

Analysis of the World-Wide Licensing and Usage of IMT Spectrum

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Contact person:

Mr. Richard Womersley
Director, Spectrum Services
Tel: +44 (0) 20 3740 6470
Email: RVWomersley@LStelcom.com

LS telcom

LS telcom UK Ltd
18 King William Street
London EC4N 7BP
United Kingdom

Tel: +44 (0) 20 3740 6470
Fax: +49 (0) 7227 9535 605
Email: info@LStelcom.com
Internet: www.LStelcom.com

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Executive Summary

In 2014, prior to the last International Telecommunications Union (ITU) World Radiocommunications Conference (WRC), LS telcom undertook an analysis of the status of licensing of International Mobile Telecommunications (IMT) spectrum which is that used for commercial mobile services, and the extent to which licensed spectrum had been put into use by operators. At the time, the analysis found that only around a half to two thirds of the spectrum that had already been identified for mobile services had actually been licensed, and that of this, around a quarter had not yet been put into commercial use.

As we approach the next WRC in 2019, mobile operators continue to face growing demand for data services, and are seeking access to additional IMT spectrum. This paper updates our previous analysis and examines what progress has been made, and how much spectrum has still yet to be licensed or used.

The findings from our updated analysis paint a very similar picture to that which we found five years ago. Specifically:

- Good progress has been made in many regions in licensing the already available spectrum for IMT services, with around an additional **33% more being licensed** compared to 2014.
- Typically only **half** of the spectrum harmonised for use in a particular region **has been licensed** to mobile operators, though this varies significantly from region to region.
- There is upwards of **300 MHz** (and in some countries as much as 700 MHz) of spectrum that is **yet to be licensed** for mobile services, from within bands that are already identified and harmonised.
- Progress towards licensing the 700, 2300 and 2600 MHz is relatively slow and licensing of the 1400 and 3300 MHz bands which were identified at the previous WRC in 2015 has hardly begun. Together these bands comprise up to 570 MHz of mobile spectrum.
- Compared to the ITU's estimations of IMT spectrum demand in 2020, **the amount of spectrum licensed is roughly a third of that forecast.**

It remains clear that operators need to continue working together with regulators to ensure that spectrum that has already been identified for IMT services is licensed and to put in-use. Similarly, regulators need to continue working to ensure that the spectrum already identified for IMT is available for licensing by mobile operators.

1 Introduction

In 2014, LS telcom undertook a survey and analysis of the amount of spectrum that a range of national regulatory and administrations around the world had licensed for IMT services. This was against a backdrop of an agenda item at the 2015 WRC which was seeking to:

“consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT).”

At the forthcoming 2019 WRC the question of spectrum for IMT services is once again on the agenda, and regulators are now striving to agree on which spectrum bands should be identified, from a number being studied ranging in frequency from 24.25 GHz to 86 GHz. Agenda Item 1.13 of the 2019 conference is directed to:

“consider identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC 15).”

It therefore once again seems prudent to examine the extent to which that spectrum already identified for IMT has been licensed to see what progress has been made.

2 Spectrum availability

2.1 Introduction

This section considers how much spectrum has been identified for terrestrial mobile networks, and how much of this spectrum is easily available for licensing in each ITU region due to having been harmonised internationally.

2.2 ITU identification

The ITU, through the WRC process, identifies spectrum “for use by administrations wishing to implement International Mobile Telecommunications (IMT)”. This identification is done through a series of footnotes in the frequency allocation table in the ITU Radio Regulations. As of the most recently published Radio Regulations (2016), the amount of spectrum that has been identified for IMT in the various regions of the world is typically around 1250 MHz in total. This varies slightly between regions, and even within a region, with some countries being party to some footnotes and others not.

The figure below illustrates which countries fall within which ITU regions:

- Region 1 is highlighted in yellow;
- Region 2 is in blue; and
- Region 3 is in pink.

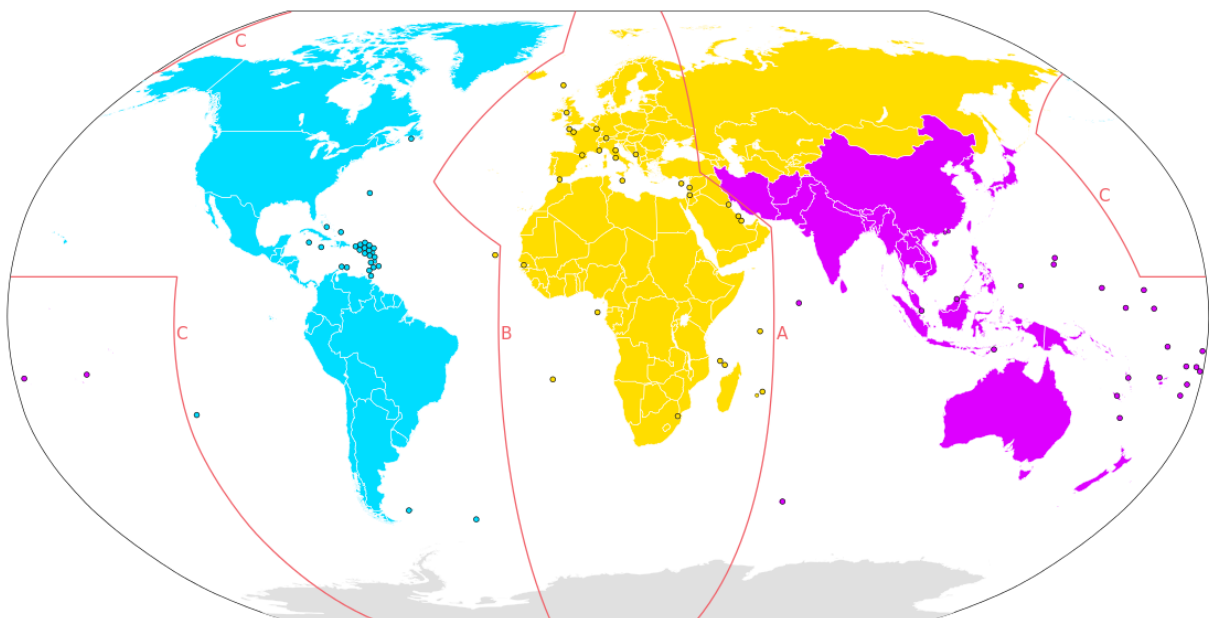


Figure 1: The three regions of the ITU

The table below shows the amount of spectrum which is identified in each of the ITU regions. The first column shows the frequency band identified by the ITU. The second shows the amount of spectrum that this band represents. The next columns show the specific footnotes which identify that spectrum for IMT use in the various regions. Note that in the case of Europe, the European

Commission has issued decisions which make specific spectrum available for IMT and these are also shown.

Those footnotes shown shaded and in italics do not apply to all countries in the region. For example footnote 5.441A only applies in Uruguay.

Band	MHz	R1 (Europe)	R1 (Af/Me)	Region 2	Region 3
450 - 470 MHz	20	5.286AA	5.286AA	5.286AA	5.286AA
470 - 608/610 MHz	140			<i>5.295</i>	<i>5.296A</i>
610/614 - 698 MHz	88			<i>5.308A</i>	<i>5.296A</i>
694/8 - 790 MHz	96	5.317A	5.317A	5.317A	5.313A
790 - 960 MHz	170	5.317A	5.317A	5.317A	5.317A
1427 - 1452 MHz	25	5.341A	5.341A	5.341B	5.341C
1452 - 1492 MHz	40	Dec (EU) 2015/750	5.436	5.341B	5.346A
1492 - 1518 MHz	26	5.341A	5.341A	5.341B	5.341C
1710 - 1885 MHz	175	5.384A	5.384A	5.384A	5.384A
1885 - 2025 MHz	140	5.388	5.388	5.388	5.388
2110 - 2200 MHz	90	5.388	5.388	5.388	5.388
2300 - 2400 MHz	100	5.384A	5.384A	5.384A	5.384A
2500 - 2690 MHz	190	5.384A	5.384A	5.384A	5.384A
3300 - 3400 MHz	100		<i>5.429B</i>	<i>5.429D</i>	<i>5.429F</i>
3400 - 3500 MHz	100	5.430A	5.430A	5.431B	<i>5.432A/B</i>
3500 - 3600 MHz	100	5.430A	5.430A	5.431B	<i>5.433A</i>
3600 - 3700 MHz	100	Dec (EU) 2014/176		<i>5.434</i>	
3700 - 3800 MHz	100	Dec (EU) 2014/176			
4800 - 4990 MHz	190			<i>5.441A</i>	<i>5.441B</i>
TOTAL		1472 MHz	1272 - 1372 MHz	1272 - 1610 MHz	1072 - 1500 MHz

Table 1: Spectrum identified by the ITU and EU for IMT services

The totals at the bottom of the table represent the amount of spectrum identified for IMT use by the ITU in each region (and by the EU in its jurisdiction). Where a range of figures are shown, the lower value equates to that which is identified in every country in the region, and the upper figure is that available to those countries which have adopted all of the country specific footnotes (i.e. those shown in italics). It is also worth noting that countries can unilaterally adopt any frequency band for IMT services, as long as it has a mobile allocation meaning that some countries who have not, according to the Radio Regulations, identified a particular band for IMT, may, nonetheless, be using it for such.

2.3 Harmonisation

Whilst the ITU identifies particular pieces of spectrum for IMT services, not all of that spectrum may necessarily be able to be used for those services. In some cases, the spectrum needs to be divided into specific frequency bands. This is particularly the case where spectrum is used in a frequency division duplex (FDD) or paired arrangement, where some spectrum needs to be used for the uplink from a mobile device to a base station, and a different piece of spectrum needs to be used for the downlink from the base station to the mobile device. A piece of spectrum is always left empty between the uplink and downlink bands to protect one from interfering with the other, this space is

known as the duplex gap. Other bands which use a time division duplex (TDD) arrangement do not need this duplex gap and thus the whole band can be used in its entirety.

Recommendation ITU-R M.1036¹ sets out the various arrangements that can be used in each piece of spectrum identified for IMT. In addition, the body which writes the standards for mobile technology (the 3GPP) also defines certain bands which are then used by manufacturers to determine how spectrum should be deployed in the infrastructure and in handsets. These arrangements ensure harmonisation of spectrum use between and across countries and regions and thus support mass market production of equipment. However, neither the ITU nor the 3GPP indicate which arrangement is or should be used in which ITU region or county, leaving this decision to be taken by each country and usage may vary between them (even within the same region).

Determining how much spectrum could be used for mobile services in each region, therefore requires an assessment of which bands and which arrangements can be used. In general there are bands common to Region 1, and a different set in Region 2. In Region 3, countries have tended to adopt a mixture of the Region 1 and 2 bands. In fact, even some countries in Region 1 have also used bands that are more native to Region 2, and some countries in Region 2 have adopted bands that are more native to Region 1. Thus, in assessing the amount of spectrum which it would be possible for a regulator to license, we need to consider which bands could be used in each region.

