Commission of the European Communities
Information Technologies and Telecommunications Task Force

# Study of the Introduction of ISDN within the Community

Consultants Final Report

SCS
Scientific Control Systems

Scicon

THE COMMISSION OF THE EUROPEAN COMMUNITIES
INFORMATION TECHNOLOGIES AND TELECOMMUNICATIONS TASK FORCE

# STUDY OF THE INTRODUCTION OF INTEGRATED SERVICES DIGITAL NETWORKS WITHIN THE COMMUNITY

CONSULTANT'S FINAL REPORT


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STUDY OF THE INTRODUCTION OF ISDN WITHIN THE COMMUNITY

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## 2. NATIONAL ISDN INTRODUCTION PLANS

### 2.1 BELGIUM

Belgium had 2.8M telephony lines in 1983. Digitalisation of the transmission network will ensure a completed 140 Mbit/s inter-district digital overlay in 1987. Digital switching is being introduced, and all new exchange orders are now for digital. By 1990, there will be 1M subscribers on digital exchanges (24%), and by 1992 50% of subscribers will be within the local area of a digital exchange.

Three ISDN field trials are foreseen for 1985-86. The first uses two connected exchanges type ITT System 12, providing digital telephony, teletex, telefax and videotex, and using the 'S' interface (mid '83 status)*. Teletex and videotex will access national services provided by packet switching, using packet switching capabilities in the local exchanges, with X75 interface to the national packet network. The second trial will investigate applications usage of an IBM Cadem graphics terminal operating at 64 kbit/s with a V35 interface. The third trial involves an exchange type GTD5, connected to two PABX's, at which an S interface passive bus (1984 status) will be provided. A variety of terminals will be investigated, including a multi-combination ISDN terminal simulator.

A pilot service is planned for 1988-89, with about 800 basic access subscribers and about 10 primary access lines, which will be provided on a limited number of exchanges spread over the country. Public service is expected to follow on from this pilot. No estimate of the number of ISDN subscribers in later years is available.

CCITT no 7 signalling with TUP is scheduled for introduction in 1985, while ISUP and SCCP will be introduced for the ISDN pilot service in 1985.

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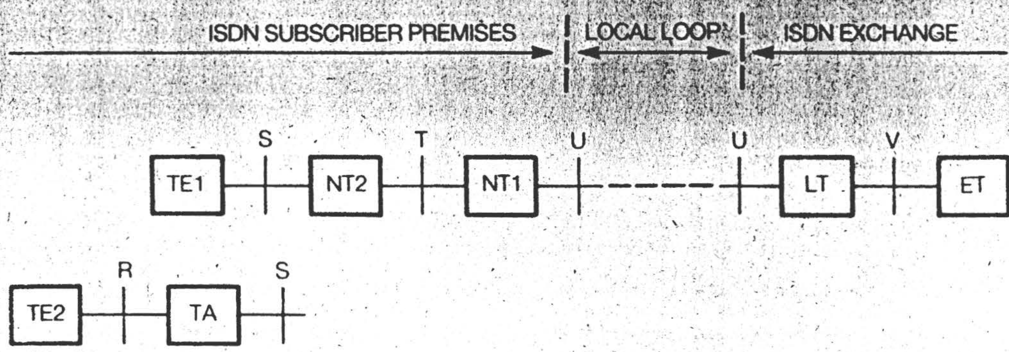
* Note: Unless otherwise specified, the term "S-interface" is used in this report to refer to the user-network interface defined for ISO-levels 1-3 by CCITT Recommendations I430, I440, I450 and I451, as at October 1984. The various CCITT reference points are identified in figure 1.




## Figure 1 **ISDN Basic Access Interface Definition**

| | |
|---|---|
| R,S,T | Interface points defined by CCITT Recommendation I210 |
| U,V | Additional interface points referred to in this study |
| ET | ISDN Exchange Termination (Line Card) |
| LT | Line Transmission Termination at Exchange |
| NT1 | Network Termination 1 (Line Transmission function) |
| NT2 | Network Termination 2 (Distribution function) |
| TA | Terminal Adaptor |
| TE1 | Terminal Equipment connecting to S interface |
| TE2 | Terminal Equipment with non-S interface (eg V, X, series) |

2.2 GERMANY

Germany had 25M telephony lines in 1984. Digitalisation of the long distance backbone transmission systems will be completed in 1985. Digital switching has been introduced, and from 1990 digital exchanges only will be installed. By 1990, there will be 3M subscribers on 200 digital local exchanges, and over 50% of subscribers will be within a local network area which includes a digital exchange.

A pilot service trial is planned for 1986-88, with a total of 800 subscribers in the towns of Mannheim and Stuttgart. Two exchanges will be used, one type Siemens EWSD, the other System 12 from SEL. Early information indicated that basic access only will be provided, to PABX's as well as individual subscribers. Terminals expected include telephony, teletex, facsimile, data transmission and fixed image terminals. Public service is expected to follow on from the pilot project in 1988, and a penetration to 3M subscribers is forecast for 1995.

CCITT No. 7 signalling will be introduced from 1986, and ISUP operation will form part of the pilot project.

2.3 DENMARK

Denmark had 2.5M telephony lines in 1984. Digitalisation of transmission has progressed to the stage that 70% of the trunks in the inter-exchange network will be digital during 1985. By 1987 digital switching will have reached 200 exchanges serving 315,000 subscribers (12%). The Ericsson AXE 10 switch will predominate, with a small number of ITT System 12 switches in two areas.

Field trials are scheduled for 1986, using the Danish-developed DIKON concentrator for access to an AXE exchange. The S interface passive bus (1984 status) will be provided. Various terminal adaptors will be used, and a high resolution videotex service is planned. A digital telephone with display and keyboard will be available.

Public service is expected to follow on gradually from the trials, with an introductory stage during which only services compatible with digital telephony will be supported. Penetration forecasts envisage 15,000 subscribers by 1988, with 120,000 by 1991, and potentially 1M by 1995.

CCITT No. 7 signalling began operation (to 1980 status) during 1984. Field trials of ISUP (1984 status) will begin in 1986. The ISUP will be in operation in the national CSDN for X21 data transmission during 1987, and No. 7 signalling to PABX's will also then be available.

## 2.4 FRANCE

France had 22M telephony lines in 1984, after a rapid growth from 12M in 1978. Digitalisation of the transmission network already allows all digital local exchanges to be fully interconnected by digital routes. Most local areas are already equipped with at least one digital switch, giving a current penetration to 10M subscribers, with 18M (70%) forecast for 1990.

A 64 kbit/s transparent circuit switched network (RTC 64) is at present in a trial stage, with service opening in 22 towns later in 1985, and extension according to demand planned for 1986.

The first TELECOM 1 satellite, launched in 1984, currently provides 20 earth terminal accesses at 1.92 Mbit/s to major business users. Interconnection of TELECOM 1 and RTC 64 is planned for 1987/88.

An ISDN pilot project is designated RENAN. First trials in 1986 will cover a total of 300 subscribers in Brittany, connected directly or via remote concentrators to three exchanges of type CIT-CGE E10B. A second trial, in 1987, will cover 1000 subscribers in the Paris area connected to exchanges of type Thomson MT25. The S interface passive bus will be provided, and all terminals in the trial will use S interfacing. Two additional subscriber equipments will be (a) a module for connection to the passive bus, allowing internal communication and DDI, and (b) a PBX based on a configuration of 16 passive buses. All services of the basic telephony network will be supported; alphaphotographic videotex, audio videotex, audiography (sound and telewriting), still and slow-scan picture service and interconnection of personal computers are being considered.

Subscriber population projections make the basic access preferable to primary rate access in the initial stages. Public service is expected to follow on in 1987-89, with a penetration of 3M subscribers on basic access, plus others on primary rate access, by 1995.

CCITT No. 7 signalling is scheduled for trials in 1986, with progressive introduction from 1987/88 onwards.

## 2.5 UNITED KINGDOM

British Telecom had 20M telephony lines in 1983. Digitalisation of transmission in BT's main network will result in 100% of long distance traffic being handled digitally by 1990. Digitalisation of switching will make all major cities fully digital by 1992, with ISDN capability available to 80% of subscribers.

BT's ISDN pilot service is opening in 1985, using four switches of type Plessey/GEC System X. Remote concentrators will provide 60 access areas, totalling 1000 subscribers at basic access, plus 40 at primary rate access. In 1986, access will be available at 400 locations, and in 1987 at 1000 locations. The pilot is considered to be a normal public service. Interface standards will initially use 80 kbit/s operation to provide 64 + 8 kbit/s B channnel access, with terminal adaptors to V and X series devices, and with digital telephony integrated into the network terminating equipment. Introduction of the CCITT 'S' interface recommendations, together with 144 kbit/s transmission, is envisaged for 1987. A second digital switching system, AXE from Thorn Ericsson, will be introduced from 1986. Penetration to 9M subscribers with digital access is foreseen in 1991.

CCITT No. 7 signalling is being introduced by BT, and international interworking, including ISUP, is expected from 1988.

Alternative national and international digital switched services will be provided from 1986 by Mercury Communications under a licence from the UK Government. Developments towards ISDN services will follow later.

2.6 GREECE

Greece had 3.4M telephony lines in 1984. Digitalisation of the transmission network will cover 50% of the junction network and 35% of the trunk network by 1995. (10% and 5% respectively by 1984).

Digital switching is not yet introduced (except the International Switching Centre). However tenders are in evaluation for national manufacture with one or two foreign associate companies.

By 1995, the penetration of digital switching starting from 1986 will cover 45% of the local loops.

The policy for the digitalisation of the Public Switch Telephone Network is to proceed in conjunction with the normal capacity expansion and replacement of the network, increasing gradually the investments in switching and transmission equipments for digital systems.

At the end of the 80's purchasing of new analogue systems will cease.

In principle, for the digitalisation programme an overlay digital network was chosen.

No specific dates have been set for introducing ISDN. The evolution towards ISDN will be possible when the PSTN has become extensive (not before the middle of the 90's).

Connections between subscribers for 64 Kbit/s will be provided through the digital part of the telephone network. As long as digital services are carried out by the digital telephone network, only services with requirements compatible with the facilities and limitations of digital telephone networks will be provided.

There are no plans for the broadband ISDN. Possible customer demands will be met by special solutions and at later stage when need arises, will be directed to the existing networks.

Digital connectivity for PABX's, etc., will be provided through the digital overlay networks until ISDN is economically and technologically possible.

2.7 ITALY

Italy had 16.5M telephony lines in 1984. Digitalisation of transmission will cover 75% of the district network and 10% of the inter-district network by 1990. Digital switching will cover all toll centres by 1990, with 25% of subscriber lines having full digital switching.

