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Citation: El-Moghazi, Mohamed, Whalley, Jason and Irvine, James (2017) International spectrum management regime: is gridlock blocking flexible spectrum property rights? Digital Policy, Regulation and Governance, 19 (2). pp. 1-13. ISSN 2398-5038

Published by: Emerald

URL: <https://doi.org/10.1108/DPRG-08-2016-0039> <<https://doi.org/10.1108/DPRG-08-2016-0039>>

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International spectrum management regime: is gridlock blocking flexible spectrum property rights?

I. Introduction

For more than a century, radio spectrum has been a unique resource that is essential for delivering wireless services. Reflecting this uniqueness, national regulators have traditionally managed spectrum by designating appropriate uses, technologies, and users in what is called the ‘command and control’ approach (hereafter, C&C). The emergence of the C&C approach, in the early days of wireless communications, created a new regime internationally.

Many emerging issues – such as spectrum shortages due to increasing demand for data services - have resulted in calls for the C&C to be reviewed (Wellenius and Neto, 2005). As a result, different alternative approaches have been suggested to overcome the deficiencies of C&C (Chaduc and Pogorel, 2008). One of these approaches is the ‘spectrum market’, which calls for treating spectrum assignment in a way similar to any other private property rights so that radiocommunication service allocation flexibility and technology neutrality apply (Cave et al., 2007). Having said that, there have been several national approaches to introduce more flexibility in service allocation where flexible spectrum property rights are traded (Cave and Webb, 2003). The main argument in favour of flexibility is that service harmonisation could lead to restrictions on the use of under- or un-used spectrum for alternative uses, and on the ability to re-farm spectrum for new services (Indepen and Aegis Systems, 2004, Chaduc and Pogorel, 2008). Therefore, Cave (2002) argues that harmonisation should be time-limited until it enables manufacturers and operators to deliver a cost effective service. After that, the market should be opened up to other services. However, most of these approaches have not been successful due to difficulties in implementation, or have been limited in effect (El-Moghazi et al., 2014).

Similarly, internationally, there have been only few attempts to bring more flexibility into the international service allocation framework including reorganising the radio regulations (RR), introducing new composite service and changing service definitions (ITU-R, 2007). Cave (2002) argues that international co-ordination is a constraint on the ability of a single country to introduce more flexibility into its spectrum use. It has also been argued that applying flexible spectrum use that is not in conformity with the ITU regulations would require extensive coordination with neighbouring countries (Indepen, 2001). Nevertheless, huge resistance from most of the international stakeholders has faced all of these attempts (El-Moghazi et al., 2012).

While this paper does not intend to address the concept of spectrum property right per se, it aims to examine the influence of the international spectrum management regime on introducing flexibility in radiocommunication service allocation nationally. To achieve this, the paper will address the main elements of the international spectrum management regime to determine to what extent they restrict flexibility nationally. It should be noted that the main motivation for this paper is that most of the previous studies that address spectrum property rights focus on national circumstances, (see, for example, Cave and Webb, 2003; Deffains, 2013; Weiser and Hatfield, 2008) while the influence of international regulations is largely overlooked.

The rest of the paper is organised as follows. The following section explores the methodological stance adopted while Section 3 focuses on the spectrum market approach. Section 4 focuses on the process of radiocommunication service allocation, and then Section

5 addresses the interaction of international spectrum regime and national spectrum management approach regarding radiocommunication service allocation. Sections 6 to 10 examine the different main elements of the international service allocation framework namely, decision making procedures, footnotes, three regions system, a priori planning and the ITU-R Master International Frequency Register (MIFR). Conclusions are drawn in the last section of the paper.

II. Methodology

We adopt a qualitative inductive methodology in this paper that examines the different elements of the international radiocommunication service allocation framework with a focus on the influence on national decisions affecting service allocation. The paper is based mainly on primary data collected from sixty-six semi-structured interviews with the main stakeholders from the three ITU-R regions including mobile operators and manufactures, broadcasters, national regulators, and regional organisation. The difference between unstructured and semi-structured interview is that the former is similar to a conversation and could contain one question, while the later comprises a list of questions on specific topics (Bryman and Bell, 2007). Interviews were selected because they enable the researcher to build on their responses, and as personal contact assures achieving more response rate (Saunders et al., 2009).

