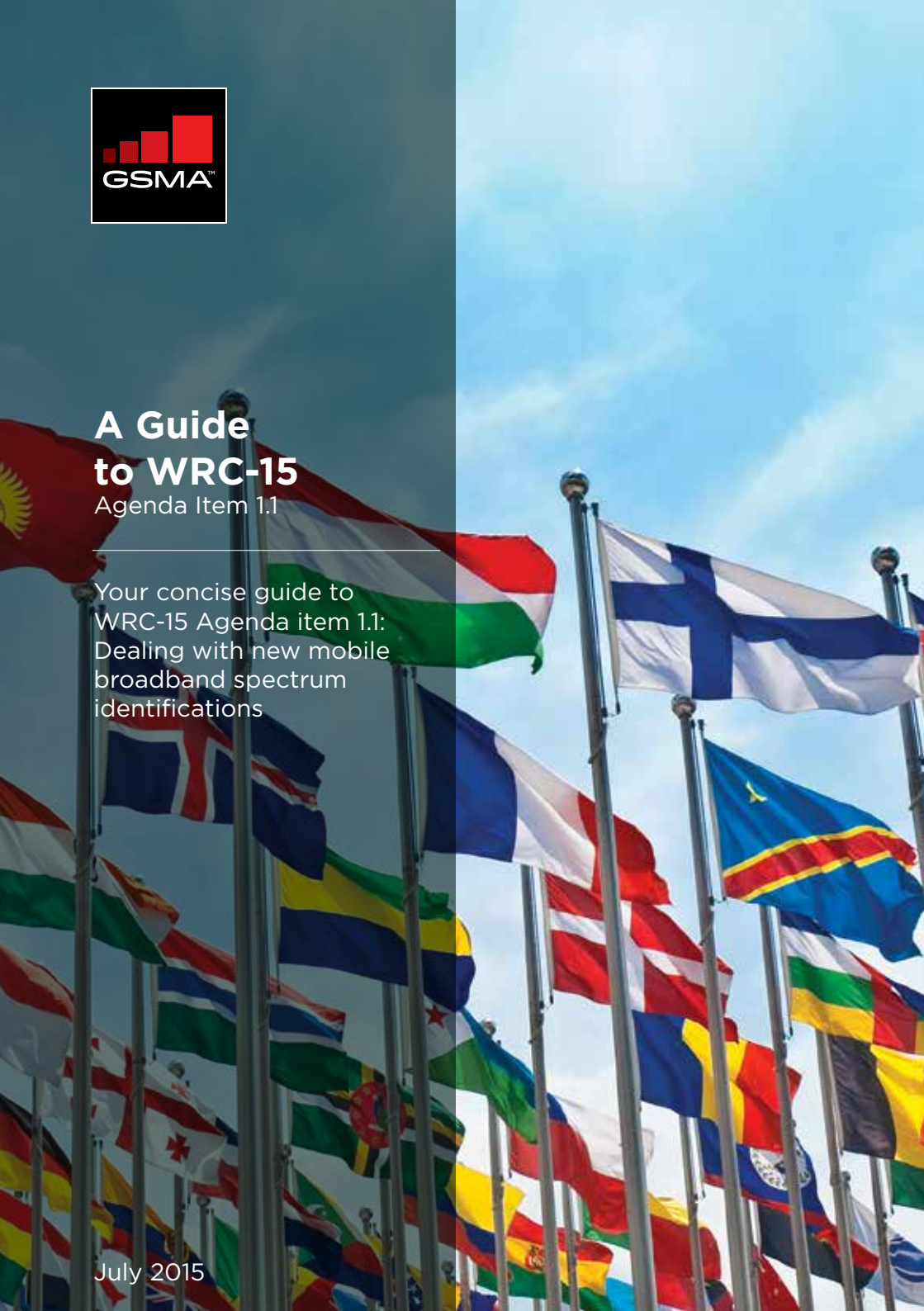

A Guide to WRC-15

Agenda Item 1.1

Your concise guide to WRC-15 Agenda item 1.1: Dealing with new mobile broadband spectrum identifications

July 2015

About the GSMA

The GSMA represents the interests of mobile operators worldwide, uniting nearly 800 operators with more than 250 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai and the Mobile 360 Series conferences.

