ECMA
EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

REQUIREMENTS FOR ACCESS TO INTEGRATED VOICE AND DATA LOCAL AND METROPOLITAN AREA NETWORKS

ECMA TR/51

June 1990

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BRIEF HISTORY

Recognizing that the introduction of fully integrated services networks will not take place for some years, it is considered desirable to identify, from the user service viewpoint, the evolutionary path that would lead to this introduction in a graceful fashion.

Consideration of the services leads to study of the required network performance, which in turn leads to examination of the available performance of building wiring and the associated regulations that govern building wiring from country to country.

Consideration has also to be given to the emerging demands of users for management facilities on their networks and the growing need for security of information, especially where transmission may be provided via a third party network.

The result of these considerations is presented in this ECMA Technical Report.

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TABLE OF CONTENTS

	Pages
SECTION I - GENERAL	1
1. SCOPE	3
2. FIELD OF APPLICATION	3
3. REFERENCES	4
3.1 ECMA Publications	4
3.2 CCITT Recommendations	4
3.3 ISO Publications	5
3.4 IEEE Publications	5
3.5 Other Publications	6
4. DEFINITIONS	6
4.1 Access Unit (AU)	6
4.2 Asynchronous Transfer Mode (ATM)	6
4.3 Bridge	6
4.4 C - channel	6
4.5 D - channel	6
4.6 H - channel	6
4.7 Hub	6
4.8 Integrated Services Network	6
4.9 Multiservice Network	7
4.10 P - channel	7
4.11 Work station (WS)	7
5. INTRODUCTION	7
6. OBJECTIVES	7
6.1 Traffic Classification	7
6.1.1 Quality of Service Parameters	8
6.1.2 Classification of Subnetwork Performance and Application Requirements by Traffic Type	9
6.2 First Generation	13
6.2.1 Considerations	13
6.2.2 Recommendations	16
6.3 Subsequent Generations	16
6.3.1 Backbone Networks	17
6.3.2 Services	18
6.3.3 Technico-economic Aspects	26

7. GENERAL CONSIDERATIONS 26

7.1 Management 26
7.2 Addressing 27
7.3 Synchronization and Framing 27
7.4 Security 27

SECTION II - FIRST GENERATION 29

8. REFERENCE SCENARIOS 31

8.1 Access to Separate Data LAN and ISPBX Networks 31
8.2 Access to a Single Multi-service LAN/MAN Network 32
8.3 Access to Separate Public or Private Data LAN and Public ISDN Networks 32

9. ACCESS UNIT FUNCTIONALITY AND MODELLING 33

9.1 Access to Separate Data LAN and ISPBX Networks 33

9.1.1 Multiple Access Unit Separate from ISPBX 33
9.1.2 Access Unit as part of ISPBX 37

9.2 Access to a Single Multi-service LAN 37

10. EMC 38

SECTION III - SUBSEQUENT GENERATIONS 39

11. TYPICAL SCENARIOS 41

12. EMC 45

APPENDIX A - CABLING SURVEY 47

APPENDIX B - COSTS ASSOCIATED WITH IVDLAN TECHNOLOGIES 57

APPENDIX C - LIST OF ABBREVIATIONS AND ACRONYMS 61

SECTION I - GENERAL

1. SCOPE

This Technical Report is concerned with recommendations for the service requirements of an interface between user terminal equipment and an integrated voice-and-data network. The interface requirements are intended to be independent of the nature of the terminal equipment (integrated service workstation, data terminal and telephone, etc.) and of the technology of the network. Details of the implementation of the interface are beyond the scope of this Technical Report.

This Technical Report has the following objectives:

- to define the requirements of an interface which will support both continuous bitstream oriented (CBO) and delimited bitstring oriented (DBO) services;
- to provide for evolution from separate voice and data networks to full multi-service integrated networks with a minimum of re-definition of the interface;
- to provide a reference model for the combination of services and networks from CCITT ISDN Recommendations and LANs and MANs, typically to IEEE P.802 standards.

EMC performance is a critical factor in network design and must be considered at the system level, as well as at the level of individual components, such as cabling.

This Technical Report is limited to expressing anticipated EMC performance in terms of existing standard LANs.

Related Projects

Related projects include ESPRIT Project 43, standardization of integrated LAN services and service access protocols, the E-Interface, which concluded in November 1987 and the continuing studies in IEEE 802 and projects within the RACE programme, such as R1059 and DIVIDEND. Many of the proposals from the ESPRIT project have been incorporated into the work described by this Technical Report. It is also noted that ISO/IEC JTC1 SC6 has invited member bodies to submit contributions identifying existing work in the area of high-speed multi-service PISNs and interfaces to such networks, in support of its development of standards in this area. Contributions have identified a number of potential candidates including IEEE 802.6 (DQDB), FDDI-II, and ORWELL.

2. FIELD OF APPLICATION

This Technical Report is intended to identify the requirements of a user having access to a variety of public and private telephony and data network services. Currently, a typical example would be a PBX and a LAN. This could be expected to evolve as the public ISDN is introduced, to a PBX extending the ISDN (ISPBX) and, possibly, a higher speed LAN/MAN. In a similar time scale one can expect the introduction of LANs/MANs carrying voice and other isochronous services. In the longer term, network implementations are expected to be dominated by the introduction of the broadband ISDN.

The services may be conveyed over separate subnetworks, a common physical interface unit, or over a truly integrated network. The services that are required by the user are likely to remain substantially constant in the near- to mid- term and to be augmented rather than radically altered by the introduction of broad-band transmission techniques. Against this background, the application of this Technical Report is to provide a reference of user requirements in these distinct phases that may be realized as a user to network interface, independent of the technology of the network and independent of the nature of the terminal equipment at the user's disposal.

3. REFERENCES

3.1 ECMA Publications

ECMA-97	Local Area Networks - Safety Requirements
ECMA-103	Physical Layer at the Basic Access Interface between Data Processing Equipment and Private Switching Networks
ECMA-104	Physical Layer at the Primary Rate Access Interface between Data Processing Equipment and Private Circuit Switching Networks
ECMA-105	Data Link Layer Protocol for the D-channel of the S-Interfaces between Data Processing Equipment and Private Circuit Switching Networks
ECMA-106	Layer 3 Protocol for Signalling over the D-channel of the S-Interfaces between Data Processing Equipment and Private Circuit Switching Networks
ECMA TR/14	Local Area Networks, Layers 1 to 4 Architecture and Protocols
ECMA TR/24	Interfaces between Data Processing Equipment and Private Automatic Branch Exchange - Circuit Switching Application
ECMA TR/43	Packetized Data Transfer in Private Switching Networks
ECMA TR/44	An Architectural Framework for Private Networks

3.2 CCITT Recommendations

I.320	ISDN Protocol Reference Model
I.331	Numbering Plan for the ISDN Era (E.164)
I.412	ISDN User to Network Interfaces, Interface Structures and Access Capabilities
I.430/1	Basic/Primary User to Network Interface, Layer 1 Specification
I.440	ISDN User to Network Interface, Data Link Layer - General Aspects (Q.920)

I.441	ISDN User to Network Interface, Data Link Layer Specification (Q.921)
I.450	ISDN User to Network Interface, Layer 3 - General Aspects (Q.930)
I.451	ISDN User to Network Interface, Layer 3 Specification (Q.931)
X.25	Interface between DTE and DCE for Terminals Operating in Packet Mode and Connected to PDN by Dedicated Circuit
X.31	Support of Packet Mode Terminal Equipment by an ISDN (I.462)

3.3 ISO Publications

ISO 8802-2	Local area networks - Logical link control
ISO 8802-3	Local area networks - Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications
ISO 9314-1	Fibre Distributed Data Interface - Token Ring Physical Layer Protocol
ISO 9314-2	Fibre Distributed Data Interface - Token Ring Media Access Control
DIS 8802-4	Local area networks - Token-passing bus access method and physical layer specifications
DIS 8802-5	Local area networks - Token ring access method and physical layer specifications
DIS 8802-7	Local area networks - Slotted ring access method and physical layer specification
DIS 9314-3	Fibre Distributed Data Interface - Physical Layer Medium Dependent requirements

3.4 IEEE Publications

IEEE 802.3	Physical Signalling, Medium Attachment and Baseband Medium Specifications:
	Type 1BASE5 ("StarLAN") (ISO IS 8802-3 DAD)
	Type 10BASET (draft standard in IEEE)
	Type 10BASE2 ("Cheapernet")
	Type 10BASE5 ("Ethernet")
	Type 10BROAD36
IEEE 802.6	Draft 1, Confirmatory Ballot
IEEE 802.9	Project Authorization Request, IEEE Plenary, November 1986; Draft, D8, January 1990

3.5 Other Publications

IEC/CISPR	IEC/CISPR Publication No. 22, "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment", 1985
RACE	RACE Definition Phase Project 1006 Final Report, December 1986
	RACE Extension Phase Project 1006 Final Report, July 1987
	RACE 89
ESPRIT	ESPRIT Project 43, Standardization of Integrated LAN Interface and Service Access Protocols, Final Report, available from Philips International TDS/ETRS, Hilversum, the Netherlands

4. DEFINITIONS

4.1 Access Unit (AU)

A device which offers an interface between the users' terminal equipment and the transmission medium or media.

4.2 Asynchronous Transfer Mode (ATM)

See CCITT Rec. I.121

4.3 Bridge

A functional unit that interconnects two or more Local Area Networks that use the same LLC protocol but may use different MAC protocols.

4.4 C - channel

A 64 kbit/s channel that may, under the user's control, be aggregated with other C - channels to support wider bandwidth, CBO channels, such as H - channels.

4.5 D - channel

The channel that is either logically or physically reserved to carry ISDN signalling and control information.

4.6 H - channel

Continuous bitstream oriented channels at predetermined bandwidths, that are supported by the ISDN, but do not have associated signalling or control information.

4.7 Hub

A unit which broadcasts all received bits to the LAN segments attached to it.

4.8 Integrated Services Network

A network that carries traffic on a common medium, independent of the type of service supported.

4.9 Multiservice Network

A network that carries two or more services over one or more media. The user is not necessarily aware of the existence of additional media.

4.10 P - channel

A channel dedicated primarily to user packet data, it may in some implementations carry ISDN signalling and control information.

4.11 Work station (WS)

A work station is seen as a single unit, or also as separate units, that contain the terminal equipment and the terminal adaptor.

5. INTRODUCTION

This Technical Report considers the emergence of multi-service networks from the point of view of the user. Multi-service networks may be realized as combinations of one or more networks offering different services or as hybrid or fully integrated service networks. Similarly, users may have a range of terminal equipment or an integrated service workstation. These scenarios are seen as evolutionary paths, new services being added to those existing rather than replacing them. This Technical Report aims to identify the services being introduced against this evolutionary background, to classify them by traffic type and to describe the requirements that are imposed on a network if it is to support these services. Typical scenarios are described and supplementary information given on the related issues of costs of cabling users premises and the regulations and practices that apply in some European countries. See Appendices A and B of this Technical Report.

6. OBJECTIVES

The objectives to be met by the requirements for integrated voice and data access will be determined by a number of factors which will change as the services offered by the integrated services networks evolve. It is the intention of this Technical Report to propose requirements that are independent of the network technology and that will allow graceful evolution to multi-service networks.

6.1 Traffic Classification

This section introduces and anticipates the types of traffic that may be carried over an interface between a user and a multi-service private network. Parameters describing the quality of service are introduced and used to classify the types of traffic by a quality of service profile. There must be some element of subjective judgement in such a classification and the requirements of some traffic types may change, e.g. the increasingly stringent requirements of facsimile transmission as it evolves through groups I to IV.

6.1.1 Quality of Service Parameters

The following parameters may be used to describe the requirements of different types of application, and will also be used to classify the performance of different types of network:

- maximum transit delay,
- delay distribution,
- throughput,
- occupancy (burstiness),
- residual error rate.

6.1.1.1 Maximum Transit Delay (D)

Maximum transit delay is defined as the 99th percentile of all one-way transfer delays across the network.

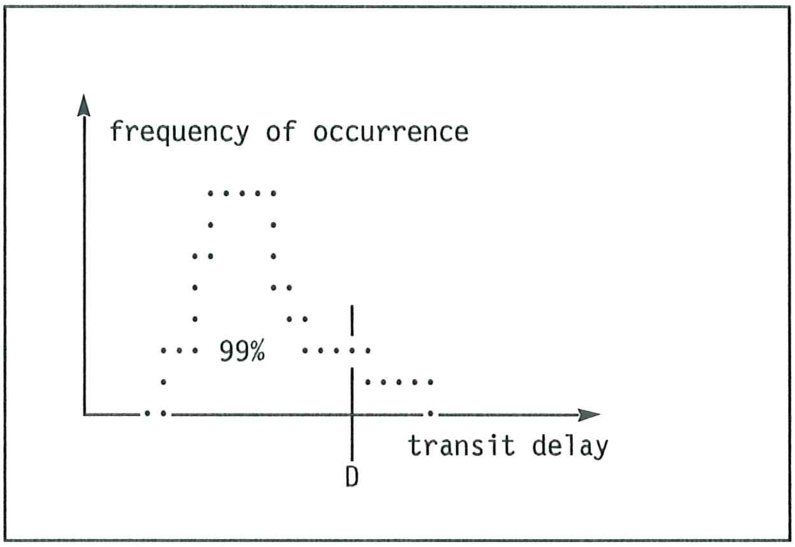


Figure 1 - Maximum Transit Delay (D)

6.1.1.2 Delay Distribution (P)

In some cases, notably where contention access systems are used, delay will follow a probability distribution. In these cases it may be necessary to characterize the transit delay distribution.

