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Fixed Radio Systems - Multipoint Equipment and Antennas - Part 1: Overview and Requirements for Digital Multipoint Radio Systems

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is part 1 of a multi-part deliverable covering the Fixed Radio Systems; Multipoint Equipment and Antennas, as identified below:

Part 1: "Overview and Requirements for Digital Multipoint Radio Systems";

Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment";

Part 3: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Multipoint Radio Antennas".

This multi-part deliverable covers characteristics and requirements for fixed multipoint radio systems using a variety of multiple access and duplex methods and operating at a variety of bit rates in frequency bands as specified in the present document.

EN 302 326-2 [6] and EN 302 326-3 [7] are Harmonized ENs and essential requirements are those requirements which are essential under article 3.2 of Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (hereafter mentioned as the R&TTE Directive [1]).

In the above, antennas are both those which are integral to the equipment and those which are non-integral.

Cross references to previous relevant ENs

Up to the publication of the first version of present document, ETSI Digital Multipoint Radio System ENs have been specified in a relatively large number.

Those ENs, replaced by this multi-part deliverable, contained both essential requirements, which were cross-referenced in EN 301 753 (V1.2.1) (see bibliography) under the R&TTE Directive [1], and other requirements that may be applicable, even if not considered essential under that Directive.

Besides its previous version V1.1.1, this multi-part deliverable replaces and supersedes, after a suitable transition period the standards that are listed in the three tables below addressing Equipment, Antenna and Harmonized standards respectively. The characteristics of equipment considered in those ENs have also been rationalized, re-compacted and re-subdivided into the various sub parts of this multi-part deliverable.

MP equipment ENs superseded

Frequency Range	Nominal Access Method	ETSI Multipoint System Equipment Standard (see bibliography)
< 1 GHz	Common to all	EN 301 460-1
< 1 GHz	TDMA	EN 301 460-2
< 1 GHz	FDMA	EN 301 460-4
< 1 GHz	DS-CDMA	EN 301 460-5
< 1 GHz	FH-CDMA	EN 301 460-3
1 GHz to 3 GHz	TDMA	EN 300 636
1 GHz to 3 GHz	FDMA	EN 301 373
1 GHz to 3 GHz	DS-CDMA	EN 301 055
1 GHz to 3 GHz	FH-CDMA	EN 301 179
3 GHz to 11 GHz	TDMA	EN 301 021
3 GHz to 11 GHz	FDMA	EN 301 080
3 GHz to 11 GHz	DS-CDMA	EN 301 124
3 GHz to 11 GHz	FH-CDMA	EN 301 253
24,25 GHz to 29,5 GHz	Common to all	EN 301 213-1
24,25 GHz to 29,5 GHz	TDMA	EN 301 213-3
24,25 GHz to 29,5 GHz	MC-TDMA	EN 301 213-5
24,25 GHz to 29,5 GHz	FDMA	EN 301 213-2
24,25 GHz to 29,5 GHz	DS-CDMA	EN 301 213-4
31 GHz to 33,4 GHz	Common to all below: TDMA, FDMA, MC-TDMA	EN 302 063: annex A annex B annex C

MP antenna ENs superseded

Frequency Range	ETSI Multipoint System Antenna Standard (see bibliography)
1 GHz to 3 GHz	EN 301 525
3 GHz to 11 GHz	EN 302 085
1 GHz to 11 GHz - circularly polarized	EN 302 078
11 GHz to 60 GHz - general aspects	EN 301 215-1
24 GHz to 30 GHz	EN 301 215-2
30 GHz to 40,5 GHz	EN 301 215-4

MP harmonized EN to be superseded

Description	ETSI Multipoint System Harmonized EN (see bibliography)
Generic Harmonized Standard	EN 301 753

National transposition dates	
Date of adoption of this EN:	1 June 2007
Date of latest announcement of this EN (doa):	30 September 2007
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2008
Date of withdrawal of any conflicting National Standard (dow):	31 March 2008

0 Introduction

0.1 General

For the purpose of the present document, multipoint radio systems may be defined as radio systems which interconnect a number of fixed stations (usually more than two). The topology of the systems may be Point-to-MultiPoint (P-MP), or MultiPoint-to-MultiPoint (MP-MP), alternatively known as "mesh". A variety of technologies for multiple access and duplex communication is used. The application of these systems is primarily, but not exclusively, to provide access to a variety of services employing a wide range of bit rates. This application is frequently referred to as Fixed Wireless Access (FWA). An alternative application of multipoint radio systems is to provide fixed communication links between stations in a network supporting a different service (such as mobile telephony). This application is frequently known as "infrastructure" or "backhaul". The main field of application of MultiPoint (MP) systems using the Fixed Service (FS) is to provide both narrowband and wideband access to both residential and business subscribers to public and private networks (PSTN, Internet, PDN, etc.). By means of MP systems the network service area may cover scattered subscriber locations. The systems may be applied to build new access networks covering urban, suburban and rural areas. Multipoint systems may provide both access and infrastructure applications simultaneously.

