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Technical Report

Generic Programmable Communication Interface (PCI) for multimedia applications; Identification of PCIs needed

European Telecommunications Standards Institute

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Contents

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Foreword

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1 Scope

The term PCI stands for Programmable Communication Interface, sometimes also referred to as Programming Communication Interface. A PCI presents a specialized Application Program Interface (API) that is related to the communications aspects of software.

The present document deals with the requirements of PCIs for multimedia applications, i.e. digital applications that combine independent isochronous and asynchronous media types together. Multimedia applications can be interactive or not. They may use and/or present different types of media either in context, or simultaneously or in loose conjunction with each other. Different types of applications and different types of media like audio, video, voice or images, impose different requirements onto the terminal equipment and the underlying communications networks. The impact of those applications and media, and the abilities of the communications networks are studied thoroughly. The demands of the (human) users are considered carefully. The present document analyses the different requirements by applying different viewpoints, which illuminate the viewpoint-specific impacts and demands. The summary of the results form a general list of requirements for PCIs for multimedia applications. Those requirements are then compared against existing PCIs. As result a detailed list of requirements for each type of PCI is obtained. Moreover, the present document structures the existing and future PCIs in accordance with existing PCI models and discusses briefly the need for future extension or creation of specific PCIs.

The general title of the present document reads "Generic PCI for multimedia applications". Since this title might mislead the reader in the sense that possibly one - and only one - PCI might exist that covers all the applications needs, the reader should note that the complexity of multimedia applications disallows this approach. Several - in nature completely different - PCIs will be needed to cover the world of multimedia applications. This becomes even more apparent, if it is considered that future multimedia applications will probably extend to run in new kinds of terminal equipment that is not even yet available.

The present document identifies the Programmable Communication Interfaces (PCIs) needed for today and future multimedia aware applications. It points out:

- what kind of PCIs are needed;
- what kind of features those PCIs shall provide;
- what kind of suitable PCIs are already defined (or standardized) by standardization bodies;
- how existing definitions of those PCIs should be extended to cover the needs of multimedia aware applications.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

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Part 7: Raster graphics content architectures.
Part 8: Geometric graphics content architectures.
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3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document the following definitions apply. In case the definition is taken from another source, the reference to the source is indicated in square brackets at the end of the definition.

asynchronous: Unrestricted transmission delay for each message [93].

isochronous: Constant transmission delay for each message [93].

NOTE: The official ITU definition is much more complicated and can be found in [92]:

isochronous: Pertaining to a signal or a time-varying phenomenon characterized by significant instants separated by time intervals having a duration theoretically equal to the duration of a unit interval or to an integral multiple of this duration.

medium: A means by which information is perceived, expressed, stored or transmitted [3].

multimedia application: A digital application that combines independent isochronous and asynchronous media types together. The multimedia application can be interactive or otherwise.

multimedia: The property of a piece of information, an application, a user equipment, to handle several types of data [3].

provider: The abstract entity that offers one or more (tele-)communications services [9].

synchronous: Bounded transmission delay for each message [93].

user: The abstract entity of a communication system that uses one or more (tele-)communications services [9].

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAL	ATM Adaptation Layer
ADSL	Asymmetrical Digital Subscriber Line
API	Application Program Interface, sometimes also referred to as Application Programming Interface
ATM	Asynchronous Transfer Mode
AVI	Microsoft Audio Video Interleaved
B-ISDN	Broadband Integrated Services Digital Network
BFT	Binary File Transfer
BMP	Windows Device-Independent Bitmap
CAD	Computer Aided Design
CATV	Community Antenna TV or Cable TV
CBDS	Connectionless Broadband Data Service
CD	Compact Disc
CD-ROM	Compact Disc - Read Only Memory
CGM	Computer Graphics Metafile
CODEC	Coder-Decoder
CSPDN	Circuit-Switched Public Data Network
DAVIC	Digital Audiovisual Council
DCE	Data Communications Equipment
DCT	Discrete Cosine Transform
DSM-CC	Digital Storage Media Control Command
DTMF	Dual Tone Modulation Frequency
DTAM	Document Transfer and Manipulation
DTAM-BT-NM	Document Transfer and Manipulation - Bulk Transfer - Normal Mode
DTE	Data Terminal Equipment
DVB	Digital Video Broadcasting
DVI	Intel Digital Video Interactive
ETR	ETSI Report
ETS	European Telecommunications Standard
FDDI	Fibre Distributed Data Interface
FR-SSCS	Frame relaying service specific convergence sublayer
FTAM	File Transfer, Access and Management
FTP	File Transfer Protocol
GCC	Generic Conference Control
GIF	CompuServe Graphics Interchange Format
GSM	Global System for Mobile communications
HCI	Human Computer Interface
HDSL	High bitrate Digital Subscriber Line
HDTV	High Definition Television
HTML	Hyper Text Markup Language

HTTP	Hyper Text Transfer Protocol
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IMTC	International Multimedia Teleconferencing Consortium
IP	Internet Protocol
IPX	Internetwork Packet eXchange protocol (Novell Inc.)
IPng	Internet Protocol Next Generation
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ITU-T	International Telecommunications Union - Telecommunications sector
JPEG	Joint Photographic Experts Group
JBIG	Joint Bi-level Image Experts Group
LAN	Local Area Network
LLC	Link Layer Control
MAC	Media Access Control
MAN	Metropolitan Area Network
MAPI	Messaging Application Programming Interface
MCS	Multipoint Communications Service
MCU	Multipoint Control Unit
MHEG	Multimedia and Hypermedia Experts Group
MHS	Messaging Handling System
MIDI	Musical Instruments Digital Interface
MIME	Multipurpose Internet Mail Extension
MJPEG	Moving JPEG
MBFT	Multipoint Binary Filetransfer
MPEG	Moving Picture Experts Group
N-ISDN	Narrowband Integrated Services Digital Network
NDIS	Network Device Interface Specification
ODA	Open Document Architecture
ODI	Open Datalink Interface
OS	Operating System
OSI	Open System Interconnection
PBX	Private Branch Exchange
PCI	Programmable Communication Interface, sometimes also referred to as Programming Communication Interface
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
POTS	Plain Old Telephone Service
PSPDN	Packet-Switched Public Data Network
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RFC	Request For Comment
SBV	Syntax-Based Videotex
SCF	Synchronization and Convergence Function
SGML	Standard Generalized Markup Language
SMDS	Switched Multimegabit Data Service
SPI	Service Provider Interface
SPX	Sequenced Packet eXchange protocol (Novell Inc.)
SSL	Secure Sockets Layer
TAPI	Telephony Application Programming Interface or TRIBUNE Application Programming Interface
TCP	Transport Control Protocol
TIA	Telecommunications Industries Association
TIFF	Tagged Image File Format
TSAPI	Telephony Services Application Programming Interface
UNI	User Network Interface
URL	Uniform Resource Locator
VDSL	Very high bandwidth Digital Subscriber Line
VEMMI	Videotex Enhanced Man-Machine Interface
VoD	Video on Demand
WAN	Wide Area Network

WAV	Windows audio WAVeform file format
WMF	Windows MetaFile
WOSA	Windows Open System Architecture
WWW	World Wide Web
XAPI	eXtensive Application Programming Interface
X/OPEN	the X/Open Company, Ltd.

4 Reader's guideline

The creation of the present document was facilitated by the existence of several recommendations, reports or surveys from various sources that present multimedia models and summarize different aspects of multimedia applications To guide the reader quickly through the most important sources for the present document, a (non-exhaustive) list of the documents providing those overall aspects is given in table 1.

Table 1: Documents dealing with overall aspects of multimedia applications

Document	Reference	Title
ITU-T Recommendation I.211	[15]	B-ISDN service capabilities
ETR 173	[5]	Functional model for multimedia applications
ETR 181	[8]	Multimedia Portfolio; A compilation of multimedia applications and services provided by ETSI members
ETR 227	[64]	Multimedia Applications and Services; Inband and outband signalling protocols; A survey
ETR 296	[30]	Multimedia; Standardization areas to be covered

The remainder of the present document is structured into four logical sections as shown in table 2.

Table 2: Logical sections of the present document

Section	which comprises…	that…
1st logical section	clause 5 (5 Methodology)	…presents the description of the methodology chosen,
2nd logical section	clause 6 (6 PCI aspects)	…briefly introduces the PCI model and summarizes existing and future PCIs that are under development,
3rd logical section	clause 7 (7 Summary of results)	…contains the "**management summary**", i.e. the summary of the results obtained,
4th logical section	clauses 8…13	…holds the detailed information, requirements and demands that lead to the results summarized in clause 0.

5 Methodology

For the purpose of the present document it is essential to apply a methodology that ensures a complete analysis of requirements and demands put onto PCIs for multimedia applications.

Since the world of multimedia applications is complex, the present document cuts it down into manageable pieces. Different viewpoints are applied to the terminal equipment that runs the multimedia applications. Like in a beam of a torch the viewpoints are illuminated and the specific requirements are isolated. Figure 1 depicts this method and shows the viewpoints applied. Because the material used is huge and wide spread, it is a fair hope that all the important aspects of multimedia applications are considered.

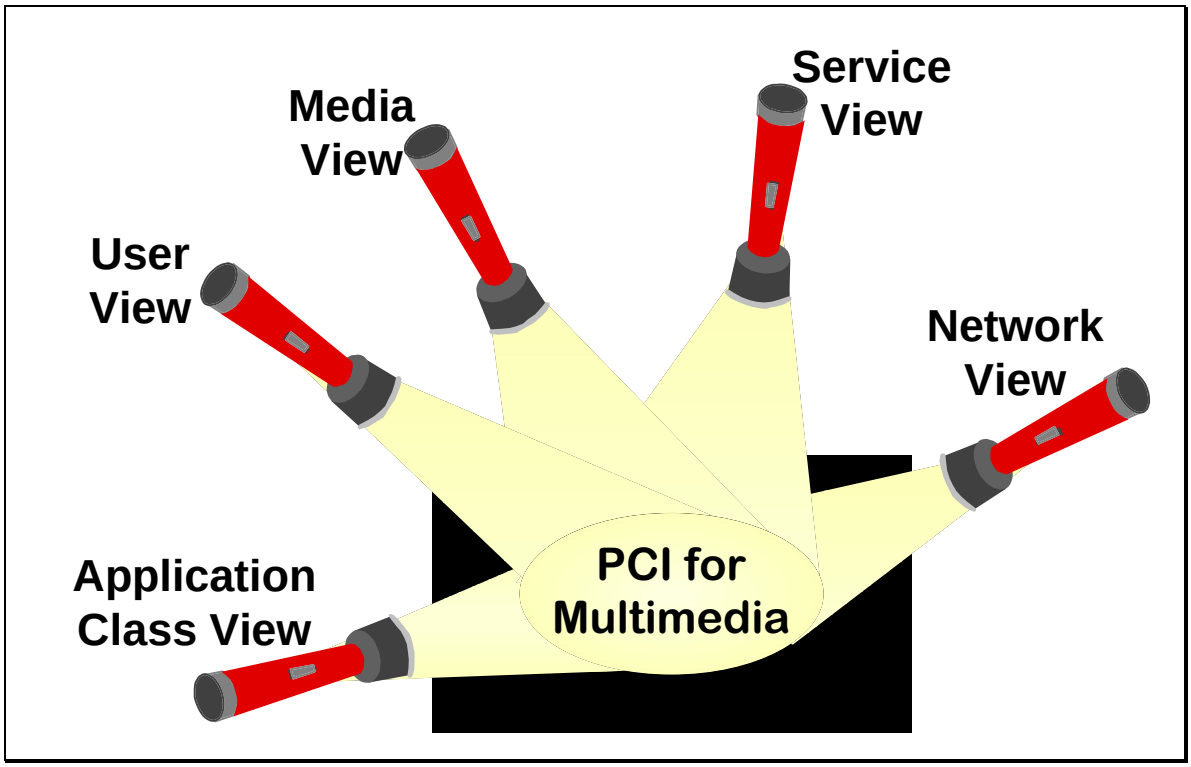


Figure 1: Viewpoints applied to structure requirements of the PCI for multimedia applications

5.1 Application class view

Multimedia applications are structured into classes. The individual requirements of each application class are isolated and studied. Clause 8 presents the application class view in detail.

5.2 User view

Users of multimedia applications belong to one of these three classes: information producer, information manager and information consumer. Clause 9 presents the user view in detail.

5.3 Media view

The transport, coding and synchronization aspects of the possible media are studied. The requirements imposed are filtered out and analysed. Clause 10 presents the media view in detail.

5.4 Service view

Multimedia application specific services, such as teleconferencing or other multipoint control services are studied and the requirements are carefully pondered. The consideration of the service view takes most attention, since implementations are rare and thorough experience with this new kind of services is not yet widely available. Clause 11 presents the service view in detail.

5.5 Network view

Existing and prospected networks and architectures are summarized. From this, requirements regarding parameters for controlling and accessing the communications network are derived. Clause 12 presents the network view in detail.

6 PCI aspects

6.1 PCI model

The present document regards a PCI as a sort of API, located within a terminal equipment that deals with the communications aspects of an application. For multimedia applications the definition of the term PCI needs careful consideration. At a first glance, two interpretations seem possible:

1) the definition of the PCI describes communications network and communications hardware related issues, of course considering special conditions of the specific environment like synchronization of data streams and bandwidth requirements. Those PCIs are called network related PCIs;

2) the definition of the PCI is oriented towards the user's application and tries to encapsulate and to encompass the communications aspects of the software. Such a PCI is (telecommunications) service related rather than network or protocol related. In some cases it might cover even several, distinct services. Those PCIs are called application related PCIs.

For monomedia environments, theses interpretations are well known. They are discussed in ITU-T Recommendation F.581 [2] and in ETR 368 [9].

In terms of the OSI Model (ITU-T X.200 Series of Recommendation):

- a network related PCI could be said to cover OSI layers 1-3, preferably offering the interface on top of layer 3 (network layer);

- an application related PCI could be said to cover OSI layer 7 (and the layers below), offering the interface somewhere within layer 7.

The characteristics mentioned cannot be used carelessly. Firstly, some data communications are not conforming to OSI at all (e.g. ITU-T Recommendation T.30); secondly, some applications might need to circumvent OSI layers because of performance or bandwidth demands.

Especially in multimedia environments, a third type of PCI can be identified. This type is dealing with transport and presentation protocols and is furthermore concerned with the internal communication of the modules related to multimedia presentation and interaction. For the purpose of the present document, those PCIs are called (transport and presentation) protocol related PCIs. In terms of the OSI Model, they can be said to be located between layer 3 and 7.

The three modelled types of PCIs are depicted in figure 2.