The table below sets out the main harmonised bands and identifies how much spectrum there could be available to be licensed in each region for both FDD (paired) spectrum and TDD spectrum.

¹ “Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR)”

3GPP Band		Uplink (MHz)	Downlink (MHz)	Region 1 (Europe)	Region 1 (non-EU)	Region 2	Region 3
FDD Bands							
31	450 MHz	452.5 - 457.5	462.5 - 467.5	10	10	10	10
28	700 MHz	703 - 748	758 - 803	60	Up to 200	90	90
20	800 MHz	791 - 821	832 - 862	60			
5	850 MHz	824 - 849	869 - 894			Up to 130	Up to 130
8	900 MHz	880 - 925	935 - 960	70			
3	1800 MHz	1710 - 1785	1805 - 1880	150	150		150
10	AWS	1710 - 1770	2110 - 2170			120	
2	1900 MHz	1850 - 1910	1930 - 1990			120	
1	2100 MHz	1920 - 1980	2110 - 2170	120	120		120
7	2600 MHz	2500 - 2570	2620 - 2690	140	140	140	140
Sub-Total				610	620	610	640
TDD Bands							
75/76	1400 MHz	1427 - 1517		90	90	90	90
33	1900 MHz	1900 - 1920		20	20		20
34	2000 MHz	2010 - 2025					15
40	2300 MHz	2300 - 2400		100	100	100	100
38	2600 MHz	2570 - 2620		50	50	50	50
52	3300 MHz	3300 - 3400					
42	3400 MHz	3400 - 3600		200	200	200	
43	3600 MHz	3600 - 3800		200			
Sub-Total				660	460	440	275
TOTAL				1270	1080	1050	915

Table 2: Harmonised spectrum bands for IMT services

Note that:

- In the frequency range 700 to 900 MHz, there are several bands which overlap and can thus not be used simultaneously. The figures shown in blue represent the optimal use of these bands avoiding any overlap.
- Band 33 (1900 – 1920 MHz) overlaps with Band 2 (1850 – 1910 paired with 1930 – 1990 MHz). In Regions 1 and 3, there is a choice between the two and in either case 20 MHz of spectrum is made available thus the 20 MHz shown alongside Band 2 could be replaced with 20 MHz in Band 33, but the overall totals would be identical (albeit with a marginally different share between FDD and TDD bands).
- Band 7 (2500 – 2570 paired with 2620 – 2690 MHz) can be combined with Band 38 (2570 – 2620 MHz) and used in a wholly TDD arrangement, when it is then known as Band 41. In either case, the total amount of spectrum available is unchanged but the amount which is TDD and the amount which is FDD would be different.
- These values represent a core set of frequencies that should be able to be licensed in each region. Some countries may have access to more than this through, for example, additional footnotes (e.g. the 4800 MHz range which is identified in just 5 countries).
- Whilst some countries have begun to license the 26 GHz band, as of today, this has not yet been identified by the ITU for IMT and as such has been excluded from our analysis.

2.4 Forecasts

It is worthwhile also considering the amount of spectrum that it has been forecast would be needed by 2020 for IMT services. This was published in ITU-R Report M.2290² which predicted that between 1340 and 1960 MHz of spectrum would be needed for IMT services based on low and high demand situations.

2.5 Summary

The table below summarises the position in each ITU Region with respect to:

- The amount of spectrum identified for IMT services;
- The amount of spectrum available to be licensed in harmonised bands; and
- The amount of spectrum forecast by the ITU to be needed for IMT by 2020.

	Region 1 (Europe)	Region 1 (Af/ME)	Region 2	Region 3
Identified by the ITU	1472 MHz	1272 – 1372 MHz	1272 – 1610 MHz	1072 – 1500 MHz
Harmonised	1270 MHz	1080 MHz	1050 MHz	915 MHz
ITU forecast demand	1340 – 1960 MHz			

Table 3: IMT spectrum identification and harmonisation in each Region

It is the harmonised figure which represents the target for countries in each region. This is the amount of spectrum that should be able to be licensed and for which there are ecosystems of equipment available. The amount of spectrum identified by the ITU is, in essence, a ‘reach’ target that some countries may be able to hit. The ITU forecast is for information only, but does provide a view on where the mobile industry thought it needed to be by 2020 to support the demand for IMT services.

² “Future spectrum requirements estimate for terrestrial IMT”

3 Total amount of spectrum licensed for IMT

3.1 Introduction

In 2014, we conducted a detailed assessment of the amount of spectrum that had been licensed in each country. This assessment has been updated as of early 2019. Information has been taken from a variety of sources such as:

- ERC Report 03 “The Licensing of ‘Mobile Bands’ in CEPT countries” (dated November 2018)
- APT/AWG/REP-15 “APT Report on Information on Mobile Operators Frequencies, Technologies and Licence Durations in Asia Pacific Countries” (dated September 2018)
- Web-sites of regulators including publications on auction outcomes
- Discussions with regulators and administrations
- LS telcom’s own data taken from ongoing primary research.

For each country, we have identified:

- Which spectrum band has been licensed; and
- How much spectrum in each band has been licensed.

3.2 ITU Region 1

ITU Region 1 covers Europe (including the CIS), the Middle East and Africa. As these regions have significantly different uses of spectrum driven by different regulatory regimes (for example, the European Union which makes directives for all countries in its purview), they have been treated independently for the purposes of our analysis. There is no perfect way to break this region into sub-regions, however we have broken down ITU Region 1 into the following three:

- The European Union and European Free Trade Area (note that Andorra, though not part of the EU or EFTA has also been included as it sits geographically within in this area);
- Africa and the Middle East which we have separated into further sub-regions: Africa, and those within the Arab Spectrum Management Group (ASMG);
- Other Region 1 countries excluding those above (primarily CIS and the Balkans).

3.2.1 European Union and EFTA

In this sub-region, the amount of spectrum identified for IMT by the ITU amounts to a total 1472 MHz from which 1270 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this sub-region.

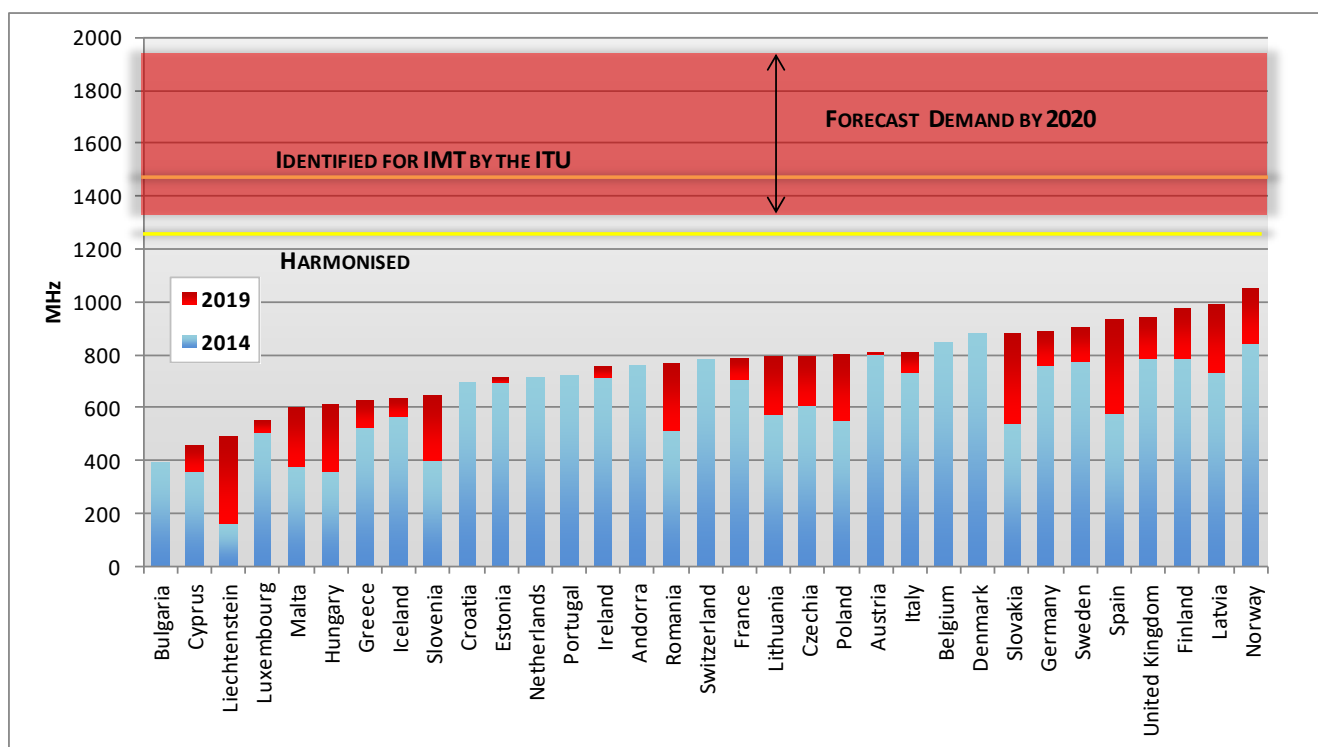


Figure 1: Spectrum licensed for IMT services in Region 1 (EU/EFTA)

It can be seen that there has been good progress in licensing additional spectrum for mobile services over the past 5 year. In 2014, the average amount of spectrum licensed in this sub-region was 629 MHz. This has now risen to an average of 757 MHz, an increase 20%. However, compared to the spectrum that is harmonised in the sub-region today, on average just 60% has been licensed.

3.2.2 ASMG Area

In this sub-region, the amount of spectrum identified for IMT by the ITU amounts to a total of between 1272 and 1372 MHz depending on the specific country, from which 1080 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this sub-region. Note that bars which are in red only, indicate countries for which no data was available in 2014 (and not that those countries had not licensed any spectrum for IMT in 2014!)