This distribution is expressed in terms of a percentage of the maximum delay (D) stated above.

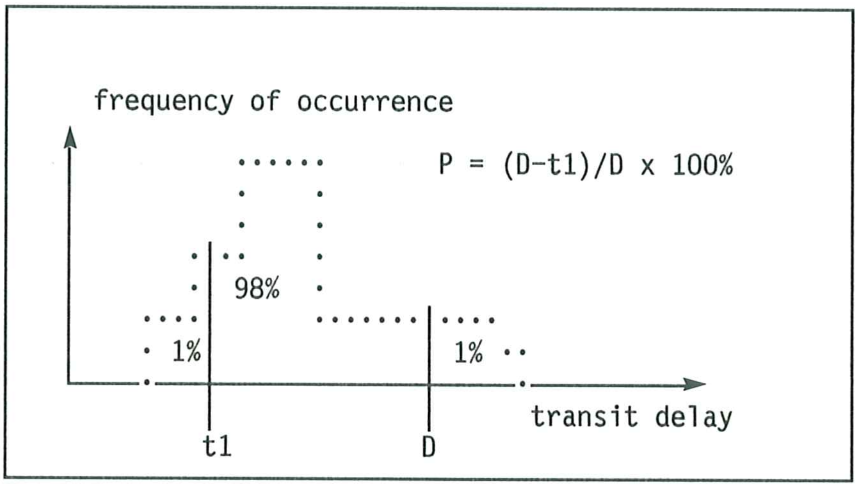


Figure 2 - Delay Distribution (P)

6.1.1.3 Maximum Throughput (T)

Maximum throughput is defined as the peak information rate that can be sustained for short periods of time.

6.1.1.4 Occupancy (O)

Throughput cannot always be assumed to be continuous. Many types of traffic will be characterized by short duration, high throughput bursts, interspersed with periods of low information transfer. This has considerable implications for network choice and design. Networks may have to offer a considerable margin over the total apparent throughput in order to cope with bursty traffic whilst under load. Expressing burstiness numerically is difficult. The approach taken here is to quote "occupancy" of the throughput demanded, i.e. the proportion of the time that the peak throughput is sustained, measured over the duration of a call.

6.1.1.5 Residual Bit Error Ratio (E)

The residual bit error ratio is the ratio of the number of bits in error to the number of transmitted bits, measured at the user to subnetwork service boundary.

6.1.2 Classification of Subnetwork Performance and Application Requirements by Traffic Type

The classification of both subnetwork performance and application requirements is inherently difficult due to their highly statistical and variable nature.

Subnetwork performance is characterized as the elements and quality of service provided by the subnetwork at the service boundary (b) in Figure 3.

The application or teleservice requirements are expressed at the application to presentation layer service boundary (or the equivalent for non-OSI conformant teleservices) and is indicated at (a) in Figure 3.

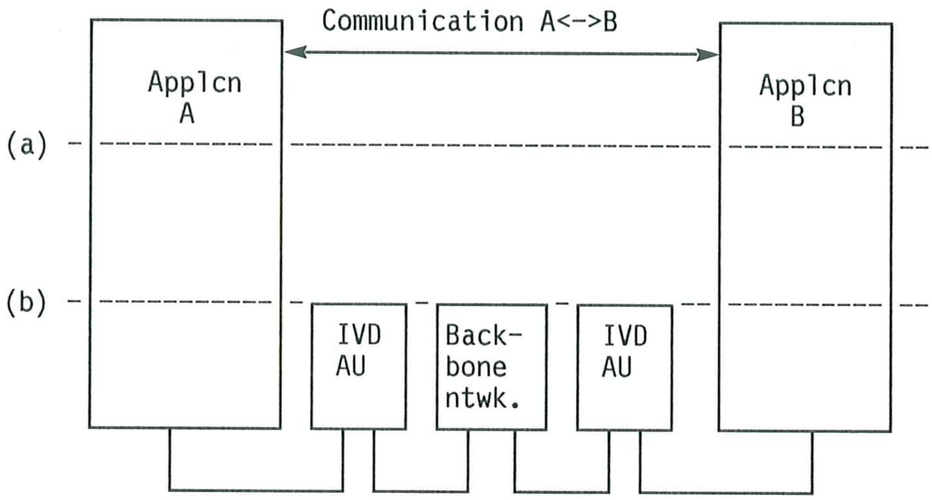


Figure 3 - Connection Schema

6.1.2.1 Classification of Subnetwork Performance

Subnetworks fall into three generic classes:

a) Continuous bitstream oriented (CBO)

This class of service involves the establishment of a connection with an associated delay and the subsequent supply of an information transfer service with an information transit delay.

In addition this class of service always offers 100% of the allocated channel bandwidth. Values given for the residual BER assume single-bit SDUs; they equate to the BER.

b) Connection-oriented - delimited bit string oriented (CO-DBO)

This class of service involves the establishment of a connection with an associated delay and the subsequent supply of an information transfer service with an information transit delay.

c) Connection-less - delimited bit string oriented (CL-DBO)

In this class of service there is no connect phase and therefore no resulting connection establishment time. The information transfer is usually impacted by competition for access to shared resources introducing a variable access time. This results in a broader transit delay distribution.

The characterization of the services in Table 1 should be regarded as a subjectively reasonable way of distinguishing one subnetwork service from another parametrically.

	Maximum transit delay D Note a)	Delay distri-bution P	Through-put bit/s T	Occupancy O	Residual BER E
PSTN	< 0,1s	< 0,1%	> 10K	100%	$< 10^{-3}$
X.21 type PDN	< 0,1s	< 0,1%	> 10K	100%	$< 10^{-6}$
ISDN with CBO on B-channel	< 0,1s	< 0,1%	> 10K	100%	$< 10^{-6}$
X.25 type PDN	< 1s	< 10%	> 10K	< 100%	$< 10^{-6}$ (Note (b))
ISDN with DBO on B-channel (TR/43)	< 1s	< 10%	> 10K	< 100%	$< 10^{-6}$ (Note (b))
IEEE 802.x type LANs	< 30ms	> 10%	> 1M	< 10% (Note (d))	$< 10^{-12}$ (Note (c))

Table 1 - Classification of Subnetwork Performance

Notes to Table 1:

(a) *Not taking into account satellite hops, or interconnection of more than one subnetwork via a different subnetwork technology.*

(b) *Figures given assume 128-octet SDUs and are typical values only; actual figures depend on average SDU size, and may depend on the topology and the loading of the subnetwork.*

(c) *Figure given assumes 128-octet SDUs and disregards possible frame loss, and represents a typical value only; actual figures depend on average SDU size, transmission medium, access method, topology and loading of the subnetwork.*

(d) *Typical value for an individual terminal accessing the LAN.*

6.1.2.2 Classification of Applications by Traffic Requirements

Table 2 below expresses application or teleservice requirements which are essentially subjective. In addition it does not attempt to characterize all possible scenarios which may be encountered. Information transfers may be seen as taking place within a "session". The frequency of occurrence and the duration of sessions are extremely variable in practice. These parameters are very important in identifying network traffic patterns and loads, they must be established along with the tabulated parameters in estimating subnetwork sizing.

All of the applications listed are considered to be connection oriented. The connection process is extremely varied and is very dependent upon the design of the application, therefore the delays recorded are exclusively the information transfer delays and do not include connection and application response times. Note also that some applications are "store & forward" based. In these cases, the transit delays quoted should be regarded as the delays between the user and the store & forward service, not user-to-user transit delays.

More than any other parameters, sensitivity to delay and residual error rate may be used to separate types of traffic into different categories.

Voice and video traffic are highly sensitive to delay, transit delay in the case of real time services and delay distribution in all cases. They are relatively tolerant of errors. Most data traffic is not sensitive to delay, the exception being process control where considerable damage can result if controller response is not quick enough.

It is conventional in data applications to provide some means of error detection and correction at one or more layers in the protocol stack. This trades reliability for some decrease in throughput and an increase in transit delay and delay distribution, the error control routine consuming some of the available throughput and increasing the transit delay. Table 2 below needs to be interpreted with a little caution; the required residual bit error ratio shown need not necessarily be delivered by the network itself, the transport layer can enhance an otherwise inadequate network.

	Maximum Transit Delay D	Delay Distri-bution P	Through-put (bit/s) T	Occupancy O	Residual BER E
Electronic mail (P1)	< 5s	> 10%	> 10K	> 1%	$< 10^{-9}$
Voice mail	< 1s	< 0,1%	> 10K	100%	$< 10^{-3}$
Bulk data transfer	< 5s	> 10%	> 10K	> 50%	$< 10^{-12}$
Dissemination of published material	< 10min	> 10%	> 1M	< 1%	$< 10^{-12}$
Teletex	< 30ms	> 10%	> 10K	> 1%	$< 10^{-6}$
Interactive data scan & retrieve	< 5s	> 10%	> 1M	> 1%	$< 10^{-9}$
Transaction process	< 1s	> 10%	> 10K	< 1%	$< 10^{-9}$
Word processing	< 30ms	> 10%	> 10K	> 1%	$< 10^{-9}$
Interactive graphics	< 1s	< 10%	> 1M	> 1%	$< 10^{-9}$
Process control	< 30ms	> 10%	> 10K	< 1%	$< 10^{-9}$
Conversational voice	< 30ms	< 0,1%	> 10K	100%	$< 10^{-3}$
Video conference	< 30ms	Note (b)	> 1M	100%	$< 10^{-3}$
Interactive TV (Video-phone)	< 30ms	Note (b)	> 1M	100%	$< 10^{-3}$
Facsimile (G3, G4) (Note (a))	< 1min	< 1%	> 10K	100%	$< 10^{-9}$
Tele-surveillance	< 1s	< 1%	> 10K	> 50%	$< 10^{-6}$
Std. Q. Broadcast TV	< 1s	Note (b)	> 1M	100%	$< 10^{-6}$
HQ broadcast TV (HDTV)	< 1s	Note (b)	> 200M	100%	$< 10^{-6}$
Telemetry	< 1min	> 10%	> 100	< 1%	$< 10^{-9}$

Table 2 - Classification of Application Requirements

Notes to Table 2:

(a) *Specific facsimile protocols, such as G3 and G4, may impose requirements for the transmission system that are more stringent than what follows from the figures given here.*

(b) *Current raster scan based display technology puts extreme requirements on the delay distribution; digital image processing and other display technology may be less demanding.*

6.2 First Generation

The objectives for access requirements to first generation LANs and MANs are developed in 6.2.1 and 6.2.2, below.

6.2.1 Considerations

i) Access requirements to voice and data LANs and MANs are aimed at the connection of general purpose office work stations to centralized and distributed data communication and telecommunication facilities in small, medium and large companies. Other, more specialized applications, may also use it, but the access requirements should not make any design trade-off for these low volume applications.

ii) First generation voice and data LANs and MANs are considered as emerging against a background of increasing penetration of PC based workstations and the ISDN. Hence the equipment to be supported per individual desk is seen as:

- a telephone handset and an associated PC based workstation via a terminal adapter;
- an IVDTE integrating the functions of a PC based workstation and a telephone handset, and incorporating adapter functions;
- basic rate ISDN telephone via an inexpensive terminal adapter.

It is important to note here that the access requirements should be able to serve office environments in which the penetration of PC type workstations and ISDN is rapidly progressing, but is still far behind the penetration level of PSTN telephone handsets.

iii) Per individual desk, the following application services need to be supported:

- ISDN compatible voice tele-service, 64 kbit/s A- or mu-law based (introduction of the separate techniques of packetized voice and lower bit rate encoded voice is not expected to influence first generation access requirements);
- other ISDN compatible tele-services, consisting of videotex, facsimile and teletex;
- access to ISDN compatible circuit and packet switched bearer services up to 2 Mbit/s, to include services such as new packet mode;
- access to LAN compatible data transmission services for use in the local environment, with a maximum throughput of around 2-4 Mbit/s per workstation.

These services may share the available bandwidth or may need to be supported concurrently leading to aggregate bandwidths in the region of 2 Mbit/s - 4 Mbit/s.

When these services are supplied to a number of desks / work stations via a common voice and data LAN or MAN, access rates of the order of 4 Mbit/s - 16 Mbit/s may be expected.

The introduction of newer WAN packet switching techniques such as Frame Mode Bearer Services are emerging as an important complement to X.25, allowing more common use of 64 kbit/s packet switched channels. The figure of 2 Mbit/s - 4 Mbit/s peak throughput is thought to be typical of enhanced workstations. Although current workstations may not use this bandwidth efficiently, the provision of greater bandwidth should be determined by considerations of cost, rather than current performance.

iv) Compatibility must be guaranteed with supported ISDN services, which implies that support must be provided for:

- LAPD,
- Q.931 signalling and E.164 addressing,
- 64 kbit/s bearer service isochronous channels and synchronization with 8 kHz clock.

Compatibility must also be guaranteed with the LAN services supported, requiring full MAC compatibility, including MAC addressing, and LLC transparency.