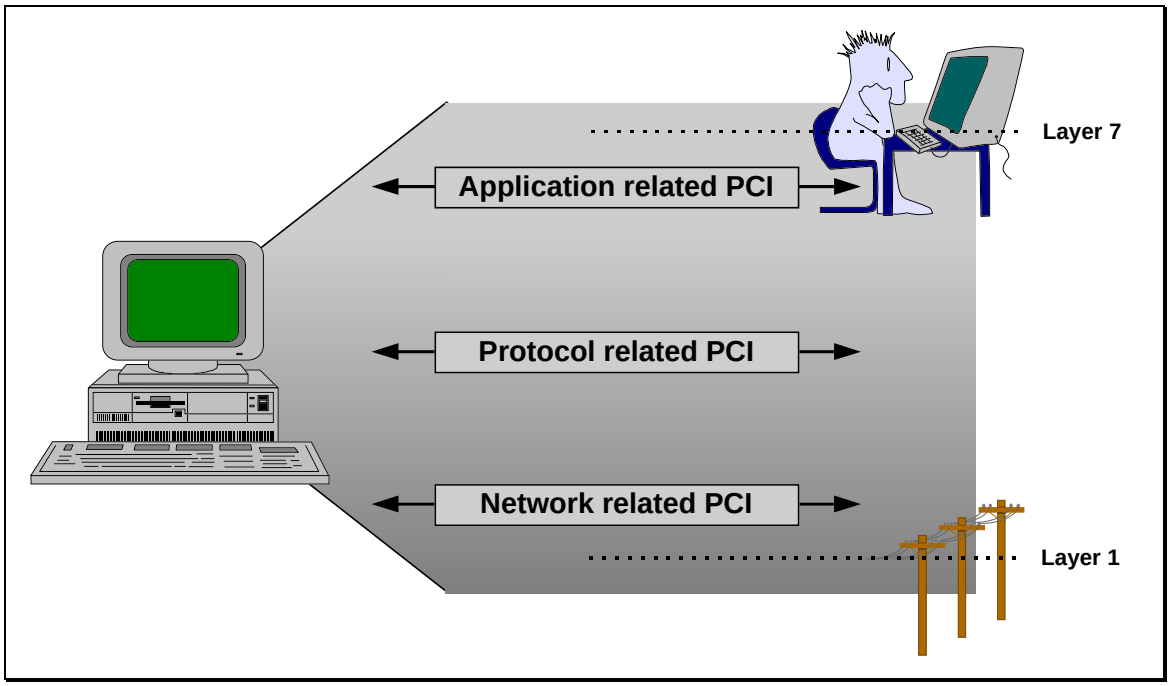


Figure 2: PCI types modelled

6.1.1 Application related PCIs

PCIs related to application aspects provide an interface that allows applications to access one or several communications services independently of an underlying network. Here the PCI fulfils at least two requirements:

- it hides the network and abstracts the access to it;
- it provides for easy access of a communications aware application in a way that minimum knowledge about the communications peculiarities is needed by the application.

An example of such a PCI is ETS 300 243-1 [10] that provides access to several telematic services independent of the underlying network.

6.1.2 Network related PCIs

PCIs related to network aspects provide access to hardware that connects the terminal equipment to the network. It is clear that such an interface, and the PCI provided by that interface, has to fulfil certain requirements like:

- ability to support all or most capabilities the network provides;
- ability to allow data and control transfer at full speed the network is capable of;
- ability to shelter the network from unqualified access, i.e. access that could harm the network operation.

An example of such a PCI is ETS 300 325 [12], which defines a PCI for access to Euro-ISDN and to the hardware providing that access.

6.1.3 Protocol related PCIs

Protocol related PCIs are concerned with internal communication of the modules related to multimedia transport, presentation and interaction. Such PCIs ideally have the following abilities:

- they provide unified access to certain network services;
- they provide transportation of all network specific parameters;
- they account for signalling peculiarities of specific networks.

Protocol related PCIs do not necessarily appear to the application as a "complete" interface covering all application needs. They rather provide access to certain aspects of the communication, but this in a way that abstracts underlying hardware access.

An example is the IMTC MCU API defines access to a Multipoint Control Unit (MCU) for teleconference applications. Another example is the forthcoming definition of the eXtensive Application Programming Interface (XAPI) [73] that is suited for teleconferencing and corporate document handling applications.

6.2 Commonalties of PCIs

The following issues are general and common to all kind of PCIs:

- PCIs have local impact only;
- use of a standardized PCI is not necessary to participate in a communications service;
- any approach taken to define a PCI can be suitable, as long as the basic requirements of the communications service are respected.

6.3 Existing PCIs

Several PCIs already exist for monomedia or telematic services. To a certain extent these PCIs are also capable to transport multimedia information. An example is the Winsock interface [65], a protocol related interface that makes available the sockets interface RFC 147 [82] for the TCP/IP protocol stack RFC 793 [62] and RFC 791 [63].

The PCIs considered by the present document are listed in table 3.

Table 3: List of existing PCIs considered

Name/Title	Primary source	Additional sources	Type	Description
Facsimile Class 1 interface	TIA TR29 EIA/TIA-578 [75]	ITU ITU-T Rec. T.31 [76]	network related	DTE-DCE interface for control of facsimile communication (ITU-T Rec. T.30) within a Modem
Facsimile Class 2/Class 2.0 interface	TIA TR29	ITU ITU-T Rec. T.32 [77]	network related	DTE-DCE Interface for control of facsimile communication
ETS 300 325 Ed.2 [13] + ETS 300 325 [12]	ETSI	--	network related	N-ISDN interface
WinISDN [14]	Microsoft	--	network related	N-ISDN interface
NDIS	Microsoft	--	network related	Network Device Interface Specification for the Windows operating system
ODI	Novell	--	network related	Open Datalink Interface for the Novell environment
Sockets Interface [82]	BSD	X/OPEN	protocol related	Interface for access to TCP/IP protocol stack
WinSock 2 Application Programming Interface [65]	Intel, Microsoft, Stardust	--	protocol related	Interface for access to various protocol stacks
WinSock 2 Service Provider Interface [66]	Intel, Microsoft, Stardust	--	protocol related	Service Provider Interface for provision of various protocol stacks
XAPI [73]	ITU ITU-T Draft T.XAPI	DAVIC	protocol related	eXtensive API; Teleconference and Corporate Document Handling transport interface
IMTC GCC API [71]	IMTC	--	protocol related	IMTC Generic Conference Control interface
IMTC MCS API [72]	IMTC	--	protocol related	IMTC Multipoint Control Unit interface
ITU-T Rec. T.611 [11] (APPLI/COM)	ITU	ETSI ETS 300 243 [10]	application related	Operating system independent telematic interface
CMC v2.0 mail interface	Lotus, Microsoft	ITU ITU-T Draft X.434 [74]	application related	Operating system independent mail interface
MAPI [31]	Microsoft	--	application related	Mail interface for the Windows operating system
TAPI [32] (NOTE)	Microsoft	--	application related	Telephony interface for the Windows operating system
TSAPI	Novell	--	application related	Telephony Services API for the Novell environment
NOTE: TAPI also stands as acronym for the TRIBUNE Application Programming Interface [33] that is described in subclause 6.3.3.3.				

6.3.1 Network related interfaces

6.3.1.1 Facsimile Class 1, Class 2 and Class 2.0 interface

The interfaces considered are concerned with facsimile group 3 control and binary file transfer (BFT, ITU-T Recommendation T.434 [23]) only.

The facsimile Class 1 interface [75, 76] defines the control procedures to be applied to the data communications equipment (DCE) to manipulate the facsimile protocol (ITU-T Recommendation T.30) and the data transfer. The handling of the ITU-T Recommendation T.30 protocol and the preparation of ITU-T Recommendation T.4 images must be carried out by the data terminal equipment (DTE) entirely.

Facsimile Class 2 interface and the Class 2.0 interface [77] assume that the manipulation of the facsimile protocol is entirely performed within the DCE. Only the preparation of the T.4 images is left to the DTE. Consequently,

programming the Class 2 (Class 2.0) interfaces is carried out in a easier way, relieving the programmer of critical timing considerations.

6.3.1.2 ETS 300 325 and ETS 300 325 edition 2

ETS 300 325 [12] and ETS 300 325 Edition 2 [13] provide access to ISDN. The PCI is designed in an operating system independent way. Mappings to popular operating systems are provided in the standard. Typically, the interface is provided directly or indirectly by the hardware implementation, i.e. the ISDN card, in the operating system compliant way.

ETS 300 325 [13] is, by definition, restricted to access to Euro-ISDN, whereas the successor, edition 2 of ETS 300 325 - the harmonized PCI for ISDN - provides access to ISDN in general, including national variants and Private Branch eXchanges (PBXs).

Currently both definitions provide access on top of OSI layer 3, being able to select and support various layer 3 and layer 2 protocols for the user channels (B-channel). The access to signalling is aiming to N-ISDN, using ITU-T Recommendation Q.931 as guidance for that access.

A variant (one could say an implementation) of ETS 300 325 [13] is presented by the TRIBUNE Application Programming Interface [33]. The TRIBUNE application programming interface provides for access to B-ISDN, especially to the ATM adaptation layer.

Unfortunately, its acronym TAPI is also used for the much more known microsoft telephony API (see subclause 6.3.3.3). However, both PCIs should not be confused.

6.3.1.3 WinISDN

WinISDN [14] defines an interface to ISDN for the microsoft windows environment. Access to ISDN is achieved by provision of a dynamic link library (DLL) called "WinISDN.DLL". Like it is the case with ETS 300 325 [13], this DLL shall be provided by the provider of the ISDN-hardware, i.e. the ISDN card.

6.3.2 Protocol related interfaces

6.3.2.1 Sockets and winsock interfaces

The Berkley socket interface RFC 147 [82] has been defined early in the year 1971 for the unix environment. It defines an entity (a socket) through which IP packets can be exchanged.

The WinSock 2 interface definitions [65, 66], created by a consortium consisting of intel, microsoft, stardust and others, reuse the definition of a socket and provide a windows operating system dependent means to access various protocol stacks over various (communications) network platforms. Those protocol stacks and platforms comprise:

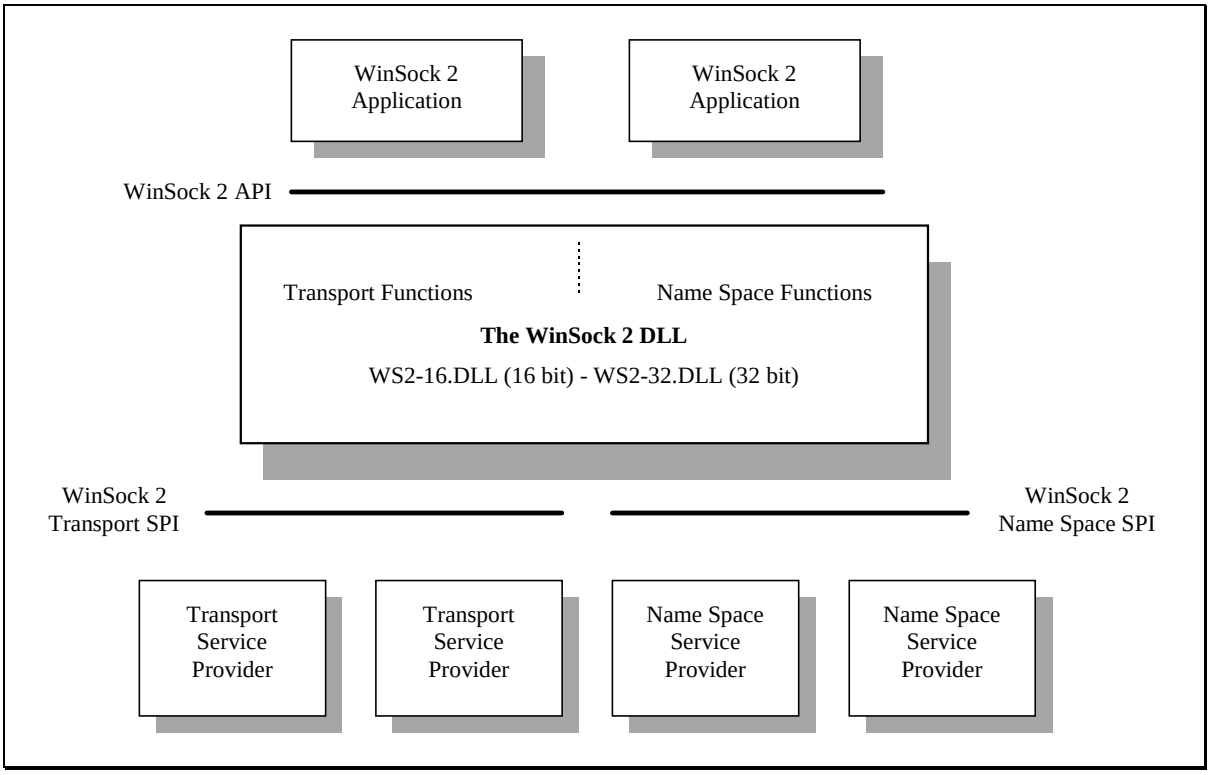
- TCP/IP protocols;
- Novell IPX/SPX protocols;(see Note)
- DECNet protocols;
- OSI protocols;
- Secure Sockets Layer protocol (SSL);
- wireless networks;
- ATM offering networks.

NOTE: IPX/SPX are the hardware independent lower layer protocols of the Novell NetWare LAN-based network operating system.

To achieve this independence, the winsock 2 specifications consist of three parts:

- the windows sockets 2 Application Programming Interface (API) [65];
- the windows sockets 2 Service Provider Interface (SPI) [66];
- the windows sockets 2 Protocol-Specific annex [67].

The relationship between these definitions and the winsock 2 architecture, which is compliant to the Windows Open System Architecture (WOSA), is depicted in figure 3.



NOTE: This figure has been taken from the Windows Sockets 2 Application Programming Interface [65]

Figure 3: WinSock 2 architecture

6.3.2.2 XAPI interface

The definition of the eXtensive Application Programming Interface (XAPI) [73] is an ongoing work that takes place in ITU-T SG8 Q1, Q8, Q10 and Q15. The primary goal of the XAPI is to provide a connection-oriented interface for teleconference and corporate document handling applications, as described in the ITU-T T.120 and T.190 series of Recommendation.

The mechanisms used in the XAPI are derived from the XTI API that has been defined by the X/OPEN group. However, XAPI is not just an extension of XTI. It rather uses the basic mechanisms of XTI for provision of a new interface for point-to-point and point-to-multipoint communications. Similar to the winsock 2 concept, it provides unified transport of data over various protocol stacks and (communications) networks.

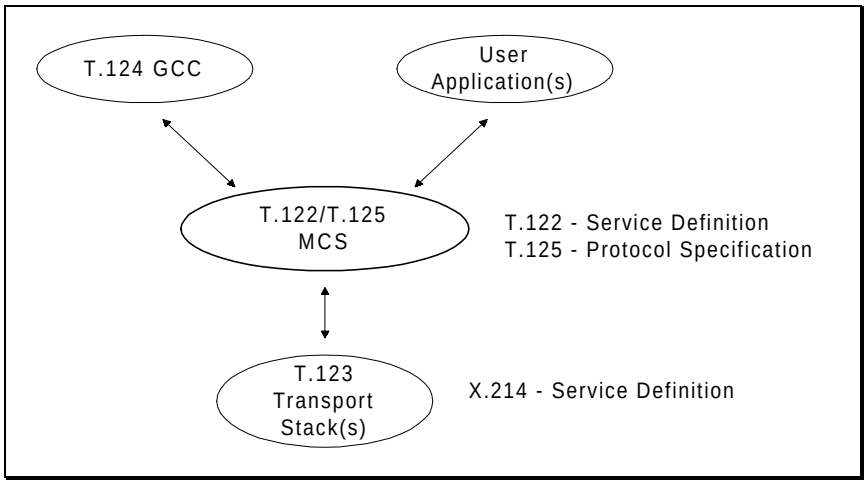
6.3.2.3 GCC and MCS interfaces

The GCC and MCS interfaces are provided by the International Multimedia Teleconferencing Consortium (IMTC).

The GCC interface presents an API for implementations of ITU-T Recommendation T.124 [19] for Generic Conference Control (GCC).

The MCS interface presents an API for implementations of ITU-T Recommendations T.122 [17] and T.125 [20] that are dealing with Multipoint Communication Services (MCS) and the related protocol.

Both interfaces are highly, but not exclusively, related to the windows operating system. The relationship of the APIs is shown in figure 4.



NOTE: This figure has been taken from the IMTC MCS API [72]

Figure 4: Relationship of GCC and MCS API

6.3.3 Application related interfaces

6.3.3.1 ITU-T Recommendation T.611 (APPLI/COM)

ITU-T Recommendation T.611 [11] and its ETSI version ETS 300 243-1 [10] present a uniform, high level interface for telematic services. Currently facsimile (group 3 and 4), telex, teletex, X.400 and file transfer services are covered. The PCI is designed in an operating system independent way. Mappings to popular operating systems are provided in the present document.

6.3.3.2 CMC v2.0 and MAPI interfaces

CMC v2.0 [74] and MAPI [31] present e-mail interfaces.

CMC, which stands for Common Messaging Call, is operating system independent and has also been adopted by ITU as ITU-T Recommendation X.434 [74].

MAPI presents the microsoft e-mail interface for the windows operating system.

6.3.3.3 TAPI interface

TAPI [32] stands for Telephony API and presents the Microsoft API for telephone applications under the Windows operating system.