Interviewees were partially identified based on the participation of the first author for several years in ITU-R activities, and a list of different topics and related questions were prepared and selected for each group of interviewees based on their background. In addition, most interviews were recorded upon permission of the interviewees and notes were taken during the interviews. The names of the interviewees are not disclosed for confidentiality reasons. Nvivo is used for the data reduction of the interviews' transcriptions in order to identify the most important themes (Bazeley, 2007). The paper also draws on secondary data illustrating the different ITU-R publications regarding radiocommunication service allocation.

III. Spectrum Market

The origin of the market approach could be traced back to Coase's seminal contribution, 'The Federal Communications Commission', in which he suggested that spectrum assignments should be treated in a way similar to property rights. Coase (1959) argues that the aim of the regulator should be to maximise the output and not to minimise the interference and that interference should not be an issue as long as the gain from it is much more than the harm it produces (Coase, 1959). Coase (1960) subsequently generalised his argument in his Nobel Prize article, 'The Problem of Social Cost', and suggests an approach toward dealing with harmful effects on others that is based on comparing the total societal product yielded by alternative social arrangements.

In general, the market approach is based on designing well defined exclusive property rights to the use of the spectrum that could be auctioned and traded while allowing maximum flexibility (Baumol and Robyn, 2006). Such flexibility could be provided through two elements, namely, radiocommunication service allocation flexibility and technology neutrality (Chaduc and Pogorel, 2008). Although there have been several theoretical attempts to define spectrum property rights, none of them have been adopted in practice (Vany et al., 1969, Cave and Webb, 2003, Cave and Webb, 2012, Vries and Sieh, 2012).

Several approaches to develop spectrum property rights have emerged nationally. For instance, Ofcom designed a model called 'Spectrum Usage Rights' (SUR) as a way of defining spectrum property right. SUR specifies the maximum level of interference that can

be caused, rather than the power that can be transmitted (Ofcom, 2008). However, there were some difficulties associated with SUR with the result that the model was eventually applied in only a limited number of cases (Eurostrategies and Ls-Telecom, 2007). The FCC studied an approach to define spectrum property rights called 'Interference Temperature' where transmission is permissible as long as the resulting interference at any unintended receiver does not exceed a certain level (Evcı and Fino, 2005). The approach was quite complex, a factor that no doubt led the FCC to decide in 2007 to abandon it, as it was impractical and may have increased interference levels (Weiser and Hatfield, 2008).

Furthermore, in 1996 Guatemala applied a private property rights approach to spectrum management where spectrum rights define ownership by specifying parameters such as the band or frequency ranges, hours of operation, geographical coverage area, and the maximum field strength or signal strength at the border of the coverage area (Hazlett and Muñoz, 2006). In El Salvador, a liberal approach to spectrum management was adopted in 1997. Spectrum assignments were technology neutral, and although the regulator allocates specific service to each spectrum band, users can deviate from such allocation without a penalty being imposed (Hazlett and Muñoz, 2006). However, it is difficult to assess the influence of these approaches considering the relatively small size of these two countries.

In Australia, spectrum property rights are defined by maximum transmit power, maximum out-of-band interference, and the maximum out-of-area interference (Cave and Webb, 2003). Cave and Webb (2003) point out that although there have been few cases of interference; the rights are not flexible enough to accommodate multiple different uses. In Europe, a concept called Wireless Access Policy for Electronic Communication Services (WAPECS) was introduced to enable more flexibility within the EU spectrum management framework by allowing using the spectrum on a technology and service neutral basis within certain technical requirements to avoid interference (RSPG, 2005). The service term in WAPECS is different than the radiocommunication service term used by the ITU-R and, therefore, WAPECS cannot be considered as fully flexible in terms of the ITU-R radiocommunication service allocation.

IV. Radiocommunication Service Allocation

The international spectrum management regime was created in line with the formulation process of national spectrum management. The main principles of the regime are the sovereign right of each state to assign its frequencies to any service or station (Lyll, 2011), and that all radio stations must not cause harmful interference to other stations, which operate in accordance with the provisions of the ITU Radio Regulations (RR) (ITU-R, 2008b). The radio sector of the ITU (ITU-R) is the administrative cooperation body responsible for setting the regime's rules through the RR and the ITU-R resolutions, recommendations and reports. The RR have international treaty status, and they are binding on all ITU-R countries (Maitra, 2004).