Five ISDN field trials have been started already. One, in Mestre and Padua, used two switches type Ericsson AXE 10, with one remote subscribers switch. A passive bus with 'S' interface characteristics was used at the subscriber premises, but with a B+D (64 + 16) channel access to the switch. The digital telephone used had display and keyboard features, and other services were provided via terminal adaptors, with a packetised videotex service on the D channel. Another trial, in Bologna, involved a switch type ITT System 12, with digital subscriber and packet switching modules. Basic access of 2B+D (144 kbit/s with echo cancelling) was provided to a small number of lines. Services provided were digital telephony, teletex (X25 at 2400 bit/s), facsimile (V24/25 at 9600 bit/s), and personal computer data (at 9600 bit/s). In a third trial, Italtel's Proteo UT 10/3 exchange was used with digital line and packet handling modules. Line transmission in burst mode gave B+D (64 + 16) basic access, and the following services were evaluated: digital telephony; mixed telephony (16 kbit/s) and still picture video (48 kbit/s); teletex (2400 bit/s, rate adapted); audioconferencing (60 kbit/s high quality, 6 KHz voice plus 4 kbit/s speakers identification and telewriting); combined audioconferencing (48 kbit/s), with facsimile (8 kbit/s) and telewriting (8 kbit/s); plus other service combinations, and packet access to host computer (B and D channels). The remaining two field trials were concerned with digital transmission on the subscriber loop, interworking with switch types Teletra AFDT1, and GTE GTD-5C.

A pilot service is scheduled for 1987/88, catering for a total of 2000 subscribers. This will develop into a nationwide public service in 1990, with a forecast penetration at that time of 50,000 subscribers, rising to 1M in 1994. Prior to the nationwide ISDN, the existing CSDN (speech and data network, RFD) will be used to provide digital links to local exchanges from digital PABX's and digital circuit switching at 64 kbit/s.

CCITT No. 7 signalling will be introduced from 1985, with an enchanced TUP, as the ISUP is considered not yet stable. Some national variants will also provide data base access for the "800" service.

2.8 IRELAND

Ireland had 0.61M telephony lines in 1983. Digitalisation of transmission will cover 34% of the high capacity network during 1985. Digital switching, introduced in 1982, will include 50% of local exchanges during 1985, rising to 85% in 1990. Switch types CIT-Alcatel E10B and Ericsson AXE 10 are used.

There are no firm plans yet for ISDN introduction, but both switch suppliers will be able to offer solutions.

CCITT No. 7 signalling will be introduced in 1986.

2.9 LUXEMBOURG

Luxembourg had 0.14M telephone lines in 1983.

No information is presently available on digitalisation or ISDN planning.

## 2.10 NETHERLANDS

Netherlands had 5.6M telephony lines in 1984. Digitalisation of transmission will result in a long distance digital overlay network connecting all primary exchanges in 1987. The introduction of SPC analogue switching during the last 10 years has resulted in 35% of subscribers connected to SPC local exchanges. This base of exchanges will not be fully replaced by digital before 2015. Digital local exchanges, to be installed from 1987 onwards, will be ISDN compatible. A 20-year programme for digital switching has been announced, involving the AT & T/Philips Telecommunications 5ESS-PRX, together with the AXE system from Ericsson and System 12 from ITT.

No firm plans are yet made concerning the introduction of ISDN, which would certainly be after 1988. Provision of 64 kbit/s switched data service by using data over voice operation on analogue local loops is also considered a possibility.

CCITT No. 7 signalling is scheduled for trial in 1987, with introduction, including ISUP, in 1988.

In view of their impending membership of the Community, the positions of Spain and Portugal are also considered here:

## 2.11 SPAIN

Spain had 10M telephony lines in 1984. Digitalisation of transmission and switching in the transit network is in progress, and will reach 31 main cities by 1988, and all of the 50 provinces by 1990. Digitalisation of the local network is expected to proceed more slowly, based on areas where significant demand for digital services is foreseen, and where equipment replacement is necessary. Current plans expect about 25% of local loops to be connected to digital exchanges by 1995. Switch types used are System 12 of Standard Electrica SA (ITT) and the AXE system of INTELSA (Ericsson).

Two field trials are planned for mid-1985,based on these two digital switching systems. Services will include digital telephony, teletex (in packet mode with X25 interface at 2.4 kbit/s), Group 3 facsimile (at 9.6 kbit/s via a V24 interface), videotex (via PSTN), and data transmission (at 9.6 kbit/s via V24). Different transmission systems for the local loop will be trialled. The System 12, at the Diana experimental exchange, will handle digital subscribers in two digital subscriber modules.

An ISDN pilot service trial is planned from the end of 1986. Some hundreds of users may be connected, with telephony, circuit switched services, and transparent switched access to the packet switched network, IBERPAC, which handles teletex, videotex, electronic funds transfer, and message switching.

A commercical ISDN public service is foreseen from 1988, in Madrid and Barcelona, with up to 1000 subscribers.

An early offering of advanced telephone and data services for different closed user groups of business customers will be made via IBERCOM, starting in Madrid during 1985. This service will provide digital connectivity via the IDN, and will use Small Digital Exchanges, which can be based on subscriber premises, and will ultimately be integrated into ISDN via its primary rate access. Over 50,000 IBERCOM connections are expected in 1988.

CCITT No. 7 signalling will be introduced in the IDN from mid-1986, with ISUP available one or two years later.

## 2.12 PORTUGAL

Portugal had approximately 1.5M telephony lines in 1983.

No information is presently available on digitalisation or ISDN planning.

# 3. COMMONALITIES AND DIVERGENCIES

## 3.1 Network Strategies

### 3.1.1 Evolution from the telephone network

The basic theme of evolution from analogue telephony to ISDN was stated by CCITT as long ago as 1972. Although a number of special-purpose networks have grown up in many countries, for example to provide packet switching, or circuit switching of data, these are of limited size and scope, oriented towards particular customers. Only the telephone network is sufficiently widespread to offer the possibility of integrated service availability to all users. The progressive introduction of digitalisation based on an agreed standard of 64 kbit/s transmission and switching is resulting in a movement towards an Integrated Digital Network in each of the EEC countries. The rate of change varies in each country because the introduction has so far been based on economic justifications arising from the historic situation in each individual network. The French network is the furthest advanced in digitalisation, particularly in switching, as a result of decisions made over ten years ago to improve the network infrastructure significantly. Table 1 shows the planned introduction of field trials and public services within the Community.

Statement 1

**At present, all Network Operators within the Community envisage that the ISDN will be achieved by further gradual evolution of the IDN.**

### 3.1.2 Worldwide penetration

The advantages of digital transmission and switching are centred on the regeneration of digital signals, allowing virtually error-free communications. The benefits for telephony are low-loss, low-noise connections allowing far better intelligibility, and transmission quality which is independent of distance. The trends, both in

TABLE 1

**Planned introduction of field trials and public services**

| | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
|---|---|---|---|---|---|---|---|---|
| B | | | ◡ | ◗ | ◗ | ● | ● | ● |
| D | | | | ◗ | ◗ | ● | ● | ● |
| DK | | | | ◗ | ◗ | ● | ● | ● |
| F | | | ○ | ○ | ● | ● | ● | ● |
| GB | | | ○ | ○ | ● | ● | ● | ● |
| GR | | | | | | | | |
| I | | ◡ | ◡ | | ● | ● | ● | ● |
| IRL | | | | | | | | |
| L | | | | | | | | |
| NL | | | | | | | | |
| E | | | ◡ | | ● | ● | ● | ● |

ISDN trial (a) without 'S' interface ◡

(b) with 'S' interface ◗

Pilot or public service

(a) without 'S' interface ○

(b) with 'S' interface ●

growing expectations from users, and economic and technological improvements in equipments, make it certain that digital telephony end-to-end between users will ultimately become the normal form of communications throughout the world. No other bearer service has the same potential for international penetration. Just as analogue data communications has shown great ingenuity in exploiting the 3kHz telephony circuit, so future equipments and services will exploit the 64 kbit/s digital circuit in ways not yet foreseen.

Statement 2

**All trends indicate that digital telephony will ultimately have worldwide penetration, bringing transmission benefits for voice which will also allow exploitation in new ways by many other services.**

3.1.3 Network configuration strategies

Most Administrations do not consider the ISDN ultimate structure to be significantly different from the telephone network structure. Switch locations and main transmission arteries will follow accepted zoning and hierarchical patterns for telephony. Of course, this is partly due to the evolution through digitalisation of the telephony networks, but it is still significant that no major changes in zoning or routing are considered necessary. Such overlay networking as will exist during the introductory phases of ISDN is merely a transitional stage, and not the introduction of a new overlay for its own purposes. Some digital islands will exist also during the introductory phases, but more as the result of local circumstances than of policy. This could be contrasted with broadband network introduction where, for example in UK, some islands of local distribution systems will be installed significantly in advance of interconnection demands. In North America, where most long-distance transmission is still analogue, large digital islands of ISDN could arise. The situation in Europe is more favourable, with most countries already well advanced in national digitalisation, but there is a danger that Europe as a whole could consist of separate, national, ISDN islands. The subject of international interworking has so far been given little attention within CEPT or CCITT.

Statement 3

**Agreed plans are urgently required on compatibility between national ISDN's and on the introduction of an international digital infrastructure to avoid the danger of separate national ISDN islands within Europe.**

3.1.4 Nationwide coverage

Those Network Operators which have progressed to the stage of public service planning are considering significant use of remote concentrators and multiplexors in the early phases. This is to deal economically with the sparse distribution of customers expected initially. To provide a nationwide service, at least between large business communities, some out-of-area subscriber connections are planned. This will have numbering, tarrif, and therefore usage implications. The numbering must be tied to the exchange to which the ISDN subscriber is connected, rather than to his physical location, in order that a telephony call originating in the PSTN can be economically routed to the ISDN subscriber. This may put pressure on the national numbering plan, requiring the permanent or temporary assignment of additional exchange codes or other number groups for subscribers with remote working. This effect is shown in figure 2. The tariffing for the ISDN subscriber may also be based on the exchange to which he is connected rather than his own physical location and charging group. This could be advantageous or disadvantageous for the subscriber, depending on his community of interest for communications, and his degree of ISDN usage.