There exists also another interface called TAPI [33]. There TAPI stands for TRIBUNE Application Programming Interface.

7 Summary of results

7.1 Requirements for PCIs in a multimedia environment

A multimedia environment may - and probably will - impose many APIs. However, the requirements for a PCI need to be focused on the communications aspects and demands of the multimedia environment. Derived from the demands listed in clause 0, tables can be computed that summarize the requirements dependent of the type of interface.

7.1.1 Requirements of network related interfaces

If applicable, a network related interface ideally supports the following features:

Table 4: Features supported by an ideal network related interface

Classification	Features	Importance
General aspects	• Operating system independence • Extendibility	
Connection type	• Connection oriented and connectionless • Point-to-point connection support • Point-to-multipoint connection support	
Information interchange	• Demand of bandwidth • Dynamic allocation of bandwidth • Support of synchronization • Support of flow control • Transparent exchange of objects • Multiplex capabilities • Transparent data compression	
Connectability	• Optional codec capabilities • Quality of service parameters (QoS)	
Security	• Authentication • Signature • Partial encryption	
Supplemental services	• Provision of charging information (Network) • Provision of charging information (Provider) • Support of network specific abilities	

7.1.2 Requirements of protocol related interfaces

If applicable, a protocol related interface ideally supports the following features:

Table 5: Features supported by an ideal protocol related interface

Classification	Features	Importance
General aspects	• Operating system independence • Extendibility	
Connection type	• Transport of connection oriented and connectionless parameters • Point-to-point connection support • Point-to-multipoint connection support	
Information interchange	• Transport information interchange specific parameters of underlying network interfaces	
Connectability	• Transport of codec parameters • Transport of quality of service parameters	
Security	• Transport of security related parameters	
Supplemental services	• Transport of charging and network specific parameters	

7.1.3 Requirements of application related interfaces

If applicable, a application related interface ideally offers the following features:

Table 6: Features offered by an ideal application related interface

Classification	Features	Importance
General aspects	• Operating system independence • Extendibility • Choice between transparent or hidden access to lower interfaces	
Connection type	• Hiding of connection type if possible	
Information interchange	• Hidden, internal allocation of bandwidth if possible • Hidden, internal support of synchronization if possible • Internal support of flow control • Transparent exchange of objects • Internal multiplex capabilities • Hidden data compression if appropriate	
Connectability	• Optional codec capabilities • Hiding of quality of service parameters (QoS) if possible	
Security	• Support of Authentication • Support of Signature • Support of Partial encryption	
Supplemental services	• Provision of charging information (Network) • Provision of charging information (Provider) • Provision of additional network specific abilities	

7.2 Additional considerations for PCIs in a multimedia environment

7.2.1 Consideration of bandwidth requirements

The flow rate of media streams that are consumed or produced by applications impose a major demand onto any PCI dealing with those streams. Hence the bandwith requirements - better said: the bandwith abilities - of any underlying network must be fulfilled by the PCI. This is true for any type of PCI, whether it is classified as network related, protocol related or application related.

As a guideline, the bandwith requirements imposed by various media are depicted in a logarithmic scale in figure 5.

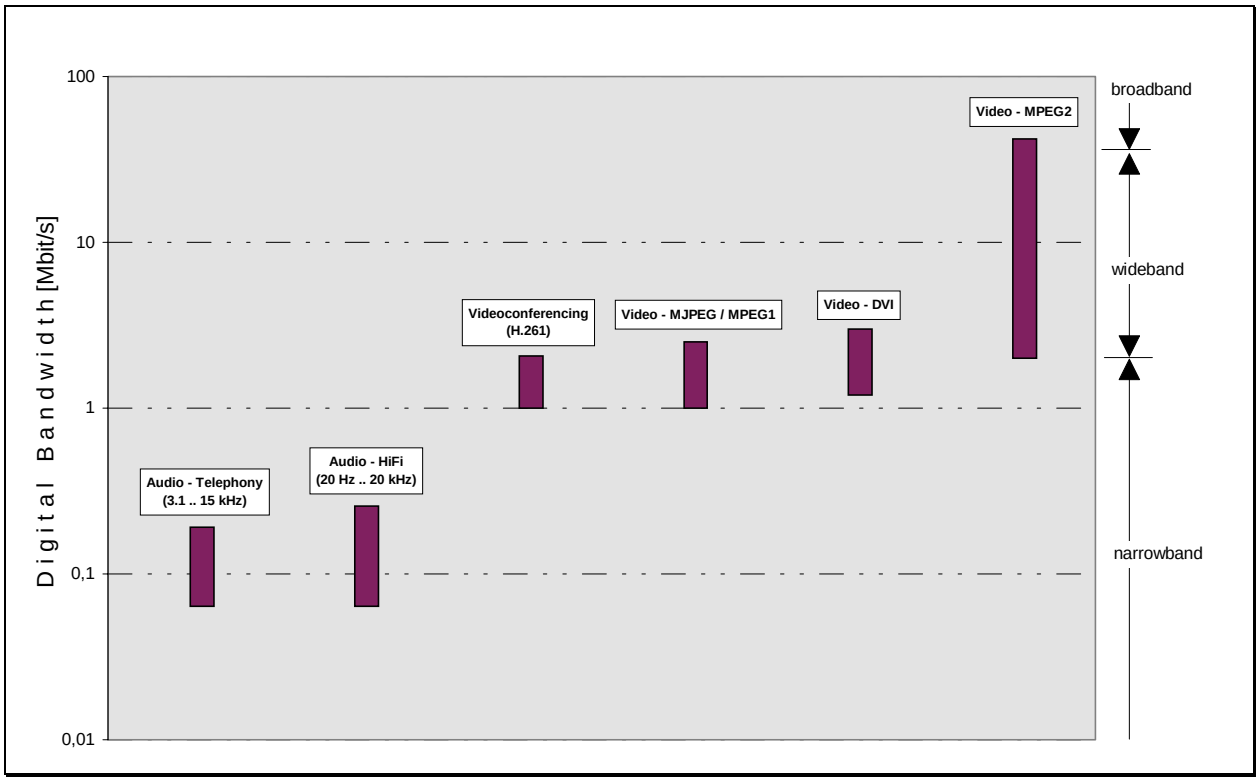


Figure 5: Digital bandwith requirements of various media

Common multimedia and monomedia application types together with an indication of the required bandwith are listed in table 7. The applications listed can be supported by many different network types but not all applications at all data rates are supported by all networks. For example, B-ISDN can support all applications at almost any data rate whereas N-ISDN can only support these same applications at a data rate up to the maximum of approximately 2 Mbit/s.

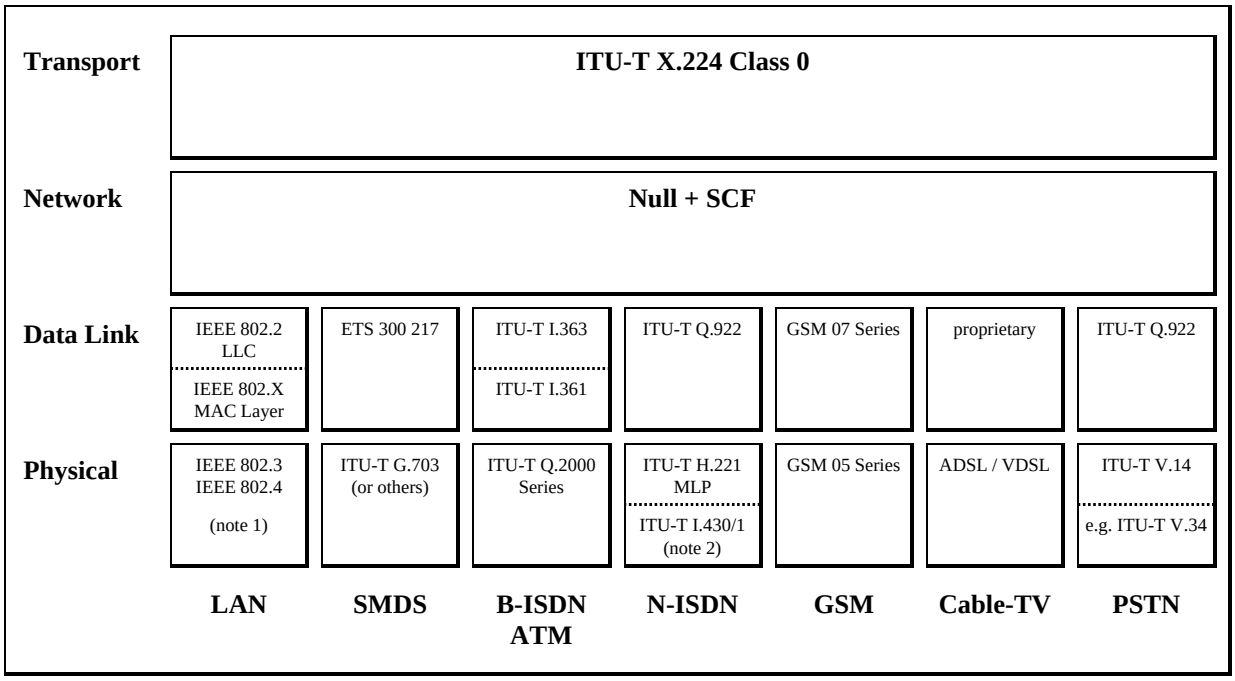
Table 7: Common monomedia and multimedia application types

Application type	Data rate (Mbit/s)	Typical application
Database Access	up to 2 2 - 10 over 10	Text & Simple Graphics Graphics Medical Images, CAD files
File Transfer	up to 2 2 - 10 over 10	Text, PC communication Graphics, Main Frame comm. Meteorology, Supercomputers
LAN Interconnect	up to 2 2 - 10 over 10	4 Mbit/s Token Ring Ethernet, 16 Mbit/s, Token Ring FDDI, 100 Mbit/s LANs
Still Image Communication	up to 2 2 - 10 over 10	Monochrome Colour High resolution (e.g. CAD/CAM)
Video & PC Conferencing	up to 2 2 - 10 over 10	Talking heads Small screen high quality Large screen high quality
Multimedia Networking	up to 2 2 - 10 over 10	Combinations of the above Combinations of the above Combinations of the above

7.2.2 Consideration of networks and protocol stacks

Figure 6 depicts the networks that should be considered when designing PCIs for multimedia environments (see also clause 0). It furthermore shows the user data protocol stacks for layers 1 and 2 (physical and data link layer) in conjunction with the OSI protocols for layers 3 and 4 (network and transport layers), that might be used in multimedia environments. In addition the use of X.25 PLP at layer 3 should be taken into account.

N-ISDN uses a separate channel in which to set up a call. For N-ISDN applications that require multiple links and/or channel aggregation (e.g. videoconferencing), control of call set-ups is also needed by the application through the PCI. For networks not requiring a separate call set-up, these PCI features will not be used. So in addition to the conclusions drawn when considering the application channels (user channels) of the mentioned networks, control of calls and channel aggregation shall be added to the functions of the PCI.



NOTE 1: IEEE 802.3 specifies Ethernet, IEEE 802.4 specifies Token Ring.
NOTE 2: ITU-T I.430 specifies ISDN basic access physical layer, ITU-T I.431 describes ISDN primary rate access physical layer.

Figure 6: Multimedia user data communication protocol stacks for various network types

When looking at the application protocol stacks for the above networks, various conclusions can be drawn. Layers 1 and 2 are always in line with the OSI reference model and consist of cells or frames in which data from layer 3 is inserted. There does not appear to be a generalised layer 3 and in some cases X.25 PLP is used here as a standardized link to higher layers. The generalised stack is shown in figure 7.

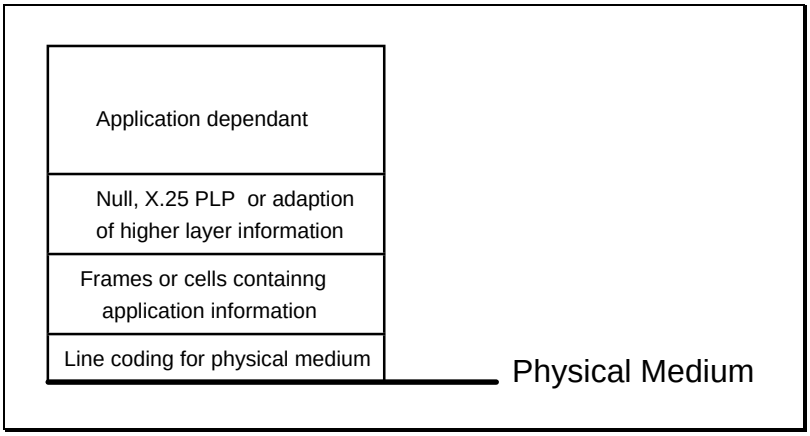
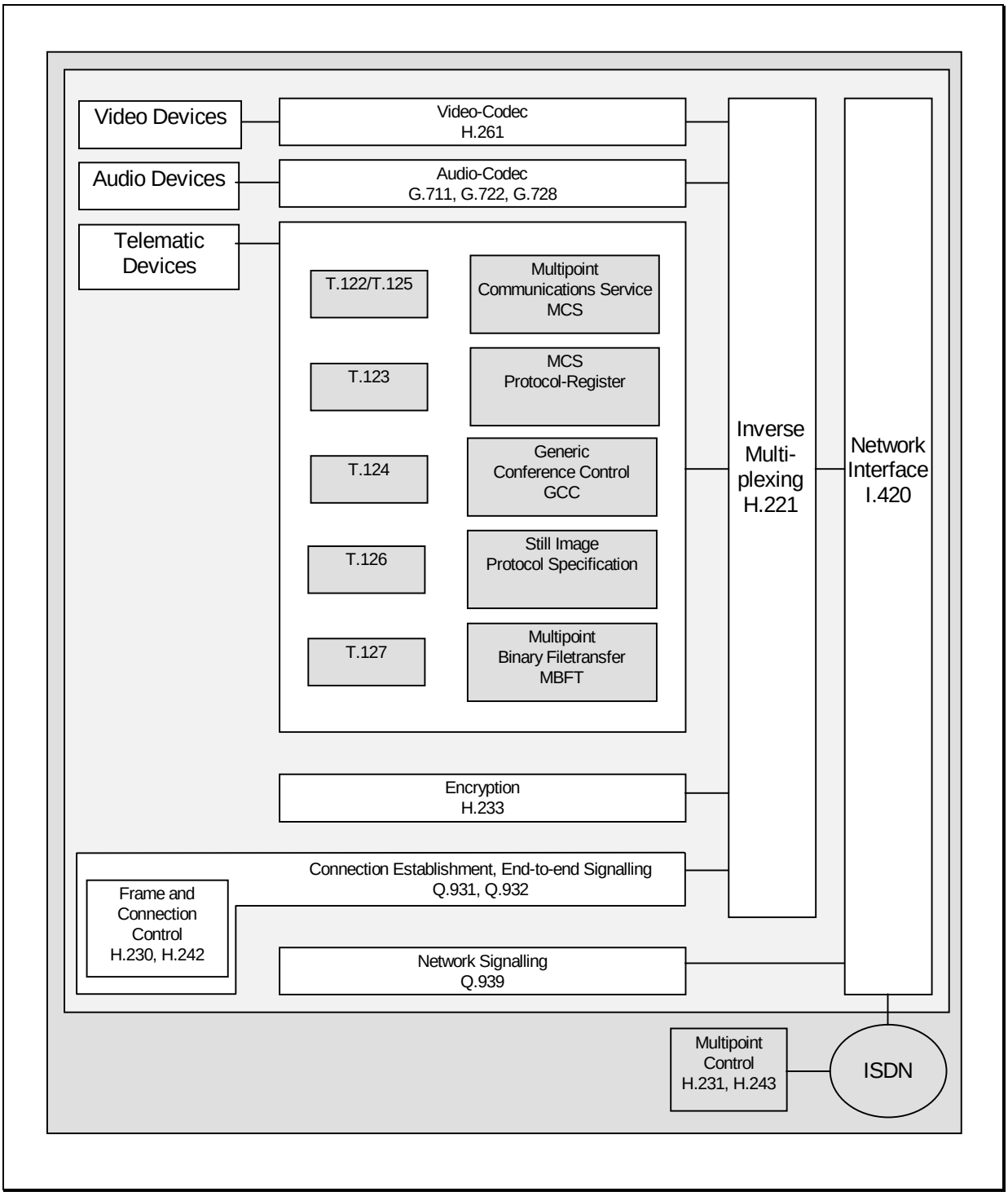


Figure 7: Generalised protocol stack

The dividing line between the application and the network varies from layer 2/3 (Frame Relay) upwards to layers 5, 6 and 7 (Internet). This clarifies that there cannot exist one standardized PCI for all (network related) aspects. The existence of one PCI only would suggest that the PCI must interface at different layers depending on the network type so that an application can be run over ATM, N-ISDN, Frame Relay etc., using the same interface primitives but would act at different layers in the network stack. In addition, specific control of calls and channel aggregation must be added to the functions of the PCI, which makes such an interface design rather complex.

