

RECOMMENDATION ITU-R F.755-2*

POINT-TO-MULTIPOINT SYSTEMS IN THE FIXED SERVICE

(Question ITU-R 125/9)

(1992-1994-1999)

The ITU Radiocommunication Assembly,

considering

- a) that there are different applications, services and deployment scenarios which require various point-to-multipoint (P-MP) system configurations;
- b) that different P-MP systems in the fixed service (FS) are used in various frequency bands depending on the services transported and the deployment scenario envisaged;
- c) that minimization of interference and optimization of spectrum usage can be achieved by proper emission control, appropriate access techniques and efficient modulation;
- d) that P-MP systems can provide comparable performance and availability objectives with those used for wired systems;
- e) that P-MP systems commonly use omnidirectional or sectorized antennas or multiple antenna configurations at the central station and directive antennas at the terminal station, and/or repeater station;
- f) that various applications are suited to different parts of the spectrum dependent upon capacity, area coverage, path length and location (rural, suburban, urban, etc.);
- g) that P-MP systems are suitable for high density deployment;
- h) that operating characteristics of P-MP systems are required in order to determine appropriate intra-service interference criteria and sharing criteria with other services,

recommends

- 1 that for time division multiple access (TDMA) P-MP systems used as radio concentrators, Recommendation ITU-R F.756 should be referred to;
- 2 that for radio-frequency channel arrangements for analogue and digital P-MP radio systems operating in frequency bands in the range 1 427-2 690 MHz, Recommendations ITU-R F.701, ITU-R F.1098, ITU-R F.1242 and ITU-R F.1243 should be referred to;
- 3 that for single channel or multichannel multipoint video distribution services, Annex 1 can be referred to for a description of a particular implementation;
- 4 that for packet radio systems, Annex 2 can be referred to for some specific examples;
- 5 that for TDMA systems for data transmission, primarily in urban areas, Annex 3 can be referred to for information on various systems;
- 6 that for some requirements for P-MP systems used in the local grade portion of an ISDN connection, reference can be made to Recommendation ITU-R F.697;

* This Recommendation should be brought to the attention of Radiocommunication Study Groups 3 (Working Party 3J) and 7 (Working Party 7D), and Joint Rapporteur Group 7D-9D.

- 7 that for performance requirements of P-MP systems which provide to the end-user a connection at or above the primary rate, reference can be made to the access section of the national portion of Recommendation ITU-R F.1189;
- 8 that Annex 4 can be referred to for applications of frequency division multiple access (FDMA) P-MP systems operating in the frequency bands 3.4-3.6 GHz, 3.6-3.8 GHz, 10.15-10.3 GHz paired with 10.5-10.65 GHz, 26/28 GHz and 32 GHz;
- 9 that Annex 5 can be referred to for technical and operational aspects in the 25-32 GHz frequency range;
- 10 that for radio-frequency (RF) channel arrangements for digital P-MP radio systems operating in the frequency bands 26 and 28 GHz, Annex 1 and Annex 2 of Recommendation ITU-R F.748 can be referred to.

ANNEX 1

An example of single-channel and multichannel multipoint distribution services

1 System description

The multipoint distribution service provides, for one-way P-MP transmission, at approximately 2 GHz, up to four channels of voice, video and data signals to geographically distributed communities of interest. These signals may be used for entertainment, business, social or community purposes. A typical multipoint distribution service system consists of an omnidirectional transmit antenna and a combiner to combine the output of each transmitter at the transmitting site, a directional receive antenna, down converter and a video receiver at each receive location. The transmit site is generally limited in output power, typically 200 W e.i.r.p., and normally drives an antenna with either an omnidirectional or a cardioid radiation pattern with gains of 10 to 16 dBi. In some instances pairs of back-to-back cardioid antennas are driven by a single transmitter. The received signal is changed by the down converter from the transmission frequency to an unused channel frequency compatible with the video receiver.

In the case of multichannel multipoint distribution services, a narrow-band channel (125 kHz bandwidth) is provided for an audio response to the transmitter site.

A typical frequency plan for a four-channel multipoint distribution service operating in the 2.5 GHz band with a maximum transmit bandwidth of 6 MHz is given below:

Transmit frequencies

$$f_n = f_0 - 128 + 24m + 12n \quad \text{for } m = 1, 3, 5, 7$$

$$f_n = f_0 - 146 + 24m + 12n \quad \text{for } m = 2, 4, 6$$

Response frequencies

$$f_n = f_0 + 89.9375 + 0.125m + n$$

where:

f_0 : frequency of the centre of band = 2 595 MHz

m : group number = 1, 2, 3, ..., 7

n : group number = 1, 2, 3, 4.

