European Radiocommunications Committee (ERC)
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FIXED WIRELESS ACCESS (FWA) SPECTRUM ENGINEERING & FREQUENCY MANAGEMENT GUIDELINES (QUALITATIVE)

Naples, February 2000

EXECUTIVE SUMMARY

This document exclusively addresses terrestrial P-MP systems used for FWA, including multimedia wireless systems (MWS) applications.

Although these guidelines are intended primarily for the use of administrations and operators, they should also be of benefit to manufacturers and all those involved in preparing corresponding standards. The material is qualitative rather than quantitative, but work is underway, within both the ERC and internationally through the ITU-R, to supplement this material with more specific and quantitative information in specific bands used for FWA.

Whilst work continues to prepare this additional material, it is expected that the current report will prove useful in its present form. Part of the report, Section 3, is of a different nature than that of the other sections in that it also contains guidance and suggested considerations for the purpose of generating frequency arrangements (band plans) appropriate to FWA use. Such plans form an important part of the work of CEPT, and this document should aid the refinement of existing plans or the generation of new ones within CEPT WG SE. It is acknowledged that extant plans were developed over many years exclusively for P-P (DRRS) systems featuring conventional channelisation schemes, but there is now a real need to tailor them to better accommodate the new generations of multipoint systems; this point has now also been recognised within the ITU-R and new Recommendations on such block-based frequency arrangements are under development.

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1 INTRODUCTION

This document exclusively addresses terrestrial P-MP systems used for FWA, including MWS, applications. These fixed wireless access systems generally feature air-side concentration and contiguous cellular (area) deployment arrangements, and this document takes due account of the several important similarities with, and differences between, these systems and both conventional P-P systems on the one hand and cellular mobile systems on the other hand.

Although these guidelines are intended primarily for the use of administrations and operators, they should also be of benefit to manufacturers and all those involved in preparing corresponding standards. The material is qualitative rather than quantitative, but work is underway to supplement this material with more specific information on specific bands used for FWA, and this should be the subject of a subsequent ERC Report.

Whilst work continues to prepare this additional material, it is expected that the current report will prove useful in its present form. Part of the report, Section 3, is of a different nature than that of the other sections in that it also contains guidance and suggested considerations for the purpose of generating frequency arrangements (band plans) appropriate to FWA use. Such plans form an important part of the work of CEPT, and this document should aid the refinement of existing plans or the generation of new ones within CEPT WG SE. It is acknowledged that extant plans were developed over many years exclusively for P-P (DRRS) systems featuring conventional channelisation schemes, but there is now a real need to tailor them to better accommodate the new generations of multipoint systems. This would lead to the encouragement of innovative technologies in a less prescriptive and more flexible regulatory regime (multiple standards, different air interface protocols, technologies, etc.) than is the case for conventional channel arrangements.

Some of the considerations within this report also relate to compatibility of FWA systems with systems in other services, and appropriate sharing studies are underway for the different bands.

1.1 Additional guidance

The additional material mentioned above will in due course contain information on interference calculation methodology, systems parameters, reference model results for model scenarios, and some information on interpretation (inc. sensitivities, identification of simplifying assumptions and other factors which may need considering).

1.2 Terminology

As far as possible, this report is consistent with the vocabulary and terminology developed within the ITU-R at the time of preparation of this report.

2 FREQUENCY ASSIGNMENT GUIDANCE

For co-deployment of FWA systems in the same geographical area, it is necessary to:

(2.1) take account of the ERC Recommendation on preferred frequency bands for FWA systems, ref. ERC/REC/(00)05.

(2.2) take account of the ERC Decision on the designation of the harmonised frequency band 40.5 to 43.5 GHz for the introduction of MWS, including MVDS, ref. ERC/DEC/(99)15.

(2.3) assign sufficient spectrum to enable operators to be competitive; sub-bands should not be too small to preserve spectrum efficiency since any guard bands must be accounted for, and wherever possible co-sharing should be encouraged.

(2.4) take note that generally best spectrum efficiency is obtained by use of contiguous rather than non-contiguous arrangements, taking into consideration systems design and necessary frequency separation issues.

(2.5) plan for traffic growth, and to remember that in general one needs continuous spectrum, although some systems may assist planning in using non-continuous spectrum.

(2.6) take note that, whereas assigning spectrum to several potential operators across a band facilitates comparison of competitive proposals by these operators, it may be equally acceptable to facilitate competition by use of other bands.

(2.7) take note that if too many operators are assigned spectrum in a band, this may be counter-productive in terms of spectrum efficiency.

(2.8) incorporate suitable guard bands to mitigate interference, taking account of the different mix of technologies used, in order to attain an acceptable compromise between performance degradation and necessary protection/mitigation measures, including guard bands.

