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Foreword

This ETSI Technical Report (ETR) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunication Standards Institute (ETSI) with assistance from other ETSI committees, in response to a request from the ETSI European Project on Information Infrastructure Starter Group (EPIISG). It provides an overview of existing standards and ongoing work on standards and publicly available specifications in the area of access networks for residential customers.

It covers:

- for wired as well as wireless technologies;

- supporting narrowband and broadband services;

- in residential environments;

standardization activities in the following areas:

- transport architecture for access networks;

- access network interfaces, in particular the physical layer and medium access control layer at the boundary between the network operator domain and the end user domain;

- operations and maintenance of access networks.

On the basis of the information contained in the overview a number of co-ordination activities are recommended within the overall context of efficient standardization support for the development of the European Information Infrastructure (EII).

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1 Scope

The purpose of this ETR is to provide an overview of existing standards and PASs (Publicly Available Specifications) and ongoing standardization work in the field of access networks for residential customers. This overview is intended to show the relationship between the multitude of standardization and specification activities related to access networks. Where it is felt that important aspects are not covered by current work these are pointed out and candidate organizations for the work are identified. This overview of standards and PAS that are relevant for the specification of European residential access networks will be used for tracking and co-ordination of the ongoing work in the context of the European Project for the Information Infrastructure (EPII).

This ETR considers all access technologies that can provide a bearer capacity of 64 kbit/s or more in support of narrowband and broadband services. Wired as well as wireless access technologies are covered, including terrestrial broadcasting. Not included in this overview are standards for direct satellite broadcasting.

The scope of this ETR is limited to the transport aspects of access networks for narrowband and broadband services in residential environments and therefore the ETR focuses on layer 1 and medium access control, and the maintenance aspects of these access network layers. The control aspects, including those related to mobility, are dealt with under the EPII project on "Telecommunication network interfaces for residential environment" [1]. Where there is an important dependency between transport and control aspects this is pointed out.

2 References

For the purposes of this ETR, the following references apply:

NOTE: As described in the Scope above, the purpose of this ETR is to give "an overview of existing standards and PASs and ongoing standardization work". Therefore, for completeness, the references below include documents which are not currently publicly available (e.g. for reference [40] we find "DTR/TM-03024" which is an ETSI work programme reference number for a document which it is intended will eventually be published as an ETR).

[1] EPII project 1.2: "Telecommunication network interfaces for the residential environment". No draft available yet.

[2] ITU-T Recommendation G.902: "Framework recommendation on functional access networks".

[3] ETR 139: "Radio Equipment and Systems (RES); Radio in the Local Loop".

[4] DAVIC 1.0 Part 04: "Delivery System Architecture and Interfaces".

[5] ETR 326, edition 1: "Transmission and Multiplexing (TM); B-ISDN access".

[6] ETS 326, edition 2: "Transmission and Multiplexing (TM); Broadband access".

[7] ITU-T Recommendation I.112: "Vocabulary of terms for ISDNs".

[8] ITU-T Recommendation I.113: "Vocabulary of terms for broadband aspects of ISDN".

[9] ITU-T Recommendation I.411: "ISDN User-Network Interfaces - Reference Configurations".

[10] Draft new ITU-T Recommendation J.1: "Terminology for new services in television and sound programme transmission".

[11] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".

[12] NET 4: "Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment to be connected to an analogue subscriber interface in the PSTN".

[13] ETS 300 448: "Business telecommunications (BTC); Ordinary quality voice bandwidth 2-wire analogue leased line (A2O) Connection characteristics and network interface presentation".

[14] ETS 300 449: "Business telecommunications (BTC); Special quality voice bandwidth 2-wire analogue leased line (A2S) Connection characteristics and network interface presentation".

[15] ETS 300 451: "Business telecommunications (BTC); Ordinary quality voice bandwidth 4-wire analogue leased line (A4O) Connection characteristics and network interface presentation".

[16] ETS 300 452: "Business telecommunications (BTC); Special quality voice bandwidth 4-wire analogue leased line (A4S) Connection characteristics and network interface presentation".

[17] ETS 300 288: "Business Telecommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Network interface presentation".

[18] ETS 300 766: "Business TeleCommunications (BTC);Multiple 64 kbit/s digital unrestricted leased lines with octet integrity presented at a structured 2 048 kbit/s interface at either or both ends (D64M); Connection characteristics and network interface presentation".

[19] ETS 300 418: "Business Telecommunications (BTC); 2 048 kbit/s digital unrestricted leased line with octet integrity (D2 048U and D2 048S); Network interface presentation".

[20] ETS 300 012: "Integrated Services Digital Network (ISDN); basic rate user-network interface; Layer 1 specification and test principles".

[21] ETR 080: "Transmission and Multiplexing (TM); ISDN basic rate access; Digital transmission system on metallic local lines".

[22] ETR 119: "Open Network Provision (ONP) study on possible new interfaces at the network side of the NT1".

[23] ETS 300 011: "Integrated Services Digital Network (ISDN); primary rate user-network interface; Layer 1 specification and test principles".

[24] ETS 300 233: "Integrated Services Digital Network (ISDN); Access digital section for ISDN primary rate".

[25] ETS 300 742: "Physical layer user network interface for 2 Mbit/s ATM signals".

[26] prI-ETS 300 811: "Transmission and Multiplexing (TM); Broadband Integrated Services Digital Network (B-ISDN); Transmission Convergence (TC) and Physical Media Dependent(PMD) sublayers for the SB reference point at a bit-rate of 25,6 Mbit/s over twisted pair cable".

[27] ETS 300 299: "Broadband Integrated Services Digital Network (B-ISDN); Cell based user network access; Physical layer interfaces for B-ISDN applications".

[28] ETS 300 300: "Broadband Integrated Services Digital Network (B-ISDN); Synchronous Digital Hierarchy (SDH) based user network interface; Physical layer interfaces for B-ISDN applications".

[29] ITU-T Recommendation I.430: "Basic user-network interface - Layer 1 specification".

[30] ITU-T Recommendation G.960: "Digital section for ISDN basic rate access".

[31] ITU-T Recommendation I.431: "Primary rate user-network interface - Layer 1 specification".

[32] ITU-T Recommendation G.962: "Access digital section for ISDN primary rate access at 2 048 kbit/s".

[33] ITU-T Recommendation I.432.1: "B-ISDN user-network interface physical layer specification - general characteristics".

[34] ITU-T Recommendation I.432.2: "B-ISDN UNI Physical layer specification for 155 520 kbit/s and 622 080 kbit/s".

[35] ITU-T Recommendation I.432.3: "B-ISDN UNI Physical layer specification for 1 544 kbit/s and 2 048 kbit/s".

[36] ITU-T Recommendation I.432.4: "B-ISDN UNI Physical layer specification for 51 840 kbit/s".

[37] ITU-T Recommendation I.610: "B-ISDN operation and maintenance principles and functions".

[38] ISO/IEC 8802-3: "Information technology; Local and metropolitan area networks; Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".

[39] ETS 300 463: "Transmission and Multiplexing (TM);Requirements of passive Optical Access Networks (OANs) to provide services up to 2 Mbit/s bearer capacity.

[40] DTR/TM-03024: "Transmission and Multiplexing (TM); Generic functional architecture for access networks".

[41] ETR 248: "Transmission and Multiplexing (TM); Use of single mode fibre in the access network".

[42] prETS 300 681: "Transmission and Multiplexing (TM); Optical Distribution Network (ODN) for OAN".

[43] ETS 300 417, Parts 1-1 to 8-1: "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy equipment".

[44] ETR 152, edition 2: "Transmission and Multiplexing (TM); High bitrate Digital Subscriber Line (HDSL) transmission system on metallic local lines; HDSL core specification and application for 2 048 kbit/s based access digital sections including HDSL dual-duplex Carrierless Amplitude Phase Modulation (CAP) based system".

[45] ETR 152, edition 3: "Transmission and Multiplexing (TM); High bitrate Digital Subscriber Line (HDSL) transmission system on metallic local lines; HDSL core specification and applications for 2 048 kbit/s based access digital sections".

[46] ETR 328: "Transmission and Multiplexing (TM); Study and investigation of Asymmetrical Digital Subscriber Lines (ADSL)".

[47] DTR/TM-06003: "Transmission and Multiplexing (TM); Very High Speed Subscriber Lines (VDSL) functional requirements".

[48] DAVIC 1.0 Part 08: "Lower layer protocols and physical interfaces".

[49] TS 03.20: "European digital cellular telecommunications system (Phase1); Security-related Network Functions (GSM 03.20)".

[50] ETS 300 550: "European digital cellular telecommunications system (Phase2); Mobile Station - Base Station System (MS-BSS) interface General aspects and principles (GSM04.01)".

[51] ETS 300 573: "European digital cellular telecommunications system (Phase2); Physical layer on the radio path General description (GSM05.01)".

[52] ETS 300 612-1: "European digital cellular telecommunications system (Phase2); Network Management (NM); Part 1: Objectives and structure of Network Management (GSM12.00)".

[53] DE/SMG-0302301: "UMTS Network Aspects; UMTS functional model and network architecture".

[54] DE/SMG-0502501: "UMTS Radio Aspects; Framework of radio system".

[55] ETR 056: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) System description document".

[56] ETR 178: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) ".

[57] ETR 185: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) ".

[58] ETS 300 175-1: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 1: Overview".

[59] ETS 300 175-2: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 2: Physical layer".

[60] ETS 300 175-3: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 3: Medium access control layer".

[61] ETS 300 175-7: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Common Interface Part 7: Security features".

[62] ETS 300 434: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) and Integrated Services Digital Network (ISDN) inter-working for end system configuration; Part 1: Inter-working specification".

[63] ETS 300 444: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Generic Access Profile (GAP)".

[64] ETS 300 701: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) ".

[65] ETS 300 651: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) Data Services Profile (DSP); Generic data link service; Service Type C, Class 2".

[66] ETS 300 755: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Data services profile; Multimedia Messaging Service (MMS) with specific provision for facsimile services; (Service type F, class2)".

[67] ETS 300 370: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications/ Global System for Mobile communications (DECT/GSM) inter-working profile Access and mapping (Protocol/procedure description for 3,1 kHz speech service)".

[68] ETS 300 756: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications/Global System for Mobile communications (DECT/GSM) interworking profile; Implementation of bearer services".

[69] ETS 300 765: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); DECT Radio local loop Access Profile (RAP)".

[70] DE/RES-03039-1: "Radio Equipment and Systems (RES); Digital Enchanced Cordless Telecommunications (DECT); Integrated Services Digital Network (ISDN); DECT/ISDN interworking for intermediate system configuration; Interworking and profile specification".

[71] ETR 310: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service DECT applications co-existing in a common frequency band".

[72] ETS 300 792: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); DECT/GSM interworking profile; Implementation of facsimile group 3".

[73] ETR 308: "Radio Equipment and Systems (RES); Services, facilities and configurations for the DECT Radio local loop Access Profile (RAP)".

[74] DE/RES-03080: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Cordless Terminal Mobility (CTM); Services and features for CTM Access Profile (CAP)".

[75] ETS 300 636: "Transmission and Multiplexing (TM); TDMA point-to-multipoint digital systems in the band 1 to 3 GHz".

[76] DE/TM-04020: "Transmission and Multiplexing (TM); Time Division Multiple Access (TDMA) point-to-multipoint digital radio systems in the frequency range 3 to 11 GHz".