The system design approach for the multipoint distribution service was selected to allow randomly sited transmitters to reuse optimally the same or adjacent channel as often as possible and provide a reasonable size of protected area surrounding each transmit site. This approach required trading off high transmit power against the availability of high gain receive antennas and limiting service to only those receive sites that have line-of-sight paths to the transmit site.

An example of the technical characteristics of a typical 2.5 GHz P-MP system used for multipoint distribution services is shown in Table 1.

TABLE 1

Transmitter		Receiver	
Modulation	VSB/AM	Antenna characteristics	Rec. ITU-R F.699
Antenna gain (dBi) (relative to omnidirectional)	13	Antenna gain (dBi)	20
Transmitter power (dBW)	10	Noise figure (dB)	8
e.i.r.p. (dBW)	23	Typical receiver antenna height (m)	9.1
Signal type	TV	Carrier/interference (dB) (unfaded)	45

2 Interference considerations

2.1 Protected area

In the multipoint distribution service, receivers are protected from harmful interference if they are located within the protected area around their associated transmit station. The protected area is defined by the maximum distance from the transmitter at which a reliable signal is provided. This maximum distance in the worst propagation area of the North American continent is 25 km for a transmit site with an e.i.r.p. of 200 W and a down converter having a 10 dB noise figure. A reliable signal for this purpose is defined to be a signal sufficient to provide a 23 dB or better signal-to-noise ratio for 99.9% of the time.

For stations using a directional transmit antenna, the protection distance D_b from the transmitter can be calculated by the following relationship:

$$D_b = D_{bmax} \cdot 10^{-\frac{(G_{max} - G)}{20}}$$

where:

D_{bmax} : distance in the direction of maximum antenna gain (km)

G_{max} : maximum antenna gain (dBi)

G : antenna gain in the direction of interest (dBi).

For either directional or non-directional antennas, the maximum protection distance, assuming a standard receive height of 9 m, is further limited to the radio horizon.

2.2 Co-channel interference

Frequency reuse in an area is controlled by ensuring that the carrier-to-interference ratio C/I owing to co-channel interference is greater than 45 dB.

This C/I offers reasonable protection from harmful interference to receivers in this service while not unnecessarily restricting the ability of new stations to provide a service to unserved areas.

The achievement of this C/I in actual systems relies upon the angular and cross-polarization discrimination characteristics of the receive antenna. The specific antenna used as a reference is instrumental in determining the amount of frequency reuse in a given area. The characteristics of a typical 0.6 m (2 ft) parabolic antenna were selected for the purpose of making such C/I calculations. In certain cases where the actual receive antenna has better performance characteristics, that antenna is used when performing C/I calculations.