(2.9) specify for FDD systems, a consistent plan for the forward (CS to TS) and reverse (TS to CS) sub-band frequencies. It may be assumed that generally the forward (down) link should be at the higher frequency, similar to accepted usage in most cellular and satellite systems, but exceptional cases may dictate the reverse. Account must be taken of the added complications where mixed up/down directions are used.

(2.10) take account that for TDD systems the designation of forward and reverse link directions is no longer possible, and in this case additional interference scenarios need to be considered.

(2.11) take account that when considering accommodation of P-MP with P-P systems in the same band, e.g. for the 24.5 - 26.5 GHz band, one possible approach can be to make appropriate regional/national allocations for each FS type from opposite ends of the sub-bands, with the proportion of total band usage for each type perhaps determined by market or other needs; the more conventional approach is to apportion parts of the band for the two FS types on an *a priori* basis.

(2.12) note that in some cases the spectrum assigned for P-MP applications could in part be used for in-band infrastructure support for the P-MP systems. Where this is done, due account must be taken of the any regulatory or other rules / requirements set for these virtual P-P sub-links.

(2.13) take care when comparing different technologies and their spectrum usage, taking account that there is as yet no definitive guide to comparing spectrum efficiency in a simple manner; consideration needs to be taken of cluster size, consequences of mixed technologies according to these guidelines, quality and grade of service and other factors.

(2.14) use actual/typical parameters, wherever possible, for the calculation of the compatibility factors, rather than just the minimum requirement limits from the corresponding ETSI/other standards, and take account of the sensitivity of the results to these parameters.

Further studies are underway to consider interference between different FWA systems, and their compatibility with systems in other services.

3 FREQUENCY PLANS

3.1 General

For geographically co-deployed FWA systems, it is necessary to:

(3.1) take note that to date FS frequency plans have generally been prepared for P-P telecommunications systems featuring use of FDD, with symmetric channel / sub-band widths which may not be appropriate for all FWA systems.

(3.2) take account that services with *variable* asymmetry are often needed, especially for broader band applications[1].

(3.3) take account that asymmetry may be achieved by:

- pairing narrower channels in one direction with wider channels in the other
- using different orders of modulation in one direction from that used in the other
- using asymmetrical TDD.

(3.4) take account that having narrower channels in one direction and wider in the other can accommodate traffic efficiently only where this traffic exhibits a *fixed* asymmetry matching the ratio of the channel/sub-band widths. Such a fixed sub-bands approach is inherently less efficient for *variably* asymmetric traffic which may exhibit *only over time* a general bias in the traffic in favour of the channel direction enjoying the wider band.

(3.5) take note that it is possible in some cases to “pair“ up and down links in widely separated bands, for example an up link within one band together with a narrower down link within a lower band to provide fixed asymmetry for certain MWS applications.

(3.6) take note that some MWS systems, especially those derived in concept from broadcast/distribution type systems, may have a bi-directional rather than unidirectional “interactivity“ channel/sub-band. All the guidance provided elsewhere in this document should also apply to this situation.

[1] as opposed to the type of *fixed* asymmetry needed by, for example, video surveillance type systems with narrowband down-link capacity and wideband upstream capacity.

(3.7) take account that different orders of modulation may be used for the two traffic directions to offer a limited degree of asymmetry (and could result in different characteristics in terms of range/robustness of the up- and down-links) and that this may permit some *variable* asymmetry if the equipment can dynamically adapt the modulation scheme independently in the two directions.

(3.8) take account that TDD with variable time allocated to up- and down-link directions can provide a manner of achieving applications having variable, asymmetrical traffic.

(3.9) take account of the need to promote an equitable burden sharing in respect to guard bands. For example, for the first FWA operator in a band it would be considered prudent and fair to ensure that any guard band/s are included within the assigned sub-band.

(3.10) note that in general a –1 dB interference criterion[2] may be considered appropriate for interference calculations between FWA systems and with other services, unless otherwise stated within ITU-R Recommendations

3.2 TDD assignments in bands with paired spectrum

3.2.1 General

In the case of TDD systems in bands with a **conventional channel arrangements for P-P** systems, it is necessary to:

(3.11) note that where part of the lower band is assigned to a TDD system then the corresponding part of the upper band should also be assigned to TDD systems, and *vice versa*.

(3.12) ensure that the TDD assignment fully respects the homogeneous pattern of frequency slots as stipulated for the FDD channel raster.