Allocating spectrum to the different services is the main responsibility of the ITU-R. In particular, the ITU-R table of frequency allocation divides the frequency band from 9 kHz to 400 GHz into smaller bands that are allocated to more than 40 radiocommunication services (ITU-R, 2001). Dividing the spectrum according to the type of service and global harmonisation of spectrum allocations are the ITU historical methods to mitigate harmful interference. More specifically, the level of protection required by one type of service, may

not be suitable for another type of service (ITU-R, 1995). The ITU-R divides the world into three regions in terms of spectrum allocation¹.

Decisions relating to spectrum allocation are taken during ITU-R World Radiocommunication Conferences (WRCs). Within WRCs, four main aspects of the spectrum are discussed:

- Type of radiocommunication service (for example, fixed, mobile);
- Type of access (primary and secondary);
- Allocation geographical areas (globally or regionally); and,
- Technology characteristics (for example, maximum transmitted power).

The WRC resolutions and recommendations are part of the RR, and thus have international treaty status. Significantly, the agenda of the current conference is determined by the previous one. Items that could be part of the agenda include revisions to the RR and any other question of a worldwide character that falls within the remit of the conference (Itu, 2011).

In case spectrum use nationally is in conformity with the primary or secondary services in the ITU-R RR, this use is protected against interference from primary and secondary services allocated in the same band, or from secondary services but cannot claim protection from primary services in the same band respectively (Indepen, 2001). Otherwise, a country cannot claim protection from primary or secondary services in the same band but could operate on a non-protection non-interference basis according to the ITU-R Article 4.42. In addition, a band could be indicated in a footnote of the ITU allocation table as being allocated to a particular service on a primary or secondary basis in an area smaller than a Region, or in a particular country (ITU-R, 2008a). However, other neighbouring countries may block such use if it will restrict their own use.

In addition to footnotes, countries can register their important frequency assignments with the ITU. There are two types of registration (Ryan, 2005). The first is called a priori planning which enables a guarantee of access to the spectrum where each country submits its requirements at a world or regional planning conference. An example of this is the ITU Regional Radio Conference of 2006 (RRC-06). This conference planned to allocate the 470-862 MHz band for digital broadcasting in Europe, Africa, the Middle East and Iran in what is called the Geneva-06 agreement (GE-06) (O'leary et al., 2006). Following RRC-06, WRC-07 and WRC-12 approved having the primary allocation in the 790-862 MHz and 694-790 MHz respectively for mobile service in addition to the broadcasting service (Beutler, 2012). Although WRC-15 discussed the possibility of having additional primary mobile allocation in the 470-694 MHz band, it was not possible to agree on the allocation due to significant resistance from most countries in Region 1.

The second type of assignment registration in the non-planned bands is on a 'first come, first-served' basis in the ITU-R MIFR. Such registration requires conformity with the ITU-R service allocation table and not causing harmful interference to existing assignments in other countries (Lyll, 2011).

¹ Region 1 comprises Europe, Africa, the Middle East west of the Persian Gulf including Iraq, the former Soviet Union and Mongolia. Region 2 covers the Americas, Greenland and some of the eastern Pacific Islands. Region 3 contains most of non-former-Soviet-Union Asia, east of and including Iran, and most of Oceania.

² The RR Article 4.4 states that "*Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations*".

The WRC-12 discussed how to enhance the international spectrum regulatory framework, where prior to the conference the ITU-R studies approached the issue from two perspectives. The first perspective focused only on convergence between fixed and mobile services, while the second addressed spectrum allocation issues more generally (ITU-R, 2011). Eventually WRC-12 decided not to change current spectrum allocation practices with regard to the two issues (ITU-R, 2012b). Nevertheless, it was decided to continue the studies on revising the definitions of fixed service, fixed station and mobile station until WRC-15 (ITU-R, 2012a). During WRC-15, it was evident that there is no intention to amend these long standing definitions, and it was decided to no change to the RR during the first week of the conference (ITU-R, 2014, ITU-R, 2015).

V. Interaction of International Spectrum Management Regime and National Spectrum Management Approaches

In general, the interviews revealed two trends regarding the dependence of countries on the RR in terms of their radiocommunication service allocation. The first is that some countries tend to make changes to the RR in order to introduce changes nationally. This trend is usually favoured by developing countries, which would wait for the ITU-R approval before adopting a particular service allocation. This is not because they are forced to do so, but mainly because it is advantageous for them to follow the ITU-R service allocations. The second trend is to introduce changes in the ITU RR following the success of changes in service allocation nationally. Countries that adopt such trend are those with large populations (for example, the United States) or in isolated geographical locations (such as Australia and New Zealand).

