WRC-07: the Technological and Market Pressures for Flexible Spectrum Access
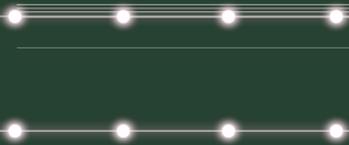
Sims, Martin

PolicyTracker

2007

Spectrum policy: what next?

Edited by Martin CAVE, Gérard POGOREL & Frédéric PUJOL

- WRC-07: the Technological and Market Pressures for Flexible Spectrum Access

- Regulatory and Policy Implications of Emerging Technologies to Spectrum Management

- Spectrum Allocation, Spectrum Commons and Public Goods: the Role of the Market

- The Role of Licence-Exemption in Spectrum Reform

- Emerging Technologies and Access to Spectrum Resources: The Case of Short-Range Systems

Interviews with

Rüdiger HAHN, Bundesnetzagentur, Germany
Richard FEASEY, Public Policy Director, Vodafone

IDATE

WRC-07: the Technological and Market Pressures for Flexible Spectrum Access

Martin SIMS
PolicyTracker, London

Abstract: By examining the preparations for the 2007 ITU World Radio Conference (WRC-07) and associated developments this paper identifies practical examples of the market and technological pressures contributing towards a more liberalised approach to spectrum management. It argues that the need to find new spectrum for advanced mobile services (WRC-07 Agenda item 1.4), the growing orthodoxy on spectrum neutrality and the need to accommodate converging technologies are helping to undermine the stricter forms of command and control spectrum management. However, the need for global harmonisation of satellite frequencies and the international variation in rolling out digital terrestrial television place limits on this drive towards greater flexibility.
Key words: 2007 World Radio Conference; WRC-07; mobile; IMT; IMT-2000; satellite; broadcasting; spectrum liberalisation; mobile TV; DVB-H; WiMAX; technology neutrality; ITU Radio Regulations

Policy development is usually a slow process, and when international co-operation is a key element - spectrum management is one example - then rapid change is even more unlikely. However, policy does change, albeit at an all too glacial pace according to the more enthusiastic spectrum liberalisers. So every few years it is interesting to take stock of how far the ice floes have shifted. In the field of spectrum management the World Radio Conference, which takes place every three to four years is an ideal opportunity to do this.

Getting the agreement of the ITU's 191 [1] member states is by no means easy, particularly when the body has a tradition of proceeding by consensus. The process is carefully managed, with a long series of pre-conference meetings to ensure that the debate is sufficiently focused to produce agreements in the few weeks allotted for the actual conference. This year's World Radio Conference (WRC-07) is being held from 22 October to 16

---

[1] See http://www.itu.int/cgi-bin/htsh/mm/scripts/mm.list?_search=ITUstates&_languageid=1

November: the pre-conference meetings for the World Radio Conference in 2011 are just beginning.

Opinion has been exhaustively pre-tested, so the proposals brought to World Radio Conferences are ones that have a realistic chance of success. This means that the extent to which they reflect the drive towards spectrum liberalisation is a good indication of how far the policy consensus has moved. The key battleground in this year's World Radio Conference (WRC-07), and the main focus of this paper, is agenda item 1.4 - the spectrum needs for the future development of mobile systems:

> "1.4: to consider frequency-related matters for the future development of IMT 2000 and systems beyond IMT 2000 taking into account the results of ITU R studies in accordance with Resolution 228. (See ITU (2007) pages ii-v)".

CAVE, DOYLE & WEBB (2007) argued recently that:

> "a command and control approach is becoming more difficult to manage as an ever expanding range of applications appears." [2]

This paper seeks to provide concrete examples of this tendency by examining recent developments and decisions in spectrum policy, focusing particularly on the preparations for WRC-07. It seeks to show that technological and market developments are undermining what POGOREL (2007) [3] has defined as the stricter forms of the command and control method of spectrum management, and are contributing towards a more liberalised approach where frequency bands are less likely to be restricted to a single technology or service.

