



The WRC series

3 GHz in the 5G era

Preparing for New Services in 3.3-4.2 GHz

October 2019

Introduction

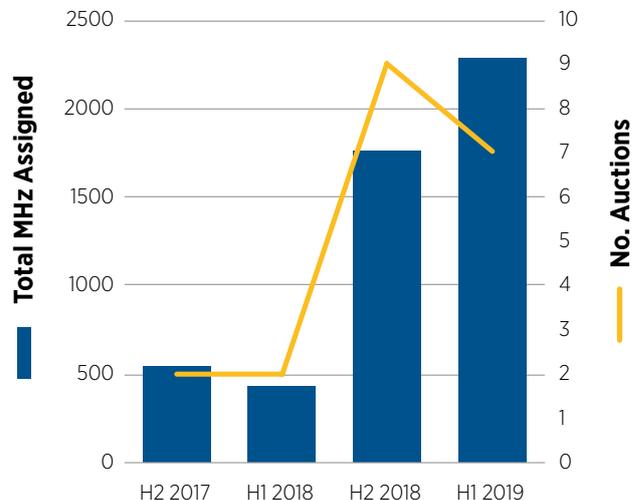
Frequencies in the range 3.3-4.2 GHz are being used as the basis for the first implementations of 5G all over the world. This spectrum is at a balancing point between coverage and capacity that has provided the perfect environment for much of the earliest 5G connectivity.

The planning of these frequencies has taken place over multiple WRC cycles and work on harmonisation continues today, but over the last two years there has been significant growth in the number of auctions assigning 3 GHz spectrum around the world.

5G networks are also reaching into mmWave for much higher capacity and use lower frequencies to provide greater coverage, but the equilibrium provided by 3.3-4.2 GHz has seen these frequencies become the global birthplace of 5G.

FIGURE 1

3 GHz auctions 2017-2019



3.3-4.2 GHz at the ITU

ITU mechanisms to harmonise spectrum in the 3.3-4.2 GHz range globally have been the subject of a long-standing project which is likely to continue to 2023. This range was discussed in WRC-07 where some regional harmonisation was achieved. At WRC-15 the band was again discussed and while some near-global harmonisation was realised in the band 3.4-3.6 GHz, only this 200 MHz piece was widely identified for IMT. Attempts to widen the part of the band which was harmonised at the ITU were unsuccessful ahead of the launch of 5G.

However, some regional activity has spurred harmonisation outside of the WRC process. Arab countries have moved to make the band 3.3-3.8 GHz available for IMT immediately and seek further

harmonisation at the ITU at a later stage. This echoes pan-European activity through CEPT to make sufficient spectrum available for the first phase of 5G at launch in the 3.4-3.8 GHz range.

5G services using parts of the 3 GHz range, being deployed in many parts of the world, are often also the subject of agreements at the ITU. Footnotes for 3.3-3.4 GHz and 3.6-3.7 GHz were also agreed at WRC-15. However, the identification to IMT is not harmonised globally beyond the first 200 MHz segment and some recent regional decisions to introduce IMT in parts of the 3 GHz range are not yet reflected in the Radio Regulations. There is a need to address this situation in order to ensure that what is agreed at the ITU keeps up with the reality: WRC-23 is an opportunity to do this.

ITU timeline

WRC-07	WRC-12	WRC-15	WRC-19	WRC-23?
80 countries sign into footnotes for 3.4-3.6 GHz	New Agenda Item agreed to discuss 3.4-4.2 GHz, inter alia	3.4-3.6 GHz harmonised; some additional identifications at 3.3-3.4 and 3.6-3.7 GHz	New Agenda Item possible for WRC-23	New proposals to look again at 3.3-4.2 GHz

Outside ITU

2011	2017	June 2017	July 2018	December 2018	December 2018	April 2019
Conditions of 3.4-3.8 GHz finalised in EU for 4G	First auctions of 3.4-3.8 GHz in Europe following agreement of use by 5G	CITEL approves 3.3-3.7 GHz bandplan for TDD	US announces flexible use of mid-band spectrum at 3.7-4.2 GHz	Arab countries announce use of 3.3-3.8 GHz	China assigns use of 3.4-3.6 GHz	Japan assigns spectrum between 3.6-4.2 GHz

Synchronisation



Member States should aim at ensuring a defragmentation of the 3 400-3 800 MHz frequency band so as to provide opportunities to access large portions of contiguous spectrum in line with the goal of gigabit connectivity.

Article 54 of the European Electronic Communications Code



Separation distances between non-synchronised networks are expected to be of approximately 60km for co-channel use (i.e cross border) and approximately 14 to 16km for adjacent channel use. Synchronisation of TDD networks is the best way to avoid interference and efficient spectrum usage can be maximised through

synchronisation procedures. Additional guard bands are not required and therefore network equipment cost can be reduced. Synchronisation between operators in the same country and region will help avoid interference while cross border interference is more likely if networks are not synchronised.

FIGURE 3

Maximising 3 GHz availability through synchronisation

Unsynchronised scenario



Synchronised scenario



Coexistence

Coexistence between IMT and fixed satellite services (FSS) at 3 GHz was the subject of a 2019 Transfinite study for the GSMA. It considered adjacent band compatibility between IMT and FSS earth stations in the 3.4-3.8 GHz band. The study considered a number of different IMT deployments (macro and small cell), IMT emissions masks (based on 3GPP limits), FSS links (with different elevation angles) and FSS earth station receiver masks.

