FLEXIBLE SPECTRUM MANAGEMENT FOR INTRODUCTION OF NOVEL BROADBAND FIXED WIRELESS SYSTEMS

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Abstract: The paper discusses the current European philosophy in the area of spectrum management and regulation for new advanced fixed broadband wireless systems, including their nomadic and mobile derivatives. It is shown how the new spectrum management approaches could be formed through combination of such flexible options as variable channel bandwidth and modulation, simplified or completely discarded licensing or possibility to choose various deployment modes (fixed vs. nomadic/mobile). The paper focuses on examples of regulatory solutions in 3.5 GHz, 64-66 GHz and 71-76/81-86 GHz bands.

Keywords: Radiocommunications, Frequency spectrum management, Fixed Wireless Systems, Wireless access systems.

1. INTRODUCTION

This paper addresses the recent European philosophy in the area of spectrum management and regulation for new advanced fixed broadband wireless systems, as well as their derivative nomadic and mobile wireless access systems. It refers to the experiences, studies and regulatory documents developed in CEPT Project Team SE19.

It may be observed that the modern development of Fixed Wireless Systems (FWS) proceeds along the two main directions:

- Introduction of increasingly higher bit-rate systems by exploiting new frequency bands in higher ranges (above 40 GHz);
- Introducing flexible deployment options for provision of converged wireless access services to consumers in lower (sub 10 GHz) frequency bands.

Both of these options, though very different, have one common implication in that they require significant changes in traditional spectrum management approaches, notably the introduction of certain flexibility in order to allow possibility for adaptable channel bandwidth and modulation, and, where justified, also possibility of multiple deployment options, such as mobile or nomadic versus fixed.

The following sections consider examples of introducing such flexible regulatory solutions in three different frequency bands.

2. BWA IN 3.5 GHz BAND

The frequency band 3.4-3.6 GHz and, in some countries, 3.6-3.8 GHz, was already for quite some time identified for deployment of Fixed Wireless Access (FWA) systems. However the uptake of FWA systems was not very enthusiastic and efforts to save the situation and bring some activity in this band resulted in introduction of new technologies with more efficient modulation and access schemes, most notably the OFDMA systems. The main feature of these new developments was that the new systems allowed establishment of reliable wireless links in non-line-of-sight conditions. This improved the business case for FWA, but also opened new deployment possibilities in non-fixed configurations, such as Nomadic (NWA) and Mobile (MWA) modes. Together with original FWA, the entire family of wireless access solutions got a name of Broadband Wireless Access (BWA).

To allow flexible deployment of BWA systems, the former rigid FWA-tailored regulatory regime for 3.5 GHz had to be re-considered and changed to allow the flexible choice of channel bandwidth and mobile/nomadic deployment modes. The situation was complicated further due to the fact that there are several technologies vying for BWA market in this band, and in particular, the preference for TDD or FDD could not be established a priori.

This problem of BWA introduction in 3.5 GHz band was studied in CEPT over several years and resulted in recent adoption of ECC Recommendation (04)05.

This recommendation outlined a fully flexible and technology-neutral approach, giving a lot of rights (as well as liabilities) to operators for themselves to manage channels inside the frequency blocks assigned to them, while the interference to neighbouring blocks would be controlled by essentially observing two limits:

- Limits for in-band emissions, expressed in terms of maximum emitted power density;
- Limits for out-of-block emissions, expressed in terms of Block Edge Mask (BEM).

The purpose of in-band power density limit is to enable evaluation of interference potential for operator of the same frequency block, used in adjacent geographic area. It therefore becomes necessary only if the blocks are assigned in different service areas to different operators, or for controlling interference in border areas for the nationally assigned licences.

The in-band limit is set by choosing a certain (arbitrary) reference value of maximum emitted power density, which allows operator of the same block in adjacent territory to evaluate the maximum geographic range of interfering emissions in un-coordinated deployment.

The out-of-block emission limits in terms of BEM define what should be the maximum transmitter output power density at a certain distance from the edge of the block, see Figure 1.

The purpose of BEM is to manage the interference between operators of adjacent frequency blocks, used in the same geographic area. In Recommendation (04)05 it was deliberately decided to define BEM only for emissions from BWA Central Station (CS), since the emissions from Terminal Stations could be sufficiently well defined by equipment standards.

The BEM limit is similar in nature to defining unwanted out-of-band emissions for individual transmitter, but here it is applied on a system-level to all emissions from the BWA CS transmitters inside the licensed block.

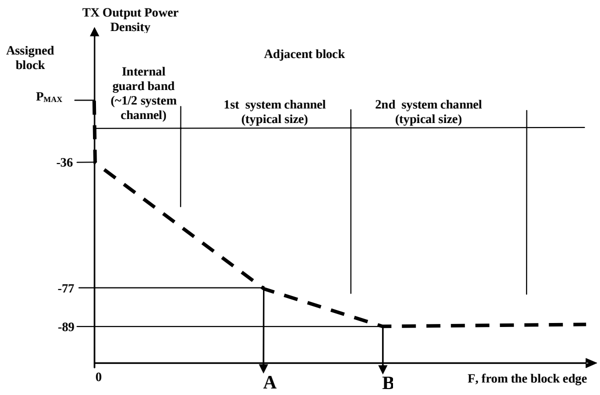

Fig. 1. Block Edge Mask for BWA Central Stations in 3.5 GHz band. The frequency off-set markers are set proportional to the block size: A=20%, B=35% of the size of allocated block.

