RECOMMENDATION ITU-R F.1498

DEPLOYMENT CHARACTERISTICS OF FIXED SERVICE SYSTEMS IN THE BAND 37-40 GHz FOR USE IN SHARING STUDIES

(Question ITU-R 107/9)

(2000)

The ITU Radiocommunication Assembly,

considering

a) that the band 37-40 GHz is allocated to the FS on a primary basis;

b) that the telecommunication deregulation trend increases demand for competitive local access alternatives;

c) that point-to-point (P-P) FS systems are deployed on a large scale and their use is growing in the band 37-40 GHz;

d) that mobile network and competitive access infrastructures represent the major FS applications in this band;

e) that an increasing number of P-P and point-to-multipoint (P-MP) FS stations are deployed or being planned for local access use in the band 37-40 GHz;

f) that the high concentrations of service users in urban, suburban and industrial areas require high-density deployment of user terminals in these areas;

g) that propagation conditions in this band are predominantly controlled by rain attenuation;

h) that technological progress in system implementation and deployment are continually improving competitive local access service provisioning in this band;

j) that the band 37.5-40 GHz is allocated on a primary basis to the FSS (space-to-Earth) and that an increasing number of FSS systems are being planned for this band;

k) that WRC-97, in Resolution 133 (WRC-97), requested to conduct studies leading to technical and operational recommendations to facilitate sharing between FS and other services in the band 37-40 GHz,

recognizing

a) that FS systems in the band 37-40 GHz may include ubiquitous deployment of P-P and P-MP systems over specific service areas;

b) that administrations may authorize P-P and P-MP systems using discrete channelling or frequency block assignments; within a frequency block, it is common practice to permit a range of technologies, carrier frequency bandwidths and access techniques,

recommends

1 that efficient spectrum utilization and performance and availability, based on the applicable ITU-T and ITU-R Recommendations, be primary considerations for high-density deployment of systems in the FS in the band 37-40 GHz (see Note 1);

2 that the propagation conditions in this band be advantageously used in path engineering to achieve extensive frequency reuse;

3 that Annex 1 can be referred to for FS system deployment guidance in the band 37-40 GHz for use in sharing studies.

NOTE 1 – Relevant Recommendations are, *inter alia*:

ITU-T Recommendations

ITU-T Recommendation G.821 – Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network.

ITU-T Recommendation G.826 – Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate.

ITU-T Recommendation G.827 – Availability parameters and objectives for path elements of international constant bit rate digital paths at or above the primary rate.

ITU-R Recommendations

Recommendation ITU-R F.697 – Error performance and availability objectives for the local-grade portion at each end of an integrated services digital network connection at a bit rate below the primary rate utilizing digital radio-relay systems.

Recommendation ITU-R F.757 – Basic system requirements and performance objectives for fixed wireless access using mobile-derived technologies offering basic telephony services.

Recommendation ITU-R F.1189 – Error performance objectives for constant bit rate digital paths at or above the primary rate carried by digital radio-relay systems which may form part or all of the national portion of a 27 500 km hypothetical reference path.

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

Recommendation ITU-R F.1400 – Performance and availability requirements and objectives for fixed wireless access to public switched telephone network.

Recommendation ITU-R SM.1046 – Definition of spectrum use and efficiency of a radio system.

Recommendation ITU-R SM.1271 – Efficient spectrum utilization using probabilistic methods.

ANNEX 1

FS deployment characteristics in the frequency band 37-40 GHz considered for use in sharing studies

1 Introduction

The progressing deployment of FS stations or FSS earth stations may affect the future expansion of either service in the same frequency band. Accordingly, the FS station deployment patterns and the FSS earth station deployment patterns required for the introduction and growth of viable services have a major impact on band sharing.

A combination of different propagation and service development conditions results in substantial FS deployment differences in the bands below 14 GHz where sharing between FS and GSO FSS systems is currently practised, and in the bands above 17 GHz which are being considered for additional sharing with space services, e.g. the FSS. Propagation conditions result in usable FS hop lengths that are inversely proportional to frequency. The bands below 8 GHz are therefore best suited for long-distance transmission, whereas the much shorter usable hops at frequencies above 17 GHz are particularly well suited for cellular infrastructures and local access applications which are rapidly growing in urban, suburban and industrial areas.

In the bands below 14 GHz, the predominant deployment patterns of both services facilitate sharing, because FS deployment along major communications routes results in branching network configurations that leave large geographical areas free for FSS gateway deployment. This facilitates realizing the interservice separation distances that are needed to limit interference to tolerable levels.