The argument made here is that the need to find new spectrum for advanced mobile applications has been a key driver in this process. Another important factor has been the growing international and cross-industry consensus on technology neutrality. The paper also seeks to point out some of the limitations on a more flexible approach to spectrum usage, principally

---

[2] The quote comes from their September 2007 *PolicyTracker* article but the argument is made at greater length in their book *Essentials of modern spectrum management*, pp.1-9, especially p. 8

[3] In "Nine Regimes of Radio Spectrum Management: A 4-Step Decision Guide", POGOREL identifies nine spectrum management regimes, pointing out that in practice there are several flavours of command and control regimes incorporating varying degrees of technology neutrality.

the global nature of the satellite industry and the varied adoption rates of digital television.

■ Future spectrum needs for mobile systems

Over the next 15 years the International Telecommunications Union (ITU) expects that mobile services will require greatly increased access to spectrum. The ITU has estimated the total bandwidth requirement by 2020 for mobile cellular systems, ranging from 2G to 4G, as 1280 MHz if user demand is low and 1720 MHz if user demand is high, acknowledging that in some countries the spectrum requirements could be higher than this (ITU, 2007, p. 23). To take Region 1 [4] as an example the total requirement is made up of 693 MHz already identified at previous World Radio Conferences and 587 MHz of new spectrum in the low usage scenario and 1027 MHz of new spectrum in the high usage scenario. In approximate terms this is at least a doubling if not a tripling of spectrum requirements.

This is a great deal of bandwidth and finding it inevitably puts pressure on the strict implementation of the command and control model of spectrum allocation where regulators or governments decide what service or technology should use a particular range of frequencies. To put it more simply: if mobiles need so much more spectrum, where is it going to come from? Analogue TV switch off will provide some free space, which will be discussed in detail later, otherwise it's a question of sharing with other services which already occupy a band or moving closer to those services than would previously have been considered.

The ITU's preparatory document for WRC-07 (ITU, 2007, pp. 23-42) identifies six candidate bands for new mobile services and explains the possibilities for sharing with services currently using these frequencies (ITU, 2007, pp. 29-32).

The candidate bands are 410-430 MHz and 450-470 MHz, 470-806/862 MHz, 2300-2400 MHz, 2700-2900 MHz, 3400-4200 MHz and 4400-4990 MHz. In the first two bands the ITU says mobile can share with low and medium power broadcasting services using mitigation techniques but says

---

[4] ITU Region 1 is Europe, Africa, the Middle East west of the Persian Gulf including Iraq, the former Soviet Union and Mongolia.

further studies are needed to resolve the interference problems raised by high power broadcasting and fixed services in these bands. In the 2700-2900 MHz band there is the issue of sharing between mobile services and aeronautical radionavigation service and meteorological radars to be resolved. In the 3400 - 4200 MHz band one of the problems is co-existence between radiolocation services and fixed satellite services currently using this band.

In order to accommodate mobile's increasing demand for spectrum the administrations gathered at WRC-07 are having to consider putting it in bands previously allocated for other services. These primary allocations, as they are known, will be split into primary and secondary allocations or co-primary allocations.

So the growth of mobile is contributing to an unpicking of the traditional command and control approach. International administrations are paving the way for the entry of popular and economically powerful mobile services into new frequencies which had previously been designed for other occupants. Opening up bands to several possible services facilitates a liberalized approach to spectrum management where the market decides which is the highest value service. This approach may not be adopted in all countries but the options being considered at WRC-07 for the expansion of mobile services create the space to apply an increasingly liberalized approach to this economically important area.

Furthermore, as the ITU preparatory document points out, there are many different views on which candidate band to choose:

> 'It should be noted that there was no consensus on the candidature or suitability of any of these bands as prospects for identification for IMT. […] For each band listed below or portions thereof, some administrations have indicated that they are considering it for IMT, while some other administrations have indicated that they use the band for other services and do not intend to deploy IMT.' (ITU, 2007, p. 34)

The diversity of national approaches to next generation mobile services is forcing the ITU to be as open as possible about allocating bands in order to accommodate all its members. Even if a single candidate band is chosen at WRC-07 is seems quite probable that further bands will be added at the next WRC in 2011 [5].