The provisions for technical neutrality in 3.5 GHz band are also very important and the solution embodied in Recommendation (04)05 may be described as follows:

- It is recommended that operators are allowed to choose freely the internal channelling inside their allocated frequency blocks;
- It is recommended that licences do not specify whether FDD or TDD systems are deployed by the operator, as the technical provisions for construction of frequency blocks would allow in principle deploying both FDD and TDD systems;
- Further provisions allow subsequent market-driven adjustments by operators (notably swapping of duplex parts of the blocks) to improve efficiency of using the spectrum.
- No specific air interface standard is prescribed.

In conclusion, the above described comprehensive approach to flexible spectrum assignment should be instrumental in ensuring most efficient utilization of spectrum and speedy deployment of BWA systems in 3.5 GHz band.

3. POINT-TO-POINT LINKS IN 64-66 GHz

This band appears very suitable for very short distance links deployed in dense scenarios. The physical propagation features in this band (characterised by high oxygen absorption) mean that the potential interference range from Point-to-Point (PP) FWS links deployed in this band would be rather limited, yet not totally negligible.

It may be therefore proposed to allow deployment of PP FWS links in this frequency range under a “lighter” licensing regime, as compared to the strict link-by-link assignment usually used for traditional long-range PP FWS links. Such flexible licensing solution for PP FWS links in frequency band 64-66

GHz was implemented in another recently developed CEPT ECC Recommendation (05)02.

The “light-licensing” regime described in the Recommendation (05)02 means that operating frequencies for PP FWS links in this band are still assigned or recorded on a link-by-link basis, but done by operators themselves by means of some simplified procedure, such as online database notification, or similar. While the national administration would be setting some basic set of conditions for PP FWS systems in subject band (such as maximum radiated power, minimum antenna gain, etc), it is then left to each individual operator to perform interference analysis and, eventually, coordinate as necessary to ensure that harmful interference is not caused to existing links registered in the database.

For example, an operator wishing to install a new PP link could consult the database of existing links in the band, operating in the desired frequency channel, and then calculate whether their intended new link would interfere with already existing links. The Recommendation (05)02 provides guidance on deriving and using the trigger interference power density levels.

If the interference potential is identified by calculations, the new link could be re-planned (e.g. by changing operating frequency, location, etc) to meet the interference requirements of existing links in the database. Otherwise, the potential conflict may be avoided through co-ordination of the new link with operators of existing links.

It should be also noted that it is recommended that national administrations choose either to allow assignments in this band without a specific channel arrangement, or establish an arrangement based on simplified 30 MHz frequency slots arrangement.

4. PP FWS LINKS IN 71-76/81-86 GHz

This band makes it possible implementing very high capacity (up to 10 Gbit/s) PP FWS links with some 1-2 km hop lengths under direct line-of-sight conditions. It is envisaged that such high capacity links would allow a rapid and effective deployment of broadband capacity in areas where fibre-optic cables are not available or are not cost-effective.

Having considered different options for the proper balance of harmonisation and flexibility in this band, CEPT developed the provisions for PP links in this band in the form of ECC Recommendation (05)07, which identifies all (or parts, depending on national situation) of the frequency bands 71-76/81-86 GHz band for licensed deployment of PP FWS links, but with certain flexibility options.

One means of achieving flexibility in this band is that the duplex channels may be formed by using the bands 71-76 GHz and 81-86 GHz as paired bands (see Figure 2a), or as separate single bands containing internal duplex separation (Figure 2b). Note that in the latter case the actual duplex separation may vary, depending on the total size of available band in a particular country. This latter option may be seen both as flexibility, but also as a certain step back from harmonisation objectives. It was done due to the fact, that not the entire bands 71-76/81-86 GHz were available for PP FWS deployment in some countries, most notably due to existing allocation of parts of these bands to military services.

Therefore the solution depicted in Figure 2b could be helpful not only as achieving flexibility objectives, but also as principal enabler of any PP FWS deployment at all in those countries, which have military allocations in those bands.

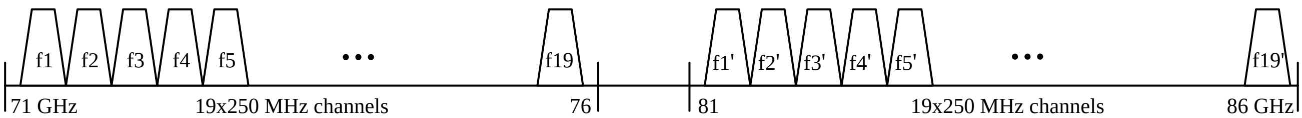

Fig. 2a. Combining both 71-76/81-86 GHz bands into a single FDD arrangement with 10 GHz duplex