In the band 37-40 GHz, however, the predominant FS deployment pattern is characterized by mobile network infrastructures and direct subscriber access in local areas of high population density, concentrated industrial activity or campus settings, and FSS deployment patterns could include these areas as well. FSS earth station deployment outside areas of dense FS deployment should present few coordination problems. The same is not necessarily true with respect to the deployment of FSS earth stations within and adjacent to the FS deployment and area-wide FS licence areas, and vice versa.

The information on FS deployment, presented in this Annex, is intended to be used in the assessment of FS/FSS earth station sharing in the 38 GHz band.

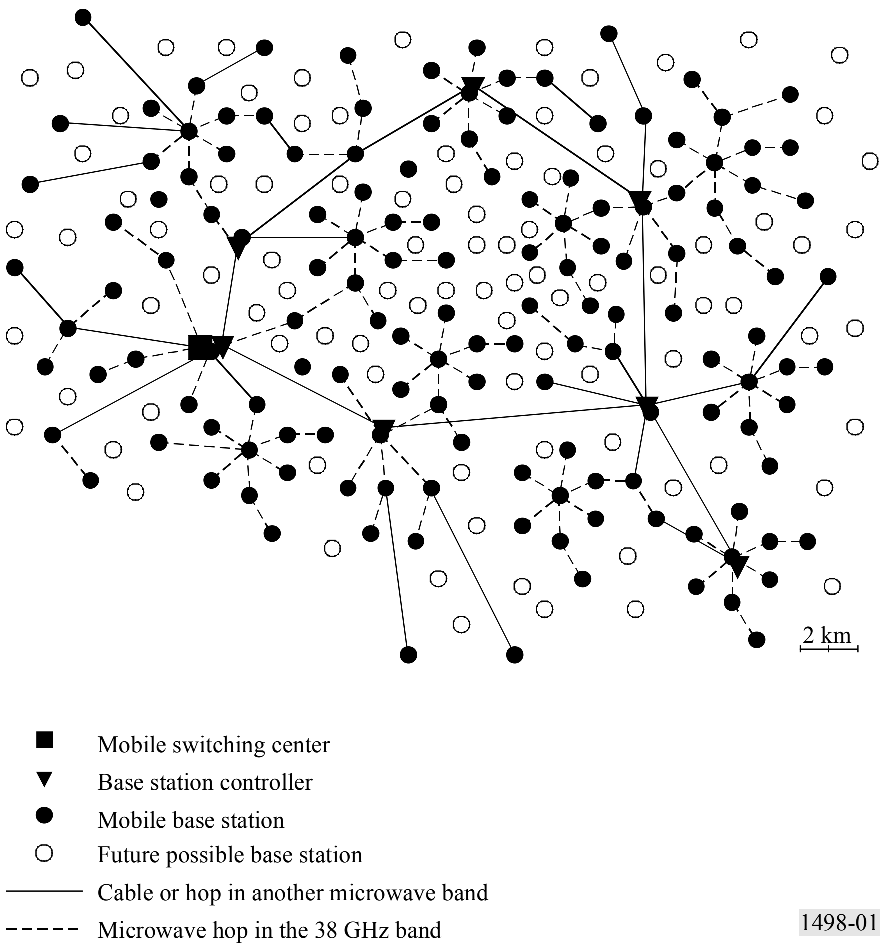
2 Progress of 38 GHz FS deployment

The initial large-scale deployment of P-P systems in the band 37-40 GHz was in mobile networks with a concentration mainly in and around urban and industrial areas. A more recent large-scale FS application in this band represents a new variety of fixed wireless access (FWA) using P-P links that terminate directly on subscriber premises.

Figure 1 illustrates an example of the current primary application within a mobile network for 38 GHz deployment in urban areas where deployment densities have progressed into the range of 1 to 10 stations per km^2. The links are designed to satisfy availability criteria between 99.99% and 99.999%.

FIGURE 1

Illustrative application of 37-39.5 GHz P-P systems for mobile infrastructure (e.g. GSM1800) in dense urban areas



While the current major use of the 38 GHz band in many countries is the application of P-P systems with capacities of a multiple of the primary rate, in the future higher capacities up to 155 Mbit/s or $n \times 155$ Mbit/s can be expected; these higher capacities will use higher level modulation methods (e.g. 16-QAM).

In Germany, for example, a total of some 12 700 terminals had been deployed by the end of 1998. It is anticipated that this number will increase significantly during the next years, with increasing FWA applications. 80% of the links are concentrated in 15% of the total area (see Fig. 2). The other links are distributed over the remaining area, but there are also numerous areas with no or neglectable 38 GHz applications. Main uses of the 38 GHz range in Germany are within mobile networks where typical hop lengths are between 1 and 4 km (see Table 1).