[77] DE/TM-04031: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); CDMA point-to-multipoint digital systems in the band 1 to 3 GHz".

[78] DTR/TM-04038: "Transmission and Multiplexing (TM); Point-to-multipoint radio relay systems (1-3 GHz) in the access network".

[79] DE/TM-04042: "Transmission and Multiplexing (TM); DS-CDMA point-to-multipoint digital systems in the band 3 to 11 GHz".

[80] DE/TM-04043: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS) for broadband local access network connections".

[81] DE/TM-04045: "Transmission and Multiplexing (TM); Frequency Division Multiple Access (FDMA) point to multipoint Digital Radio Relay Systems (DRRS) in the band 1 to 3 GHz".

[82] DE/TM-04046: "Transmission and Multiplexing (TM); Frequency Division Multiple Access (FDMA) point to multipoint Digital Radio Relay Systems (DRRS) in the band 3 to 11 GHz".

[83] ETR 133: "Radio Equipment and Systems (RES); High Performance Radio Local Area Networks (HIPERLAN); System definition".

[84] ETS 300 328: "Radio Equipment and Systems (RES); Wideband data transmission systems; Technical characteristics and test conditions for data transmission equipment operating in the 2.4 GHz ISM band and using spread spectrum modulation techniques".

[85] ETS 300 652: "Radio Equipment and Systems (RES); High Performance Radio Local Area Networks (HIPERLAN); Functional specification".

[86] DE/RES-10-08: "Radio Equipment and Systems (RES); HIgh PErformance Radio Local Area Networks (HIPERLAN); Multimedia over wireless ATM".

[87] ITU-T Recommendation G.964: "V interfaces at the digital local exchange (LE) - V5.1 interface (based on 2 048 kbit/s) for the support of access network (AN)".

[88] ITU-T Recommendation G.965: "V interfaces at the digital local exchange (LE) - V5.2 interface (based on 2 048 kbit/s) for the support of access network (AN)".

[89] ITU-T SG13 Q.14: "Report of the rapporteur's group meeting, Ipswich, 29th to 31st of January 1996".

[90] ETS 300 324-1: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN); Part 1: V5.1 interface specification".

[91] ETS 300 347-1: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN); Part 1: V5.2 interface specification".

[92] ETR 242: "Signalling Protocols and Switching (SPS); Open Network Provision (ONP) standardization for access to the local loop".

[93] RTR/TM-03066: "Transmission and Multiplexing (TM); Transmission delay; Hypothetical reference model and planning guidelines".

[94] ETS 300 795: "Signalling Protocols and Switching (SPS); Local Exchange (LE) and Access Network (AN) performance design; Requirements for call processing and bearer connection management".

[95] ITU-T Recommendation Q.512: "Digital exchange interfaces for subscriber access".

[96] ETR 257: "Signalling Protocols and Switching (SPS); V interfaces at the digital Service Node (SN); Identification of the applicability of existing protocol specifications for a VB5 reference point in an access arrangement with Access Networks".

[97] DE/SPS-03046-1: "V interfaces at the digital Service Node (SN); Interfaces at the VB5.1 reference point for the support of broadband or combined narrowband and broadband Access Networks Part 1: Interface specification".

[98] DE/SPS-03047-1: "V interfaces at the digital Service Node (SN); Interfaces at VB5.2 reference point for the support of broadband or combined narrowband and broadband Access Networks; Part 1: Interface specification".

[99] ETS 300 376-1: "Signalling Protocols and Switching (SPS); Q3 interface at the Access Network (AN) for configuration management of V5 interfaces and associated user ports; Part 1: Q3 interface specification".

[100] ETS 300 378-1: "Signalling Protocols and Switching (SPS); Q3 interface at the Access Network (AN) for fault and performance management of V5 interfaces and associated user ports; Part 1: Q3 interface specification".

[101] DE/SPS-03045-1: "V interfaces at the digital Service Node (SN); Management interfaces associated with the VB5.2 reference point; Part 1: Interface specification".

[102] DE/SPS-03049-1: "V interfaces at the digital Service Node (SN); Management interfaces associated with the VB5.1 reference point; Part 1: Interface specification".

[103] DTR/TM-02222: "Transmission and Multiplexing (TM); Management of the Access Network (AN)".

[104] I-ETS 300 736-2, 4 & 5 :"Transmission and Multiplexing (TM); Operations and maintenance of Optical Access Networks; Part 2, 4 & 5: Information model and fragments".

[105] DTR/TM-02226: "Transmission and Multiplexing (TM); Operations and Maintenance (O&M) of Optical Access Networks (OANs); Ensembles applicable to OANs".

[106] DE/TM-02227: "Transmission and Multiplexing (TM); Management of generalized Access Networks (ANs)".

[107] DI/TM-02235: "Transmission and Multiplexing (TM); Service provisioning ensemble of access networks".

[108] DTR/TM-02238: "Transmission and Multiplexing (TM); Operation And Maintenance (OAM) of Optical Access Networks (OANs); Transmission fragment (element view)".

[109] DTR/TM-02239: "Transmission and Multiplexing (TM); Operation And Maintenance (OAM) of Optical Access Networks (OANs); Test and performance fragment".

[110] ETR 240: "Transmission and Multiplexing (TM); Operations and maintenance of Optical Access Networks".

[111] ATM Forum/95-1 416R2: "Baseline text for the Residential Broadband Working Group".

[112] ATM Forum/96-006: "RBB Living List".

[113] Draft new ITU-T Recommendation J.82: "Transport of MPEG-2 Constant Bit Rate television signals in B-ISDN".

[114] ITU-T Recommendation J.83: "Digital Multi-programme systems for television, sound and data services for cable distribution".

[115] Draft new ITU-T Recommendation J.84: "Distribution of digital multi-programme signals for television, sound and data services through SMATV networks".

[116] ITU-T contribution COM 9-1 (Rev1): "New questions allocated to Study Group 9".

[117] ETS 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[118] ETS 300 421: "Digital Broadcasting Systems for Television, Sound and Data Services; Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[119] ETS 300 429: "Digital Broadcasting Systems for Television, Sound and Data Services; Framing structure, channel coding and modulation for cable systems".

[120] ETS 300 473: "Digital Broadcasting Systems for Television, Sound and Data Services; Satellite Master Antenna Television (SMATV) distribution systems".

[121] ETS 300 468: "Digital Broadcasting Systems for Television, Sound and Data Services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) Systems".

[122] ETS 300 472: "Digital Broadcasting Systems for Television, Sound and Data Services; Specification for Conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) Bitstreams".

[123] ETS 300 744: "Digital Broadcasting Systems for Television, Sound and Data Services; Framing Structure, Channel Coding and Modulation for Digital Terrestrial Television". (Based on DVB Technical Module TM1 354).

[124] ETR 162: "Digital Broadcasting Systems for Television, Sound and Data Services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) Systems".

[125] ETR 211: "Digital Video Broadcasting (DVB); Guidelines on Implementation and Usage of Service Information".

[126] ETR 154: "Digital Video Broadcasting (DVB); Implementation guidelines for the use of MPEG 2 systems; Video and audio in satellite and cable broadcasting applications".

[127] DVB TM 1 468: "Return channel for interactivity in DVB broadcasting systems - Concept and System".

[128] DVB-RC-126: "Draft specification for DVB interaction channel for CATV".

[129] DVB-RC-052 rev. 3: "Draft specification for DVB interaction channel through PSTN/ISDN".

[130] DVB-RC-100: "Draft specification of DVB interaction channel for SMATV systems based on satellite and coax sections".

[131] EN 50083-1: "Cabled distribution systems for television and sound signals - Part 1: Safety requirements".

[132] EN 50083-2: "Cabled distribution systems for television and sound signals - Part 2: Electromagnetic compatibility for equipment".

[133] EN 50083-3: "Cabled distribution systems for television and sound signals - Part 3: Active coaxial wideband distribution equipment".

[134] EN 50083-4: "Cabled distribution systems for television and sound signals - Part 4: Passive coaxial wideband distribution equipment".

[135] EN 50083-5: "Cabled distribution systems for television and sound signals - Part 5: Headend equipment".

[136] EN 50083-6: "Cabled distribution systems for television and sound signals - Part 6: Optical equipment".

[137] EN 50083-7: "Cabled distribution systems for television and sound signals - Part 7: System performance".

[138] EN 50083-8: "Cabled distribution systems for television and sound signals - Part 8: Electromagnetic compatibility for equipment".

[139] EN 50083-9: "Cabled distribution systems for television and sound signals - Part 9: Interfaces for CATV/SMATV head-end and similar professional equipment".

[140] EN 50083-10: "Cabled distribution systems for television and sound signals - Part 10: System performance and associated methods of measurement for return channel transmission in multimedia applications".

[141] EN 50083-11: "Cabled distribution systems for television and sound signals - Part 11: DVB interaction channel (DVB-RC-126)".

[142] EN 50201: "Interfaces for digital video broadcast integrated receiver decoder (DVB-IRD)".

[143] EN 50221: "Common interface specification for conditional access and other digital video broadcasting decoder applications".

[144] EN 50256: "Characteristics of DVB receivers [CENELEC Technical Committee 206]".

[145] CLC/Technical Committee 205(SEC)175A: "HBES report no. 4; Applications and requirements - Class 2 and 3 [CENELEC TC 205]".

[146] ETS 300 748: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for Multipoint Video Distribution Systems (MVDS) at 10 GHz and above".

[147] DAVIC 1.1: "MMDS specification and LMDS specification".

[148] IEEE 802:10: "IEEE standards for local and metropolitan area networks: Interoperable LAN/MAN Security (SILS): Secure Data Exchange (SDE) sublayer management and recommended practice for SDE on Ethernet V2.0 in IEEE 802 LANs".

[149] IEEE 802-14-94/002R3: "IEEE P 802.14 Cable-TV functional requirements and evaluation criteria".

[150] ITU-T Recommendation G.704 (1995): "Synchronous frame structures used at 1 544, 6 312, 2 048, 8 488 and 44 736 kbit/s hierarchical levels".

[151] ITU-T Recommendation G.804 (1993): "ATM cell mapping into plesiochronous digital hierarchy (PDH)".

[152] Draft ITU-T Recommendation G.707 (1996): "Synchronous digital hierarchy bit rates".

[153] ITU-T Recommendation G.728 (1992): "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".

[154] CEPT Recommendation T/R 13-01 (1993): "Harmoniasation des disposition des canaux radioélectriques pour les services fixes foncionant dans la gamme des 1-3 GHz".

[155] CEPT Recommendation T/R 22-06: "Bandes de fréquences harmonisées pour les réseaux locaux radioélectriques européens à haute performance (HIPERLAN) dans la gamme de fréquences des 5 GHz et 17GHz".

[156] CEPT Recommendation T/R 52-01: "Check-list for operation and maintenance aspects in specifications and tenders".

[157] ISO/IEC 8802 (1994) [ANSI/IEEE 802.2, 1994 Ediiton]: "Information technology - Telecommunications and information exchange between systems - Local and Metropolitan area networks - Specific requirements - Part 2: Logical link control".

[158] TBR 06 (1993): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) General terminal attachment requirements".

[159] TBR 10 (1993): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT) General terminal attachment requirements: telephony applications".

