

**GUIDELINES FOR IMPLEMENTATION
FIXED WIRELESS SYSTEMS**

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FOREWORD

GFI0501 Guidelines for implementation, Fixed wireless systems contains clarifications and adjustments to ITU and ETSI deliverables specifying fixed wireless systems. The aim of this document is to ensure the proper planning and operation of fixed wireless systems.

This guideline document has been prepared by the members of the national standardization group for transmission systems. The Steering Group for Telecommunications Standardization has discussed this document and recommends it to be followed when implementing fixed wireless systems.

1 INTRODUCTION

This GFI defines general requirements for different fixed wireless systems and error performance and availability objectives which should be used as a basis when planning fixed wireless systems. The main characteristics are defined in ITU recommendations and ETSI standards and this GFI contains text only for some clarifications or adjustments related to the referenced base documents.

2 REFERENCES

ETSI EN 302 217-1 V1.1.3 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview and system-independent common characteristics

ETSI EN 302 217-2-1 V1.1.3 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2-1: System-dependent requirements for digital systems operating in frequency bands where frequency co-ordination is applied

ETSI EN 302 217-2-2 V1.1.3 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2-2: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for digital systems operating in frequency bands where frequency co-ordination is applied

ETSI EN 302 217-3 V1.1.2 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 3: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for equipment operating in frequency bands where no frequency co-ordination is applied

ETSI EN 302 217-4-1 V1.1.3 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-1: System-dependent requirements for antennas

ETSI EN 302 217-4-2 V1.1.3 (2004-12) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-2: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for antennas

ETSI EN 302 326-1 Fixed Radio Systems (2005-03); Multipoint Equipment and Antennas; Part 1: Overview and Requirements for Digital Multipoint Radio Systems

ETSI EN 302 326-2 Fixed Radio Systems (2005-03); Multipoint Equipment and Antennas; Part 2: Harmonised EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment

ETSI EN 302 326-3 Fixed Radio Systems (2005-03); Multipoint Equipment and Antennas; Part 3: Harmonised EN covering the essential requirements of Article 3.2 of the R&TTE Directive for Multipoint Radio Antennas

Ficora 4F/2005M: Radio Frequency Regulation

ITU-R Recommendation F.1668; "Error performance objectives for real digital fixed wireless links used in 27 500 km hypothetical reference paths and connections"

ITU-T Recommendation G.826: "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections"

ITU-T Recommendation G.828: "Error performance parameters and objectives for international, constant bit rate synchronous digital paths".

ITU-R Recommendation F.1703: "Availability objectives for real digital fixed wireless links used in 27 500 km hypothetical reference paths and connections"

ITU-R Recommendation P.530: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".

DTR/TM-04135 (EMF) Feb. 2005: "Study on the electromagnetic radiated field in fixed radio systems for environmental issues"

EN 50383 Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunications system (110 MHz – 40 GHz)

Mastotyön työsuojeluohjeet 2004. Työturvallisuuskeskus

3 GENERAL REQUIREMENTS

3.1 System configurations and definitions

Fixed Wireless Systems¹ (FWS) - also known as Digital Fixed Radio Systems² (DFRS) - are terrestrial transmission systems between fixed terminals utilizing electromagnetic waves propagating in the lower troposphere at frequencies above 30 MHz.

Fixed Wireless Systems use frequencies allocated to fixed services in the VHF, UHF, microwave and millimeter wave bands or are used for fixed applications in mobile service. This document is also applicable to fixed wireless systems using infrared or visible light signals. The wireless transmission path can be realized using either point-to-point or multipoint systems.

Point-to-point system (PP-system) comprises two terminals at the end-points of the transmission path. Several PP-systems may be connected in tandem for longer connections. Antennas are typically very directional (narrow-beam antennas).

Multipoint system (MP-system) consists of several terminals which may be interconnected directly or via other terminals acting as repeaters. There may be several alternative routes between two terminals. Directional, sector, and omni-directional antennas may be used.

