RECOMMENDATION ITU-R F.1401*, **

FREQUENCY BANDS FOR FIXED WIRELESS ACCESS SYSTEMS AND THE IDENTIFICATION METHODOLOGY

(Questions ITU-R 215/8 and ITU-R 140/9)

(1999)

1 Introduction

1.1 Purpose

The objective of this Recommendation is to provide guidance for the identification of suitable frequency spectrum for terrestrial FWA applications, taking due account of sharing issues. Both traditional wireless telephony applications as well as emerging broadband wireless applications are considered.

The potential for FWA to enhance availability of telecommunications services in both developing and developed countries is substantial.

1.2 Background

Wireless access has been defined (see Recommendation ITU-R F.1399 as “end-user radio connection(s) to core networks”, where core networks include, for example, PSTN, ISDN, PLMN, PSDN, Internet, WAN/LAN, CATV, etc. Wireless access applications can be provided within the definitions of the radio services FS, MS, FSS and MSS contained in the ITU Radio Regulations (RR) (see § 4 for list of acronyms). FWA is one of these wireless access applications in which the location of the end-user termination and the network access point to be connected to the end-user are fixed.

Technologies in use today for implementing wireless access include cellular systems, cordless phone and cordless telecommunication systems, satellite systems, and specialized P-P and P-MP radio systems. New technologies and systems such as IMT-2000, wireless broadband ISDN, wireless ATM, etc., also form part of wireless access if their application satisfies the basic criteria of end-user radio connection(s) to core networks (see § 4 for list of acronyms).

1.3 Traditional telephony wireless access applications

Advances in technology and competitive access are driving the revolution towards wireless access infrastructure for the provision of basic telephone service. Traditionally the most difficult component of the network to build and the least cost-effective to maintain has proven to be the LAN, regardless of a developing or a developed economy. The sheer scope of investment and engineering efforts required to build and maintain copper-based networks has made high penetration rates for basic telephone service available only to industrialized nations of the world. Even the relatively low target subscriber density (teledensity) rate of 20 lines per 100 population set by the ITU, has been far beyond the capability of many nations until recently.

Wireless access is an application of radio technology and personal communication systems experiencing tremendous growth, especially in developing economies.

Generally, a wide range of radio system designs could be used for FWA and the suitability is a function of a number of factors. The most suitable system for a particular application will tend in general to depend on the requirements of the end-user (POTS only or many service features), the cost of deployment (which will depend on the density of the subscriber population and the type of system being considered) and the availability of the appropriate radio-frequency spectrum for that system. The requirement for mobility, or evolution for mobility, would tend to drive the deployment of systems derived from cellular technologies. Alternatively, the requirement for wireline quality and services (such as G3 FAX and voiceband data or even ISDN) would tend to be drivers towards special-purpose designed systems.

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* This Recommendation was developed jointly by Radiocommunication Study Groups 8 (Working Party 8A) and 9 (Working Party 9B), and any further revision should be undertaken jointly.

** This Recommendation should be brought to the attention of Radiocommunication Study Groups 4 (Working Party 4A) and 8 (Working Party 8A).

Understanding the drivers for the deployment of each technology is a key factor in minimizing the cost and maximizing the effectiveness of the solution. In some cases wireless access may offer potential for evolution and synergy with mobile services. An infrastructure supporting a fixed wireless system using an air interface developed for mobile services, (e.g. Recommendations ITU-R F.757, ITU-R M.622, ITU-R M.687, ITU-R M.819, ITU-R M.1033, and ITU-R M.1073) might be readily extended to support mobile users. Alternatively, special-purpose systems can be designed to meet the quality requirements in an optimal manner. Volume I of the ITU-R Land Mobile (including Wireless Access) Handbook provides further information on the basic principles and descriptions of wireless access systems.

1.4 Broadband wireless access

Local access and other high density radio-relay service planning and system deployments have rapidly accelerated in the last few years in many administrations. This acceleration is due in large part to the trend towards increased demand and competition in the provision of high bit-rate local telecommunications and video distribution services. Because of cost and speed of deployment considerations, these developments are placing a major new focus on the provision of services directly to end-users via fixed wireless access systems.