[160] TBR 22 (1996): "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital Enhanced Cordless Telecommunications (DECT) Generic Access Profile (GAP) applications".

3 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

ADPCM	Adaptive Differential Pulse Code Modulation
ADSL	Asymmetric Digital Subscriber Line
AN	Access Network
ANI	Access Network Interface
ANSI	American National Standards Institute
ATM	Asynchronous Transport Mode
B-ISDN	Broadband -ISDN
CAP	Carrierless Amplitude Modulation
CATV	Community Antenna TV
CDMA	Code Division Multiple Access
CEPT	Conference of European Posts and Telecommunications Administrations
CT2	Cordless Telephone 2nd generation
CTM	Cordless Terminal Mobility
CTR	Common Technical Regulation
DAVIC	Digital Audio-Visual Council
DCS 1800	Digital Cellular System working at 1800 MHz
DECT	Digital Enhanced Cordless Telecommunications
DTMF	Dual Tone Multi Frequency
DVB	Digital Video Broadcasting
EII	European Information Infrastructure
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
ENG/OB	Electronic News Gathering/Outside Broadcast
EPII	European Project for the Information Infrastructure
EPIISG	European Project on Information Infrastructure Starter Group
ESF	Extended Superframe
EU	European Union
FDMA	Frequency Division Multiple Access
FPLMTS	Future Public Land Mobile Telecommunication System
FTTC	Fibre To The Curb
FTTH	Fibre To The Home
GAP	Generic Access Profile
GII	Global Information Infrastructure
GSM	Global System for Mobile communications
HDSL	High bit rate Digital Subscriber Line
HFC	Hybrid Fibre Coax

HIPERLAN	High Performance Radio Local Area Network
IP	Internet Protocol
IRD	Integrated Receiver Decoders
ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific and Medical
ITU	International Telecommunications Union
ITU-R	ITU - Radiocommunications standardization sector
ITU-T	ITU - Telecommunications standardization sector
LED	Light Emitting Diodes
LMDS	Local Multipoint Distribution Systems
MAC	Medium Access Control
MMDS	Multichannel Multipoint Distribution Systems
MPEG	ISO/IEC Moving Pictures Experts Group
MSC	Mobile-services Switching Centre
MVDS	Multipoint Video Distribution System
NMT	Nordic (Scandinavian) Mobile Telephone system
NNI	Network Node Interface
NT	Network Terminations
OAM	Operations, Administration and Management
OAN	Optical Access Networks
ONP	Open Network Provision
PAS	Publicly Available Specification
PDH	Plesiochronous Digital Hierarchy
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PMD	Physical Medium Dependent
POF	Plastic Optical Fibre
PON	Passive Optical Network
POTS	Plain Old Telephony Service
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RBB	Residential Broadband
SDH	Synchronous Digital Hierarchy
SMATV	Satellite Master Antenna TeleVision
SNI	Service Node Interfaces
SPP	Service Provisioning Platform
SS7	Signalling System No. 7
STC	ETSI Technical Sub-Committee
STU	Set Top Unit
TACS	Total Access Communications System
TC	Transmission Convergence
TDMA	Time Division Multiple Access
TII	Transport Independent Interface
TV	Television
UMTS	Universal Mobile Telecommunications System
UNI	User Network Interface
VC	Virtual Container
VDSL	Very high bit rate Digital Subscriber Line
VP	Virtual Path
VSB	Vestigial SideBand

4 Overview of existing standards and ongoing activities

This clause gives a brief overview of existing standards and ongoing work. It is not intended to provide a tutorial on access networks, because there is already ample tutorial information contained in the documents that are referred to in the following clauses.

The bodies involved in access standards and PAS are using different classification schemes for the types of networks they are describing. This overview does not follow any particular existing scheme. This ETR emphasizes the interface aspects of access networks and therefore this overview is organized firstly according to the types and capacity of the interfaces that are being provided and secondly according to the access technology being used.

4.1 Access Network (AN) architecture and evolution

ITU-T Recommendation G.902 [2] is a framework recommendation on the architecture and functions of access networks. It describes access types, management and service node aspects. An Access Network (AN) as defined by ITU-T Recommendation G.902 [2] is bound by User Network Interfaces (UNI) at the customer side and Service Node Interfaces (SNI) at the core network side and does not interpret user-network signalling. ITU-T Recommendation G.902 [2] builds on the concepts that were developed in ETSI in the context of the narrowband SNI (V5) to encompass also broadband access networks.

ETR 139 [3] examines the architecture and technologies in use, or under development, in Europe for Radio in the Local Loop (RLL). Cordless technologies: DECT (Digital Enhanced Cordless Telecommunications) and CT2 (Cordless Telephone 2nd generation), Cellular technologies: DCS 1800 (Digital Cellular System working at 1 800 MHz), GSM (Global System for Mobile communications), NMT (Nordic (Scandinavian) Mobile Telephone system) and TACS (Total Access Communications System), microwave Point-to-Multipoint (P-MP) systems and spread spectrum CDMA (Code Division Multiple Access) technologies are all being considered.

The Digital Audio Visual Council (DAVIC) 1.0 Specification Part 04 [4] gives an overview of delivery system architecture and interfaces. DAVIC has classified networked delivery systems into cabled, hertzian and hybrid networks. The delivery system is partitioned in a core and access network. A number of wired access network types are distinguished. These are referred to by DAVIC as Asymmetric Digital Subscriber Line (ADSL) AN, Very high bit rate Digital Subscriber Line (VDSL) AN, Fibre To The Curb (FTTC) AN, and Fibre To The Home (FTTH) AN. FTTH ANs are assumed to use "active" Network Terminations (NT). The other types may use "passive" NTs. Terrestrial broadcasting networks have also been addressed by a recent DAVIC call for proposals. The definition of such access networks will be included in future DAVIC Specifications. ETS 300-744 [123] is one of the potential candidates.

ETR 326 [5] describes the architectural principles for broadband Integrated Services Digital Network (B-ISDN) access. One of the architectures that is covered is that of Asynchronous Transport Mode Passive Optical Networks (ATM-PON). Work on a revision of this report to cover cascaded transmission systems and non-homogeneous access types has just started under RTR/TM-03075 [6].

DTR/TM-03024 [41] deals with ongoing work on requirements of Optical Access Networks (OANs) for evolving services. Two access network types are currently elaborated; so called fibre twisted pair systems and Hybrid Fibre Coax (HFC) passband transmission systems.

ATM Forum/95-1 416R2 [111] documents the progress of the work in the ATM Forum Residential Broadband (RBB) working group. It shows the RBB reference architecture and the interfaces for which the ATM Forum seeks specifications. Ongoing work that is not judged mature enough to enter the baseline text (see [111]) is captured in the RBB living list (see [112]). These include technology specific UNIs, the Access Network Interface (ANI) -called SNI in ITU-T Recommendation G.902 [2]- and the home UNI.

IEEE 802.14/94-002R3 [149] documents the status of the work of IEEE project 802.14 on Cable TV functional requirements and evaluation criteria for the MAC and Physical layer standards that are being developed. It includes a logical reference model and a description of the network topologies that should be supported.

4.2 Terminology

ITU-T Recommendation I.112 [7] provides terminology for Integrated Services Digital Network (ISDN). ITU-T Recommendation I.113 [8] gives additional vocabulary for the broadband aspects of ISDN. ITU-T Recommendation I.411 [9] describes ISDN UNI reference configurations and explains the concepts of reference points and functional groups. Draft new ITU-T Recommendation J.1 [10] defines terminology for television and sound programme transmission.

There does not seem to be a document that provides a generally accepted set of definitions applicable to access networks; each standard or PAS contains its own set of definitions.

This ETR attempts to use the terminology provided by ITU-T Recommendation G.902 [2]. The term UNI is used in the widest possible sense for the boundary between an end-user domain and an access network operator domain. In this interpretation it depends on the type of access network and market and regulatory considerations whether the UNI is a wired line type interface commonly referred to as a "U" interface, an air-interface or a conventional ISDN "S/T" type interface. With this use of the term UNI the only common technical characteristic of any wired UNI is that it is physically accessible e.g. at a socket or a set of terminals. For a wireless UNI the accessibility requirement translates into the need for a fully specified air-interface.

4.3 Access network external interfaces

Ideally standards should define a minimum set of access network interfaces independent of the access technology being used. The existing interface standards for POTS (Plain Old Telephony Service), narrowband and broadband ISDN could be considered to be such a set. In practice this approach may however carry a certain cost penalty depending on the access technology of choice. Particularly in the residential environment, which is a very cost sensitive area of the transport infrastructure, the industry is challenged to find a reasonable compromise between initial costs and life cycle costs of the access network: Whereas a low initial cost objective leads to technology specific interfaces, uncontrolled proliferation of different interfaces will tend to increase the life cycle cost of the access infrastructure.

A number of recent initiatives have increased the pace with which new interfaces are being defined. Since many of these are technology specific it is tempting from a tutorial point of view to start with a listing of different access architectures. However it is not the implementation but the interfaces that have been or are being defined that are of prime importance for the EPII, because these provide for the interconnection of end-users to the network (in case of the UNI) and between networks (in the case of the SNI). We will therefore first list existing and new interfaces and background material on underlying system concepts afterwards.

4.3.1 Existing wired UNIs

4.3.1.1 Analogue telephony for POTS

For analogue voice band services ITU-T Recommendation Q.552 [11] specifies the transmission characteristics at 2-wire analogue interfaces of digital exchanges. Strictly speaking it specifies the SNI, but if the AN is a simple twisted pair it can also be considered as a "U" type UNI specification. NET 4 [12] gives general technical requirements for equipment to be connected to an analogue subscriber interface in the PSTN (Public Switched Telephone Network); i.e. it gives requirements that terminal equipment has to satisfy at the UNI. The detailed specification of the POTS UNI varies in Europe per country and can be found in national specifications.

4.3.1.2 Data interfaces

Data interfaces according to one on the ITU-T V series of Recommendations are in wired residential access networks generally not provided as UNIs, but via a voice band modem or ISDN terminal adaptor connected to a POTS or ISDN UNI. Current wireless access technologies are generally not capable to support the whole range of voice band data services. A 32 kbit/s DECT channel for instance will support voice-band modems up to 4,8 kbit/s (7,2 kbit/s with some degradation) and GSM will only support data services up to 9,6 kbit/s via digital interfaces employing either V.24/V.28 (R interface) or V.110 (S interface). For RLL applications with network operator provided radio terminations at the customer premises these may include data adaptors in which case V-interfaces appear as UNIs.

Broadcasting media are going to be more and more used to convey data uni- or bi-directionnally. The protocols defined in MPEG (e.g. DSM/CC) and DAVIC will be important references to define the data interfaces. Special data streams have also been defined for specific applications (e.g. the SI system described in ETS 300 468 [121]).

4.3.1.3 Analogue leased lines

ETS 300 448 [13] specifies the connection characteristics and network interface presentation for ordinary voice bandwidth 2-wire analogue leased lines; i.e. it specifies the UNI for these leased lines. ETS 300 449 [14] specifies the same for special quality voice bandwidth 2-wire analogue leased lines. It should be noted that the interface presentation is identical. ETS 300 451 [15] and ETS 300 452 [16] are the equivalent standards for ordinary and special quality 4-wire analogue leased lines respectively.

