

REPORT ITU-R F.2047

Technology developments and application trends in the fixed service

(Question ITU-R 221/9)

(2004)

1 Introduction

This Report provides guidance on the future development of the fixed service (FS) reflecting recent technology developments and application trends for fixed wireless systems, including fixed wireless access (FWA) applications, and frequency sharing studies to enhance spectrum utilization efficiency.

2 Scope

This Report addresses the following items in relation to the future development of the FS:

- FS technology trends overview;
- development of the role of FS systems in telecommunication networks;
- FS band usage trends in some countries;
- frequency sharing studies with other services;
- possible future applications in the FS.

The scope of this Report covers conventional radio-relay systems, FWA systems, fixed wireless links for back-haul communications, systems utilizing high altitude platform stations (HAPSs), and nomadic wireless access (NWA) systems, when operating in the FS, including consideration of technology convergence of terrestrial wireless systems.

3 List of acronyms and abbreviations

BS	Broadcasting service
BSS	Broadcasting-satellite service
BWA	Broadband wireless access
DVB	Digital video broadcasting
EESS	Earth-exploration satellite service
FDD	Frequency division duplex
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
ISM	Industrial, scientific and medical

ISP	Internet service provider
ISS	Inter-satellite service
LMCS	Local multipoint communication systems
LMDS	Local multipoint distribution systems
MDS	Multipoint distribution system
MP-MP	Multipoint-to-multipoint
MS	Mobile service
MWA	Mobile wireless access
MWS	Multimedia wireless systems
NWA	Nomadic wireless access
PDA	Personal digital assistant
P-MP	Point-to-multipoint
P-P	Point-to-point
QoS	Quality of service
RF	Radio frequency
RL	Radiolocation
RLAN	Radio local area network
RN	Radionavigation
RRS	Radio-relay system
SDH	Synchronous digital hierarchy
SDR	Software defined radio
SONET	Synchronous optical network
STM-1	Synchronous transport module 1
TDD	Time division duplex

4 Developments in the FS

4.1 FS technology trends overview

In terms of the evolution of the FS, issues that merit close attention include the following:

- convergence of services and technology offerings, e.g. the concept of multimedia wireless systems (MWSs);
- convergence of nomadic and fixed and mobile applications, including licence-exempt applications;
- HDFSs are used for both network infrastructure support and end user access. It is worth noting that WRC-2000 designated the following frequency bands as available for HDFS systems:
 - 32, 38, 42, 52, 56 and 65 GHz;
- a possible trend towards more flexible regulatory regimes;

- fairly rapid progress in design and development of more frequency agile, flexible and autonomous systems to give good spectral efficiency in a manner which also aids faster and cheaper deployment practices;
- user demands for greater quality of service (QoS), particularly in relation to the next 15 years or so of worldwide build-out of infrastructure that will support the explosive growth of the Internet;
- understanding of different development status of countries, and possible growth of FS spectrum needs;
- possibilities for review of applications in any current band that is used for the FS;
- possibilities for improved sharing with traditional FS and licence-exempt FS and MS applications.

Convergence in digital telecommunications (data, voice, sound, image and video) is giving rise to technology trends in the FS that are not only rapid but also highly unpredictable especially in time-frames beyond five years.

The role of the FS is changing. In the past, the FS served a variety of trunking and transport applications ranging from very low capacity applications (less than the primary rate) to very high capacity applications, where typically 1: n diversity protection was needed at system bit rates above the order of STM-1. For example, telecommunication operators could consume a large part of a given frequency band in these very high capacity applications. In the access network, the FS was used sparingly as an adjunct to cable networks. Over the last several years, however, these very high capacity radio-relay applications have largely been replaced with fibre optic transmission systems and this trend will continue for the foreseeable future.

On the other hand, the FS has, more recently, been establishing a stronger presence in the access network in licensed and licence-exempt spectrum. This is due in part to a growing demand and economical equipment which in turn is a result of agreed standards for FWA systems at the medium access control and physical-layers. In the future, the FS is expected to serve a greater role in the access network, complemented with low, medium and high-capacity trunking and transport applications. These new trunking applications will typically not require 1: n diversity protection and will complement fibre optic transmission systems in rugged, remote and difficult terrain areas of the world.

Increased flexibility of equipment through software control will enable varying traffic asymmetry (mainly in the access network) requirements in the FS.

Also, in some cases, the boundary between systems in the FS and MS is becoming less well defined. As next generations of P-MP fixed systems address non-line-of-sight, high performance and broadband challenges, as well as new mesh architectures in the access network, the FS could have a major role in the implementation of the transport network for IMT-2000 and systems beyond IMT-2000. This role may include not only the provision of service but also infrastructure support networks, as considered in the later section.

To further increase spectral efficiency and service flexibility, advanced FWA (including HDFS/BWA) systems are increasingly likely to employ a range of techniques that may include different duplex technologies, and mixes of them, and dynamic allocation of bit rate, of modulation and of antenna beamwidth/pattern. Such systems will likely have the functional capability of variable or flexible channelization; this better facilitates transmission of symmetrical or asymmetrical services, based on need, an important factor in the growth of wireless services.

In this connection it is attractive to consider SDR.

SDR is generally characterized as a radio technology in which the operating parameters, in particular spectrum-related parameters, can be changed via software without replacing the hardware components. Definition of SDR and its associated techniques are under study in ITU-R. It should be noted that some of today's radio equipment employ programmable memory modules as firmware or hardware components. In this sense there are already some forms of SDR in the existing networks.