In addition, it was argued by several interviewees that such influence depends on the interpretation of each country of the RR. For instance, Japan adopts a very literal interpretation of the ITU-R regulations and recommendations. On the other hand, the RR article 4.4 is a key element in US spectrum policy. The influence is also related to the population distribution of the country. For instance, in the US, relatively little of the population lives along the Mexican border while this is not the case for the Canada / US border. Such influence also depends on the size of the market, which, in turn, determines the ability of a country to deviate from the RR.

Regarding the influence of the RR on introducing more flexibility into radiocommunication service allocation nationally, most of the interviewees (33) indicated that any country can do whatever it wants as long as it is not causing interference with its neighbours. This implies that, in practice, there are only restrictions on borders area. The issue of spectrum property rights is a national issue while the RR provide a global framework for the harmonised use of the spectrum. The ITU framework promotes sharing, as it accommodates three categories of service allocations - primary and secondary and permitted use - according to the RR Article 4.4. In addition, the RR allow multiple service allocations in the same spectrum band and, therefore, flexibility could be introduced by having additional service allocation.

Moreover, the RR accommodate several examples where there are forms of flexible spectrum property rights. One case of this is the identification of the International Mobile Telecommunication (IMT) in the 3.5 GHz band where technical conditions of Power Flux Density (PFD) level were included in the RR so that mobile service could operate in a band where there are allocations to other radiocommunication services. Another interviewee explained that conditions associated with technical conditions of spectrum property rights at the national level could be incorporated in the RR by footnotes. The following quote from one of the interviews could be considered as a summary of the view that the RR provide

enough flexibility: *“The artist Picasso once said, “form liberates” ...so it creates certain constraints, but it also leaves a lot of freedom within those bounds”*.

On the contrary, there were views that there are specific spectrum bands where there could be restriction from one radiocommunication service on another such as the case of the UHF band where there are co-primary allocations between mobile and broadcasting services, or the case of special radiocommunication services such as satellite or radiolocation. Moreover, compatibility studies conducted in the ITU-R on allocations to be discussed at WRCs may to a degree influence national decision regarding service allocation.

Regarding the influence of the RR on the limited application of the spectrum market approach in practice, there were two views among interviewees. The first is that the limitation of spectrum trading was more due to the view that the market environment does not encourage spectrum trading rather than any regulatory structure. The second is that the traditional rigidity of the RR in terms of definitions of use did influence negatively the spectrum market, which requires certain fungibility where one spectrum use can be replaced by another use.

VI. Radiocommunication Service Definitions

One element that is worth examining is the current radiocommunication service definition in the ITU-R RR on national regulators' flexibility. We shall focus on three radiocommunication services: fixed, mobile and broadcasting. This is important considering that convergence could enable application to operate under more than just one radiocommunication service.

The data analysis showed two distinct views on the issue. The first is that the current ITU-R definitions are not restricting flexibility for the following reasons. Firstly, convergence is happening on the application level where different equipment under different services can provide similar services to those provided by other services. However, this is not happening at the radiocommunication service level. For instance, while mobile networks are carrying content, this happens within a mobile environment, which is different than a broadcasting environment from a radiocommunication service viewpoint. In other words, convergence on the application level does not necessary mean convergence in radiocommunication service allocations. Therefore, flexibility is already provided in the current ITU-R service structure, as the different application could be provided through different type of radiocommunication services.

In addition, separation between services is needed to conduct sharing studies as radiocommunication services have different sharing criteria. Hence, combined or hybrid services will make sharing more difficult, as it is unknown which radiocommunication service you have to share the spectrum with. Besides, concerns were expressed in case of changing the definitions. For instance, the flexibility in the interpretation of the RR definitions may create a problem in licensing, since the operators are also categorised as mobile or fixed. Secondly, there would be a need to change several ITU-R recommendations and reports. Moreover, it was clarified that the ITU-R services are not necessarily mutually exclusive, which means that there are common areas between the different radiocommunication services (for example, Wi-Fi lies between the fixed and mobile services). This enables the current definitions to accommodate convergence.