---

[5] Many administrations favour a mobile allocation in UHF at WRC-11 rather than WRC-07. See later in this paper.

As we can see from the preparatory discussions for WRC-07, economics, consumer demand and international diversity are forcing national administrations to consider the use of mobile across a wide range of bands. While changing the band allocations would not compel national administrations to admit mobile services into these new bands, it certainly makes it easier for those countries seeking to take a flexible approach. The band allocations provide a pre-tested framework where certain applications are guaranteed protection from interference from neighbouring countries. Having such a structure readily available may encourage more traditionally minded administrations to implement greater flexibility.

■ Technology neutrality: the new orthodoxy

Administrations are increasingly moving away from the stricter forms of command and control and adopting a technology neutral approach. This is a step towards a more liberal system where the regulator would merely set technical limits and allow the market to decide which technology or application would be adopted. This paper argues that the build-up to WRC-07 demonstrates how restricting technology choice is becoming increasingly impractical. Firstly, technology neutrality seems the only policy option which can produce agreement between different countries and between diverging sectoral interests. Secondly, and connected to the above, technology specificity in the mobile field is being undermined by the pressure to make international standards embrace a wider range of technologies.

DVB-H

In recent months the clearest example of the impracticality of being technology specific has been the European Commission's failed attempt to mandate DVB-H as the region's mobile TV standard. In March 2007 the Information Society Commissioner Viviane Reding said if industry could not agree on a common mobile TV standard by the end of the summer she would impose one, and that would be DVB-H. The Commission had earlier set up a cross-sector body to push forward the development of mobile TV, but the European Mobile Broadcasting Council (EMBC) had concluded that technology neutrality was the best approach. Ms Reding was scornful of the EMBC's efforts, saying she 'would have expected more in terms of proposed solutions and strategic vision.' (SIMS, April 2007b).

However, by June 2007 the strength of opposition had forced the Commission to backtrack (NEWLANDS, July 2007). 'Flabbergasted', 'baffled', 'bemused', 'unbelievable' were some of the words used by senior industry figures to describe the Commissioner's intervention (SIMS, April 2007b). 'This idea that there is a huge untapped demand out there only constrained by the shambolic nature of the industry is laughable,' said one mobile operator (SIMS, April 2007b). Within a few weeks the incoming EU Presidency had added their voice to the opposition. In a conference address the Portuguese made it plain that they favoured technology neutrality, not a mandated standard. (SIMS, July 2007b). The Commission recanted and now offered only the 'strongest encouragement' to member states to adopt DVB-H, while promising to monitor market developments over the coming year (European Commission, July 2007a, July 2007b).

The Commission made several reasonable arguments in support of mandating DVB-H. It was the best technology and was developed in Europe and so would bring the greatest advantages to the EU's economy, giving it a lead in mobile-TV in the same way that the GSM Directive had made Europe a world leader in mobile in the 1990s. These are valid points, and although the counter arguments are also very robust [6], expounding them is not the purpose of this paper. The point it seeks to make is that it is now very difficult to get the necessary cross-industry support for technology specificity as a policy option. Mandating DVB-H did not get the support of the mobile operators, the mobile manufacturers, or of national administrations. It did not even win the support of the body which was instrumental in developing the DVB-H standard – the European Broadcasting Union. Among other things the EBU did not want to harm the interests of its members who had invested in another EU-developed technology which can be used for mobile TV, the digital radio standard, DAB.

WIMAX/IMT-2000

A further example of the international and cross-industry support for technology choice can be found in the progress made in including WiMAX in the IMT-2000 standard. WiMAX is widely seen as a disruptive technology with the ability to revolutionize the wireless industry by giving WiFi-type broadband wireless access technology with coverage areas of up to fifty square kilometers. Including it within IMT-2000 would give it potentially the

---

[6] For a detailed analysis of these arguments, see NEWLANDS (April 2007).

same spectrum access as 3G mobile technologies. Some see this as a way of opening up the mobile industry to greater competition; others see it as a way for mobile operators to reduce costs by using WiMAX for some services.