For more information, please visit the GSMA corporate website at www.gsma.com.
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* The GSMA believes mobile bands can be found within these frequency ranges in most countries. However, not all countries will be able to use all mobile bands due to the need to support other vital services.

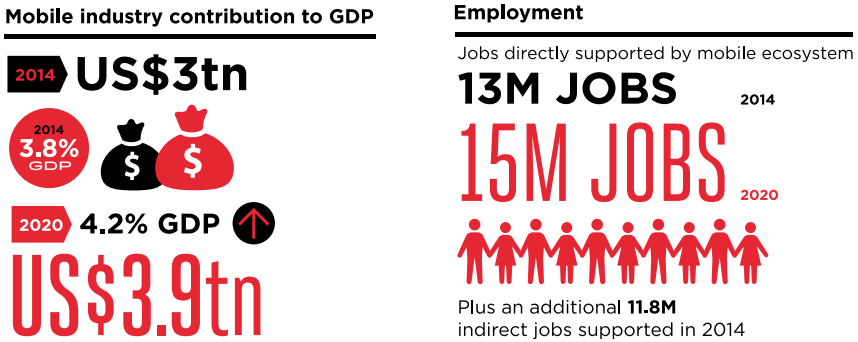
Overview

At the World Radiocommunication Conference in November 2015 (WRC-15), agreements will be made on changes to international spectrum allocations and associated regulatory provisions. With mobile traffic growth far outpacing historical predictions, the outcome of WRC-15 will be the single most important factor determining the future availability of affordable, ubiquitous, high-speed mobile broadband services worldwide.

Agenda Item 1.1 at WRC-15 addresses the need to identify additional spectrum for IMT-based mobile broadband in harmonised global bands to meet rising mobile data demands worldwide.

This outcome will have a direct impact on the wealth, well-being and future prospects of all countries and their citizens, as the mobile industry is a significant contributor to the global economy.

The growing global economic impact of mobile services[1]



The rapidly growing socioeconomic impact of mobile services is reliant on networks that can scale to meet unprecedented demand. Mobile data traffic is expanding dramatically and is expected to grow 10-fold from 2014-2019[2]. This is being driven by rapid adoption of 3G and 4G services as well as major smartphone uptake, which are being used to consume bandwidth hungry apps, especially video.

The tremendous growth in mobile data usage means that significant additional spectrum needs to be made available for International Mobile Telecommunications (IMT) at WRC-15 to avoid a degraded consumer experience in future.

The GSMA predicts that an additional 600-800 MHz should be made available so it can be licensed, where necessary, to meet demand in 2020. This takes into account other methods to augment mobile capacity including newer technologies, denser networks and Wi-Fi offload.

Future spectrum requirements

1340–1960MHz
Total mobile spectrum required by **2020** according to the **ITU**

600–800MHz
Additional mobile spectrum required by **2020** according to **GSMA**

Without additional spectrum, there is a risk that mobile broadband services will slow or require far higher investment potentially leading to higher consumer prices and falling mobile demand.

Although there is opposition to new mobile bands from incumbent services, it is important to appreciate that mobile spectrum will not be licensed until local market demands require it.

Therefore incumbent services can continue to operate in the bands until national regulatory authorities decide to license the bands to mobile operators and have made plans to accommodate incumbents in either a smaller amount of spectrum or an alternative band.

This document addresses the need for more mobile spectrum, the most appropriate frequency bands and proposes how the needs of incumbent spectrum users can continue to be met. The aim is to inform policymakers and regulators making long-term spectrum identification decisions at WRC-15.

The GSMA proposes four frequency ranges within which new mobile broadband identifications (i.e. IMT) could be found. These bands can also be widely harmonised around the world to drive low cost devices, enable roaming and minimise international interference:

- Sub-700 MHz (470-694/698 MHz)
- L-Band (1350-1400 & 1427-1518 MHz)
- 2.7-2.9 GHz
- C-Band (3.4-3.8 GHz & 3.8-4.2 GHz)

Six key considerations

WRC-15 represents a precious opportunity for governments to work together to prepare for the long-term future of wireless services. To make the most of this opportunity there are six key considerations to bear in mind regarding future mobile spectrum:

1. Support greater flexibility in future:
It is important to recognise that new bands at WRC-15 will only be licensed to mobile operators by governments when there is necessary demand. Identifying additional spectrum for IMT is not a choice between incumbent services or mobile. Administrations can continue to support existing services for as long as necessary, but will gain greater flexibility to make more spectrum available for mobile services when required.