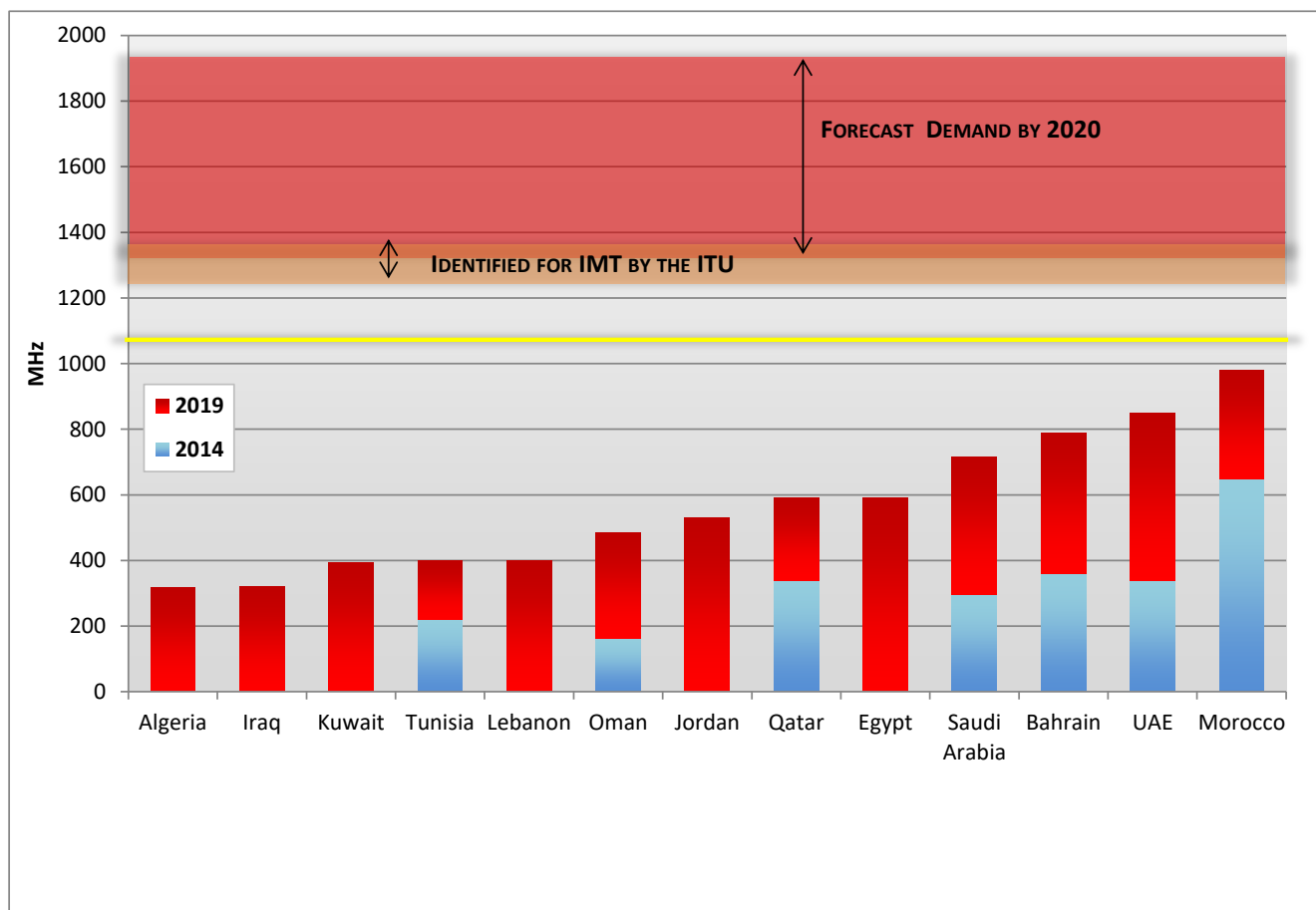


Figure 2: Spectrum licensed for IMT services in Region 1 (ASMG Area)

For those countries where data was available in 2014 and again in 2019, it is clear that very significant progress has been made in licensing additional spectrum with many countries now having licensed double that which they had five years ago.

The average amount of spectrum licensed in this region today is 566 MHz, which is just under 50% of that which is harmonised.

3.2.3 Africa

In this sub-region, the amount of spectrum identified for IMT by the ITU amounts to a total of between 1272 and 1372 MHz depending on the specific country, from which 1080 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this sub-region.

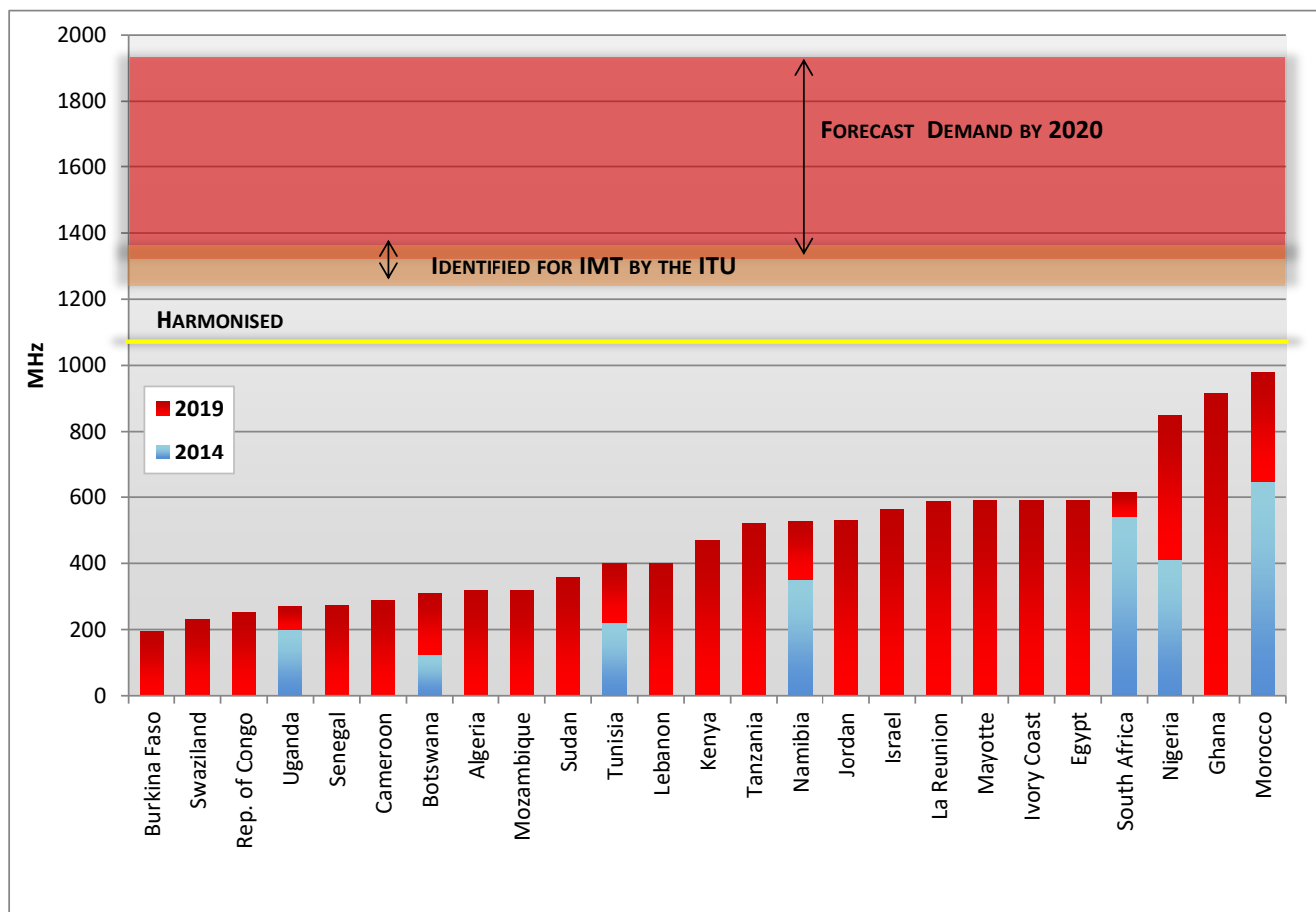


Figure 3: Spectrum licensed for IMT services in Region 1 (Africa)

For those countries where data was available in 2014 and again in 2019, it is clear that significant progress has been made in licensing additional spectrum with many countries now having licensed double that which they had five years ago.

The average amount of spectrum licensed in this region today is 477 MHz, which is well under 50% of that which is harmonised.

3.2.4 CIS and the Balkans

In this sub-region, the amount of spectrum identified for IMT by the ITU amounts to a total of 1272 MHz, from which 1080 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this sub-region.

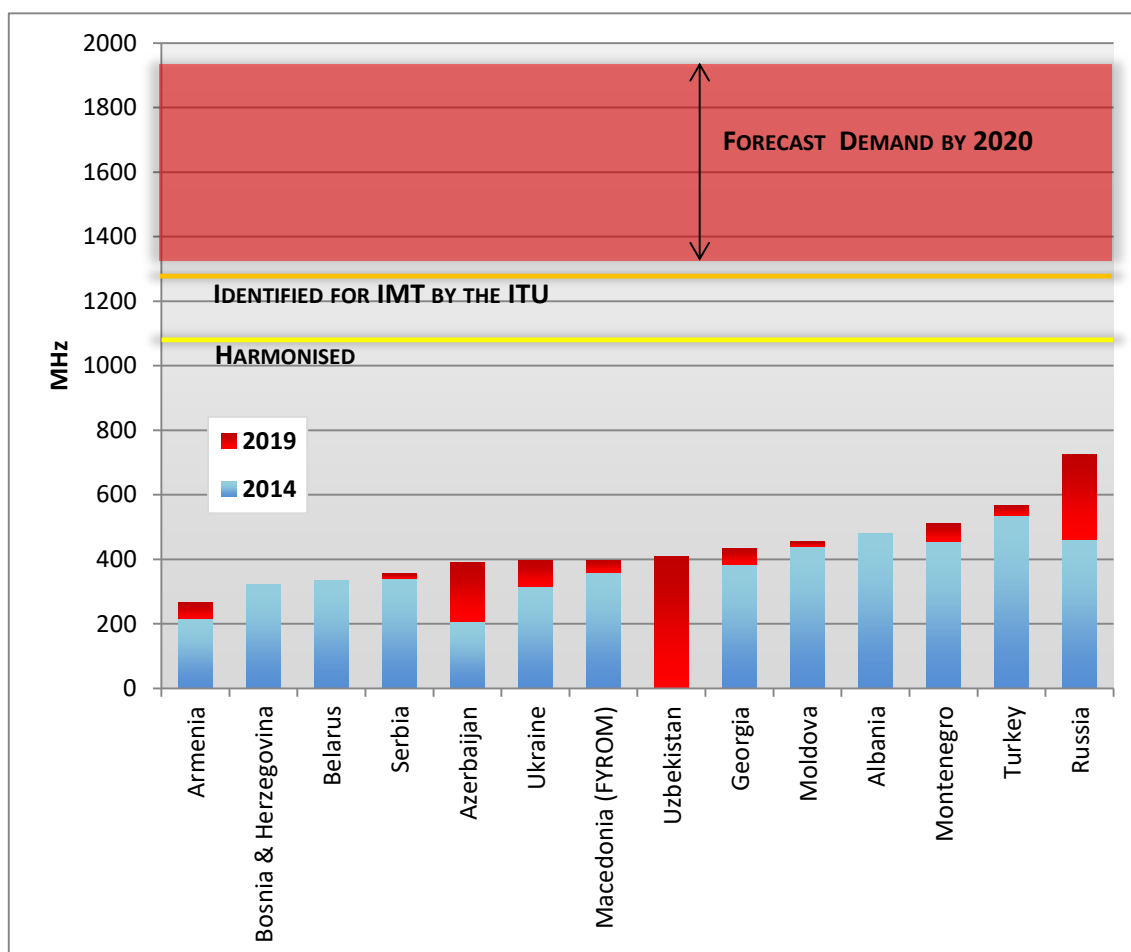


Figure 4: Spectrum licensed for IMT services in Region 1 (CIS and Balkans)

For those countries where data is available for 2014 and 2019, significantly less progress appears to have been made in this region than in others in Region 1. This is particularly evident in the average amount of spectrum today that has been licensed which stands at just 432 MHz, or 40% of those bands that are harmonised for IMT use.