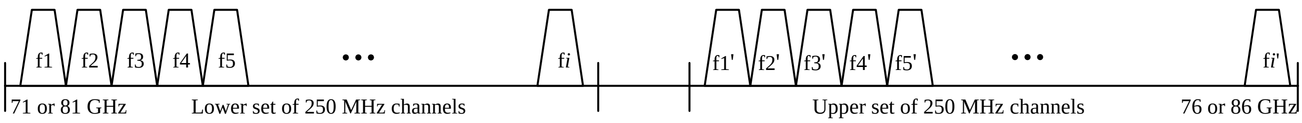

Fig. 2b. Placing channels in a single 71-76 GHz or 81-86 GHz band with duplex of less than 5 GHz

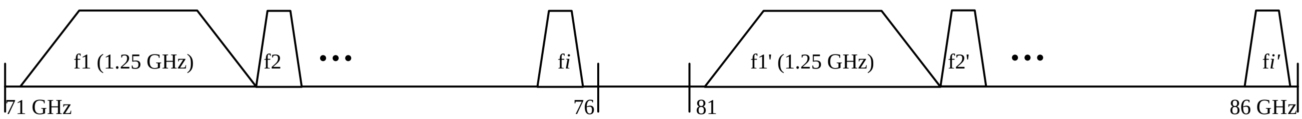

Fig. 3. Example of creating larger channels by aggregating up to 5x250 MHz channels, possibly alongside with original 250 MHz wide channels

Further important flexibility feature established for this band in Recommendation (05)07 is the possibility of flexible aggregation of multiple channels when extremely high bit rate system with high system gain (low modulation state) is required, see Figure 3. It is envisaged, that it should be possible to aggregate up to 5 basic 250 MHz channels, forming 1.25 GHz channels.

In conclusion, it may be suggested that opening of these most recent new frequency bands in the 70/80 GHz range, with the described flexible regulatory elements, should provide significant resource for future development of short-distance high-capacity PP FWS links.

5. CONCLUSIONS

The described examples of recent regulatory solutions for FWS in three different bands show that European regulatory philosophy has already made a significant step towards flexible spectrum management and industry self-regulation.

The most notable example of this paradigm shift is the regulatory solution for BWA in 3.5 GHz, where not only many technical provisions for equipment were de-regulated and made technology/standard neutral (such as FDD/TDD choice, channelling, modulation etc), but also very important flexibility for usage modes were allowed, making it possible to transform the original rigid fixed service system concept (FWA) into the flexible mobile-nomadic-fixed service offering. This regulatory solution should provide an adequate answer to the requirements of modern vibrant wireless communications industry and may lead to improved competition in the field of converged telecommunications services, in the segment previously addressed by “traditional” cellular mobile systems, such as 3G/UMTS, EDGE, DVB-H etc.

But the other two examples described in this article showed that even in the domain of pure PP FWS bands, the flexibility might be as important element of regulation. It could be explored in two directions.

The first one deals with providing for more flexible and dynamic deployment of PP links by alleviating the need for strict licensing procedures. This could be done through introduction of license-exempt operations (e.g. like in 57-59 GHz band, discussed previously and therefore not considered here), but also through introduction of light-licensing regime, as chosen for the PP FWS links in 64-66 GHz band. This provides another interesting possibility where links could be deployed as quickly as in a licence-exempt band, but enjoying more reliable interference protection by means of essential industry self-regulation mechanisms embodied in the light-licensing regime.

The second way of introducing more flexibility in PP FWS regulations is providing more flexible technological options, such as the flexibility to choose channel width, channel centre frequency and even duplex separation in some of the bands. These options were exploited in the described cases of European PP FWS regulation in 64-66 GHz and 71-76/81-86 GHz bands.

As an overall conclusion, it could be noted that the European regulators took considerable initiatives on introducing flexibility in all recent regulatory solutions, most notably in the field of FWS bands and applications, as described in this article.

It is therefore expected that these steps and the resulting novel regulatory solutions should open new avenues for the dynamic development of FWS applications in Europe in the short to long time frame. The most important forces that could be in play in such cases are the more flexibility given to operators to deploy a wider choice of links, and the better innovative environment for manufacturers of FWS equipment, which all together should hopefully contribute to improved competition conditions and better services to the users.

REFERENCES

ECC Recommendation (04)05, *Guidelines for accommodation and assignment of Multipoint Fixed Wireless Systems in frequency bands 3.4-3.6 GHz and 3.6-3.8 GHz* (2006). Available at: http://www.ero.dk/.

ECC Recommendation (05)02, *Use o f the 64-66 GHz frequency band for Fixed Service* (2005). Available at: http://www.ero.dk/.

ECC Recommendation (05)07, *Radio frequency channel arrangements for Fixed Service Systems operating in the bands 71 - 76 GHz and 81 - 86 GHz* (2005). Available at: http://www.ero.dk/.

BIOGRAPHY

Arturas Medeisis worked at the European Radio-communications Office since 2001. His main area of expertise covers spectrum engineering and frequency management, with interest in fixed services and wireless access. Most recently he chaired the CEPT project team SE PT 19, that was mandated with development of several European regulatory solutions for FWS and BWA deployment, described in this article.