Current broadband wireless access data rates over individual circuit paths range from about 1.5 Mbit/s to about 45 Mbit/s, and are expected to reach at least 310 Mbit/s within the next few years, as radios utilizing higher order modulation schemes become available (see Recommendation ITU-R F.758).

The variety of possible broadband FWA network configurations includes: conventional P-P, conventional P-MP, and combinations thereof, e.g. P-P systems deployed in multisectored P-MP configurations. High density deployment of independent P-P links similarly results in clusters that assume the essential characteristics of P-MP deployment. An emerging system architecture is that of MP-MP, similar to mesh systems used at, for example, HF.

These broadband FWA systems are predominantly deployed in dense urban, suburban, and campus environments where transmission path elevation angles may reach up to about 40° to 60°. Links are regularly deployed on an on-demand basis to meet specific end-user requirements as they develop.

2 Scope

This Recommendation provides, as an initial response to Questions ITU-R 215/8 and ITU-R 140/9, a methodology for identification of suitable frequency spectrum for FWA and a list of items to be addressed in identifying candidate bands. These take into account the results of ITU-R studies on compatible operations with systems of existing radio services in FS and MS frequency allocations, characteristics and operational requirements, spectrum requirements, spectrum sharing criteria, and technologies for enhancing spectrum sharing. The bands identified could support traditional telephony wireless access applications or new and emerging broadband wireless access.

The scope of this Recommendation covers only FWA system operation in the FS and MS allocations; i.e. terrestrial.

3 References

This list of references includes both those specifically used in this document and other general references relevant to the topic of FWA.

– Recommendation ITU-R F.637: Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band

– Recommendation ITU-R F.746: Radio-frequency channel arrangements for radio-relay systems

– Recommendation ITU-R F.755: Point-to-multipoint systems used in the fixed service

– Recommendation ITU-R F.757: Basic system requirements and performance objectives for fixed wireless local loop applications using cellular type mobile technologies

– Recommendation ITU-R F.758: Considerations in the development of criteria for sharing between the terrestrial fixed service and other services

– Recommendation ITU-R F.1399: Vocabulary of terms for wireless access
– Recommendation ITU-R F.1400: Performance and availability requirements and objectives for fixed wireless access to public switched telephone network
– Recommendation ITU-R F.1402: Frequency sharing criteria between a land mobile wireless access system and a fixed wireless access system using the same equipment type as the mobile wireless access system
– Recommendation ITU-R M.819: International Mobile Telecommunications-2000 (IMT-2000) for developing countries
– Recommendation ITU-R M.1033: Technical and operational characteristics of cordless telephones and cordless telecommunication systems
– Recommendation ITU-R M.1073: Digital cellular land mobile telecommunication systems
– Resolution 122 (WRC-97): Use of the bands 47.2-47.5 GHz and 47.9-48.2 GHz by high altitude platform stations in the fixed service and by other services
– Resolution 726 (WRC-97): Frequency bands above 30 GHz available for high-density applications in the fixed service
– RR Number S5.547.

4 List of acronyms

ATM	Asynchronous transfer mode
CATV	Community antenna television
CDMA	Code division multiple access
FDD	Frequency duplex division
FPLMTS	Future public land mobile telecommunication systems (see IMT-2000)
FS	Fixed service
FSS	Fixed satellite service
FWA	Fixed wireless access
HAPS	High altitude platform stations
HDFS	High density applications in the fixed service
IMT-2000	International mobile telecommunications-2000
ISDN	Integrated services digital network
LAN	Local area network
LMCS	Local multipoint communications systems
LMDS	Local multipoint distribution systems
MMDS	Multichannel multipoint distribution systems
MP-MP	Multipoint to multipoint
MS	Mobile service
MSS	Mobile satellite service
MVDS	Multipoint video distribution systems
PCS	Personal communications systems
PLMN	Public land mobile network
P-MP	Point-to-multipoint
POTS	Plain old telephone service
P-P	Point-to-point
PSDN	Public switched digital network
PSTN	Public switched telephone network
RLAN	Radio local area network
TDD	Time division duplex
TDMA	Time division multiple access
WAN	Wide area network

5 Considerations related to the use of the spectrum for FWA

5.1 General

The terms fixed (radio) service and mobile (radio) service are defined by the Radio Regulations. The radio service definitions form the basis for the allocation of radio spectrum internationally by the ITU as well as domestically by each country. For the most part, the ITU has made joint allocations to the mobile and fixed services in various frequency bands. In some countries a choice has been made to limit use to one of the two services.