2. Consider your maximum mobile requirements in 2020-2025:
As it takes about eight to ten years to allocate new bands, free spectrum, build equipment and issue licences, it is essential that administrations act now to provide themselves with the flexibility to license harmonised spectrum in the future to meet growing consumer demand.

3. Work together to support low cost mobile devices:
Newly identified mobile spectrum at WRC-15 must be harmonised globally, or at least regionally, to drive the economies of scale required for low cost smartphones and to enable roaming and minimise cross-border interference. It is also essential to appreciate that governments who use new mobile bands first will drive the economies of scale for governments who use the bands later. This means countries with less mature mobile markets have an interest in supporting governments with higher spectrum requirements.

4. Support a mixture of coverage and capacity bands:
New mobile spectrum at WRC-15 should comprise a mixture of coverage (i.e. lower frequency) and capacity (i.e. higher frequency) bands to drive good value, high speed mobile broadband services in rural and metropolitan areas as well as deep inside buildings.

5. Not all IMT identified spectrum is available to be be licensed to mobile:
All internationally identified IMT spectrum is also allocated on a primary basis to other important services. In many countries, governments actively use these bands for other services and have no immediate, or even long-term, plans to make them fully available for mobile. Therefore governments will often realistically only be able to use a portion of globally IMT identified spectrum for mobile services - so must ensure they have enough to meet their needs. The greater the amount of IMT identified spectrum, the more options governments have to decide which band to license next, and therefore preserve spectrum for the most vital incumbents.

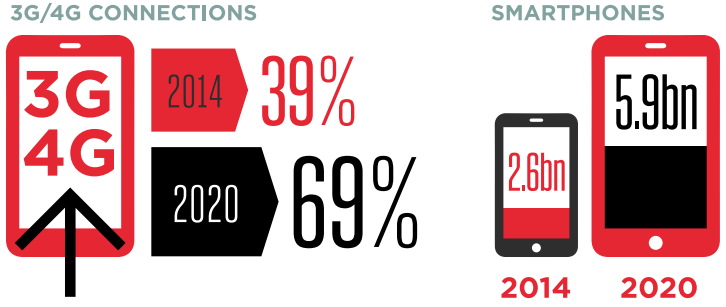
6. Make the most of a scarce resource:
The growth in wireless services combined with the finite supply of spectrum means that increasing spectrum efficiency by sharing bands between services is more important now than ever. New technologies and changing usage patterns mean spectrum bands can be used more intensively. It is important to consider realistic sharing conditions that take advantage of the latest spectrum management techniques – not just worst case conservative scenarios.

Whilst it is clear that co-channel, co-location sharing is not normally feasible, this does not rule out sharing in principle. In many circumstances it is possible for incumbent users (perhaps with investment in new equipment) to still provide the same service, but with less spectrum. This would allow bands to be segmented, and hence increase overall spectrum efficiency. It is also possible to increase adjacent channel sharing with investment in equipment upgrades, such as better filtering. The question will be if the economic benefits outweigh the costs of such arrangements, and this will vary from country to country.

Future mobile spectrum requirements

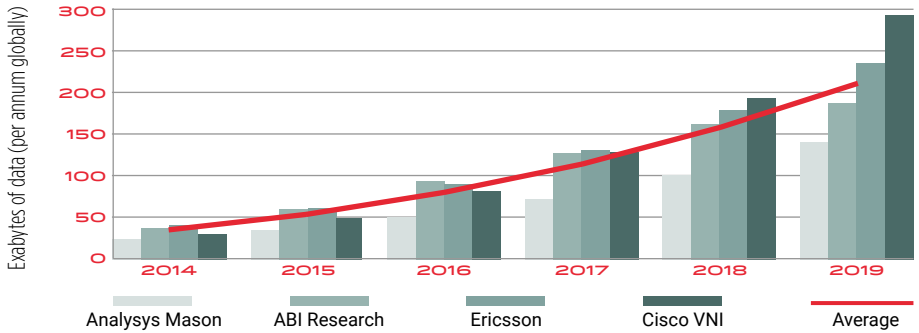
Mobile broadband demands are increasing far faster than anticipated. With more people using more smartphones to consume more bandwidth-hungry apps over more mobile broadband networks – there is an unavoidable need for more mobile spectrum.