4.3.1.4 Digital leased lines

ETS 300 288 [17] specifies the network interface presentation for a 64 kbit/s digital unrestricted leased line with octet integrity. DE/BTC-02068 [18] concerns ongoing work on the network interface presentation for a nx64 kbit/s leased line. ETS 300 418 [19] specifies the network interface for 2 048 kbit/s digital leased lines with octet integrity.

4.3.1.5 Basic rate ISDN

ITU-T Recommendation I.430 [29] specifies the UNI for basic rate ISDN at the S/T reference point. ETS 300 012 [20] identifies which aspects are regarded as normative or informative and gives further requirements or modifications to I.430 [29]. It also specifies the test principles, PICS (Protocol Implementation Conformance Statement) and PIXIT (Protocol Implementation eXtra Information for Testing) to verify conformance to the standard.

ETR 080 [21] describes the characteristics of a digital transmission system which provides a basic rate access digital section. This basic rate "U" type interface is not provided as an UNI in Europe. A study on technical and economical aspects of a "U" type UNI can be found in ETR 119 [22].

4.3.1.6 Primary rate ISDN

ITU-T Recommendation I.431 [31] specifies the UNI for primary rate ISDN at the S/T reference point. ETS 300 011 [23] identifies which aspects are regarded as normative or informative and gives further requirements or modifications to I.431 [31]. It also specifies the test principles, PICS and PIXIT to verify conformance to the standard.

ETS 300 233 [24] describes the characteristics of a digital transmission system which provides a primary rate access digital section. This primary rate "U" type interface is not provided as an UNI in Europe.

4.3.1.7 2 048 kbit/s B-ISDN

Draft new ITU-T Recommendation I.432.3 [35] specifies the ATM physical layer for a 2 048 kbit/s B-ISDN UNI. The general characteristics of the B-ISDN UNI are given in I.432.1 [33]. ETS 300 742 [25] is concerned with the profiling and test specifications for the ITU-T base standard.

4.3.1.8 155 520 kbit/s and 622 080 kbit/s B-ISDN

Draft new ITU-T Recommendation I.432.2 [34] specifies the ATM physical layer for the 155 520 kbit/s and 622 080 kbit/s B-ISDN UNIs. ETS 300 299 [27] is concerned with the profiling and test specifications for the cell based UNIs specified in ITU-T Recommendation I.432.2 [34], while ETS 300 300 [28] covers the Synchronous Digital Hierarchy (SDH) based UNIs in ITU-T Recommendation I.432.2 [34].

These high bit-rate B-ISDN UNIs are not considered to be of direct interest for residential customer applications.

4.3.2 Potential wired UNIs

4.3.2.1 High bit rate Digital Subscriber Line (HDSL)

Within ETSI, HDSL transmission systems are assumed to be terminated within an AN, similar to the configuration for basic and primary rate access (see subclause 4.4.1.3). DAVIC on the other hand shows access configurations where the HDSL system is terminated internal to a Set Top Unit (STU), implying a "U" type HDSL UNI. For completeness HDSL is therefore listed in this subclause.

4.3.2.2 ADSL

Like for HDSL, DAVIC is showing a reference configuration with the ADSL termination integrated into a STU, which is why ADSL is listed as a potential UNI. Activities in ETSI in the field of ADSL are covered under subclause 4.4.1.4.

4.3.2.3 VDSL

DAVIC 1.0 Part 08 [48] is providing a complete specification for a point-to-multipoint VDSL system. This specification describes a range of VDSL interfaces with different bit rate combinations as shown in table 1 below:

Table 1: A range of VDSL interfaces

Type	Downstream	Upstream
A	51,84 Mbit/s	19,44 Mbit/s
B	51,84 Mbit/s	1,62 Mbit/s
C	25,92 Mbit/s	1,62 Mbit/s
D	12,96 Mbit/s	1,62 Mbit/s

The Physical Medium Dependent (PMD) sublayer specification uses Carrierless Amplitude Modulation (CAP) in a 16-CAP constellation in the downstream direction. Upstream, Quadrature Phase Shift Keying (QPSK) modulation is used. The physical medium may be either twisted pair or coax. The Transmission Convergence (TC) PHYsical (PHY) sublayer defines a 810 byte downstream frame and a 71 byte (plus gap) upstream frame both carrying ATM cells. This VDSL interface is defined for the FTTC access architecture. It should be noted that the TC sublayer includes a Medium Access Control (MAC) protocol allowing up to 4 VDSL terminations to be connected to a single UNI. Therefore this interface could be described as a bus "U" type interface. In the DAVIC FTTC architecture the bus is only intended as in-premises distribution wiring; it is not shared with other subscribers.

ETSI TM6 is working on functional requirements for VDSL under work item DTR/TM-06003 [47], (see subclause 4.4.1.5). As yet there are no proposals in ETSI to specify a VDSL based UNI.

4.3.2.4 Analogue cable TV distribution

Detailed specifications for the interface presentation of analogue TV signals at the outlets of cable TV networks in Europe can only be found in national standards. Some common ground can be found in the EN 50 083 [131] series.

4.3.2.5 Digital cable TV distribution

ITU-T Recommendation J.83 [114] deals with the distribution of digital television and sound signals over cable TV networks. This recommendation is derived from ETS 300 429 [119]. It specifies the use of the MPEG2-Transport Stream with a 204 byte framing structure after Reed-Solomon encoding. It specifies Quadrature Amplitude Modulation (QAM) in either a 16-, 32-, or 64-QAM constellation. DAVIC 1.0 Part 08 [48] contains its own version of these specification. It specifies 16-, 64-, or 256-QAM. An example of useful MPEG2-TS bit rates for an 8 MHz channel, without the use of the high reliability marker is given in table 2 below:

Table 2: MPEG2-TS bit rates for an 8 MHz channel

Modulation	MPEG2-TS bit rate
16-QAM	25,491 Mbit/s
64-QAM	38,236 Mbit/s
256-QAM	50,981 Mbit/s

DAVIC 1.0 Part 08 [48] contains a second interface specification which supports the transport of ATM cells over a cable TV network. The PMD layer is the same as for the MPEG2-TS. This interface packs seven ATM cells plus transport overhead in two 188 byte MPEG2-TS-like packets.

4.3.2.6 Interaction channel for cable TV networks

DAVIC 1.0 Part 08 [48] specifies a bi-directional interaction channel, using QPSK modulation in both directions. The Extended Superframe (ESF) frame structure specified in ITU-T Recommendation G.704 [150] is used in the downstream direction in which ATM cells are mapped according to ITU-T Recommendation G.804 [151]. The downstream bit rate is specified as 1 544 kbit/s; upstream is 256 kbit/s or also 1 544 kbit/s. The M-bits in the ESF are used for Medium Access Control (MAC) purposes. The upstream channel is divided in the time domain in slots. Four slot types are defined: ranging, contention, reservation and Time Division Multiple Access (TDMA) slots, which can be flexibly assigned by a bandwidth controller at the head-end of the cable TV network. This is a bus "U" type interface, where the bus is shared between all subscribers connected to a single coaxial tree.

DVB TM1 468 [127] is currently a working paper on several alternatives to implement an interaction path in Digital Video Broadcasting (DVB) broadcasting systems and it includes a number of proposals for the interface to a cable TV network. It considers some of the MAC proposals that have also been put forward in IEEE 802.14 [149] but also the DAVIC specification and the DECT MAC protocol [60] are discussed. A draft specification for the DVB interaction channel for Community Antenna TV (CATV) networks can be found in DVB-RC-126 [128], for Satellite Master Antenna Television (SMATV) systems in DVB-RC-100 [130], and for interaction through PSTN/ISDN in DVB-RC-052 [129]. It is intended that DVB-RC-126 [128] will be converted to EN 50 083-11 [141].

4.3.2.7 Cable TV based broadband interface

Despite the fact that DAVIC has frozen its release 1.0 specification in December 1995, the industry continues to pursue alternative cable TV MAC protocols in IEEE 802.14 [149]. At its January 1996 meeting there were 13 MAC proposals on the table. Not surprising for a IEEE 802 group, the focus in the 802.14 project is on the support of high speed data. Nevertheless a number of the proposed protocols have special provisions to support nx64 kbit/s with low delay (less than 2 ms one-way) for voice applications. It was decided that low delay for voice is not one of the evaluation criteria for the MAC protocol.

4.3.2.8 Ethernet

The current demand for low cost, high peak bit rate Internet access is leading to equipment and services that are tailored to the interfaces that are available on home PCs at relatively low cost. Equipment is currently on the market that is offering 10Base-T Ethernet [38] interfaces. These are provided over dedicated twisted pairs making use of HDSL or ADSL transmission technology, or over so called cable modems making use of modified Ethernet technology for transmission over cable TV networks. Current systems make use of proprietary "U" interfaces and the modem is supplied by the access provider, which positions the 10Base-T interface as a UNI.

4.3.3 Existing and potential wireless UNIs

Wireless access can take many forms. The basic RLL reference model given in ETR 139 [3] shows a premises radio termination which supports one or more of the wired UNIs mentioned above depending on the wireless technology being used. The ETR does however also consider the use of portable cordless or mobile terminals in which case the air interface may be considered as a "U" type UNI. It is this latter case which is of interest for this subclause on UNIs.

4.3.3.1 GSM/DCS 1800

Because of its restricted bandwidth of 13 kbit/s the GSM/DCS 1800 air interface does not meet the criterion of being able to support at least 64 kbit/s bearers. The format of the radio interface introduces a one-way transmission delay of around 70 ms; speech encoding adds a further 20 ms. Because of speech compression GSM is lacking transparency for Dual Tone Multiple Frequency (DTMF) signalling and voice band data modems. This does not take away the fact that the existence of the mobile GSM/DCS 1800 infrastructure offers the possibility to offer fixed or low-mobility voice telephony and low speed digital data access if licenses would allow for this, which is why GSM is listed here. The GSM air interface specification can be found in the GSM 05 and GSM 04 series of recommendations. ETS 300 573 [51] gives a general description of the physical layer on the radio path and is the starting point for the GSM 05 series. ETS 300 550 [50] which specifies the general aspects and principles of the Mobile Station to Base Station is the starting point for the GSM 04 series.

Work is in progress in ETSI Technical Committee SMG to enhance the GSM air interface to allow for higher data bit rates up to 8x9,6 kbit/s in order to support amongst others 28,8 kbit/s data and single B-channel ISDN.

GSM operates throughout Europe in the same regulated frequency bands, for GSM and for DCS 1800. To support higher bit rates in high subscriber density areas a European wide allocation of 150 MHz (75 MHz + 75 MHz) at 1,8 GHz is sought for DCS 1800.

4.3.3.2 DECT

The DECT standard was designed to provide cordless telecommunications access with a possible RLL application in mind. DECT has a flexible air interface. Voice telephony is provided over a 32 kbit/s bearer with Adaptive Differential Pulse Code Modulation (ADPCM) encoding, which is transparent for DTMF. The one-way transmission delay caused by the TDMA frame on the radio interface is 10 ms; speech and other processing adds another 2 ms. Higher bit rate bearers can be provided up to 352 kbit/s bi-directionally or 736 kbit/s in one direction. Basic rate ISDN access can be provided over a combination of two 64 kbit/s double slots and a single slot.