With respect to the convergence between fixed and mobile services, it was indicated by the interviewees that this is not an issue, as in most cases there is a common allocation between fixed and mobile. Moreover, having merged fixed and mobile services would lead to more coordination and less effective use of the spectrum, because in such case there would be

a need to consider the worst case of non-directional antenna of the mobile service while the fixed service creates less interference outside its directional beam. Regarding convergence between broadcasting and mobile, it was expressed that it is difficult to implement services of high power next to bidirectional telecommunications services like mobile services as they have different technical characteristics. Another interviewee, a broadcaster, argued that the definitions are valid as the broadcast concept is point-to-area and not point to multi point, so there is a clear difference between mobile and broadcasting service. Moreover, there is a topological difference between broadcasting and mobile in which the broadcasting network has the topology of high power and high tower, although, of course, mobile networks can broadcast TV content.

On the other hand, there were views that some of the radiocommunication service definitions are old and do not correspond to the current state of affairs. More specifically, some radiocommunication services that are supposed to be fixed are used in reality as mobile, which creates problems in registering these definitions in the ITU-R MIFR. Another example is mobile networks where the downlink frequencies could be used for delivering linear TV while it is not categorised under broadcasting service according to the ITU-R.

There was also another view that there is a need to refine the definitions specifically to address the difference between point-to-point and point-to-multi-point applications. In particular, it was pointed out that there are deficiencies in the fixed service definition regarding the case of point to multi-points communication, which gives the impression that nomadic services belongs to fixed services. One other view was that there should be a move towards non-specific allocation as individual platform can now carry a multiplicity of services. In addition, there is a move from high power/large cell to low power/small cell and this makes the ITU-R approaches less essential. Furthermore, the service definitions for the mobile and fixed services are out-dated, because there are technologies that fall in between. Therefore, it was suggested that nomadic use could be part of the mobile service.

VII. Decision Making Procedures

Regarding the influence of service allocation decision-making procedures at the ITU-R on national regulators' flexibility, there were two views. The first is that these procedures do not restrict flexibility, as they have been able to accommodate many different types of technology developments over numerous years. The working methods of the ITU-R are determined by its member countries. Regarding the long cycle between the conferences, it was argued that while some may find it not time efficient, it has also a protection against the technology gap that exists between developed and developing countries. In addition, the decision system is based on reaching consensus, and it inevitably takes time to agree on a decision. As expressed by one of the interviewees: *"WRC restores my faith in humanity in that a hundred and ninety countries can get together albeit they are with competing either national or regional interests, and yet at the end of 4 weeks of hard work they can actually arrive at an agreement"*.

Besides, quicker decisions increase the risk of making the wrong decision that needs to be changed afterwards. Furthermore, WRCs are sovereign and modification of the agenda can be done at the plenary of the conference. It was also argued that there should be a balance between regulatory certainty to encourage investment and flexibility in order to cope with the pace of technology. More specifically, these stringent and clear rules are important to foster regulatory certainty internationally. It was also mentioned that although WRC is a treaty making conference, countries may legally deviate from it. More specifically, while the final

act is signed by the member states, they can at the time of signature record their reservations towards particular propositions that may conflict with their national interest legislation.

On the other hand, there was a view that the current ITU process may limit the capabilities of countries to introduce flexibility into their spectrum use. In particular, countries cannot make decisions until the time of a WRC. Moreover, more frequent meetings of WRCs may be needed as decisions can only be taken every three or four years and seven to eight years to have a new issue on the agenda of the conference. It was also expressed that technology does not wait for the ITU to meet and that the process is slow “*in six to eight years GSM went from nothing to be the major mobile technology*”. Therefore, it was suggested to hold conferences that relate to the particular issue.

VIII. Footnotes

There were two distinct views on the influence of footnotes on radiocommunication service allocation flexibility. On one hand, there was a view that footnotes provide flexibility to deviate from the RR, as they could be used to respond to the particular request of the country in order to have international protection for them and a legal basis to coordinate. In addition, footnotes could provide flexibility via additional or alternative service allocation or to be exempted from a service (for example, developing countries want to use the C-Band for IMT while in island countries, fixed satellite service is more attractive). Moreover, when a new allocation is made at the conference, some countries may need time to re-farm some radio spectrum bands in order to adopt this new use. In such cases, footnotes could be used to indicate that in this particular country there will be a specific additional allocation at least until the next WRC.

