

The APT Frequency Arrangement in the 700 MHz: Reflections on the International Spectrum Management Regime

Mohamed El-Moghazi

Department of Electronic & Electrical Engineering, University of
Strathclyde

Jason Whalley

Newcastle Business School, Northumbria University

James Irvine

Department of Electronic & Electrical Engineering, University of
Strathclyde

Abstract: Following WRC-12, discussions have emerged with regard to the frequency arrangements in the 700 MHz band, out of band emissions (OOBE) of the mobile terminals below 694 MHz considering the allocation of the 694-790 MHz band to the mobile service.

These discussions have shown that there is a tendency to partially harmonise with the APT plan and to adopt APT OOBE values. This reflects the emerging approach of countries in Regions 1 and 2 that are aligning themselves with Region 3 to lower the cost of end user equipment. Countries such as Australia and New Zealand are leading the discussion in Region 3.

The 700 MHz issue has revealed that the ITU-R decision making procedures are mostly based upon consensus with the possibility of few countries blocking the discussion. Moreover, it suggests that there is a need to revise the current ITU-R structure of three regions.

Introduction

African and Arab countries made their voice heard during the World Radiocommunication Conference (WRC-12) when they called for an immediate allocation of the 694-790 MHz band to mobile service to meet growing demand for broadband. Even so, the European countries opposed the proposal, arguing that the band is heavily utilised by broadcasters in their countries. Eventually, the conference approved the allocation, which was effective immediately after WRC-15 (El-Moghazi, Whalley, & Irvine, 2013).

Following WRC-12, a discussion has emerged with regard to the frequency arrangements in the 700 MHz band, and limits of the out of band emission (OOBE) of mobile devices in the

700 MHz band. During these discussions, it was evident that the influence of the APT countries, which lie in ITU-R Region 3ⁱ within the ITU-R, has been extended to Regions 1 and 2. In particular, it seems that the APT frequency arrangement and OOB values in the 700 MHz in Region 3 did have further consequences on the discussions in the other Regions.

Accordingly, the overarching research question of this paper is formulated as 'What are the policy implications of the 700 MHz band mobile allocation in Regions 1 and 2 given the APT activities in Region 3?'. More specifically, the paper examines the influence of the APT plan for 700 MHz on the other ITU-R regions and the role that was played by geographical isolated countries such as Australia and New Zealand. Additionally, the paper reflects on the decision-making procedures of the ITU-R and the three region systems.

The rest of the paper is organized as follows. Section two explores the literature review on the 700 MHz issue while Section three highlights the adopted research method. Section four and five examines the frequency arrangements in the 700 MHz and OOB values. While Section seven discusses the different policy implications of the 700 MHz issue, Section eight concludes.

Literature Review

The ITU is the main institution of the international telecommunication regimeⁱⁱ (Cowhey & Aronson, 1991). One of the main normsⁱⁱⁱ of the international regime is organising global commons (e.g., spectrum) while the regime's decision-making procedures are based on one vote for each country within the ITU (Cowhey, 1990). The Radiocommunication Sector of the ITU (ITU-R) discusses the wireless industry main issues through WRC, which aims at reviewing and revising the international Radio Regulations (RR) (Gregg, 2009).

WRC is one of the ITU-R conferences that consider specific radiocommunication matters. Regional organizations usually present common proposals to the WRC on behalf of their member states as proposals must have the support of more than one administration to be considered (Contant & Warren, 2003). There are six main regional organisations in the ITU-R, namely, European Conference of Postal and Telecommunications Administrations (CEPT), the Asia Pacific Telecommunity (APT), the inter-American commission of telecommunications (CITEL), the Arab Spectrum Management Group (ASMG), the African Telecommunications Union (ATU), and The Regional Commonwealth in the field of Communications (RCC).

The WRC-12 has witnessed the success of Arab and African countries in acquiring an additional allocation to the mobile service in the 700 MHz band in region 1 so that growing demand for broadband in ITU-R regions 2 and 3 could be met (Standeford, 2012b, 2012c). The European countries opposed such proposals because the 694-790 MHz band is mainly

used for broadcasting service in their territories and a large investment has already been made to fund the transition to digital television (Sims, 2012). Eventually, WRC-12 decided to allocate the 694-790 MHz frequency band in Region 1 to mobile service on a primary basis in addition to the existing primary broadcasting service and to identify the band for IMT (ITU-R, 2012b).

Historically, most of the UHF band (470-862 MHz) was planned for analogue terrestrial broadcasting service in Region 1. In 2006, the Regional Radiocommunication Conference 2006 (RRC-06) planned the digital terrestrial broadcasting service in Region 1 and in the Islamic Republic of Iran to be in the frequency bands 174-230 MHz and 470-862 MHz (ITU, 2006). Shortly after that, the WRC-07 approved an additional allocation in the frequency band 790-862 MHz to mobile service effectively from 17 June 2015 (ITU-R, 2007).

Following WRC-12, the ITU-R studied the channelling arrangements for the mobile services adapted to the frequency band below 790 MHz taking into account the existing arrangements Region 1 in the bands between 790 and 862 MHz, the harmonization with arrangements across the three regions, and the compatibility with other primary services to which the band is allocated including in adjacent bands. To achieve that, the Joint Task Group 4-5-6-7iv (JTG 4-5-6-7) was established (Stirling, 2012).