Whether or not WiMAX will revolutionize existing business structures the point this paper seeks to make is that the majority of administrations and sector players are keen to give it spectrum access. The process of getting WiMAX accepted into IMT-2000 only began in November 2006 (NEWLANDS, December 2006), but has been proceeding with remarkable speed, considering this is the first time an attempt has been made to add a new air interface to the standard. The relatively smooth progress (NEWLANDS, July 2007) is indicative of the broad range of support for the measure. Roger Marks, chair of the IEEE 802.16 working group which has overseen the development of WiMAX, reported that ITU-R Working Party 8F which monitors the development of the IMT-2000 standard was very open to including WiMAX. "Every delegate encouraged me to submit [a proposal] for consideration and requested that I do so as soon as possible" he said in a report [7] written after attending an 8F meeting.

The only administrations to make significant objections to the inclusion of WiMAX were China and Germany, and these were largely procedural in nature. There was also broad support from industry, with one of the isolated protests coming from Qualcomm, which has developed a potential WiMAX competitor: Flash-OFDM. At the time of writing the final approval for WiMAX to be accepted into IMT-2000 was expected to be given at the Radiocommunications Assembly immediately before WRC-07.

This represents a remarkable change of heart for the mobile industry, which only a few months earlier had argued against WiMAX access to 3G expansion bands like 2.5-2.69GHz (NEWLANDS, December 2006; GSMA, 2006). The volte-face reflected a growing acknowledgement that in the long term WiMAX may develop as a significant new technology no matter what the mobile community does and it was better to prepare for and manage the change .

The overwhelming support for opening up spectrum reserved for the most economically valuable of applications – advanced mobile services like IMT-2000 – is an important indicator of opinion shifting away from the

[7] http://grouper.ieee.org/groups/802/16/liaison/docs/L80216-06_020.pdf

'regulator decides which technology' model of spectrum management. While WiMAX entry into the IMT-2000 family does not guarantee the technology spectrum access in every country, it sets a tested international framework for the IMT-2000 technologies to co-exist and makes access much harder to refuse. The level of support for making the standard more inclusive is also more evidence of technology neutrality as the only policy option which can command international and cross-sector support.

■ Updating the ITU Radio Regulations

A further example of how the development of technology is undermining the stricter forms of command and control can be found in ITU Resolution 951, which is being considered under WRC-07 agenda item 7.1. Resolution 951, agreed at WRC-03, asked the ITU to carry out studies to consider whether the Radio Regulations are still effective and appropriate considering the evolution and convergence of technologies. Speaking at a recent conference [8] the chairman of the WRC-07 preparatory meeting, Kavouss Arasteh, said "Unfortunately we are still working on definitions [drawn up] 50 years ago. We have a classical separation of services: we call this fixed; this mobile; the other broadcasting; whereas in practice convergence means fixed [can be] mobile, mobile [can be] fixed and broadcasting is all of them." The European regulators organisation, CEPT, has pointed out that some administrations are unsure under which categorisation convergent services should fall (CEPT, 2007, p. 7).

Three options (CEPT, 2007, pp. 5-6) have been proposed to meet the requirements of the resolution. The first is to continue addressing convergence issues through the existing regulations and schedule of WRC meetings. The second is to revise some of the existing service definitions and the third is to introduce a provision in the regulations which would allow services to be substituted for each other e.g. fixed for mobile or vice versa.

Neither of the proposals to change the current system would be easy to implement. Kavouss Arasteh argues that changing current service definitions is impractical: "Regulators and lawyers will sit down and talk about a single vote for days and days without any result," he said [9]. CEPT believes that

---

[8] Second European Spectrum Management Conference, Brussels, 5-6 June 2007.