The growing global economic impact of mobile services[3]



The mobile broadband revolution is having a dramatic impact on global data traffic which continues to exceed estimates. Such is the speed of growth that leading analyst firms such as Analysys Mason and ABI Research recently raised their predictions for 2019 by as much as 30%.

DATA GROWTH FORECASTS[4]



Taking into account increasingly efficient mobile technologies (e.g. LTE Advanced), denser mobile networks and Wi-Fi offload, there is still a requirement for significant additional mobile spectrum in future. The ITU's official spectrum demand model estimates that between 1340MHz-1960 MHz should be identified for IMT worldwide by 2020 to meet potential demand[5].

The ITU study assumes that mobile traffic will increase between 44 and 80-fold between 2010 and 2020. By comparison, we know that global mobile data traffic grew 76-fold between 2008 and 2014[6]. An average of current analyst forecasts predicts that data traffic will grow by over 100-fold between 2010 and 2019[7].

Total Spectrum requirements for IMT in 2020

The ITU's spectrum estimates are in line with those of the GSMA which predict that an additional 600-800 MHz should be sought at WRC-15 worldwide to meet potential demand in 2020 – based on the fact that around 1 GHz is identified for IMT currently.

It is important to appreciate that not all internationally IMT identified spectrum is available for mobile services in all countries. All IMT identified spectrum is also allocated on a primary basis to other important services. Governments actively use some of these bands for other services and sometimes have no immediate, or even long-term, plans to make them available for mobile services. Therefore governments will often realistically only be able to use a portion of globally IMT identified spectrum for mobile services.

Recommended mobile bands

New mobile bands at WRC-15 need to be widely harmonised to drive low cost devices, enable roaming and minimise international interference. They also need to comprise a mixture of coverage and capacity bands to provide good value, high speed mobile broadband services in urban and rural areas.

There are 19 candidate bands being considered for IMT at WRC-15. These were agreed by the ITU's Joint Task Group 4-5-6-7 and later confirmed by the CPM, both meetings included participation from the different industries and communities that use the radio spectrum. Based on this shortlist, the GSMA proposes four frequency ranges within which new mobile broadband identifications (i.e. IMT) could be found.

The GSMA's recommended bands have been carefully chosen to ensure that the impact on incumbent services is minimised and represent credible options because they could be used in most markets across all three ITU Regions creating widely harmonised bands.

THE GSMA'S RECOMMENDED WRC-15 MOBILE BANDS

The GSMA recommends that new IMT identifications are found within the following four frequency ranges

- Sub-700 MHz (470-694/698 MHz)
- L-Band (1350-1400 & 1427-1518 MHz)
- 2.7-2.9 GHz
- C-Band (3.4-3.8 GHz & 3.8-4.2 GHz)

Candidate Bands

The table below shows a comparison of the number (and frequencies) of the candidate bands for WRC-15 compared to those at WRC-07.

WRC-15 Candidate Bands	WRC-07 Candidate Bands	WRC-07 Identified Bands
1. 470-694/698 MHz	1. 410 - 430 MHz	1. 450-470 MHz
2. 1350-1400 MHz	2. 450 - 470 MHz	2. 698-806 MHz (Region 2 & parts of Region 3)
3. 1427-1452 MHz	3. 470 - 862 MHz	3. 790-862 MHz (Region 1 and parts of Region 3)
4. 1452-1492 MHz	4. 2300 - 2400 MHz	4. 2.3-2.4 GHz
5. 1492-1518 MHz	5. 2700 - 2900 MHz	5. Parts of 3.4-3.6 GHz in a large number of countries
6. 1518-1525 MHz	6. 3400 - 3600 MHz	
7. 1695-1710 MHz	7. 3600 - 3800 MHz	
8. 2700-2900 MHz	8. 3800 - 4200 MHz	
9. 3300-3400 MHz	9. 4400 - 4990 MHz	
10. 3400-3600 MHz		
11. 3600-3700 MHz		
12. 3700-3800 MHz		
13. 3800-4200 MHz		
14. 4400-45 00 MHz		
15. 4500-4800 MHz		
16. 4800-4990 MHz		
17. 5350-5470 MHz		
18. 5725-5850 MHz		
19. 5925-6425 MHz		

Sub-700MHz UHF (470-694/698 MHz)

Mobile industry ask

Allocate the band to the mobile service on a co-primary basis worldwide alongside broadcasting

Identify a significant portion for IMT in ITU Regions 2 and 3

Americas

Asia Pacific

Why is the band suitable for mobile?