TABLE 1

Distribution of hop lengths in the 38 GHz band by the end of 1998 in Germany

Hop length (km)	0-2	2-4	4-6	6-8	8-10	Total
Number of links	2 951	2 780	565	44	6	6 346

Figure 3 illustrates, for one metropolitan area in the United States of America, a deployment of P-P systems in hub configurations providing various transmission capacities ranging from sub-primary data rates to 45 Mbit/s. The links shown in Fig. 3 are actual links. The larger triangles represent potential customers.

In this area, hub locations are typically on high-rise buildings, and subscriber stations are mounted on rooftops and/or elsewhere on or within the building. Line-of-sight hop lengths are limited to a few kilometres due to propagation conditions and high availability requirements. Distances may increase in low rain fade areas or due to lower availability requirements. P-P deployment densities, expressed by the number of 38 GHz stations per km^2 have already reached up to about 100 per km^2 in some instances and are moving higher. One operator reports a nationwide growth rate in link installation from January 1998 to August 1998 of approximately 300%.

The 38 GHz band has been extensively licensed for FS use in the United States of America. There are now approximately 65 FS licensees in the 38 GHz band with over 1 400 area-wide licences. At least three of these United States of America licensees have licences covering 180 million people or more. These 38 GHz licensees are deploying a new type of FS wireless local network providing digital links directly to subscribers. The local networks interface with the public telecommunications network through local switches and fibre rings.

Subscriber links of up to 0.5 km in length account for about one third of the total installed base in all currently served metropolitan areas, links up to 0.75 km for about one half, and links up to 1 km in length for about two thirds of the total. These links are usually engineered to provide 99.999% availability and to satisfy the performance objectives of Recommendation ITU-R F.1092. Area-licensed 50 MHz channel pairs in the band 38.6-40 GHz enhance flexible service provisioning and spectral efficiency through frequency re-use, similar to cellular and personal communications service (PCS) operators' practice in the mobile bands below 2 GHz.

Whereas the existing service in the band 38.6-40 GHz is based on the use of P-P systems with a simple modulation scheme, e.g. 4-PSK, the development trend is toward both P-MP systems and more complex modulation schemes, e.g. 64-QAM, that substantially increase the spectral efficiency and offer higher transmission capacities, e.g. up to

250 Mbit/s. In the United States of America the combined P-P and P-MP station densities per km^2 are expected to reach up to about 200 within one year in some instances and to continue rapidly increasing afterwards. This anticipated growth is contemplated by the licences already granted, and requires no new authorization.