[9] *Ibid*.

implementing substitutability would require considerable additional work on defining technical parameters (CEPT, 2007, pp. 4-5), so the most likely result is that no final decision will be taken on this resolution until WRC-11.

Adapting the Radio Regulations to deal with convergence seems troublesome in practice but the fact that many countries think it is necessary shows how technological developments are pushing administrations towards recognising the need for flexibility.

■ Mobile in UHF: the limits of liberalisation

The developments examined so far point to an erosion of the command and control approach under the influence of technological change and changing user demand. However, the limits of this policy shift are shown by the debate over a mobile allocation in UHF. As discussed earlier in this paper using either all or part of the UHF band (470-862 MHz) is one of the options proposed for accommodating the additional spectrum needed for mobile services. This has been strongly advocated by liberalizers like the UK and the European Commission [10] as well as industry giants Nokia. The company says a mobile allocation in UHF at WRC-07 is essential to the creation of innovative wireless services:

> "Non allocation would leave our industry in total uncertainty […] and is likely to lead to fragmented band plans as several countries go on with their national decisions." [11]

However, this approach has encountered much opposition, revealing a division between regional and international approaches, between early and later adopters of digital terrestrial television and between developed and developing countries.

From a European perspective the paradox is that although the regional regulators' organisation, CEPT, has agreed a voluntary harmonised sub band for mobile in UHF, most CEPT members are opposed a similar mobile

---

[10] Both describe a failure to do so as a 'missed opportunity': see Ofcom (2007) and RSPG (2007).

[11] See Letter from Nokia Siemens Networks and Nokia to RSPG: available on the ERO website (http://www.ero.dk) by selecting ECC activities/ meeting documents; entering the user name rrc and password rrc and choosing ECC TG4 Digital Dividend.

allocation at WRC-07. 17 out of 29 CEPT administrations are currently opposed to allocating the UHF band for mobile services at WRC-07; only 6 are in favour. The majority view is that any decision should be delayed until WRC-11 (CEPT Electronic Communications Committee, 2007, p. 12).

The Commission has described the WRC-07 allocation as a "test case on the commitment of administrations to move ahead with flexibility of spectrum use" saying "the digital dividend should not be frozen, or limited to pre-determined applications […] giving mobile services the same allocation status as broadcasting and other possible services [would] keep all options open." The Commission said those opposing the WRC-07 allocation were acting "to the detriment of those member states with early switch-off dates." (RSPG, 2007, pp. 5 and 6).

The contrary view, held by the majority of European administrations, is that RRC-06 already gives sufficient flexibility to deploy mobile services and there is no urgency to provide additional mobile frequencies because there is plenty of unused capacity still available. Some member states say they wouldn't be able to deploy mobile services anyway because of interference with neighbouring countries.

From an international perspective Kavouss Arasteh has argued that using UHF for mobile is a difficult proposition:

> 'The lower bands are almost totally occupied by broadcasting. Delegates don't want to compromise the result of last years international treaty on broadcasting [RRC-06] and there is no need for an immediate decision - we will have to wait to see what emerges as a digital dividend [frequencies released by analogue TV switch-off]. This is also a political issue.' (SIMS, April 2007a)

In those countries where plans for digital switch off are already well advanced, like the UK, which will be releasing 112MHz in the 470-862MHz band after switch off, using this spare capacity for new mobile services makes sense. But in less developed countries where dispensing with analogue TV is not an immediate prospect, opening up a broadcasting band to mobile is unattractive. As 470-862 MHz is often occupied identifying this band would do little to speed one of the key advanced mobile applications - the introduction of badly needed wireless broadband services in rural areas. Furthermore, from a political perspective, why create insecurity among the broadcasters who are not only an equally vital development partner, but also in some cases closely connected with the state?