This effectively means that development activities should be concentrated on the physical layer and on the MAC layer and Data Link layer convergence protocols, to support both ISDN and IEEE 802 services over point-to-point physical links.

v) Per individual desk, the following transmission services need to be supportable:

- at least 2 isochronous channels of 64 kbit/s,
- a packet channel of at least 2 Mbit/s,
- an isochronous or packet channel for the support of the ISDN D-channel functions,
- channels which may be allocated under user control for additional isochronous or packet services.

vi) For a first generation IVDLA a star topology based on unshielded twisted pair is seen as the most attractive solution. Other options such as fibre or shielded twisted pair are seen as more expensive, but may be utilized where necessary e.g. to meet local EMC requirements, or expected future growth. In many applications the IVD LAN is expected to terminate in access units (AUs) placed in or close to distributed wiring centers. In a smaller number of applications the AU may be located near or in the PTNX.

vii) IVD LAN will be compared with:

- ISPBX (or PTNX) for applications requiring only ISDN services (where voice is the dominant service),
- and possibly, the combination of Basic Rate (BR) ISDN and 802.3 10BASET, 10BASE2, over the same cable bundle.

In order for an IVD LAN to be attractive, the following cost objectives should be met:

- the total cost per connected workstation for an IVD LAN supporting only ISDN services should be not significantly higher than the total cost per workstation for BR ISDN.
- the total cost per connected workstation for an IVD LAN supporting both ISDN and LAN services should be significantly lower than the total cost per workstation for the combination of ISDN and 802.3 10BASET or 10BASE2.

In determining the cost per connected workstation, the share of each port in the AU must be included. It is felt that the above requirements can be met by a modular design of the AU and integration of the concentration function in the AU (increasing the cost of the AU, but decreasing the cost per connected workstation). An IVD LAN offering isochronous channel support for the ISDN D-channel functions is expected to be cheaper for ISDN only applications than those offering support on a packet channel (Appendix B refers).

viii) An IVD LAN may be employed as an alternative to private implementations of ISDN. Conversion from PSTN to ISDN is expected to rise in the 1990s. In order for an IVD LAN to be accepted, products should be available in that time frame, i.e. early 1990s.

6.2.2 Recommendations

Effort should concentrate on:

i) the development of a first generation IVDLA operating in the region of 2 Mbit/s - 16 Mbit/s aggregate bit rate across the interface and supporting IEEE 802 LAN services, capable of supporting 2B + D - channels and a 2 Mbit/s - 4 Mbit/s LAN, based on star topology unshielded twisted pair wiring;

ii) a data link convergence function to provide ISDN and IEEE 802 LAN service.

6.3 Subsequent Generations

The main difference between the first generation IVDTE and subsequent generations is the capability of handling video information, either in the form of moving or still, high quality images. These capabilities are to be offered to the user by means of a number of new services (broadband services) mainly related to the transfer of image information.

Although some of these new services might require specialized terminals (e.g. video-conference) it seems unlikely that each service would require a specialized type of terminal. From this it may be deduced that the concept of Integrated Voice, Data & Image TE would play an important role in the broadband scenario. This kind of terminal is referred to as ISTE (Integrated

Service Terminal Equipment) and this term will be adopted for the remainder of this Technical Report.

Increasing use of ISTEs and their support for, and use of, these higher information rate services will lead to the need for higher performance "backbone" transport services. The previous generation of access to IVD LANs will frequently be able to support these higher information rate requirements, but in some more demanding cases, higher performance backbone based services may need to be supplied to the desks.

In the long term scenario, ATM (Asynchronous Transfer Mode) techniques are considered as the most suitable for the integration of services with very different traffic requirements.

6.3.1 Backbone Networks

The introduction of ISTEs and supporting networks will take place in a progressive way and therefore a number of communication networks will co-exist for an undetermined period. These networks can be divided into the following categories:

- Voice networks (PBX, PSTN),
- Data networks (LAN),
- Integrated private networks (ISPBX),
- Integrated public networks (ISDN),
- Integrated broadband private networks (CPN, MAN),
- Integrated broadband public networks (MAN),
- Specialized broadband networks (Cable TV),
- Integrated broadband public WANs (IBCN).

Note that some or all of these networks could be used, individually or in combination, as backbone networks.

A general scenario is shown in Figure 4. As there are a high number of access possibilities the AU functionality has to be carefully defined. In the long term scenario it can be assumed that, in the public side, the networks will evolve towards the IBCN, which will provide universal communication capabilities for every kind of service. The same idea will be applicable to the private area and the CPN-type networks will integrate the functionalities of current LANs and ISPBXs in a broadband environment.

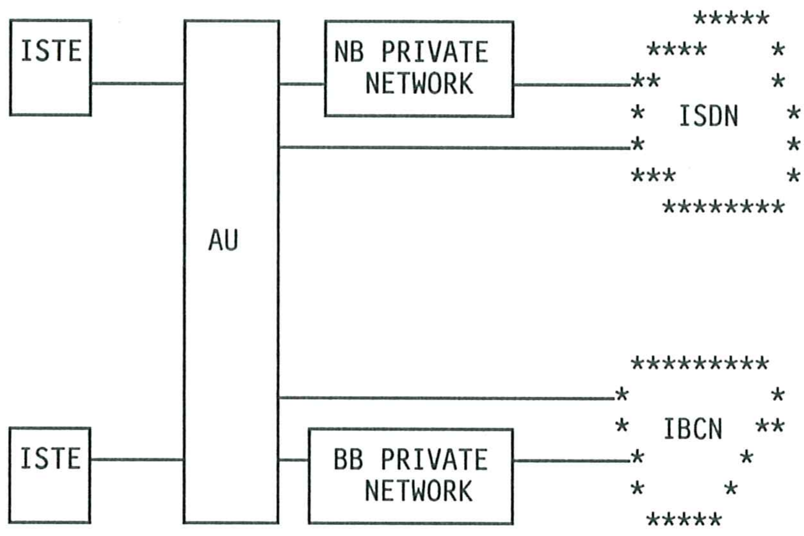


Figure 4 - Backbone Networks Scenario

6.3.2 Services

In order to define the requirements of an IVD LAN Access in relation to the mid-term time frame (i.e. 1995 - 2000) a classification and definition of telecommunication services is needed.

It is proposed here to use a similar approach to the RACE analysis of the terminal environment for the introduction of broadband services in Europe [reference: RACE Definition Phase Project 1006 Final Report, December 1986].

6.3.2.1 Evolution

One of the principles that will characterize the future IBC Network, will be the integration of distributive services in addition to interactive services that are supported by most narrowband networks. This implies that the number of user services supported will be very large; the user service mix will depend on the environment (residential, office, industrial, etc.).

The introduction of new services and the evolution towards IBC from the user services point of view is illustrated in Figure 5, which places emphasis on two important environments: the residential and the office.

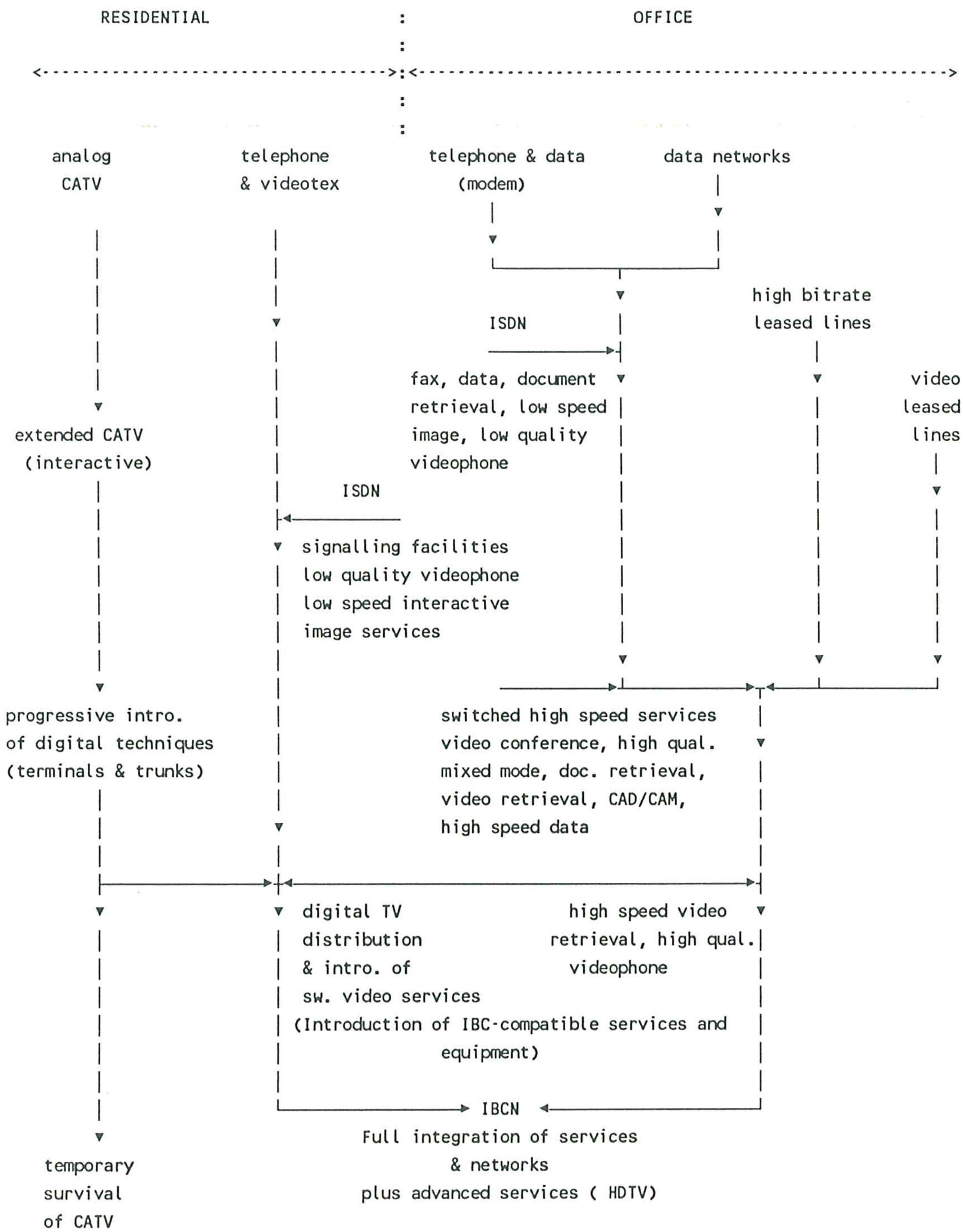


Figure 5 - Integration of Interactive and Distributive Services for Office and Residential Customers

6.3.2.2 Classification

A three-level structure is used to identify current and future telecommunication services:

1. **Applications**: these are activities which fulfil the needs of the end users by using telecommunication means, e.g. "tele-shopping", "tele-education", "home-banking", CAD/CAM.
2. **User Services**: these are the basic communication services, defined by e.g. CCITT, such as telephony, teletex, video-telephony, message handling services, telefax, etc. This would include LAN based filing and printing services.
3. **Service Components**: these are the building blocks of the user services, and are defined using three main attributes: types of communication; types of information; quality class.

Types of Communication:

* **Conversational (Conv)**

  CONV provides real-time, user-to-user information transfer. The transfer of information in each direction is controlled by the originator of that information. From a communication point of view, both users are equal and mutually interchangeable. Therefore, during the communication, the assignment of control is continuously negotiated.

* **Distributive (Dist)**

  DIST provides unidirectional, real-time, information transfer from one user (the originator) to one or more other users (destination(s)). The transfer of information is controlled by the originator. The distribution to more than one destination does not necessarily occur simultaneously. However, when this does occur, the distribution service is known as multicast.

* **Collective (Coll)**

  COLL provides unidirectional, real-time, information transfer from one or more users (originators) to one user (destination). The transfer of information is controlled by the destination.

Note that "store & forward" information systems retain the quality requirements of the corresponding real-time services, but without the restrictions on absolute delay.

Types of Information:

* **audio:**

  The transmission of voice and/or music, described as a scalar function of the variable time.

* **video:**

  Moving pictures, described as a vector (colour) or scalar (grey scale) function of at least three variables, one of which is the variable time.

* **image:**

  Still pictures, described as a vector (colour) or scalar (grey scale) function of at least two variables, but independent of time.

* **text:**

  Characters string.

* **graphics:**

  Synthetic images, described as a number of objects with attributes.

  Note that:

  i) text can be seen as a special case of graphics, in this case the character image description ("font") may be transmitted with the character codes.

  ii) the differentiation between video and graphics is for further study.

* **data:**

  Information that is essentially discrete in nature at the presentation to application layer boundary.

The foregoing classification identifies services as seen by the user and it is this classification that will be used in the identification of service requirements. There are some consequences for network implementation, as follows:

* digital transmission of audio information:

  may be obtained by sampling at constant time intervals, with the option of applying compression techniques;

* digital transmission of video and image information:

  may be obtained by scanning techniques, with the option of applying compression techniques.

Quality Class:

These classes are dependent on the type of information; some examples are shown in Table 3 below.