Up to the publication of this multi-part deliverable, ETSI Digital Multipoint Radio System ENs have been specified in a relatively large number. There are separate equipment standards for ranges of radio frequencies and access technologies. Similarly, there are separate antenna standards for ranges of radio frequencies. Harmonized European Norm EN 301 753 (see bibliography) identified the essential requirements (in accordance with article 3.2 of the R&TTE Directive [1]) by cross referencing the appropriate sections of the equipment and antenna standards. This multi-part deliverable replaces the current multipoint radio equipment and antenna standards for all frequencies up to 33,4 GHz and the Harmonized EN which defines the essential parameters for these multipoint radio systems. It thereby:

- Presents the characteristics, parameters and requirements for multipoint radio systems in a much more concise form, thus facilitating the distinction between parameters applicable to different Equipment Classifications.
- Removes the extensive cross-referencing in the previous Harmonized EN.
- Facilitates the maintenance of the standard with a far greater degree of uniformity than possible with the current disparate set of standards.
- Facilitates the evolution of the standard in line with the strategy set by the European Commission.
- Rectifies some historical discrepancies in similar requirements appearing in the various MP ENs to be superseded.

This multi-part deliverable is divided as described in clause 1.1.

For systems already covered by the previous EN 301 753 (see bibliography), in general only equal or technically equivalent or less demanding requirements have been used for this multi-part deliverable. Only in a few cases have additional requirements been set or slightly more stringent requirements been imposed, in order to have a more uniform and fair standardized framework across all MP technologies. In all cases, care has been taken that such variations will not affect any frequency planning assumptions for networks already deployed. Therefore, from a strictly technical point of view, in most cases it is expected that equipment already conforming to the previous versions of Harmonized EN 301 753 (see bibliography), would not need re-assessment of essential requirements according to this multi-part deliverable. The legal implications of the declaration of conformity and equipment labelling are, however, outside the scope of this multi-part deliverable. Cases, where additional conformance assessment is required, will be specifically mentioned, where appropriate, in EN 302 326-2 [6] and EN 302 326-3 [7].

In the case of equipment (as opposed to antennas) a specific type of equipment shall be identified by an Equipment Classification (EqC) coherent set, which will specify the principal attributers of the equipment insofar as is necessary to determine which aspects of this multi-part deliverable are applicable. The Equipment Classification is specified in annex A.

Annex G provides guidance to equipment suppliers on how to apply this multi-part deliverable.

0.2 Technology features of multipoint systems

0.2.1 General

There are several mutually independent aspects of technology for Multipoint systems including:

- Network Topology (see clause 0.2.2).
- Multiplexing method (examples are given in clause 0.2.3).
- Multiple access method (examples are given in clause 0.2.4).
- Duplex method (examples are given in clause 0.2.5).
- Modulation method (examples are given in clause 0.2.6).
- Error correcting method (examples are given in clause 0.2.7).

0.2.2 Network topology overview

This multi-part deliverable is concerned mainly with the performance of multipoint equipment and multipoint antennas. However, in practice, a multiplicity of pieces of equipment and connected antennas will work in concert to provide a communication network. The present document considers just two alternative topologies:

- Point-to-Multipoint.
- Multipoint-to-Multipoint (also known as Mesh).

In concept, a **Point-to-Multipoint network topology** provides a communication route (on a single radio channel for each sector) from one central point to a number of terminals where users are located. Each user location is either served directly from the central location or via one or more radio repeaters. In general, each user location communicates with the central location by a single pathway.

In concept, a **Multipoint-to-Multipoint (or mesh) network topology** provides communication pathways (sharing a limited number of radio channels) between various system nodes where each node has a communication pathway with a few of its near neighbours. One (or a few) of the nodes might be associated with a core network interface, and many will be at user terminal locations. The communication pathway between core network and user will comprise a number of node-to-node hops. In general there will be multiple alternative routes from user terminal to a core network.

These topologies are discussed more fully in clause 4.

0.2.3 Multiplexing methods overview

A variety of different multiplex methods is used in Point-to-Multipoint (P-MP) systems to multiplex together the signals from a central station (CS) to a number of Terminal Stations (TSs) to allow the radio medium to be shared effectively between the various traffic paths typically under the control of the central station.

Examples of **multiplexing methods** are:

TDM: Time Division Multiplexing.

FDM: Frequency Division Multiplexing.

CDM: Code Division Multiplexing.