Point- to-multipoint system (PMP-system) is a multipoint system consisting of several terminals (substations) and one or more central stations. Each central station has an omni-directional or sector antenna defining a geographical area (coverage area) where substations may operate. Each substation has a directional antenna pointing at the central station. Repeaters may be used to extend the range; repeater stations are similar to central stations in the outbound side of the station (towards substations) and similar to substations in the inbound side (towards the central station). Repeaters typically use separate antennas for the inbound and outbound directions. The transmission path may be between a substation and the central station, or between two substations via the central station.

Radio link is a digital transmission path between two points established using either point-to-point, or multipoint fixed wireless systems used for providing telecommunication services in public networks.

3.2 Functional and interface requirements

Functional and interface requirements are defined in the relevant ETSI equipment standards: for PP-systems in EN 302 217 and for PMP/MP-systems in EN 302 326.

Mandatory parameters of the air interface are defined in the The Radio Frequency Allocation Table annexed to the Radio Frequency Regulation (Ficora 4F/2005M).

¹ ITU terminology

² ETSI terminology

ETSI standards are currently limited to systems using frequencies below about 100 GHz and are not applicable to fixed wireless systems using infrared or visible light. The characteristics of the wireless optical transmission systems are agreed upon between the manufacturer and the network operator.

In any case all fixed wireless systems shall meet the requirements given in section 3.3 (Supervision and maintenance objectives) as well as sections 4 (Error performance objectives) and in section 5 (Availability).

It is recommended that the principles of P.530 (newest version) are used for link planning.

3.3 Supervision and maintenance of radio links

The fixed wireless system shall be connected to a remote supervision system, which will generate alarm status and alarm history data required for the proper maintenance of each radio link. Sufficient data shall be provided for maintenance operations and equipment fault locating. Error performance and availability monitoring shall provide data for estimating compliance with requirements given in this document and to determine the cause of any non-compliance.

3.4 Safety

The antenna system shall be installed in such a way that unintentional access to areas near to the antennas where safety limits for EMF-exposure given in EU Commission decision 1999/519/EC may be exceeded is prevented. Adequate warning signs about the potentially dangerous EMF-radiation levels shall be used.

The values included in the document "Mastotyön työsuojeluohjeet 2004. Työturvallisuuskeskus " should be taken into account when evaluating safety distances for fixed radio systems.

Calculation guidelines of EMF-safety distances given in EN 50383 may be used. ETSI report DTR/TM-04135 (EMF) "Study on the electromagnetic radiated field in fixed radio systems for environmental issues" which is under final acceptance procedure (Feb.2005) proposes more accurate means to evaluate safety distances for fixed radio systems and is more preferable for these calculations).

3.5 Environmental conditions for outdoor equipment

ETSI equipment standards give two alternative environmental classes: EN 300 019-1-4 class 4.1 (operational temperature range -33...+40 C) or class 4.1E (-45...+45 C). It is recommended that equipment specifications should be based on the environmental class 4.1E, which corresponds better to the actual range of conditions in Finland.

The material strength and rigidity of the equipment and supporting infrastructure should be designed and equipment installed taking into account high wind velocities up to 55 m/s (200 km/h) and simultaneous ice loads of 25 mm maximum radial thickness. Equipment should survive these conditions without any permanent deformation, antenna misalignment or damage. Temporary deflections should not cause more than 3 dB loss of wanted signal level.

4 ERROR PERFORMANCE OBJECTIVES (EPO)

4.1 Definitions

The error performance objectives apply only when the system is considered to be in available state. The availability and unavailability of the system are explained in section 5 of this document.