Type of Information	Quality class	Description
Audio	Standard	Current standard used in telephony (0,3 to 3,4 KHz)
	Extended	0,3 to 5KHz or 0,3 to 7 KHz
	HiFi (Note 1)	Equivalent to studio or compact disc quality (0,02 to 15 or to 20 KHz)
Video	Substandard	Low quality pictures with total bandwidth of the composite analogue picture signal(s) ≤ 1 MHz, e.g. Picturephone
	Standard	Total composite analogue signal bandwidth ≤ 10 MHz, e.g. * Broadcast TV (monochrome, NTSC, PAL, SECAM and their variations) * improved standards (E-MAC)
	High definition	Total composite analogue bandwidth > 10 MHz, e.g. high definition standards (HD-TV)
Image	p1	Pixel encoding for black and white image information
	p2	Pixel encoding for image information with a limited number (16) of grey scale levels
	p3	Pixel encoding for image information with an extended number (256) of grey scale or colour levels
Graphics	Character Sets (Note 2)	Text: character encoding for alphanumeric information Graphics: Synthetic images encoded in terms of objects with attributes
Binary Information	-	

Note 1:

Note that stereo or multi-channel audio information will require a number of channels of appropriate bandwidth.

Note 2:

Quality of text is a concept without rigid classification. It may be considered as a range beginning with the simplest, IA5, and progressing through richer sets to the ultimate, graphics.

Table 3 - Relation between Type of Information and Quality Classes

Taking into account this method of classification, some possible user services in an evolutionary scenario are shown in Tables 4a, 4b and 4c.

User Services	Information type					Quality class	Communic. type
	audio	vdeo	text	grph	data		
Telephony	* *					Std Ext	Conv Conv
Audio conference	* *					Std Ext	Dist Dist
Voice mailbox	* *					Std Ext	Conv/Dist Conv/Dist
Telefax		* *				p1 p2	Conv Conv
Teletex			*			Char	Conv
Interactive data procssng					*		Conv
Data acquisition					*		Coll
Data retrieval		 *	*		 *	p1 p2 p3	Conv/Coll Conv/Coll Conv/Coll
Data Transfer					*		Conv

Table 4a - Possible IBC User Services, also of interest in First Generation Networks

User Services	Information type: audio	video	image	text	grph	data	Quality class	Communic. type
Video- telephony	*	 *					Std Substd	Conv
	*	 *					Ext Std	Conv
Video conference	*	 *					Std Substd	Dist
	*	 *					Ext Std	Dist
Telefax			*				p3	Conv
Teletex mixed mode			*	*	*		Char	Conv
Video surveillance		* *					Std Substd	Dist Dist
Video Mailbox	* *	* *					Std HiFi/HD	Conv/Dist Conv/Dist
Video retrieval	*	 *					Ext Std	Conv/Dist
	*	 *					HiFi HD	Conv/Dist

Table 4b - Possible additional IBC User Services

User Services	Information Type						Quality class	Communic. type
	audio	video	image	text	grph	data		
Audio surveillance	*						Std	Dist
Broadcast radio	* *						Ext HiFi	Dist Dist
Broadcast TV	*	*					Ext Std	Dist
	*	*					HiFi HD	Dist
Broadcast data			*	*		*	Char p1,2,3 bit	Dist Dist Dist
Mixed mode Broadcast			* * *	* * *			Char.p1 Char.p2 Char.p3	Dist Dist Dist

Table 4c - Some additional IBC User Services
(not considered to be in the scope of this Technical Report)

6.3.3 Technico-economic Aspects

The transmission and switching for the IBCN is Asynchronous Transfer Mode (ATM) including the interface at the S_B reference point, which is the access point of the station to the network. One of the main characteristics of ATM is the flexibility of the bandwidth allocation, depending on the needs of the terminals: one single terminal only uses the bandwidth that it needs, leaving free the rest for other stations, and allowing efficient use of the network resources.

The interface at the S_B reference point should support the introduction of additional services with higher information rates, new types of multi-service terminal equipment and technology evolutions with minimum impact on previous investments of the user, e.g. in simple terminals. This target must be accomplished in order to obtain an acceptable market size, especially at the introduction of IBCN. The characteristics of ATM are designed to achieve this goal.

With these considerations in mind it is believed that the evolution of interfaces for the new generation of terminals (single or multi-service) will be towards interfaces at the S_B reference point, without any intermediate generation between first generation integrated voice and data workstations and broadband ISTEs. In the interim period, broadband customer networks will provide interfaces to the then existing terminals, in a cost effective way.

7. GENERAL CONSIDERATIONS

7.1 Management

Management must be considered as an integral part of network design. In the case of integrated service networks, the special issue of bandwidth allocation must be addressed. Given that the mix of services and even the demand within services may vary, some form of flexible or dynamic allocation of bandwidth to services is necessary. Equivalence to Q.931 Layer 3 needs to be considered.

The bandwidth demand of isochronous services will be fixed by the nature of the service and allocated to CBO bandwidth. Packet based services may conceivably be allocated to P-, C- or D-channels. It is in this area that the network management must either perform some conversion between terminals wishing to communicate over different channels, or else monitor the allocation of services to channel type.

In the evolutionary scenario, it is anticipated that all services will be handled in a similar fashion, e.g. in an ATM format, and the problem of channel contention will not arise. Some management will still be necessary to match the possibly conflicting demands for bandwidth of services on different terminals.

7.2 Addressing

Two philosophies of addressing exist: public telephone networks traditionally identify the terminal location by use of a network address; in the case of ISDN this is a 60-bit address to E.164; ISO 8802 LANs use either a universal 48-bit MAC address, or a 16-bit local MAC address, identifying the user. In the case of integrated service terminal equipment this can lead to dual numbering, the number for data services being portable with the user and the address for voice and other traditional teleservices being associated with the location, although this may change with the advent of the "personal communication network". If digits are required from the public network to perform internal (private) network routeing, as in the case of Direct Dialling In (DDI), then a numbering range has to be obtained from the national telecommunications administration. If routeing is to be completely local to the private network there are no constraints on the scheme to be adopted.

One approach which may be considered is to make available an address field which may support 16-, 48- or 60-bit addresses at the user's choice, the scheme used indicated in a further header field. This approach may have some practical advantages to the network implementor. Concern has been expressed that using E.164 addresses at the MAC layer may lead to exhaustion of the 60-bit address range.

7.3 Synchronization and Framing

All digitally connected elements within the private network should be synchronized to the same clock source. Where the private network is connected to a higher order network from which a clock source is available, e.g. the ISDN, then this clock should be used as the synchronization source. In other cases a single element should be nominated as the master.

7.4 Security

In view of the probable applications of multiservice networks, e.g. dealer rooms, information conveyed on them may be expected to be sensitive, but unclassified i.e. not of national security. Since it is possible that such networks will pass through more than one user's premises, measures must be taken to ensure:

- confidentiality,
- integrity,
- acknowledgement, and
- sender authentication.

Physical security will not be sufficient in such cases, and measures such as encryption must be adopted.

Measures taken should conform to a recognized security architectural framework, e.g. the framework presently under development within ECMA TC32-TG9, or that under study in IEEE 802.10, or the content of ISO 7498 Part 2.

Guaranteed delivery, and guaranteed time of delivery of, e.g. broadcast messages, is seen as a function of network management.

SECTION II - FIRST GENERATION

8. REFERENCE SCENARIOS

With a view to supporting the range of services identified, the following reference configurations reflect the different types of networks possible on the network side of the Access Unit and are to be used as a guide in deciding on the requirements for interfacing to the different networks. These reference configurations are not intended to constrain or limit implementations but have been selected to show distinct connectivity plans. The terminal equipment shown in the diagrams demonstrate the range to be supported.

8.1 Access to Separate Data LAN and ISPBX Networks

This scenario shows separate interfaces to the network side of the access unit for ISPBX and data LANs. The voice and LAN data traffic from the terminal would be separated at the access unit and steered towards the appropriate network.

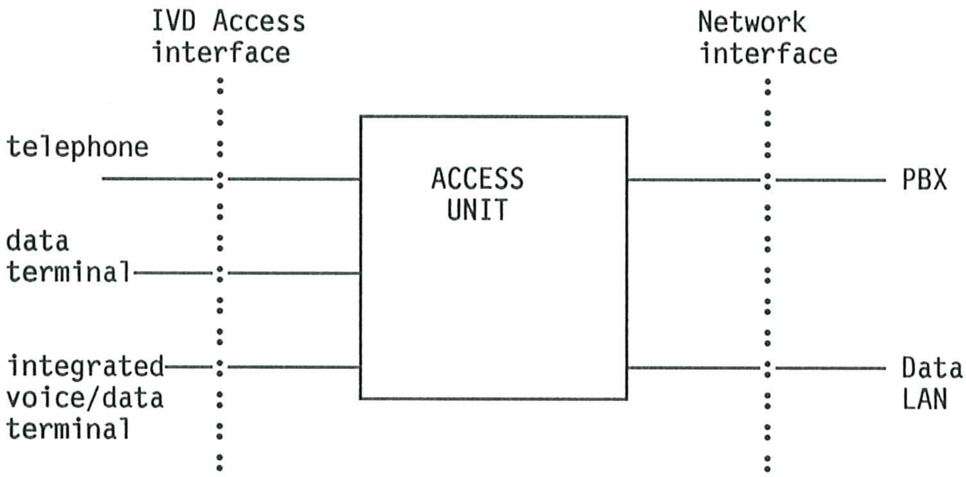


Figure 6 - Access Unit with separate interfaces for Private ISPBX and Private Networks

8.2 Access to a Single Multi-service LAN/MAN Network

In this scenario the access unit is connected to a multi-service LAN interface such as FDDI-II.

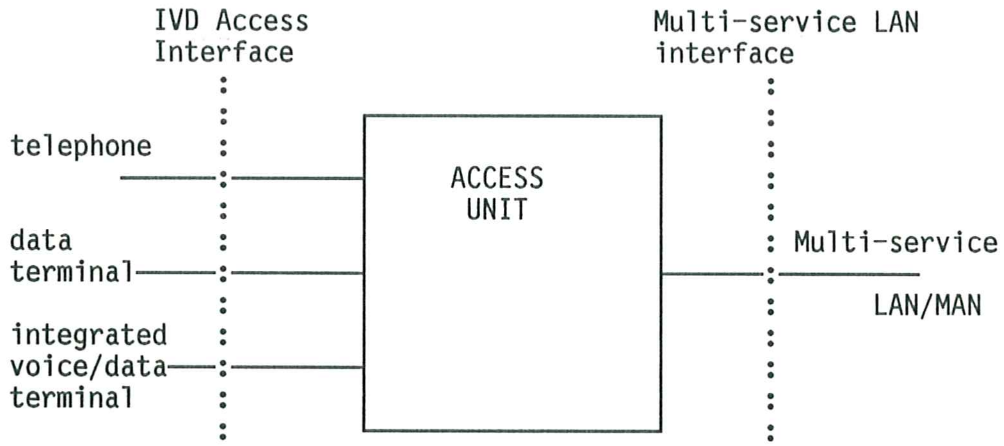


Figure 7 - Access Unit with single interface to Multi-Service LAN Network

8.3 Access to Separate Public or Private Data LAN and Public ISDN Networks

The access unit is connected to a central office and a data LAN.

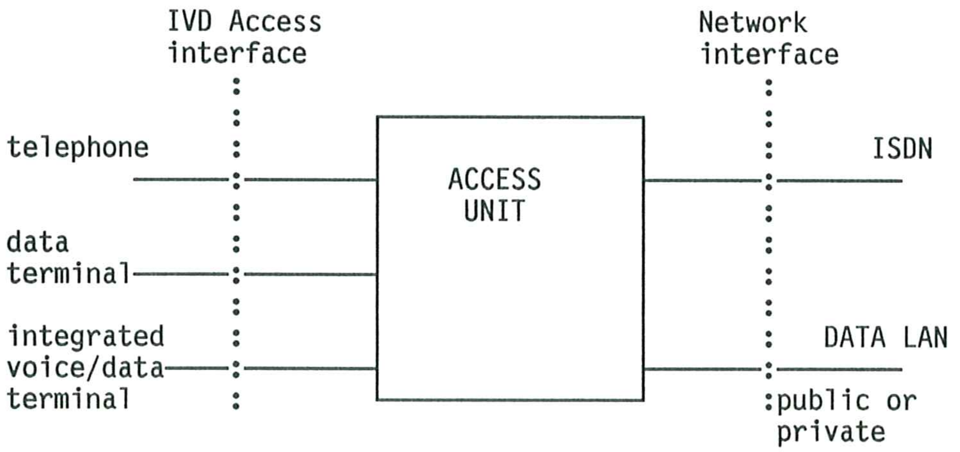


Figure 8 - Access Unit with separate interfaces for ISDN and Data Networks

9. ACCESS UNIT FUNCTIONALITY AND MODELLING

The functionality of the access unit for each of the scenarios in Clause 8 is now considered.

9.1 Access to Separate Data LAN and ISPBX Networks

This could be implemented as follows:

9.1.1 Multiple Access Unit Separate from ISPBX

Advantages of this reference configuration (see Figure 9):

* utilizes existing site wiring,
* minimum functionality in access unit,
* low cost.

Disadvantages of this reference configuration (see Figure 9):

* no true integration of services,
* for N x BRI, (1 < N < PRI) each terminal needs a separate physical connection between exchange and access unit (not a problem for PRI),
* no provision for isochronous channels of bandwidth > 64 kbit/s, unless H-channels are supported between access unit and ISPBX.

- The B- and D- channels are multiplexed and demultiplexed with the packet channel at the access unit;
- The access unit is transparent, above the PHY layer, to the B- and D- channels;
- The B- and D- channels are connected directly from the access unit to the ISPBX over unshielded twisted pair.