Statement 4

**For several network operators, nationwide coverage will require the use of remote concentrators or multiplexors in the early years. This could create charging problems in the medium term if the network does not include at least one ISDN exchange in each charging area.**

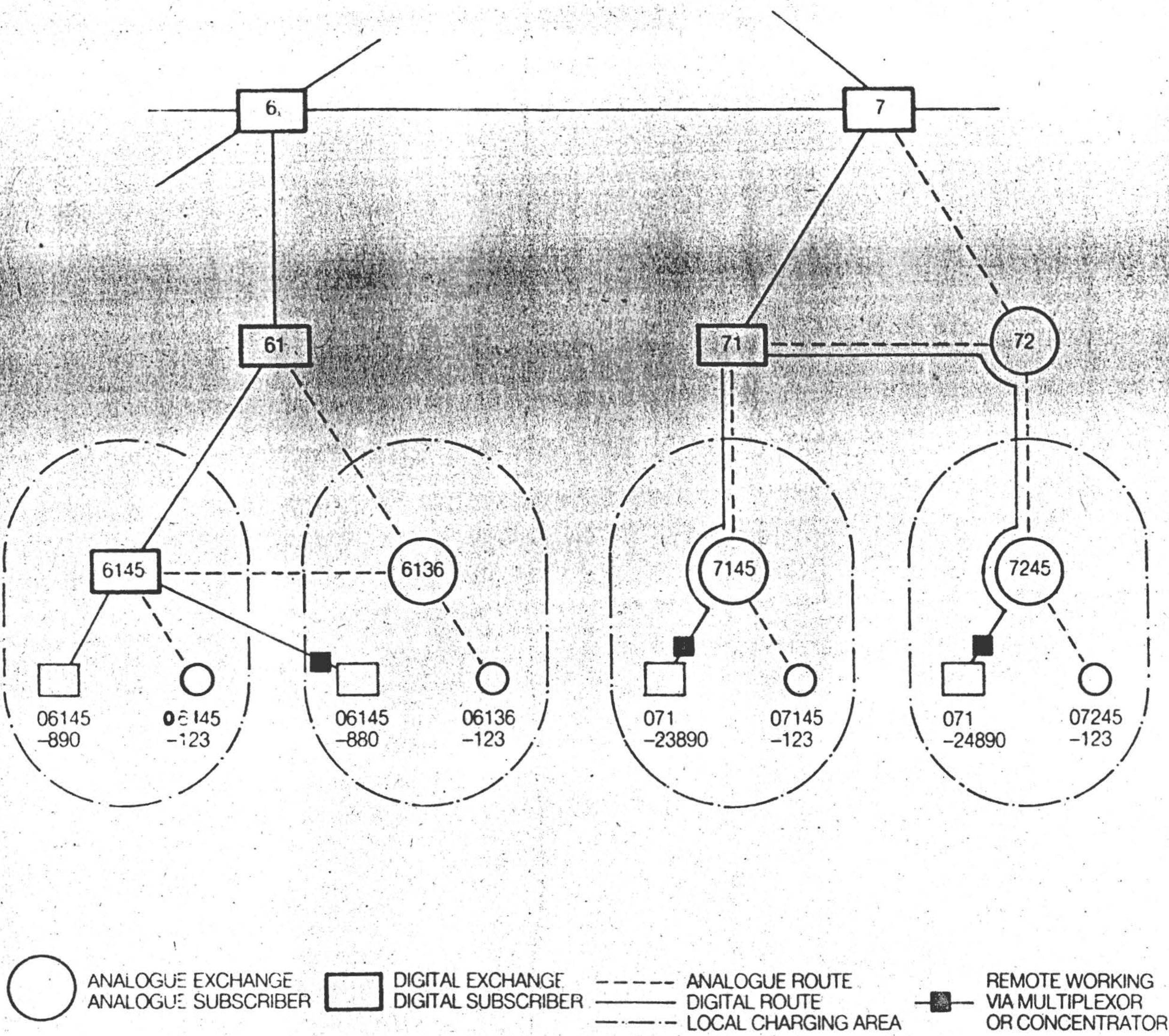



Figure 2 **Effect of Remote Working on Numbering and Charging**

Note: Possible arrangements for remote working will depend on available digital exchanges with digital subscriber capability, and on digital route availability.

3.1.5 Impact on numbering schemes

The CCITT recommendation that ISDN numbering be based on telephone network numbering plans has been accepted by all Network Operators. The possible pressure on the national numbering plan from remote working has already been described. However, there is a further impact on numbering schemes from Direct Dialling In to PABX's, particularly if this feature is to be available on calls originating in and signalling through the PSTN. The ISDN number identifies the physical or virtual interface at the S or T reference points to which a call is to be routed, but this may include discrimination between different equipments on a passive bus situated at the user's desk. CCITT recommendations allow for additional subaddress information of up to 32 decimal digits which may be required to be transmitted through the ISDN to identify the wanted user or equipment.

Statement 5

**National numbering schemes may need to be reviewed and augmented in size or capability to cater for ISDN terminal addressing, and out-of-area remote working.**

3.1.6 Introduction of CCITT No. 7

In order to cater for even the most basic ISDN features, such as addressing and call set-up, an inter-exchange Common Channel Signalling scheme is essential, and the CCITT No. 7 signalling system is the obvious candidate. Provision is allowed within this scheme for national variations, provided the recommended structure is adhered to. Network Operators generally indicate that CCITT No. 7 will be used in their national networks, and Table 2 shows the planned introduction of No. 7 throughout the Community. However, it is not always clear which options will be excluded, or even whether a similar but different national system will be devised. Certainly, national variants will exist in the early stages of ISDN. For example, Italy has specified a national adaptation covering the Message Transfer Part, Telephone User Part, and Data User Part. This allows for additional features such as Closed User Group and

TABLE 2

**Planned introduction of CCITT No. 7 signalling system**

| | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
|---|---|---|---|---|---|---|---|---|
| B | ◡ | ◡ | ◗ | ◗ | ◗ | ● | ● | ● |
| D | | ◡ | ◡ | ◑ | ● | ● | ● | ● |
| DK | | ○ | ○ | ◑ | ● | ● | ● | ● |
| F | | | | ◡ | ○ | ○ | ○ | ○ |
| GB | ◡ | ○ | ○ | ○ | ○ | ● | ● | ● |
| GR | | | | | ○ | ○ | ○ | ○ |
| I | ◡ | ◡ | ○ | ○ | ○ | ○ | ○ | ○ |
| IRL | | | | ○ | ○ | ○ | ○ | ○ |
| L | | | | | | | | |
| NL | | | | ◡ | ◑ | ● | ● | ● |
| E | | | | ○ | ○ | ● | ● | ● |

National or international trial
(a) without ISUP ◡
(b) with ISUP ◗

National or international service
(a) without ISUP ○
(b) with ISUP ●

Calling and Called Line Identity, and is being introduced already in the speech and data network (RFD). A Second phase of CCS introduction is foreseen, in which the above features will lie within the ISDN User part of No 7, but a date for this introduction is not yet given.

Statement 6

**Although CCITT No 7 signalling is being introduced throughout Europe, there are significant national variations, and action is needed now to agree an interpretation which will apply internationally throughout the Community.**

3.1.7. Basic and primary rate access

Network Operators are agreed on the S and T interfaces for basic access terminations to ISDN, and on the use of the S interface passive bus.

Individual systems for subscriber access have been devised for ISDN trials and pilot service. These have been defined in advance of the 1984 I-Series recommendations, and may provide different data rates. For example, the UK pilot service will use B+B'+D channels at 64, 8 and 8 kbit/s, whilst some Italian trials used B+D at 64, 16 kbit/s, as well as the I-Series format of 2B+D at 64, 64 and 16 kbit/s. These differences are not important at this stage of implementation, as all Network Operators have agreed to use the 2B+D format, with aggregate 144 kbit/s rate for the ultimate ISDN.

The primary rate access of 30B+D is also generally agreed for use on 2.048 Mbit/s circuits to PBX's and multiplexors. Some countries have proposed smaller groups of channels, such as the 704 kbit/s, 10B+D arrangement described for the French RENAN subscriber concentrators.

Several varieties of network terminations NT2 have been proposed at the basic rate 'T' interface. These incorporate local switching functions, as shown in figure 3 and Table 3. Some systems propose

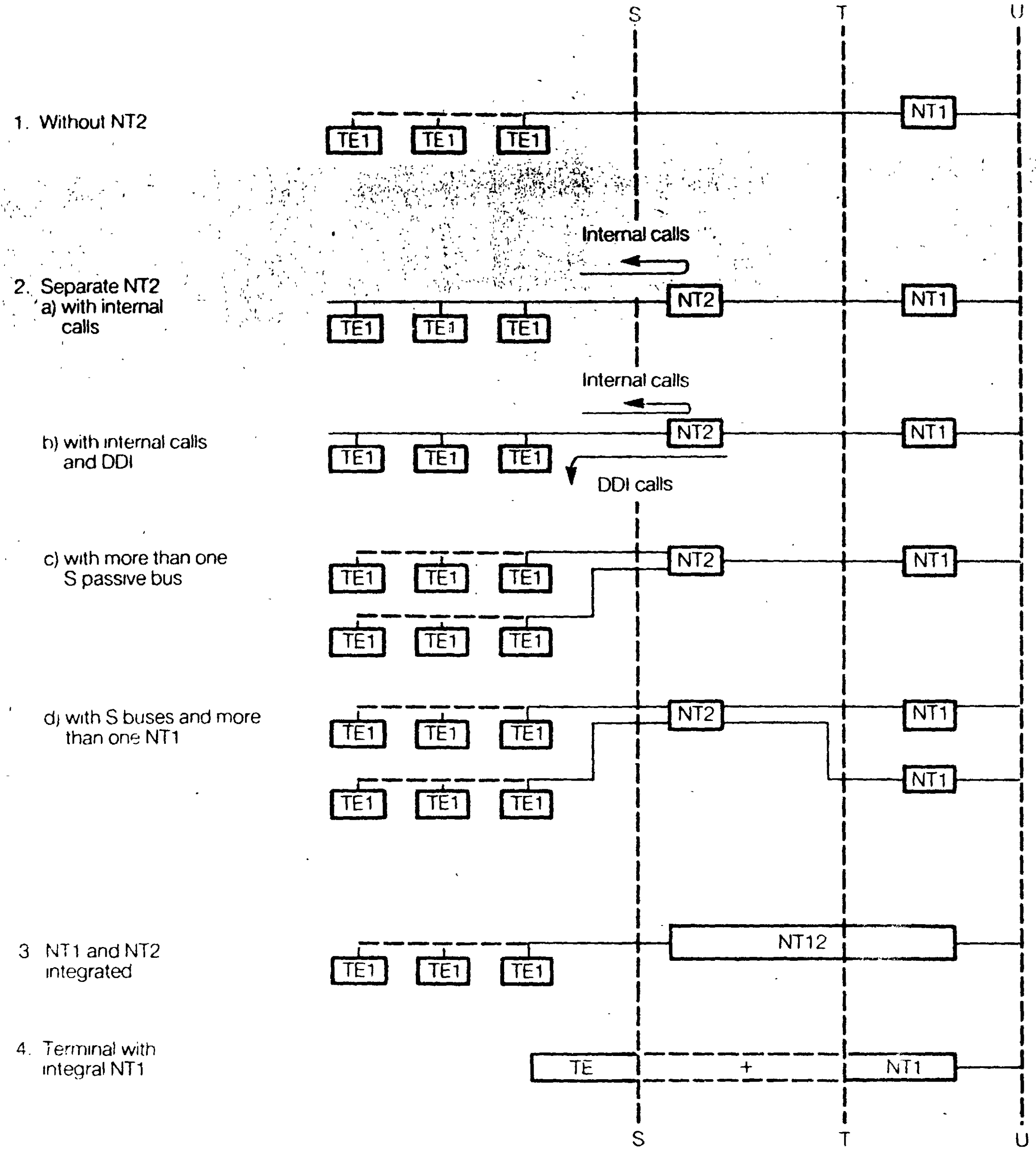



Figure 3 **Possible Variations of Network Terminations for Basic Access**

TABLE 3

**Variations of network terminations proposed at the T interface**

| | B | D | DK | F | GB | GR | I | IRL | L | NL |
|---|---|---|---|---|---|---|---|---|---|---|
| NTI function only (no NT2) | ● | ● | ● | ● | ● | | | | | |
| NT2 with internal calls | ● | | | | | | | | | |
| NT2 with internal calls and DDI | ● | | | ● | | | | | | |
| NT2 handling more than one S-bus | ● | | | ● | | | | | | |
| NT2 with S-buses and more than one NTI | | | | ● | | | | | | |

the use of the passive bus for internal traffic, which may involve complex procedures, and could lead to blocking of incoming calls. There is also a tendancy for some Network Operators to propose adding a wide variety of message types on the D channel in addition to the call handling messages. It is possible that the implicit costs of handling this traffic in the exchange network could be considerable.