Certain evolving FWA applications do not fit explicitly into the definitions of either the FS or the MS. The appropriate approach is to apply some flexibility in the interpretation of these definitions to be able to embrace these integrated applications under the umbrella of the FS and the MS. A key to the interpretation of the use of these terms is the concept of mobility. If the device is intended to be used in motion or is normally moved from place to place, it is considered as part of the MS. On the other hand it is generally understood that portable systems, which are moveable but operate always in the fixed state, belong to the FS.

Applications are envisaged for fixed radio service systems where the integration of wireless access devices that function as mobile (requiring mobile allocations) radio stations might be required. These situations have resulted from the converging requirements of both mobile and fixed radio services and the use of wireless access devices in integrated radio applications.

In order to facilitate the introduction of FWA systems the following factors should be considered:

– Systems can use technologies derived from both mobile and fixed P-P systems.

– There is a growing trend in certain frequency bands where fixed and mobile applications are converging.

– Frequency reuse becomes increasingly effective at higher (millimetre wave) frequencies.

– Adaptive technologies and other advances are likely to afford greater effective capacity and spectrum efficiency in the future.

– Flexibility is needed in the frequency band structure to provide for multiple technologies and a variety of services.

– Area-wide and site-by-site frequency assignments are commonly used for FWA.

– Service providers may benefit from economies of scale in bands where there is significant regional or worldwide harmonization.

– In the future the convergence of telecommunications and broadcast applications may prompt the development of hybrid FS/broadcasting service applications.

5.2 Spectrum characteristics for wireless access

This section points out relevant characteristics of the radio spectrum for FWA implementation. Most of these characteristics are also relevant for other services.

The main characteristics of the use of the frequency bands allocated on a primary basis to FS and MS, suitable for wireless access are summarized as follows:

Below 1 GHz:

– telephony and low-speed data;

– good propagation for long reach – beyond horizon (rural systems);

– high-level of coverage reliability;

– limited bandwidth available;

– many bands heavily used for MS, broadcasting and other services;

– difficult to achieve high antenna gains with small antenna structures;

– easy to generate high transmit power at base station;

– components very readily available;

– coordination distances between co-channel systems is quite large;

– frequencies below 50 MHz suffer from propagation anomalies – ducting due to temperature inversion – ionosphere skip.

1-3 GHz:

- telephony and low/medium speed data;
- good propagation – limited-trans-horizon path (particularly suitable for both fixed and mobile applications);
- good coverage reliability – limited blockage problems;
- many bands already heavily used by existing MS, FS, satellite and radiolocation/radionavigation services;
- moderate bandwidth available;
- good range for urban and rural applications;
- antenna structures can be quite small (e.g. cellular, cordless);
- easy to generate high transmit power at base station;
- components readily available.

3-10 GHz:

- telephony and low/medium/high speed data;
- propagation generally limited to near line of sight;
- propagation through foliage is relatively good;
- path length generally less than 20 km for P-MP, more for P-P;
- more bandwidth available;
- many fixed/mobile bands shared with satellite services:
  - sharing constraints more favourable to P-P systems;
- components of reasonable cost and availability;
- more expensive to generate transmit power;
- coverage reliability is moderate-poor due to blockage;
- bands can be suitable for FWA applications employing high-gain antennas at the base station and subscriber station.