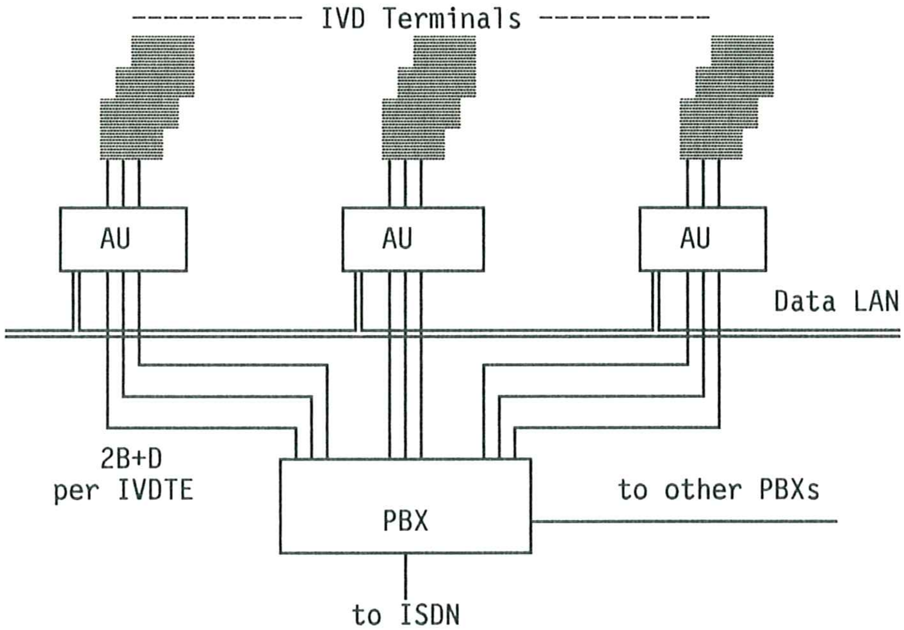


Figure 9 - Access Unit separate from ISPBX

The packet channel may be connected to the data LAN by:

A Hub alone (Figure 10):

* has an arbitration scheme for access to the LAN,
* the hub broadcasts all received packets to the terminals attached to the hub and to the LAN.

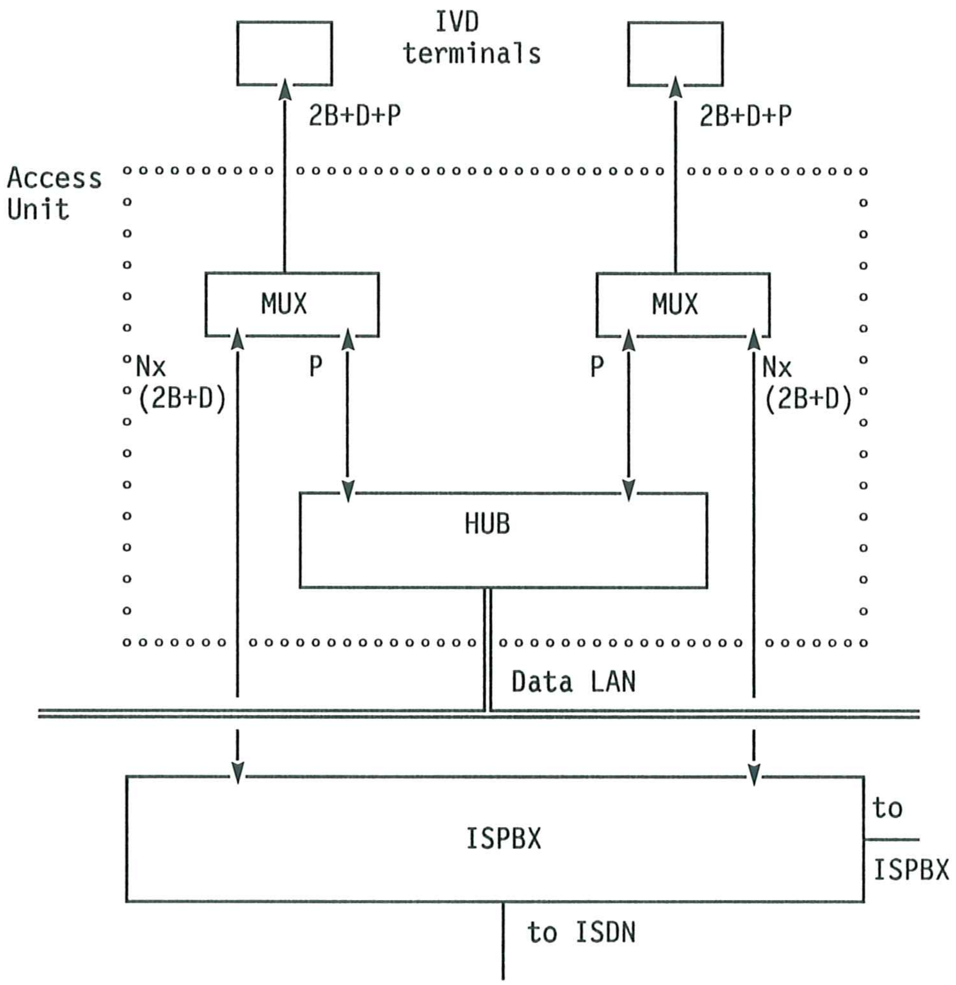


Figure 10 - Access to separate LAN and ISPBX Networks, using a Hub in the Access Unit

A Hub and Bridge (Figure 11):

* has an arbitration scheme for access to the hub,
* the hub broadcasts all received packets to the terminals attached to the hub and to the bridge,
* the bridge forwards all traffic not addressed to terminals on the hub to the appropriate access unit.

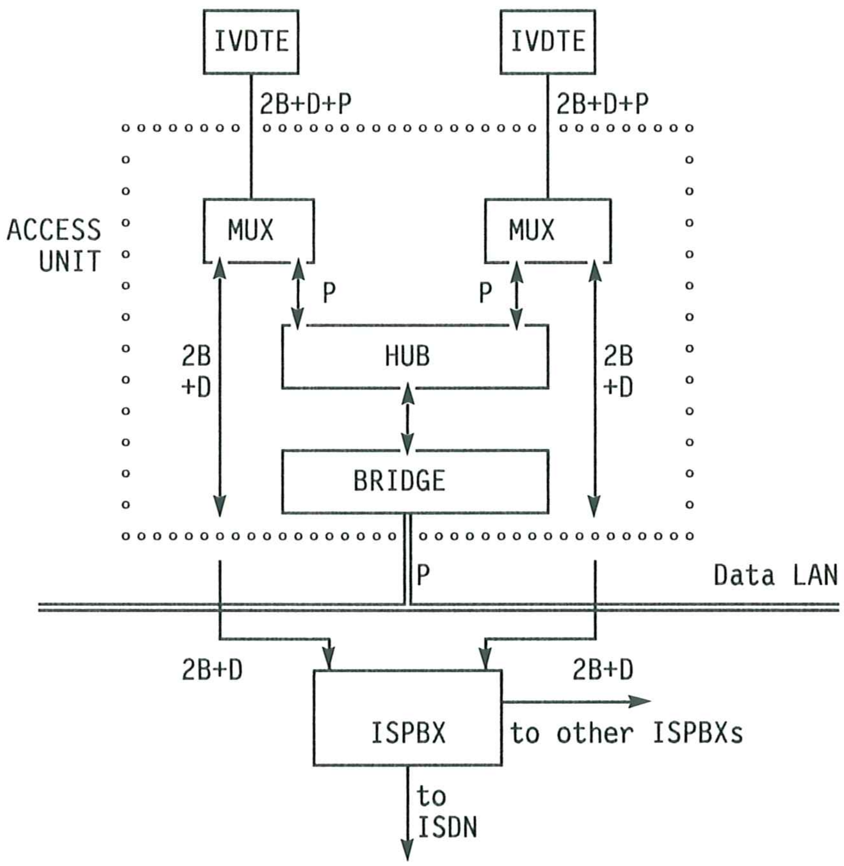


Figure 11 - Access to separate LAN and ISPBX Networks, using a Hub and a Bridge in the Access Unit

A Multiport Bridge (Figure 12):

The bridge is able to connect IVDTEs attached to the same access unit or forward packet traffic onto the backbone network.

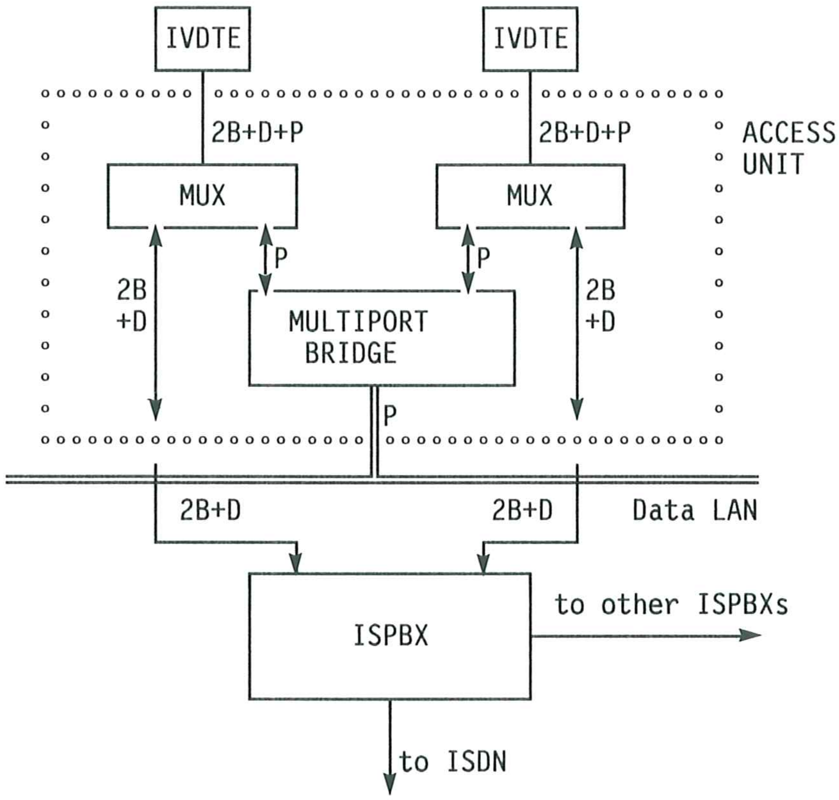


Figure 12 - Access to separate LAN and ISPBX Networks, using a Multi-port Bridge in the Access Unit

9.1.2 Access Unit as part of ISPBX

The B- and D- channels are separated from the packet channel at the ISPBX.

Advantages:

* the data LAN is contained within the ISPBX,
* central management.

Disadvantages:

* restricted choice of ISPBX.

9.2 Access to a Single Multi-service LAN

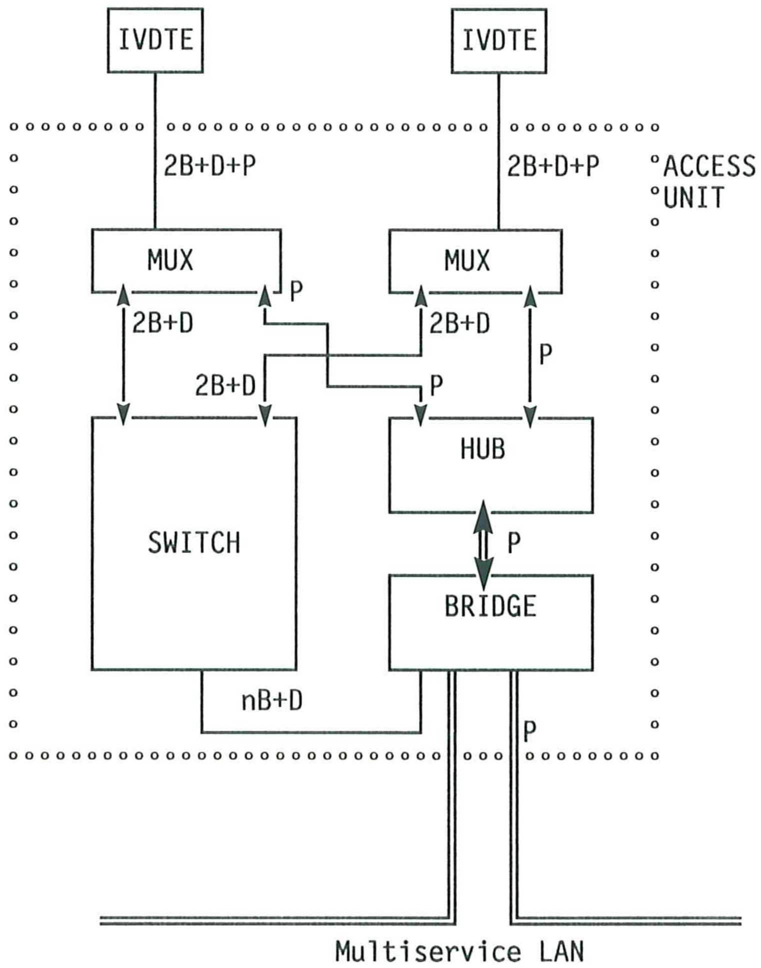


Figure 13 - Access to Multi-Service LAN, using a Hub and a Bridge in the Access Unit

10. EMC

The detailed specification of system implementation is beyond the scope of this Technical Report. However, known examples of implementation may be cited as instances of feasible performance. Elsewhere, suggested implementations are based on extrapolated performance and are clearly marked as such.

