PROPOSED SPECTRUM PLAN FOR MULTIMEDIA WIRELESS SYSTEMS (MWS) FOR THE EUROPEAN MARKET

REVISION 02

SUBMITTED TO THE
BRITISH RADIOCOMMUNICATIONS AGENCY (RA);
EUROPEAN RADIOCOMMUNICATIONS OFFICE (ERO/CEPT);
EUROPEAN TELECOMMUNICATIONS STANDARD INSTITUTE (ETSI)

February 1999

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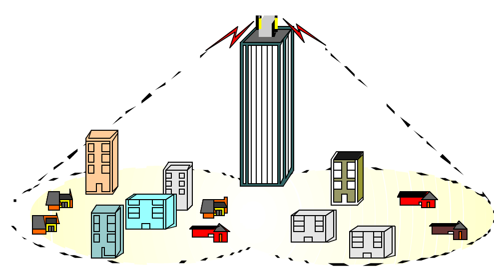
1. Introduction

This paper examines the channelization plan currently being considered for MWS in the 24.5-26.5 and 27.5-29.5 GHz regions for the European market and proposes an alternative plan that promotes the true benefits of multipoint networks, including maximizing the competitive advantages of MWS operators in the local wireless access market. The alternative plan advocates the licensing of large contiguous spectrum, as opposed to the narrow duplex channel pairs specified by CEPT 13-02 [1]. The proposed spectrum plan offers the following benefits for MWS operators:

a) the ability to access a relatively large market to share the cost of the base station infrastructure over many subscribers,
b) the flexibility to support different services and rates dynamically,
c) efficient deployment of in-band wireless backhaul links between base stations,
d) the ability to augment the network with repeaters to address gaps in coverage,
e) improved frequency reuse,
f) the requirement for less radios to fill the spectrum, representing a significant cost reduction and minimizing number of antennas required on rooftops,
g) the flexibility to support symmetrical or asymmetrical services, and
h) the flexibility to address interference with other services including satellite systems.

The following section elaborates upon these points followed by a description of proposed spectral plans.

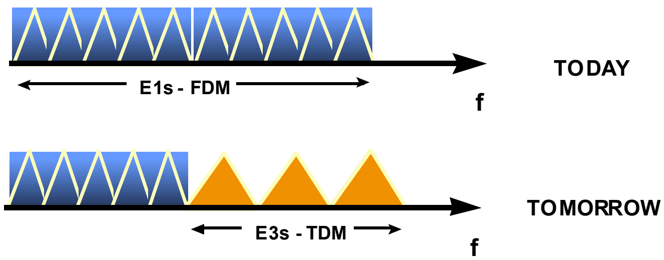
2. Maximum Market Penetration



A principal advantage of an MWS network is that immediate access to a relatively large market is achieved once a base station or central radio station (CRS) has been commissioned. This allows the operator to distribute the cost of the network and base station infrastructure amongst a large number of customers during the critical initial roll-out phase, thus increasing cost effectiveness and providing an important competitive advantage. Based on a survey of several business models being developed for different MWS operations throughout the world, the type of service offerings being considered by licensees address a wide range of applications including telephony, high speed local area network (LAN), Internet Protocol (IP) access, telemedicine, personal communications services (PCS) backbone, multimedia distribution (e.g. video conferencing), circuit connections (E1, E3), etc. To support these multiple services and meet business plan objectives, requires large spectrum blocks, typically on the order of 100's of MHz.

3. Different Services and Rates

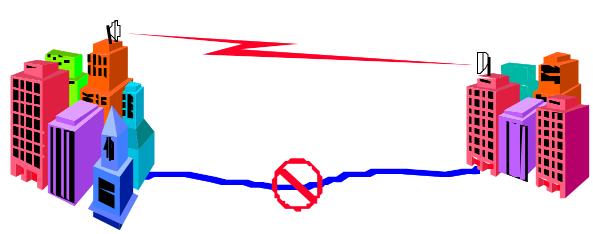
A contiguous broadband licensed spectrum provides the operator the flexibility to dynamically provide different services and data rates in response to market demand. For example, the operator may offer E1 or fractional E1 connections today to compete in the local wireless loop (WLL) market. However, in the future, as demand for higher bandwidth and more sophisticated applications such as video conferencing and multimedia services grows, larger channel sizes will be required (e.g. E3 carriers as shown below).