OFDM: Orthogonal Frequency Division Multiplexing.

NOTE: OFDM has some attributes of a modulation technique as well as of a multiplexing method.

0.2.4 Multiple access methods

A variety of multiple access methods is used to provide multiple access from a number of TSs to one CS, thus sharing the available radio capacity into the CS between the traffic requirements of the TSs.

Examples of **multiple access methods** are:

TDMA: Time Division Multiple Access either using a single carrier or multiple carriers; the latter usually identified as Multi Carrier-Time Division Multiple Access (MC-TDMA), whose requirements are generally different from the single carrier applications.

FDMA: Frequency Division Multiple Access.

DS-CDMA: Direct-Sequence Code Division Multiple Access.

FH-CDMA: Frequency Hopping-Code Division Multiple Access.

OFDMA: Orthogonal Frequency Division Multiple Access.

It should be noted that the above list of access methods is historically derived from those defined in the earlier set of multipoint standards. It is not exhaustive and in this respect this multi-part deliverable is, as far as possible, independent of access method. In particular modern digital access technology allows the use of more than one basic access layer (e.g. TDMA/OFDMA).

A description of some of the different basic access methods and a generic comparison among them is provided in TR 101 274 (see bibliography).

Generally, the multiplex method is analogous to the access method. For example, a system using FDMA as the multiple access method from the TSs to CS typically uses Frequency Division Multiplexing (FDM) as the multiplexing method from the CS to the TSs. However, this correspondence is neither universal nor mandatory.

It should be noted that, in general, these different access methods have different values of parameters applicable due to the variation in necessary technical characteristics of such systems.

0.2.5 Duplex methods overview

Two different **duplex methods** are used to separate the two directions of signal in a bi-directional link:

TDD: Time Division Duplex.

FDD: Frequency Division Duplex.

NOTE: In FDD operation, two operational modes are possible:
- When both directions transmit simultaneously (generally known as full duplex).
- When the two directions operate at different times (generally known as half duplex, H-FDD).

0.2.6 Modulation overview

In order to transmit digital data across the radio frequency path, one or more parameters of the radio frequency signal is modulated, typically frequency, phase or amplitude. For the commonly used modulation technique, Quadrature Amplitude Modulation (QAM), the two orthogonal carriers are independently amplitude modulated, with the number of discrete amplitude steps permitted for each phase determining the number of possible different states each symbol may assume. In order to constrain the bandwidth of the modulated signal, either the modulating signals or the modulated carriers are filtered (for example, systems may use square root raised cosine shaping of the carrier/sub-carrier). Within a multipoint system different modulation methods may be applied in different situations, at different times and in alternate directions: up-link and down-link.

Examples of **modulation techniques** which may be used in multipoint radio systems are:

FSK: Frequency Shift Keying.

PSK: Phase Shift Keying.

QPSK: Quadrature Phase Shift Keying.

QAM: Quadrature Amplitude Modulation.

OFDM: Orthogonal Frequency Division Multiplexing.

NOTE 1: OFDM has some attributes of a multiplexing method as well as of a modulation technique.

NOTE 2: OFDM has some attributes of a modulation technique as well as of a multiplexing method.

0.2.7 Error correction overview

The error performance of the system may be improved by the use of **Forward Error Correction** (FEC) or **Automatic ReQuest for retransmission** (ARQ). One of the main differences between these two techniques stems from their different implementation aspects within an ISO 7 layer model.

Forward error correction may use an inner code (such as convolutional coding), an outer code (such as Reed Solomon), a concatenation of an inner and outer code, or an integrated inner and outer code (such as Turbo code). In general, FEC incurs a constant delay to the data transported and a constant overhead to the available bit rate, although a system may adapt the level of FEC to varying conditions.

ARQ detects the reception of data which are in error and requests retransmission of the faulty data. In general, the delay to the data transmitted may vary, as may the overhead to the available bit rate, although bit error rates approaching zero may be obtained for a wider range of conditions.

A multipoint system may use FEC, ARQ, both, or neither.

0.2.8 Equivalent Modulation Order (EMO)

The modulation order of a modulator and demodulator is determined by the number of discrete states which may be assigned to each symbol. The modulation order is defined as $\log_2(N)$, where N is the number of permitted states per symbol. All other factors being equal, modulation at higher orders is capable of carrying a higher bit rate in the equivalent radio frequency channel when compared with modulation at lower orders, but it can tolerate less interference for the same bit error rate.

However, with the advent of techniques such as forward error correction (as described in clause 0.2.7), the instantaneous bit rate of information which may be transmitted over the air is no longer solely determined by the modulation order. Similarly, the BER performance of a system with FEC is no longer determined solely by the modulation order.