7.2.3 Consideration of complex services

Certain new services, like videoconferencing, corporate document handling and other types of multipoint communications services are currently under development. Implementation of applications using these services are complex, because various components must play together. As an example of this complexity, a videoconferencing system for N-ISDN according to ITU-T Rec. 320 is depicted in figure 8.



NOTE: This figure is very much based on an article appeared in PC Professionell (German Edition) in 1995 [96].

Figure 8: N-ISDN visual telephone systems and terminal equipment according to ITU-T Recommendation H.320

At present time, most implementations of such complex services are monolithic, using however a sort of standardized network related PCI - sometimes with proprietary extensions - to access the network and to allow for channel aggregation.

Additional provision of a standardized (protocol related) transport interface for exchange of information between the components and provision of a standardized interface for access to the GCC and MCS components could possibly ease development of such complex systems.

However, if such interfaces are defined, the requirements should be considered:

- The transport interface should:
  - have a lean design;
  - provide fast information transport;
  - provide unique access for various components.
- The interface for access to the GCC and/or MCS should:
  - provide a good logical model for sequencing access to its functionality;
  - support basic and extended features;
  - be extendible, because standardization of such services is still ongoing;
  - hide communications aspects as much as possible.

7.3 Estimation of PCIs

Table 8 gives an overview of the PCIs that are currently standardized or that are under a standardization procedure of any kind. The "Rating" column shows the estimated usability of the PCIs for an multimedia environment.

Table 8: Fitness of present PCIs for use in a multimedia environment

Name/Title	Type	Rating
Facsimile Class 1 interface	network related	Does not cope with multimedia data streams.
Facsimile Class 2/Class 2.0 interface	network related	Does not cope with multimedia data streams.
ETS 300 325 [13] + ETS 300 325 [12]	network related	N-ISDN interface. Well suited for most cases. Has wide spread implementations (Ed. 2 only). Lacks support of channel aggregation, certain QoS parameters and is not yet optimized for very high bandwidth.
WinISDN [14]	network related	Competitor of the above. Not yet widely accepted, but might take over the lead in future. Lacks support of channel aggregation and certain QoS parameters, but supports H-channels. Reliability and versatility is not yet known, since the definition is still young.
Sockets Interface [82]	protocol related	Supports everything that can be transported with a TCP/IP protocol (everything). However, it is not built for high bandwidth and lacks certain QoS parameters.
WinSock 2 Application Programming Interface [65]	protocol related	Well suited. Supports many of the requirements of the present document. Provides also support of ATM protocol stack (AAL5).
WinSock 2 Service Provider Interface [66]	protocol related	Well suited. Service Provider Interface for provision of various protocol stacks
XAPI [73]	protocol related	Well suited for Teleconference and Corporate Document Handling transport (that is, what it is mainly defined for).
IMTC GCC API [71]	protocol related	Well suited, for what the name implies (Generic Conference Control interface)
IMTC MCS API [72	protocol related	Well suited, for what the name implies (Multipoint Control Unit interface)
ITU-T Rec. T.611 [11] (APPLI/COM)	application related	Does not cope with multimedia data streams.
CMC v2.0 mail interface	application related	Does not cope with multimedia data streams.
MAPI [31]	application related	Does not cope with multimedia data streams.
TAPI [32] (see note)	application related	Does not cope with multimedia data streams.
NOTE: TAPI also stands as acronym for the TRIBUNE Application Programming Interface [33] that is described in subclause 6.3.3.3.		

7.4 Conclusion

As shown in subclause 6.3.3.3 (and throughout other places of the present document) is apparent that more than one PCI, and more than one type of PCI, will be needed to cover the world of multimedia applications.

Since PCIs are local to terminal equipment, one might argue that the operating system manufacturers could provide those PCIs in a operating system convenient way. In fact, it is expected that exactly this will happen more and more in the future. However, since an operating system design naturally tries to abstract hardware and network aspects, one could expect that concurrent and competing definitions of PCIs will appear for the application related PCIs first. Because this will probably happen on a per operating system basis, it could be a good idea, to focus future standards on network or protocol related PCIs rather than on application related ones.

For multimedia environments, the present document concludes that standardization of the network and/or protocol related PCIs mentioned in the subclauses following could make sense. However, it is worth a consideration, whether PCIs need to be standardized within a (European) Telecommunications Standards Institute. This might be especially true when considering:

- the duration of the standardization process;
- the demand for flexible and fast reaction of manufacturers;
- the existence of de facto standardization bodies that are directly driven by the industry and that are providing competing specifications;
- the political dimensions the PCI gets when it becomes an european standard (a PCI is originally intended to be merely a specification of how an application can locally access another communications entity).

7.4.1 Extension of ETS 300 325

Extension of ETS 300 325 [13] to:

- incorporate channel aggregation;
- allow for additional QoS Parameters;
- support higher bandwith;
- be prepared for support of B-ISDN;
- in general, consider the requirements of the present document.

However, at present the european industry might not be too interested to produce another standard because:

- NetManage has released the WinISDN interface definition that aims at the same purpose and might possibly take over the lead;
- there might not yet be enough experience with certain multimedia requirements and "new" protocols available to ensure high quality of the extensions.

7.4.2 Adaptation of the XAPI interface

It could be considered to support the XAPI interface, whose definition is an ongoing work within ITU, because:

- this interface is closely related to T.120 Series of ITU-T Recommendations;
- the definition of a transport interface could ease development of new applications.

7.4.3 Creation of a native ATM interface

Creation of a native ATM interface could aid development of standardized ATM hardware access. However, there exists already one specification (WinSock 2) that would compete with this development. Furthermore, ATM access could also be dealt with within an extension of ETS 300 325 [12].

8 Application class view

8.1 Main categories of applications

ITU-T Recommendation I.211 [15] introduces the classification of multimedia services over B-ISDN. For the purpose of the present document, this classification will be extended to other networks, and the term "service" will be extended to "application". Three main categories of Multimedia applications can be identified:

- the **conversational family;**
- the **retrieval family;**
- the **distribution family.**

Figure 9 presents an overview of these families in a more detailed way:

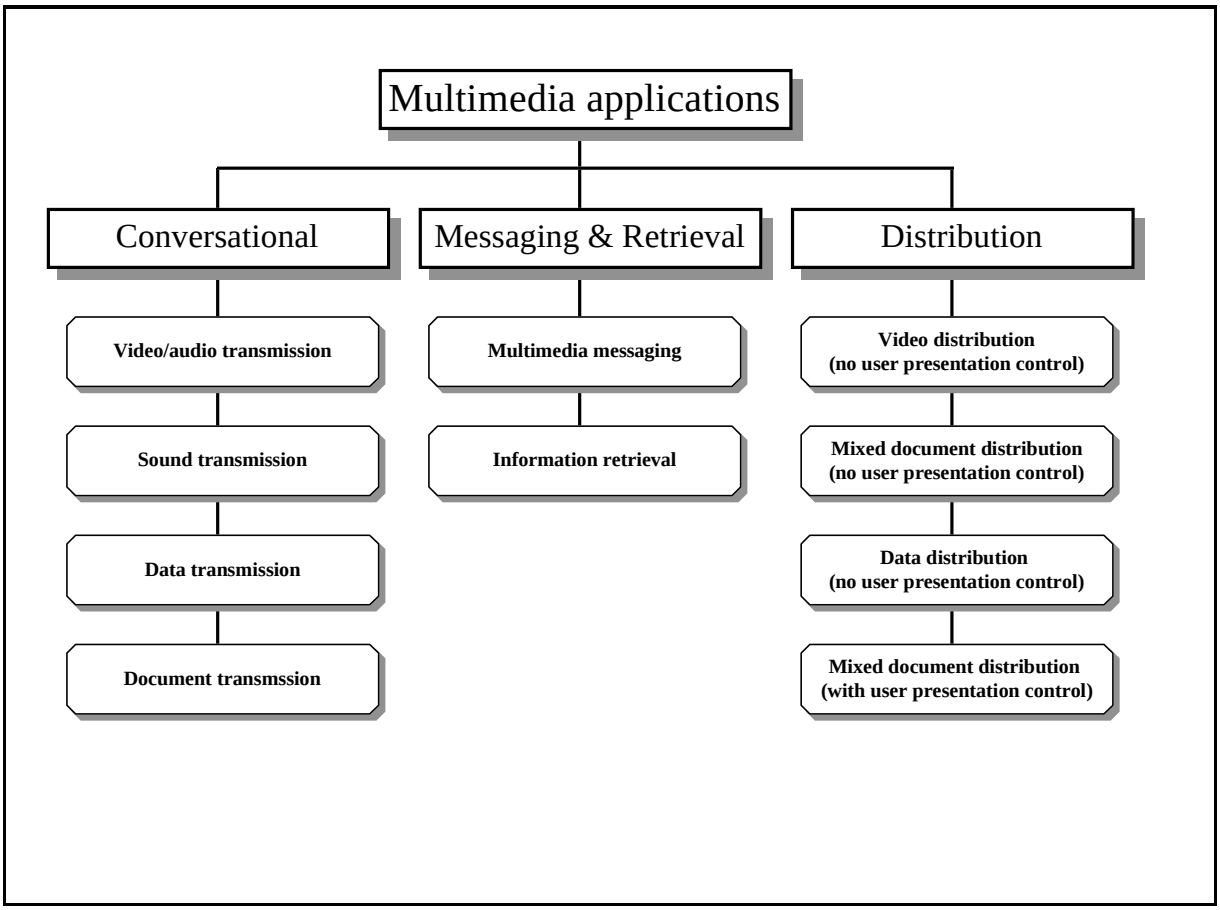


Figure 9: Multimedia applications overview

8.2 Conversational family requirements

This family of applications uses point-to-multipoint isochronous communications involving video, audio, and document transmission as well as co-operative work. It can be decomposed into four main parts:

- video/audio transmission;
- sound transmission;
- data transmission;
- document transmission.

8.2.1 Video/audio transmission

This part of the conversational family includes:

- video-telephony;
- videoconference;
- video-surveillance;
- video/audio information transfer.

8.2.1.1 Video-telephony

This type of application provides person-to-person communications including audio and video between two locations. Its requirements are shown in table 9.

Table 9: Video-telephony requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ITU-T Rec. H.320 [40] • ITU-T Rec. H.32Y [41]	• **Audio:** ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27] • **Video:** ♦ ITU-T Rec. H.261 [24]	• Bandwidth up to 1920 Kbit/s • Connection on demand, reserved or permanent • Point-to-point connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Dynamic bandwidth allocation • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access) • Synchronization between audio and video	• Optional codec access capability (video codec, ...) • External devices connectability (smart card reader, ...)

The protocols being used are described in:

- ITU-T Recommendation H.320 [40], which defines narrow-band visual telephone systems and terminal equipment;
- ITU-T Recommendation H.32Y [41], which defines the adaptation of H.320 terminals to B-ISDN.

The media being transmitted are described in:

- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;
- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines coding of speech at 16 kbit/s using low-delay code excited linear prediction;
- ITU-T Recommendation H.261 [24], which defines video codec for audiovisual services at p x 64 kbit.

8.2.1.2 Videoconference

This type of application provides multipoint communications including audio, video, document transfer and co-operative work between two or more locations. Its requirements are shown in table 10.

Table 10: Videoconference requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ITU-T Rec. T.122 [17] • ITU-T Rec. T.123 [18] • ITU-T Rec. T.124 [19] • ITU-T Rec. T.125 [20] • ITU-T Rec. T.126 [21] • ITU-T Rec. T.127 [22]	• **Still pictures:** ♦ ISO JPEG [39] ♦ Microsoft BMP • **Annotations:** ♦ there is no coding method for annotations • **Document:** ♦ Any type of monomedia document (e.g. text, CAD sheet, ...) • **Audio:** ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27] • **Video:** ♦ ITU-T Rec. H.261 [24]	• Bandwidth up to 1920 Kbit/s • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Dynamic bandwidth allocation • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access) • Synchronization between all the media	• Optional codec access capability (video codec, ...) • Charging (service provider)

The protocols being used are described in:

- ITU-T Recommendation T.122 [17], which defines the Multipoint Communication Service (MCS) for audiographic and audiovisual systems;
- ITU-T Recommendation T.123 [18], which defines the protocol stacks for audiographic and audiovisual teleconference applications;
- ITU-T Recommendation T.124 [19], which defines the generic conference control for audiovisual and audiographic terminals and Multipoint Control Units (MCU);
- ITU-T Recommendation T.125 [20], which defines the Multipoint Communication Service (MCS) protocol;
- ITU-T Recommendation T.126 [21], which defines the multipoint still image and annotation protocol;
- ITU-T Recommendation T.127 [22], which defines the multipoint binary file transfer service.

These protocols are part of the ITU-T T.120 Series Recommendation, which defines the teleconferencing service.

The media being transmitted are described in:

- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;
- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines coding of speech at 16 kbit/s using low-delay code excited linear prediction;
- ITU-T Recommendation H.261 [24], which defines video codec for audiovisual services at p x 64 kbit.

8.2.1.3 Video-surveillance

This type of application provides multipoint communications including video and possibly audio between two or more locations. Its requirements are shown in Table 11.

Table 11: Video-surveillance requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	• **Audio:** ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27] • **Video:** ♦ ITU-T Rec. H.261 [24]	• Bandwidth up to 1920 Kbit/s • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Unidirectional data transfers • Dynamic bandwidth allocation • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access) • Synchronization between audio and video	• External devices access capability (camera control, ...) • Optional codec access capability (video codec, ...) • Charging (service provider)

The media being transmitted are described in:

- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;
- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines Coding of speech at 16 kbit/s using low-delay code excited linear prediction;
- ITU-T Recommendation H.261 [24], which defines Video codec for audiovisual services at p x 64 kbit.

8.2.1.4 Video/audio information transfer

This type of application provides multipoint communications including audio and video transfer between two or more locations. It is somehow related to the Distribution family, but is different in this sense that it uses teleconference protocols and does not intend to provide TV broadcast at home, but video and audio information during a conference, for example. Its requirements are shown in Table 12.

Table 12: Video/audio information transfer requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ITU-T Rec. T.122 [17] • ITU-T Rec. T.123 [18] • ITU-T Rec. T.124 [19] • ITU-T Rec. T.125 [20] • ITU-T Rec. T.126 [21] • ITU-T Rec. T.127 [22]	• **Audio:** ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27] • **Video:** ♦ ITU-T Rec. H.261 [24]	• Bandwidth up to 1920 Kbit/s • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Dynamic bandwidth allocation • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access) • Synchronization between audio and video	• Optional codec access capability (video codec, ...) • Charging (service provider)

The protocols being used are described in:

- ITU-T Recommendation T.122 [17], which defines the Multipoint Communication Service (MCS) for audiographic and audiovisual systems;
- ITU-T Recommendation T.123 [18], which defines the protocol stacks for audiographic and audiovisual teleconference applications;
- ITU-T Recommendation T.124 [19], which defines the generic conference control for audiovisual and audiographic terminals and Multipoint Control Units (MCU);
- ITU-T Recommendation T.125 [20], which defines the Multipoint Communication Service (MCS) protocol;
- ITU-T Recommendation T.126 [21], which defines the multipoint still image and annotation protocol;
- ITU-T Recommendation T.127 [22], which defines the multipoint binary file transfer service.