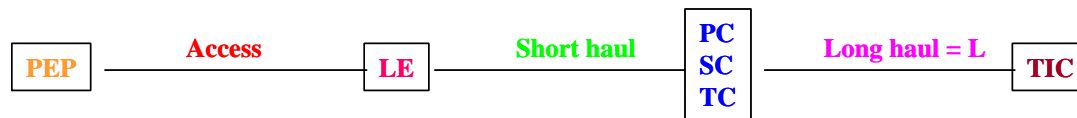
4.1.1 Error performance events and parameters

The ITU-T recommendation G.826 defines the error performance events and parameters for paths and connections as follows:

- **Block:** a set of consecutive bits; each bit belongs to one and only one block; consecutive bits may not be contiguous in time
- **Defect:** the definitions of in service anomalies and defects are rather complicated issues and hierarchy dependent. See the references in section 2 of this document. For example for PDH-systems the defects are: loss of signal, alarm indication signal, loss of frame alignment
- **EB, errored block:** a block in which one or more bits are in error
- **ES, errored second:** a one-second period with one or more errored blocks or at least one defect; one second period in which one or more bits are in error or during which Loss of Signal or Alarm Indication Signal is detected
- **ESR, errored second ratio:** the ratio of ES to total seconds in available time during a fixed measurement interval
- **SES, severely errored second:** a one-second period which contains $\geq 30\%$ errored blocks or at least one defect; one second period which has a bit error ratio $\geq 10^{-3}$ or during which Loss of Signal or Alarm Indication Signal is detected; SES is a subset of ES
- **SESR, severely errored second ratio:** the ratio of SES to total seconds in available time during a fixed measurement time
- **BBE, background block error:** an errored block not occurring as part of a SES
- **BBER, background block error ratio:** the ratio of BBE to total blocks in available time during a fixed measurement interval

4.1.2 National portion of the hypothetical reference path (HRP)

Based on the ITU-R recommendation F.1668 the national portion of the hypothetical reference path (HRP) can be described with the following examples:



Path end point (PEP)	Path access element (PAE)	Local exchange (LE)	Path National core element (NPCE)	Primary (PC), Secondary (SC) or Tertiary Centre (TC)	Long haul = L	Terminal International centre (TIC)
Telephone subscriber	subscriber line (copper)	concentrator	Point-to-point radio relay	exchange	High capacity radio relay or fiber Note 1: the same long haul section can be used for several accesses and short hauls	international exchange
ADSL-modem	subscriber line (copper)	DSLAM	Point-to-point radio relay	router	High capacity radio relay or fiber	router
Telephone subscriber	subscriber line (copper)	PMP-terminal station	Point-to-point radio relay	PMP-central station	High capacity radio relay or fiber	
PMP subscriber terminal station	wireless access	PMP-central station	Point-to-point radio relay	exchange	High capacity radio relay or fiber	
Note 2: The sections below differ from the basic sections above.						
Broadcasting receiver	broadcasting connection Note 3. Not covered in this GFI	Broadcasting station	Long haul section = L, Point-to-point radio relay			program delivery centre
Mobile phone	mobile access Note 3. Not covered in this GFI	Mobile Network Base Station	Point-to-point or PMP fws	BSC	High capacity radio relay or fiber	MSC
Mobile phone (fixed)	mobile access	Mobile Network Base Station	Point-to-point or PMP fws	BSC	High capacity radio relay or fiber	MSC

Figure 1. Examples of the national portion of HRP

4.2 Error performance objectives for long haul network section

The error performance objectives applicable to each direction of any real fixed wireless link of length L_{link} belonging to the long haul network section of the national portion of HRP the values in Table 1a for SDH systems derived according to ITU-T Recommendation G.828 and in Table 1b for other systems derived according to ITU-T Recommendation G.826 should apply. The lower limit of L_{link} , used to scale the objectives to the real case, is $L_{min} = 50$ km.