The result will be an MWS band comprising a mix of traffic channel sizes. With a channelized scheme, such as the one specified in CEPT 13-02, the traffic may not necessarily utilize the full bandwidth of each pre-defined slot, resulting in spectrum wastage or inefficiencies. A contiguous block, on the other hand, allows the operator to place carriers of disparate sizes immediately adjacent to each other, hence optimizing spectral efficiency.

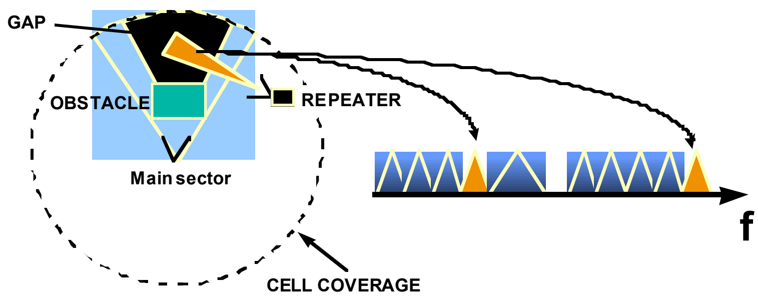
4. In-Band Inter Cell Links

Another advantage associated with contiguous broadband licensing is the efficiency it offers regarding the provisioning of an in-band backhaul capability, also referred to as a wireless Inter-Cell Link (ICL). Operators can use part of the MWS band and infrastructure to interconnect two base stations with in-band ICL radios without having to resort to fiber lines, which typically have high tariffs, or out-of-band point to point radios, which require additional licensing. With the in-band approach, the same base station equipment and rooftop facilities can be used by the ICL radios, significantly increasing cost-effectiveness. Also, as with the previous point, a contiguous MWS block allows the operator to optimize the placement of carriers to increase spectral efficiency.



5. Gap Fillers/Cell Extenders

A contiguous block also offers efficiency regarding the deployment of gap filler repeaters (GFRs) or cell extenders. GFRs are used to repeat signals between the base station and subscriber where there are gaps in coverage due to obstacles such as buildings. With a contiguous band, the operator can place the repeated carriers, which can vary in bandwidth, as close to each other as possible to minimize spectral waste.

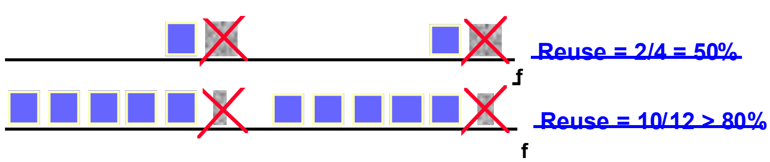


6. Frequency Reuse

A large contiguous spectrum block improves frequency reuse, i.e the amount of spectrum that can be reallocated within a service area. A higher frequency reuse factor increases revenue generating capacity for a given service area, thus enhancing competitiveness for the MWS operator.

A cellular structure such as MWS operating with high order modulation signals (e.g. 16 QAM) tend to have frequency reuse factors less than 100 % due primarily to interference, which can originate from within the network (self interference) or from external sources such as other MWS networks operating co-channel in adjacent areas. To contend with interference, some of the spectrum will simply have to be avoided through careful network planing.

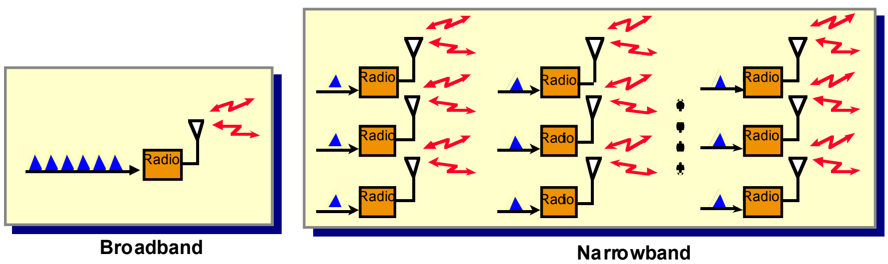
The advantage of a large block of licensed spectrum is that the ratio of lost or unusable carriers to usable carriers becomes small, resulting in a high frequency reuse factor. For example, an operator with 56 MHz of spectrum configured to transmit and receive in 28 MHz pairs as shown below, can suffer a 50% reduction in spectrum usage if one of the carriers is overcome by interference. By contrast, a large block of spectrum with say 6 pairs of carriers, will yield a reuse factor of 80% should one of the carriers be hindered by interference.