There is also some confusion in defining the S and T reference points for primary rate access, as the primary rate NT2 functions are assumed to include concentration of signalling as well as distribution of channels.

Statement 7

**Although the CCITT basic and primary rate access are generally agreed, some countries are proposing varieties of network termination which could result in lack of equipment harmony within Europe.**

3.1.8 Local loop transmission systems

Many researchers are active in devising local loop transmission systems for basic access. There are no agreed standards for such a system, indeed CEPT has excluded the relevant 'U' interface from its considerations. Two main methods of operation over a two-wire circuit are being considered - burst mode transmission, with so called "ping pong" alternation of the direction of transmission, andmethods using simultaneous transmission in both directions, with elimination of known transmitted waveforms and their echoes to allow detection of the received signal. Neither technique has yet emerged as superior, although the echo cancellation systems may be more adaptable to lines with impedance mismatches found in the existing local loop plant, and may also have a potential advantage in maintenance, through immediate detection of changes in loop transmission characteristics.

A North American standard for the 'U' interface will be necessary if the FCC maintain the present regulatory attitude on what constitutes Customer Premise Equipment, which effectively places the network demarcation at the U interface instead of the T interface. This location has operational disadvantages, as it prevents the Network Operator incorporating maintenance facilities in the network termination. Nevertheless, it is possible that a U interface standard will emerge outside Europe, whilst a large variety of European national systems are being implemented.

Statement 8

**A wide variety of local loop transmission systems are being developed in Europe, whilst it is possible that a standard for the U interface may be proposed in other parts of the world which do not use the T interface as the network demarcation point.**

3.1.9 Digital interfaces behind a PABX

The termination of basic or primary rate access at a PABX does not preclude the use of proprietory digital telephone interface techniques at the extension which are different from the recommended S interface.

In fact, many PABX's with proprietory digital telephones have already been installed, and may be early users of ISDN. In some countries the regulatory environment may permit the digital telephone interface behind a PABX to be specified, whereas in countries with more liberalised supply of subscriber equipment, it may not be possible to guarantee an S interface in the face ofother, possibly commercial influences. The degree of penetration of S interface points is crucial to the market size for S interface terminals, and for the effective cost reduction of IC devices to implement the S interface itself. It would be ideal for the S interface to be supported as far as the users desk by all PBX manufacturers, but this does not appear likely to occur in practice.

Statement 9

> **At present, it does not appear likely that the S interface will be universally adopted behind a PABX, despite the beneficial effect this would have on S interface costs generally.**

3.1.10 Interworking with existing networks

As shown in Table 4, those Network Operators which are at the stage of public service planning are proposing to interwork with existing dedicated networks. This includes the PSTN or enhanced speech plus data network (as in Italy) and national dedicated circuit or packet switched data networks. Several administrations will use the minimum integration scenarios, with switched B channel access through the ISDN to a gateway interworking port on the packet switched network. The UK has indicated that dial up or private circuit access to PSS will be obtained in this way in the pilot service. The CLI and CUG features of ISDN will be used to simplify charging arrangements and prevent fraudulent use of PSS access points reserved for specific customers. The maximum integration scenario envisages packet handling resources within the ISDN, accessed either via a circuit switched B channel, or over the spare capacity of the (packetised) D channel. The French RENAN project will use both methods of access for virtual calls, and will allow connectionless service on the D channel. Three of the field trials already carried out in Italy have investigated packetised services, with a packet handling facility being included in the ISDN local exchange in some cases. The Belgian field trial in 1985 will have integral packet switching in the local exchange. Denmark, however is considering the minimum integration scenario with semi permanent B channel access to the packet switch network, in view of the restrictions placed on packet services by the characteristics of the D channel itself. Only packet terminals up to 9.6 kbit/s can use the D channel, with maximum user data field of 256 octets, and conformity to CCITT recommendations on multiplexing, use of numbered information frames, and compatibility checking.

TABLE 4

**Planned interworking between ISDN and existing networks**

| | B | D | DK | F | GB | GR | I | IRL | L | NL | E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PSTN | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● |
| Low speed CSDN | | ● | ● | | | ● | ● | | | | |
| 64 kbit/s CSDN | | ● | | ● | | | ● | | | | |
| PSDN via B channels | ● | | ● | ● | ● | | ● | | | | ● |
| PSDN via D channels | ● | | | ● | ● | | ● | | | | ● |
| Telex | | ● | ● | | ● | | | | | | |
| Teletex on PSTN | | | | ● | ● | | ● | | | | |
| Teletex on CSDN | | ● | ● | | | | ● | | | | |
| Teletex on PSDN | ● | | | ● | ● | | ● | | | | ● |
| Videotex on PSTN | ● | ● | | ● | ● | ● | ● | | | | |
| Videotex on CSDN | | | ● | | | | | | | | |
| Videotex on PSDN | | | | | | | | | | | ● |
| Facsimile on PSTN | ● | ● | | ● | ● | ● | ● | | | | ● |
| Facsimile on CSDN | | | ● | | | | ● | | | | |
| Facsimile on PSDN | | | | | | | | | | | |

Access to teletex and telex subscribers is also included in some Network Operators planning. In some cases a circuit or packet switched data network will be interposed between the ISDN and the other subscriber network. This concatenation of networks in tandem may give rise to some addressing problems and may make it difficult to meet the CEPT objective of single stage selection.

Statement 10

**A variety of methods are proposed for interworking with existing networks, both circuit and packet switched. Techniques are based on historical circumstances in each country, and no common philosophy is apparent.**

3.1.11 Early experience with 64 kbit/s terminals

As shown in Table 5, several countries are proposing to introduce 64 kbit/s circuit switched services almost immediately, to allow early experience with terminals working at this speed. In Germany, the "model" network, based on enhancements to the exising EDS circuit switched network, will be available in 50 cities during 1985. In France, the special network, RTC 64, has planned penetration of 22 switches nationwide in 1985. In Italy, 64 kbit/s connectivity will be introduced into the speech and data network, RFD, starting in 1985. The UK pilot service will be available at 60 access points nationwide during 1985. All these networks can support X21 terminals at up to 64 kbit/s, using separate call control units in some cases. The possibility may exist for interchanging terminals or interworking between the networks to highlight some of the problems of 64 kbit/s terminal compatibility.

Statement 11

**Early experience with 64 kbit/s terminals and networks is considered important by several Network Operators, but there are no known plans to interchange terminals or interwork the 64 kbit/s networks.**

TABLE 5

## Proposed early availability of 64 kbit/s circuit switching

| | B | D | DK | F | GB | GR | I | IRL | L | NL |
|---|---|---|---|---|---|---|---|---|---|---|
| 64 kbit/s CSDN | | ● | | ● | ● | | ● | | | |
| Access via single channel | | ● | | ● | ● | | ● | | | |
| Access via 30 channel PCM | ● | | | ● | | | ● | | | |
| Transparent digital connectivity | ● | ● | | ● | ● | | ● | | | |
| Support for X21 at 64 kbit/s | | ● | | ● | ● | | ● | | | |
| Access switches in 1985 | 15 | 50 | | 22 | 60 | | | | | |

3.1.12 Use of satellite circuits

Satellite Multi Services allowing circuits and circuit groups to be easily established between small dish antennae will be available on a series of satellites in Europe. The French Telecom 1 satellite, the EUTELSAT-sponsored ECS, the German DFS, the UK's Unisat, and the Italian Italsat will all be carrying such traffic within three years, and circuits may be leased out to some of the Network Operators for national as well as international routes. Some of the systems use a transformation from 64 kbit/s PCM to 32 kbit/s ADPCM to economise on voice channel bit rates over the satellite link. Even links which are not recoded in this way are subject to transmission delays such that two satellite links should not be connected in tandem for voice calls.

Statement 12

**Network Operators must not use satellite circuits within a national switched ISDN as this could create problems in international connectivity, in avoiding two satellite circuits being used within the same connection.**

3.2 Market Strategies

3.2.1 ISDN trials prior to public service

Some ISDN field trials have already been conducted, notably in Italy in 1984. The UK pilot ISDN service has also been demonstrated in live operation. Nevertheless, with the exception of the UK pilot service, Administrations are planning trials for several more years before public service introduction as detailed in Chapter 2. In some cases, such as the French RENAN, the trial is intended to develop into a public service. In some other countries there is no commitment beyond the field trial stage, or even no defined field trial programme at present. In most cases the field trials contain only a small element of market investigation. They mainly cover technical aspects, such as the development of equipment and terminals for the S interface, alternative methods of local loop transmission, and adaptation of nationally-used exchanges with ISDN hardware and software. Some countries use exchanges, notably the Ericsson AXE 10 and the ITT System 12, which are also used elsewhere within Europe, and in which the amount of new development per country will be small. Some other exchange types are unique to one country within Europe, in which case all development effort must be borne nationally. Such factors necessarily affect the speed of introduction foreseen in different countries.

Statement 13

**There is no common attitude to the relationship between field trials and public service for ISDN, nor any common programme for introduction.**

3.2.2 Identification of ISDN customers

There is general agreement that "leading edge" corporation major offices will be among the initial users of ISDN, with subsequent penetration to smaller offices and independent businesses. There are mixed views about residential customers. In some cases they are thought to have little involvement with ISDN until some future date when digital telephony provision costs are directly comparable with analogue costs, at which time a gradual conversion from analogue to digital telephony will occur. In other cases, residential demand for ISDN is considered to be quite strong, with customers prepared to pay a rental premium for better speech quality or for high speed data access to new services such as telesoftware for home computers or teleshopping via photovideotex. Some countries, notably France, are taking positive action to encourage the growth of such new services, whilst others only intend to follow market demand when voiced. Even within the field of business communications, it is not yet clear which features of ISDN will be most attractive. In the early years of ISDN, traffic volumes and patterns will be difficult to forecast, while new market sectors are identified, and new applications emerge.

Statement 14

**Potential ISDN customers are not well identified. Targetting ISDN at different potential customers could result in different network characteristics emerging in some countries.**

### 3.2.3 Estimates of penetration

Few countries have firm planning estimates for the penetration of ISDN subscribers. UK expects the majority of business customers to have the opportunity of access to the ISDN by 1990, but has not released figures for projected uptake of the service. Italy has indicated that the ISDN layer could have 50 thousand subscribers by 1990, with capability for 1 million by 1994. France and Germany have indicated possible penetration to 3 million users by 1995, whilst Denmark foresees 1 million users by that time. Other countries intend only to follow user demand, or have no firm commitment to ISDN at present. In the absence of firm market strategies, the rate of penetration of ISDN will vary greatly between the different countries.

