International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R F.1519
(05/2001)

Guidance on frequency arrangements based on frequency blocks for systems in the fixed service

F Series
Fixed service

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from http://www.itu.int/ITU-R/go/patents/en where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

(Also available online at http://www.itu.int/publ/R-REC/en)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	**Fixed service**
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note*: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication
Geneva, 2010

RECOMMENDATION ITU-R F.1519*

Guidance on frequency arrangements based on frequency blocks for systems in the fixed service

(Question ITU-R 215/5)

(2001)

Scope

This Recommendation provides an explanation of block-based frequency arrangements for systems in the fixed service. Guidance material for preparation and use of such arrangements are also given in the Annex including that for implementation and deployment.

The ITU Radiocommunication Assembly,

considering

a) that frequency band plans have continued to be developed over many years for point-to-point (P-P) digital radio-relay systems and which exclusively feature conventional channelling arrangements;

b) that new generations of systems include P-P, point-to-multipoint (P-MP) and multipoint-to-multipoint (MP-MP) systems;

c) that systems may feature frequency reuse in geographically contiguous, cellular-type deployments;

d) that a frequency arrangement based on frequency blocks is already in use by some administrations;

e) that fixed service systems may be deployed on an area basis and utilize flexible frequency arrangements within the area, rather than by link-by-link frequency assignment basis;

f) that systems may feature, *inter alia*, dynamic frequency control; variable traffic (e.g. temporal, fixed asymmetric, symmetric or adaptive); integral in-band, network infrastructure (backhaul); variable or dynamic modulation arrangements;

g) that there are a number of important factors that need to be considered in developing such sub-banding arrangements, including *inter alia* the choice of appropriate width for the sub-band(s)/block(s) (see Annex 2),

recommends

1 that administrations should consider possible use of frequency arrangements based on contiguous frequency blocks in the fixed service (FS) bands, as shown in Annex 1;

2 that the material in Annex 2 may be considered as guidance where frequency block-based plans are applied (see Note 1).

NOTE 1 – Two examples of such arrangements are provided in Annex 3 of this Recommendation and Recommendation ITU-R F.1488.

---

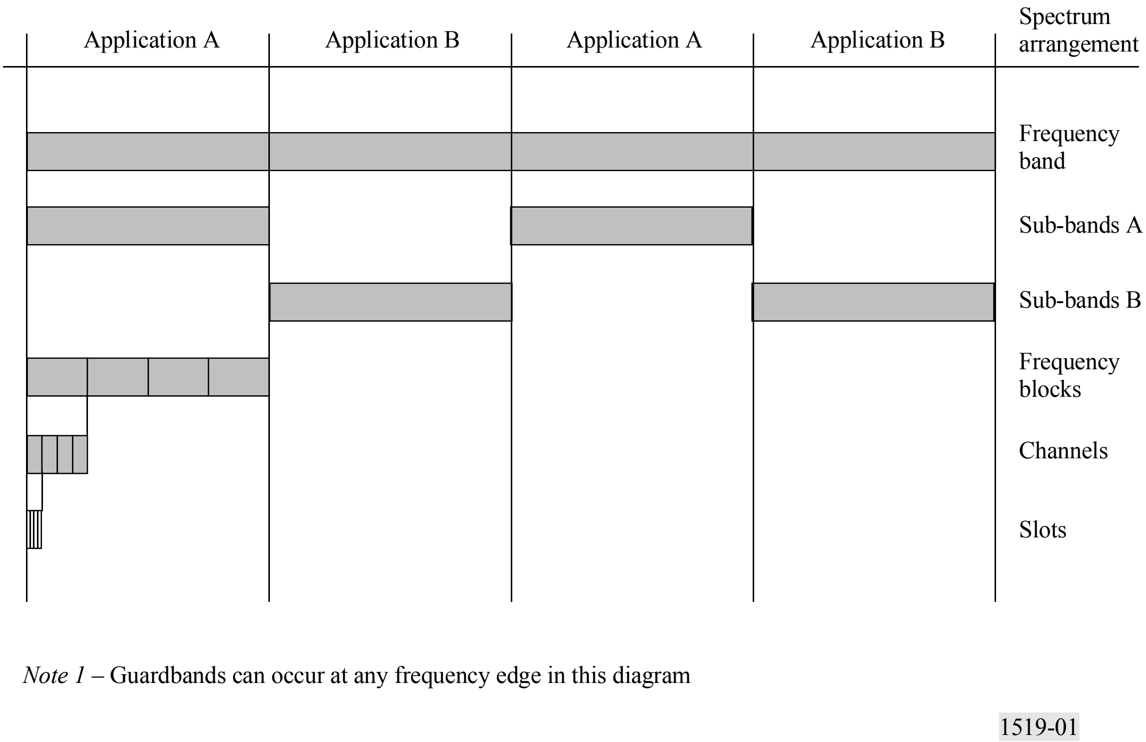
* Study Group 5 made editorial amendments to this Recommendation (on 7-8 December 2009) in accordance with Resolution ITU-R 1.