A contiguous license further improves frequency reuse by allowing finer channel allocations, which in turn promotes finer control of interference. With a contiguous block, the operator has the flexibility to deploy narrow channel sizes for the low data rate subscribers. Let us consider as an example a subscriber transmitting a 1 MHz signal in an MWS band of 200 MHz. If that subscriber causes prohibitive interference to a base station receiver, then the reuse factor is calculated to be 99.5% (1-1/200). On the other hand, if the channelization plan was followed, and say a channel size of 28 MHz was deployed, then the full 28 MHz channel would have to be avoided in an interference situation, representing a reuse factor of 1-28/200=86%. The higher reuse factor, from the contiguous band approach, represents significant competitive advantages for the MWS operator.

7. Cost

Perhaps the most compelling argument for a broadband contiguous spectrum license relates to equipment cost. A broadband approach requires fewer radios, as illustrated in the left box of the figure below, since a single radio can transmit and receive multiple carriers. This represents the true essence of a multipoint system - the ability to serve multiple users from a single entity. By serving more customers with less base station infrastructure, the MWS operator is able to increase the cost effectiveness of his network.



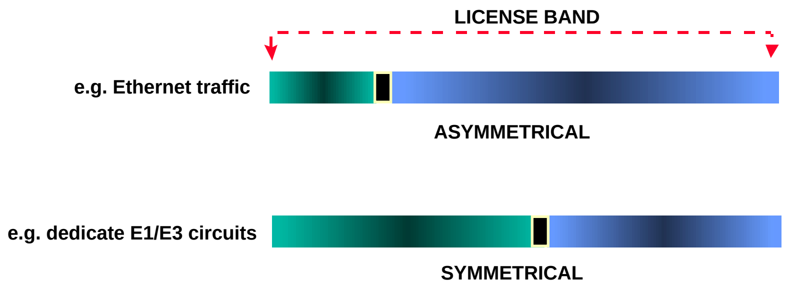
By contrast, the channelization approach, depicted in the right hand figure, requires multiple carriers, and hence multiple radios, to serve a similar market. It is not difficult to see that the amount of radios needed to fill a reasonable amount of spectrum, say 200-500 MHz, becomes significant.

With the broadband approach, less radios are required, implying the need for less physical space at the base station. Furthermore, with less radios, the antenna count on roof-tops is reduced, which is an extremely critical issue with landlords concerned about aesthetics.

8. Frequency Planning

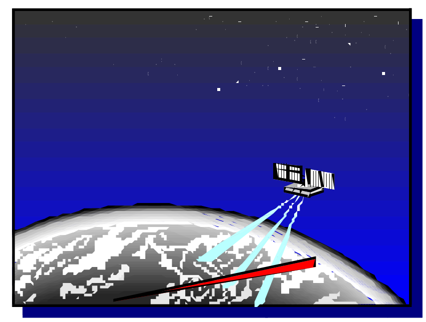
Another important advantage of a contiguous broadband allocation is the flexibility it offers with regards to frequency planning. With a contiguous block, the operator can decide on the level of spectrum symmetry to implement based on customer demand in a given market. Spectrum symmetry, in this context, refers to the ratio of bandwidth allocated between the upstream (subscriber to base station) and downstream (base station to subscriber) links.

If, for example, subscribers in a particular service area are predominantly Internet users, then a highly asymmetric band would likely be required, as shown in the top part of the figure below. On the other hand, if the operator is serving an area comprising primarily dedicated E1/E3 fixed connections, then a symmetrical spectrum profile may be more appropriate.