Statement 15

**There is no common agreement on estimated penetration of ISDN, and there are different degrees of commitment from the Network Operators for their own published plans.**

### 3.2.4 Tariff policies

Only a few Network Operators have so far declared a tariff policy for ISDN calls. All intend to charge calls by duration and zoning in the same way as for PSTN voice calls. This will probably include cheap rate periods, also as for voice calls. This tariff policy fits well with the ultimate objective of digital service to all telephony subscribers and the replacement of the PSTN by the ISDN. The policy should also be favoured by INTUG and ECMA, who have expressed the view that charging should be a function of call usage, without differentiation between voice or data occupancy of a circuit. Higher rental and installation charges for ISDN access are also proposed, to reflect the high technology equipments involved. But some administrations may have proportionately lower charges for primary rate access, so that at a relatively low number of ISDN channels it will be cheaper to provide access by primary rate, rather than basic access circuits. In practice, tariffs have a great influence on user investments in terminals and services.

Statement 16

**There is no common view on tariffing for ISDN, even though an early declaration of broad tariff policy would have a great influence on user investments.**

### 3.2.5 Impact of Digital PABX's

In several countries, PABX suppliers are already installing digital PABX's with capability for ISDN access. Private digital circuits are available from some Network Operators, allowing networking between PBX's. In the UK, a national signalling system has been defined, based on CCITT No. 7, to allow PBX facilities such as transfer and ring back to be accessed from a remote PBX on the same network. The system is used by several suppliers, and a trial involving networking between PBX's from three different manufacturers is scheduled in the first half of 1985. Undoubtedly a method of using ISDN to provide the networking capabilities presently provided by private digital circuits will be required by users. It is also likely that users will want to split a 30 channel primary rate access arrangement to provide some circuits with switched access to ISDN, and other circuits with semipermanent connection to other user sites, or to packet switching, telex or other dedicated network facilities.

Statement 17

**The sophisticated features available in modern PABX's will demand tariff and market strategies which allow maximum customer flexibility in the use of ISDN.**

## 3.3 Services to be Offered

### 3.3.1 Bearer services

Network Operators will provide a 64 kbit/s bearer service which may be transparent, as for data, or non-transparent for speech, in which event digital speech interpolation, echo cancellation, or other signal processing systems may be included in the path. The service may be established on a demand or non-immediate basis. It is clear that all countries will offer demand service, but the non-immediate offerings may vary. A second bearer service to be established in all countries will be 1920 kbit/s transparent, non-immediate, namely primary rate connections between major users. The method of providing packet switching bearer service is less clear and may vary between countries. Most will provide virtual circuit, demand or non-immediate, using X25 LAPB via the B channel. Some may also provide D channel service, either virtual circuit or connectionless. Table 6 shows that a variety of connection types are planned for trials or future introduction.

Statement 18

**A variety of bearer services are proposed, but the only switched bearer service universally available will be 64 kbit/s transparent, circuit switched.**

### 3.3.2 Telephony

Some confusion is created through the CCITT not having explicitly defined telephony as a teleservice, but rather as a collection of lower level connection attributes. Nevertheless, telephony will be

TABLE 6

**Connection types planned for trials or future introduction**

| | | B | D | DK | F | GB | GR | I | IRL | L | NL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 kbit/s, transparent, | switched | ● | ● | ● | ● | ● | | ● | | | |
| | reserved | ● | ● | ● | ● | ● | | ● | | | |
| 64 kbit/s, speech, | switched | ● | – | – | ● | ● | | ● | | | |
| | reserved | ● | – | – | ● | ● | | ● | | | |
| 384 kbit/s, transparent, | reserved | – | – | – | ● | – | | ● | | | |
| 1920 kbit/s, transparent, | reserved | | ● | | ● | ● | | ● | | | |
| ≤64 kbit/s, packet virtual cct, | switched | ● | – | – | ● | ● | | ● | | | |
| | reserved | ● | – | ● | ● | ● | | ● | | | |
| ≤16 kbit/s, packet virtual cct, | switched | ● | – | – | ● | – | | ● | | | |
| | reserved | ● | – | – | ● | – | | ● | | | |
| ≤16 kbit/s packet connectionless, | – | ● | – | – | ● | – | | ● | | | |

supported in all countries. Speech quality should be improved through lower attenuation even on calls to PSTN telephones, whilst between two digital telephones there will be better signal to noise ratio and low attenuation independent of distance. Several digital telephone instruments have already been developed for trials. Most include sophisticated features such as hands free conversation and a display to indicate call progress and charges or calling line identification. In the UK, one network terminating equipment which incorporates a digital telephone is also used to establish paths for data transmission from terminal equipments, and to swap between voice and data during a call. In Italian trials, one digital telephone with a keyboard as well as a display used D channel end-to-end signalling for message transfer between users.

Supplementary services for telephony have been defined by CCITT, including closed user groups, call waiting with subscriber number indication, registration of incoming calls, call diversion, completion of calls to busy subscribers etc. Table 7 shows that it is not yet clear which supplementary services will be supported in each national network, or internationally.

Statement 19

**Even for telephony some confusion exists, due to the lack of a clear definition of telephony as a teleservice. Instead it is regarded as a collection of bearer service attributes. In the different countries, a variety of supplementary services for telephony are proposed by Network Operators.**

### 3.3.3 Data transmission

Several Network Operators have indicated that they will support data terminals to existing standards of V-Series, X21, X21bis, or X25 through terminal adaptors. This service may be provided for many years whilst customer demand for this class of terminal continues. There may however be some national variations of the rate adaption schemes. This would not prevent international working, since the data rate adaption is specified by the user at the initiation of a

TABLE 7

**Planned introduction of supplementary services on 64 kbit/s switched connections**

| | B | D | DK | F | GB | GR | I | IRL | L | NL |
|---|---|---|---|---|---|---|---|---|---|---|
| Abbreviated dialling | ● | ● | ● | ● | ● | | ● | | | |
| Call waiting | | ● | ● | ● | ● | | ● | | | |
| Call diversion | | ● | ● | ● | ● | | ● | | | |
| Call barring | | ● | ● | ● | ● | | ● | | | |
| Call forwarding | | ● | ● | | ● | | ● | | | |
| Completion of calls to busy subscriber | | ● | ● | | ● | | ● | | | |
| Fixed destination call | | ● | ● | ● | ● | | ● | | | |
| Conference call | | ● | ● | | ● | | ● | | | |
| Call hold for enquiry | | ● | ● | ● | ● | | ● | | | |
| Calling line identification | ● | ● | | ● | ● | | ● | | | |
| "Secret" CLI | | | | ● | ● | | | | | |
| Malicious call identification | | | ● | ● | ● | | ● | | | |
| Call progress message | | ● | | | ● | | ● | | | |
| Charging information | ● | ● | ● | ● | ● | | ● | | | |
| Call charge meter | | ● | ● | ● | | | ● | | | |
| Reverse charging | | ● | ● | ● | | | ● | | | |
| Freephone | | ● | ● | | ● | | ● | | | |
| Payphone/credit card calling | | ● | ● | | | | ● | | | |
| Closed user group | ● | ● | ● | | ● | | ● | | | |
| User to user signalling | ● | | ● | ● | ● | | ● | | | |
| Change of service during a call | | ● | | | ● | | ● | | | |
| Direct dialling in | ● | ● | ● | ● | ● | | ● | | | |
| Logging of incoming calls | | ● | | | | | | | | |
| Do not disturb | | ● | ● | | | | ● | | | |
| Priority | | ● | ● | | | | ● | | | |
| Interception of calls | | ● | ● | | | | | | | |
| Multi-addressing | | ● | ● | | | | | | | |
| Sub-addressing | ● | | ● | ● | | | ● | | | |
| Code conversion | | ● | ● | | | | | | | |
| Speed conversion | | ● | ● | | | | | | | |
| Delivery confirmation | | ● | ● | | | | | | | |
| Delayed delivery | | ● | ● | | | | | | | |

call, but a gateway conversion function might be required, and there would be an impact on terminal interchangeability within the Community. Some anomalies will exist - for example, the UK Pilot service does not support 600 bit/s synchronous operation, but does support the non-standard rate of 8 kbit/s. Bearing in mind also the interworking arrangements with existing dedicated data networks, it is not clear which data classes of service will be supported over international connections.

Statement 20

**Due to the different national solutions for data transmission, it is not clear which data classes can be supported internationally.**

### 3.3.4 CCITT defined Telematic services

The Telematic services which have been defined in detail by CCITT comprise facsimile, teletex, videotex and mixed-mode teletex, the last being a combination of teletex and Group 4 facsimile, sometimes referred to as textfax. The CCITT definitions of these services were originated for earlier networks with lower speeds and are not specifically valid for 64 kbit/s transmission, although this will not cause difficulties in practice. Videotex has a wide variety of standards throughout Europe, and increased speed will be handled differently in different countries. Germany, for example, is considering that high speed videotex images in the B channel may be accompanied by additional speech information. In the UK, 64 kbit/s photovideotex may be introduced. In effect, videotex is a national service, with individual national characteristics, but this is partly in keeping with its connection profile of user to data base communications, rather than user to user communications.

All countries plan to support teletex and digital facsimile in their ISDN, most from the initial trial period onwards. Group 4 facsimile has already been demonstrated in the UK pilot service, although the terminals used are still expensive and in short supply. Interworking of teletex and Group 4 facsimile with appropriate terminals on other dedicated networks, including telex and PSTN teletex, is foreseen in most countries, but the implications for possible speed conversion and for communication between group 4 and the lower facsimile groups are not completely clear. There is at present no reason why teletex and digital facsimile terminals for ISDN should vary significantly between countries, although minor national variations of keyboards are to be expected.

Statement 21

**CCITT definitions of telematic services are not specifically valid at 64 kbit/s, and no agreement has yet been reached on implementations which will allow maximum interworking of equipments.**

3.3.5 Supplementary services

Those Network Operators which have identified supplementary services for telephony, such as closed user groups, call waiting or diversion, will generally be able to provide these services also for teletex and facsimile calls.

Several other supplementary services can be envisaged which could also be classified as Value Added Network Services. These fall in the areas of interworking or protocol conversion, information retrieval, and messaging. Most Network Operators have plans for some or all of these services, and in some countries the regulatory environment will allow independent suppliers to provide certain VANS. A step towards standardisation in this area has been taken with the X400 Message Handling Systems recommendations. These give procedures for submission, delivery, and confirmation of receipt of documents in store and forward systems, sometimes loosely termed electronic mail.

Several telematic services which are not yet defined by CCITT are being considered for introduction in national ISDNs. Slow scan video is proposed in UK, Italy, Germany and France. Telewriting is being considered in France and Germany. Telealarm or telemetry services will be used in Denmark, France, UK and Germany. Voice teleconferencing is also proposed in several countries.

Statement 22

**A variety of telematic supplementary services are proposed in different countries. It is clear that teletex and digital facsimile should be internationally supported, but precise details of their supplementary services are not yet fully defined.**

3.3.6 Videotelephony potential

Several countries are already involved with videoconferencing services using the COST 211 recommended techniques at 2.048 Mbit/s. At present these services use pre-arranged circuits without switching on demand, but prototype switches are being studied, and a switched 2 Mbit/s service could be provided in a future broadband network.