TABLE 1a

Long haul Error Performance Objectives for real SDH fixed wireless links (G.828)

Rate (Mbit/s)	1 664 (VC-11, TC-11)	2 240 (VC-12, TC-12)	6 848 (VC-2, TC-2)	48 960 (VC-3, TC-3)	150 336 (VC-4, TC-4)
ESR	$0.01 \times A$	$0.01 \times A$	$0.01 \times A$	$0.02 \times A$	$0.04 \times A$
SESR	$0.002 \times A$				
BBER	$5 \times 10^{-5} \times A$				$1 \times 10^{-4} \times A$

TABLE 1b

Long haul Error Performance Objectives for other real fixed wireless links (G.826)

Rate (Mbit/s)	<primary rate	1.5 to 5	>5 to 15	>15 to 55	>55 to 160	>160 to 400
ESR	0.04 A	0.04 A	0.05 A	0.075 A	0.16 A	Not applicable
SESR	0.002 A	0.002 A	0.002 A	0.002 A	0.002 A	0.002 A
BBER	Not applicable	$2 A \times 10^{-4}$	$2 A \times 10^{-4}$	$2 A \times 10^{-4}$	$2 A \times 10^{-4}$	$1 A \times 10^{-4}$

where:

$$A = (0.01 + 0.002) L_{link}/100$$

$$\text{for } 50 \text{ km} \leq L_{link} \leq 100 \text{ km}$$

$$A = 0.01 + 2 \times 10^{-5} L_{link}$$

$$\text{for } 100 \text{ km} < L_{link}$$

Example 1: the SESR for a 50 km hop in the long haul network section equals:

$$\text{SESR} = 0.002 \times 0.012 \times 50/100 = \underline{0.000012 (0.0012 \%)}$$

As a rule of thumb a SESR value of 0.001 % could be recommended for a single fixed wireless link hop, which is part of the long haul network section. It is also suggested to reserve a margin (3-10 dB) in congested areas in the link budget to guarantee the objectives also in the long term.

4.3 Error performance objectives for short haul network section

The error performance objectives applicable to each direction of any real fixed wireless link forming all of the short haul network sections of the national portion of the HRP the values given in Table 2a for SDH systems derived according to ITU-T Recommendation G.828 and in Table 2b for other systems derived according to ITU-T Recommendation G.826 should apply.

TABLE 2a

Short haul Error Performance Objectives for SDH fixed wireless links (G.828)

Rate (Mbit/s)	1 664 (VC-11, TC-11)	2 240 (VC-12, TC-12)	6 848 (VC-2, TC-2)	48 960 (VC-3, TC-3)	150 336 (VC-4, TC-4)
ESR	0.00075	0.00075	0.00075	0.0015	0.003
SESR	0.00015 (0.015 %)				
BBER	3.75×10^{-6}				7.5×10^{-6}

TABLE 2b

Short haul Error Performance Objectives for other fixed wireless links (G.826)

Rate (Mbit/s)	<primary rate	1.5 to 5	>5 to 15	>15 to 55	>55 to 160	>160 to 400
ESR	0.003	0.003	0.00375	0.005625	0.012	Not applicable
SESR	0.00015 (0.015 %)					
BBER	Not applicable	1.5×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	7.5×10^{-6}

As a rule of thumb a SESR value of 0.01 % could be recommended for a single fixed wireless link hop, which is part of the short haul network section. It is also suggested to reserve a margin (3-10 dB) in the link budget to guarantee the objectives also in the long term.

4.4 Error performance objectives for access network section

The EPOs applicable to each direction of any real fixed wireless link forming all of the access network sections of the national portion of the HRP the values given in Table 3a for SDH systems derived according to ITU-T Recommendation G.828 and in Table 3b for other systems derived according to ITU-T Recommendation G.826 should apply.

TABLE 5a

Access Error Performance Objectives for SDH fixed wireless links (G.828)

Rate (Mbit/s)	1 664 (VC-11, TC-11)	2 240 (VC-12, TC-12)	6 848 (VC-2, TC-2)	48 960 (VC-3, TC-3)	150 336 (VC-4, TC-4)
ESR	0.00075	0.00075	0.00075	0.0015	0.003
SESR	0.00015 (0.015 %)				
BBER	3.75×10^{-6}				7.5×10^{-6}

TABLE 5b

Access Error Performance Objectives for other fixed wireless links (G.826)

Rate (Mbit/s)	<primary rate	1.5 to 5	>5 to 15	>15 to 55	>55 to 160	>160 to 400
ESR	0.003	0.003	0.00375	0.005625	0.012	Not applicable
SESR	0.00015 (0.015 %)					
BBER	Not applicable	1.5×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	7.5×10^{-6}

It is suggested to reserve a margin (3-10 dB) in the link budget to guarantee the objectives also in the long term.