(3.13) note that for *fixed asymmetrical* applications based on FDD and operated with channel arrangements previously designed to be suitable for *symmetrical* FDD use (having equal channel widths in both upper and lower bands), it is possible for n channels of the lower sub-band to be paired with m channels of the upper sub-band. The "surplus" unpaired |m-n| channels could be usefully assigned to TDD services (including any necessary guard band allowance)

(3.14) take account that in (3.13), and notwithstanding the availability of the m+n channels for fixed asymmetric FDD services, it is possible that these channels could be assigned to one or more TDD channels.

(3.15) take into account the possibility of using the centre gap for TDD, provided the requirements of Sec. 2 are observed.

3.2.2 Implementation

In the case of TDD systems in bands with a **conventional channel arrangement for P-P** systems, it is necessary to:

(3.16) note that there may be particular spectrum engineering issues (such as constraints on transmitter masks and the need for guard bands) associated with operating TDD systems in a band already accommodating FDD systems.

(3.17) note that additional parameters may have to be considered in coexistence planning of TDD systems.

(3.18) note that it has been asserted that the issue of verifying TDD compatibility with existing FDD systems is a larger task than checking compatibility of a FDD system with existing FDD system (with the same duplex spacing).

4 DEPLOYMENT

For deployment of FWA systems, it is necessary to:

(4.1) consider the benefits of encouraging co-operation between operators in order to minimise interference and consequent economic impact, and to seek to use the spectrum efficiently.

(4.2) note that where central stations belonging to different operators in the same geographical area are proposed to be sited relatively close, it may be preferable to co-locate these stations to minimise and better define the near/far effect. This may be especially appropriate in those cases where the directions of the forward and reverse frequency sub-bands are consistent between operators.

(4.3) note that where considering compatibility with P-P and other P-MP systems, CS and TS installations should wherever possible minimise P-MP antenna heights and judiciously use antenna angular discrimination, including nulls in the polar pattern, as an additional mitigation measure and to minimise guard band requirements and assist with co-existence.

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[2] long term; this noise floor degradation is equivalent to –6 dB I/N.

(4.4) note that similarly where considering co-existence between co-frequency operators across service - area boundaries, CS and TS installations should wherever possible minimise P-MP antenna heights and judiciously use antenna angular discrimination, including nulls in the polar pattern, as an additional mitigation measure.

(4.5) Note that polarisation may be used as a system propagation discriminate, although less usefully at lower frequencies. This can be useful to mitigate interference.

(4.6) Note that in some case terrain features can usefully be exploited to minimise interference, both intro- and inter-service.

(4.7) Note that where considering compatibility with FSS systems, account should be taken of ITU-R Recommendations where available, including any guidelines covering the FSS and P-MP antenna heights, separation distances, allowable range of elevation view angles, additional diffraction or other mitigation measures.

(4.8) note that where considering compatibility with the radioastronomy service, it is important to comply with both the ITU-R Radio Regs. and also the ERC Report on necessary separation distances (ref. ERC [XX-Y]), taking account the aggregation effect of P-MP systems as appropriate.

(4.9) note that where considering compatibility with radiolocation/navigation systems in adjacent bands or in neighbouring countries, account should be taken of existing relevant ITU-R Recommendations. For radiolocation / navigation systems that may be in-band, account should be taken of ITU-R Recommendations where available, including any specific methodology needed to ensure compatibility for the particular technology and radar type/s. Furthermore ERC Report 051 may be found instructive in this regard.

(4.10) take account of the need to plan and deploy CS and TS antennas which are no less directional than is required for the intended intra-system deployment and which are sited no higher than is necessary to ensure adequate performance margin.

(4.11) implement any necessary synchronisation and/or other measures to accommodate mixed technologies are implemented as appropriate.

5 EQUIPMENT DESIGN

For FWA systems, it is necessary to:

(5.1) take account of the importance of minimising spurious and out of band emissions through appropriate equipment design.

(5.2) take account of the importance of maximising receive selectivity (and noting that ETSI/other standards may be insufficiently detailed/stringent in all cases).

(5.3) take account of the desirability, consistent with compliance with the required level of quality and grade of service, of incorporating measures to ensure adequate transmit power control, dynamic channel/frequency and/or other adaptive measures to enhance compatibility.

GLOSSARY AND ABBREVIATIONS

CS	Central (base) station
DRRS	Digital Radio Relay System
FDD	Frequency Division Duplex
Forward link	CS to TS path, also termed down-link
FS	Fixed service (ITU-R service category)
FWA	Fixed wireless access
MWS	Multimedia wireless systems
Multipoint	Embraces all P-MP and MP-MP FS systems
P-P	Point - to - point
P-MP	Point - to – multipoint
Reverse link	TS to CS path, also termed up-link
RPE	Radiation Pattern Envelope
TDD	Time Division Duplex
TS	Terminal (end user) station