Enables good value, high quality mobile broadband services over wide areas including rural locations and deep inside buildings

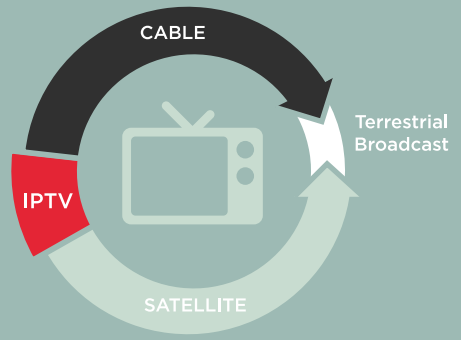
Prevents the existing 700 MHz and 800 MHz bands reaching capacity in future thus avoiding deteriorating mobile services in rural areas and inside buildings or risking higher mobile pricing

Existing usage

TERRESTRIAL BROADCAST TV SERVICES

How could part of the band be made available for mobile?

All existing TV services and future expansion could be supported in less spectrum using new technologies



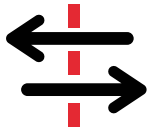
MOST POPULAR BROADCAST TV DELIVERY METHODS

A recent study of the Arab States found that a total of 112-168 MHz in the band could be made available for other services with no impact on current or planned future TV requirements[8]

Terrestrial TV is little used in many countries so governments should have greater flexibility to use part of the band for other services

How can the band be shared?

Various techniques can mitigate co-channel interference, such as antenna pointing, to enable cross-border coordination



The existing 700 MHz and 800 MHz mobile bands have proven this in practice

Common misunderstandings

Too early to re-plan TV services again

Support for a mobile band below 700 MHz would not require the immediate re-planning of broadcasting services. Countries could gradually use part of the band for mobile services based on their own preferred timeframe and in coordination with their neighbours. Protection to support the long-term future of broadcast services can be secured through appropriate regulatory and technical provisions

TV services cannot be supported in less spectrum

This is not the case. Existing DVB-T2 technology combined with the MPEG4 codec can support 14 standard definition (SD) channels in an 8 MHz multiplexer. The latest codec, PERSEUS, which has been endorsed by the European Broadcasting Union, can support three times the number of SD and HD channels in the same amount of spectrum. This trend will continue in future, allowing more TV channels and higher resolutions in less spectrum

L-band (1350-1400 MHz and 1427-1518 MHz)

Mobile industry ask

Allocate a significant portion to the mobile service on a primary basis worldwide, alongside existing services, and identify it for IMT

Why is the band suitable for mobile?

Provides a good balance of capacity and coverage over relatively large areas, including inside buildings

Existing usage

Various applications including aeronautical telemetry, military and civilian radar systems, and fixed link transmission systems

Radar

Aeronautical telemetry

Broadcast satellite service

Fixed links

How could part of the band be made available for mobile?

The 1427-1518 MHz portion is already allocated to mobile worldwide

Creating a major opportunity to quickly identify a harmonised IMT band

This includes a portion that is currently reserved for digital radio broadcasting (1452-1492 MHz) which is effectively unused

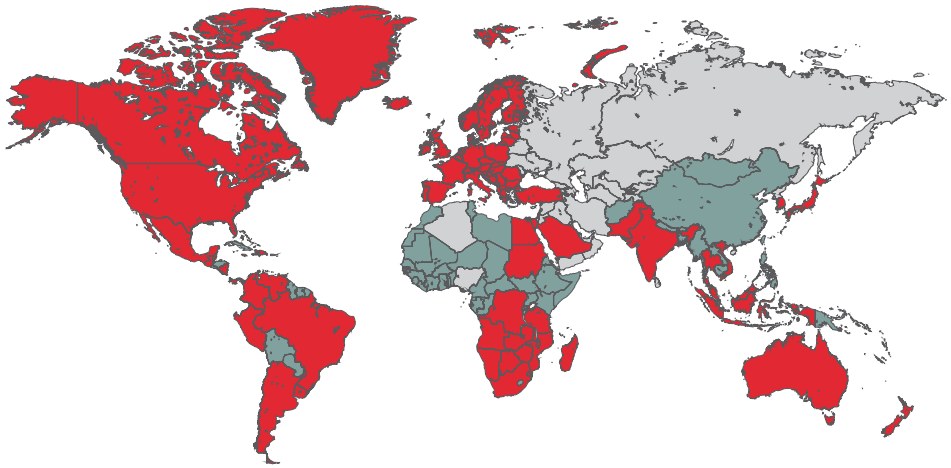
How can the band be shared?