By having a broadband contiguous license, the operator is given the freedom and flexibility to deploy the spectrum in a manner that optimizes utilization within a particular market segment.

9. Coordination With Other Fixed Services



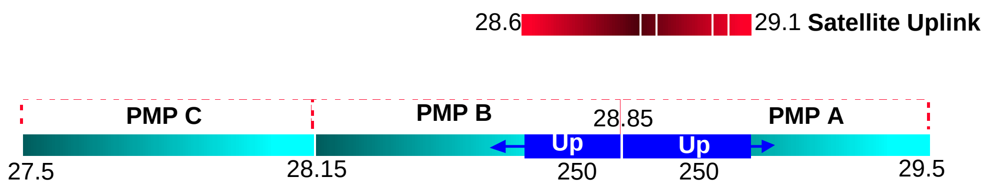
Finally, a large contiguous block of spectrum provides the operator with the flexibility to coordinate with other co-channel systems such as fixed satellite services. Preliminary analysis indicates that it may be possible to operate MWS subscribers in this overlapping region without presenting interference to the satellite receiver. Some of the key points to support this view are that subscriber radios:

- operate with automatic power control (APC)
- use highly directional antennas (hence, aggregation effects are negligible)
- transmit only one at a time in a given channel per sector

If the analysis is accepted, then the operator, with a large contiguous license, can place all or most of the upstream traffic in the overlapping region, taking full advantage of the spectrum. The same principle applies to the coordination of other fixed services such as neighboring MWS networks operating co-channel in adjacent areas. By having a contiguous broadband spectrum, the operator is able to optimally manage the services and placement of subscriber and base station traffic within the licensed band to address interference.

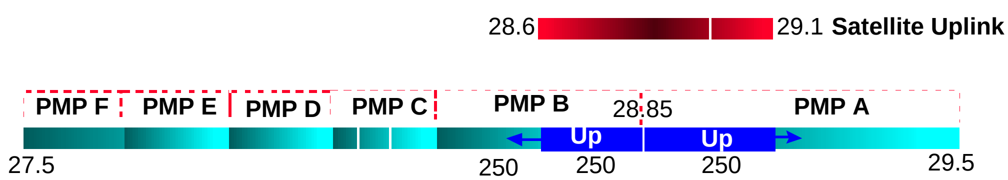
10. Possible Frequency Plans

The following provides an illustration of the benefits of flexible channel plans essential to the success of MWS. Based on the points articulated above, it is proposed that the MWS spectrum be licensed in large contiguous blocks. Two options are presented for the 27.5 to 29.5 GHz region. The first option proposes splitting the spectrum equally into 650 MHz blocks to support three large MWS operators, as shown below.



Also depicted in the figure is the satellite region overlapping with operators A and B. Until the satellite issue is resolved, one strategy may be to stipulate that operators A and B can begin operating outside the satellite region - when co-channel is proven to be feasible, then both can gradually migrate their upstream traffic into the 250 MHz overlapping region. This should not be difficult to achieve, since it is expected that subscriber radios will have the ability to tune over a wide range of frequency under network management control.

An alternative frequency plan proposes to have a mix of spectrum sizes, comprising large operators to small ones, as shown in the figure below.



As before, operator A is allocated with 650 MHz of spectrum, with the condition that 250 MHz of that is subject to successful coordination with the satellite services. Operator B holds 500 MHz, again with the same coordination caveat. The remaining spectrum supports multiple licenses with bandwidths on the order of 200 MHz (excluding guard bands).

In no way should this be seen as an encouragement of segmentation of spectrum between fixed satellite services and fixed services.

ABBREVIATIONS

APC	Automatic Power Control
ERO	European Radiocommunications Office
ETSI	European Telecommunications Standards Institute
FDM	Frequency Division Multiplex
GFR	Gap Filler Repeater
MWS	Multimedia Wireless System
PMP	Point to Multipoint
RA	Radiocommunications Agency
TDM	Time Division Multiplex
WLL	Wireless Local Loop

REFERENCES

[1] 'Preferred channel arrangements for fixed services in the range 22.0-29.5 GHz', CEPT Recommendation T/R 13-02 E, Montreux 1993.