In some aspects the SDR technology has been applied since the early 1990s in some parts of radio systems and more use of SDR is expected to be made in the future. SDR could provide an efficient solution to the problem of building multi-mode, multi-band, and multi-functional wireless devices. With software programmability, high-speed digital signal processing performs many of the functions previously carried out in hardware, and the radio can be made capable of transmitting and receiving over a range of frequencies.

One of the SDR impacts on radio equipment for the FS is that manufacturers could develop a common hardware platform on which various SDR functions are implemented, and that a single hardware is economically applied to many operators' different specifications. Such a feature may also affect equipment authorization, type approval standards or declaration of conformity.

Traditionally, manufacturers have been responsible for the approval of their fixed wireless equipment for a specific set of technical parameters. With SDR, this responsibility may need to be shared with the operators. In fact, operators must be aware of the potential technical and sharing constraints over the complete range of operating frequencies and modulation schemes. SDR could provide a leverage to harmonize emission standards across frequency bands on a global or regional basis.

In terms of FS deployment arrangements, in the near future there will be connected (ring) as well as conventional cascades ("daisy chain" or radio relay) for P-P schemes, and multipoint schemes will include MP-MP (mesh) structures as well as P-MP and various hybrid FS arrangements. The air-side concentration is a significant distinguishing feature in multipoint system usage as compared to conventional P-P systems. Some multipoint systems are already deployed in infrastructure support. Many more FS deployments will be needed as network infrastructure support for the rapidly growing cellular mobile/nomadic markets, i.e., these are not access but conventional infrastructure applications.

It should be noted that even P-P systems used in fairly conventional type of deployment architecture will benefit from these advances in systems design and in spectrum usage, including the use of block-based frequency arrangements rather than conventional channelization, and this will be influenced by the evolution in design of the multipoint, which are largely access systems.

4.2 Development of the role of FS systems in telecommunication networks

FS systems have been and continue to play a role in long-haul or inter-exchange links in telecommunication infrastructure networks. However, increasing demand for wireless access systems and development of optical fibre systems have brought about changes in the development of FS systems. ITU-R is experiencing an increased interest in systems used in the access portion of telecommunication networks.

Recent work in ITU-R reflecting the above developments can be summarized as follows:

- a new term "fixed wireless system" has been defined in Recommendation ITU-R F.592 on terminology instead of conventional "radio-relay system";

- many new or revised Recommendations on RF channel arrangements have been adopted in the frequency bands identified by WRCs for use for HDFS or other bands used for FWA systems (see Recommendations ITU-R F.1098, ITU-R F.1496, ITU-R F.1497, ITU-R F.1488, ITU-R F.748, ITU-R F.749, ITU-R F.1520, ITU-R F.1567 and ITU-R F.1568);
- studies on new delivery technologies such as HAPS that could also be utilized for access networks have been continuously facilitated (see Recommendations ITU-R F.1500 and ITU-R F.1501, ITU-R F.1569, ITU-R F.1607, ITU-R F.1608 and ITU-R F.1609);
- studies on frequency sharing between FS systems and other services have been carried out (see Recommendations ITU-R F.1489, ITU-R F.1509, ITU-R F.1570, ITU-R F.1612 and ITU-R F.1670).

4.2.1 Transport or trunking networks

Traditional transport or trunking networks operate in frequency bands in the range below 15 GHz. With the increase in traffic demand, many service providers are now deploying fibre optic networks instead of building new, very high capacity radio-relay networks (e.g. higher than SDH STM-1) or augmenting existing very high-capacity radio-relay networks. In some administrations, the frequency bands that have been used for very high capacity transport applications may be expected to be employed less in the future in these kinds of applications. In most administrations, existing trunking networks are likely to remain in use but are not expected to grow significantly, however an increase in traffic demand due to Internet access might be expected especially in rural areas.

In many cases existing bands for low, medium and high-capacity P-P, radio-relay networks will continue to be needed to satisfy a growing number of competing public and private telecom networks. Low and medium capacity short haul P-P links are serving an important role in providing links for an increasing number of organizations and corporations that are operating networks that are not part of public network infrastructure. Furthermore, there is expected to be increasing use of low, medium or high-capacity systems for short haul (a few hops or a single hop) applications, as well as for mobile and FWA backhaul networks.

A further emerging application is for fibre optic network back-up that will require very high capacity FWSs. Whatever the application, effective spectrum utilization will require the preparation of new and flexible RF channelization plans. In preparing such channelization plans however, account will need to be taken of continued coexistence with other primary services in these bands.

4.2.2 FS use in IMT-2000 infrastructure networks

After WRC-2000 identified additional mobile service bands for IMT-2000, the global build-out of IMT-2000 began, which is placing demands on FS spectrum for network infrastructure. Some of the network infrastructure will be supplied by optical fibre systems, and this trend needs to be carefully assessed in the deployment of future FWSs in this application.

A study has shown that by the year 2010 the required transmission capacity for access links to individual base stations (except for indoor environments) will increase several times or more than that compared with pre-IMT-2000 systems. Moreover, according to recent studies in ITU-R, the objective for a potential new radio interface is to support up to 50-100 Mbit/s in the mobile environment in the down-stream direction by around the year 2010 to 2015 (see Recommendation ITU-R M.1645). Such a trend may lead to further demands for the FS use on interconnecting the different layers of IMT-2000 networks.