Annex A addresses Equipment Classification (EqC) and defines a new key element in the system profile, Equivalent Modulation Order (EqC-EMO). The supplier indicates a value of EqC-EMO, (which need not necessarily correspond to the physical modulation order) which together with other aspects of EqC, determines which requirements of the standard are applicable to that equipment.

Annex E discusses practical implementation issues concerning the relationship between transmitted bits per second, symbol rate and error correction aspects and considers the reference points at which the minimum gross bit rate and BER may be defined.

Within a multipoint system different modulation orders may be applied in different situations, at different times and in alternate directions up-link and down-link. It should be noted that in P-MP systems CS may use different modulation order (generally higher) than that used in TSs.

0.3 The licensing authority of the national administrations

The sovereign authority of national administrations is, of course, unrestricted by the provisions of this multi-part deliverable and remains outside ETSI's remit.

This multi-part deliverable sets out the requirements for multipoint systems in using alternative topologies, several alternative frequency band and channel plans, using alternative duplex methods, using different equipment types and different antenna types. However, attention is drawn to the fact that many aspects of the equipment and antennas addressed by this multi-part deliverable will be subject to national licensing rules. For instance, the national licensing authorities might restrict the deployment and operation of equipment and antennas compliant with this multi-part deliverable, as an example in terms of:

- Network topology.
- Operating radio frequency bands and block and/or channel arrangements.
- EqCs permitted (for the purpose of "effective use of spectrum" according to the R&TTE Directive).
- Duplex method and, in the case of FDD, duplex separation and sense.
- Antenna gain, permitted classes and polarization.

Several frequency bands are explicitly listed in clause 5 of the present document as identified by CEPT for multipoint systems. However, multipoint systems may be licensed on a national basis for use in other bands currently assigned by CEPT to Fixed Service (see ERC Report 25 (see bibliography)) or in other bands within the frequency ranges as permitted by national administrations. The present document may be applied to any bands, or parts of bands, within the frequency ranges covered by the scope of the present document (see clause 1.2), pending national administration or future CEPT regulation. However, it is intended that this multi-part deliverable shall be applied only to frequency bands which are co-ordinated, whether such co-ordination is on a national or CEPT basis.

1 Scope

1.1 Multipoint radio systems

This multi-part deliverable is applicable to fixed digital MultiPoint (MP) radio systems, where multipoint encompasses both Point-to-MultiPoint (P-MP) and MultiPoint-to-MultiPoint (MP-MP) network architectures.(Although MP-MP systems may, in principle, be realized using directional or sectorial/omnidirectional antennas, only those using directional antennas are within the scope of this multi-part deliverable).

The applicability of this multi-part deliverable to MP equipment is governed by the definition of a number of system profiles that define the set of consistent requirements (see clause 6) to which equipment shall conform. The supplier shall uniquely identify in the technical construction file which Equipment Classification(s) (EqC) (among those limited sets defined in clause 6 and annex A) apply to his equipment and assess it consequently.

The individual parts of this multi-part deliverable are applicable as follows:

The present document includes for multipoint radio systems (equipment and antennas, whether integrated or not):

- Descriptions and parameters of the characteristics of multipoint radio systems.
- Cross-references to EN 302 326-2 [6] and EN 302 326-3 [7] where limits for essential parameters for conformance with article 3.2 of the R&TTE Directive are concerned.
- Specifications which may be complied with on a voluntary basis (normative).
- Recommended limits for other parameters (informative).
- Informative text which assists in the understanding of the specification.

EN 302 326-2 [6] includes for multipoint radio equipment (whether or not integrated with an antenna):

- Essential requirements for conformance with article 3.2 of the R&TTE Directive.

EN 302 326-3 [7] includes for antennas used with multipoint radio systems (whether or not integrated with the equipment):

- Essential requirements for conformance with article 3.2 of the R&TTE Directive.

For Administration's guidance when notifying their regulated Interfaces in accordance with article 4.1 of the R&TTE Directive [1], annex B provides explanatory considerations on the applicability of the TCAM-RIG format for P-P Fixed Links. An example of such a notification is also provided. Annex H has been elaborated in co-ordination with the CEPT ECC WG SE.

1.2 Frequencies

This multi-part deliverable is applicable to multipoint radio equipment and antennas operating in bands allocated to Fixed Service and assigned by national regulations to MP applications, at the date of publication of this EN, within the following frequency ranges:

- Equipment:
  - 30 MHz to 11 GHz.
  - 24,25 GHz to 29,5 GHz.
  - 31,0 GHz to 33,4 GHz.

NOTE 1: Equipment operating in the band from 40,5 GHz to 43,5 GHz is not covered by the present document, but is to be found in EN 301 997-1 and EN 301 997-2 (see bibliography).