These protocols are part of the ITU-T T.120 Series Recommendation, which defines the Teleconferencing service.

The media being transmitted are described in:

- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;
- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines Coding of speech at 16 kbit/s using low-delay code excited linear prediction;
- ITU-T Recommendation H.261 [24], which defines Video codec for audiovisual services at p x 64 kbit.

8.2.2 Sound transmission

This type of application only includes multiple sound programme signals diffusion. It could be used for multilingual programmes diffusion during a conference. Its requirements are shown in Table 13.

Table 13: Sound transmission requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	• **Audio:** ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27]	• Bandwidth up to 64 Kbit/s for one sound programme, but may be more if several high quality simultaneous audio programmes are transmitted • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Charging (network) • Security (restricted access)	Optional codec access capability (audio codec, etc.)

The media being transmitted are described in:

- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;
- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines Coding of speech at 16 kbit/s using low-delay code excited linear prediction.

8.2.3 Data transmission

This part of the conversational family includes:

- unrestricted digital information transmission;
- file transfer;
- teleaction.

8.2.3.1 Unrestricted digital information transmission

This type of application is computer interconnection-oriented. It provides data transfer between two or more computers (or whatever digital information treatment- and storage-related entity). Its requirements are shown in Table 14.

Table 14: Unrestricted digital information transmission requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	Any type of digital information (audio, video, documents, ...) may be transferred in a monomedia way	• Bandwidth depends on the amount of information to be transferred • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Connectionless ability (LAN-oriented data transfer) • Transparent data compression • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access, firewall)	• Charging (service provider)

8.2.3.2 File transfer

This type of application provides multipoint communications to transfer files between two or more locations. Its requirements are shown in Table 15.

Table 15: File transfer requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ETS 300 383 [42] • ETS 300 388 [43] • RFC 959 [44]	Any type of file can be transmitted	• Bandwidth depends on the volume of the file(s) to be transferred • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional symmetric data transfers • ISDN B-channels aggregation when using N-ISDN • Transparent data compression • Charging (network) • Security (user identification, restricted access, firewall)	• Simultaneous file transfers • Charging (service provider)

The protocols being used are described in:

- ETS 300 383 [42], which defines euro-file transfer;
- ETS 300 388 [43], which defines File Transfer, Access and Management (FTAM);
- RFC 959 [44]; which defines File Transfer Protocol (FTP).

8.2.3.3 Teleaction

This type of application provides multipoint communications providing the transfer of data related to hardware parameters (e.g. temperature, pressure, sensors, ...) between two or more sites. Its requirements are shown in Table 16.

Table 16: Teleaction requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	Any type of digital information related to hardware parameters obtained from sensors can be transmitted	• Bandwidth depends on the type of information to be transferred • Connection on demand, reserved or permanent • Point-to-point or point-to-multipoint connections • Bi-directional asymmetric data transfers • Charging (network) • Security (user identification, restricted access)	Connectability to external devices (sensors, oven, fridge, etc.)

8.2.4 Document transmission

This part of the conversational family includes:

- telefax transmission;
- high resolution image transmission;
- mixed document transmission.

8.2.4.1 Telefax transmission

This type of application is related to the exchange of facsimile documents including text, images, drawings between two or more locations. It is somehow related to the Multimedia messaging category, but differs from it in this sense that it can be dedicated to multipoint communications. Its requirements are shown in Table 17.

Table 17: Telefax requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ITU-T Rec. T.611 [11]	• **Facsimile including:** ◆ Text ◆ Images ◆ Drawings	• Bandwidth up to 64 Kbit/s • Connection on demand • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Charging (network) • Security (user identification)	• Connectability to external devices (scanner, printer, etc.) • Authentication for the legal use of the transmitted documents

This service is monomedia-oriented, because even if the document itself includes several types of media, it is considered as a media itself.

The protocol being used is described in ITU-T Recommendation T.611 [11], which defines a Programmable Communication Interface (PCI) APPLI/COM for facsimile group 3, facsimile group 4, teletex, telex, E-mail and file transfer services.

8.2.4.2 High resolution image transmission

This type of application is related to the exchange of high resolution images for medical use between two or more locations. Its requirements are shown in Table 18.

Table 18: High resolution image transmission requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	• **Still pictures:** ♦ Microsoft BMP ♦ CompuServe GIF ♦ TIFF	• Bandwidth up to 64 Kbit/s, but may be more if the image resolution is very high and/or if the transfer time is an important factor • Connection on demand • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Charging (network) • Security (user identification)	Connectability to external devices (camera, scanner, etc.)

High resolution images are often used by doctors in hospitals who need very precise information to establish a diagnostic. The used compression algorithm shall be lossless, because DCT algorithm like in ISO JPEG [39] degrades the image quality.

8.2.4.3 Mixed document transmission

This type of application is near from the Telefax transmission, but is slightly different in this sense that it provides the ability for the receiver to re-use the different media which are parts of the document. Its requirements are shown in Table 19.

Table 19: Mixed document transmission requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ITU-T Rec. T.522 [45]	• **Documents including:** ♦ Text ♦ Graphics ♦ Still pictures ♦ Audio ♦ Video	• Bandwidth up to 2 Mbit/s because of the possibility to include video within the document • Connection on demand • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or bi-directional asymmetric data transfers • Charging (network) • Security (user identification)	Connectability to external devices (camera, microphone, scanner, printer, etc.).

The protocol being used is described in ITU-T Recommendation T.522 [45], which defines Document Transfer and Manipulation - Bulk Transfer - Normal Mode (DTAM-BT-NM).

ISO/IEC 8613 Part 1 to 14 [48], which defines Open Document Architecture (ODA) provides a means to describe mixed documents including all the media being transmitted.

8.3 Messaging and retrieval family requirements

This family of applications is dedicated to Multimedia messaging and Information retrieval. ITU-T Recommendation I.211 [15] separates these two categories, but Multimedia messaging is too restricted to be defined as a family of applications.

8.3.1 Multimedia messaging

By adding multimedia capabilities such as still pictures, audio and video transfer to existing messaging applications, they become more friendly to the user. Their requirements are shown in table 20.

Table 20: Multimedia messaging requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ITU-T X.400 Series Rec. [50] • ITU-T Rec. T.611 (1994) [11]	• **E-mails including:** ♦ Text ♦ Graphics ♦ Still pictures ♦ Audio ♦ Video	• Bandwidth is not very important because messaging services are for non real-time interchange • Connection on demand • Point-to-point or point-to-multipoint connections • Bi-directional symmetric or unidirectional data transfers • Charging (network) • Security (user identification, restricted access, firewall)	• Authentication / signature • Encryption capability • Connectability to external devices (camera, etc.) • Optional codec access capability (MPEG-1 codec, etc.) • Charging (service provider)

The protocols being used are described in:

- ITU-T X.400 Series Recommendation [50], which defines Messaging Handling System (MHS);
- ITU-T Recommendation T.611 (1994) [11], which includes Email support.

Multipurpose Internet Mail Extension (MIME), which is an industry standard, could also be used.

Video could also be considered as a media being transmitted, but is not yet described as media attachment for messaging services. ISO/IEC MPEG-1 [37] video files may be used in such a case.

8.3.2 Information retrieval

This category of applications is becoming more and more popular on the market place, with the use of Videotex, Videotex Enhanced Man-Machine Interface (VEMMI), MHEG, and the Internet World Wide Web (WWW). Note that ETSI is currently working on Interworking between Videotex and Internet HTML documents TC-TR 004.

This category includes:

- videotex-based information retrieval;
- video retrieval;
- high resolution images retrieval;
- document retrieval;
- data retrieval;
- internet world wide web.

8.3.2.1 Videotex-based information retrieval

This type of application provides a means to end users to access retrieval services with many terminal equipment's such as Minitel and PC platforms. Its requirements are shown in table 21.

Table 21: Videotex-based information retrieval requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• ETS 300 222 [61] • ETS 300 223 [59] • ETS 300 076 [56] • ETS 300 079 [60] • ETS 300 382 [16]	• **Videotex:** ♦ ETS 300 072 [52] ♦ ETS 300 074 [54] • **Enhanced Videotex:** ♦ ETS 300 382 [16] • **Graphics:** ♦ ETS 300 073 [53] • **Still pictures:** ♦ ETS 300 177 [57] ♦ ISO JPEG [39] ♦ Microsoft BMP ♦ CompuServe GIF • **Audio:** ♦ ETS 300 149 [58] ♦ ITU-T Rec. G.711 [25] ♦ ITU-T Rec. G.722 [26] ♦ ITU-T Rec. G.728 [27] ♦ ISO/IEC MPEG-1 [37] ♦ Microsoft WAV ♦ MIDI files • **Video:** ♦ ITU-T Rec. H.261 [24] ♦ ISO/IEC MPEG-1 [37]	• Bandwidth up to 128 Kbit/s (2 ISDN B-channels), but may need to be up to 2 Mbit/s if several media resources are transmitted simultaneously together with MPEG-1 stream • Variable allocation of bandwidth depends on the media being transferred • Connection on demand • Point-to-point connections • Bi-directional asymmetric data transfers • ISDN B-channels aggregation when using N-ISDN • Synchronization between all the media • Transparent connect and disconnect • Charging (network) • Security (user identification, restricted access, firewall)	• Local storage capability • Transparent exchange resources (bitmap and sound files) • Optional codec access capability (JPEG decoder, for example) • Access to external devices (smart card reader, etc.) • Authentication / signature • Charging (service provider)

The protocols being used are described in:

- ETS 300 222 [61], which defines Framework of Videotex terminal protocols;
- ETS 300 223 [59], which defines Syntax-based Videotex common end-to-end protocols;
- ETS 300 076 [56], which defines Terminal Facility Identifier (TFI);
- ETS 300 079 [60], which defines Syntax-based Videotex end-to-end protocols, circuit mode DTE-DTE;
- ETS 300 382 [16], which defines Videotex Enhanced Man-Machine Interface (VEMMI).

These protocols define Syntax-Based Videotex (SBV).

The media being transmitted are described in:

- ETS 300 072 [52], which defines the Videotex presentation layer data syntax;
- ETS 300 074 [54], which defines the Videotex presentation layer data syntax for transparent data;
- ETS 300 382 [16], which defines the Videotex Enhanced Man-Machine Interface (VEMMI) provides a user interface using windows, dialogue boxes, menus, mouse;
- ETS 300 073 [53], which defines the Videotex presentation layer data syntax for Geometric display;
- ETS 300 177 [57], which defines the Videotex Photographic Syntax;
- ISO JPEG [39], which defines the Digital compression and coding of continuous-tone still images;
- ETS 300 149 [58], which defines Videotex Audio Syntax;
- ITU-T Recommendation G.711 [25], which defines Pulse Code Modulation (PCM) of voice frequencies;

- ITU-T Recommendation G.722 [26], which defines 7 kHz audio-coding within 64 kbit/s;
- ITU-T Recommendation G.728 [27], which defines Coding of speech at 16 kbit/s using low-delay code excited linear prediction;
- ITU-T Recommendation H.261 [24], which defines Video codec for audiovisual services at p x 64 kbit;
- ISO/IEC MPEG-1 [37], which defines the Coding for moving pictures and associated audio for storage media up to about 1,5 Mbit/s.

8.3.2.2 Video retrieval

This type of application provides an access to remote video databases. It is not dedicated to Broadcast TV, since it belongs to the Retrieval category. The image quality may not be good enough for Video on Demand (VoD) applications. Its requirements are shown in table 22.

Table 22: Video retrieval requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ISO/IEC MHEG [28]	• **Audio:** ♦ ISO MPEG-1 [37] • **Video:** ♦ ISO MPEG-1 [37]	• Bandwidth up to 1,5 Mbit/s • Variable bandwidth allocation depends on the media being transferred • Connection on demand or reserved • Point-to-point connections • Bi-directional asymmetric data transfers • ISDN B-channels aggregation when using N-ISDN • Charging (network) • Security (user identification, restricted access)	• Connectability to external devices (VCR, remote control pad, smart card reader, etc.) • Optional codec access capability (MPEG-1 decoder, etc.) • Charging (service provider)
NOTE: MPEG-1 video and audio bitstreams don't require synchronization because it is provided within ISO/IEC MPEG-1 [37] bitstream (multiplex mechanism).			

The protocol being used is ISO/IEC MHEG [28], which defines a means to handle Multimedia and Hypermedia. MHEG objects can be described by using a script language such as ISO/IEC 8879 Standard Generalized Markup Language (SGML) [78].

The media being transmitted are both described in ISO/IEC MPEG-1 [37]. MPEG-1 allows the transmission of audio (stereo, high quality) and video at up to 1,5 Mbit/s, corresponding to a typical CD-ROM bitrate. ISO/IEC MPEG-2 [38] deals with video broadcast (2 Mbit/s -> 40 Mbit/s) and shall be included in the Distribution services category.

NOTE: ITU-T Recommendation H.261 [24] video compression technique, ITU-T Recommendation G.711 [25], ITU-T Recommendation G.722 [26] and ITU-T Recommendation G.728 [27] audio compression techniques could also be used (lower bitrate, but implies lower quality).

8.3.2.3 High resolution image retrieval

This type of application provides an access to high resolution images. Its requirements are shown in table 23.

Table 23: High resolution image retrieval requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	• **High resolution images:** ♦ ISO JPEG [39]	• Bandwidth up to 64 Kbit/s, but may be more if the image resolution is very high and/or if the transfer time is an important factor • Connection on demand • Point-to-point connections • Bi-directional asymmetric data transfers • Charging (network) • Security (user identification)	Connectability to external devices (camera, scanner, etc.)

High resolution images are often used by newspaper editors to retrieve digitised photos stored by international press agencies. The transmitted images don't have to be lossless, but must be provided in different resolutions so that the user can have a quick overview. The appropriate format is described in ISO JPEG [39], which defines the digital compression and coding of continuous-tone still images.

8.3.2.4 Document retrieval

This type of application provides a means to retrieve mixed documents stored in remote databases. Its requirements are shown in table 24.

Table 24: Document retrieval requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ISO/IEC MHEG [28]	• **Documents including:** ♦ Text ♦ Graphics ♦ Still pictures ♦ Audio ♦ Video	• Bandwidth up to 64 Kbit/s, but may be up to 1,5 Mbit/s if video support is required, and up to 2 Mbit/s if simultaneous resources transfers occurs during a video diffusion • Variable bandwidth allocation depending on the media being transferred • Connection on demand • Point-to-point connections • Bi-directional asymmetric data transfers • ISDN B-channels aggregation when using N-ISDN • Transparent connect and disconnect • Transparent data compression • Charging (network) • Security (user identification, restricted access)	• Transparent exchange of MHEG objects • Local storage capability • Authentication / signature • Encryption capability • Connectability to external devices (smart card reader, etc.) • Optional codec access capability (JPEG decoder, MPEG-1 decoder, etc.) • Charging (service provider)

The protocol being used is ISO/IEC MHEG [28], which defines a means to handle multimedia and hypermedia.

ISO/IEC 8613 Part 1 to 14 [48], which defines Open Document Architecture (ODA) provides a means to describe mixed documents including all the media being transmitted.

8.3.2.5 Data retrieval

This service provides a means to retrieve data (e.g. files, ...) which is stored on a server. Its requirements are shown in table 25.

Table 25: Data retrieval requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	Any type of digital information (audio, video, documents, ...) may be transferred in a monomedia way	• Bandwidth depends on the type of media to be transferred, it can go from a few Kbit/s for text transfer to 1,5 Mbit/s for video transfer • Variable bandwidth allocation depending on the media being transferred • Connection on demand • Point-to-point connection • Bi-directional asymmetric data transfers • ISDN B-channels aggregation when using N-ISDN • Transparent data compression • Charging (network) • Security (user identification, restricted access)	• Local storage capability • Authentication / signature • Encryption capability • Connectability to external devices (smart card reader, etc.) • Charging (service provider)

8.3.2.6 Internet World Wide Web (WWW)

This well-known multimedia retrieval service has become quite important on the market place, and is to be compared with the document retrieval applications. Its requirements are shown in table 26.