10-30 GHz:

- telephony, low, medium and high data rates, video;
- mature P-P and multipoint technology;
- propagation:
  - line of sight required;
  - rain attenuation is a factor;
  - urban/suburban applications;
- employ small antenna structures;
- path lengths generally less than 10 km for P-MP, more for P-P;
- substantial contiguous bands of FS spectrum are available;
  - support broadband applications;
- transmit power is more expensive;
- high-level of frequency reuse, especially in the 20-30 GHz range;
- many FS/MS bands shared with satellite services;
- sharing between FS (including FWA) and FSS/MSS may be difficult.

30-50 GHz:

– telephony, low-medium and high data rates, video;

– propagation:

  – line of sight;

  – rain attenuation – a significant factor;

– antenna structures can be very small, and have high levels of gain;

– path lengths generally less than 5 km for P-MP, more for P-P;

– large contiguous bands of spectrum available for broadband FWA applications;

– applications are urban/suburban;

– very high level of frequency reuse;

– sharing between FS (including FWA) and FSS/MSS may be difficult;

– some countries have broadband FWA systems in the 38 GHz band.

Above 50 GHz:

– high atmospheric losses in the 55-66 GHz range;

– rain attenuation – a significant factor;

– generally the range is up to 10 km;

– very high level of frequency reuse;

– technology under development;

– sufficient spectrum available for FWA systems due to decisions at WRC-97.

Table 1 provides a generalized categorization of frequency bands by service and constituency. For the purposes of this Recommendation, the types of services are defined in Recommendation ITU-R F.1400 – Performance and availability requirements and objectives for fixed wireless access to public switched telephone network.

Type 1: Analogue signals such as voice and voiceband data at rates up to 64 kbit/s (minimum 3.1 kHz audio as identified in ITU-T Recommendation G.174).

Type 2: Access bearer service from 64 kbit/s to bit rates below the primary rate.

Type 3: Digital services operating at the primary rate or above.

TABLE 1

Frequency bands broadly categorized by service and constituency

Class of service	Service constituency		
	Rural	Suburban	Urban
Type 1	≤ 5 GHz	≤ 5 GHz	≤ 5 GHz
Type 2	≤ 5 GHz	1-11 GHz	1-11 GHz
Type 3	3-70 GHz(1)	3-70 GHz	3-70 GHz

(1) The bandwidth requirements for Type 3 services cannot be accommodated, generally, in frequency bands below 3 GHz and may need higher frequencies, up to 70 GHz, even if the range is therefore severely reduced.

6 Recommendations

The ITU Radiocommunication Assembly recommends that the following points be taken into consideration in the identification of suitable frequency bands for the implementation of FWA systems.

6.1 Methodology to identify possible bands for FWA

Step 1: Identify either or both FS and MS bands taking into account the following considerations:

- bands already in use for FWA or for which equipment is available;
- bands identified in existing Resolutions from radiocommunication conferences (e.g. HDFS);
- bands with greatest possibility for global harmonization (less sharing constraints);
- FS bands which may be under-utilized (candidates for re-farming).

Step 2: Consider the spectrum implications of the performance and availability requirements for the required telecommunication services.

Step 3: Consider cost-effectiveness and equipment availability of the bands under consideration.

Step 4: Identify sharing and regulatory constraints:

- List of applicable ITU-R Recommendations (technical);
- Radio Regulations, including footnotes (regulatory).

Step 5: Identify complementary sharing studies with other primary radio services in the bands identified in accordance with Step 1.

Step 6: If Steps 4 and 5 indicate ITU-R sharing studies are inconclusive or there is potential for interference, perform analysis to determine if sharing between FWA systems and these services is feasible.

Step 7: Identify the frequency bands that have passed the tests above.

6.2 Information to be compiled for the identification of frequency bands

Based on the above methodology, the following items are necessary for the identification of possible FS and MS bands eligible for FWA systems covering the range 400 MHz to 70 GHz:

- frequency band,
- bandwidth,
- ITU-R Recommendations on spectrum,
- other ITU-R Recommendations,
- regional Recommendations on spectrum,
- other regional Recommendations,
- sharing studies,
- current use,
- other information.

Studies are invited addressing these items with a view to identifying candidate frequency bands.