FIGURE 2

38 GHz deployment in Germany by the end of 1998

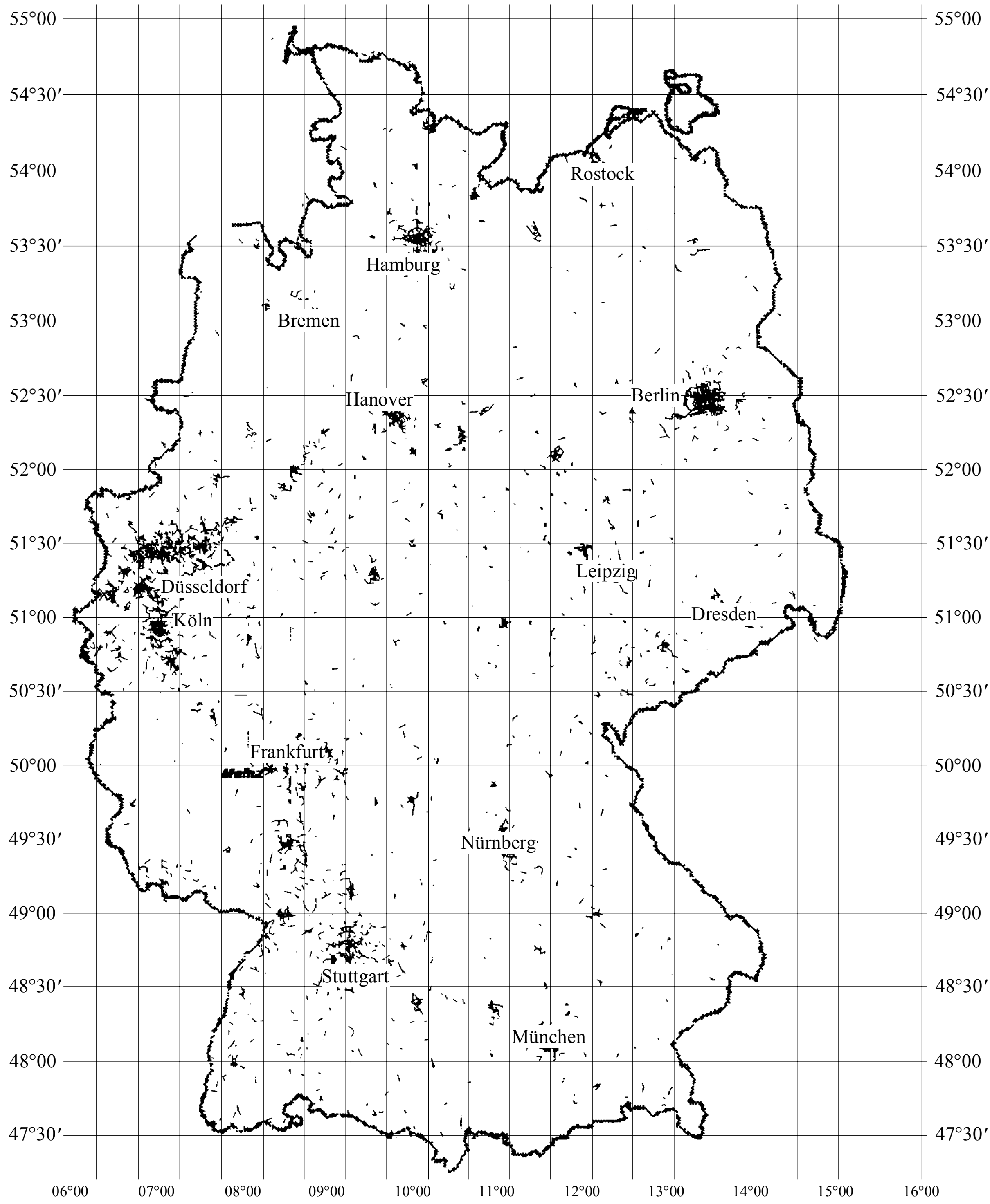


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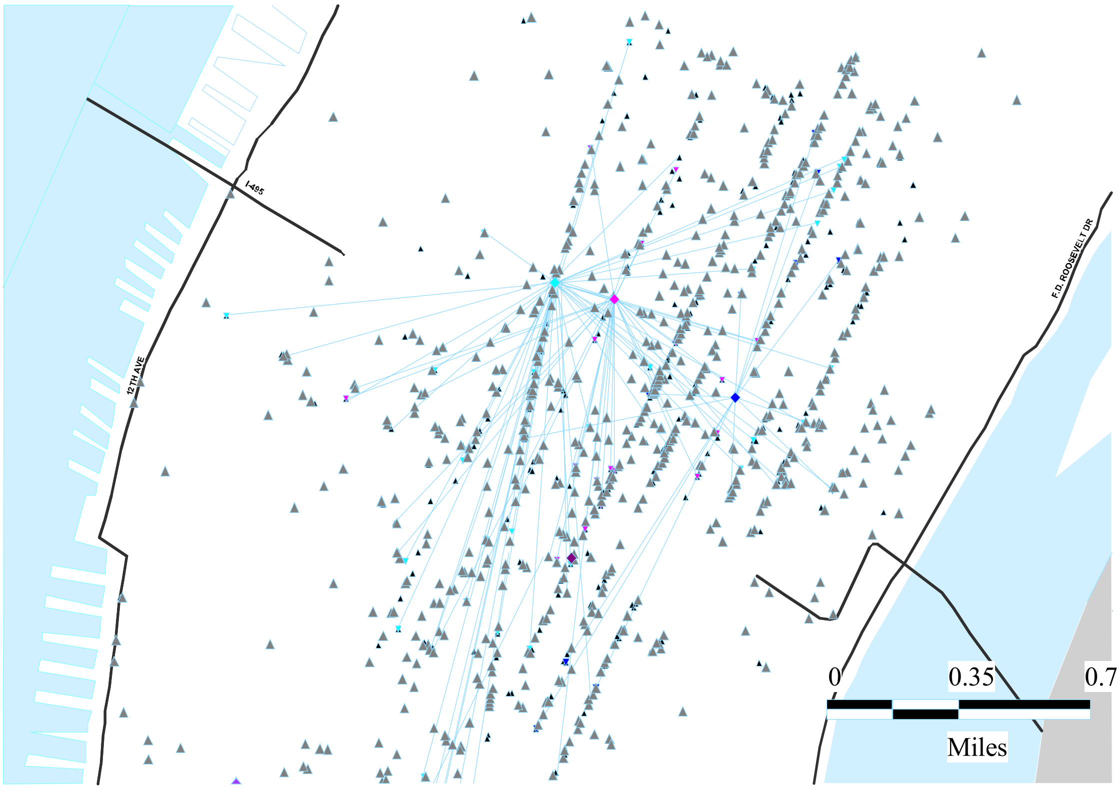
FIGURE 3