Examples (expected to meet FCC Class A RFI limits):

- 1BASE5, 1 Mbit/s over UTP up to 250 meters radius.
- 10BASE1, also known as 10BASET, 10 Mbit/s over UTP up to 100 meters radius.
- 10BASE2, 10 Mbit/s over "thin" coaxial up to 200 meters.
- 10BASE5, 10 Mbit/s over "thick" coaxial up to 500 meters.

NOTE 1

The examples given here are based on FCC RFI requirements. These may not correlate to the EC Technical Directive on EMC. Testing methods differ and differences will arise from the use of different mains voltages and frequencies. Both the FCC requirements and the EC Directive include limits for mains-borne conducted interference. CISPR SCG are understood to be looking at the problem of conducted interference on telecommunication cables.

SECTION III - SUBSEQUENT GENERATIONS

11. TYPICAL SCENARIOS

This Clause addresses the subject of typical backbone networks for evolutionary workstations.

For the analysis of user access in a broadband environment, different organizations such as CCITT, CEPT and RACE have established a reference configuration similar to the one used in ISDN (Figure 14).

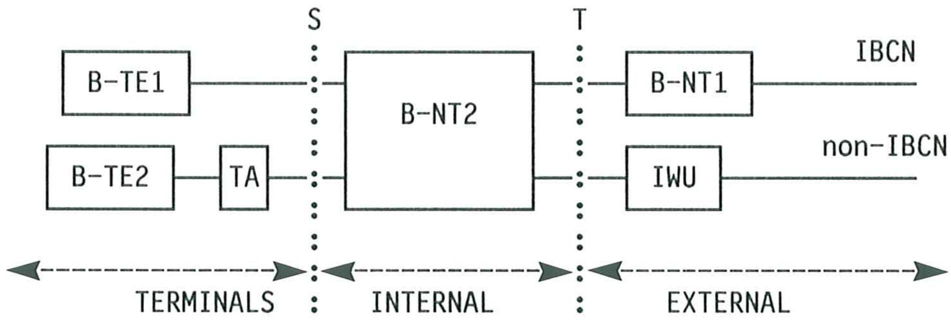


Figure 14 - Reference Configuration

In this configuration three areas can be considered from the point of view of the user: the terminal area, the internal network(s) and the external network(s). The letter B- is used to indicate that the corresponding functional grouping is able to support broadband services.

In the long term scenario it is expected that only one public external network will exist with private networks at the user premises with standardized interfaces at the S and T reference points. Until this ideal situation becomes reality it is likely that other external networks will coexist and may be accessed from the B-NT2 by an Inter-Working Unit (IWU).

For the same reason, within the user premises it will be possible to find different kinds of local networks not compatible with the standardized IBC interfaces at S and T. In order to analyze this situation, an extension to the previous model is shown in Figure 15.

In Figure 15 we can find the following elements:

- N-TE: Narrowband terminal (may be an IVD workstation).
- B-TE1: Broadband terminal with compatible interface at S reference point (S_B).
- B-TE2: Broadband terminal with non-compatible interface at reference point S. If connected directly to the B-NT2, these terminals need a terminal adaptor (TA).
- B-NT2: Broadband internal network with compatible interfaces at S and T reference points.
- Broadband internal network with non-compatible interfaces.
- Narrowband internal network (ISPBX, LAN, IVDLAN, etc.).

- B-NT1: Network termination for broadband public network (IBCN).
- IWU: Interworking unit for access to non-IBC internal or external networks.

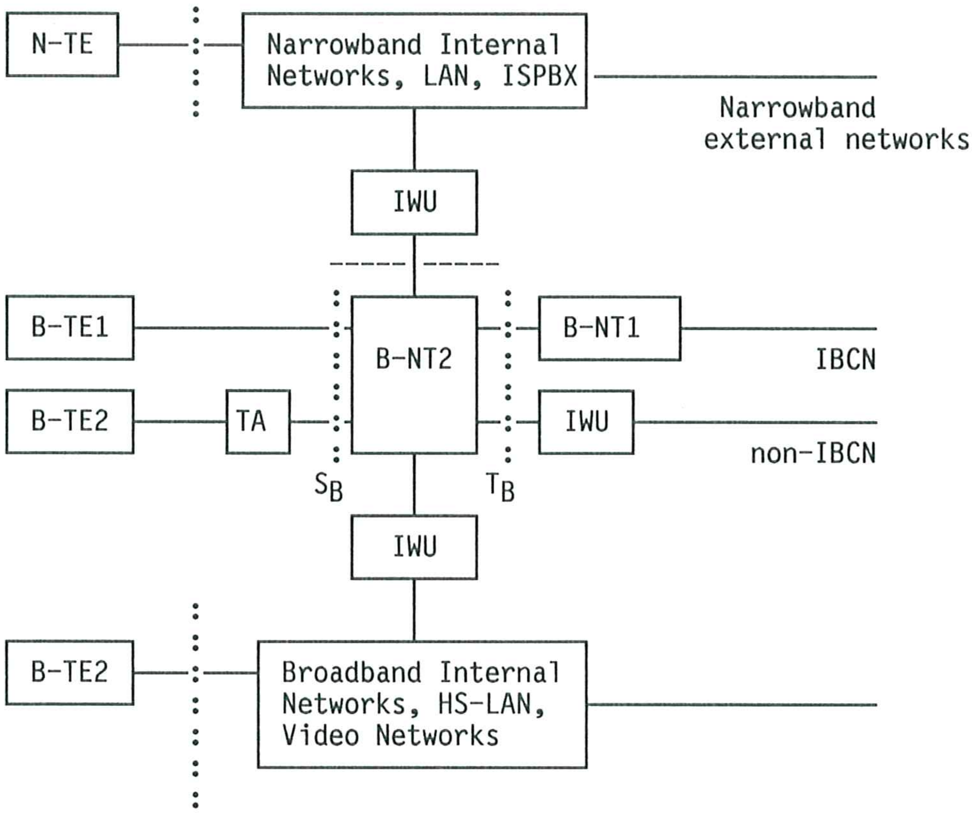


Figure 15 - Extended Reference Configuration : Scenario B

The basic configuration of Figure 15 can be used to illustrate the evolution of user equipment according to the introduction of broadband services by the public networks as summarized in Figure 16.

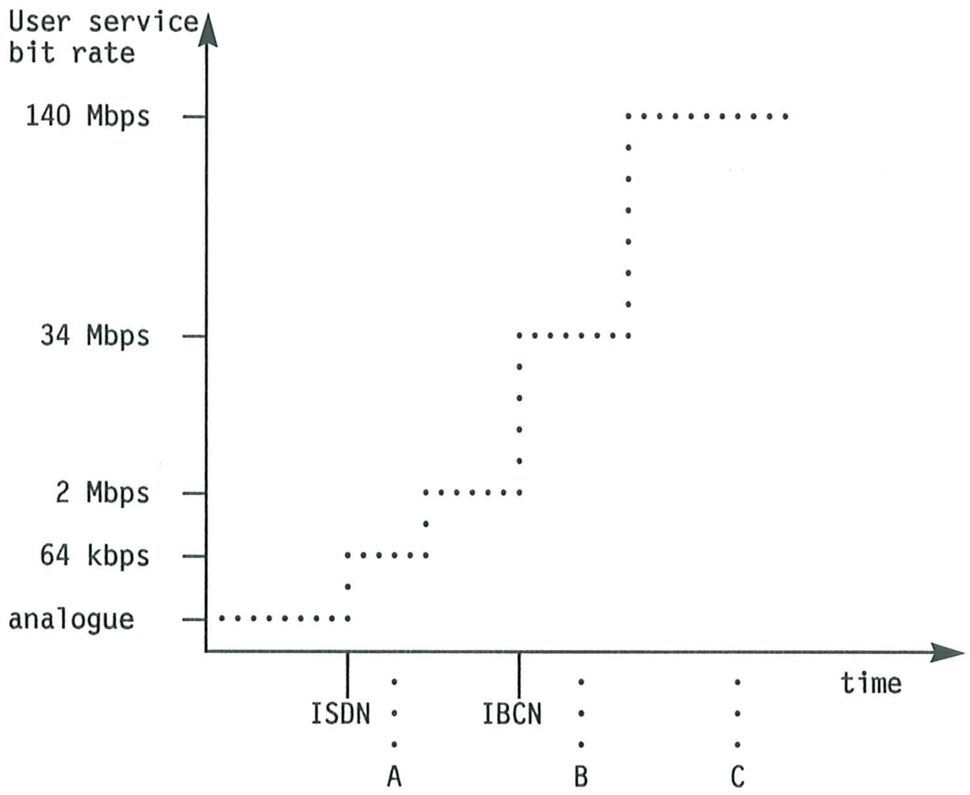


Figure 16 - Broadband Services Introduction

If we take a specific environment such as the office, three scenarios can be considered. Scenario A represents the introduction of ISDN, and its configuration is shown in Figure 17. Scenario C (Figure 18) corresponds to the long-term situation when the IBC network and services are well established. The intermediate situation (Scenario B), around the introduction of IBCN, can be described by any partial implementation of the basic configuration of Figure 15.

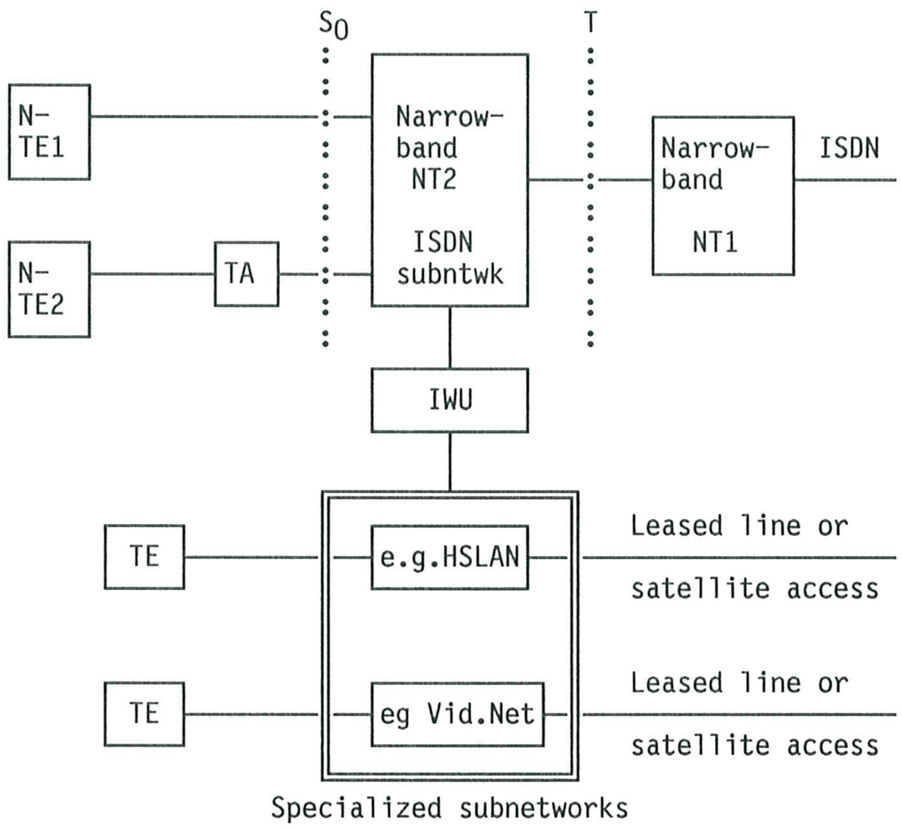


Figure 17 - Scenario A

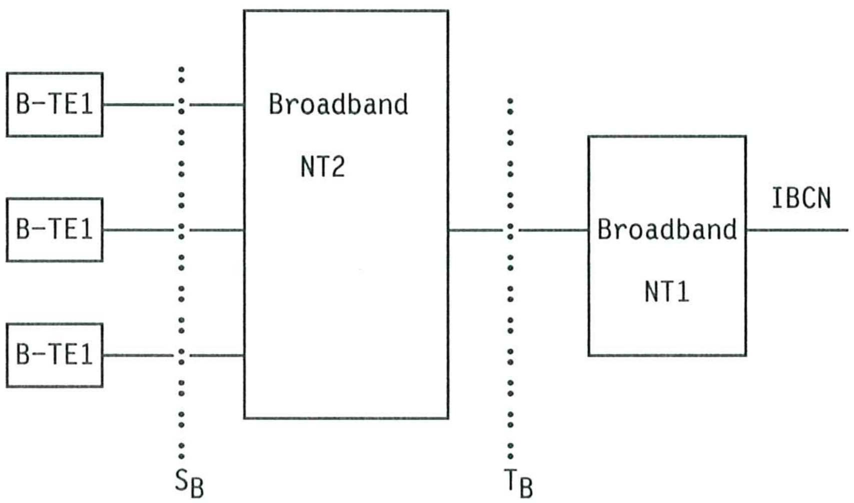


Figure 18 - Scenario C

12. EMC

The detailed specification of system implementation is beyond the scope of this Technical Report. However, known examples of implementation may be cited as instances of feasible performance. Elsewhere, suggested implementations are based on extrapolated performance and are clearly marked as such.

Example (expected to meet FCC Class A RFI limits):

- MAP Broadband Medium Specification, 450 Mbit/s over "thick" coaxial up to 10 km, with up to 16 cascaded amplifiers.