3.3 ITU Region 2

In this region, the amount of spectrum identified for IMT by the ITU amounts to a total of between 1272 and 1610 MHz depending on the specific country, from which 1050 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this region.

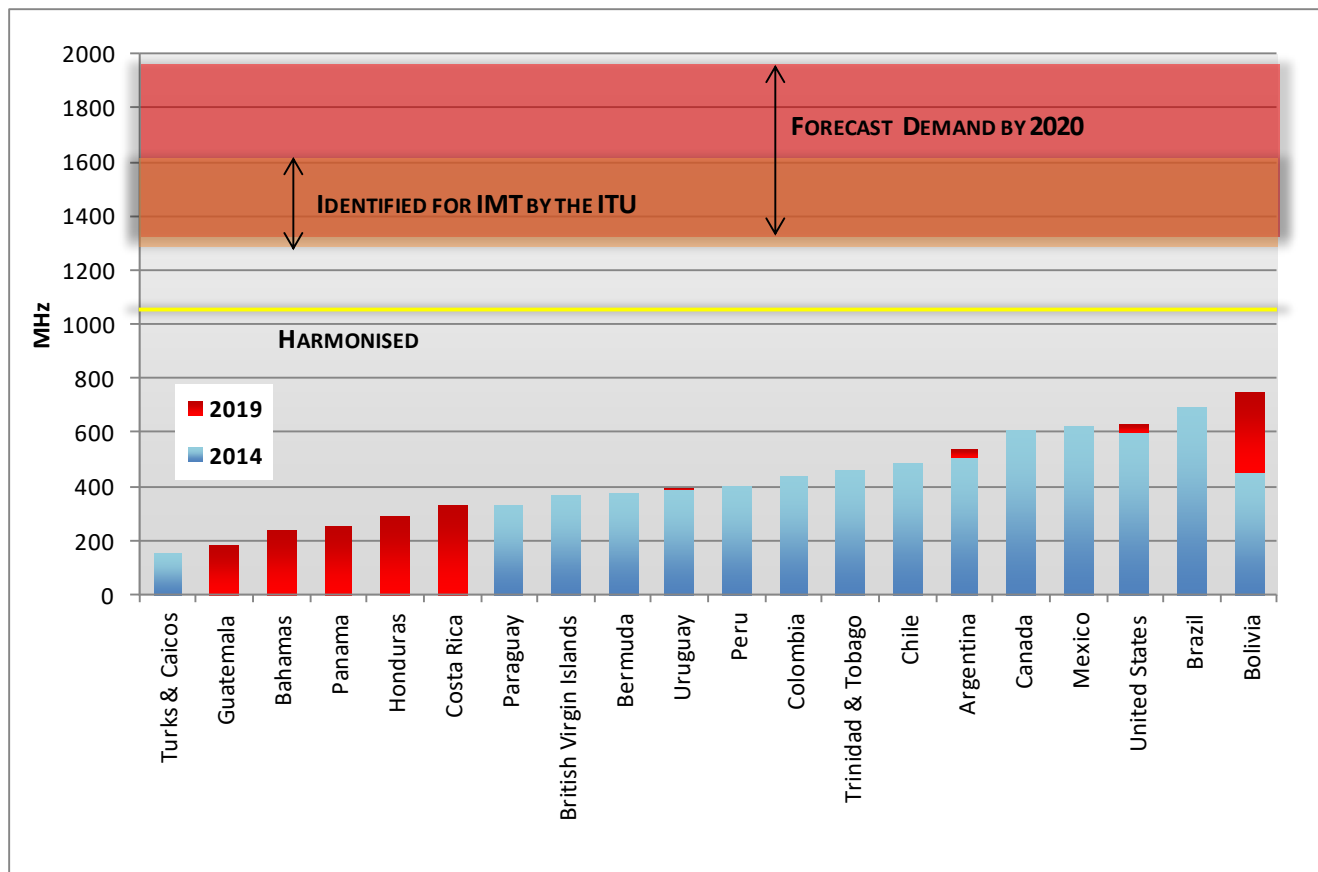


Figure 5: Spectrum licensed for IMT services in Region 2

In this region, on average, just 426 MHz of spectrum has been licensed for IMT service today, which is 40% of that which is harmonised.

3.4 ITU Region 3

In this region, the amount of spectrum identified for IMT by the ITU amounts to a total of between 1072 and 1500 MHz depending on the specific country, from which 915 MHz forms harmonised mobile bands.

The figure below shows the amount of spectrum that has been licensed for mobile services in each of the countries in this region.

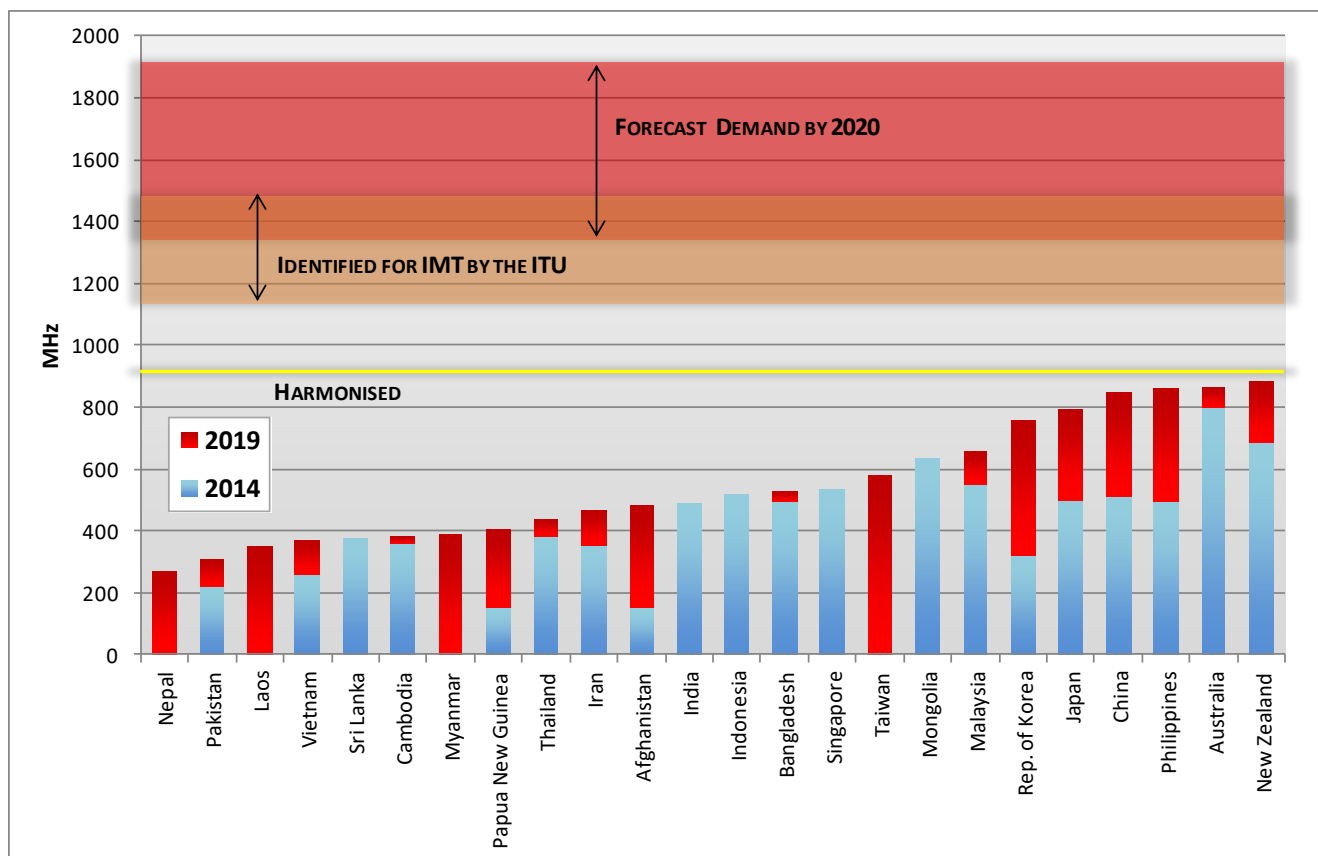


Figure 6: Spectrum licensed for IMT services in Region 3

For those countries where data is available for 2014 and 2019, good progress is being made in licensing additional spectrum. On average in this region, 549 MHz of spectrum has been licensed for IMT to today, which is 60% of that which is harmonised. There are a number of countries who have licensed nearly all of the harmonised spectrum in the region.

3.5 Summary

The following table summarises the global situation with regards to the amount of spectrum that has been licensed in each of the areas studied.

	Region 1 (EU/EFTA)	Region 1 (ASMG)	Region 1 (Africa)	Region 1 (CIS/Balkans)	Region 2	Region 3
Average spectrum licensed in 2014 (original countries)	629 MHz	337 MHz	356 MHz	388 MHz	458 MHz	438 MHz
Average spectrum licensed in 2019 (original countries)	757 MHz	686 MHz	564 MHz	443 MHz	482 MHz	579 MHz
Improvement since 2014	+20%	+103%	+58%	+14%	+5.3 %	+32%
Average spectrum licensed in 2019 (all countries)	757 MHz	556 MHz	477 MHz	430 MHz	426 MHz	549MHz
Percentage of harmonised spectrum licensed (2019)	60%	52%	44%	40%	41%	60%
Typical amount of spectrum yet to be licensed	300 ~ 400 MHz	500 ~ 600 MHz	500 ~ 700 MHz	600 ~ 700 MHz	500 ~ 600 MHz	300 ~ 500 MHz

Table 4: Summary of licensing situation in each region

The first row of the table shows the average amount of spectrum licensed for IMT services in 2014 across those countries for which data was available in 2014. The second row shows the amount of spectrum licensed for IMT in 2019, but only for those countries for which data was available in 2014. This permits an assessment of how much additional spectrum has been licensed in those countries. It would not be fair to compare this to the data for all countries for which data is available in 2019, as many of the new countries for which data has been identified assigned less spectrum than the original countries, and thus lower the average. This can clearly be seen in Region 2 where the average across all countries is 426 MHz, which is less than the 2014 average across those countries for which data was available in 2014, and hence if the all countries average were used for comparison, it would suggest that the amount of spectrum that has been licensed had reduced since 2014.

The fourth row shows the average amount of spectrum licensed for IMT services across all the countries for which data is available in 2019, and the fifth row shows how much of the harmonised spectrum this represents. Taken as a global figure, therefore, it seems that on average between 40% and 60% of spectrum that is harmonised for IMT usage has been licensed.