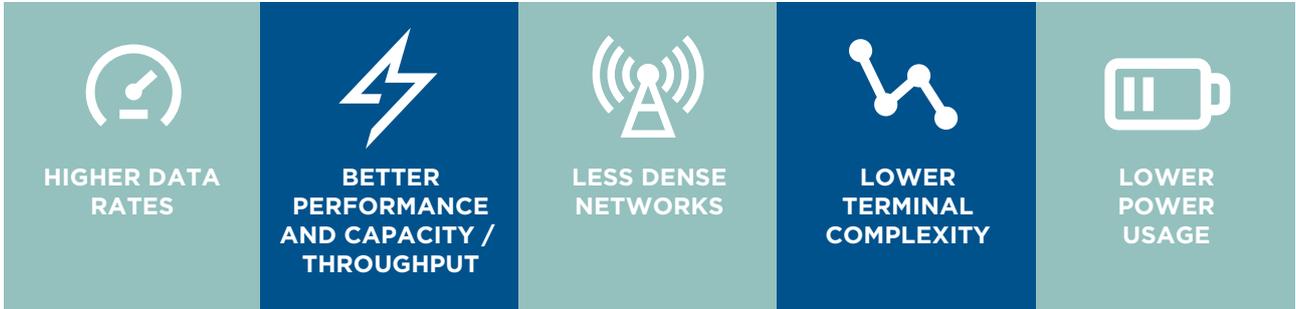
The results of the study indicate that, for IMT macro deployment and all combinations of spectrum masks and FSS links considered in the study, a guard band of 18 MHz would allow an FSS protection criterion of I/N = -10 dB to be satisfied. For IMT small cell deployment, a guard band of 0 MHz would allow this.

The study highlights that the performance of FSS earth station receivers will be very important in determining their resilience to interference from other services in adjacent bands. In event of interference to an FSS earth station, increasing the guard band will in many cases have little impact and will not be the best way of resolving any interference cases, with other mitigation measures such as site shielding or improved FSS receiver filtering being more effective.

The full report can be found here:

https://tslstorage.blob.core.windows.net/papers/Report_for_GSMA_on_3.4-3.8_GHz_Compatibility.pdf

Channel bandwidth and network performance



The use of band 3.3-4.2 GHz for mobile broadband has been the subject of harmonisation activity at various points in the past fifteen years both at the International Telecommunication Union (ITU) and within regional groups. Europe's process for making the band 3.4-3.8 GHz available has been long standing and while practical implementation issues remain, the band has been clearly harmonised for 5G within Europe / CEPT. Meanwhile, ASMG announced plans in December 2018 to move ahead of the ITU process with the harmonisation of the range 3.3-3.8 GHz for IMT.

However, global harmonisation within the band 3.3-4.2 GHz is limited with only a small portion of 200 MHz at 3.4-3.6 GHz having near-global harmonisation.

For the 3.3-4.2 GHz frequencies, channels of 80-100 MHz are required for each operator to maximise the efficiency and affordability in the first phase of roll out. More capacity will be required as demand increases. The earliest adopting markets from North America and Europe, through the Persian Gulf to East Asia, have made strong capacity plans in this range.

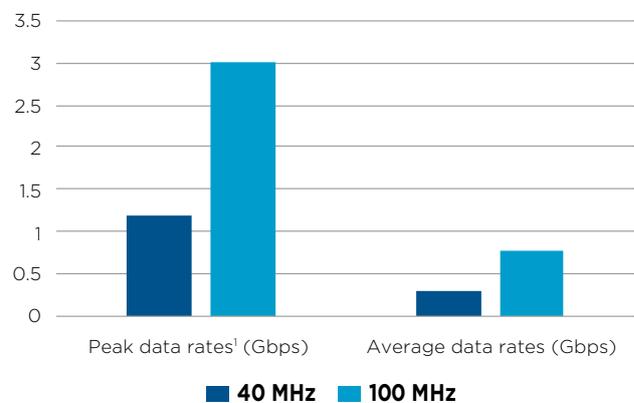
Work at the ITU has provided significant volumes of technical data regarding the performance of mobile networks and their interaction with other services.

Data rates and network density are enhanced with 80-100 MHz channels while simpler terminals rely less on spectrum efficiency techniques such as MIMO.

Data rates

Many 5G applications have significant data rate requirements. Video and virtual reality applications, enabled by enhanced mobile broadband (eMBB), will require the rate experienced to be above 100 Mbps.

The channel bandwidth available in 5G NR will affect data rates across the scale: peak, average and in the lower percentiles. Using IMT-2020 spectral efficiency targets we can get an assessment of the performance using different channel bandwidths. The table below uses these targets to show the achievable gross data rates with 40 MHz and 100 MHz contiguous blocks.



1. Cell peak data rate requires 8 MIMO streams

Network density

The importance of sufficient channel bandwidth is also shown in the impact this can have on network density. This is an important factor in determining the cost of 5G services to consumers - wider channels means fewer base stations and lower costs - but also has other advantages including less base station sites.

The number of sites is roughly inversely proportional to channel bandwidth. Decreasing channel bandwidth from 100 MHz to 60 MHz in the 3 GHz range will require increasing the number of cell sites by 64%.

CHANNEL SIZE IMPACT

100 MHz → 60 MHz =
64% INCREASE IN
NUMBER OF
CELL SITES





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