There could also be a significant demand for narrowband videotelephony. At least two American companies have already demonstrated working colour videotelephony systems running at 56 kbit/s including both video and sound information. At present the picture compression algorithms are still being refined, and the equipment has not yet been committed to LSI technology, but when this is undertaken in the near future a dramatic reduction in size, power, and cost will result. Market forecasts for videotelephony are notoriously doubtful, as there has so far been a marked reluctance for subscribers to accept video communications. Nevertheless, if videotelephony becomes a service of interest to subscribers, the low call charges and worldwide accessibility of 64 kbit/s narrowband ISDN could prove an attractive alternative to higher quality broadband offerings.

Statement 23

**Narrowband videotelephony is just one example of a new service which could exploit the universality and relative cheapness of ISDN.**

## 3.4 Standard Issues

### 3.4.1 National interim standards

All Network Operators will support the CCITT I-Series interfaces in their networks during the public service phase. During preliminary trial phases, other interfaces have been, and will be used, largely dependant on the state of technology and of international standardisation when the trial was initiated. It can take several years to prepare and introduce an ISDN trial. Only the United Kingdom is proposing a public service in advance of implementing I-Series recommendations. The initial subscriber terminations using 80 kbit/s transmission and 64 + 8 + 8 channel structure will continue to be supported for several years, but the introduction of 144 kbit/s basic access may occur from 1987 onwards, and a migration from national interim standards to CCITT I-Series is foreseen.

Statement 24

**National interim standards will give way to CCITT I-series recommendations when public service is introduced, or shortly thereafter.**

### 3.4.2 CEPT interpretation of CCITT recommendations

Several areas in the CCITT recommendations are open to national interpretation, or selection of options, and some necessary requirements of Network Operators in establishing a public service have not been covered. This is only to be expected, considering the worldwide nature of the CCITT forum, but it leaves scope for futher work in applying the recommendations in a common way throughout Europe. CEPT has had a special study group on ISDN for several years, which has contributed significantly to establishing the I-Series recommendations, and which is continuing to oversee the activities of several working groups on ISDN techniques and services. An action plan for CEPT studies on ISDN for the period 1985-88 has been initiated. Some study points are of obvious immediate applicability, whilst others, such as subrate switching, new coding methods for telephony, or packetised voice, may not need to impact the provision of 64 kbit/s services initially.

Statement 25

| |
|---|
| **CEPT is continuing to do valuable work in achieving a common European interpretation of ISDN, but activities are not yet firmly focussed on priority issues.** |

3.4.3 Harmonised transmission plans

ISDN telephony is fundamentally a zero-loss, 4-wire medium between digital telephones at each end. The transmission plan for this service could be universally applied throughout Europe, so that all instruments have the same transmission characteristics. The send and receive levels must be set in accordance with two operating constraints - (a) between two digital phones and (b) between a 4-wire digital phone on ISDN and a 2-wire phone on PSTN. In the latter case the transmission losses will vary between countries according to the existing telephony plans and the points of interworking between PSTN and ISDN. Signals transmitted from the digital phone will have zero loss paths to and from the PSTN 2-wire/4-wire hybrid conversion point, making the hybrid return loss more objectionable to the digital phone user. Many digital phones propose hands-free operation, which brings the possibility of room echoes returning via a path with lower loss than usual to the 2-wire telephone. Such digital phones usually include voice switching (or variable attenuation) to combat this problem, and it may be beneficial to standardise the technique used, or even to include it in digital phones which are not hands-free. This would result in symmetrical transmission paths, which would reduce the likelihood of one user dominating the conversation. Transmission standards within digital PABX's may also vary across Europe.

Statement 26

**Due to the influence of the already-existing PSTN on transmission plans, a specific effort is required to harmonise transmission plans within Europe, and create the opportunity of a universal digital phone.**

3.4.4 Rate adaption schemes for data

Rate adaption schemes are detailed in CCITT recommendation X30. At present it can only be assumed that all countries will conform to these schemes in their public service ISDNs. Failure to conform would eliminate the possibility of common terminal adaptors throughout Europe. Alternatively, the adaption could be provided in the terminal itself.

Statement 27

**Agreement is required on adherance to standards for data rate adaption to ensure Europe-wide transportability of terminals, and common terminal adaptors.**

3.4.5 Bilateral international agreements

From the information presently available, no known bilateral variation of standards have been determined. It is possible that groups of countries may adopt mutually compatible arrangements which are in some way at variance with the rest of Europe. Of the EEC countries, Denmark may be in this situation as a member of the Nordic group, but the implications of this are not yet clear. The standards to be used for international interworking of ISDN's have not yet begun to be studied by CCITT or CEPT.

Statement 28

**The lack of standards for international interworking of ISDN's leaves open a possibility for groups of countries to adopt interworking arrangements which may ultimately be at variance with the rest of Europe.**

3.5 Summary of Convergencies and Divergencies

This Chapter has reviewed current plans for the introduction of ISDN in the Member States of the Community, identifying convergencies and divergencies of approach:-

- All Network Operators envisage ISDN evolving from the telephone network. However, some countries will force the evolution rapidly, some will follow customer demand, and some have no firm plans as yet. Some countries do not expect to introduce an ISDN before the mid 1990's.

- Current plans do not guarantee compatibility between different national ISDN's. There is such a wide variety of connection types and services supported in the different networks that the only common prospective service which appears realistically achievable is the transparent 64 kbit/s circuit switched bearer.

- No international digital infrastructure is currently being planned. There is no common interpretation of international signalling options. Standards activities in CEPT are not yet focussed on priority issues.

- Terminals in each country will be significantly different. Transmission plans for digital telephony are not yet harmonized. There is no agreement on terminals to be supported, terminal adaptors or interfaces for terminals behind a PABX. A large variety of European local loop transmission systems are being developed.

- No common policy exists on numbering schemes for ISDN terminals, or on the basis for ISDN tariffs.

- Market assessments are weak, without firm identification of leading edge or long term customer requirements.

Statement 29

**From this review of current plans, the only possible conclusion is that**
**A COMMUNITY-WIDE ISDN WILL NOT EMERGE UNTIL AT LEAST 1995 WITH THIS APPROACH.**

# 4. NETWORK INTRODUCTION PHILOSOPHIES

An examination of the nature of new telecommunications networks and the broad alternatives in their provision will help to identify fundamental causes for divergency in ISDN introduction plans and set a framework for convergent action in the Community.

## 4.1 The Role of Network Operators

Telecommunications indisputably has a growing infrastructural importance for all EC countries, comparable to other infrastructure components such as the road system. In all countries the provision of public telecommunications networks is regulated, with a monopoly environment (or one with strictly limited competition) for network operators - whether they are organised as a pure administration, a public enterprise (with a monopoly for at least part of their activities), or a private enterprise (holding an operating licence).

Whilst all countries fund investment in certain infrastructural sections via tax revenues (and thus only indirectly by users), investment in telecommunications networks and services is generally required to be covered by service revenues from users and subscribers. Nevertheless, the privileged "monopoly" environment is intended to enable the network operators to invest in telecommunications infrastructure and the development of new services on a basis which is broader than short-term commercial demand-and-supply.

Statement 30

**Although telecommunications is generally regarded in Europe as a "natural" monopoly, the network carriers have become accustomed to behaving in their financial activities like private enterprises, requiring early profitability and introducing new networks and new services in a "demand-oriented" investment pattern.**

It follows that investments are generally required to be based on market studies and "forecasts" of demand for the product or service which the investment will introduce.

But it is clear that a whole range of investments - those which can be regarded initially or permanently as supplying a new infrastructure - cannot be justified or timed on the basis of firm user demand. This is the reason why many such infrastructural investments are conducted through state-funding.

In the case of establishing telecommunications services, the following activities may be distinguished:-

- Infrastructural tasks aimed at setting up a network infrastructure with equal access for the whole population;

- Infrastructural tasks to establish some "basic" services;

- Commercial operation, offering services to customers on the basis of user demand and profitable supply.

The role of the network operator (as a vehicle for infrastructure development or as commercial concern) can be different from network to network, from service to service, and with time over the life-cycle of telecommunications systems.

## 4.2 Network Alternatives

Today there are in Europe different types of telecommunications network, and it is important to distinguish between them, to recognise the fundamental character of particular networks, and the influence this has on the introduction philosophy for new networks and services.

### 4.2.1 Fundamental networks and their introduction

There are networks, such as the Public Switched Telephone Network (PSTN) or the Telex network, where the network was technically specified and planned first; then, in conjunction and subsequently, appropriate terminals were developed to use the network. We define these as Status I networks.

Statement 31

> **Status I Networks are public networks, of which the PSTN is the prime example, which have been technically defined and planned independantly of pre-existing terminal characteristics. They offer totally new possibilities for transmission of traffic, and the ultimate potential for universal access from all households. With the characteristics of the network defined, new terminals arise which are dedicated to exploiting the network in new ways.**

Since by definition Status I networks include significant new elements and permit new telecommunication services, they exhibit a number of important characteristics which strongly influence network introduction.

Statement 32

> **Status I networks require a significant planning and investment period before the first subscriber can be connected. We call this period Phase 0; Phase 0 may last for as long as 10 years.**

The value of a new telecommunications service is directly related to the number of potential participants.

Statement 33

> **For a new network the usage value to an individual subscriber is initially very low and grows with the number of subscribers connected.**

Interworking with existing networks and services can increase the initial usage value of a new network.

Statement 34

| For a status I network operator, initial costs per subscriber are inversely related to the network's usage value to the individual subscriber. |
|---|

Network costs per subscriber are very high at the outset, falling as the number of subscribers grows. Service tariffs however must be related to usage value and the longer term cost per subscriber.

Statement 35

| For any status I network there exists an introductory phase of operations (which may last for 10 years or more) during which subscriber revenues do not cover operating costs. We call this Phase 1 of a status I network. |
|---|

For the customer, the value of a network lies only in the services he can obtain, and these are represented in most cases by his terminal equipment.

Statement 36

| The value of a status I network depends on the availability of adequate terminals. |
|---|

Terminals which exploit the new features and capabilities of a status I network can only be defined and developed after the full technical definition of the network. Services on such networks require that the communicating parties have terminals which work together - ie are standardised for interconnection. The degree of standardisation may vary up to full service standardisation (OSI layers 1-7).

Statement 37

**During Phases 0 and 1 of a status I network private industry cannot take market decisions on the development of terminals specialised for the new network until the network operator commits to its technical details and its introduction schedule and plans.**

Statement 38

**Because of the large changes in value to the user during Phase I, reliable forecasts for customer demand for the new network cannot be made. True customer demand does not exist until the network has reached a certain threshold of number of users, and cannot be proved by market studies during Phases 0 and 1. It follows that decisions for investment by the network operator cannot be justified by customer demand, and must be based on other criteria such as:**

- potential for innovation
- influence on the economy as a whole
- industrial aspects

Statement 39

**Pilot projects in Phase 0 can only reduce technical risks, not the risks of investment decisions. Because of the small scale, pilot users will not show "real" customer acceptance or "real" demand. Investment risks can only be reduced by waiting for the experience of other countries. This would inevitably lead to a long period where the home market is suppressed, and industry is uncompetitive on the world market for new networks and terminals.**

It is clear that network operators should try to reduce the duration of Phases 0 and 1 for a new status I network and reach self-supporting commercial operation as quickly as possible.