Methodology

In order to answer the main research question, this paper adopts a qualitative methodology that examines the case study of the APT countries regarding the 700 MHz mobile allocation in the period until WRC-15. More specifically, the paper focuses on two main issues from the APT perspective namely, OOB values and frequency arrangements in the 700 MHz. Case studies require conducting a detailed investigation of specific case(s) in order to obtain a closer insight into the context and processes involved in the research subject (Meyer, 2001).

The paper also adopts an inductive approach where the theory is developed based on the observations or the findings of the research (Bryman & Bell, 2007). Inductive research is more suitable when the researcher intends to understand the nature of a problem and is concerned with the context in which events have taken place (Saunders, Lewis, & Thornhill, 2009). The context in this paper is the discussions related to the 700 MHz issue within the ITU-R.

The paper is based on primary data collected mainly through semi-structured interviews with the several stakeholders that participated in the 700 MHz debate during and after WRC-12. The paper also draws on the observations made by the lead author who attended meetings where the 700 MHz allocation was discussed. In addition, the paper is driven from

secondary data from the APT countries' contributions in the various ITU-R working parties (WPs).

The difference between unstructured and semi-structured interview is that the former is similar to a conversation and could contain one question, while the latter comprises a list of questions on specific topics (Bryman & Bell, 2007). However, structured interviews have a rigid structure that cannot be easily modified (Bryman & Bell, 2007).

Interviews were selected for a variety of reasons (Saunders et al., 2009). Firstly, they enabled the interviewer to build on their responses and thus explore issues as they emerge in greater depth. Secondly, personal contact helps achieve a greater response rate as interviewees may hesitate when providing sensitive data or be reluctant to spend time explaining their answers. For confidentiality reasons, the names of the interviewees are not disclosed.

Frequency Arrangements

The first issue that is related to the 700 MHz mobile allocation is the frequency arrangements or channel planning in the 700 MHz band in region 1 considering harmonisation with the other regions. Channel planning accommodates type of channel duplex mode (Frequency Division Duplex (FDD) and Time Division Duplex (TDD)) and the width of the channel (e.g. 20 MHz). The issue of agreeing on one frequency arrangement in the 700 MHz band was quite important, as having different arrangements in the band would negatively influence global harmonisation between the three ITU-R regions.

In Europe, CEPT adopted a plan in the 800 MHz that operates in the bands 791-821 MHz, 832-862 MHz and provides 2x30 MHz for FDD operation. In addition, the US adopted a more complicated plan that comprises a mix of FDD operation in the bands 698-716 MHz, 728-746 MHz, 746-763 MHz, and 776-793 MHz and TDD operation in the band 716-728 MHz (ITU-R, 2012a). The US plan has the disadvantage of being highly fragmented and it offers less spectrum for mobile broadband use (Zehle, 2013). In addition, there are interoperability difficulties between the different band blocks in the US plan (Standeford, 2012a).

In Asia, at the beginning, there were views to partially harmonise with the US plan in the 700 MHz band (APT, 2009). The 700 MHz band was of a critical importance to Region 3 countries because most of the 800 MHz band is used for application other than mobile (APT, 2009). Eventually, the APT adopted a plan in the 700 MHz in 2010 that operates in the bands 703-748 MHz and 758-803 MHz and provides 2x45 MHz for FDD operation of broadband systems (APT, 2010). Figure 1 (below) shows the APT plan and the guard band between it and the digital terrestrial TV (DTTV) in the UHF band.

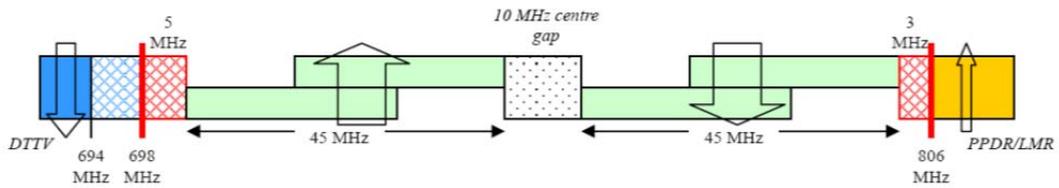


Figure 1 - Harmonised FDD Arrangement of 698-806 MHz band (APT, 2010)

In Latin American countries, shortly before the WRC-12, CITEL countries adopted a new recommendation highlighting two options for frequency arrangements in the 700 MHz, mainly the APT FDD and the US plans (CITEL, 2011). By 2013, the number of countries in Region 3 who decided to adopt the APT 700 MHz plan was 18 countries – all of the countries in Region 3 except for Bolivia had decided to adopt the US band plan (Bateson, 2014; Migwalla, 2013).

The APT band plan is different than the other plans because it compromises of a dual-duplexer arrangement with 2x30 MHz for each one (APT, 2010). The reason for adopting dual-duplexer is that the maximum bandwidth of a duplexer for a terminal at this frequency range is usually around 30-35 MHz (APT, 2009). Therefore, it is difficult to have a user handset that covers the 2x45 MHz of the APT plan with only one duplexer.