4.5 Error performance objectives for links protecting cable sections

In some cases the wireless link protects a cable section and is in actual use only during the short periods when the cable path is unavailable.

The Error Performance Objectives ESR and SESR should be met during "any month", i.e. during the average of annual worst months. On the other hand it maybe assumed that during the available time the cable section is virtually error-free. If cable failures will be repaired within a few days, the protecting wireless link is used no more than about 10% of any month. Cable-related unavailability and wireless error events may be assumed to be uncorrelated. The mean time between failure of the cable section is normally longer than one year. It is therefore suggested that Error Performance Objectives ESR and SESR for the wireless link could be relaxed by a factor of 10.

As an example, the SESR objective for a wireless link in the short haul section (0.015%) may be increased to 0.15% of the short time period the wireless link is in actual use. Nevertheless, the overall SESR for the average worst month will not exceed the target 0.015%, if the rest of the month will be almost error-free.

5 AVAILABILITY OBJECTIVES

5.1 Definitions

A bidirectional radio link path or connection is in the unavailable state if either one or both directions are in unavailable state.

The ITU-T recommendations G.826 and G.827 define availability and unavailability as follows:

- The unavailability of fixed wireless systems may be due to radio propagation effects, equipment failure, human intervention, interference or other causes.

It is recommended nationally that one third of the unavailability may be due to radio propagation effects.

- Unavailability is detected after 10 consecutive Severely Errored Seconds (SES). Those 10 seconds are calculated to the unavailable time
- Availability is detected after 10 error free seconds (ES, errored seconds are allowed). The whole 10 seconds period is calculated to available time.
- **AR, availability ratio:** the ratio of availability to the total time during a fixed measurement interval (at least one year)
- **UR, unavailability ratio:** the ratio of unavailability to the total time during a fixed measurement interval (at least one year)
- **AR + UR = 1**
- the end to end UR for a simple basic path without protection is a sum of URs of all hops on the path (if the URs are small and considered to be independent)
- the end to end UR for a 1+1 protected path can be calculated by formula:

$$\mathbf{UR(total) = [UR(1) \times UR(2)] + UR(a) + UR(b)}$$

UR(total) = total unavailability ratio of protected path

UR(1) = unavailability ratio of first parallel path

UR(2) = unavailability ratio of second parallel path

UR(a) = unavailability ratio of the protection switch in the beginning of the path

UR(b) = unavailability ratio of the protection switch in the end of the path

(if the URs are small and considered to be independent)

The end to end availability and unavailability calculations for more complicated path topologies see the references in section 2 of this document.

- if the connection is not planned to be a permanent one, the periods when the connection is not in service do not count in the calculation of its availability

5.2 The availability objectives for the long haul section of the national portion

The recommendation ITU-R F.1703 defines the availability objectives as follows:

5.2.1 $50 \text{ km} \leq L_{link} < 250 \text{ km}$

$$AR = 1 - \left(1.9 \cdot 10^{-3} \frac{L_{link}}{2500} + 1.1 \cdot 10^{-4} \right)$$

If L_{link} is shorter than 50 kilometres, 50 kilometres is used.