The DECT standard is specified in the 9-part ETS 300 175, of which ETS 300 175-1 [58].provides an overview. The physical layer is specified in ETS 300 175-2 [59], the MAC layer in ETS 300 175-3 [60]. ETR 178 [56] provides a complete guide to all DECT standards, which include application-specific profiles. The Generic Access Profile (GAP) ETS 300 444 [63] defines a mandatory air-interface UNI for speech services, for which conformance is tested by Common Technical Regulations (CTRs) 06, 10 and 22 which are based, in turn, on TBR 06 [158], TBR 10 [159] and TBR 22 [160]. ETS 300 434 [62] defines a UNI for ISDN-like wireless terminals, whilst DE/RES 03 039 [70] will be a standard for ISDN transport, which may serve either as a UNI for customer adaptors or as an interface at the U reference point for network terminations offering an So UNI at the T reference point. For non-voice services, ETR 185 [57] gives an overview of the data service profiles. These all define packet-based air interfaces profiles which may again be applied either as wireless UNIs or as U reference-point interfaces for network terminations offering different types of UNI at the T reference point. In particular, ETS 300 701 [64] defines a UNI for Internet Protocol (IP) packet transfer, ETS 300 651 [65] defines an air interface for dial-up serial data links, providing a V.24 interface to the terminal adaptor, whilst ETS 300 755 [66] defines an object-based interface for fax transport, for which the typical reference S or T-point interface is T.30 over POTS.

For access to GSM-based fixed networks over the DECT air interface, ETS 300 370 [67] specifies a wireless UNI for voice services, augmented by ETS 300 756 [68] for data services and ETS 300 792 [72] for fax services.

A primary and protected frequency band is available European wide for DECT systems between 1 880 MHz and 1 900 MHz. This band is unregulated: shared by all users, with no provision yet made for exclusive allocations. Power output and other restrictions limit the maximum effective range to below five km. High traffic densities may be supported by DECT access networks through the close spacing of base stations, possible due to the system's use of dynamic channel selection. DTR/RES-03077 [71] provides an analysis of this traffic capacity.

4.3.3.3 Universal Mobile Telecommunication System (UMTS)

Within ETSI, STC SMG5 has elaborated on the requirements for a UMTS. In March 1996 the responsibility for the UMTS documentation has been transferred to other STCs in SMG, whilst SMG5 has

taken on the responsibility for project management of the UMTS project in SMG. A starting point for the documentation of this ongoing work can be found in DE/SMG-0302301 [53]. It is expected that under the UMTS umbrella a new air interface will be defined with capabilities for wide band (up to 2 048 kbit/s) services. DE/SMG-0502501 [54] provides a framework of the radio system and identifies the requirements of the radio interface(s) of UMTS. A model of the protocol stack of the radio interface is included.

The planned frequencies for UMTS are 1 885 MHz - 2 025 MHz and 2 110 MHz - 2 200 MHz, which includes 15 MHz of the DECT band. The UMTS task force is seeking the initial allocation within the European Union (EU) of the 1 980 MHz - 2 010 MHz and 2 170 MHz - 2 200 MHz bands (1 980 MHz - 1 990 MHz and 2 170 MHz - 2 180 MHz past the year 2005). The need for further substantial UMTS spectrum (approximately 2x180 MHz below 3 GHz) is foreseen for mass market application of wideband services.

4.3.4 SNIs

Compared to the number of UNIs that have been defined and are being progressed the definition of SNIs is far less popular. All of the work to date has been initiated in ETSI STC SPS3, and subsequently been carried forward in ITU-T Study Group 13 (SG13). The ATM-Forum is also planning to work on a broadband SNI (called Access Network Interface (ANI) in the Forum) but this specification has not been progressed yet.

For GSM/DCS 1800 networks the Mobile Switching Centre (MSC) to PSTN interface could be considered as an SNI of a kind, but one that does not follow the ITU-T Recommendation G.902 [2] AN paradigm, which stipulates that the AN does not terminate user-network signalling. In a mobile network the MSC clearly does terminate user-network signalling and the SNI is technically a trunk level Network-Network Interface (NNI) carrying SS7 signalling. The characteristics of NNIs are beyond the scope of this ETR.

4.3.4.1 Narrowband SNIs

ETS 300 324-1 [90] specifies the V5.1 interface. V5.1 is a non-concentrating 2 048 kbit/s SNI which defines apart from a message based signalling logical channel a separate logical channel to communicate maintenance information between AN and SN. This latter channel allows for activation and deactivation of the layer 1s of basic rate ISDN ports and blocking of all port types on a port by port basis. A port is in this context the function that supports a single UNI. ITU-T Recommendation G.964 [87] is the ITU-T version of the same specification. Although there are editorial differences the specifications are technically identical.

It should be noted that V5.1 assumes that the AN is non-blocking. In spite of this V5.1 could be used in combination with a blocking AN, e.g. a wireless AN, but the behaviour for a terminating call in case of blocking is not defined by the standard.

ETS 300 347-1 [91] specifies the V5.2 interface. V5.2 is a concentrating interface for a group of maximum 16x2 048 kbit/s physical interfaces. Signalling and port control are identical as in V5.1. In addition a connection control channel is defined over which the SN requests a connection of a bearer in the AN from SNI to UNI. ITU-T Recommendation G.965 [88] is the ITU-T version of V5.2. Differences with the ETSI standard are only editorial.

V5.2 obviously allows for blocking ANs. Its concentration capability minimizes the number of interfaces required at the SN which makes it an attractive interface, also for wireless ANs.

The current V5 specifications prescribe the use of the 2 048 kbit/s G.703 physical layer. Work is ongoing in ITU-T SG13 under Q.14/13 [89] to allow for the use of SDH physical layers. The current working assumption is that an SDH V5 interface shall be structured in VC-12 for V5 interface links and further according to the SDH interface specifications. The 2 048 kbit/s V5 interface links shall use the byte-synchronous mapping including Time Slot 0 (TS0) according to ITU-T Recommendation G.707 [152].

ETR 242 [92] examines the possible use of V5 interfaces in the context of the Open Network Provision (ONP) framework of the EU. It is clarified in this ETR that the V5 interface does not support dynamic selection of core network provider (i.e. service node) by the user at call set up. Static allocation (i.e. subscription) of UNIs on the same physical AN to different SNs is possible, in which case the AN is split in different logical ANs, one for each SN.

4.3.4.2 Broadband SNIs

ETR 257 [96] examines the functional requirements for a broadband SNI, referred to as VB5, in conjunction with the narrowband V5 specifications mentioned above. It is identified that the VB5 protocol will only be carried over an ATM transmission path at the SNI, although that in itself may be provided over a Plesiochronous Digital Hierarchy (PDH) or SDH transmission section. Three implementation scenarios are described to carry narrowband services over a broadband access network. Either the AN provides separate VB5 and V5 interfaces to separate SNs, in which case VB5 does not carry narrowband services. Or VB5 does carry narrowband services to either separate SNs, with the narrowband SN connected to the broadband SN, or to an integrated broadband/narrowband SN. For the latter two cases it is recommended that narrowband services are supported by V5 functionality which is carried via 2 048 kbit/s circuit emulation over an ATM transmission path.

As for narrowband V5, dynamic selection of core network provider by the user by means of control plane signalling is excluded. Static provisioning of different Virtual Paths (VPs) at the UNI to different VB5 interfaces belonging to different SNs is possible. This would allow the user to dynamically select a certain VP. It should be noted that the difference with V5 where it is the physical UNI port - instead of a logical VP port - that is allocated to an SN.

It should be noted that since ETR 257 [96] has been completed, some refinement and further elaboration of the specific functions of the VB5 interfaces has taken place and is ongoing within ETSI STC SPS3. Therefore, this first edition of ETR 257 [96] will not fully reflect the developing standards.

The VB5 interface standards are developed in two phases, as recommended in the report. Firstly a simple non-concentrating interface, referred to as VB5.1 , where the AN may act as a cross-connect on VP or VC level, is being developed. Secondly, a VB5.2 interface is under development, where the AN may act as a VC switch, and which allows for concentration at the VC level. Dynamic control of UNI VP properties is under consideration for VB5.2, although this capability is not covered by ITU-T Recommendations. Both VB5.1 and VB5.2 support provisioning of VP properties both at the SNI and at the UNI. The implications of the use of medium access control for shared media such as cable TV, wireless access or ATM-PON networks, with possible implications for flow control, have yet to be evaluated.

DE/SPS-03046-1 [97] is concerned with the elaboration of the VB5.1 interface specification. This interface has no concentration capabilities, neither at the VP nor at the VC level. VPCs are allocated at the periphery of an AN by means of provisioning. The standard will include a management co-ordination protocol that allows for blocking of user and service ports in real time. A capability to broadcast VCs in an AN by means of provisioning is under consideration.

DE/SPS-03047-1 [98] is concerned with the elaboration of the VB5.2 interface. This work is still in an early stage. As described in ETR 257 [96] VB5.2 will allow for static VPC allocation by provisioning and dynamic VCC allocation on a connection by connection basis which provides concentration capability at VC level. Support of dynamic switching of VPs is being considered.

ITU-T SG13 has just initiated their work under Q.14/13 on VB5 interfaces by means of a first version of a VB5 baseline document.

4.4 Access network internal interfaces

Traditionally interfaces are the prime delineation point for the elaboration of requirements and specifications. This is based on the desire to standardize only those aspects of a system that are necessary for the interconnection and interoperability of systems and networks without imposing undue implementation constraints. It is generally realized that the very choice for a physical interface specification is an implementation choice, which has led to new specification methods that define the behaviour of functional components as it may be observed through a physical interface, without prescribing a one-to-one relationship between component and choice of physical interface. The ETSI SDH standards [43] are an example of standards that follow the functional component method. This subclause is titled AN internal interfaces because the large majority of access standards follow the interface paradigm, but it is intended to cover all standardization activities that specify behaviour that may be perceived at a transport interface internal to an access network.

A number of "U" type interfaces that are, at least within ETSI, considered as AN internal interfaces have already been mentioned under subclause 4.3, because they have been suggested as UNIs in other fora. These are briefly mentioned again in the following subclauses for ease of reference.

4.4.1 Wired AN internal interfaces

4.4.1.1 Basic rate ISDN

ETR 080 [21] describes the characteristics of a digital transmission system which provides a basic rate access digital section. Both 4B3T and 2B1Q line codes are covered.

4.4.1.2 Primary rate ISDN

ETS 300 233 [24] describes the characteristics of a digital transmission system which provides a primary rate access digital section.

4.4.1.3 HDSL

ETR 152 Edition 2 [44] defines different types of HDSL transmission system that support a 2 048 kbit/s access digital section over 2 and 3 twisted pairs. ETR 152 Edition 3 [45] covers ongoing work on a 2 048 kbit/s HDSL transmission system for operation over a single twisted pair.

4.4.1.4 ADSL

Under ETR 328 [46] a study is carried out into the requirements for and specification of Asymmetrical Digital Subscriber Lines, in close co-operation with American National Standards Institute (ANSI) committee T1E1.4. Bit rates under consideration are up to 6 Mbit/s downstream and up to 640 kbit/s upstream.

4.4.1.5 VDSL

DTR/TM-06003 [47] is concerned with functional requirements for VDSL. Like for HDSL and ADSL there is co-operation with ANSI T1E1.4. The emphasis in ETSI STC TM6 is on the use of VDSL over the existing line plant. Only point-to-point systems are considered with downstream bit rates of 6,5, 13 and 26 Mbit/s; 52 Mbit/s is under consideration as a further option.