The APT plan overlaps with the CEPT plan in the band 791-803 MHz, which means that countries cannot adopt both of the two plans at the same time and a choice between them has to be made. If a country decides to adopt the CEPT plan, it will not be able to utilise the large bandwidth of 45 MHz of the APT plan in the 700 MHz. On the other hand, fully adopting of the APT plan would impact the harmonisation with CEPT plan as shown in Figure 2 (below).

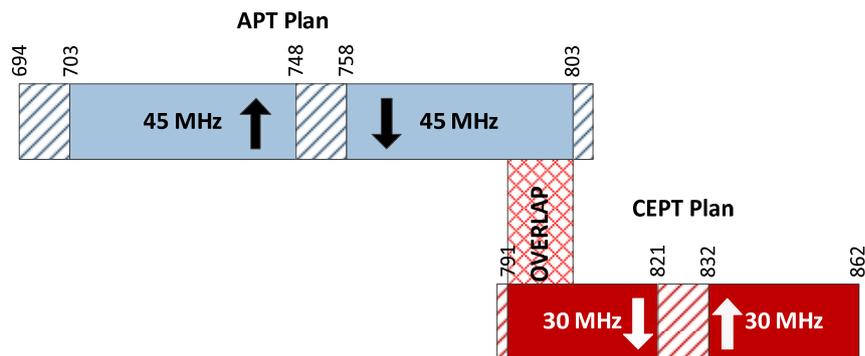


Figure 2 Overlap between the APT Plan in the 700 MHz Band and the CEPT Plan in the 800 MHz Band (Egypt, 2012)

Similarly, adopting the CEPT plan in full would contradict with the CDMA or GSM plans in the 850 MHz that is used by many countries in Africa, and using the CDMA 850 or GSM 850 band plans in their entirety would contradict with the plan of the 900 MHz that is used for

systems such as GSM900. Figure 3 (below) shows the shows the different frequency arrangements in the 700 MHz, 800 MHz, 850 MHz, and 900 MHz bands.

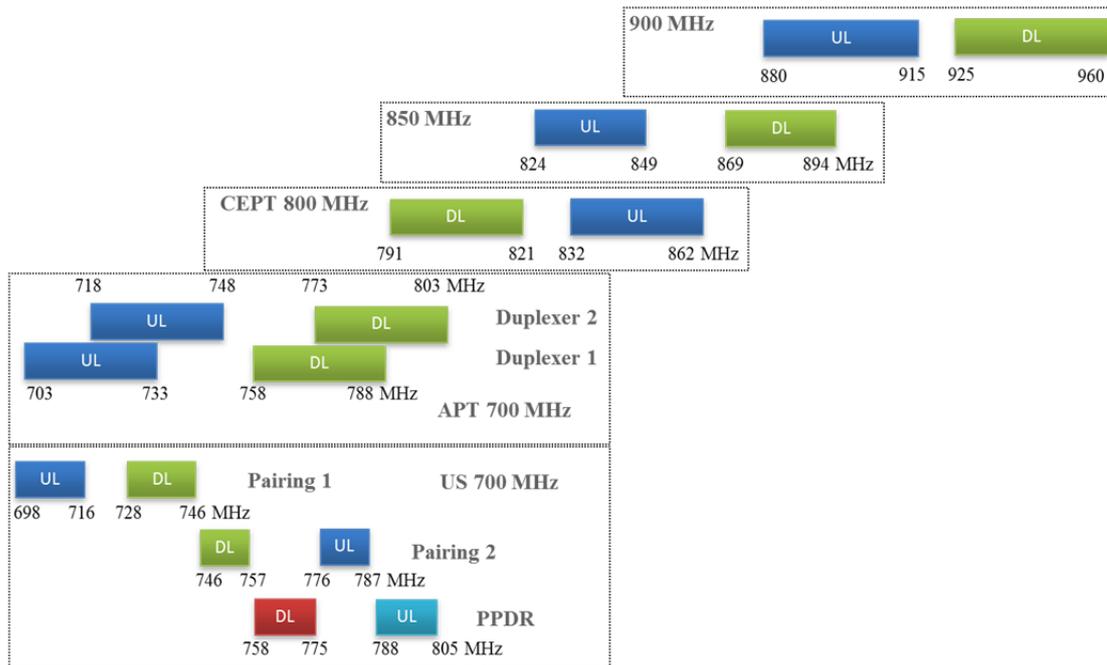


Figure 3 - Frequency Arrangements in the 700 MHz, 800 MHz, 850 MHz, 900 MHz (Rancy, 2012)

Having said that, harmonisation between the CEPT 800 MHz plan and the APT 700 plan is possible by adopting the lower duplex of the APT plan of the spectrum bands, 703-733 MHz and 758-788 MHz as shown in Figure 4. This implies that end user equipment can operate according to the APT plan in the 700 MHz band in the Asian countries while being able to roam in Europe on the 800 MHz band using the CEPT plan.