In the case of mobile services in UHF the gap between early and later adopters of digital TV is acting to inhibit the opening up of the band. Many developing nations and several European countries like Russia and Turkey (SIMS, July 2007a) have yet to plan out digital TV so are understandably reluctant to jump a stage and consider the next step in spectrum planning – what to do with the frequencies released by switchover. Furthermore RRC-06 has already made it clear that most Arab countries are not thinking in terms of a digital dividend and see UHF primarily as a TV band (SIMS, July 2007a).

Developing countries' resistance to a mobile allocation in UHF is in one sense a paradox because the superior propagation characteristics of this band would make it ideal for the establishment of low cost wireless broadband networks. A network at higher frequencies would require more base stations and so cost more.

Another reason for favouring the higher bands rather than UHF for new mobile services is the amount of spectrum available. IMT-advanced services typically require 100 MHz of spectrum and most countries would want four competing operators. To ensure a level playing field they would need spectrum with similar propagation characteristics. This requires 400MHz of contiguous spectrum and 3-5GHz is the only range where this is currently available (SIMS, July 2007a).

◼ Satellite

A further restriction on the opening up of bands to a variety of technologies is the needs of satellite operators. By nature a global industry, satellite relies on spectrum access which is harmonised worldwide. Satellite is therefore particularly concerned about the erosion of this harmonisation by the proposed creation of mobile allocations in two of these globally harmonised frequencies, 3400-4200MHz and 4400-4990MHz.

Satellite operators have been particularly vocal about the use of C-band (3400-4200MHz) as a potential candidate for future IMT-2000 use. '[Mobile] operators are using language that goes beyond national coverage, which is quite a new strategy for them,' said Cecil Ameil, head of regulatory affairs for satellite company SES Global. 'They are openly claiming that they want European coordination for their aspirations and they hope they will be able to expand throughout Europe and beyond.' (WATSON, March 2007).

SES Global argues that the proposal faces two key problems. The first is that satellite operators use C-band for space-to-earth transmissions. As these transmissions do not need to be authorised, most of them are not recorded. 'This means we do not know the location of those who receive the signals,' said Ameil. 'That makes any coordination very difficult, if not impossible.' The second problem in sharing this band would be the need to coordinate in some areas of national territory. According to Ameil, this means either that terrestrial operators would not be able to operate in a certain geographical zone or that they would only be able to operate under such constraints that their services would not be feasible at all. 'The terrestrial operators are saying that they need to access radio spectrum which they cannot use efficiently,' said Ameil. [12]

Another candidate band, 4.500-4.800MHz, has been allocated for fixed satellite service (FSS) on a primary basis for many years. FSS operators will want to see convincing evidence of the feasibility of IMT-2000 sharing this band too. 'Everything exclusive to FSS (and broadcast satellite service, BSS) is something that secures our business. As soon as you start talking about flexibility and letting other services into these bands, that is a concern,' said Ameil.

The satellite industry would like the ITU not to make any prescriptive decisions on these two bands at WRC-07, pointing out that many countries and regions oppose the introduction of terrestrial operators in this band. They will be arguing that this decision should be made at a regional rather than international level (WATSON, March 2007).

---

[12] See ITU (2007) p. 32 "…sharing is feasible only when the receiving earth station is at a specified location and under the condition that the minimum required separation distance together with the criteria mutually agreed between the concerned administrations are observed. If FSS is deployed in a ubiquitous manner and/or with no individual licensing of earth stations, sharing is not feasible in the same geographical area since no minimum separation can be guaranteed."

■ Conclusion

This paper has endeavoured to demonstrate by reference to recent developments in spectrum policy how market and technological developments are combining to encourage a more liberalised approach to frequency usage. There are ample examples of the problem identified by CAVE, DOYLE & WEBB: namely the difficulty of managing an ever expanding range of applications through the command and control approach [13]. The development of mobile into 3G and beyond has created an international drive to find more spectrum, and this means placing mobile services in bands previously identified for other services, principally satellite, broadcasting and radar. Balancing conflicting industry needs also mitigates against any international or regional tendency towards favouring particular technologies. Examples of this can be found in the moves towards including WiMAX in the IMT-2000 family and in the overwhelming opposition to mandating DVB-H as the EU mobile TV standard.