NOTE 2

The examples given here are based on FCC RFI requirements. These may not correlate to the EC Technical Directive on EMC. Testing methods differ, and differences will arise from the use of different mains voltages and frequencies. Both the FCC requirements and the EC Directive include limits for mains-borne conducted interference. CISPR SCG are understood to be looking at the problem of conducted interference on telecommunication cables.

APPENDIX A

CABLING SURVEY

A.1 GENERAL

A.1.1 Scope

This survey covers regulatory aspects, wiring practices and specifications of PBX telephone system cables in use in Europe. The survey was conducted during 1988, and this Appendix completed early in 1989.

It also indicates where the PBX cabling systems could be shared with LAN systems.

Furthermore, it provides technical guidelines for the cabling requirements of LAN systems based on telephony wiring, and the evaluation of existing wiring.

A.1.2 Field of Application

This Appendix is intended as a guide both for designers and potential users of LAN systems capable of using PBX cabling systems.

NOTE

The content of this Appendix reflects the situation at the end of 1988. Subsequent changes in policies and procedures, which cannot be covered in this Appendix, may necessitate contact with the PTT administration(s) in question in order to verify the information to be used. At the time of publication of this Technical Report, the process of European harmonization now encompasses building wiring and may be expected to generate a number of changes to policy and practice.

A.1.3 Additional Definitions

For the purpose of this Appendix the following definitions apply:

A.1.3.1 Bridged Tap or Stub

Segment of an open-ended pair unduly connected in parallel to an active pair.

A.1.3.2 Far End Crosstalk (FEXT, FXT)

Coupling between two pairs in a cable. The signal on the disturbed pair caused by the signal sent on the disturbing pair is measured at opposite ends.

A.1.3.3 Intersymbol Interference

Interference in a digital transmission system caused by a symbol in one signalling interval being spread out and overlapping the sample time of a symbol in another signal interval.

A.1.3.4 Near End Crosstalk (NEXT, NXT)

Coupling between two pairs in a cable. The signal on the disturbed pair caused by the signal sent on the disturbing pair is measured at the same end.

A.2 REGULATORY ASPECTS

With regard to the regulatory aspects of the use of excess wiring of PBX cables for a LAN the following points are covered:

- Cable ownership,
- Permission to use excess wiring (cable sharing),
- Approval requirements,
- Safety requirements,
- EMI/RFI requirements,
- Conclusions.

The information available covers the following countries:

- Belgium,
- France,
- Germany FR,
- Italy,
- Netherlands,
- Norway,
- Spain,
- Sweden,
- Switzerland,
- United Kingdom.

A.2.1 Cable Ownership

The ownership of PBX cables is related to the ownership of the PBX itself as shown in Table A-1.

COUNTRY	PBX OWNERSHIP			CABLE OWNERSHIP		
	PRIVATE	PTT	BOTH	PRIVATE	PTT	BOTH
Belgium			Yes			Yes
France	Yes			Yes		
Germany FR			Yes			Yes
Italy			Yes			Yes
Netherlands		Yes			Yes (Note 1)	
Norway		Yes			Yes	
Spain	Yes			Yes		
Sweden		Yes			Yes	
Switzerland		Yes			Note 2	
UK			Yes			Yes

Table A-1

Note 1:
After January 1st 1989 privately owned cabling will be permitted.

Note 2:
Cable ownership is thought to rest with the PTT but this has not been confirmed

A.2.2 Permission to Use Excess Wiring

The policies on the countries surveyed vary from "permitted without requirements" to "not permitted". A further issue is whether the sharing of cable ducts is permitted if sharing of cables is not allowed. This provides the picture shown in Table A-2 below:

COUNTRY	PTT-OWNED CABLES		PRIVATELY-OWNED CABLES		DUCT
	PERMITTED	APPLICATION REQUIRED	PERMITTED	APPLICATION REQUIRED	
Belgium	Yes	Yes	Yes	Yes	Yes-if approved
France	n/a (1)	n/a	Yes	No	Yes-if requirements met (2)
Germany FR	Yes	No	Yes	No	n/a
Italy	No	n/a	tbd (3)	tbd	No
Netherlands	Yes	Yes	n/a (4)	n/a	Yes
Norway (5)	No	n/a	n/a	n/a	No
Spain	n/a	n/a	Yes	No	Yes
Sweden	No	n/a	n/a	n/a	No (6)
Switzerland	No	n/a	n/a	n/a	Yes with special permission
UK	Yes	Yes	Yes	Yes	n/a

Table A-2

Note 1:
n/a = not applicable

Note 2:
Permission to use excess wiring in PTT-owned or privately-owned cables implies that PTT requirements have to be met.

Note 3:
tbd = to be defined.

Note 4:
After January 1st, 1989 privately owned cabling will be permitted.

Note 5:
The rules in Norway may change in 1989.

Note 6:
In practice Yes, unless system interferes with the PBX.

A.2.3 Approval Requirements

The technical requirements for approval of sharing the PBX cables with a LAN are not sufficiently well specified. Table A-3 below gives an overview of the current situation:

COUNTRY	REQUIREMENTS
Belgium	The requirements concerning PBX installations for impedance, crosstalk and impedance balance apply.
France	Maximum out-of-band spectrum or unwanted signals induced on PTT lines. Crosstalk not specified.
Germany FR	Crosstalk in the voice band (300-3400 Hz) is specified.
Italy	n/a for PTT-owned cables. For privately-owned cables: to be determined.
Netherlands	Requirements are still being determined.
Norway	n/a
Spain	No information
Sweden	n/a
Switzerland	n/a
UK	BSI 6305 and 6317 regarding maximum signal levels apply.

Table A-3

A.2.4 Safety

In the absence of national or European safety regulations, it is recommended that the LAN should be designed and installed in accordance with Standard ECMA-97 - Local Area Networks - Safety Requirements.

A.2.5 EMI/RFI Requirements

Reference should be made to CISPR 22 - Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment, which is becoming the accepted standard.

A.2.6 Conclusions

Although many details are not yet available, the following conclusions may be drawn:

i) Cable sharing between PBX and LAN is often not permitted.

ii) Where cable sharing is permitted, generally PTT approval is required.

iii) Where sharing of PBX cables is permitted without PTT approval, some technical requirements must always be met.

iv) With regard to safety and EMI/RFI requirements, these are specified in international standards. No special PTT rules apply.

A.3 INSTALLED WIRING

A.3.1 Availability of Wiring

With regard to the question of the availability of excess wiring for a LAN system, this applies only to those countries where cable sharing is permitted, as shown in Table A-4 below:

COUNTRY	CABLE SHARING
Belgium	Permitted
France	Permitted
Germany FR	Permitted
Italy	To be determined
Netherlands	Permitted
Norway	Not permitted
Spain	Permitted
Sweden	Not permitted
Switzerland	Not permitted
UK	Permitted

Table A-4

In the countries where cable sharing is permitted, the situation is as follows:

Belgium: The PBX owner installs the cable. In the case of the PTT approximately 20% spare cabling is available. In the case of a private owner, it is up to the customer to decide on his requirements.

France: Approximately 10% - 20% of spare pairs for trunk cables, seldom for distribution cables.

Germany FR: Some excess wiring is available.

Netherlands: Spare pairs may exist up to the first wiring panel, but normally no extra pairs are available.

Spain: The amount of excess wiring depends on what the customer ordered.

UK: The amount of excess wiring depends on what the customer ordered.

In conclusion, it cannot be assumed that PBX wiring provides enough excess wiring to allow installation of a LAN. The extra capacity available would normally be needed for future expansion of the PBX itself.

With the exception of those countries where privately-owned cables are permitted and the customer can thus pre-wire the premises for all communications requirements, LAN cabling will have to be newly installed.

A.3.2 Characteristics of Installed Wiring

The electrical characteristics of installed wiring are generally specified only in the voice frequency band.

The characteristics given hereafter for high frequencies, when available, are average measured values, except where expressed as "max" or "min" values.

Table A-5 below is applicable only for countries where cable sharing is permitted.

Param. \ country	type	diameter mm	isolation	mutual cap nF /km	dielectric kV ac	High Frequency characteristics 1 MHz att dB /km	1 MHz Zc ohm	1 MHz NXT dB	2 MHz att dB /km	2 MHz ZC ohm	2 MHz NXT dB	4 MHz att dB /km	4 MHz Zc ohm	4 MHz NXT dB	10 MHz att dB /km	10 MHz Zc ohm	10 MHz NXT dB
BELGIUM	770 ITT 26626	0,5 --- 0,6	PVC	90 max	1												
FRANCE	SYT	0,5 --- 0,6	PVC	160 max	0,5	37	74	40									
	278	0,4 --- 0,6	PE	50 max	0,8 w/w 1,0 w/s	--- 22	--- 95	--- 45 min	--- 31	--- 94	--- 36 min	---	---	---	--- 62	--- 93	--- 30 min
GERMANY FR	I-Y. (2)	0,6	PVC	120 max	0,8	50 to 35	65 to 80	35	70 to 50	65 to 80	30						
	I-2Y. (2) (3)	0,6	PE	52 max	0,5 w/w 2,0 w/s	20 to 15	100 to 130	40									
ITALY	no information																
NETHER LANDS (1)	88	0,5		40 max	2,0 w/w	20	120										
	14	0,8		33 max	2,0 w/w	13	150	58 FXT 2km									
SPAIN	DAL-48232	0,5	PVC	57 max		18	135	35	29		30	45		27	92	120	36
UK		0,5	PVC	100 max		35		38									

Table A-5

NOTE

The high frequency characteristics are normally never specified for voice grade cables. Figures given here result from measurements.

Note 1:

Type 14 cable is in use for longer distances, and is not an internal distribution type cable; it may be used for LANs however.

Note 2:
Figures given represent the estimated range for the high frequency characteristics; for still higher frequencies no data is available.

Note 3:
Not yet installed in 1988.

A.4 PLANNING GUIDELINES

When planning a cabling system the following guidelines describe the steps that should be taken in order to evaluate whether existing cabling could be a part of the system or whether new cabling must be installed:

Step 1

Is sharing of the installed wiring permitted ?
(Cf. A.2.2)

Yes: Go to step 2
No: Go to step 4

Step 2

Is spare wiring available ?
(Cf. A.3.1)

Yes: Go to step 3
No: Go to step 4

Step 3

Measure characteristics of installed wiring
(Cf. A.5)

Installed wiring OK: Use it
Installed wiring not OK: Go to step 4

Step 4

Install new wiring: Go to step 3

A.5 QUALIFICATION OF INSTALLED WIRING

A.5.1 General

The qualification of an installed wiring is to be done when the characteristics of the installed cables are partially or totally unknown.

This qualification may be performed with limited measurements on four parameters only:

- Attenuation,
- Characteristic impedance,
- Intersymbol interference,
- Noise.

A.5.2 Examples of Qualification for Specific LAN Types

A.5.2.1 Qualification of Installed Wiring for 1BASE5

The following applies to 802.3 1BASE5.

A.5.2.1.1 Attenuation

Attenuation shall be measured so as to check the maximum value of 6.5 dB between two end points at 1 MHz.

NOTE

It is not necessary to check the attenuation at other frequencies as it is very likely that the attenuation dependency with frequency will approximately follow the well known square root law.

The measurement shall be done with 100 ohms terminations.

A.5.2.1.2 Characteristic Impedance

Characteristic impedance should be measured using preferably a reflection cancellation method and must be between 80 ohms and 115 ohms at 1 MHz.

A reflection cancellation method has the advantage of making apparent possible "bridged taps" or "stubs". However, such anomalies can be detected also by a jitter measurement (see hereafter).

A.5.2.1.3 Intersymbol Interference

Intersymbol interference shall be measured with the method described in clause 12.7.2.4 of the 1BASE5 addition to the 802.3 standard. The pseudo-random generator used for this measurement may be the same as the generator used for the crosstalk measurement (see hereafter). The limit for jitter is ± 17 ns for a 2,5 V, Manchester-encoded, 22 ohms impedance source. The measurement is done at the end of the cable terminated with a 96 ohms load.

NOTE

If the measurement of the characteristic impedance is done using a reflectometer, the intersymbol interference measurement may be omitted because reflections are the main source for this impairment.

A.5.2.1.4 Noise

A.5.2.1.4.1 Near End Crosstalk (NEXT)

The NEXT attenuation between any couple of pairs in the same cable shall be at least:

NEXT dB = 45 - 15 $\log_{10}$ F (MHz) in the range 0,5 to 4 MHz.

Alternatively, and preferably, the NEXT attenuation can be measured using a pseudo-random generator of Manchester-encoded signals as for the jitter measurement. A pseudo-random sequence of 511 bits (according to CCITT Rec. V.52) is recommended.

The NEXT attenuation, measured through a 2-pole, 2 MHz, Butterworth low-pass filter shall be at least 45 dB.