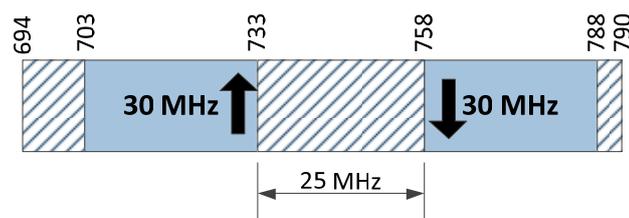


Figure 4 - Using the Lower Duplexer of the APT Plan (Egypt, 2012)

The issue of the preferred frequency arrangements in the 700 MHz in region 1 was discussed extensively in the WP 5D following WRC-12 where there were 14 different proposed frequency arrangements that were fully or partially harmonised with the APT plan (Migwalla, 2013). This indicates that harmonization with the APT plan was almost a common target in order to reap the benefits of economies of scale. In particular, at the beginning of the discussions, several African countries wanted to make the maximum use of the 700 MHz band by utilising most of the APT plan (e.g., 2x40 MHz), if not all (2x45 MHz),

even if that would be on the cost of losing harmonisation with the CEPT plan in the 800 MHz band (Egypt, 2013; Kenya (Republic of), 2014).

Meanwhile, CEPT countries made a proposal on the frequency arrangements issue indicating that CEPT is focusing its work on a channelling arrangement for IMT in the 694-790 MHz band which consists of 2x30 MHz of the lower edge of the APT plan in addition to up to 20 MHz (738-758 MHz) for supplemental downlink (United Kingdom of Great Britain and Northern Ireland, 2014). Eventually, it was agreed that channelling arrangements would consist of a common baseline arrangement: 2x30 MHz FDD (uplink: 703-733 MHz, and downlink: 758-788 MHz), which is the lower duplexer of the APT plan in the 700 MHz band (Working Party 5D, 2014). Outside of the ITU, several countries announced that will adopt the lower duplex of the APT plan (Bateson, 2013b; Youell, 2014).

Out of Band Emission (OOBE) Values

The second issue that was discussed following WRC-12 is the OOBE values of the mobile service terminals in the band below the frequency 694 MHz, which are required for the protection of broadcasting services. The issue with the OOBE values is that a too stringent OOBE limit would make it more technically challenging for IMT end user devices to meet them without further design complexity and cost increases. On the contrary, a less stringent OOBE limit may imply additional measures to protect the broadcasting service operating below 694 MHz such as filters on the broadcasting receivers (ITU-R, 2014).

One of the first identified OOBE value in the 700 MHz band was determined in association with the APT plan in 2011 to be not exceeding -34 dBm/MHz below the frequency 694 MHz which is equivalent to -25 dBm/ 8MHz (APT, 2011). Such a value was formally provided to the JTG 4-5-6-7 meeting by the APT (APT, 2013). Several African countries and mobile industry entities supported adopting such a value (ECOWAS Administrations plus Cameroon (Republic of), 2013; GSMA, 2013; Nokia Corporation, 2013, 2014).

During the discussion, several Arab and African countries made a significant step, which was perhaps the first of its kind, by conducting detailed technical studies themselves to support their arguments. More specifically, five African countries conducted Monte Carlo simulations and provided evidence that for the urban environment, IMT OOBE of -25 dBm/8 MHz represents an appropriate regulatory limit (Cameroon (Republic of), Kenya (Republic of), Lesotho (Kingdom of), South Africa (Republic of), & Zimbabwe (Republic of), 2013). Similarly, five Arab countries made similar contributions indicating the same result in terms of OOBE value (Bahrain (Kingdom of), Egypt (Arab Republic of), Qatar (State of), Kuwait (State of), & Emirates, 2013).

Later on, perhaps for the first time of the history of the ITU-R, 30 African countries presented common proposals to a study group meeting. These 30 African countries proposed that a OOB limit of $-25 \text{ dBm}/8\text{MHz}$ to be adopted as a suitable value for the protection of broadcasting service (Angola (Republic of) et al., 2014). On the other hand, some European broadcasters suggested OOB values in the range $-47 \text{ dBm}/8 \text{ MHz}$ to $-52 \text{ dBm}/8 \text{ MHz}$ (Broadcast Networks Europe, 2014), and Russia made a proposal to establish OOB limits for not higher than $-52 \text{ dBm}/8 \text{ MHz}$, or $-56 \text{ dBm}/8 \text{ MHz}$ (better), with a guard band not less than 9 MHz (Russian Federation, 2014).

There was a proposal to draft an ITU-R recommendation on the suitable values of OOB. After extensive discussion, the draft recommendation accommodated that the OOB of an IMT mobile station operating in region 1 in the frequency band 703-733 MHz with an IMT channel bandwidth greater than 10 MHz should not exceed $-25 \text{ dBm}/8 \text{ MHz}$ into the frequency band 470-694 MHz and that the out-of-band emission of an IMT mobile station operating in region 1 in the frequency band 703-733 MHz with an IMT channel bandwidth of 10 MHz or less should not exceed $-42 \text{ dBm}/8 \text{ MHz}$ into the frequency band 470-694 MHz (Chairman ITU-R Joint Task Group 4-5-6-7, 2014). This means that CEPT countries could achieve the $-42 \text{ dBm}/8\text{MHz}$ value by limiting the use of larger channel than 10 MHz to frequencies higher than 713 MHz. In fact, the $-42 \text{ dBm}/8 \text{ MHz}$ value was a political compromise within CEPT with the European broadcasters to provide further protection for their systems (Youell, 2015).