The final row shows the amount of spectrum that has been harmonised that is yet to be licensed in each of the regions studied. The amount varies between 300 and 700 MHz of spectrum, which, in some cases, represents more than 50% of the total spectrum harmonised for IMT services. Despite good progress in licensing additional spectrum, it is clear that there is still, in many countries, a very long way to go to make use of the spectrum that has already been identified for IMT services.

4 Licensing of individual bands

4.1 Introduction

This section explores which individual bands have been licensed across the various regions, and considers which particular bands still remain to be awarded for IMT services.

4.2 ITU Region 1

As with the previous analysis, due to the different uses of spectrum across different parts of this region (driven by different regulatory regimes), we have once again broken it down into a number of sub-regions.

4.2.1 European Union and EFTA

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this sub-region.

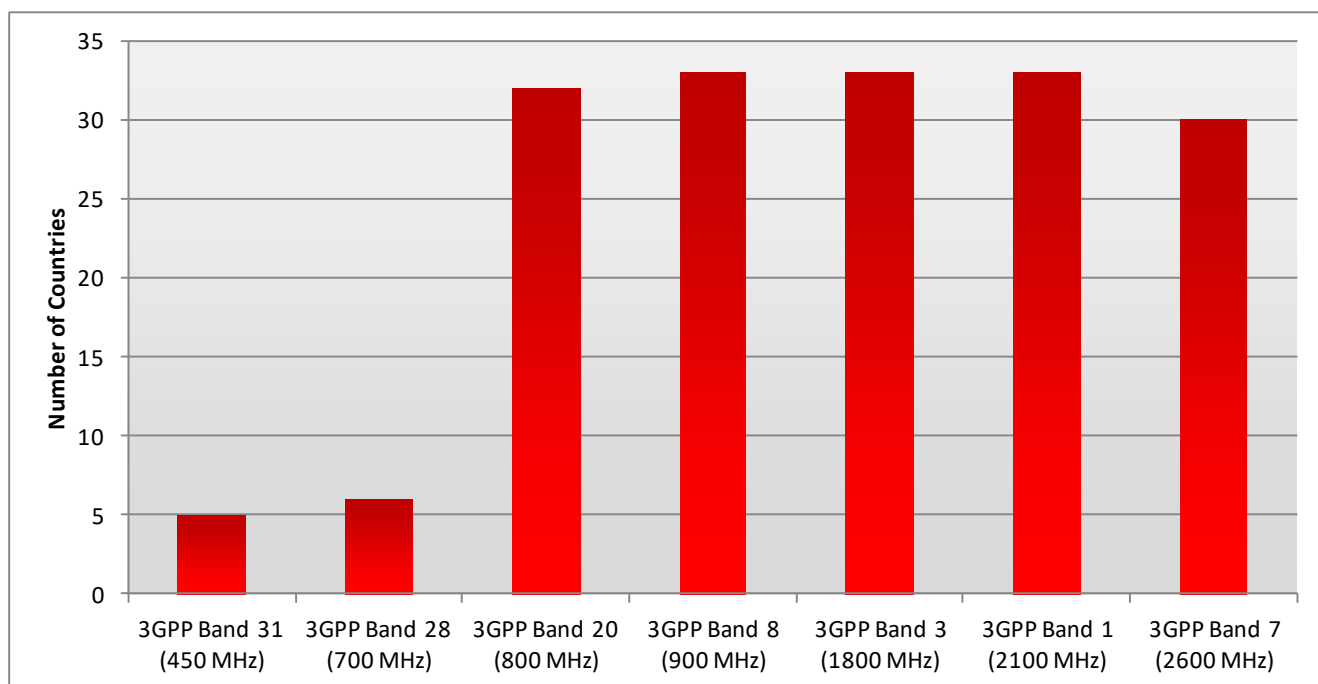


Figure 7: FDD Bands licensed for IMT services in Region 1 (EU/EFTA)

There are 33 countries in this region. Of these, all have licensed the 900, 1800 and 2100 MHz band and only one (Bulgaria) has not yet licensed the 800 MHz band. The 700 MHz band is the subject of European Parliament Decision 2017/899³ and should be made available in every Member State by 2022 at the latest; at present just 6 countries have licensed it.

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0899&from=en>

Only 3 countries (Bulgaria, Croatia and Ireland) have yet to license the 2600 MHz band, however it is worth noting that in a further 8 countries, there remain portions of this band that have not yet been licensed.

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this sub-region.

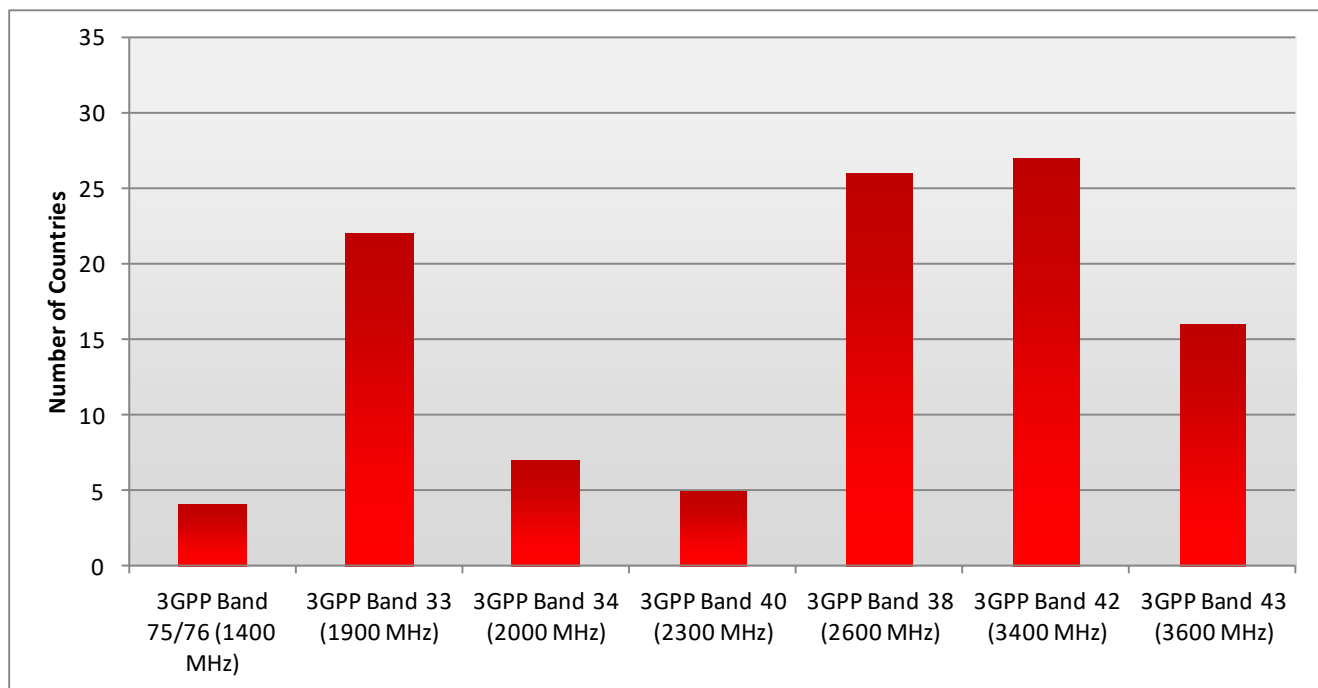


Figure 8: TDD Bands licensed for IMT services in Region 1 (EU/EFTA)

Note that whilst a number of countries have licensed Band 34 (2010 – 2025 MHz), this band has been withdrawn from use for IMT services in the European Union under the Commission Implementing Decision 2016/339⁴ for use by wireless video cameras.

As was the case in 2014, licensing of the TDD bands is at a significantly lower level than the FDD bands. 26 countries (of 33) have licensed the 2600 MHz TDD band, and a similar number have licensed the 3400 MHz band. It is in these bands where many countries in this region still have significant amounts of spectrum yet to be licensed.

⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016D0339&from=EN>

4.2.2 ASMG Area

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this sub-region.

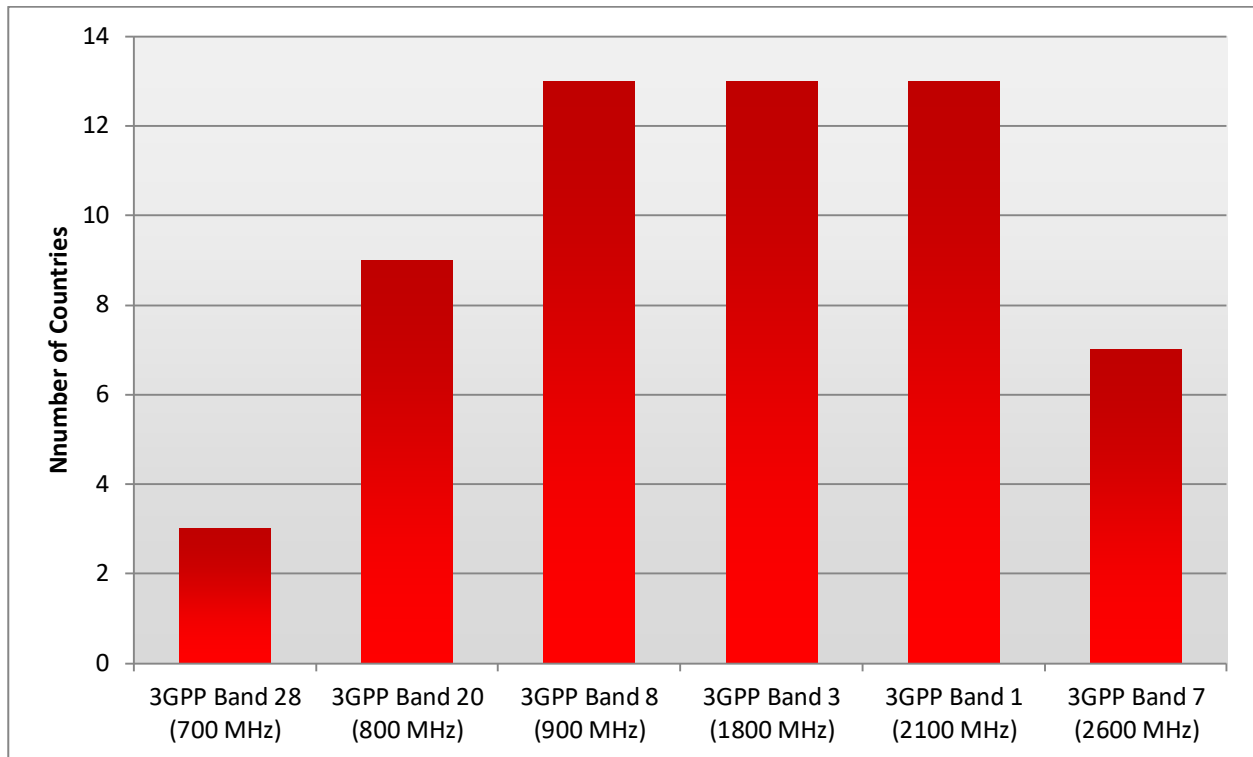


Figure 9: FDD Bands licensed for IMT services in Region 1 (ASMG area)

The 900, 1800 and 2100 MHz bands have been licensed in all 13 countries surveyed. Many of the countries in this sub-region have made good progress licensing the 800 MHz band, and around half have so far licensed the 2600 MHz band. Progress with licensing the 700 MHz band is slow (despite this sub-region being one of the major promoters of this band being identified for IMT services at the WRC).