Statement 40

**Rapid introduction of a status I network is significantly assisted by operator actions such as:-**

- **early publishing of the network technical definition for suppliers**
- **high infrastructure investments for nationwide access**
- **long-term tariff policy for subscribers (with initial deficit funding)**
- **network interworking to enhance the user community**
- **adequate encouragement for mass production of terminals**

When the number of subscribers in a new telecommunications network passes a threshold level (at which network costs per subscriber can be balanaced by network usage value to each subscriber) a new phase of operations is entered, which we call Phase 2. Pure infrastructural investments are no longer required, and further development of the network is influenced by factors which are different from those in the introductory phases. Phases in the life-cycle of a status I network are shown in Figure 4.

Statement 41

**In Phase 2 of a status I network, customer demand can be forecast and the network operator will base expansion investment on growth in demand.**

Statement 42

**In Phase 2 of a status I network, service tariffs must produce revenues which adequately cover network costs.**

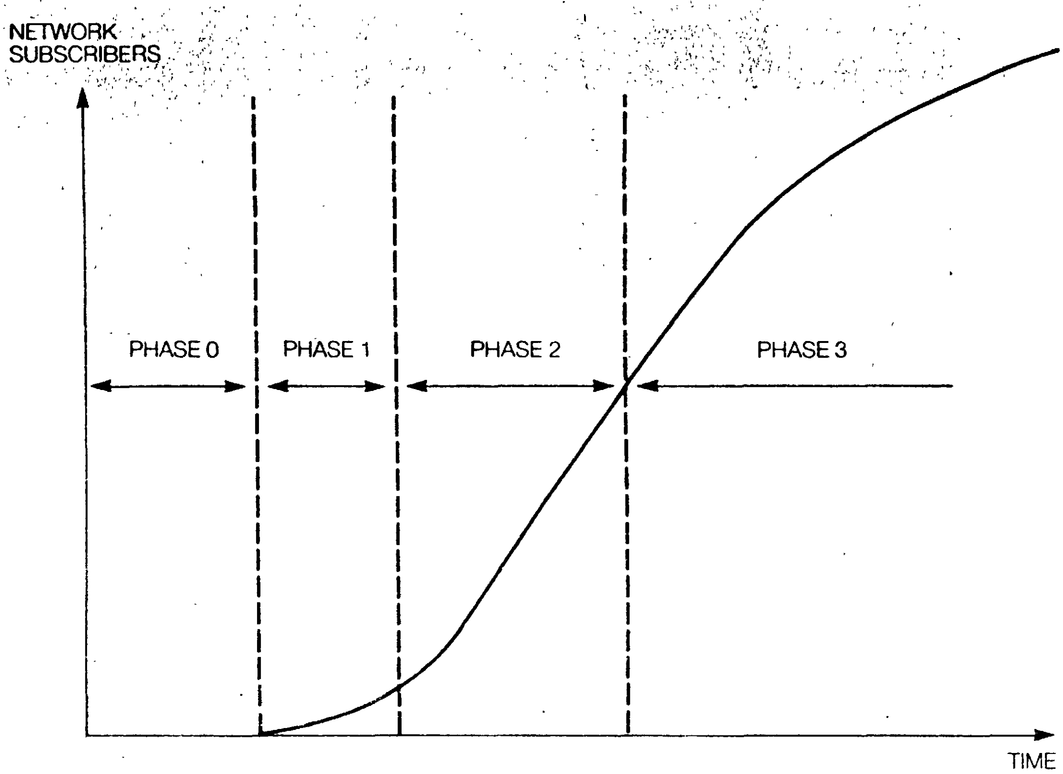



Figure 4 **Phases in the Life-Cycle of a Status I Network**

Statement 43

**In Phase 2 of a status I network the operator benefits from mass-production economies in network equipment. New technologies are only introduced if they are more cost-effective than existing ones.**

As a status I network expands and its usage grows over time, the replacement of older equipment begins - and several technology generations may co-exist for equipment implementing the same technical network features. A wide range of terminals becomes available to users. When the number of subscribers has passed a further threshold level (perhaps around 50% of all households or 20% of the population), we may observe an additional operational phase in the network's life, which we call Phase 3. Again, new characteristics govern the network's role.

Statement 44

**In Phase 3 of a status I network, service and subscriber revenues must generate significant profit levels in order to fund the infra structural investments for future new networks.**

Statement 45

**In Phase 3 of a status I network, additional revenues and profit for the network operator will arise from novel applications not originally envisaged when planning the network.**

4.2.2 Dedicated networks and their introduction

In contrast to the fundamental Status I networks for telephony or telex, there are networks in Europe which are of a distinctly different type. These were introduced by network operators to serve some already existing class of communications traffic.

A basic example would be the fixed-connection or leased-circuit networks provided for voice-grade and, more particularly, data transmission. These facilities are "dedicated" to the traffic arising from an existing class of terminals - eg computer systems and their ancillary devices. The switched data networks are more recent examples of such dedicated networks, which we define as status II networks.

Statement 46

> **<u>Status II networks</u> are public networks which were technically defined and planned for previously established types of traffic and terminals.**

Whereas for status I networks, terminals are specially developed and "dedicated" to the technical specifications and features of the network, in the case of status II networks the specifications of the network include standardised interfaces "dedicated" to the special requirements of selected established terminal types with existing traffic applications.

The factors influencing introduction of a new status II network differ markedly from those for a status I network.

Statement 47

> **For a status II network, the terminal types and classes of traffic are already established and therefore customer demand can exist before network introduction.**

Statement 48

> **For a status II network, customers understand potential applications well enough before network introduction to permit reliable market studies and demand forecasting.**

Statement 49

**The only pre-operations infrastructure development required for a status II network is investment in service and access to meet the initially forecast demand.**

Thus the phase 0 (period of planning and investment prior to connection of the first subscriber) for a status II network can be significantly shorter than is the general case for status I networks.

Statement 50

**Because there is pre-existing demand, the value of a status II network for an individual subscriber may be independent of the total number of subscribers connected.**

This is clearly so in the case of leased-circuits, but is also largely true for switched data networks since these are frequently employed as a more economical alternative to fixed-connections in "closed" applications.

As a consequence the phase 1 operational period (building to a threshold subscriber level with cost-covering tariffs) can be relatively short for a status II network.

Statement 51

**The network operator can introduce a Status II network to a known user demand, without high infrastructure investment or terminal development costs, and rapidly reach the profitable Phase 2 operation.**

It should be noted that there is no separate equipment market for terminals specially developed for status II networks. Rather, the established terminals (for example data processing devices) represent an independent market which develops and grows largely uninfluenced by the status II networks which service it.

## 4.3 The Existing Telecommunications Networks in Europe

The broad categorisation of telecommunications networks presented in section 4.2 can be confirmed through the example of existing networks in Europe. A history of the different networks also shows that a new network's establishment is strongly influenced by:-

- the introduction philosophy (infrastructural or demand driven);
- the development of terminals;
- initial tariff policies;

In fact this reflects whether the new network was perceived predominantly as being of status I or status II, and this difference in approach by network operators may also help to explain the divergencies emerging in ISDN plants in the EC countries, noted in Chapter 3.

It should be noted that a new telecommunications network is taken here to include not only a physically totally new resource but also a network which offers new transmission or service options although employing parts of existing networks.

### 4.3.1 The Public Switched Telephone Networks

Market penetration of the PSTN in EC countries is shown in Figure 5. During the decade 1970-1980 a number of national networks matured into phase 3 operations and some are now approaching saturated penetration in terms of households. Other networks are in earlier phase 3 operation or passing from phase 2. In all countries the introductory phase 1 for the national PSTN was successfully completed many years ago.

Based on the long history of large-scale acceptance and usage of the telephone service, the network operators have developed reliable modelling techniques for forecasting demand for connections to the network and for traffic, so that equipment and technology

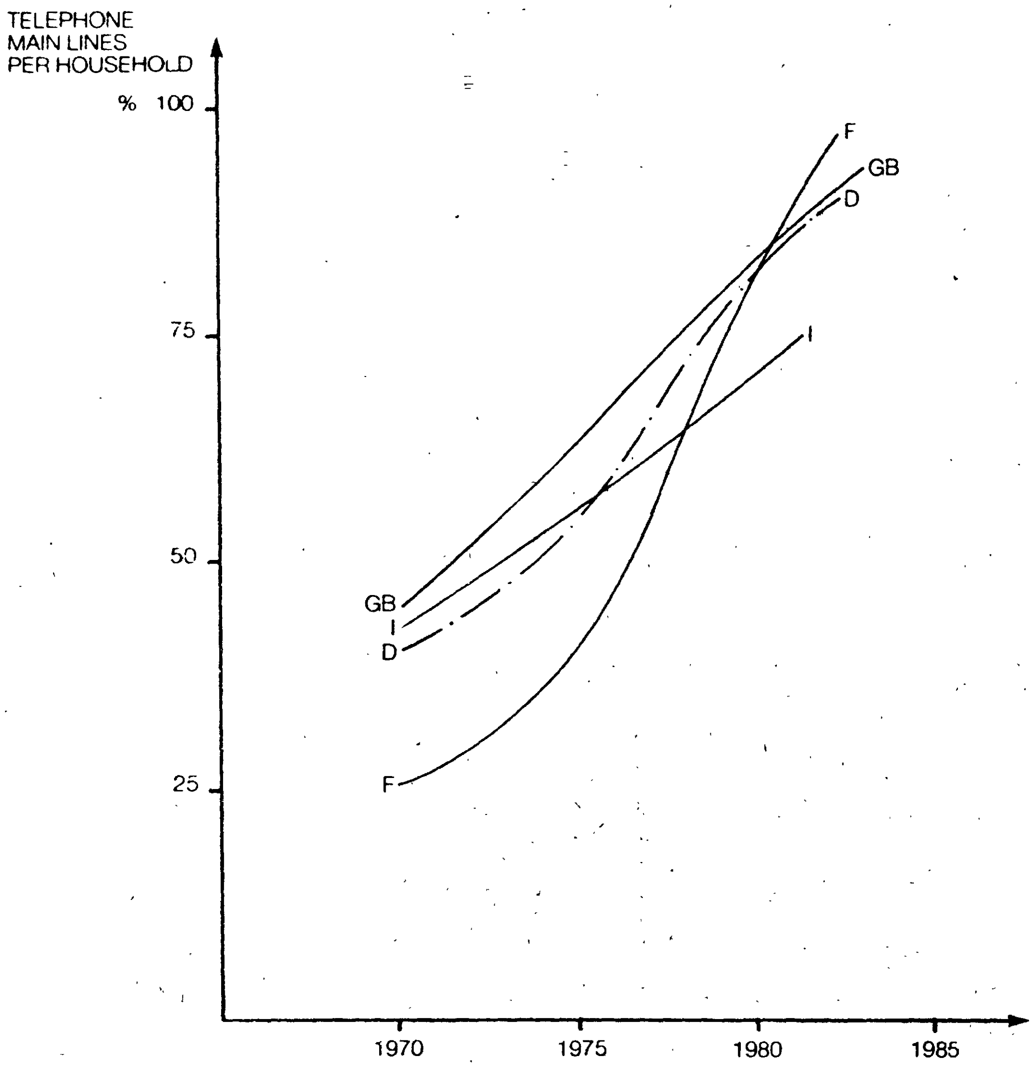



Figure 5 **PSTN Penetration by Households**

investments can be planned to follow network demand.