While most of the ITU-R countries attending the meetings supported such a recommendation, due to the opposition of a few countries the recommendation could not be agreed. In particular, there were two views. The first view was that the recommendation was mature and should be adopted and approved. On the other hand, Russia and Iran had the view that the draft recommendation was not mature enough to be agreed. Eventually, the OOB recommendation was approved in the Radio Assembly of 2015 with some changes to indicate that these OOB values would facilitate protection of the broadcasting service in the lower UHF band (470-694 MHz) rather than directly protect it (ITU-R, 2015).

Policy Implications

The 700 MHz mobile allocation issue has raised a lot of issues that needs further examination. Firstly, it seems that the APT plan adopted in Region 3 did have an influence on the discussion on the 700 MHz mobile allocation in the other ITU-R Regions. More specifically, the interviews with the main stakeholders revealed that although the European countries were against the 700 MHz mobile allocation during WRC-12, they agreed to the allocation considering that the Arab and African countries may align themselves solely to the

Asian APT band plan. If this occurred, the manufacturing industry in Europe would be the loser.

As further explained by one interviewee from an Arab country, the European countries were not ready at the WRC-12 in terms of having a suitable frequency arrangement. More specifically, APT and the US already had their frequency arrangements developed in the 700 MHz band. Moreover, adopting the APT band plan was perceived as being much more efficient in terms of lowering the cost and achieving roaming. A statement made by an interviewee conveys this current reality “much of Africa and Middle East has probably more aligned East to West (region 2 and 3) rather than North and South”.

Furthermore, one senior interviewee from the APT region explained that the APT wants to be in line with other regions as much as possible and this is the reason why the APT was keen that other countries from other regions follow their 700 MHz channel arrangements. One other interviewee from APT explained that it managed to develop a plan and there was interest in gaining momentum behind it. In particular, the Asian manufacturers had a special interest in gaining market share in the Arab and African countries. That was indeed a surprise for the European countries, who were used to determining what happened in the other countries located within.

Meanwhile, several interviewees indicated that some non-European countries, including the African and Arab ones, which were interested in the 700 MHz band allocation, were also keen to have the European countries agree on the allocation. More specifically, although the African and Arab countries intended initially to have an immediate allocation even in their own territories, they also wanted the European countries to join the allocation in order to have a regional allocation for all Region 1 countries.

However, at the WRC-15, the European countries would already be prepared and have their frequency arrangements in the 700 MHz band agreed. In fact, this is one of the reasons why the European countries requested to have the allocation activated by the time of WRC-15 and not immediately in WRC-12. In particular, one interviewee from CEPT explained that if the Asian, African and Arab countries are interested in that band, Europe would not miss the chance of having cheap handsets imported from Asia. One other interviewee from CITELE commented on the frequency arrangements proposed by the US and how it was expected that, at least, Canada and Mexico would follow the US to achieve economies of scales. However, Mexico despite incredible pressure from the US government decided to adopt the APT plan. One other senior interviewee from the US clarified that the US frequency arrangements originated from politicians rather than engineers.

The second issue that is worth examination is the role of geographical isolated countries such as Australia and New Zealand in the APT in leading the discussions in Region 3. Firstly, the APT plan emerged when New Zealand led several Asian countries to harmonise a frequency arrangement in the 700 MHz band. New Zealand was motivated by having its analogue TV services in the VHF bands; this made re-farming the use of part of the UHF band for the mobile service relatively easier (Newlands, 2010a). In particular, the beginning was when the Australian Communications and Media Authority (ACMA) sought views on the best possible plan for the digital dividend in Australia and Telstra and Telecom New Zealand made a joint proposal that was endorsed later on by APT and ACMA (Vanston, 2013). In fact, Australia was motivated by having a harmonised band plan in the 700 MHz with the Asian countries to achieve economies of scales (Newlands, 2010b).

Additionally, Australia was the first to have assignment in the 700 MHz in line with the APT plan (Bateson, 2013a) and the first to have a live network in the band via Telstra (Ericsson, 2014). Furthermore, not only were the Arab and African proposals regarding OOB values influenced by the APT decision on such values but also by the practical implementation in the APT region. For instance, in a regional African meeting, Egypt made a proposal to keep supporting the OOB value of $-25\text{dBm}/8\text{MHz}$ as a baseline for Region 1 considering the successful implementation of these values in Australia (NTRA of Egypt, 2014). Similarly, Australia reported to the JTG meetings its practical experience in deploying the APT plan in the 700 MHz band (Australia, 2013).

The third issue that needs close examination is the decision-making procedures of the ITU-R. The discussions in the ITU-R are based on consensus, which means that it is possible for few countries to have their views included. In practice this is what happened regarding the ITU-R recommendation on OOB. While the recommendation had the support of several African, Arab and European countries, it was not possible to obtain agreement regarding the recommendation during the ITU-R meetings.