Another use of footnotes is using them as part of negotiations with neighbouring countries. In other words, they could be used as part of the trading positions regarding other agenda items in WRCs. One other use that was mentioned by interviewees is that footnotes may be used by countries that have some special interest. For instance, the WRC may decide to allocate a specific band for maritime mobile service but a land-locked country may not have access to the sea. Hence, such a country may use the band for another use (such as land mobile). One other useful feature is that footnotes could provide flexibility when it is hard to reach a compromise and they could be also considered as a starting point for harmonised allocation in the RR “*it gives the opportunity it to build confidence and then expand that out*”. One example of such footnote is the mobile footnote in the C-Band, which was argued to be useful for the mobile community as the footnote has large number of countries participating so that it has similar effect to regional allocation in the RR.

On the other hand, there was a view that footnotes could be used to constrain spectrum use. For instance, they could be used to provide priority to the incumbent service or to reduce flexibility in case they remove an allocation out of the RR. Moreover, the flexibility provided to some countries may reduce the flexibility to a neighbouring country. Finally, it was clarified that the large amount of footnotes complicates the understating of the RR, and that global harmonisation would mean fewer footnotes.

IX. Three Region System

Regarding the influence of the three regions system on radiocommunication service allocation flexibility, one view was that while the ITU-R is trying to achieve harmonisation between the three regions, the system per se does not restrict flexibility. Moreover, by having three regions, it is easier to decide on a flexible allocation within each region. More specifically, it allows for having different frequency plans in different regions and the

division of the three regions makes it less problematic to reach consensus. In other words, the division makes it possible to get an agreement in one region, as the alternative would be to block the whole agreement globally. It was also expressed that the division is unavoidable due to the different interests and requirements that exist between countries. This may be related to geographical circumstances; for example, in tropical countries they often need the C band because of propagation conditions.

On the other hand, it was argued that the division creates problems when the same spectrum bands are used for different services between the three regions. Some interviewees argued that the three regions are, in practice, six regions and that for Regions 2 and 3, flexibility is much better than region one where you have got four smaller regional groups - CEPT, ASMG, ATU, and RCC - that all have to agree. Moreover, countries on the borders between the regions - such as Iran, which lies in Region 3 but share borders with Region 1 - face additional challenges. Therefore, it is argued that the three regions system does not restrict flexibility for regions but it restricts flexibility for countries located on the borders of the regions.

X. A Priori Planning

The analysis of the interviews revealed that the GE-06 agreement already accommodates flexibility, because it has not included the very detailed frequency planning and has not set up a specific situation with geographically fixed data. Accordingly, the values of the coordination trigger used in GE-06 provide sufficient flexibility for countries to make use of their international spectrum use with regard to their neighbours. Another interviewee explained that flexibility depends on a country's position, and how diverse use by their neighbours is. Therefore, GE-06 could provide flexibility to introduce mobile service if, for example, that is the common approach adopted by neighbour countries. Furthermore, the plan can accommodate new broadcasting standards, such as DVB-T2 although the plan was originally based on DVB-T.

There was a contrasting view that a priori planning conferences cannot anticipate technologies and, as a result, they always need to be updated. The development of new services has made the life cycle of such agreements much shorter compared to previous agreements. Another argument against a priori planning conferences is that these conferences take a lot of time and effort and coordination is still needed. It was also mentioned that it would have been easier if, during RRC-06, the decision of WRC-07 to allocate the band 790 to 862 MHz for mobile service had been taken into consideration. In addition, these conferences could be a restrictive because they are regional conference, which means in practice that only a regional conference can make any modifications to the agreement.

XI. MIFR

In general, it was indicated during the interviews that a country's dependence on MIFR is related to its geographical position and its relationship with neighbouring countries. Therefore, in cases where it is difficult to register assignments due to neighbouring countries, there would be a need to have bilateral agreements with them. Another important issue that was raised by one of the interviewee is that if there is no registered assignment in a particular band, this may provide an indication that band should be reallocated to another service. An example of this is related to the C-band where today many FSS stations are registered in the MIFR. However, before WRC-07 where IMT identification in the band was discussed, not that many stations were registered but then the satellite community invited countries and operators to register their stations to provide an indication of the actual use of the band.