4.4.1.6 Cable TV network interfaces

The cable TV network interface specifications and ongoing activities referred to in subclauses 4.3.2.6 and 4.3.2.7 are envisaging the use of these specifications for "U" type UNIs. This does not preclude the possibility that an access network operator chooses to supply a network termination equipment which provides any one or a combination of analogue POTS, analogue TV and S/T type ISDN interfaces. In this case the "U" interface becomes an AN internal interface.

4.4.2 Wireless AN internal interfaces

In case an AN provider chooses to offer wired UNIs to his customers that are supported over wireless means, the air interface is internal to the AN. In this case the radio termination is fixed, allowing for outside and directional antenna, which greatly increases range and spectrum efficiency of the radio system. It should be noted that there may also be regulatory constraints that do not allow the use of portable terminals in certain frequency bands to protect legacy point-to-point terrestrial radio links that use the same frequency bands. One other aspect worth mentioning is that under this subclause we not only cover fully standardized air interfaces but also standardization activities that limit themselves to conformance requirements that equipment has to meet to be allowed to operate in a certain frequency band.

4.4.2.1 DECT and GSM/DCS 1800

In case of fixed wireless terminations the same air interface as referred to under subclause 4.3.3.1 and subclause 4.3.3.2 would apply. A notable addition is ETS 300 765 [69] regarding the Radio Local Loop Access Profile (RAP) for DECT, which defines an internal interface for speech and voice-band data services.

4.4.2.2 Point-to-multipoint (P-MP) wireless access systems

ETSI STC TM4 is elaborating a number of specifications for the use of P-MP radio systems in access networks. It should be noted that the use of the term point-to-multipoint by TM4 does not really distinguish

these systems from DECT or GSM/DCS 1800 which are technically also P-MP systems. A distinction that is essential is that TM4 does not consider the use of mobile terminals. DTR/TM-04038 [78] covers ongoing work on a comparison between different medium access techniques: Frequency Division Multiple Access (FDMA), TDMA and CDMA. ETR 139 [3] only covers TDMA systems under the subclause on P-MP systems. DS-CDMA systems are considered separately.

The ETSs that TM4 is progressing are intended to provide conformance requirements for the use of certain frequency bands. They will not provide a detailed air interface specification. DE/TM-04045 [81] and DE/TM-04046 [82] specify FDMA systems in the 1 GHz to 3 GHz and 3 GHz to 11 GHz bands respectively. DE/TM-04031 [77] and DE/TM-04042 [79] specify DS-CDMA systems in the 1 GHz to 3 GHz and 3 GHz to 11 GHz bands respectively. And ETS 300 636 [75] and DE/TM-04020 [76] specify the use of TDMA systems in the 1 GHz to 3 GHz and 3 GHz to 11 GHz bands respectively. CEPT Recommendation T/R 13-01 [154] describes the harmonized channel arrangements in the frequency range 1 GHz to 3 GHz. There does not seem to be a common requirements document or classification scheme for the bearer capabilities of these systems. The data rates that are supported vary from 16 kbit/s voice according to ITU-T Recommendation G.728 [153] up to 512 kbit/s bi-directionally.

CEPT SE (96) 44 annex A is specifying harmonized radio frequency channel arrangements for low and medium capacity systems in the band 3 400 MHz to 3 600 MHz. It recommends that frequency allocations should in all cases be based on blocks of 0,25 MHz slots within the 3 410 MHz to 3 600 MHz band and that administrations should be allowed to allocate all or part of the band to any service or combination of the three services (Point-to-Point (P-P), P-MP and Electronic News Gathering/Outside Broadcast ENG/OB). Two possible duplex spacings are defined: 100 MHz, and 50 MHz when sharing between ENG/OB links and P-MP systems must be implemented.

CEPT SE (96) 1 annex A is recommending radio frequency channel arrangements, based on 0,5 MHz slots, for administrations that have the paired bands 10,15 GHz to 10,3 GHz and 10,5 GHz to 10,65 GHz available for the fixed service. For P-MP systems discrete channel centre frequencies should be obtained from within the 0,5 MHz slots.

4.5 Home network and "S" type interfaces

Strictly speaking the interfaces internal to a STU or home network are outside of an AN, but standardization activities in these areas are covered because they are intimately related to the development of AN standards.

This report does not deal with the specification activities of physical media for use in access networks or customer premises. It should be pointed out however that in particular for broadband signals the characteristics of home wiring systems are very relevant to the definition of access network UNIs, i.e. to the way that customers are connected to the network.

4.5.1 Wired home network interfaces

4.5.1.1 S_B twisted pair interfaces

I-ETS 300 811 [26] specifies the TC and PMD sublayers at the S_B reference point at 25,6 Mbit/s over twisted pair cable. The specification is intended for desktop applications using twisted pair cable. This low cost interface with minimum maintenance facilities has not been proposed as a UNI, but may become of interest in the residential environment in the future for teleworking ATM to the desktop applications, following the pattern mentioned under subclause 4.3.2.8 for 10BaseT.

ITU-T Recommendation I.432.4 [36] defines an S_B interface at 51 840 kbit/s for use over a UTP3 medium with a CAP16 PMD sublayer and an SDH or cell based TC sublayer.

4.5.1.2 S_B optical interfaces

The ATM Forum is standardizing an S_B interface [111], called a Home UNI in the ATM Forum, based on Plastic Optical Fibre (POF) and visible Light Emitting Diodes (LEDs), at a bit rate in the region of 20 Mbit/s to 50 Mbit/s (to be finalized). The intention is to provide a low cost interface, using a physical medium which can be installed by amateurs and which eliminates the problems of Electromagnetic Interference (EMI) in the home environment. A range up to 50 m is envisaged using LEDs at 650 nm. The use of POF is also being specified in the ATM Forum for 155 Mbit/s interfaces in private network applications.

4.5.1.3 STU interfaces

The DVB group is specifying a range of DVB STUs, called DVB Integrated Receiver Decoders (IRD), varying from receive only to interactive STUs. Information on the characteristics of DVB receivers can be found in EN 50256 [144]. Interface specifications for DVB STUs can be found in EN 50201 [142]. General requirements applicable to home and building electronic systems with telecommunications and broadcast signal applications are being progressed in CENELEC TC205 [145]. For conditional access DVB has developed the concept of a common interface to allow a single STU to be used with different conditional access systems. The common interface specification for conditional access and other digital video broadcasting decoder applications is elaborated in EN 50221 [143].

4.5.1.4 A0 - Transport Independent Interface (TII)

The multitude of "U" type interfaces for ANs has given rise to the idea of a TII to decouple higher layer functions from the large variety at layer 1. In a sense this is a re-invention of the ISDN NT1 concept, with the difference that the ISDN "T" interface was not intended as an internal equipment interface, which the TII is. The term TII appears in the ATM Forum RBB baseline text [111]. In DAVIC this interface is identified as the A0 reference point. An initial specification of the A0 interface can be found in DAVIC 1.0 Part 08 [48].

4.5.2 Wireless home network interfaces

CT2 and DECT are prime examples of standards that have been developed initially for use in private networks, but that have subsequently found wider applications. For this reason we make reference here to the work on HIPERLAN in ETSI STC RES10, which is facing similar technological challenges as the work in TM4 on radio systems for broadband access.

4.5.2.1 HIPERLAN

In December 1992 CEPT published Recommendation T/R 22-06 [155] that allocated the 5 150 MHz to 5 300 MHz range to "HIPERLAN", the name for a system specification covering "local area network applications", i.e. customer premises or home networks. ETS 300 652 [85] specifies what is now referred to as HIPERLAN-1, which uses a distributed MAC scheme. The indoor range is some 50 m and the bit rate for each of five channels is 23,5 Mbit/s.

ETS 300 328 [84] specifies technical characteristics and test conditions for wireless LANs operating in the 2,4 GHz ISM (Industrial, Scientific and Medical) band. This is a conformance specification, it does not define the air interface. One of the functional specifications that could be applied in this band is IEEE 802.11.

DE/RES-10-08 [86] is concerned with the development of a second functional HIPERLAN standard, HIPERLAN-2, for wireless ATM systems. Additional spectrum around 5 GHz band is sought for this application. If this does not become available the two modes of HIPERLAN will have to share the same spectrum. RES10 is investigating liaison with the ATM Forum concerning the specification of interworking and management functions required for wireless ATM.

Finally the Advanced Communication Technologies and Services (ACTS) projects WAND (Wireless ATM Network Demonstrator) and MEDIAN (Wireless Broadband CPN/LAN) should be mentioned in the context of wireless ATM. WAND aims at operation in the 17 GHz range at around 20 Mbit/s bit rates. It explicitly aims to feed into the ETSI standardization process. MEDIAN plans to operate in the 60 GHz band with bit rates up to 155 Mbit/s.

4.6 Access system specifications

As mentioned above standards limit themselves in general to high level system architectures from which detailed interface specifications are developed to allow interconnection and interoperability between systems and networks. Implementation details on system configurations, size and power consumption are usually avoided. As a consequence most of the system oriented standards and ongoing activities reported in this subclause are architectural in nature. They are grouped together here under the names commonly used in the industry to have a source of reference for the major access systems that are being pursued.

4.6.1 Conventional copper access

Existing copper access network structures are not standardized as such. In general two or three distribution points are used to fan out high-capacity multi-pair cables from the Main Distribution Frame (MDF) at a local exchange towards individual subscribers.

Depending on distances and installation practices a combination of basic rate, primary rate and HDSL and ADSL transmission systems (see subclauses 4.4.1.1 to 4.4.1.4) can be used to provide digital bearers over the existing line plant.

4.6.2 Hybrid Fibre Coax (HFC)

Although many cable TV networks are still fully coaxial, fibre is increasingly used starting from the head end where broadcast signals are collected and distributed downstream. Most modern cable TV networks could therefore call themselves HFC, but many users of the term HFC mean to imply an upstream bandwidth on the final coaxial distribution plant of some 25 MHz to 45 MHz.

Equipment specifications for one-way cable TV networks can be found in the EN 50083 series. EN 50083-3 [133] specifies active coaxial wideband distribution equipment. EN 50083-4 [134] deals with passive equipment. General requirements for head end equipment can be found in EN 50083-5 [135] and for optical equipment in EN 50083-6 [136].

The DVB TM1468 [127] discusses among others the characterization of the upstream channel.

The IEEE 802.14 cable TV functional requirements document [149] gives a number of (US based) reference configurations including node sizes and distances as starting points for the development of requirements for the 802.14 MAC/PHY standards.

Further work on the characterization of HFC ANs is in progress in DVB, IEEE P802.14, DAVIC delivery system group and ETSI STC TM3 under DE/TM-03024 [41].

4.6.3 Fibre In The Loop (FITL)

ETS 300 463 [39] provides requirements for narrowband passive optical access network systems, with bearer capacity up to 2 048 kbit/s. The systems considered in this ETS are based on TDMA methods. One and two fibre systems are described. For the specification of the optical distribution system reference is made to ETS 300 681 [42].

ETS 300 463 [39] has been contributed to ITU-T and on this basis work is in progress in SG15 on draft ITU-T Recommendation G.PON.