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this sub-region.

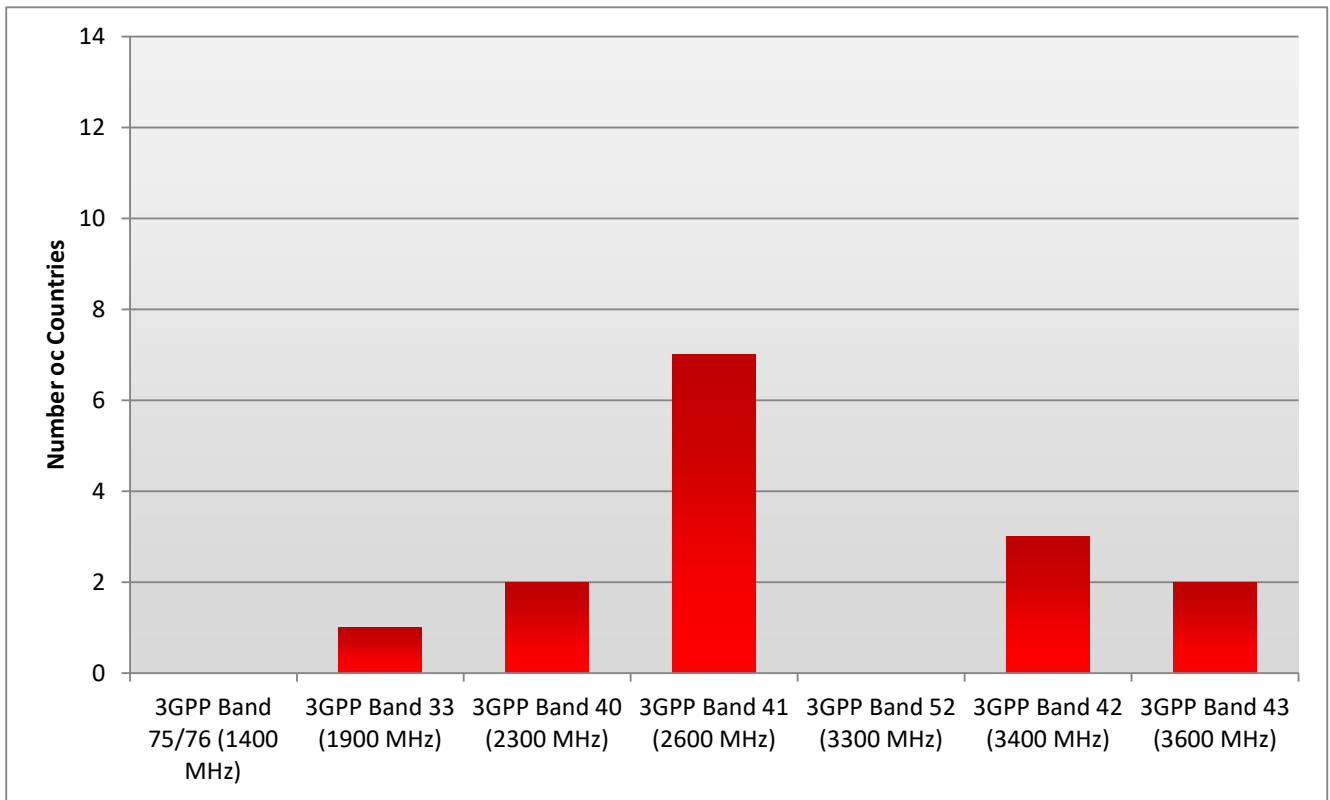


Figure 10: FDD Bands licensed for TDD services in Region 1 (ASMG area)

TDD spectrum remains poorly licensed with the 2600 MHz band being the most common.

With regards to 3400 MHz, 3 countries have so far licensed spectrum in this band (Bahrain, Morocco and Tunisia). Two countries (Morocco and the UAE) have licensed spectrum in the range 3600 – 3800 MHz, however there are no footnotes identifying the use of these frequencies for IMT spectrum in these countries.

4.2.3 Africa

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this sub-region.

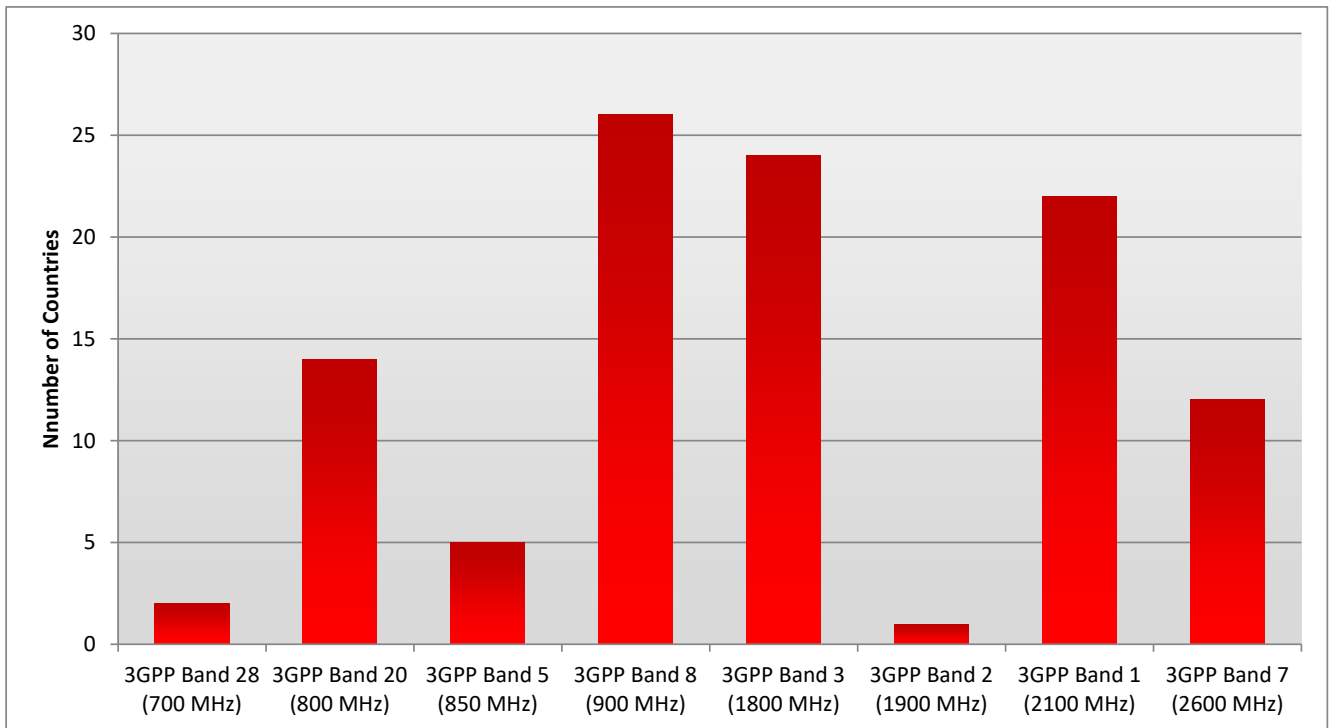


Figure 11: FDD Bands licensed for IMT services in Region 1 (Africa)

The only band licensed in all countries (26 in total) is the 900 MHz band. Only around half of the countries in this sub-region have licensed the 800 and 2600 MHz band. Progress with licensing the 700 MHz band is slow.

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this sub-region.

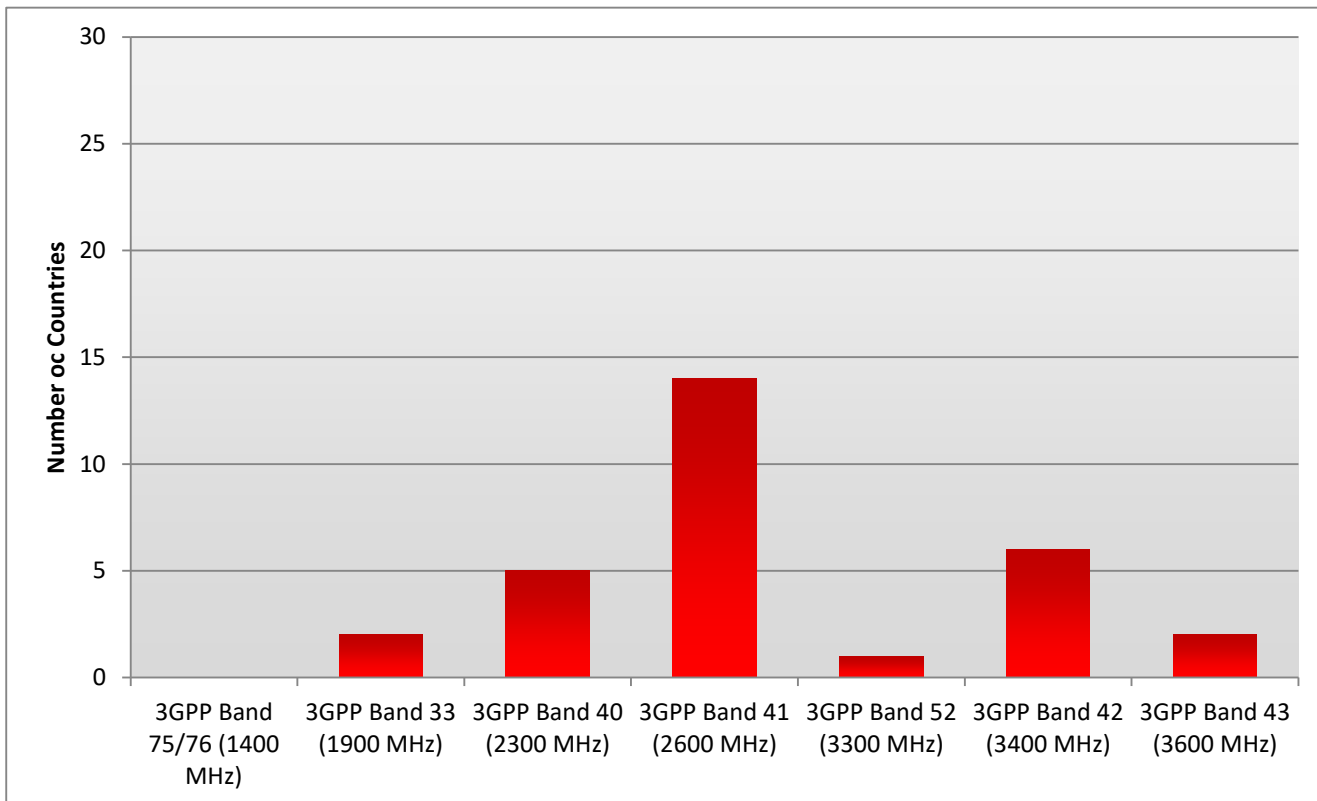


Figure 12: TDD Bands licensed for IMT services in Region 1 (Africa)

Once again, TDD spectrum remains poorly licensed with the 2600 MHz band being the most common. It is interesting to note that more countries have licensed 2600 MHz TDD spectrum (14) than the equivalent FDD band (12). No countries have yet licensed the 1400 MHz band.