Where neighbouring countries use the 1350-1518 MHz portion for fixed links, IMT usage is still possible using frequency separation and/or geographical separation[9]

Where neighbouring countries use the 1350-1400 MHz portion for radar, it is possible to support IMT uplink in the band using frequency separation and/or geographical separation around radar antennas[10]

Global support for the band

STATUS OF SUPPORT MAP



Support or partial support for 1427-1518 MHz

Unknown/Undecided

Opposed

2.7-2.9 GHz

Mobile industry ask

Allocate the band to the mobile service on a primary basis worldwide, alongside existing services, and identify a significant portion for IMT

Existing usage

Primarily used for civil and military air traffic control radars, which are mainly located at airports, and meteorological radars in some countries

Why is the band suitable for mobile?

To deliver vital extra mobile capacity in urban areas where traffic is growing fastest

Deployments would be relatively low-cost because existing 2.6 GHz cell sites could be used

How could part of the band be made available for mobile?

The band is underutilised. Some countries have no radars at all, in many others there are only one or two, while almost all of the remainder have no more than a few tens of radars operating in the band

There is significant potential to use spectrum in the band much more efficiently. A recent study[11] for the UK, which is one of the countries that uses the band most heavily for radars, shows all existing radar requirements in the south-east of England, where they are most densely used, could be relocated into the 2.8-2.9 GHz portion of the band – with capacity to spare

How can the band be shared?

Sharing is feasible using more spectrum efficient radar systems that operate in one portion of the band leaving IMT to operate in the other portion

Economic benefits

Mobile services in the band would deliver major economic benefits even taking into account the cost of re-planning existing radars. Studies show that the economic value of spectrum released would be much greater than the costs involved[12]

Countries/Regions	Benefits Millions USD	Cost Millions USD	Net Benefits Millions USD	Benefit/Cost Ratio
Western Europe	10149	826	9323	12:1
Australia	951	241	710	4:1
Bangladesh	1100	15	1085	73:1
Brazil	3700	286	3414	13:1
Colombia	661	68	593	10:1
Egypt	494	28	466	18:1
Indonesia	1900	72	1828	26:1
Kenya	770	19	751	41:1
Malaysia	329	69	260	5:1
Nigeria	2700	36	2664	75:1
Pakistan	1260	24	1236	53:1
Saudi Arabia	290	77	213	4:1

Common misunderstanding

Radar services cannot operate alongside mobile without prohibitively large exclusion zones

Previous studies for the band have concentrated on sharing the same frequencies between IMT and radar systems. However, sharing can be possible if radar systems are planned, using more spectrum efficient technology, so the occupy the upper portion of the band (2.8-2.9 GHz). Mobile broadband can then operate in the lower portion with a suitable guard band in between the two services[13]

C-band (3.4-3.8 / 3.8-4.2 GHz)

Mobile industry ask

Allocate the band to the mobile service on a primary basis worldwide, alongside satellite.

3.5-4.2 GHz is already allocated in the Americas and Asia Pacific

Americas

Asia Pacific

Identify a significant portion for IMT

Why is the band suitable for mobile?

The size of this band provides a unique opportunity to deliver major additional capacity and very fast mobile broadband services in busy urban hotspots

Existing usage

Although the C-band is starting to be used for LTE services in some countries, it is predominantly used for Fixed Satellite Services (FSS)

C-band satellite services are very important in tropical countries where the effect of heavy rainfall has historically limited the use of other satellite bands

How could part of the band be made available for mobile?