On the other hand there are countervailing pressures which restrict this tendency towards flexibility in spectrum access. Satellite's need for harmonised global access is one of these, as is the international variation in adoption of digital terrestrial TV. The argument of this paper is that while these pressures exist, they are not as strong as the drive towards greater flexibility.

Changing spectrum policy is often seen as a matter of convincing regulators to look at things in a different way. What this paper has tried to practically demonstrate is that consumer demand; technological developments; and the necessity of formulating policy which can command international and cross-industry support are in themselves powerful forces pushing towards a more liberalised approach to spectrum management. [14]

---

[13] See footnote 2.

[14] Martin Sims is grateful for the research carried by his *PolicyTracker* colleagues, Jonathan Watson and Michael Newlands which provides the factual basis for many of the arguments in this paper.

Bibliography

CAVE M., DOYLE C. & WEBB W:

- (Sept 2007): "Applying market principles to spectrum management", *PolicyTracker* .
- (2007): *Essentials of modern spectrum management*, Cambridge.

CEPT (2007): Draft CEPT Brief on Agenda Item 7.1 (Resolution 951 (WRC-03), May 2007 document no. CPG07(2007)096 Annex VIII 27.

CEPT Electronic Communications Committee (2007): *CEPT Progress Report on WRC-07 Preparation*
http://rspg.ec.europa.eu/doc/documents/meeting/rspg13/rspg07_182.pdf

European Commission:

- (July 2007a): Communication: "Strengthening the internal market for mobile TV"
http://ec.europa.eu/information_society/policy/ecomm/info_centre/documentation/communic_reports/index_en.htm
- (July 2007b): News Release: "Commission opens Europe's Single Market for Mobile TV services".
http://www.europa.eu/rapid/pressReleasesAction.do?reference=IP/07/1118&format=HTML&aged=0&language=EN&guiLanguage=en

European Radiocommunications Office TG4 Working Group (2007): "Report B: technical feasibility of harmonising a sub-band of bands IV and V for fixed/mobile applications (including uplinks), minimising the impact on GE06". http://www.ero.dk/

GSM Association (GSMA) (2006): "Optimising spectrum for future mobile service needs", a report from the GSMA to the European Commission
http://www.gsmworld.com/documents/extensionbands_s1_e1.pdf

ITU (2007): "CPM Report on technical, operational and regulatory/procedural matters to be considered by the 2007 World Radiocommunication Conference"
http://www.itu.int/md/dologin_md.asp?lang=en&id=R07-CPM-R-0001!R1!PDF-E

POGOREL G. (2007): "Nine Regimes of Radio Spectrum Management: A 4-Step Decision Guide", *COMMUNICATIONS & STRATEGIES*, no. 65, April 2007.
http://www.idate.fr/fic/revue_telech/623/CS65_POGOREL.pdf

NEWLANDS M.

- (December 2006): "Formal application made to include WiMAX in 3G standard", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=463
- (July 2007): "ITU clears the way for WiMAX recognition", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=566

Ofcom (2007): "Consultation on candidate bands under consideration at WRC-07 for IMT". http://www.ofcom.org.uk/consult/condocs/wrc07/

Radio Spectrum Policy Group (RSPG) (2007): Chairman's report for meeting 13.
http://rspg.ec.europa.eu/meeting_documents/index_en.htm

SIMS M.:

-        (April 2007a): "Mobile services in UHF proving a tricky proposition", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=524

-        (April 2007b): "Industry condemns Commissioner's call to mandate DVB-H", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=532

-        (July 2007a): "Breakthrough on mobile services in digital dividend", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=571

-        (July 2007b): "Incoming presidency rebuffs Commission's radical spectrum proposals", *PolicyTracker*. http://www.policytracker.com/alerts.php?tact=567

WATSON J, (March 2007): "Preparations for WRC-07 get underway", *PolicyTracker*, http://www.policytracker.com/alerts.php?tact=508