Only one country (Ghana) has licensed the 3300 MHz band, despite this being widely available through the relevant footnote.

With regards to 3400 MHz, 6 countries have so far licensed spectrum in this band (Ghana, Kenya, Morocco, Nigeria, South Africa and Tanzania). Two countries (Ghana and Morocco) have licensed spectrum in the range 3600 – 3800 MHz, however there are no footnotes identifying the use of these frequencies for IMT spectrum in these countries.

4.2.4 CIS and the Balkans

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this sub-region.

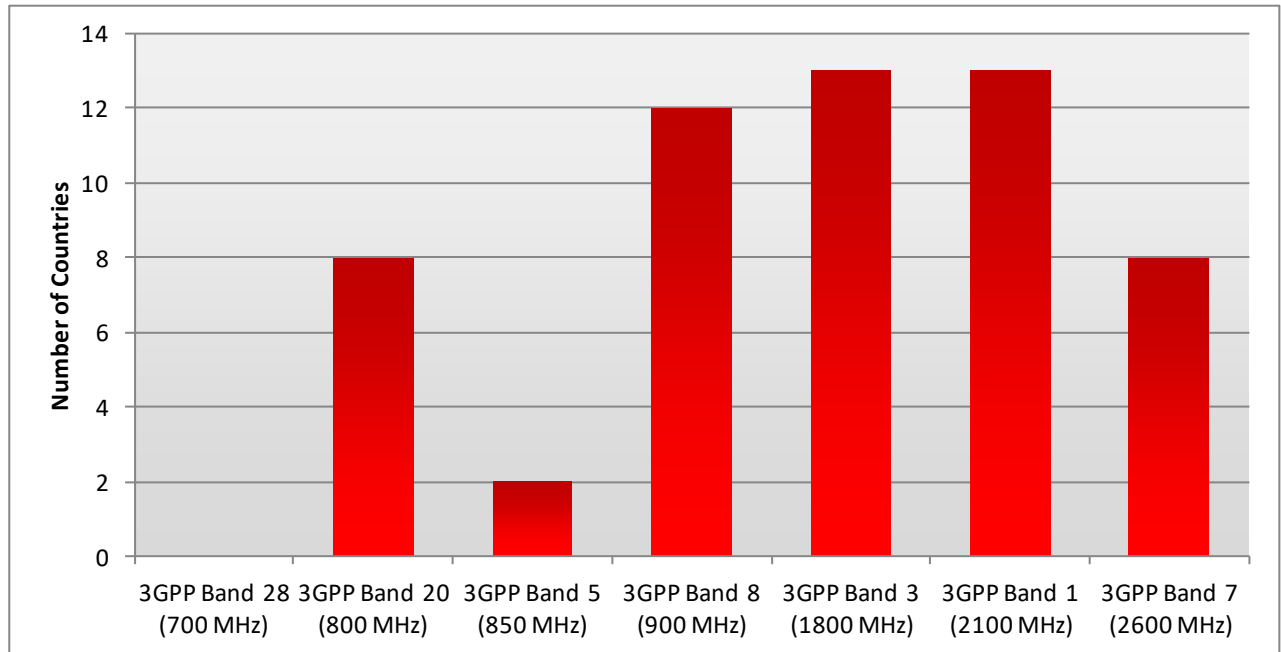


Figure 13: FDD Bands licensed for IMT services in Region 1 (CIS and the Balkans)

The 900 and 1800 MHz bands are licensed in all of the 13 countries in this sub-region and good progress is being made in licensing the 800 MHz and 2600 MHz bands (8 countries for each). No country from which information is available is yet to license the 700 MHz band.

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this sub-region.

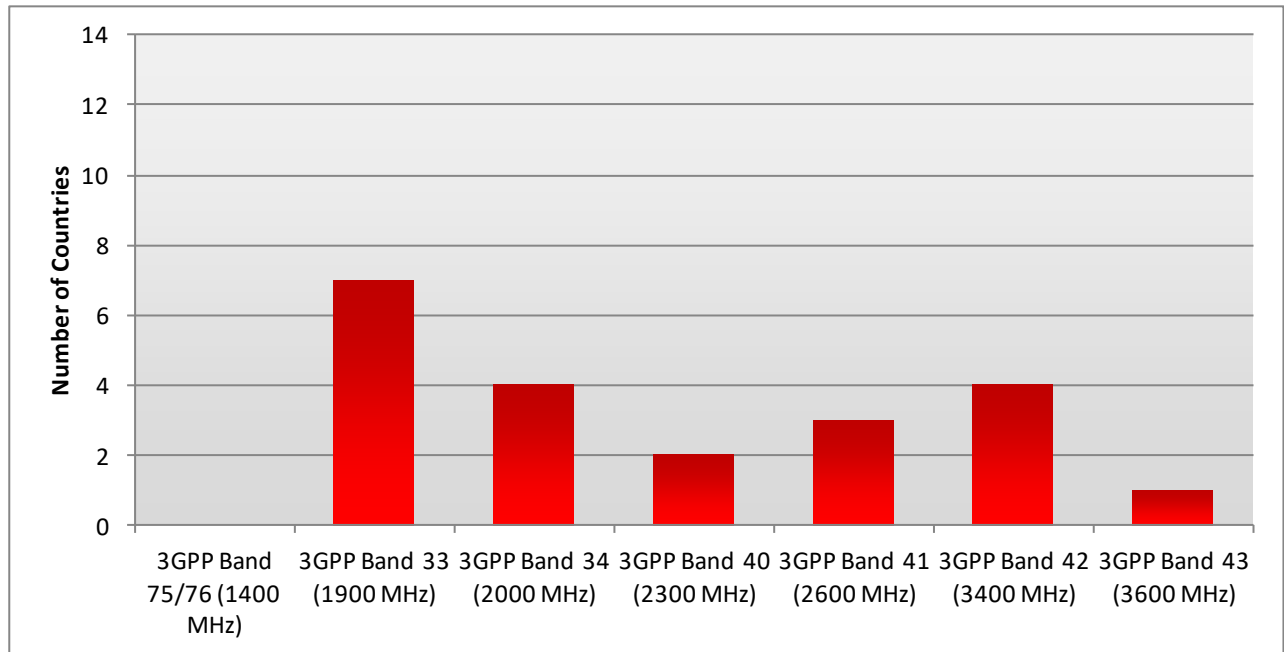


Figure 14: TDD Bands licensed for IMT services in Region 1 (CIS and the Balkans)

TDD bands are licensed far less than the FDD bands in this sub-region. In particular the 2300 and 2600 MHz bands have been licensed in just 3 and 4 countries respectively.

The 3400 MHz band has been licensed in 4 countries (Azerbaijan, Belarus, Macedonia and Montenegro). Spectrum in the frequency range 3600 – 3800 MHz has been licensed in Azerbaijan despite there being no footnote to identify its use for IMT in this sub-region.

4.3 ITU Region 2

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this region.

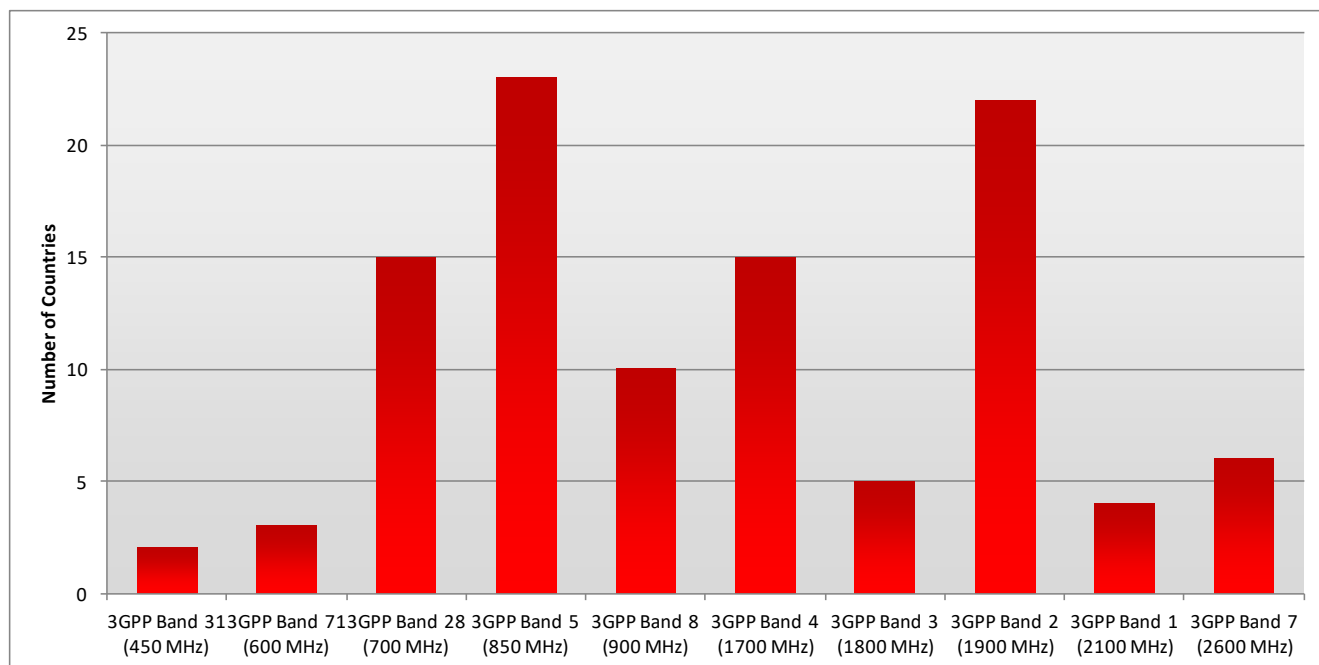


Figure 15: FDD Bands licensed for IMT services in Region 2

Note that whilst we have labelled the 700 MHz band as being in the APT arrangement (Band 28) as this is the most common choice in the region, this also includes those countries which have adopted the USA arrangements (Bands 12 and 13).

This region comprises 25 countries and surprisingly there is no single band which is licensed in every country. This is primarily due to some countries following European norms (e.g. 3GPP Bands 3 and 8) whilst others follow North American norms (e.g. 3GPP Bands 5 and 2). The 850 and 1900 MHz bands are the most commonly licensed. In this region licensing of the 700 MHz band has progressed significantly, and licensing of the 600 MHz has begun.