Table 26: Internet World Wide Web requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements

• Transport Control Protocol / Internet Protocol (TCP/IP):
  ♦ RFC 793 [62]
  ♦ RFC 791 [63]
• Hyper Text Transfer Protocol (HTTP)
• ISO/IEC 9070 [79]
	• **Text:**
	  ♦ Hyper Text Markup Language (HTML) [29]
	• **Still pictures:**
	  ♦ Microsoft BMP
	  ♦ CompuServe GIF
	• **Audio:**
	  ♦ Microsoft WAV
		• Bandwidth up to 64 Kbit/s
		• Connection on demand
		• Point-to-point connection
		• Bi-directional asymmetric data transfers
		• Transparent addressing provided by the use of Uniform Resource Locator (URL), as defined in RFC 1738 [68]
		• Transparent connect and disconnect
		• Charging (network)
		• Security (user identification, restricted access, firewall)
			• Local storage capability
			• Authentication / signature
			• Charging (service provider)

RFC 793 [62] and RFC 791 [63] define Transport Control Protocol / Internet Protocol (TCP/IP). ISO/IEC 9070 [79] defines the registration procedures for public text owner identifiers. Internet Protocol Next Generation (IPng), also called IP version 6, is about to replace IP version 4, providing more capabilities:

- expanded routing and addressing;
- point-to-multipoint communications;
- quality of Service (flow label, priority);
- security.

By adding these capabilities, IP can be used for real-time interchange of media such as audio or video.

Hyper Text Markup Language (HTML) [29] is the standard used for the transmission of multimedia documents on the Internet. Its main limitation is that it only allows navigation between documents and/or servers by using Hyper Text Transfer Protocol (HTTP) links, but does not allow any interactivity. To provide a solution, SUN Microsystems has defined a script language called JAVA [81], which describes a means to write applets providing interactive applications on Internet WWW browsers. It is close from C++, but is platform-independent and not compiled. As a consequence, it runs slower.

The problem with the Internet World Wide Web is that *de facto* standards emerge on the market place, allowing browsers to be extended by downloading plug-ins (e.g. RealAudio, viewers).

8.4 Distribution family requirements

This family can be divided in two categories:

- distribution without user individual presentation control: this category is related to broadcasting since the user cannot interact with the TV programmes;

- distribution with user individual presentation control: this category allows the user to interact with the TV programme (e.g. choose a camera during a sport event, browse a TV programmes menu, ...).

8.4.1 Distribution without user individual presentation control

8.4.1.1 Video distribution

This type of application is dedicated to broadcast TV and pay-per-view at different qualities: existing quality, High Definition TV (HDTV). Its requirements are shown in table 27.

Table 27: Video distribution requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
• Digital Video Broadcasting (DVB) • ISO/IEC MHEG [28] could also be used, but no user interaction is required.	• **Audio:** ♦ ISO MPEG-2 [38] • **Video:** ♦ ISO MPEG-2 [38]	• Bandwidth up to 40 Mbit/s per TV programme, depending on the TV quality, but may be more if several TV programmes are multiplexed within the same MPEG-2 bitstream • Variable bandwidth allocation • Connection on demand (selection) or permanent • Broadcast connections • Bi-directional asymmetric or unidirectional data transfers • Charging (network) • Security (restricted access)	• Connectability to external devices (VCR, remote control pad, smart card reader, etc.) • Optional codec access capability (MPEG-2 decoder, etc.) • Scrambling capability • Charging (service provider)

The protocol being used is Digital Video Broadcast (DVB).

ISO/IEC MPEG-2 [38] is the commonly agreed standard for the transmission of audio and video. ISO/IEC MPEG-1 [37] could have been used, but it implies only one video channel, and a lower image quality which is not sufficient for TV broadcast.

NOTE: MPEG-2 video and audio bitstreams don't require synchronization because it is provided within ISO MPEG-2 [38] system bitstream (multiplex mechanism).

8.4.1.2 Mixed document distribution

This type of application is dedicated to the diffusion of various media, but not including audio and video. A typical application would be electronic newspaper. Its requirements are shown in table 28.

Table 28: Mixed document distribution requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ISO/IEC MHEG [28]	• **Text** • **Graphics** • **Still pictures**	• Bandwidth depends on the type of media being transferred • Connection on demand (selection) or permanent • Broadcast or point-to-multipoint connections • Bi-directional asymmetric or unidirectional data transfers • Charging (network) • Security (restricted access)	• Connectability to external devices (remote control pad, smart card reader, etc.) • Optional codec access capability (JPEG decoder, etc.) • Charging (service provider)

The protocol being used is described in ISO/IEC MHEG [28], which defines a means to handle Multimedia and Hypermedia.

There are no standards for the media being transmitted in a distribution family application.

8.4.1.3 Data distribution

This type of application is dedicated to the distribution of any type of data. Its requirements are shown in table 29.

Table 29: Data distribution requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
None	Any type of digital information (audio, video, documents, ...) may be transferred in a monomedia way	• Bandwidth depends on the amount of information to be transferred • Connection permanent • Broadcast connections • Unidirectional data transfers • Charging (network) • Security (restricted access)	Charging (service provider)

8.4.2 Mixed document distribution with user individual presentation control

This type of application is dedicated to full channel broadcast videography including text, graphics, audio, still images and video. A typical application would be remote education and training. Its requirements are shown in table 30.

Table 30: Mixed document distribution with user individual presentation control requirements

Protocols	Transmitted media	Requirements expected from the communication entity	Other requirements
ISO/IEC MHEG [28]	• **Text** • **Graphics** • **Still images** • **Audio:** ♦ ISO MPEG-2 [38] • **Video:** ♦ ISO MPEG-2 [38]	• Bandwidth depends on the type of media being transferred • Connection permanent • Broadcast connections • Unidirectional data transfers • Charging (network) • Security (restricted access)	• Connectability to external devices (remote control pad, smart card reader, etc.) • Charging (service provider)

The protocol being used is described in ISO/IEC MHEG [28], which defines a means to handle multimedia and hypermedia.

There are no standards for the media being transmitted, except for audio and video which coding processes are described in ISO/IEC MPEG-2 [38]. MPEG-2 also provides a means called Digital Storage Media Command Control (DSM-CC) for user interaction on video sequences restitution.

9 User View

9.1 Main categories of users

ETR 084 [7] introduces three categories of users:

- the information **producer** is the source of the multimedia and hypermedia information accessed and interchanged within the service;
- the information **manager** is the service operator, responsible for enabling access to the information base as well as administering information interchange between users;
- the information **consumer** is the final user of the service, who retrieves and consults the information for its own purposes.

9.2 Information producer requirements

The information producer is in charge of the conception of the Multimedia application. He must provide:

- the different media;
- the scripts linking these media.

If the information producer is not the owner of the server, his main requirement may be to upload the application (media, scripts):

- by off-line means (CD-ROM, ...);
- by on-line means (network access).

In both cases, the interchange is non real-time.

9.3 Information manager requirements

The information manager is in charge of the server. He administers the multimedia application provided by the information producer in order to make it available to the information consumer. His main requirements are:

- administration of media and scripts;
- administration of users (information producers, information consumers);
- upload of multimedia applications including media and scripts;
- charging;
- access control / protection (firewalls);
- system monitoring.

9.4 Information consumer requirements

The information consumer is the end user who consults the multimedia information made available by the information manager. His main requirements are:

- remote consultation (real-time downloading) of multimedia information (media, scripts);
- local consultation (non real-time downloading) of multimedia information (media, scripts);
- charging (service / network).

Other important attributes can also be identified, which are out of the scope of the present document. For example:

- cost of terminals;
- cost of Metropolitan and Wide Area Networks (MAN, WAN) deployments;
- Human Computer Interface (HCI).

10 Media view

The aim of this part of the present document is not to establish an exhaustive list of existing standards for the coding for various media. It identifies the different categories of media, builds a list of requirements for each and gives the main coding formats.

10.1 Main categories of media

ETR 225 [6] and TCR-TR 026 [1] introduce a categorization of media:

- **telematic files;**
- **graphics;**
- **still picture;**
- **audio;**
- **video.**

In some cases, these media have particular distribution and / or processing requirements, as shown thereafter.
ETR 084 [7] may also be another helpful source of information for the description of these media by building a quite exhaustive list of techniques, international standards and industry formats.

10.2 Telematic files

Telematic files are documents including text in any type of coded form (e.g. fax, word processor document, simple ASCII, etc.). They don't have particular processing requirements. Note that characters may be coded with 7 bits or 8 bits, depending on the ASCII coding system being used, so converters may be needed.

10.3 Graphics

In most cases, this media is used for simple graphic presentations (e.g. charts, CAD sheets, ...). These graphics are coded with vectors, which differentiate them from still pictures. Its main processing requirements are:

- high definition video cards;
- high definition screens;
- fast vector computing;

- as long as the amount of information is low, bitrate is not an important attribute.

The main formats used to code graphics are:

- Windows MetaFile (WMF);
- Computer Graphic Metafile (CGM);
- Corel Draw (CDR);
- AutoDesk AutoCAD sheets (DXF).

10.4 Still pictures

This media is coded pixel-by-pixel and sometimes uses a compression algorithm. This algorithm can be of two types:

- lossless, if high quality is required (e.g. medical images);
- non-lossless (lossy), if fast access is a requirement.

Still pictures main processing requirements are:

- large colour palettes;
- high definition video cards;
- high definition screens;
- bitrate, if fast access / downloading is necessary (e.g. for press agencies scanning photo catalogues);
- interleave coded form, giving the ability for a system receiving the picture to display it before it is completely transmitted;
- Discrete Cosine Transform (DCT) decoder for JPEG still pictures.

The main formats used to code still pictures are:

- Windows Device-Independent Bitmap (BMP);
- CompuServe Graphics Interchange Format (GIF);
- Tagged Image File Format (TIFF);
- ISO/IEC JPEG [39].

10.5 Audio

Audio processing depends on:

- quality to be produced (e.g. speech, CD-Audio quality, ...);
- number of simultaneous audio tracks (mono, stereo, Dolby Surround, ...).

Its main requirements (for a real-time use) are:

- high bandwidth (up to 64 Kbit/s);
- constant bitrate;
- synchronization, when more than one audio track is transmitted.

NOTE: ISO/IEC MPEG-1 [37] and MPEG-2 [38] provide an embedded synchronization within the bitstreams.

The main formats used to code audio are:

- ITU-T Recommendation G.711 [25];
- ITU-T Recommendation G.722 [26];
- ITU-T Rececommendation G.728 [27];
- Microsoft WAVeform (WAV);
- ISO/IEC MPEG-1 audio streams [37];
- ISO/IEC MPEG-2 audio streams [38];
- Musical Instruments Digital Interface (MIDI).

NOTE: MIDI files does not contain any audio information. They simply contain note numbers and associated parameters such as velocity, aftertouch, which will be reproduced by an internal (audio card) or external (keyboard) synthesizer.

10.6 Video

This media (for a real-time use) requires:

- high bandwidth (up to 1,5 Mbit/s for MPEG-1, up to 40 Mbit/s for MPEG-2);
- constant bitrate;
- Discrete Cosine Transform (DCT) decoder;
- synchronization, when more than one audio track is transmitted.

NOTE: ISO/IEC MPEG-1 [37] and MPEG-2 [38] provide an embedded synchronization within the bitstreams.

The main formats used to code video are:

- ITU-T Recommendation H.261 [24];
- Microsoft Audio Video Interleaved (AVI);
- Intel Digital Video Interactive (DVI);
- ISO/IEC MPEG-1 [37];
- ISO/IEC MPEG-2 [38].

NOTE: Moving JPEG (MJPEG) is another way of coding video information by using only JPEG frames instead of intra-coded, predicted and interpolated pictures as for MPEG-1 or MPEG-2.

Most of the active Multimedia working bodies have agreed that MPEG (whether it is MPEG-1, more appropriate for CD-ROM, or MPEG-2 for TV broadcast) is the major video coding standard. So it appears that Microsoft Audio Video Interleaved (AVI) and Intel Digital Video Interactive (DVI) will not be used very much.

11 Service view

At present time, new multimedia services are still under development. For the purpose of the present document videoconferencing and corporate document handling have been considered. These services are defined by the ITU-T T.120 Series of Recommendation and the ITU-T T.190 Series of Recommendation, respectively. They both introduce the element of multipoint communications that is dealt with in ITU-T Recommendations T.122 [17] and T.125 [20].

The service view results in requirements for an (network related) transport interface between the components of a ITU-T T.120 Series conforming implementation and an application related interface, that offers MCS and GCC functionality to an application.

12 Network view

Multimedia applications can be supported by many different types of network. In order to derive a hypothetical standard multimedia PCI for all possible multimedia and monomedia applications for all applicable network types, the following analysis has been carried out:

- list and explanation of applications that need to be supported;
- types and simple descriptions of possible networks used to support multimedia and monomedia applications presented as a table;
- for each network type the following details have been presented:
    - detailed description of network capabilities;
    - typical protocol stack for an applicable multimedia application;
    - listing of network attributes;
    - listing of applicable ITU-T Recommendations, ETSI Standards and abbreviations.
- standardized representation of network protocol stacks derived from all applicable network types;
- recommendations for multimedia and monomedia generalised API based on network view and applicable applications.

Each of the above items is considered in the subclauses below.

12.1 Networks - general description

Each of the network types are reviewed in table 31 and their capabilities in the support of different data types and other information is also included.

Table 31: Use of different networks in the support of multimedia

Network	Description
PSTN	Public Switched Telephone Network: This is the general telephone network with analogue local loops. Multimedia applications can be supported using modems. Different data types can be supported limited by the maximum data rate of 32 kbit/s (without compression). The PSTN with the addition of digital local loops (i.e. N-ISDN) provides better support and greater bandwidth for data applications. Design of a generalised API need not specifically take into account analogue loop PSTNs.
CSPDN	Circuit-Switched Public Data Network: CSPDNs are the X.21-based data networks. Multimedia applications can be supported for different data types limited by the maximum data rate of 64 kbit/s (without compression) although multiple connections can be made to achieve greater bandwidth. This type of network is being replaced by N-ISDNs and design of a generalised API need not take into account CSPDNs.
PSPDN	Packet-Switched Public Data Network: PSPDNs are the X.25-based networks ideally suited for file transfer applications. This type of network is not intended for the transfer of isochronous data (real-time voice and video), but can still support multimedia applications limited by the effective maximum data rate of 9,600 bit/s. Some PSPDN users are changing to Frame Relay and SMDS networks to achieve higher throughput. Design of a generalised API need not specifically take into account PSPDNs although X.25 PLP is often used at layer 3 in the support of some LAN/WAN networking applications so this layer 3 protocol must not be excluded from the API considerations.
N-ISDN	Integrated Services Digital Network (Narrowband - to distinguish it from the Broadband version): ISDNs are digital end-to-end networks that support 64 kbit/s channels (circuit-switched) although multiple connections can be made to achieve greater bandwidths (up to 1,920 kbit/s per primary rate access). ISDNs can also support packet data via packet handling equipment.
GSM	Global System for Mobile Communications: A digital mobile telephony network with a data service based on 9.6 kbit/s bandwidth. Multimedia applications can be supported for different data types limited by the maximum data rate of 9.6 kbit/s (without compression) although when the new HSCSD (High Speed Circuit Switched Data) service starts, bandwidths of 64 kbit/s, 76.8 kbit/s and 96 kbit/s can be achieved.