In fact, consensus is related to one of the most important concepts in the telecom industry: harmonisation. If consensus is not possible, each group of countries would have their own solutions and economies of scales would not be achieved. However, consensus has the drawback of countries blocking the discussion even on the basis of linking the issue to other issues. What could be concluded on this issue is that countries are not totally independent in their decision making when it comes to international spectrum. In particular, while each country is sovereign in their territories regarding spectrum use, countries need the other countries agreement in order to have a regional or global harmonised use of spectrum. Otherwise, in most cases, countries do not have the scale to act alone in the telecom industry,

and even if they have the scale, they still need their citizens to be able to roam in other countries

Consensus is also related to the concept of mutual interests, which the international telecommunication regime is based on. Zacher (1996) explains that the creation and durability of international regimes is based on the existence of important mutual interests in cooperation. The concept of mutual interest was quite evident in the issues of OOB where the African and Arab countries tended to reach a win-win situation with the European countries, as having different OOB values for each group of countries will increase the prices of the user terminals and make them more complicated.

Having said that, it could be argued that the ITU-R decision-making procedures do not enable a particular group of countries to impose their views on others, and it encourages the ITU-R countries to reach a compromise. Such a compromise could imply that all participants are equally happy and unhappy. This is the reason why voting has rarely been used in the ITU-R. Meanwhile, the decision-making procedures could be considered as a double-edged sword due to the capabilities of few countries to block the whole discussion.

The fourth issue that needs highlighting is the three region system. In particular, while the 700 MHz mobile allocation discussion in the ITU-R was considered a Region 1 issue, several entities from region 2 and 3 were involved. Firstly, Iran, a Region 3 country, as part of GE-06 plan which covers Region 1 in addition to Iran, was interested in the 700 MHz discussion. While most of the Region's countries (Arab, African, European) were keen to have the mobile allocation, Iran was more concerned with the protection of their terrestrial broadcasting service in the 700 MHz from the deployment of mobile in neighbouring region 1 countries. Therefore, it could have been more convenient to have Iran as part of region 1 instead of having this historical division between region 1 and 3 that is geographically unexplained.

In fact, the situation of Iran is complicated as explained by one of the interviewees. On the one hand, Iran is part of region 3, which has already a mobile allocation in the 700 MHz band. On the other hand, Iran is also against having mobile allocation in the 700 MHz band in region 1 unless their broadcasting service is fully protected. In other words, although the 700 MHz allocation in region 1 should be a region 1 decision, a country from region 3 is involved in the discussion. One other issue that was raised is related to Russia, which is far away geographically from Africa and is still able to oppose decisions related to service allocation in Africa. As stated by one of the interviewees from Africa "we are on the other side of the earth, we can't cause interference to the Russians".

In general, it is argued that the three regions system does not accurately reflect the geographical situation where countries in Region 1 are quite close to countries in Region 3,

and Region 1 accommodates different interests between countries in different stages of development.

Conclusions

The main adopted band plan in the 700 MHz band is the APT one which provides 2x45 MHz for FDD operation of broadband systems but overlaps with the CEPT plan in the 800 MHz. While the African and Arab countries intended to follow the WRC-12 to fully harmonise with the APT plan, it was eventually agreed to partially harmonise with the APT plan by the adopting the lower duplex of it.

One of the first identified OOB value in the 700 MHz was determined in association with the APT plan in 2011 to be not exceeding -34 dBm/MHz below the frequency 694 MHz. While the Arab and African countries supported the APT value, other countries and broadcasters suggested more stringent values. Eventually, the ITU-R recommendation on the OOB values was agreed due to the support from most of Region 1 countries although it was met with resistance from a few countries.

The 700 MHz mobile allocation issue has shown that there is a tendency of African and Arab countries and the Latin American countries to align with the Asian market instead of with the European and American ones respectively, largely to lower the cost of the end user equipment. In addition, it is shown how geographical isolated countries such as Australia and New Zealand have influence over the countries in their Region and even on countries located in other Regions.

The examination of the decision making procedures in the light of the 700 MHz discussion has revealed that although the countries are sovereign in their territories regarding spectrum use, there is still a need for the other countries in order to have a regional or global harmonised use of spectrum. Therefore, discussions in the ITU-R are mostly based upon consensus. Moreover, having this conflict of interest during the 700 MHz discussions between countries in different ITU-R Regions raised a big question mark regarding the current ITU-R three regions system. In general, this paper has argued that, in this era of globalisation, it is not beneficial for a country or a group of countries to act separately from the rest of the world even if they could.

Acknowledgements

The authors are solely responsible for the opinions expressed in this paper.