Annex 1

Illustration of fixed service spectrum terminology (see also Recommendation ITU-R F.1399)

FIGURE 1

Frequency arrangement using sub-bands, frequency blocks and their relationship to channelization



Annex 2

Guidance material in connection with the preparation and use of fixed service frequency arrangements based on sub-bands and contiguous frequency blocks, especially for multipoint systems

1 Introduction

The material presented here primarily addresses considerations on P-MP and MP-MP systems as used for fixed wireless access (FWA), but may be more generally applicable to FS systems. These systems generally feature air-side concentration and contiguous cellular (area) deployment arrangements, and it is necessary to take 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.

Specific bands are not discussed in detail in this Annex, and the material is qualitative rather than quantitative. However, an existing large scale FWA application example is described in Annex 3.

Frequency arrangements based on contiguous sub-bands/blocks can facilitate:

– simpler, efficient planning of the spectrum;
– simpler administration of frequency allocations and the accommodation of market/technology evolution;
– faster deployment of new services due to reduced administrative burdens;
– equitable treatment of several operators in a region;
– 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 channelization arrangements.

Many of these systems are appropriate for the delivery of Internet Protocol (IP) – or asynchronous transfer mode (ATM) – based communications traffic.

1.1 Guidance on coordination and related issues

Guidance material has been identified as an important requirement for effective use of available spectrum, including intra-system, inter-system, inter-service issues. In due course this will contain information on interference calculation methodology, systems parameters, reference model results for model scenarios, and some information on interpretation (including sensitivities, identification of simplifying assumptions and other factors which may need considering). Sections 2 to 5 present useful considerations on spectrum engineering issues, including frequency plans for geographical co-deployment of FWA systems.

2 Frequency allocation guidance

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

– take account of regional or other recommendations on preferred frequency bands for FWA systems;
– allocate sufficient spectrum to enable operators to be competitive; frequency blocks should not be too small to preserve spectrum efficiency since any guardbands must be included, and wherever possible co-sharing[1] should be encouraged;
– 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;
– plan for traffic growth, and to remember that in general one needs contiguous spectrum, although some systems may assist planning in using non-contiguous spectrum;

[1] Equitable, efficient apportionment of the band between operators within the same region/area, not co-frequency sharing normally.

– take note that, whereas assigning spectrum to several potential operators across a band facilitates comparison of competitive schemes by these operators, it may be equally acceptable to facilitate competition by use of different bands;

– take note that if too many operators are assigned spectrum in a band, this may be counter-productive in terms of spectrum efficiency;

– incorporate suitable guardbands 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 guardbands;

– specify for frequency division duplex (FDD) systems, a consistent plan for the forward central station (CS) to terminal station (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;

– take account that for time division duplex (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;

– 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 attractive approach can be to make appropriate regional/national allocations for each FS type from opposite ends of the band, with the proportion of total band usage for each type perhaps determined by market or other needs;