Network	Description
Frame Relay	Although originally specified as a service of N-ISDN, Frame Relay networks now exist in their own right and are being used as the replacement for applications that would normally use packet-switched networks (both public and private). This type of network is not intended for the transfer of isochronous data, but can still support multimedia applications limited by the effective maximum data rate of 2 048 kbit/s. These networks rely upon the built-in reliability and virtually error-free performance of digital networks so the protocol stack for Frame Relay does not include the error checking and retransmission overhead normally associated with packet networks. For Frame Relay the higher layer end-to-end protocols are expected to verify the integrity of the data. The generalised API need not support applications based on Frame Relay as these networks generally only support file and text transfers.
SMDS (CBDS)	Switched Multimegabit Data Service (called Connectionless Broadband Data Service by ETSI): These are digital end-to-end networks operating at rates up to 140/155 Mbit/s providing a connectionless data service. Information is sent in packets (at layer 3). This type of network is not intended for the transfer of isochronous data (although some network providers claim that they are adding isochronous service to SMDS) but can still support multimedia applications.
LAN	Local Area Networks (e.g. Ethernet, Token Ring): These type of networks deliver applications and services to the desktop and operate at data rates up to 100 Mbit/s. Current systems do not adequately support applications involving real-time voice and video although there are some newer developments in this area. The generalised API must support applications based on LANs.
ATM To The Desktop	Asynchronous Transfer Mode: ATM is starting to be used with LANs as a high-bandwidth switch and this is delivering many applications to the desktop. Work in this area is being addressed by the ATM Forum and the generalised API must address this area.
Public ATM (B-ISDN)	Broadband ISDN: This type of network supports everything that any of the other networks support and can carry information at up to 622 Mbit/s. All types of multimedia applications can be supported (including video-on-demand). Work in this area is being addressed by the ATM Forum/ITU-T but it is probably five to eight years before a full public service will be available. Specification of the generalised API should take into account the current work being undertaken by the ATM Forum/ITU-T.
Cable TV	This type of network was primarily intended to provide broadcast TV to homes. Using the latest technology and delivery systems, many different types of multimedia applications can be supported. These networks will have similar capabilities to B-ISDN with the main difference being the emphasis on services (i.e. TV distribution is the first consideration for Cable TV networks whereas communication is the first consideration for B-ISDNs) and the distribution. Cable TV networks are traditionally "tree and branch" networks, whereas public telephone networks (from which B-ISDN can be considered to have evolved from) usually employ a policy of individual local loops per subscriber, although this may change. Note that Cable TV is not to be confused with CATV (Community Antenna TV) which is a TV antenna/aerial distribution system. The generalised API must support applications based on Cable TV systems.

Now the support for the identified applications are considered for each of the networks mentioned above. Table 32 gives a general overview of the capabilities of the network in handling various applications.

Each of these network types are now examined in greater detail and examples are given of how each network type can support multimedia applications.

12.2 Networks - detailed description

The following network types are considered in detail:

- PSTN;
- CSPDN;
- PSPDN;
- N-ISDN;
- GSM;
- Frame Relay;
- SMDS (CBDS);
- LAN;
- ATM To The Desktop;
- Public ATM (B-ISDN);
- Cable TV.

Table 32: Network support for various applications

Service	Data Rate [Mbit/s]	Typical Application	PSTN with Modem	CSPDN X.21 or X.21bis	PSPDN X.25	GSM	ISDN	Frame Relay	SMDS	LANs	B-ISDN with ATM	Cable TV
Database	up to 2	Text & Simple Graphics	Some	Some	Some	Some	Some	All	All	All	All	All
Access	2 - 10	Graphics	--	--	--	--	--	Some	All	Some	All	All
	over 10	Medical Images, CAD files	--	--	--	--	--	--	Some	Some	All	All
File	up to 2	Text, PC comms	Some	Some	Some	Some	Some	All	All	All	All	All
Transfer	2 - 10	Graphics, Main Frame comms	--	--	--	--	--	Some	All	Some	All	All
	over 10	Meteorology, Supercomputers	--	--	--	--	--	--	Some	Some	All	All
LAN	up to 2	4 Mbit/s Token Ring	--	Some	Some	--	--	All	All	--	All	All
Interconnect	2 - 10	Ethernet, 16 Mbit/s Token Ring	--	--	--	--	--	Some	All	--	All	All
	over 10	FDDI, 100 Mbit/s LANs	--	--	--	--	--	--	Some	--	All	All
Still Image	up to 2	Monochrome	Some	Some	Some	Some	Some	All	All	All	All	All
Communication	2 - 10	Colour	--	--	--	--	--	Some	All	Some	All	All
	over 10	High resolution e.g. CAD/CAM	--	--	--	--	--	--	Some	Some	All	All
Video & PC	up to 2	Talking heads	Some	Some	--	Some	Some	--	Some	Some	All	All
Conferencing	2 - 10	Small screen high quality	--	--	--	--	--	--	Some	--	All	All
	over 10	Large screen high quality	--	--	--	--	--	--	Some	--	All	All
Multimedia	up to 2	Combinations of the above	--	Some	--	Some	Some	--	Some	Some	All	All
Networking	2 - 10	Combinations of the above	--	--	--	--	--	--	Some	--	All	All
	over 10	Combinations of the above	--	--	--	--	--	--	Some	--	All	All

12.2.1 PSTN

The PSTN is a circuit-switched network ideally suited for isochronous communications, such as:

- full-duplex voice communications (3,1 kHz telephony);
- full-duplex data communication (including still image and video) using modems.

Although the core of the PSTN (i.e. the IDN) is digital, the PSTN is regarded as an analogue network due to its analogue local loops. Voice is PCM encoded in order to be transported across the IDN. Data transmission is possible by modulating all binary information into audible signals in the telephony voice frequency range (300 to 3 400 Hz) and it is then PCM encoded in a similar manner to voice for transportation across the IDN. These modulated binary signals are then demodulated in order to recover the binary information. For multimedia applications, the PSTN can still be used although there is a finite limit of the data bandwidth that can be achieved for full-duplex communication. The upper limit for modems is regarded as being in the order of 32 kbit/s. Using data and video compression techniques effective bandwidths of up to 500 kbit/s can be achieved.

The PSTN can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by a PSTN, is shown in figure 10.

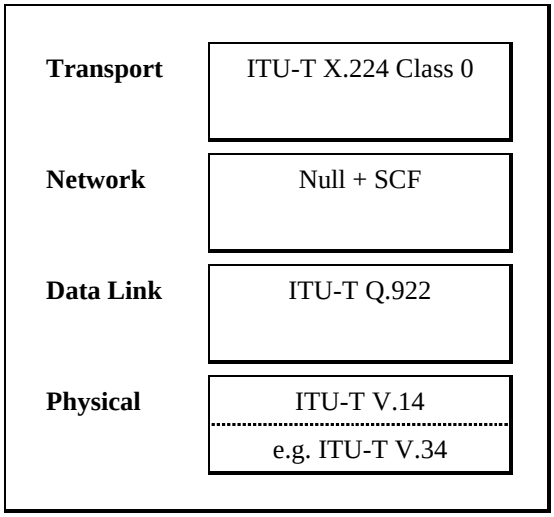


Figure 10: PSTN protocol stack

- ITU-T Q.922 [83]: ISDN data link layer specification for frame mode bearer services;
- ITU-T V.14 [84]: Transmission of start-stop characters over synchronous bearer channels;
- ITU-T V.34 [85]: Modem operating at data signalling rate of 28 800 bit/s;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

The network has the following service attributes:

Table 33: Service attributes of PSTN

Attribute	Value
information transfer mode	• circuit switched
information transfer rate	• up to 32 kbit/s using modem
information transfer capability	• unrestricted digital information (with modem) • speech • audio (3,1 kHz) • video (slow-scan, poor-quality - with modem)
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical (except using certain modems - asymmetrical)
type of user information	• speech • sound • text • facsimile • videotex • video
synchronous/asynchronous	• for data using modem - synchronous and asynchronous
structure	• for data - modem dependant
UNIs	• 2-wire analogue local loop
call set-up protocols	• Loop dialling, or • DTMF

12.2.2 CSPDN

The CSPDN is a 64 kbit/s circuit-switched network intended for full-duplex digital data transmission.

The CSPDN can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by a CSPDN, is shown in figure 11.

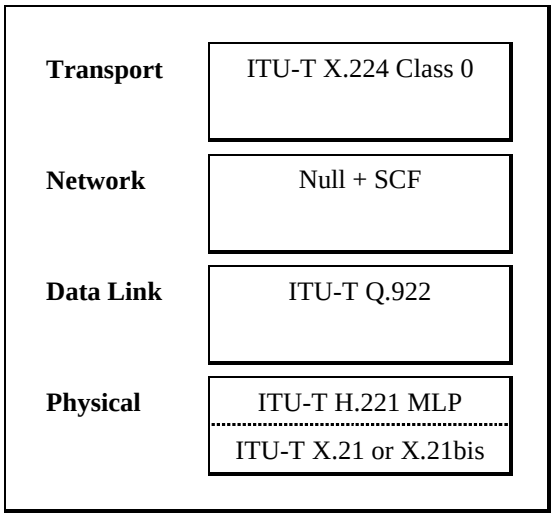


Figure 11: CSPDN protocol stack

- ITU-T H.221 [70]: Frame structure for a 64 to 1 920 kbit/s channel in audiovisual teleservices;
- ITU-T Q.922 [83]: ISDN data link layer specification for frame mode bearer services;
- ITU-T X.21 [86]: Interface between data terminal equipment and data circuit-terminating equipment for synchronous operation on public data networks;
- ITU-T X.21bis [87]: Use on public data networks of data terminal equipment which is designed for interfacing to synchronous V-series modems;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

The service attributes are shown in table 34.

Table 34: Service attributes of CSPDN

Attribute	Value
information transfer mode	• circuit switched
information transfer rate	• 64 kbit/s
information transfer capability	• unrestricted digital information
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical
type of user information	• speech • sound • text • facsimile • videotex • video
synchronous/asynchronous	• synchronous
structure	• 8 kbit/s
UNIs	• 4-wire digital
call set-up protocols	• ITU-T X.21 (or X.21bis)

12.2.3 PSPDN

The PSPDN is a packet-switched network intended for full-duplex digital data transmission.

PSPDN generally cannot support real-time isochronous data applications (i.e. telephony and videoconferencing). However, there is a protocol stack defined for PSPDNs in the support of the multipoint communication service for audiographics and audiovisual conferencing. It is quite likely that the response times for this service will be unacceptable. The protocol stack for this multimedia service is shown in figure 12.

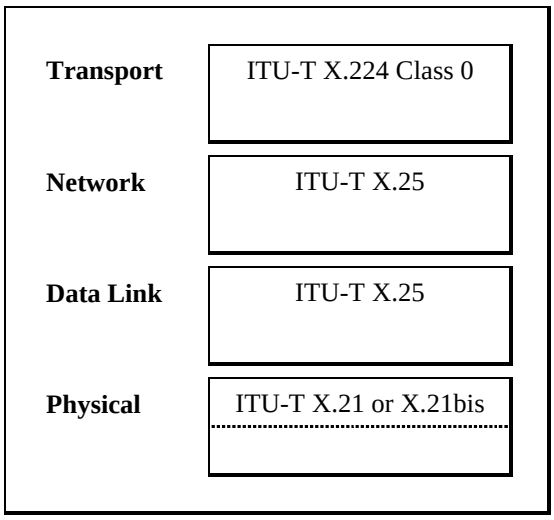


Figure 12: PSPDN protocol stack

- ITU-T X.21 [86]: Interface between data terminal equipment and data circuit-terminating equipment for synchronous operation on public data networks;
- ITU-T X.21bis [87]: Use on public data networks of data terminal equipment which is designed for interfacing to synchronous V-series modems;
- ITU-T X.25 [88]: Interface between data terminal equipment and data circuit-terminating equipment for terminals operating in the packet mode and connected to public data networks by dedicated circuit;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services.

Table 35: Service attributes of PSPDN

Attribute	Value
information transfer mode	• packet switched
information transfer rate	• 2 400 bit/s, 4 800 bit/s and 48 000 bit/s
information transfer capability	• data
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical
type of user information	• text • binary data
synchronous/asynchronous	• direct network connection is synchronous, via PAD either is possible
structure	• PDU
UNIs	• 4-wire digital or via PAD over 2-wire analogue using X.28
call set-up protocols	• Layer 1 - ITU-T X.21 or X.21bis • Layer 2 - ITU-T X.25 • Layer 3 - ITU-T X.25 PLP

12.2.4 ISDN

The ISDN is a circuit-switched digital network ideally suited for isochronous communications, such as:

- full-duplex voice communications (using PCM encoded 3,1 kHz speech);
- full-duplex data communication (including still image and video).

The ISDN can also be used for packet data communication using either an internal or external packet handling function. ITU-T Recommendation X.31 [91] gives all the relevant details. The ISDN can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by a ISDN, is shown in figure 13.

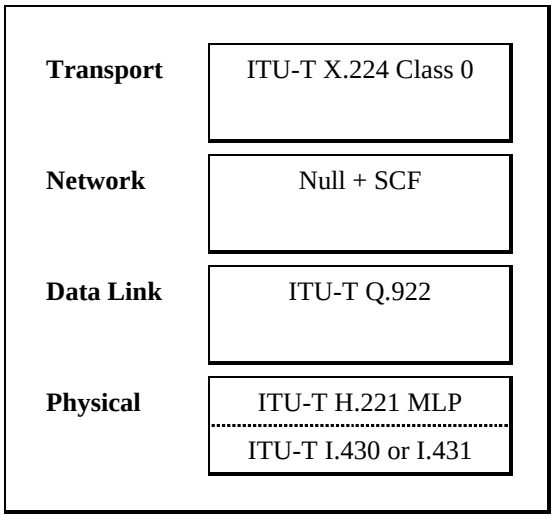


Figure 13: ISDN protocol stack

- ITU-T H.221 [70]: Frame structure for a 64 to 1 920 kbit/s channel in audiovisual teleservices;
- ITU-T I.430 [89]: Basic user-network interface - Layer 1 specification;
- ITU-T I.431 [90]: Primary rate user-network interface - Layer 1 specification;
- ITU-T Q.922 [83]: ISDN data link layer specification for frame mode bearer services;
- ITU-T X.31 [91]: Support of packet mode terminal equipment by an ISDN;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 36: Service attributes of ISDN

Attribute	Value
information transfer mode	• circuit switched (B-channel) • packet switched (B-channel and/or D-channel)
information transfer rate	• circuit-mode transfer - 64 kbit/s (384 kbit/s, 1 536 kbit/s and 1 920 kbit/s possible in some networks) • packet mode transfer - packets per second t.b.d.
information transfer capability	• unrestricted digital information • speech • audio (3,1 kHz or 7 kHz) • video
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical
type of user information	• speech • sound • text • facsimile • videotex • video
synchronous/asynchronous	• synchronous
structure	• 8 kbit/s
UNIs	• Basic Access (2B+D) • Primary Rate Access (30B+D)
call set-up protocols	• Layer 1 - ITU-T I.430/I.431 • Layer 2 - ITU-T Q.920/Q.921 • Layer 3 - ITU-T Q.930/Q.931

12.2.5 GSM

GSM is a circuit-switched digital voice network with a data communication service

GSM can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by GSM, is depicted in figure 14.

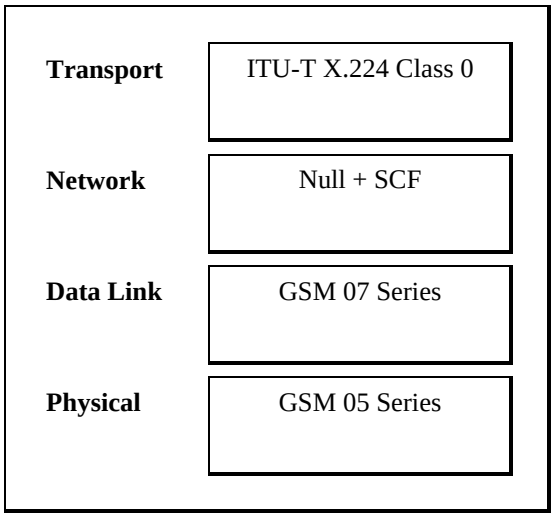


Figure 14: GSM protocol stack

- GSM 05 Series [103]: Physical Layer on the Radio Path;
- GSM 07 Series [104]: Terminal Adaptation Functions for MSs;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 37: Service attributes of GSM

Attribute	Value
information transfer mode	• circuit-switched
information transfer rate	• 6,5 kbit/s or 13 kbit/s
information transfer capability	• unrestricted digital information • speech • audio (3,1 kHz or 7 kHz) • video
establishment of connection	• demand
symmetry	• symmetrical
type of user information	• speech • sound • text • facsimile • videotex • video
synchronous/asynchronous	• synchronous
structure	• 4 kbit/s, 8 kbit/s or PDU
UNIs	• GSM Air Interface
call set-up protocols	• Layer 1 - ETSI GSM 05 series specifications • Layer 2 - ETSI GSM 04.06 specification • Layer 3 - ETSI GSM 04.08 specification

12.2.6 Frame Relay

Frame Relay is a packet-switched digital network ideally suited for data communications. These networks are not to be confused with the ETSI and ITU-T specified Frame Relaying services that are supported by ISDNs.