In most countries satellite operators[14] are increasingly using higher frequency bands (e.g. Ka and Ku) to deliver improved performance and better value services. This means that a portion of the C-band is starting to be made available for mobile broadband, and this could accelerate as mobile data traffic rises further and more mobile devices support the band

Options include retaining all satellite use in the band in rural areas where it is most needed, while allowing part of the band to be used for mobile broadband in urban areas where the mobile capacity challenge is greatest[15]

In tropical countries where rain fade can be a significant factor, governments can continue to use as much of the band as necessary for satellite services. These would be protected through international coordination between neighbouring countries and appropriate technical and regulatory conditions

How can the band be shared?

Recent studies show sharing is possible in this band – and indeed is already happening in numerous countries – with geographic and/or frequency separation

There are no known cases of cross-border interference between the C-band satellite and IMT services using existing protections in the Radio Regulations

Economic benefits

A study of the Asia-Pacific market by Frontier Economics shows the benefits of mobile in the 3.4-3.8 GHz portion exceed the costs of moving satellite services by about eight times, would increase government revenue by US$52bn, and create over 100,000 new jobs. Studies in other regions show similar economic benefits[16]

Common misunderstanding

Interference studies show mobile and satellite cannot co-exist in the C-band

Recent sharing studies show that large exclusion zones are not necessary making mobile broadband use possible. Portions of the band are already being successfully shared between mobile operators and satellite providers. For example, the UK already operates FSS and LTE services in the C-band without interference problems

Methods to Implement Changes to the Radio Regulations

The WRC will consider how to satisfy Agenda Items through revisions of the Radio Regulations. The ways in the ITU's Radio Regulations can be revised, or revisions can be proposed, is referred to as a Method.

For Agenda Item 1.1, three methods were proposed by the JTG to allow Member States to represent their view on a candidate band. These are:

Method A: No change to the existing Radio Regulations

Method B: Allocation to the mobile service (either by)
- B1: Inclusion of allocation in table of allocations
- B2: Inclusion of allocation via footnote

Method C: Identification for IMT

For the GSMA target bands, an identification for IMT (Method C) is recommended and, if it does not already exist, an allocation to the mobile service (Method B).

There are specific guidelines within the CPM text as to how these Methods could be implemented for each band.

Conclusion

The outcome of WRC-15 will be the single most important factor determining the future availability of affordable, ubiquitous, high-speed mobile broadband services worldwide.

Over the coming years mobile services could transform society more than at any other time in its history. Faster and more ubiquitous mobile networks are set to create a more connected world where billions of wirelessly-enabled devices will create data feeds that drive new smart cities, industries and whole countries. Billions of people who have never accessed the internet before could become connected in the coming years over mobile networks and a new generation of low cost smartphones.

But the cost, capacity and reach of mobile services will always be largely determined by spectrum. By ensuring sufficient coverage and capacity spectrum is allocated to the mobile service at WRC-15, national administrations will have the flexibility to assign the amount they choose rather than having their future confined by existing allocations.

Without additional spectrum, networks could slow or require far higher investment, potentially leading to higher consumer prices and falling mobile demand as well as a degraded consumer experience.

This booklet, along with GSMA's document on 'Mobile spectrum requirements and target bands for WRC-15' underline the principal arguments and counter-arguments that will be discussed during the WRC. If you require any further information please do not hesitate to get in touch on spectrum4all@gsma.com.

APPENDIX

AGENDA ITEMS AT WRC-15

WRC-15 will address spectrum provisions for all types of wireless services under a large number of Agenda Items. The table overleaf provides a high level description of the Agenda Items which are considered in the CPM text and notes any impact on mobile (if any).