– 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, grade of service and other factors;

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

3 Frequency plans

3.1 General

For co-deployed systems, it is necessary to:

– take note that to date FS frequency plans have generally been prepared for P-P telecommunications systems featuring use of FDD, with symmetric channel block widths which may not be appropriate for all FWA systems;

– take account that services with variable asymmetry are often needed, especially for broader band applications[2];

– 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 multi-carrier modulation;
  – using asymmetrical TDD within the paired spectrum;

– 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/frequency block widths. Such a fixed frequency block 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;

– take note that it is possible in some cases to pair uplinks and downlinks in widely separated bands, for example an uplink within one band together with a narrower downlink within a lower band to provide fixed asymmetry for certain wideband applications;

– take note that some multimedia wireless systems, especially those derived in concept from broadcast/distribution type systems, may have a bidirectional rather than unidirectional interactivity channel/block. All the guidance provided elsewhere in this Annex should apply to this situation;

– 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 uplinks and downlinks) and that this may permit some variable asymmetry if the equipment can dynamically adapt the modulation scheme independently in the two directions;

– take account that TDD with variable time allocated to uplink and downlink directions can provide a manner of achieving applications having variable, asymmetrical traffic;

– take account of the need to promote an equitable burden sharing in respect to guardbands. For example, for the first FWA operator in a band it would be prudent and fair to ensure that any guardband(s) is (are) included within the assigned frequency block or sub-band;

– note that in general an interference margin (criterion) of –1 dB ($I/N - 6$ dB) might be considered appropriate in interference calculations between FWA systems and, unless stated otherwise in ITU-R Recommendations, with other services.

[2] As opposed to the type of fixed asymmetry needed by, for example, video surveillance type systems with wideband downlink capacity and narrow upstream capacity.

3.2 TDD assignments in bands with paired spectrum

3.2.1 General

In the case of TDD systems in bands with a frequency plan based on standard paired spectrum, it is necessary to:

– ensure that the TDD assignment respects the channel or frequency block plans for the FDD assignment/raster;

– 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, and vice versa;

– 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 frequency block or sub-band. The surplus unpaired $|m - n|$ channels could be usefully assigned to TDD services (including any necessary guardband allowance);

– take account that in the latter case, 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;

– take into account the possibility of using the centre gap for TDD, provided the requirements of Section 2 are observed.

3.2.2 Implementation

In the case of TDD systems in bands with a frequency plan based on standard paired spectrum, it is necessary to:

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

– take note that polarization may be used as a system propagation discriminant, although less usefully at lower frequencies. This can be useful to mitigate interference;

– note that additional parameters may be needed for the coexistence planning of TDD systems;

– 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). But once compatibility in the lower (or upper) block/sub-band has been demonstrated, compatibility in the other block/sub-band can be inferred.

4 Deployment

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

– consider the benefits of encouraging cooperation between operators in order to minimize interference and consequent economic impact, and to seek to use the spectrum efficiently;

– note that where CSs belonging to different operators are proposed to be sited relatively close, it may be preferable to co-locate these stations to minimize and better define the near/far effect. This may be especially appropriate in those cases where the directions of the forward and reverse frequency blocks are mixed or not designated, e.g. where different duplex technologies/spacings are mixed;
– note that where considering compatibility with P-P systems, CS and TS installations should wherever possible minimize P-MP antenna heights and judiciously use antenna angular discrimination, including nulls in the polar pattern, as additional mitigation and to minimize guardbands;
– note that where considering compatibility with fixed-satellite service systems, account should be taken of ITU-R Recommendations where available, including any guidelines covering the fixed-satellite service and P-MP antenna heights, separation distances, allowable range of elevation view angles, additional diffraction or other mitigation measures;
– note that where considering compatibility with the radioastronomy service, it is important to comply with the Radio Regulations, taking account of the aggregation effect of P-MP systems;
– note that where considering compatibility with radiodetermination systems in adjacent bands or in neighbouring countries, account should be taken of existing relevant ITU-R Recommendations. For radiodetermination 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 radiodetermination systems;
– 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;
– ensure that any necessary synchronization and other measures to accommodate mixed technologies are implemented as appropriate.