Frame Relay can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by Frame Relay, is depicted by figure 15.

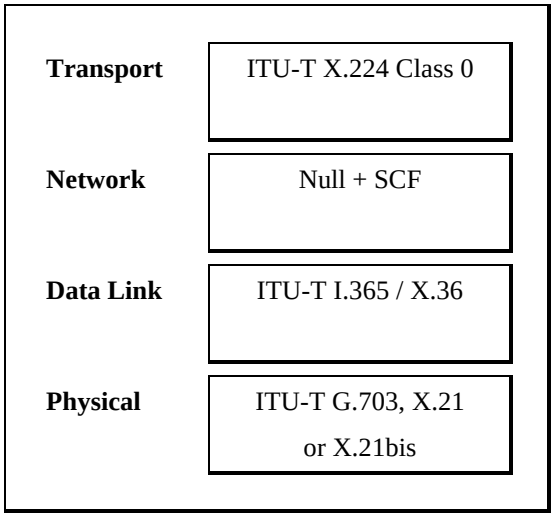


Figure 15: Frame Relay protocol stack

- ITU-T G.703 [97]: Physical/electrical characteristics of hierarchical digital interfaces;
- ITU-T I.365 [98]: Frame relaying services specific convergence sublayer;
- ITU-T X.21 [86]: Interface between data terminal equipment and data circuit-terminating equipment for synchronous operation on public data networks;
- ITU-T X.21bis [87]: Use on public data networks of data terminal equipment which is designed for interfacing to synchronous V-series modems;
- ITU-T X.36 [99]: Interface between DTE and DCE for public data networks providing frame relay datatransmission service by dedicated circuit;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 38: Service attributes of Frame Relay

Attribute	Value
information transfer mode	• frame relaying/PDU
information transfer rate	• from 64 kbit/s to 2 048 kbit/s (typical values)
information transfer capability	• data
establishment of connection	• demand • permanent
symmetry	• bi-directional symmetric
type of user information	• text • binary data
synchronous/asynchronous	• synchronous
structure	• service data unit integrity
UNIs	• can be wire, coax or fibre
call set-up protocols	• ITU-T I.365/X.36

12.2.7 SMDS (CBDS in ETSI)

SMDS is a circuit-switched digital network

SMDS can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by SMDS, is shown in figure 16.

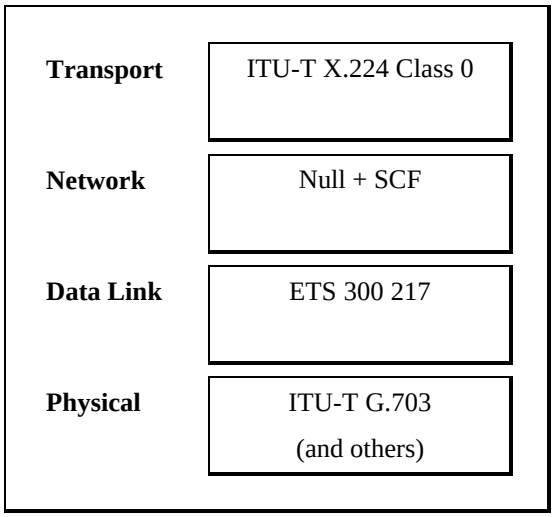


Figure 16: SMDS protocol stack

- ITU-T G.703 [97]: Physical/electrical characteristics of hierarchical digital interfaces;
- ETS 300 217 [102]: Connectionless Broadband Data Service (CBDS);
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport service;
- SCF: Synchronization and Convergence Function.

Table 39: Service attributes of SMDS

Attribute	Value
information transfer mode	cell
information transfer rate	up to 155 Mbit/s
information transfer capability	• unrestricted digital information • video (isochronous SMDS only)
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical
type of user information	• text
synchronous/asynchronous	• synchronous
structure	• cell
UNIs	• ITU-T G.703 and others
call set-up protocols	• ETSI 300 217 specification

12.2.8 LANs

LANs are a connectionless digital local network ideally suited for datacommunications. LANs can support multimedia services but primarily are used in the support of monomedia services. The protocol stack for these service are depicted in figure 17.

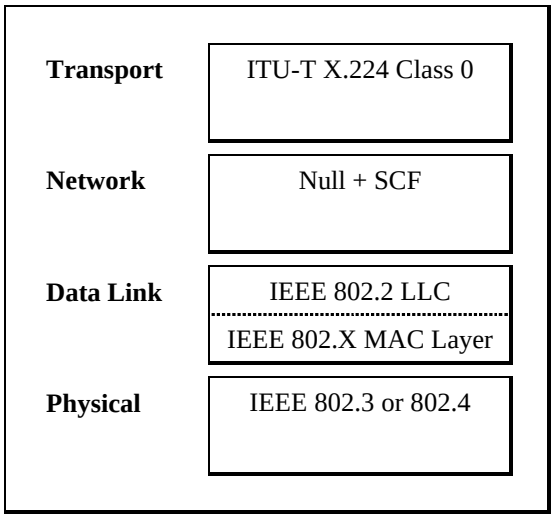


Figure 17: LAN protocol stack

- IEEE 802.2: Logical Link Control (LLC);
- IEEE 802.3: Ethernet;
- IEEE 802.4: Token Ring;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 40: Service attributes of LANs

Attribute	Value
information transfer mode	• connectionless
information transfer rate	• variable depending on loading
information transfer capability	• unrestricted digital information
establishment of connection	• demand
symmetry	• symmetrical
type of user information	• text • facsimile • videotex
synchronous/asynchronous	• synchronous
structure	• LAN messages (IEEE 802)
UNIs	• Media Access Units (IEEE 802)
call set-up protocols	• IEEE 802 series

12.2.9 ATM to the desktop and B-ISDN

ATM is a connection-oriented and connectionless digital network ideally suited for isochronous communications, such as:

- full-duplex voice communications (using PCM encoded 3,1 kHz speech);
- full-duplex data communication (including still image and video).

ATM can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by ATM, is shown in.

B-ISDN is a connection-oriented and connectionless digital network ideally suited for isochronous communications, such as:

- full-duplex voice communications (using PCM encoded 3,1 kHz speech);
- full-duplex data communication (including still image and video).

B-ISDN can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by B-ISDN, is also depicted in figure 14.

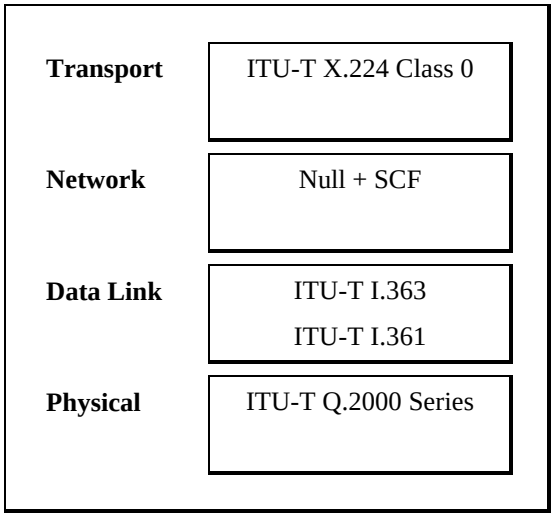


Figure 18: ATM protocol stack

- ITU-T Q.2000 Series: Broadband ISDN;
- ITU-T I.361 [100]: B-ISDN ATM layer specification;
- ITU-T I.363 [101]: B-ISDN ATM adaption layer specification;
- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 41: Service attributes of ATM

Attribute	Value
information transfer mode	• circuit switched • packet switched and connectionless
information transfer rate	• circuit-mode transfer • packet mode transfer
information transfer capability	• unrestricted digital information • speech • audio (3,1 kHz, 7 kHz or 15 kHz) • video
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical and asymetrical
type of user information	• speech • sound • text • facsimile • videotex • video • TV
synchronous/asynchronous	• synchronous and/or asynchronous
structure	• cell
UNIs	• ITU-T Q.2000 series
call set-up protocols	• Layer 1 - ITU-T Q.2000 series • Layer 2 - ITU-T Q.2921 • Layer 3 - ITU-T Q.2931

12.2.10 Cable TV

A Cable TV network is:

- full-duplex voice communications (using PCM encoded 3,1 kHz speech);
- full-duplex data communication (including still image and video).

A cable TV network can support multimedia services, such as multipoint communication service for audiographics and audiovisual conferencing. The protocol stack for this multimedia service supported by a ISDN, is shown in figure 19.

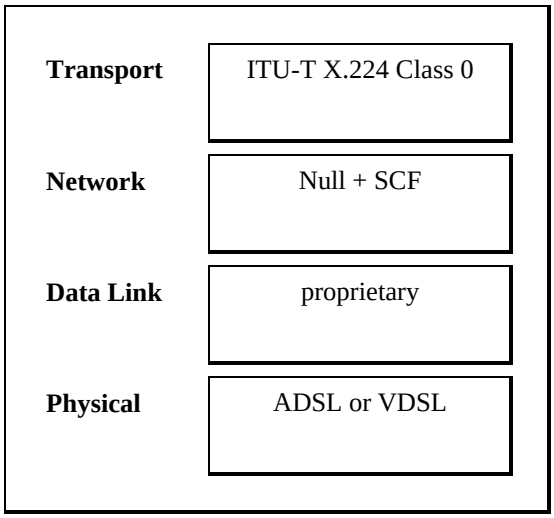


Figure 19: Cable TV network protocol stack

- ITU-T X.224 [49]: Protocol for providing the OSI connection-mode transport services;
- SCF: Synchronization and Convergence Function.

Table 42: Service attributes of Cable-TV networks

Attribute	Value
information transfer mode	• varies
information transfer rate	• varies
information transfer capability	• unrestricted digital information • speech • audio (3,1 kHz, 7 kHz or 15 kHz) • video
establishment of connection	• demand • semi-permanent • permanent
symmetry	• symmetrical
type of user information	• speech • sound • text • facsimile • videotex • video • TV
synchronous/asynchronous	• synchronous
structure	• varies
UNIs	• Cable TV (wire, coax or fibre)
call set-up protocols	• not standardized

13 List of demands of multimedia environments

The present document tries to filter out the demands and issues imposed by the different categories of multimedia applications, users, media, services and networks in order to come to a list of requirements the generic PCI shall provide.

13.1 Demands of multimedia application classes

The requirements for PCIs depend on:

- information interchange type (real-time or non real-time, as introduced in ETR 084 [7]);
- security;
- connectability;
- independence from network aspects;
- connection types.

Table 43 gives the requirements list:

Table 43: Requirements list for demands of multimedia application classes

Real-time information interchange	Non real-time information interchange	Security	Connectability	Independence from network aspects	Connection types
• Demand of bandwidth • Dynamic allocation of bandwidth • Demand of synchronization • Demand of flow control • Transparent exchange of objects • Multiplex capabilities • Transparent data compression	• Demand of bandwidth • Dynamic allocation of bandwidth • Demand of flow control • Multiplex capabilities • Transparent data compression	• Authentication • Signature • Partial encryption • Charging information (network) • Charging information (service provider)	• Optional codec capabilities • Connectability to external devices (handset, VCR, smart card reader, etc.) • Operating System independence • Ability to be easily extended	• Connectability on demand • Transparent connect and disconnect • Transparent addressing capability	• Symmetric / asymmetric interactivity considerations • Point-to-point and point-to-multipoint capabilities • Capability to act as the starting or the ending point of a connection

13.2 Demands of users

The requirements for PCIs depend on:

- information interchange type (real-time or non real-time, as introduced in ETR 084 [7]);
- security;
- connection types.

Table 44 gives the requirements list:

Table 44: Requirements list for demands of users

Real-time information interchange	Non real-time information interchange	Security	Connection types
• Demand of bandwidth • Dynamic allocation of bandwidth • Demand of synchronization • Transparent exchange of objects	• Demand of bandwidth • Dynamic allocation of bandwidth	• Authentication • Signature • Partial encryption • Charging information (network) • Charging information (service provider)	• Symmetric / asymmetric interactivity considerations • Point-to-point and point-to-multipoint capabilities • Capability to act as the starting or the ending point of a connection

13.3 Demands of media

The requirements for PCIs depend on:

- information interchange type (real-time or non real-time, as introduced in ETR 084 [7]);
- connectability;
- independence from network aspects.

Table 45 gives the requirements list:

Table 45: Requirements list for demands of media

Real-time information interchange	Non real-time information interchange	Connectability	Independence from network aspects
• Demand of bandwidth • Dynamic allocation of bandwidth • Demand of synchronization • Demand of flow control • Transparent exchange of objects • Multiplex capabilities • Transparent data compression	• Demand of bandwidth • Dynamic allocation of bandwidth • Demand of flow control • Multiplex capabilities • Transparent data compression	• Optional codec capabilities • Connectability to external devices (handset, VCR, smart card reader, etc.)	• Transparent data compression

13.4 Demands of services

Only videoconferencing and corporate document handling services have been considered. The demands derived result in:

- provision of ITU-T Recommendation T.122 (MCS) conforming functionality;
- provision of ITU-T Recommendation T.124 (GCC) conforming functionality;
- provision of ITU-T Recommendation X.214 conforming primitives.

13.5 Demands of network

The following network protocol stacks need to be considered when designing standardized PCIs:

- N-ISDN;
- GSM;
- SMDS (CBDS);
- LANs;
- ATM to the desktop;
- public ATM (B-ISDN);
- Cable TV.

In addition the use of X.25 PLP at layer 3 has to be taken into account.

N-ISDN uses a separate channel in which to set up a call. For N-ISDN applications that require multiple links and/or channel aggregation (e.g. videoconferencing), control of call set-ups is also needed by the application through the PCI.

Annex A: Glossary

ADSL: Asymmetrical Digital Subscriber Line. ADSL is an enhanced system developed for high bitrate transmission on twisted pair copper cables.

B-ISDN: Broadband ISDN. This type of network supports everything that any of the other networks support and can carry information at up to 622 Mbit/s.

Cable TV: This type of network was primarily intended to provide broadcast TV to homes. Not to be confused with CATV.

CATV: Community Antenna TV, which is a TV antenna/aerial distribution system.

CSPDN: Circuit-Switched Public Data Network. CSPDNs are the X.21-based data networks.

Frame Relay: Although originally specified as a service of N-ISDN, Frame Relay networks now exist in their own right and are being used as the replacement for applications that would normally use packet-switched networks (both public and private).

GSM: Global System for Mobile communications. A digital mobile telephony network with a data service based (for the time being) on 9,6 kbit/s bandwidth.

LAN: Local Area Network. This type of network deliver applications and services to the desktop and operate at data rates up to 100 Mbit/s.

N-ISDN: Integrated Services Digital Network; Narrowband - to distinguish it from the Broadband version.

PSPDN: Packet-Switched Public Data Network. PSPDNs are the X.25-based networks.

PSTN: Public Switched Telephone Network. This is the general telephone network with analogue local loops, also known as Plain Old Telephone Service (POTS).

SMDS: Switched Multimegabit Data Service; CBDS (Connectionless Broadband Data Service) in ETSI. These are digital end-to-end networks operating at rates up to 140/155 Mbit/s providing a connectionless data service. Information is sent in packets (at layer 3).

Annex B: Bibliography

The following material, though not specifically referenced in the body of the present document, gives supporting information.

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History

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