AI	Outline	Considerations for mobile
1.1	To agree new spectrum for mobile and IMT	The most important Agenda Item for mobile globally
1.2	To allow Region 1 allocation of 694-790 MHz for mobile	The allocation will improve the overall quality of mobile services and support the growth of mobile broadband in region 1 especially in developing markets, rural areas and deep inside buildings. It will also establish a globally harmonized LTE 700 MHz band
1.3	To consider changes to the resolution specifying spectrum for Public Protection and Disaster Relief (PPDR)	Proposals expected to specify additional frequencies for PPDR. This is a valuable service but it is important it does not interfere with harmonised IMT spectrum
1.4	To look at new spectrum for amateur radio in the 5 GHz band	
1.5	To look at using some fixed satellite bands for unmanned aircraft	
1.6.1	To consider 250 MHz more spectrum for fixed satellite in 10-17 GHz in Region 1	This spectrum is currently used for cellular backhaul
1.6.2	To consider 250 MHz more spectrum for fixed satellite in Region 2 & 3 in 13-17 GHz	This spectrum is currently used for cellular backhaul
1.7	To review spectrum use at 5 GHz by fixed satellite service	
1.8	To review regulations of earth stations on vessels	
1.9.1	To consider new fixed satellite service allocations in the 7 & 8 GHz bands	This spectrum is currently used for cellular backhaul
1.9.2	To consider more spectrum for maritime mobile in the 7 & 8 GHz bands	This spectrum is currently used for cellular backhaul
1.10	To consider more mobile satellite spectrum in 22-26 GHz	This spectrum is currently used for cellular backhaul
1.11	To consider more earth exploration satellite service at 7-8 GHz	
1.12	To consider 600 MHz more spectrum for earth exploration satellites at 8-9 GHz	
1.13	To consider changing regulations for space research service	
1.14	To consider achieving a universal time reference or ‘universal clock’	
1.15	To consider spectrum demands for maritime mobile	
1.16	To consider regulations and spectrum for Automatic Identification System (AIS)	
1.17	To consider spectrum for wireless avionics	
1.18	To consider the 77 GHz band for automotive	
2-9	Stock Agenda Items which deal with regulatory provisions and are at all WRCs	9.1.5: Addresses regulatory provisions for the Fixed Satellite Service (FSS) which may significantly impact IMT by potentially giving satellite services in the C-band protected status on safety-of-life grounds
10	To recommend future WRC Agenda Items	A perennial Agenda Item but will be important to the growth of future communications services. This Agenda Item will also consider future spectrum for mobile at WRC-19

Notes and References

1 Statistics in supporting table sourced from the GSMA Mobile Economy Report 2015

2 According to Cisco's VNI predictions

3 GSMA Mobile Economy Report 2015

4 Analysys Mason, Global Mobile Network Traffic, Oct 2014
ABI Research, Mobile Data Traffic & Usage, Oct 2014
Cisco VNI Mobile Forecast, Jan 2015
Ericsson Mobility Report, Feb 2015

5 See ITU-R Report M.2290

6 Mobile data grew from 33PB per month in 2008 (Cisco VNI 2009) to 2.5EB per month in 2014 (Cisco VNI 2015)

7 Average of four traffic predictions for 2019 (Analysys Mason, Global Mobile Network Traffic, Oct 2014; ABI Research, Mobile Data Traffic & Usage, Oct 2014; Cisco VNI Mobile Forecast, Jan 2015; Ericsson Mobility Report, Feb 2015) compared with Ericsson's measurement of data traffic at the start of 2010

8 See Plum Study for the GSMA entitled 'UHF spectrum requirements for terrestrial broadcasting in the ASMG region', August 2015

9 JTG Chairman's Report 4-5-6-7/715 Annex 10 & 26

10 JTG Chairman's Report 4-5-6-7/715 Annex 25

11 CEPT document CPG-PTD(15)043, "2.7-2.9 GHz band segmentation, radar spectrum efficiency, and compatibility between IMT and radars", April 2015

12 The research was conducted by Aetha Consulting and is available from the GSMA website

13 JTG Chairman's Report 4-5-6-7/715 Annex 30

14 Companies which offer higher frequency (Ka and Ku) satellite services include SES, o3B and Avanti. Some are even offering services in tropical areas and can overcome the challenge of rain fade (e.g. see JTG4567/550-E: A study of rain fade depth on FSS frequency bands)

15 Studies comparing coexistence between IMT/ and VSAT in Malaysia, South Africa and Colombia found that, 'under realistic but conservative assumptions, a separation distance of less than 5 km would typically be required. This is in contrast with the much larger separation distances that have been calculated in JTG 4-5-6-7'

16 In Africa, the benefits were found to be range from approximately PPP US$10 billion to PPP US$22 billion, while costs are estimated between PPP US$0.3 billion and PPP US$1.1 billion. In the Arab States the benefits were found to range from approximately PPP US$5 billion to PPP US$11 billion, while costs are estimated between PPP US$0.1 billion and PPP US$0.6 billion

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