Deployment pattern in an urban area in the United States of America



In P-MP systems, unlike P-P systems, the base station antenna will be either omnidirectional or sectoral. In each case the base station antenna will be oriented to serve all the subscribers within the serving area of that base station. As a result the base station antenna will have less gain and directivity than in the case of the hub end of a series of P-P hops configured in a hub and spoke configuration. In the P-MP configuration the subscriber end of the path will operate with less receive signal level and will therefore require higher gain antennas to maintain an acceptable fade margin to compensate for rain attenuation.

Consistent with vertical radiation patterns of omnidirectional and sectoral antennas, the e.i.r.p. from the base station antenna will decrease as the subscriber terminal moves closer to the base station. This reduced signal strength is somewhat compensated for by the corresponding reduction in path length. However, the net effect is a reduction in signal strength and therefore a corresponding decrease in fade margin. Also, it follows that as the path between the hub and the subscriber decreases, the elevation angle of the subscriber terminal increases, thus reducing available atmospheric loss and increasing the susceptibility of the receiver to interference from satellite emissions. The described local access services for mobile network infrastructures and direct subscriber access achieve high spectral efficiencies due to favourable frequency re-use conditions which derive from the propagation conditions that limit the usable line-of-sight hop lengths in the band 38 GHz to a few kilometres when 99.999% availability is required. Experience shows that area licensing stimulates operation at the highest possible spectral efficiencies, and simultaneously enables several local competitors to coexist in the same local market, in the same way as cellular and PCS operators do in the mobile bands below 2 GHz.

In recent years, Brazil has experienced a tremendous growth in the deployment of P-P digital radio systems, mainly with transmission capacity ranging from 2 to 34 Mbit/s, for mobile telecommunication system back-haul connections, as well as for corporate wireless access applications, at frequency bands higher than 15 GHz. Currently, in the metropolitan areas, due to the saturation at the lower frequency bands, the 38 GHz band has been authorized for the above applications. More than 260 hops were already licensed by the end of 1997, and a high deployment rate of radio hops is expected at 38 GHz as the privatization of telecommunication advances. This is a good example of emerging FS systems deployments in the 38 GHz band.

3 Considerations regarding the determination of the coordination area in respect to the FS

In general, coordination between FS stations and FSS earth stations can be exemplified by the following scenarios:

– Areas without FS deployment:

  The geographical areas in which the FSS will not need to coordinate with the FS will be larger in the 37-40 GHz band in comparison with the currently shared lower frequency bands where the FS deployment is spread out over much larger geographical areas.

– Areas with sparse FS deployment:

  In intermediate cases, where the FS is sparsely deployed, station-to-station coordination is feasible.

– Areas with dense FS deployment:

  In service deployment areas where there is dense deployment of FS stations, coordination with and by FSS earth stations should be carried out on a basis other than a station-to-station basis. The Report of CPM-97 to WRC-97 stated in section 7.5.3.2, § 1, that because high-density FS intra-service station distances are substantially smaller than inter-service separation distances, coordination with and by other services should be carried out for high-density FS service areas instead of individual high-density FS stations.

These three deployment scenarios are illustrated in Fig. 2.

The following additional considerations are of key importance to any coordination between FS stations and FSS earth stations:

– Both the FS and the FSS need to assure line-of-sight coverage of their subscriber base. The fact that FS hub stations are being placed in exposed locations, such as on top of high-rise buildings in many cases, reduces the opportunity to use natural or man-made shielding by the FSS in order to reduce the separation distance. In those instances, most interference paths would have line-of-sight propagation conditions.

– Under area-wide licensing, service is implemented using both P-P and P-MP FS systems. The use of sectoral antennas in the hub stations of P-MP systems is more restrictive to coordination. Such antennas cover a segment of 360° or are stacked for omnidirectional service area coverage, as required. Sectoral antennas reduce the benefits of using angle discrimination in coordination, as compared to parabolic antennas. The actual required separation distance between the FS transmitter and the FSS receiver depends on the actual parameters of both systems, such as FS transmitter power density, minimum operational elevation angles of satellite systems, off-axis antenna gain of both systems, and the terrain topography.