A.5.2.1.4.2 Impulse Noise

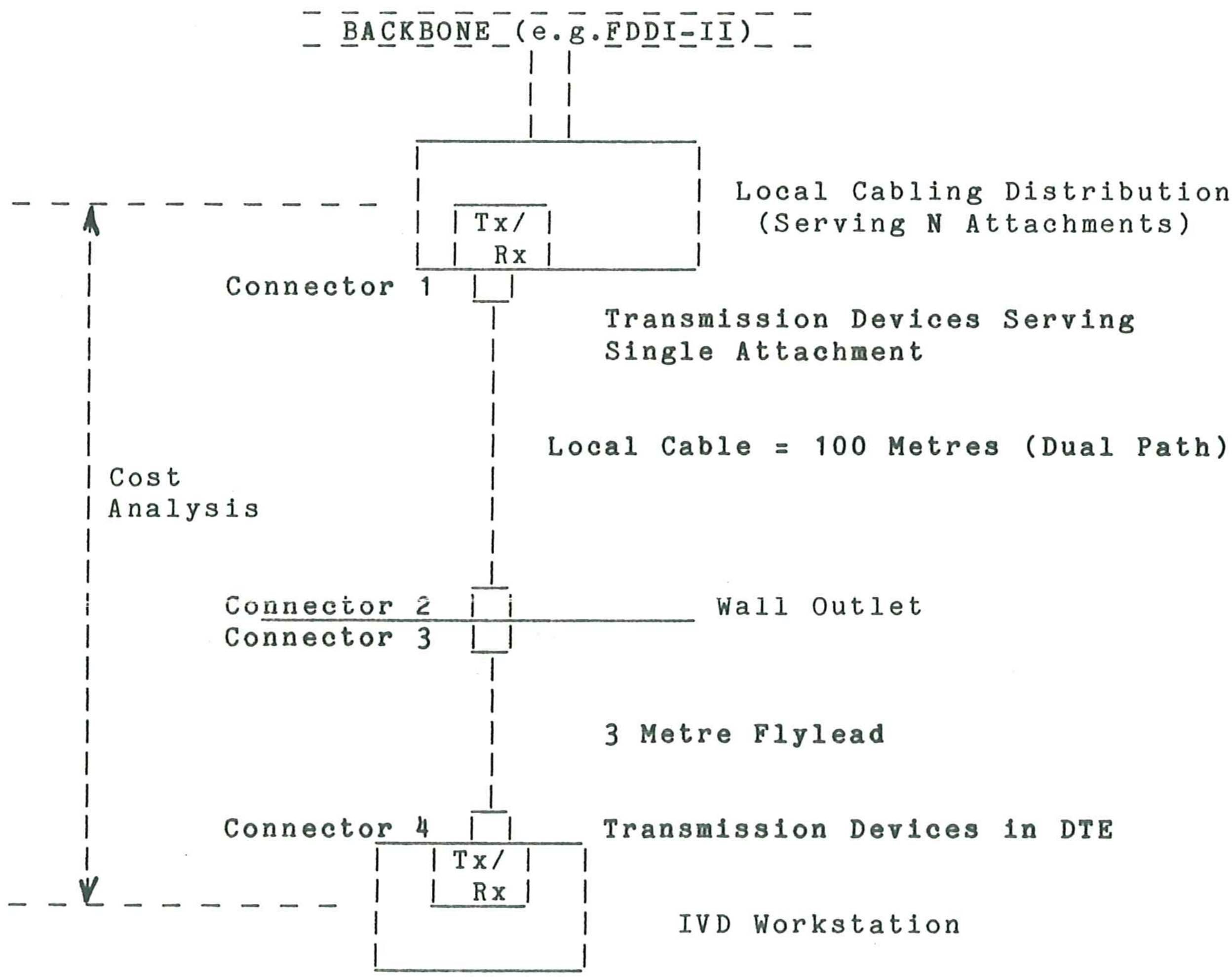
Using the same low-pass filter as for the NEXT measurement and a receiver with a 170 mV threshold, no more than 9 impulses should be recorded in a 30 minute interval (each count is followed by a 100 µs "deaf" interval).

APPENDIX B

COSTS ASSOCIATED WITH IVDLAN TECHNOLOGIES

This Appendix presents an analysis of costs associated with local network transmission systems over the period 1990 to 1995. The media considered are twisted-pair and coaxial copper plus graded-index optical cables. Costs of all components plus associated labour elements (i.e. installation and termination) are taken into account.

B.1 LAN MODEL



B.2 COMPONENT COST GUIDELINES

The following is a guide to current and projected **base** costs for the components featured in the above model, plus any associated labour costs. All figures are based on reasonable volume purchases and have been translated from an exchange rate of 1.3 ECU = 1.0 GBP (United Kingdom pound).

	ELEMENT	NOTES	COST (ECUs)		
			1990	1992	1995
A	103 m Dual UTP	1	34	34	34
B	103 m Dual STP	2	68	68	68
C	103 m Dual Coax	3	54	54	54
D	103 m 62,5/125 Optical		245	245	245
E	Installation of 100 m Cable	4	561	620	717
F	4 Duplex UTP Connectors	5	5	5	5
G	4 Duplex STP Connectors	5	30	30	30
H	8 Simplex Coaxial Connectors	6	10	10	10
J	4 Duplex Optical Connectors	5, 7	68	60	50
K	Termination 4 UTP Connectors	8	7	7	7
L	Termination 4 STP Connectors	9	37	40	47
M	Termination 8 CoaxConnectors	10	52	56	66
N	Termination 4 FO Connectors	11	68	60	50
P	2 Tx/Rx Copper 1-10 Mbit	12	7	7	7
Q	2 Tx/Rx Optical ≥ 50 Mbit	13	100	68	50
R	2 Tx/Rx Optical ≥ 200 Mbit	14	544	476	340

NOTES

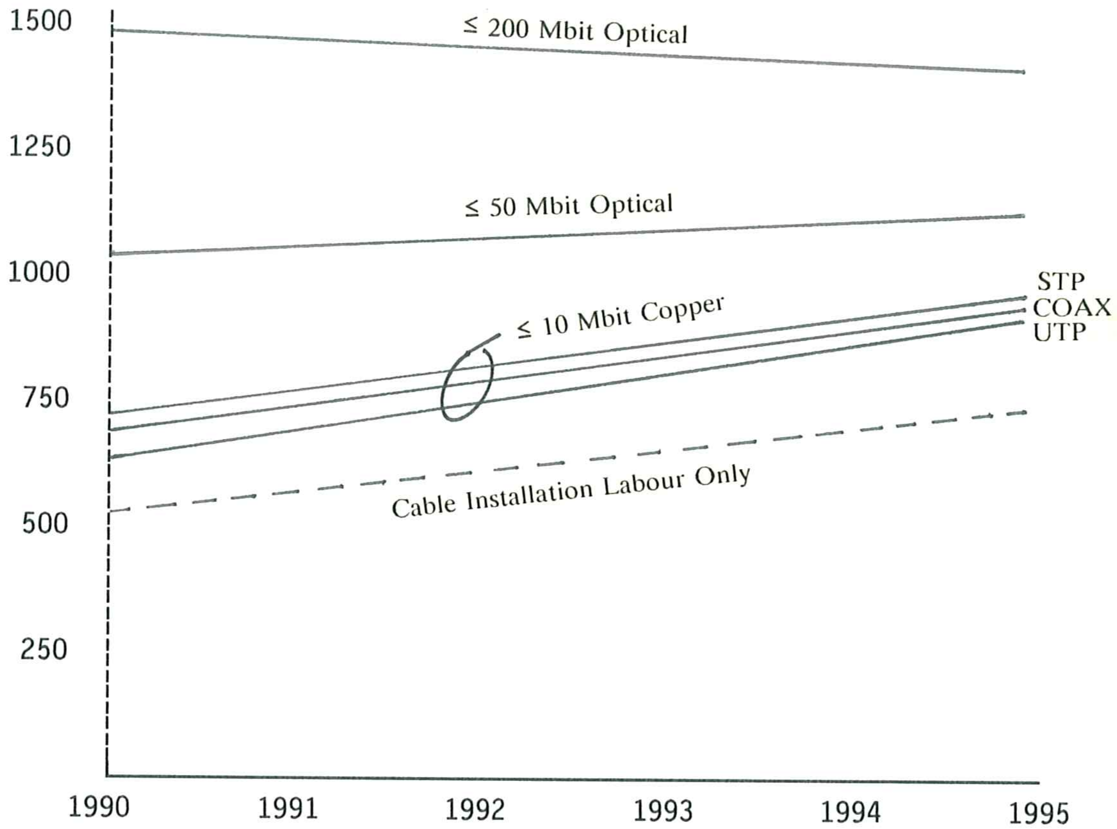
1. Unscreened Twisted-Pair.
2. Screened Twisted-Pair.
3. Thin Coax (i.e. RG 58).

4. Average of 5 ECUs per cabled metre assumed as guideline (varies from approximately 3 ECUs/metre to 7 ECUs/metre). Cost of cable trays/trunking, etc. not considered.
Labour assumed to increase 5% per annum.
5. 1 connector mounted on faceplate as "wall outlet", others floating.
6. BNC Crimp Connector.
7. FDDI Connector, based on forecasts.
8. 2 minutes per end, IDC termination.
9. 10 minutes per end, IDC termination.
10. 7 minutes per end, Crimp termination.
11. 20 minutes per end, reducing as techniques improve.
12. Basic Transmission Devices Only.
13. Basic Transmission Devices Only, 850 nm LED + PIN, 5v.
14. Basic Transmission Devices Only, 1300 nm LED + PIN, 5v.

B.3 TOTAL SYSTEM COSTS

SYSTEM		COST (ECUs)/WORKSTATION		
		1990	1992	1995
A+E+F+K+P	≤ 10 Mbit UTP Copper	614	673	770
B+E+F+J+L	≤ 10 Mbit STP Copper	739	793	887
C+E+H+M+P	≤ 10 Mbit CoaxCopper	684	747	854
D+E+J+N+Q	≤ 50 Mbit Optical	1042	1053	1112
D+E+J+N+R	≤ 200 Mbit Optical	1486	1461	1402

TOTAL SYSTEM COST (ECUs) / WORKSTATION



APPENDIX C

LIST OF ABBREVIATIONS AND ACRONYMS

ATM	Asynchronous Transfer Mode
AU	Access Unit
B-ISDN	Broadband Integrated Services Digital Network
B-NT1	Network Termination for Broadband public network (IBCN)
B-NT2	Broadband internal network with compatible interfaces at S and T reference points
B-TE1	Broadband Terminal Equipment with compatible interface at S reference point
B-TE2	Broadband Terminal Equipment with non-compatible interface at S reference point
BER	Bit Error Rate
BR	Basic Rate
BRI	Basic Rate ISDN
CAD	Computer Aided Design
CAM	Computer Aided Manufacture
CATV	Communal Antenna TeleVision
CBO	Continuous Bitstream Oriented
CCITT	Commité Consultatif International de Téléphone et Télégraphie
CEPT	Council of European Post and Telecommunications Authorities
CISPR	Comité International Spécial Perturbations Radio électrique
coax.	coaxial
Coll	Collective
Conv	Conversational
CPN	Customer Premises Network
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
D	Maximum Transit Delay
DAD	Draft ADdendum
DBO	Delimited Bitstring Oriented
DCE	Data Circuit terminating Equipment
DDI	Direct Dialling In
Dist	Distributive
DQDB	Distributed Queue Dual Bus
DTE	Data Terminal Equipment
E	Residual Bit Error Rate
EC	European Commission
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
ESPRIT	European Strategic Programme of Research in Information Technology

ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDDI	Fibre Distributed Data Interface
FDDI-II	FDDI / circuit switching hybrid
HD	High Definition
HDTV	High Definition TeleVision
HiFi	High Fidelity
HQ	High Quality
HSLAN	High Speed LAN
IA5	International Alphabet 5
IBC	Integrated Services Broadband Communication
IBCN	Integrated Services Broadband Communication Network
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IS	Integrated Services
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ISPBX	Integrated Services Private Branch Exchange
ISWS	Integrated Services Work Station
IVD	Integrated Voice and Data
IVDIWS	Integrated Voice, Data and Image Work Station
IVDLA	Integrated Voice and Data LAN Access
IVDLAN	Integrated Voice and Data Local Area Network
IVDLAR	Integrated Voice and Data LAN Access Requirements
IVDTE	Integrated Voice and Data Terminal Equipment
IVDWS	Integrated Voice and Data Work Station
IWU	InterWorking Unit
JTC1	Joint Technical Committee 1 (of ISO/IEC)
LAN	Local Area Network
LAPD	Link Access Protocol over the D-channel
LLC	Logical Link Control
MAC	Medium Access Control
MAN	Metropolitan Area Network
MAP	Manufacturing Automation Protocol
MUX	Multiplexor (and Demultiplexor)
N-TE	Narrowband Terminal Equipment
NB	Narrow Band
NTSC	National Television Standards Committee
O	Occupancy
P	Delay Distribution
P(A)BX	Private (Automatic) Branch Exchange
PAL	Phase Alternate Line
PC	Personal Computer
PDN	Public Digital Network
PHY	Physical
PISN	Private Integrated Services Network
PMD	Physical Medium Dependent

PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network
RACE	Research and development of Advanced Communications in Europe
RFI	Radio Frequency Interference
S_B	Broadband interface at the S reference point
SDU	Service Data Unit
SECAM	Séquentielle Couleur à Mémoire
T	Maximum Throughput
TA	Terminal Adaptor
T_B	Broadband interface at the T reference point
TE	Terminal Equipment
TE1	Terminal Equipment with compatible interface at S reference point
TE2	Terminal Equipment with compatible interface at S and T reference points
TV	TeleVision
UTP	Unshielded Twisted Pair
WAN	Wide Area Network
WS	Work Station