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this region.

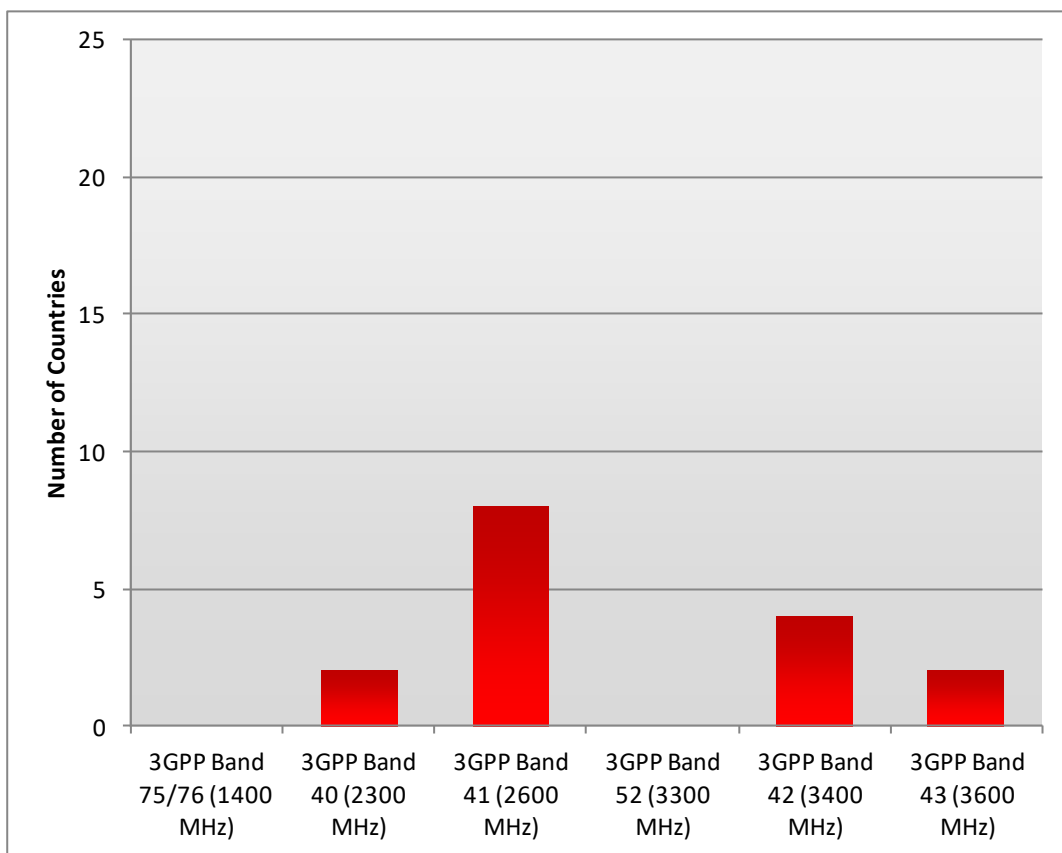


Figure 16: TDD Bands licensed for IMT services in Region 2

With the exception of Band 41, very few TDD bands have been licensed in this region at all. From the available data, no country has yet licensed the 1400 MHz band, nor for that matter, the 3300 MHz band.

The 3400 MHz band had been licensed in 4 countries (Argentina, Bolivia, Brazil and Canada). For the 3600 – 3700 MHz band, only 4 countries (Canada, Colombia, Costa Rica, and the USA) have a footnote permitting them to use this band for IMT services. From the available data, however, it appears that Canada is using the band in line with the footnote, and that Bolivia are also using the band despite not being party to the footnote.

4.4 ITU Region 3

The following diagram shows the number of countries which have licensed each of the available and harmonised FDD bands in this region.

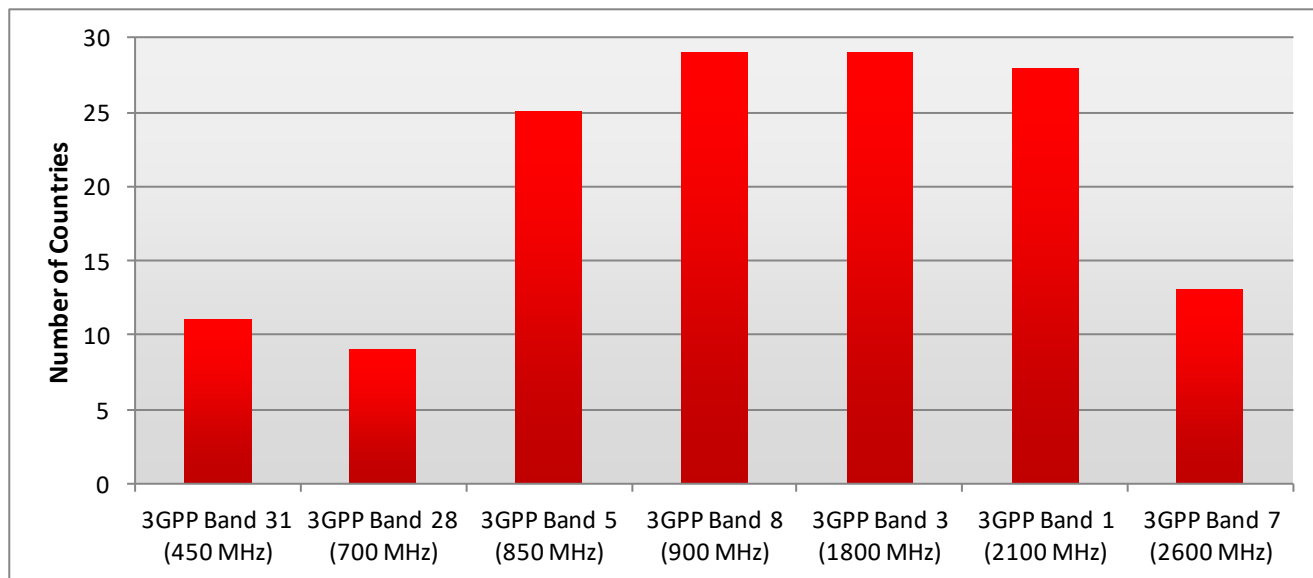


Figure 17: FDD Bands licensed for IMT services in Region 3

Of a total of 29 countries, all have licensed the 900 and 1800 MHz bands, and only one (Papua New Guinea) has not yet licensed the 2100 MHz band. A significant number (25 of 29) have also licensed the 850 MHz band. The new APT 700 MHz band has not yet been licensed in many countries, and progress with licensing the 2600 MHz band is relatively slow.

The following diagram shows the number of countries which have licensed each of the available and harmonised TDD bands in this region.

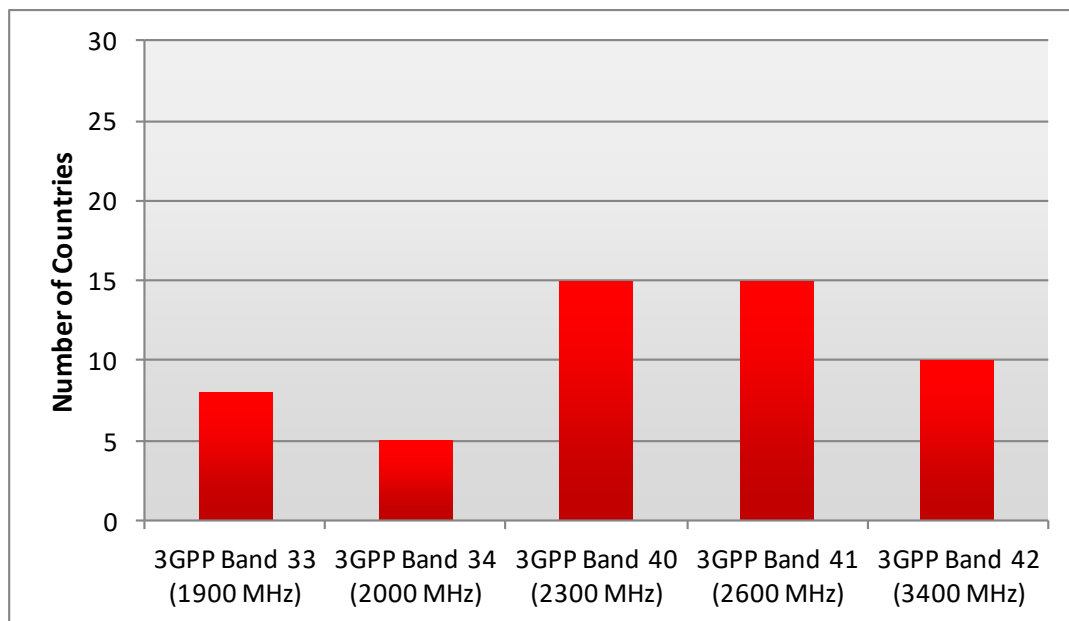


Figure 18: TDD Bands licensed for IMT services in Region 3

Licensing of TDD bands is once again much lower than for the FDD bands. Good progress is being made in licensing the 2300 MHz band and the 2600 MHz band. It is notable that more countries have licensed the 2600 MHz band in a TDD format (e.g. Band 41) rather than the FDD format (Band 7).

With regards to the 3400 MHz band, 11 countries in the region have a footnote identifying this band for IMT services (Australia, Bangladesh, China, India, Iran, Japan, New Zealand, Pakistan, The Philippines, Singapore and South Korea). Of these countries, Bangladesh, India, Pakistan and Singapore have yet to license the use of the band, however Afghanistan and Mongolia have licensed IMT services in the band despite not being party to the relevant footnotes.

4.5 Summary

Good progress is being made in licensing the available spectrum for IMT services, however there remain a number of bands for which there is some way to go:

- The 700 MHz band is still to be licensed in many countries. This could be due to its historic use for television broadcasting, and the need to re-farm services from the band before licensing it for mobile services. Countries with few broadcasting services will find this easier than those with vibrant television markets.
- The 1400 MHz and 3300 MHz band (as identified for IMT at the previous WRC in 2015) have yet to be licensed in nearly every country despite offering almost 200 MHz of additional spectrum between them.
- The 2300 MHz band remains to be licensed in many countries (either in whole or in part). In many countries this is a governmental frequency band and thus re-farming existing users can be more time-consuming.
- With the exception of the EU/EFTA area, licensing of the 2600 MHz band appears to be moving slowly. There also seems to be a trend towards licensing the band in its TDD arrangement (e.g. 3GPP Band 41) rather than in the FDD arrangement. This would make sense, as the TDD arrangement permits the band to be used for 5G services more easily.

It is also important to highlight that in comparison with the demand forecasted for 2020, the amount of spectrum that is actually harmonized and effectively assigned is still considerably lower than the one forecasted as demand. In most cases there is an average difference of almost 50% between the spectrum assigned and the one harmonized to be assigned.