5 Equipment design

For co-deployment of FWA systems in the same geographical area, it is necessary to:
– take account of the importance of minimizing spurious and out-of-band and out-of-block emissions through appropriate equipment design;
– take account of the importance of maximizing receiver selectivity (and noting that relevant standards may be insufficiently detailed or stringent in all cases);
– 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;

– take note in considering compatibility with possible radiodetermination systems the desirability of enhanced resilience to interference by measures such as improved error correction/detection and other post-detection processing, fast overload recovery in the radio-frequency (RF) receiver, etc.

Annex 3

An example of the use of frequency blocks for systems in the fixed service in the 38 GHz band

1 Introduction

The large scale and high density deployment of subscriber-based broadband wireless access (BWA) systems in the frequency band 38.6-40.0 GHz in many administrations use the RF channel arrangement of Annex 2 to Recommendation ITU-R F.749 (1994 version), consisting of 13 channel pairs, e.g.

1-A:	38 600-38 650 MHz	1-B:	39 300-39 350 MHz
2-A:	38 650-38 700 MHz	2-B:	39 350-39 400 MHz
13-A:	39 200-39 250 MHz	13-B:	39 900-39 950 MHz

It should be noted that the 14-A and 14-B channel pair has been subsequently added (see Annex 3 to Recommendation ITU-R F.749).

This basic RF channel arrangement provides the necessary flexibility for users requiring larger or smaller RF channel bandwidths, as follows:

– users requiring more transmission capacity than can be accommodated by one channel pair could obtain two or more channel pairs;

– users may subdivide the allocated RF channel pairs for applications requiring smaller bandwidths.

2 Usage of the RF channel arrangement of Annex 3 to Recommendation ITU-R F.749 in terms of frequency blocks

The usage of this band is based on area-wide licensing of a number of usually contiguous RF channels. The number of channels and their positions in the channel arrangement are separately determined for each licensed area and each operator. The operator plans specific usage in a manner that results in the most efficient usage for the purpose, i.e. maximizing the service provisioning in the given licensed area. This usually means maximizing the number of potential users served with transmission capacities they require.

Referring to Fig. 1, the correspondence between the illustrated frequency arrangement and terminology used in this Figure, and the RF channel arrangement of Annex 3 to Recommendation ITU-R F.749 is exemplified as follows:

Figure 1	*Annex 3 to Recommendation ITU-R F.749*
Frequency plan band	38.6-40.0 GHz
Sub-band	Licensed contiguous RF channel group
Frequency block	A single RF channel, e.g. 38 650-38 700 MHz
Channel	Subdivision of an RF channel, e.g. 38 650-38 660 MHz
Slot	Next level subdivision in time of frequency

3 Framework for practical usage of frequency blocks in the deployment of subscriber-based BWA systems in the 38 GHz band

The variety of BWA systems used in the band 38.6-40 GHz in many administrations currently encompasses:

– P-P systems with T-1 (1 544 kbit/s), 4 × T-1, 8 × T-1, T-3 and OC-3 (or STM-1, 155.52 Mbit/s) data rates;

– P-MP systems with a T-3 data rate;

– modulation formats range from QPSK to 128-QAM;

– occupied bandwidths from 1 to 25 MHz;

– orthogonal polarizations used in some cases.

A variety of combinations of different systems are being accommodated in the 50 MHz RF channels used as frequency blocks, depending on the specific deployment needs. This includes combining P-P and P-MP systems in the same 50 MHz RF channel in some cases. The increasing service requirements make it necessary to make best possible use of the available frequency spectrum, and the inherent flexibility of frequency arrangements based on frequency blocks that can be combined and/or subdivided according to specific needs greatly increases the overall frequency spectrum efficiency.