Example 2: the availability objective for a 50 km hop in the long haul section equals:

$$AR = 1 - \left(1.9 \cdot 10^{-3} \frac{50}{2500} + 1.1 \cdot 10^{-4} \right) = 0.999852 \text{ (99.9852 \%)}$$

5.2.2 $250 \text{ km} \leq L_{link} < 2\,500 \text{ km}$

$$AR = 1 - \left(3 \cdot 10^{-3} \frac{L_{link}}{2500} \right)$$

Example 5: the availability objective for a 500 km path in the long haul section equals:

$$AR = 1 - \left(3 \cdot 10^{-3} \frac{500}{2500} \right) = 0.9994 \text{ (99.94 \%)}$$

5.3 The availability objectives for the short haul section of the national portion

The recommendation ITU-R F.1703 defines the availability objectives for the short haul section of the national portion:

$$AR = 1 - 4 \times 10^{-4} = 0.9996 \text{ (99.96 \%)}$$

5.4 The availability objectives for the access section of the national portion

The recommendation ITU-R F.1703 defines the availability objectives for the access section of the national portion:

$$AR = 1 - 5 \times 10^{-4} = 0.9995 \text{ (99.95 \%)}$$

ANNEX 1 OTHER DOCUMENTS RELATED TO FIXED WIRELESS SYSTEMS

General

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 (R&TTE Directive).

Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (89/336/EEC) (EMC Directive).

Council Directive of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (73/23/EEC) (LV Directive).

ETSI EN 301 751 (V1.2): "Fixed Radio Systems; Point-to-Point equipments and antennas; Generic harmonized standard for Point-to-Point digital fixed radio systems and antennas covering the essential requirements under article 3.2 of the 1999/5/EC R&TTE Directive".

ETSI EG 201 752: "Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Equipments and Antennas; Identification of European standards (EN), applicable to fixed radio systems, for the essential requirements under the article 3.1 of the 99/05/EC Directive".

ETSI EN 301 753: "Fixed Radio Systems; Multipoint equipment and antennas; Generic harmonized standard for multipoint digital fixed radio systems and antennas covering the essential requirements under article 3.2 of the Directive 1999/5/EC."

Performance objectives

ITU-T (for paths and sections in general)

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: "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections

ITU-T Recommendation G.828: "Error performance parameters and objectives for international, constant bit rate synchronous digital paths".

ITU-T Recommendation G.829: "Error performance events for SDH Multiplex and regenerator sections".

ITU-T Recommendation G.921: "Digital sections base on the 2048 kbit/s hierarchy"

ITU-T Recommendation G.823; "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy

ITU-T Recommendation G.825: "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)

ITU-T Recommendation I.356: "B-ISDN ATM layer call transfer performance".

ITU-T I.356 B-ISDN ATM cell layer transfer performance

ITU-T I.380 IP packet transfer and availability parameters

ITU-R (for radio paths and sections)

ITU-R Recommendation F.1668; "Error performance objectives for real digital fixed wireless links used in 27 500 km hypothetical reference paths and connections"

ITU-R Recommendation F.634: "Error performance objectives for real digital radio-relay links forming part of the high-grade portion of international digital connections at a bit rate below the primary rate within an integrated services digital network".

ITU-R Recommendation F.696: "Error performance and availability objectives for hypothetical reference digital sections forming part or all of the medium-grade portion of an ISDN connection at a bit rate below the primary rate utilizing digital radio-relay systems".

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

Availability objectives

ITU-T (for paths and sections in general)

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

ITU-T Recommendation I.357: "B-ISDN semi-permanent connection availability".

ITU-T Recommendation Y.1540: "Internet protocol data communication service - IP packet transfer and availability performance parameters".

ITU-R (for radio paths and sections)

ITU-R Recommendation F.557: "Availability objective for radio-relay systems over a hypothetical reference circuit and a hypothetical reference digital path".

ITU-R Recommendation F.695: "Availability objectives for real digital radio-relays links forming part of a high grade circuit within an integrated services digital network".

Interfaces

ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".

ITU-T Recommendation G.707: "Network node interface for the synchronous digital hierarchy (SDH)".

ITU-T Recommendation G.708: "Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)".

ITU-T Recommendation G.957 : "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".

ITU-T Recommendation I.412: "ISDN user-network interfaces - Interface structures and access capabilities".