4.6.4 Fibre To The Curb (FTTC)

In DAVIC the term FTTC specifically refers to AN architectures that use baseband VDSL transmission systems over twisted pair or coax for the final connection to the customer premises (see [48]). But the term FTTC is also used in a wider sense. Apart from the VDSL system no other aspects of a FTTC AN have been specified so far.

Further work on the characterization of FTTC ANs is in progress in the DAVIC delivery system group and ETSI TM3 under DE/TM-03024 [41].

4.6.5 Fibre To The Home (FTTH)

Further work on FTTH is in progress in the ATM Forum RBB group. ETR 326 [5] covers amongst others broadband ATM PONs at an architectural level.

4.6.6 GSM/DCS 1800

The GSM/DCS 1800 system has already been comprehensively specified. Further work is in progress in ETSI Technical Committee SMG on phase 2 standards.

4.6.7 DECT

ETR 308 [73] describes the application of DECT to fixed access network architectures. Work is also progressing in STC RES-03 on the development of air-interface support for Cordless Terminal Mobility (CTM), as described in DE/RES-03080 [74].

4.6.8 P-MP wireless access systems

The term P-MP wireless access systems is used in ETSI to refer to narrowband fixed wireless access systems. The technology may be FDMA, TDMA or DS-CDMA.

There is ongoing work on these systems in ETSI TM4.

4.6.9 UMTS

The detailed scope of standardization activities for UMTS has yet to be defined.

4.6.10 Satellite Master Antenna Television (SMATV)

ETS 300 473 [120] describes the modulation, channel coding and framing structure for digital multi-programme television for distribution by SMATV. An SMATV system is intended for the compatible distribution of signals received by a satellite receiving antenna, and a terrestrial receiving antenna, to households located in one or more adjacent buildings. Two system approaches are described. System A uses transmodulation at the SMATV head-end from satellite QPSK signals [118] to one of the QAM schemes defined in ETS 300 429 [119] for cable TV systems. System B uses direct distribution of the satellite QPSK signals and comes in two flavours: SMATV-IF uses frequency conversion to the extended IF band (above 950 MHz) and SMATV-S to the VHF/UHF band. ITU-T Recommendation J.84 [115] covers the same topic. It includes a third SMATV- Vestigial Sideband (VSB) approach using the 16 VSB cable TV mode described in ITU-T Recommendation J.83 [114], which is only of interest for the US. It should be noted that these different systems require different receivers i.e. a different STU interface.

4.6.11 MMDS/LMDS

Multichannel Multipoint Distribution Systems (MMDS) and Local Multipoint Distribution Systems (LMDS) are very similar technologies for providing wireless distribution of video. In general, programming distributed by these systems comes to the system head end from satellite feeds. The use of microwave frequencies makes it necessary for the antenna at the customer premises to be in line-of-sight with the transmitter or a signal repeater.

Analogue MMDS systems are widely deployed in the US in the 2,5 GHz band, where the spectrum allocation allows for 33 analogue 6 MHz video channels. The reach is around 40 km, depending on antenna height. LMDS operates in the 28 GHz band with some 10 km line-of-sight reach. These bands are not available in Europe for this purpose.

Under ETS 300 748 [146] work is in progress on a similar system in the 40,5 GHz to 42,5 GHz band. This band has been harmonized within CEPT for this purpose under Recommendation T/R 52-01 [156]. The proposed system uses the same QPSK modulation scheme as specified in ETS 300 421 [118] for direct satellite broadcasting, in order to be compatible with the same STU when used with a down-converter for the appropriate frequency band. It is referred to as a Multipoint Video Distribution System (MVDS).

DAVIC has also started work on MMDS and LMDS in the context of the DAVIC 1.1 specification [147].

COM 9-1 [116] contains a new ITU-T SG9 question on the physical distribution of MMDS services and possible harmonization with SMATV and cable TV distribution.

4.6.12 Terrestrial broadcasting

A specification for a baseline transmission system for digital terrestrial television broadcasting has been approved by DVB and is under publication as ETS 300 744 [123]. This ETS specifies the channel coding/modulation system intended for digital multi-programme Low, Standard, Enhanced and High Definition Television (LDTV, SDTV, EDTV and HDTV) terrestrial services. It identifies the global

performance requirements and features of the baseline system, in order to meet the service quality targets.

The system is directly compatible with MPEG-2 coded TV signals. It has been designed for 8 MHz channels although an adaptation to 6 MHz and 7 MHz can easily been achieved by scaling down the various parameters, changing the clock frequency. Two modes of Orthogonal Frequency Division Multiplexing (OFDM) operation are defined: a "2k mode" and an "8k mode". The "2k mode" is suitable for single transmitter operation and for small Single Frequency Networks (SFNs) with limited transmitter distances. The "8k mode" can be used both for single transmitter operation and large SFN networks. Simulcast based on hierarchical channel coding and modulation is also considered to cover e.g. specific coverage and/or portability issues. QPSK, 16-QAM and 64-QAM are proposed for different code rates (1/2, 2/3, 3/4, 5/6 7/8) and guard intervals (1/4, 1/8, 1/16, 1/32) offering a wide range of possible useful bit rates from 4,98 Mbit/s to 31,67 Mbit/s.

4.7 Functional requirements for access networks

4.7.1 Access network security

Any network built with shared media has potential security problems that differ from those of conventional architectures with dedicated media such as the copper line plant. While no communication system that sends data outside physically secure premises is perfectly secure, the existence of shared media means that a potential attacker has easier physical access to the network than in other media. To defend end-users against this threat shared media access systems may offer a form of encryption at the transport level, regardless of the additional measures that an end-user or end-to-end service delivery system may use at the application level.

This potential security threat is well covered in existing wireless access standards. ETS 300 175-7 [61] describes the security features of the DECT system. DTS/SMG-03020 [49] gives an overview of the security-related network functions of GSM/DCS 1800.

IEEE 802.10 [148] provides a security architecture for encryption in layer 2 of the OSI reference model of IEEE 802 LANs. The encryption algorithm is not specified by IEEE 802.10 [148] , but the location in the protocol stack and its interfaces.

It should be noted that the vulnerability of a cable TV network is somewhat less than that of a radio or LAN network, because of the use of different upstream and downstream frequencies and directional splitters.

A security issue that is specific to the distributive delivery of pay television signals is conditional access. The common interface specification that has been developed as part of the DVB project can be found in EN 50221 [143].

Safety issues for cable TV networks are covered in EN 50083-1 [131]. EN 50083-2 [132] and EN 50083-8 [138] provide the EMC requirements for cable TV equipment and systems. Amendment EN 50083-1/A1 to the safety requirements which has been produced by CLC/Technical Committee 209 is currently in the approval procedure.

4.7.2 Access network management

ITU-T Recommendation G.902 [2] provides a basic philosophy for access network management, which is that the AN should provide a system management function which co-ordinates operations and maintenance across all entities in an access network.

The management specifications for the V5 interfaces cover a number of generic AN management aspects because these V-interfaces are independent of the access technology that provides the specific V-interface. ETS 300 376-1 [99] specifies the information model for V5 configuration management. ETS 300 378-1 [100] specifies the information model for fault and performance management of V5 interfaces.

The management specifications associated with the VB5 interfaces (DE/SPS-03049-1 [102] for VB5.1 and DE/SPS-03045-1 [101] for VB5.2) specify the information models for configuration, fault and performance management. They also define the relationship between OAM flows and the object model.

ETR 240 [110] is concerned with operations and maintenance of Optical Access Networks (OANs). It provides requirements and a framework for the development of an information model for OAN configurations according to ETS 300 463 [39]. I-ETS 300 736 parts 2, 4 & 5 [104] are the common fragment, transmission fragment and equipment fragment of this OAN information model. DTR/TM-02238 [108]. and DTR/TM-02239 [109]. capture the work done so far on the transmission and test and performance fragments. Further work is needed to convert these reports into specifications, but input is currently lacking. A work item DTR/TM-02226 [105] has been created for the definition of ensembles applicable to OANs. This work item will produce a report detailing the ensembles that will be produced based upon I-ETS 300 736 [104]. DI/TM-02235 [107].contains the ongoing work on a service provisioning ensemble for OANs.

DTR/TM-02222 [103] will capture the issue and considerations which relate to the management of Access Network which have arisen in the course of the work on I-ETS 300 736 [104], but which have been decided to be outside the scope of I-ETS 300 736 [104]. It also indicates areas where additional standards may be required.

DE/TM-02227 [106] intends to specify the management of generalized access networks and covers the production of Q type interfaces for the operation and maintenance of access networks not covered by I-ETS 300 736 [104]. It shall provide guidelines for the integration of different management information models or managed objects of different technologies and applications used within the access networks.

Apart from these generic and OAN management standards there is a body of standards associated which each specific access system.

ETS 300 612-1 [52] provides objectives and structure of network management for GSM phase 2.

4.7.3 Access network performance

In order to satisfy overall end-to-end quality of service objectives for bearer services some apportionment of these objectives to ANs is required. This is an increasingly complicated task because of the growing variety in access network architectures and their geographic coverage, which leads to system specific performance requirements.

RTR/TM-03066 [93] deals with planning guidelines for transmission delay for which purpose an end-to-end hypothetical reference model is being developed. Delay is one of the more critical design criteria for ANs, in particular for the design of the MAC protocol for use of shared media.

ETS 300 795 [94] deals with ongoing work on performance requirements for call processing and bearer management for narrowband access networks with V5 interfaces.

EN 50083-7 [137] details system performance requirements for distributive cable TV networks. EN 50083-10 [140] deals with the system performance of return channel transmission in cable TV networks and describes associated measurement techniques.

IEEE802.14/94-002R3 [149] gives detailed performance requirements for the evaluation of cable TV network PHY/MAC proposals in IEEE project 802.14. These include traffic parameters, delay, error rate and cell loss requirements for synchronous and asynchronous services.

5 Analysis of the current activities

The above overview of existing standards and ongoing activities illustrates the fact that traditionally separate industries are indeed converging and in particular on the provision of access to services for end-users i.e. on access networks. This subclause identifies areas of synergy between these ongoing standardization activities as well as areas where there is divergence that ought to be addressed in the interest of the harmonious development of the EII. Recommendations on how to address these areas of synergy and divergence are left to the final clause of this report.

5.1 Reference models and terminology

As every group adapts the reference models and terminology of other groups for its own purposes it becomes more and more difficult for the users of access standards - as opposed to the developers - to understand the relationship between different specifications. An effort to harmonize models and

terminology at least within Europe would be in order, and not just to satisfy the engineering mind. As access network interfaces are of considerable regulatory interest, well defined terms are also supportive for an unambiguous harmonized regulatory regime.

Figure 1 shows the reference models that are used in ETSI, the ITU-T, the ATM Forum and in DAVIC 1.0. The figure highlights the different terms that are used and their relationship. It should be noted that there is less resemblance between the models than one would think at first sight; this is due to differences in interface and functional definitions.

