 42.5-43.5 GHz,
- 45.5-47 GHz,
- 47-47.2 GHz
- 47.2-50.2 GHz,
- 50.4-52.6 GHz,
- 66-76 GHz,
- 81-86 GHz

In general, the NGMN highlights the preference for the lower frequency bands (e.g. below 43.5 GHz), based largely on more favourable radio propagation characteristics in these bands. However, NGMN acknowledges that other factors also need to be considered, including available bandwidth, conflict with backhaul use, possibility to use bands for both backhaul and 5G service links, and the feasibility to share with other services to which the band may be currently allocated (possibly used now in to the future). That said, the initial priority of NGMN members is to focus on the lower rather than the higher bands under study for WRC-19.



Noting the proximity to the 28GHz bands that some countries in Asia and North America have already decided to use for 5G trials and/or deployments, the 24.25 – 27.5GHz is of high priority, and equipment developed for 28GHz might offer a tuning range spanning both bands. The bands 31.8 – 33.4GHz and the range 37 - 43.5GHz are also of interest. The 37-40GHz and 40.5-43.5GHz portions of the 37-43.5GHz tuning range are considered in various parts of the world.

Notwithstanding these initial preferences for lower frequencies, and recognising that the decision at ITU level will not be taken until 2019, at this stage NGMN supports consideration of all of the Agenda Item 1.13 bands.

5 REQUIRED NEXT STEPS ON SPECTRUM FOR 5G

The release of new spectrum bands at high and low frequencies is needed to enable early 5G deployments. Some 3GPP band designations below 6 GHz may be suitable for re-farming for 5G in the future, but others will not be sufficient for providing the peak throughput high bit-rate requirements and capabilities for 5G. The priority sub-6GHz bands which are available today include global IMT bands at 700MHz and 3.5GHz, which should be available on a technology neutral basis as “5G ready” but leaving maximum flexibility for operators to decide on the optimal technology to be deployed over time. It should be further noted that other mobile bands already in use may provide additional early opportunities, such as 2.6GHz in some markets.

Existing spectrum licensed for mobile networks should be available for use on a technology neutral basis to deliver 5G capabilities within the timescales that operators may require.

Early decisions on spectrum bands above 24GHz to support higher bit-rate shorter range capabilities are needed. As explained above, all of the WRC-19 Agenda Item 1.13 bands should be carefully considered. However, the bands below 43.5GHz are of greatest interest, in particular around 26GHz (24.25-27.5GHz), 32GHz (31.8-33.4GHz) and 40GHz (37-43.5GHz). Studies of these bands are a priority from the perspective of NGMN.

6 GLOSSARY

IMT	International Mobile Telecommunications (as defined by the ITU)
ITU	International Telecommunications Union (www.itu.ch)
3GPP	Third Generation partnership project (3gpp.org)
WRC-19	ITU World Radiocommunication Conference to be held in 2019.