IEEE 802.3: "Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".

ISO/IEC 8802-3: "Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".

Testing

ETSI EN 301 126-1: "Fixed Radio Systems; Conformance testing; Part 1: Point-to-Point equipment - Definitions, general requirements and test procedures".

ETSI EN 301 126-3-1 (V1.1): "Fixed Radio Systems; Conformance testing; Part 3-1: Point-to-Point antennas; Definitions, general requirements and test procedures".

IEEE 1802.3 (2001): "Conformance Test Methodology for IEEE Standards for Local and Metropolitan Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications: Currently Contains Attachment Unit Interface (AUI) Cable (Section 4)".

IEC 60835-2-4: "Methods of measurement for equipment used in digital microwave radio transmission systems - Part 2: Measurements on terrestrial radio-relay systems-Section 4: Transmitter/receiver including modulator/demodulator".

IEC 60835-2-8: "Methods of measurement for equipment used in digital microwave radio transmission systems - Part 2: Measurements on terrestrial radio-relay systems - Section 8: Adaptive equalizer".

Network and maintenance network (TMN)

ITU-R Recommendation F.750: "Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based network".

ITU-R Recommendation F.751: "Transmission characteristics and performance requirements of radio-relay systems for SDH-based networks".

ETSI TR 101 035: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS)".

ETSI ETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) radio specific functional blocks for transmission of M-times STM-N".

ETSI ETS 300 645: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) radio relay equipment; Information model for use on Q-interfaces".

ETSI EN 301 167: "Transmission and Multiplexing (TM); Management of Synchronous Digital Hierarchy (SDH) transmission equipment; Fault management and performance monitoring; Functional description".

ITU-T Recommendation G.773: "Protocol suites for Q interfaces for management of transmission systems".

ITU-T Recommendation G.783: "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".

ITU-T Recommendation G.784: "Synchronous digital hierarchy (SDH) management".

Environment, power feeding

ETSI EN 300 019: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment";

ETSI EN 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".

Planning

ITU-R Recommendation F.1093: "Effects of multipath propagation on the design and operation of line-of-sight digital radio-relays systems".

ITU-R Recommendation F.1605: "Error performance and availability estimation for synchronous digital hierarchy terrestrial fixed wireless systems"

ITU-R Recommendation F.752: "Diversity techniques for radio-relays systems".

Characteristics

ITU-R Recommendation F.1101: "Characteristics of digital radio-relays systems below about 17 GHz".

ITU-R Recommendation F.1102: "Characteristics of digital radio-relays systems above about 17 GHz".

Safety

EN 60950: "Safety of information technology equipment".

EN 60825 (series): "Safety of laser products",

EN 50384 Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz). Occupational

EN 50385 Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz). General public

Frequency utilization

Frequency plans

ITU Radio Regulations.

ITU-R Recommendation F.746: "Radio-frequency arrangements for fixed service systems".

CEPT ERC Report 25: "Frequency band 29.7 MHz to 105 GHz and associated European table of frequency allocations and utilizations".

Ficora 4D/2004M: Use of Radio Frequencies

EMC

ITU-R Recommendation F.1191: "Bandwidths and unwanted emissions of digital radio-relay systems".

ITU-R Recommendation SM.329-9: "Spurious emissions".

ERC/REC 74-01: "Spurious Emissions".

ETSI EN 301 390: "Spurious emissions and receiver immunity at equipment/antenna port of Digital Fixed Radio Systems".

ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

ETSI EN 301 489-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services".

Terminology

ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the article 3.2 of 99/05/EC Directive to Fixed Radio Systems"

ETSI TR 101 036: Fixed Radio Systems; Generic wordings for standards on DRRS characteristics"

Antennas

ITU-R Recommendation F.699: "Reference radiation patterns for line-of-sight radio-relay system antennas for use in coordination studies and interference assessment in the frequency range from 1 GHz to about 70 GHz".

IEC 60154: "Flanges for waveguides"

IEC 60169 "Radio-frequency connectors"