References

- Angola (Republic of), Benin (Republic of), Botswana (Republic of), Burkina Faso, Burundi (Republic of), Cameroun (Republic of), . . . of), Zimbabwe (Republic. (2014). Modelling of Potential Interference from IMT Uplink to Fixed Rooftop Digital Terrestrial Receivers. Paper presented at the Meeting of Fifth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- APT. (2009). UHF Band Usage and Considerations for Realizing the UHF Digital Dividend. Paper presented at the The 7th APT Wireless Forum Meeting, Phuket.
- APT. (2010). APT Report on Harmonized Frequency Arrangements for the Band 698-806 MHz. Paper presented at the 9th APT Wireless Forum Meeting, Seoul.
- APT. (2011). APT Report on Implementation Issues Associated with Use of the Band 698-806 MHz by Mobile Service. Paper presented at the 11th APT Wireless Forum Meeting, Chiang Mai.
- APT. (2013). Liaison Statement to ITU-R Joint Task Group 4-5-6-7 - Study of IMT User Equipment (UE) Out-of-Band (OoB) Emission Limits and Associated Implementation Issues with the Use of the Band 698-806 MHz Paper presented at the Meeting of Fourth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Australia. (2013). Studies on Frequency Related Matters for IMT and Other Terrestrial Mobile Broadband Applications. Technical and Regulatory Framework in Australia to Protect Digital Terrestrial Television Broadcasting below 694 MHz. Paper presented at the Third Meeting of the Joint Task Group 4-5-6-7, East London. www.itu.int
- Bahrain (Kingdom of), Egypt (Arab Republic of), Qatar (State of), Kuwait (State of), & Emirates, United Arab. (2013). Compatibility between the Mobile Service in the Band 694-790 MHz and the Broadcasting Service Operating below 694 MHz. Paper presented at the Fourth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Bateson, Ross. (2013a). Brazil Looks Set to Adopt APT 700 MHz Band Plan. PolicyTracker. Retrieved from PolicyTracker website: <https://www.policytracker.com>
- Bateson, Ross. (2013b). UAE Adopts Hybrid Solution for 700 and 800 MHz Bands. PolicyTracker. Retrieved from PolicyTracker website: <https://www.policytracker.com>
- Bateson, Ross. (2014). Analysis: Chilean 700 MHz Auction Provides First Step in South America. PolicyTracker. Retrieved from PolicyTracker website: <https://www.policytracker.com>
- Broadcast Networks Europe. (2014). IMT UE OOB Emissions Required to Protect DTTB Reception. Paper presented at the Meeting of Fifth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Bryman, A., & Bell, E. (2007). Business research methods. New York: Oxford University Press.
- Cameroon (Republic of), Kenya (Republic of), Lesotho (Kingdom of), South Africa (Republic of), & Zimbabwe (Republic of). (2013). Application of Monte Carlo Statistical Analysis for the Assessment of IMT Uplink Interference into Fixed Rooftop Digital Terrestrial Television Receivers. Paper presented at the Fourth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Chairman ITU-R Joint Task Group 4-5-6-7. (2014). Executive Report to Study Groups 5 and 6 on the Work of Joint Task Group 4-5-6-7. Paper presented at the Meeting of Study Group 5, Geneva. www.int.itu
- CITEL. (2011). Final Report (Item on the Agenda: 7). Paper presented at the CITEL Coordination Meeting San Juan.

- Contant, Corinne M., & Warren, Jennifer. (2003). The World Radiocommunication Conferences Process: Help or Hindrance to New Satellite Development? *Acta Astronautica*, 53(4).
- Cowhey, Peter, & Aronson, Jonathan D. (1991). The ITU in Transition. *Telecommunications Policy*, 15(4), 298-310.
- Cowhey, Peter F. (1990). The International Telecommunications Regime: The Political Roots of Regimes for High Technology. *International Organization*, 44(2), 169-199.
- ECOWAS Administrations plus Cameroon (Republic of). (2013). Work on Agenda Item 1.2. Paper presented at the Third Meeting of the Joint Task Group 4-5-6-7. www.itu.int
- Egypt. (2012). WRC-15 Agenda Item 1.2: Proposals for the Band Plan of the 700 MHz Band for Region 1. Paper presented at the 14th ITU-R WP 5D meeting, Geneva.
- Egypt. (2013). Proposals Regarding the Frequency Arrangements of the 700 MHz Band. Paper presented at the 15th ITU-R WP 5D meeting, Geneva.
- El-Moghazi, Mohamed, Whalley, Jason, & Irvine, James. (2013). International Spectrum Management Regime: A Case of Regulatory Lock-in for the Developing Countries? . Paper presented at the CPR Asia / CPR Africa, Mysore.
- Ericsson. (2014). Telstra and Ericsson Complete "World First" Live Test of APT 700 MHz Band
- GSMA. (2013). Modelling of Potential Interference from IMT Uplink to DTT Paper presented at the Meeting of Fourth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- ITU-R. (2007). Article 5: Frequency Allocations.
- ITU-R. (2008). Article 5: Frequency Allocations Radio Regulations (Vol. 1).
- ITU-R. (2012a). ITU-R Recommendation M.1036-4: Frequency Arrangements for Implementation of the Terrestrial Component of International Mobile Telecommunications (IMT) in the Bands Identified for IMT in the Radio Regulations (RR) M Series. Mobile, Radiodetermination Amateur and Related Satellite Services.
- ITU-R. (2012b). WRC-12 Resolution 232. Use of the Frequency 694-790 MHz by the Mobile, Except Aeronautical Mobile, Service in Region 1 and Related Studies. Provisional Final Acts - World Radiocommunication Conference (WRC-12).
- ITU-R. (2014). CPM Report on Technical, Operational and Regulatory/Procedural Matters to be Considered by the 2015 World Radiocommunication Conference. Retrieved from www.itu.int.
- ITU-R. (2015). Chairman Ad-Hoc Group Plen 1 (M Series Recommendations). DRAFT NEW RECOMMENDATION ITU R M.[BSMS700]. Specific Unwanted Emission Limit of IMT Mobile Stations Operating in The Frequency Band 694-790 MHz to Facilitate Protection of Existing Services in Region 1 in the Frequency Band 470-694 MHz. Paper presented at the Resolutions Radiocommunication Assembly (RA-15), Geneva. www.itu.int
- ITU. (2006). Article 1: Definitions Final Acts of the Regional Radiocommunication Conference for Planning of the Digital Terrestrial Broadcasting Service in Parts of Regions 1 and 3, in the Frequency Bands 174-230 MHz and 470-862 MHz (RRC-06).
- Kenya (Republic of). (2014). Channeling Arrangement for the 694-790 MHz for Agenda Item 1.2. Paper presented at the 19th ITU-R WP 5D meeting, Halifax.
- Krasner, Steven. (1982). Structural Causes and Regime Consequences: Regimes as Intervening Variables. *International Orginzation*, 36(2).
- Meyer, Christine Benedichte. (2001). A Case in Case Study Methodology. *Field Methods*, 13(4), 329-352.