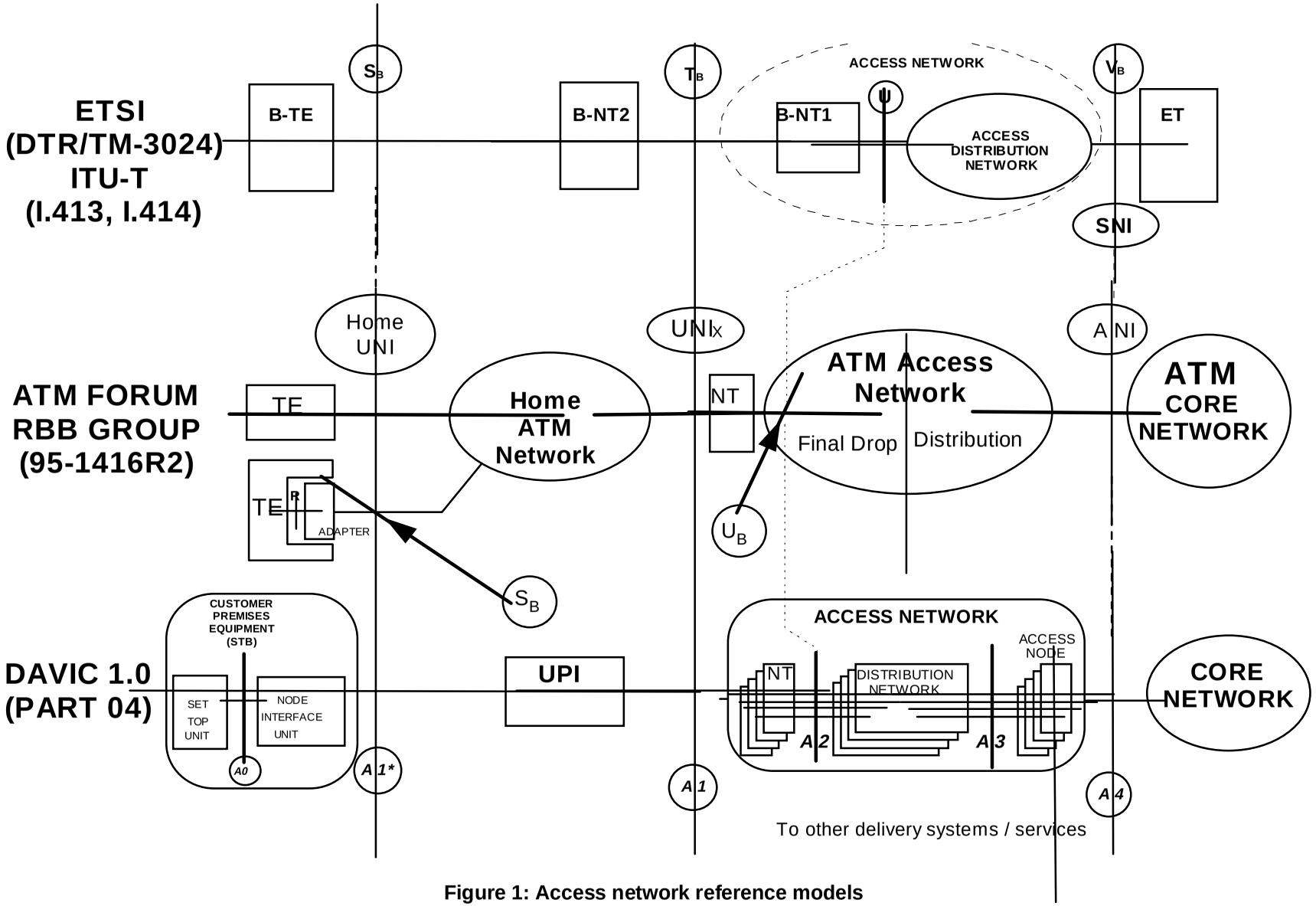

Figure 1: Access network reference models

5.2 Separate versus embedded NTs

One of the more controversial issues, usually debated in the context of AN reference models, is the way that the AN is terminated at the customer premises. There are two aspects to this debate. One is the operational desire to have a well defined boundary of the AN operator's responsibility for quality of service and maintenance (see also subclause 5.8). A separate NT satisfies this requirement; the downside however is the associated costs. The other aspect is one of technical feasibility. Depending on the assumptions that are being made about home wiring and sources of interference, the characteristics of the wiring within a home, if used as a direct extension of the outside line plant, may well constrain the bitrate/distance that can be achieved over the existing line plant. Co-ordination between ETSI STC TM6 and CENELEC on the characteristics of home wiring systems is required to lead to a consistent set of assumptions.

5.3 Physical layer modulation techniques

The advent of digital encoding in combination with the processing power of the latest integrated circuit technologies have led to a revival of sophisticated modulation techniques for application in access networks. Although every medium has its own peculiarities there is more synergy between the modulation techniques than one would suspect from the names they are given. A mechanism for exchange of information on the specification and testing of new modulation techniques would benefit the industry.

5.4 Medium Access Control (MAC) layer

The use of a shared medium is a given in the wireless business, but is also pursued for wired media as a possible avenue to provide high peak capacity to individual residential end-customers at reasonable cost. Like the physical layer, MAC protocols tend to be optimized for the intended medium, but face many common challenges. A good example of a cross-media application is a proposal put forward to DVB to use the DECT MAC protocol for narrowband services over cable TV networks. Co-ordination between groups working on MAC protocols is desirable for two reasons:

1) it is highly desirable to make the upper sublayer of the data link layer independent of the MAC layer and thereby of the medium being used. This requires co-ordination on the interface that the MAC layer is offering to higher layers with the objective to define a superset of MAC capabilities from which specialized subsets can be selected for specific applications; and

2) although it seems unrealistic to expect consensus on a single MAC protocol for a particular medium it is of great interest to the industry and end-users that mechanisms are established that allow for co-existence of simple low-cost and more sophisticated MAC protocols on the same network. This way early obsolescence of simple implementations to allow for end-customers that require a richer set of communication capabilities can be avoided.

5.5 ATM over shared media

The current status of ITU-T Recommendations does not exclude the use of dynamic allocation of VP capacity, but leaves many aspects for further study. The working assumption in ETSI STC SPS3 for the development of VB5.1 is that VP capacity is statically provisioned at the interfaces to ATM access networks. An access network in which VP resources are static throughout the AN, would not allow ATM to take full advantage of a shared medium. This may be a disadvantage for VBR and ABR type services in an environment where native ATM may have to compete with ISO/IEC 8802 [157] based solutions. The restrictions which apply to VB5.1 do not apply to VB5.2. A common approach to the use of ATM over shared media is urgently required because of the multitude of ongoing standardization activities that deal with shared media: wireless ATM in ETSI STCs RES10 and TM4, ATM-PON in STC TM3 and ATM over cable TV networks in DAVIC and IEEE P802.14.

5.6 UMTS

UMTS is one of those abbreviations in the business where despite years of discussion there is still no widespread consensus on what it means. Looking only at the transport aspects there does appear to be some consensus that at the beginning of the next century, when UMTS is expected to be introduced, there will be a need for an air interface definition which supports terminal mobility in combination with "bandwidth on demand". The latter beyond the bit-rates that can realistically be offered on a large scale by DECT or GSM. Co-ordination on such a third generation air interface between Technical Committees SMG, RES and TM is desirable, notwithstanding the fact that the market will offer room for systems with

non-standardized air interfaces as well, for which standards should only support co-existence in certain bands.

5.7 Performance requirements

There is an unfortunate tendency for performance standards to be addressed after functional standards have been completed. Because of the many ongoing functional standards activities there is a dire need for co-ordination to establish a general performance framework for access networks.

5.8 Physical layer maintenance

The trend in recent access network architectures to avoid a separate network termination equipment at the customer premises by using a "U" type rather that an "S/T" type UNI, cannot be ignored from a maintenance perspective. Also with "U" type interfaces the access network operator will require sufficient maintenance capabilities to maintain his network at low cost. This means that facilities for loop backs, remote alarming, performance monitoring and fault diagnostics in general continue to be required, also when the actual transmission section termination function is integrated in an end-user owned STU. An overview document of physical layer operations and maintenance requirements for specific access technologies would be of assistance to ensure that the extensive experience in this area is taken into account.

5.9 Technology Independent Interface (TII)

The need for a TII is a common threat in many access standardization activities, but so far progress in this area is limited. From an EII/GII perspective a co-ordination activity to document a superset of capabilities at the TII is highly desirable to de-couple innovations at the access network physical and MAC layers from higher layer developments.

6 Recommendations

From this overview of access network standards developments it is clear that there is overlap between activities from different groups, or to put it more positively that the same items are tackled from different angles. This is to be expected in a highly competitive environment and something that an access network co-ordination project should accommodate. The main added value of a project is to put the different activities in context and to provide a kind of "directory service" to both developers as well as the users of access standards. In view of this two types of recommendations are drawn from the material in this ETR: project recommendations that deal with the core activities of the co-ordination project itself and area recommendations that highlight existing or desirable collaboration for specific subject areas.

6.1 Project recommendations

1) A small access network project team should be established in the context of the overall EII project. This team, consisting of representatives of ETSI, CENELEC, DVB, DAVIC, ATM-Forum and IEEE 802-14, should provide a "directory service" to existing standards and ongoing standardization activities. It should highlight areas of overlapping work and, perhaps more important, gaps in existing workplans;

2) this ETR should be maintained and enhanced as part of the access network project, as a starting point for the directory service mentioned above; and

3) this ETR should be made available on the ETSI server with as many hyperlinks as possible to the references contained in this ETR. Mutual visibility and accessibility of information is the most basic requirement to foster synergy between the activities of different groups.

6.2 Area recommendations

1) **Reference models and terminology:**

Harmonization of existing access network reference models and terminology should be pursued. Within ETSI this expertise is within STC TM3 WG2, which should be invited to carry out this work in co-operation with all other groups working in the field, in particular ITU-T SG13.

2) **Separate versus embedded network terminations:**

The transmission performance aspects of the location of the Network Termination function should be considered by ETSI STC TM6 in close consultation with CENELEC Technical Committee 205 on the characteristics of home wiring. The maintenance aspects are covered under recommendation 6.

3) **Wireless access networks:**

Wireless Local Loop standards should be considered as, may be, the first step towards UMTS and therefore, regulatory aspects such as licence regimes and frequencies should be managed in a co-ordinated manner by the RES RPM group.

The ETSI RLL co-ordination group that has recently been set up will act as the focal point for wireless access network standardization activities. Based on its interim report, expected in June 1996, the scope of this group with respect to broadband wireless access has to be evaluated.

4) **ATM over shared media and medium access control:**

To de-couple the development of MAC protocols for shared media from the ATM layer, a generic interface definition is required between MAC and ATM layers. STC NA5 should be invited to take initiatives in this field in close co-operation with DVB, RES10, SPS3, TM3 and TM4 and taking due account of work in this field in the RBB group of the ATM forum.

5) **Performance requirements:**

Despite the obvious need there is no ongoing activity to elaborate a general performance requirements framework for access networks. STCs TM3, TM2 and NA4 should be invited to initiate a joint activity in this field. CENELEC Technical Committee 209 should be involved in this work for the performance requirements for cable TV networks.

6) **Physical layer maintenance requirements:**

The potential introduction of shared medium access arrangements and "U" type UNIs requires careful analysis of the associated maintenance requirements. STCs TM3, TM2 and NA4 should be invited to study the maintenance and management requirements for these architectures.

7) **Technology Independent Interface (TII):**

The TII is an interface internal to a STU or desktop intended to de-couple physical layer termination aspects from higher layer functions. It is of prime importance to any STU standardization activity and therefore co-ordination of the TII activities should be carried out under EII project 4.2, which concerns itself with the STU.

History

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