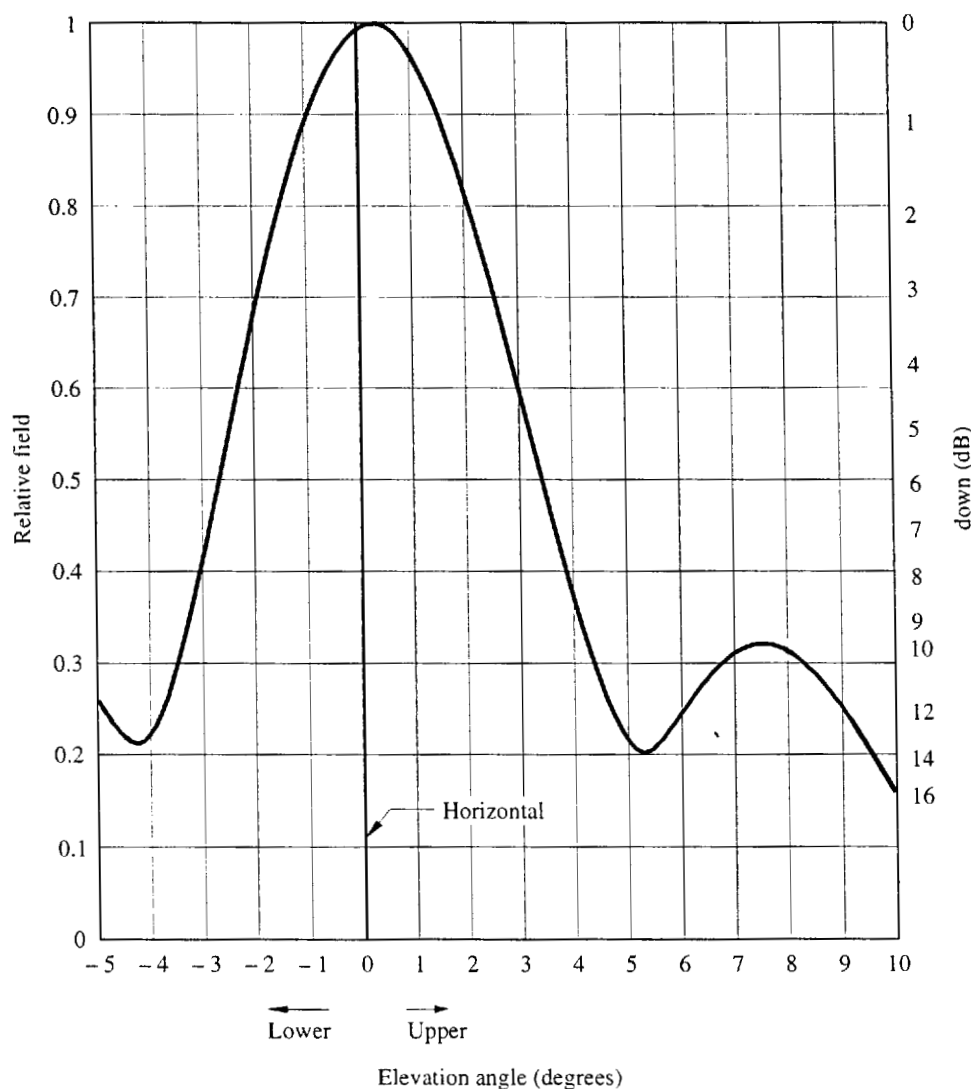
2.3 Adjacent-channel interference

Adjacent-channel interference is controlled by imposing conditions on both the multipoint distribution service transmit and receive sites. An objective of 0 dB C/I was chosen for this condition. In order to help achieve this condition in a practical manner, multipoint distribution service stations serving the same area are encouraged to co-locate transmit antennas as close as physically possible (0.5 km, or less separation) and to transmit on orthogonal polarization, but with signals of equal power. Further study is required as to the effects of propagation on polarization stability in the 2 GHz band.

2.4 Sharing considerations

The vertical pattern for the typical omnidirectional transmit antenna used in 2.5 GHz P-MP system is shown in Fig. 1. Figure 1 and Table 1 are appropriate to use in determining sharing considerations with other services.

FIGURE 1
Typical transmit antenna pattern in the vertical plane



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ANNEX 2

Examples of packet radio systems**1 Introduction**

This Annex describes packet radio technology and systems. Packet radio techniques are now being successfully used in a number of countries.

2 System application

Packet radio systems function most effectively when the data traffic they must handle is in the form of bursts. Systems operated below 1 GHz normally carry low data rates up to 9.6 kbit/s. Above 1 GHz, higher data rates can be used. For example, a packet radio network can provide the interconnection means in a computer communications network. Communications may be between host computers and end user terminals, and between end terminals.

In addition, such systems are often installed in rural areas, where the cost of adding new cables between the customer's node and the nearest network facility can be prohibitive. In other cases, a chronic shortage of copper loops makes such systems attractive in urban areas.

3 System description

The basic concept in packet radio is that the data are transmitted in packets. Systems employing TDMA and carrier sensed multiple access (CSMA) have been designed. These systems allow simultaneous access to one radio channel by either a CSMA or a TDMA protocol, and both permit individual stations to act as store and forward repeaters to handle traffic locations farther from the central site. Alternatively, two frequency duplex regenerative repeaters can be used to provide additional flexibility in system design.

Packet switching conveys with it superior error control techniques and a CRC-16 check sum can be appended to each block of data (reference ITU-T X.25 standards). To achieve very low bit-error ratios (BERs) (better than 1×10^{-11}) on transmission of large blocks of data, more than one CRC-16 check sum can be used in the block. In P-MP data transmission systems, it has been observed that block retransmission techniques are superior to forward error correction (FEC).

Since packet data systems do not operate in real time because of padding delays, special techniques can be used to keep the overall delay to a minimum, such as commencing transmission before the complete packet is received and using high network transmission rates such as 4.8 to 9.6 kbit/s. Clearly, not being "real time" offers significant benefits in spectrum conservation, since data are sent at the highest possible speed on the network even though the destination is a low speed device.

In one TDMA system configuration, network management is conducted by a unit called a station. Such a station has a number of radios in its subset and it determines the overall link connectivity of the network. In environments composed of fixed and possibly mobile units, each radio collects possible link connections, stores the information in memory, and sends it to the station. Using these data, the station establishes a final connectivity network. Network architecture can be varied to include configurations without stations or a broadcast configuration.

4 Efficiency and modulation methods

CSMA systems have the advantage of being able to use standard land mobile radio transceivers employing frequency modulation. This provides the capability to carry up to 9.6 kbit/s of data and achieve a BER of 1×10^{-6} at receive carrier levels of -107 dBm. Measurements have shown that, in a well designed CSMA system, up to 40% of the channel capacity can be used. Typical channel capacities in a CSMA operating between 130 and 960 MHz are given in Table 2.