- Migwalla, Elizabeth. (2013). Regional Harmonisation and Channelling Arrangements for Band 694-790 MHz. Paper presented at the 9th Spectrum Management Workshop in Africa, Kampala.
- Newlands, Michael. (2010a). Asia Pac Countries Working on 700 Mhz Band Harmonisation PolicyTracker.com. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Newlands, Michael. (2010b). Australia Consults on Digital Dividend PolicyTracker.com. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Nokia Corporation. (2013). Additional OOB Attenuation from LTE UE to Frequencies Used for DTT Broadcasting. Paper presented at the Fourth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Nokia Corporation. (2014). Updated Simulation Results on the DTT Interference Probability at 700 MHz. Paper presented at the Fifth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- NTRA of Egypt. (2014). Views on IMT Deployment in the band 694-790 MHz. Paper presented at the 2nd AfriSWoG Meeting, Nairobi.
- Rancy, Francois. (2012). Harmonisation of Digital Dividend Bands: Current Work. Paper presented at the 2nd ATU Digital Migration and Spectrum Policy Summit, Accra.
- Russian Federation. (2014). Definition of Out-of-Emission Limit for Mobile Service Users Equipment under the Agenda Item 1.2. Paper presented at the Meeting of Sixth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Saunders, M., Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students (5th edn.): Pearson Education Limited.
- Standeford, Dugie. (2012a). FCC Moves to Unleash 700 MHz, 2 GHz Spectrum. PolicyTracker. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Standeford, Dugie. (2012b). Mobile Broadband Tops Arab Countries' Agenda for WRC-12. PolicyTracker.com. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Standeford, Dugie. (2012c). WRC Agrees on Several Items but Mobile Broadband Issues Remain Unresolved. PolicyTracker.com. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Stirling, Andrew. (2012). Africa is Pushing Ahead in the Race for 700 MHz. *International Journal of Digital Television*, 3(3).
- United Kingdom of Great Britain and Northern Ireland. (2014). Channeling Arrangement for the 694-790 MHz Band. Paper presented at the 19th ITU-R WP 5D meeting, Halifax.
- Vanston, Mark. (2013). Asia Pacific Telecommunity (APT) 700 MHz Whitepaper Telstra.
- Working Party 5D. (2014). Liaison Statement to Joint Task Group 4-5-6-7: Channeling Arrangements for 694-790 MHz for Agenda Item 1.2. Paper presented at the Meeting of Sixth Meeting of Joint Task Group 4-5-6-7, Geneva. www.int.itu
- Youell, Toby. (2014). ECC Agrees on (Mostly) Harmonised 700 MHz Band Plan. PolicyTracker. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Youell, Toby. (2015). Russia Has Doubts about 700 MHz Band OOB Limits. PolicyTracker. Retrieved from <https://www.policytracker.com> website: <https://www.policytracker.com>
- Young, Oran R. (1982). Regime Dynamics: The Rise and Fall of International Regimes. *International Organization*, 36(2), 277-297.

Zacher, Mark W. (1996). *Governing Global Networks: International Regimes for Transportation and Communications*: Cambridge University Press.

Zehle, Stefan. (2013). *The APT Band Plan, A Brief Introduction*. Coleago Consulting Ltd.

Endnotes

ⁱThe world is divided in terms of radiocommunication service allocation into three regions where 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 (ITU-R, 2008).

ⁱⁱYoung (1982) defines regimes as social institutions governing the actions of those interested in specifiable activities and international regimes as regimes pertaining to activities of interest to members of the international system.

ⁱⁱⁱRegimes can be defined as sets of implicit or explicit principles (beliefs of facts, causation, and rectitude), norms (standards of behaviour defined as rights and obligations), rules (specific prescriptions and proscriptions for action), and decision-making procedures (prevailing practices for making / implementing collective choices) around which actors' expectations converge in a given area of international relations (Krasner, 1982; Zacher, 1996).

^{iv} The name of the group indicates the cooperation between four main study groups (SGs) in the ITU-R: SG 4 (satellite services), SG 5 (mobile services), SG 6 (broadcasting services), and SG 7 (science services).