Regarding the influence of MIFR on flexibility, one view was that MIFR is not related to flexibility but to international recognition of the spectrum used in a country with respect to other countries. In addition, changing the assignments could be conducted at any time unlike the case of footnotes where you have to wait for a WRC to amend them. Moreover, it was pointed out that while MIFR may formally impose a restriction because all the data about the assignments must be submitted it does not, however, restrict them in practice. This is due to many countries do not registering their assignments.

On the other hand, it was argued that registering assignments might restrict neighbouring countries' flexibility. In particular, it could restrict countries registering their assignments in the future in cases where changes have occurred. Therefore, one interviewee argued that it is better to have good agreements than to do it through the ITU-R because it is restricting possibilities for countries that register their assignments as well. It was also argued that there is a trade-off between flexibility and protection where in cases there is a need for flexibility, international protection would not be provided by the MIFR. More specifically, if the national assignments are flexible enough, they will not be registered in the MIFR, which has specific rules so that it would be possible to register the assignment under one allocation.

One point that was raised during the interviews is that there should be a filter to distinguish real assignments from assignments that are not deployed in practice. Some countries register assignments and even after these assignments become unused and out-dated, they do not withdraw such assignments. Moreover, there is no good mechanism to delete these entries and, therefore, this could be a restriction as the ITU does not have any means of determining real deployment and in case countries claim some deployment, the ITU have to accept such claim as true.

XII. Conclusions

In general, our analysis has shown that the RR are perceived more as a framework for harmonisation while not constraining the ITU-R countries' flexibility in order to enable the mass production of equipment and to raise the economic value of the spectrum. In other words, while countries are sovereign when it comes to radiocommunication service allocation, they simply follow the RR for the sake of gaining harmonisation benefits and protecting against interference. Moreover, countries are only restricted on the borders with their neighbours and flexibility is already enabled through different measures such as having multiple allocations in the same band.

While the current ITU-R radiocommunication services definitions are not necessarily mutually exclusive, and in most cases there is a common allocation between the different services which provide additional flexibility, some of the radiocommunication service definitions are old and do not correspond to today's circumstances. Additionally, one view is that the ITU-R decision-making procedures do not restrict flexibility, as they were able to accommodate any type of technology developments over numerous years, and ITU-R countries themselves set them. The other view is that these procedures may limit countries capabilities to introduce flexibility to their spectrum use, as they cannot make decisions until the time of a WRC. Regarding footnotes, the interviews revealed that they are considered as a double-edged sword; while they are a relatively adequate tool to introduce flexibility, they may also restrict spectrum use in neighbouring countries.

With respect to the influence of the three regions system on radiocommunication service allocation flexibility, one view was that while the ITU-R is trying to achieve harmonisation between the three regions, the system does not restrict the flexibility except for these countries on the borders between the regions. The examination of the a priori planning

conferences highlights the view that while they allow enough flexibility to accommodate other uses and technologies, these conferences could be restrictive because only a regional conference can make any modifications to regional agreements. Moreover, one view was that MIFR is not related to flexibility but to international recognition of the spectrum used in a country with respect to other countries, registering assignments in the MIFR may restrict neighbouring countries' flexibility.

In conclusion, it is shown that the international spectrum management regime permits relative degrees of flexibility to ITU-R countries in terms of radiocommunication service allocation. This flexibility depends mainly on the interpretation of the RR, which is related to a country's national laws and whether what is not allowed is what is not mentioned in the law or what the law forbids. Moreover, several elements of the RR could be used in both ways, to promote countries' flexibility or to restrict the decisions of others. Besides, the degree of flexibility or restriction is related also to the geographical position of countries, size of market, population distribution, and, most importantly, its relationship with its neighbouring countries.

At the end of the day, it is the ITU-R countries themselves that formulated the different RR elements, and the ITU-R as an entity cannot enforce any country to follow the RR. The nature of some radiocommunication services such as broadcasting or satellite requires a certain degree of restriction to promote efficient use of the spectrum without harmful interference. Furthermore, it seems that the main concerns for countries today is harmonisation even if it is traded off against less flexibility. Last but not least, we have shown that the international spectrum management regime is not one of the reasons for the unsuccessful application of flexible spectrum property rights concept in practice. This leads to the suggestion that there is a need to review whether there still is a need for such concepts given the increasingly importance of global harmonisation and economies of scales.

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