Again, for many years, the introduction of new technology into the PSTN (eg SPC exchanges, PCM Transmission systems, digital exchanges) has in most countries been based on purely commercial considerations in conjunction with regular replacement of old equipment and steady growth in network size.

Although there certainly were infrastructural investment phases for the PSTN in all countries, these were so long ago that they have largely been forgotten.

Statement 52

**The PSTN is a status I telecommunications network which in all EC countries has reached mature phase 2 or phase 3 operation.**

It would not be appropriate here to attempt a country by country history of the PSTN. However, the example of Germany provides a relatively recent case, where the post-war PSTN was planned in 1953.

The German network investment plan was in no way based on actual demand, but against a target of establishing equal service access throughout the country by 1957 coupled with provision of subscriber line plant based on a thirty year forecast of network penetration.

From the outset the network was aimed ultimately at serving all households. The chosen introduction policy, of infrastructural provision, allowed the rapid take-up of subscriber main lines in Germany during the 1960's when increased demand for telephone service occurred.

This may be contrasted with the situation in France at that time, where the policy for resource provision within the PSTN was much more demand oriented. Since actual demand was difficult to forecast, installed network capacity lagged behind the surge in demand - leading to long waiting lists and PSTN subscriber penetration in France falling behind that in other countries.

However, France reversed this situation during the 1970's, when the development of a telecommunications infrastructure was declared a "national programme" which was not directly demand related. Today the PSTN in France has achieved a superior standard, with a high proportion of modern digital exchanges and transmission equipment.

Statement 53

**The initial development and growth of a new status I telecommunications network is highly influenced by its intended ultimate market being either universal (ie all business and private households) or a restricted group (eg business users).**

The demarcation between special groups may vary or disappear over time. Thus it is possible to argue that a network which is initially orientated to one group could later be enlarged to serve others (eg from corporate business, to small business, and then to private residential households). Indeed, actual demand for services on a status I network may typically follow this pattern - even when conceived initially as a universal service. But there is a real difference between:-

- a network planned from the outset for the entire population;

and:

- a network planned for a special consumer group, with the possibility of subsequent enlargement if demand from other groups actually materialises.

Despite the early predominance of business subscribers, it should be observed that the PSTN was always orientated ultimately to universal use. This meant that long periods of infrastructural investment and pay-back were accepted; that mass-production of equipment was possible; that telephone instruments were planned as relatively simple, cheap, and easy-to-use terminals. As a result there was a steady rise in subscriber numbers and in the value to an individual subscriber of his telephone network connection.

Demand for a network is closely related to aspects of its initial introduction policy, and later examples suggest that demand justification for enlarging a network from a special target customer group to other groups may never arise.

4.3.2 The Mobile Telephone Network

The mobile telephone network has the characteristics of a status I network. In the past no EC country introduced it as a universal network, but rather it was targetted to a very restricted special customer group, and historically this matched technology restrictions which limited the number of network subscribers. However, with the new cellular technology, very large subscriber populations could be supported in new mobile telephone services.

Whether in the long term a universal "popular" service develops will depend on how network operators treat mobile service introduction from the outset - either planning for a high volume infrastructure, or introducing a premium, restricted target service (which will normally require relatively small investment in infrastructure).

4.3.3 The Telex Network

The telex network is a status I network; but it has clearly been orientated to big business users and introduced in all countries in relation to demand amongst a very restricted user group. This has been reflected in relatively small scale network implementation, together with:-

- high subscription fees;
- high usage tariffs;
- high-priced terminals.

Although it might be argued that only corporate business users had a need for rapid text transmission, it is clear that demand for text transmission from small businesses or residential users via the telex network could not (and did not) arise with these cost patterns.

Statement 54

**The example of telex shows that if a status I network is targetted from conception at restricted groups of users then demand will be constrained and only develop within those groups. The network will stay small.**

Statement 55

**Restricted introduction philosophies lead to particular:**

- **service definitions, or**
- **patterns of provision and costs**

**which themselves prevent the emergence of further demand from other users.**

As a pointer to appropriate introduction policies for ISDN, we may observe that demand for text transmission services from residential households is unlikely to exist unless it is created by the availability of a network universally offering a suitably cheap and effective text service.

4.3.4 Videotex Networks

For the purpose of this study we have included as new networks those which offer new transmission and service opportunities to their users, whether or not all the physical components are new. In this sense videotex is a new network, however whether it is a status I or status II network is not entirely clear, since it has been introduced differently in different EC countries. As examples, we may look at videotex in France, Germany, and the UK.

4.3.4.1 Videotex in France

In France, videotex was planned as a new network with clear objectives:-

- to offer the videotex service universally;

- to develop special videotex terminals to exploit the network.

Videotex in France therefore is a status I network orientated to the general public. Significant infrastructure (rather than demand-based) investments were made to establish equal access arrangements throughout the country and particular encouragement has been provided to ensure the development of terminals for mass-production (Minitel) - these are characteristics typical of phase 1 of a status I network; particular applications (eg for directory information) are promoting the growth of a large subscriber base, and as a result the videotex service in France has reasonable prospects for a development pattern similar to that of the telephone service in the past.

4.3.4.2 Videotex in Germany

Videotex in Germany was initially planned as a status I network, for general public use. The technical standards of the network were defined independently, and high infrastructural investments were made in a Phase 0. But the operational service has not attracted subscribers in anything like the numbers forecast and is mainly oriented to a restricted business user group, since:-

- high function terminal standards were defined (CEPT level 3, including graphics), probably inappropriate for a "popular" network, and really inexpensive terminals (or decoders for TV sets) have not yet been developed.

- services offered have not been attractive or relevant to private domestic users.

Possible development approaches for the videotex network in Germany would include supporting additional existing terminal types (such as personal computers, via less complex protocol standards) or more active promotion of full terminal production and economies of scale (through intervention activities similar to those in France). It should be noted that the first option would involve a shift to status II for the network, following an existing type of demand and becoming subject to the progress of another market (personal computers) rather than establishing its own identity.

### 4.3.4.3 Videotex in the UK

The British Telecom videotex service in the UK (Prestel) was conceived as a status I network for general business and domestic public use. Although subscriber numbers are far behind the original forecasts, the network now has some 50,000 subscribers and a growth rate of some 25,000 per year (and thus may exceed the number of UK Telex subscribers within two years). Around half of Prestel subscribers are now residential rather than business users; however initially this was not the case.

Significant Phase 0 (pre-service) infrastructure investments were made - particularly in establishing national access arrangements - and a relatively simple terminal specification was published, but:-

- no mass production was specifically promoted: terminal industry was required to predict network accceptance;

- initial services and tariffs generally were not attractive.

This was compounded by the fact that initially Prestel did not support external computer systems, but only offered BT operated data-base services tariffed to external Information Providers. Initial take up was rather slow and mainly for business and trade information retrieval.

More recently, third party Value Added Network Service (VANS) operators have been encouraged to join with Prestel and these have developed home finance and related transaction services, home computer support, and messaging services which have attracted considerable subscriber growth. In particular, these VANS services have coupled their applications with tariff packages including low out-of-hours costs and "bundled" provision of low-cost terminals (or adaptors). These new services and tariffing patterns have significantly boosted videotex subscriber numbers, particularly amongst residential users.

Statement 56

**Videotex examples confirm that the pattern of development and of customer demand for a network are largely influenced by the overall philosophy behind the introduction of the network.**

4.3.5 The Dedicated Data Networks

Dedicated data networks, as section 4.2.2 has already suggested, originated chiefly to meet the needs of the EDP world in connecting remote peripheral devices and data stations to central computer systems (eg for remote job entry computing) and in inter-computer transmission of data (to support distributed computing).

In the first instance their needs were met through leased-circuits which were allocated to a particular use and a specific customer - and this is still common practice for data users today.

Since this "fixed-connection" service was always introduced by network operators purely "on-demand" from the existing EDP market, such networks can clearly be classed as Status II networks. Indeed, for terrestrial circuits there was normally no phase 0 construction period (since physical plant from the telephone network was employed). Furthermore, there was essentially no phase 1 build up to a viable subscriber base, since customer usage and value in the network is self-contained to his nominated fixed connections.

A similar situation applies in the case of satellite circuits employed for data transmission - although in this case a significant phase 0 construction investment had to occur before any subscriber could be connected. This investment, however, would normally be on behalf of the public switched network infrastructure.

4.3.5.1 Circuit-Switched Data Networks

Only a minority of the EC countries have introduced a public CSDN. In principle these may be viewed as networks for "switched dedicated data circuits" in that, although not permanently allocated (and thus more economical), they are extensively employed in self-contained fixed-connection data applications. These networks can thus also be classed as status II networks, oriented to a restricted group of customers (having EDP systems).

Historically the introduction philosophy for these networks was based on direct demand (forecast from existing EDP use of dedicated circuits or the PSTN). The networks were dedicated to existing terminal types (through use of defined interface X.21, etc.) and no support was directed by network operators at new terminal development. To meet initial demand levels a modest phase 0 was necessary (to put exchanges in place). Subscriber penetration of CSDN has remained low, even amongst the special target customer group.

From a technical point of view, there are similarities between CSDN and the narrow-band ISDN (ie circuit switched transparent digital channels) and thus the existing customer base for the CSDN is automatically a potential market for the ISDN. Therefore it is important to repeat that the CSDN is a status II network dedicated to only a restricted user group.

4.3.5.2 The Packet-Switched Data Network

Packet-switched data networks (PSDN) were developed to provide a more economical alternative to dedicated circuits for data transmission, by employing intelligent network components to introduce shared circuit use. Aimed at traffic and terminal types which already exist, the PSDN are thus status II networks.

Although a limited phase 0 period of pre-service investment was necessary (to establish the network exchanges, etc), all network operators have introduced the PSDN based on a demand-oriented strategy, extrapolating existing EDP data traffic demand and cost trends. PSDN network interfaces (X.25, and particularly X.28, etc) have been defined to adapt existing classes of EDP equipment; there has been little sponsorship of user-terminal development especially for connection to the PSDN (which in any case offers no fundamentally new telecommunications capabilities for EDP).

Marketed on a demand basis, the subscriber penetration of PSDN has followed trends in remote-access computing installations, but even in this special target market subscriber numbers have remained relatively small. Marketing of PSDN, together with services and tariff structures, has nowhere been directed at the general public.

In servicing the remote-access computing market many PSDN have provided interfaces and tele-service applications (such as EDP-terminal protocol management and conversion functions) which are specialised to this restricted user group, and which go beyond the traffic services normally identified for ISDN.

Statement 57

**Dedicated data networks show that status II networks do not promote a terminal industry, and remain of small size in restricted target markets.**

## 5. CHARACTERISTICS OF THE NARROW-BAND ISDN

Although the narrow-band ISDN in all European countries will be derived from the analogue telephone network - through digitisation of the switching and transmission equipment and exploitation of existing cables, including the subscribers local loop - there can be no doubt that the narrow-band ISDN (as defined in CCITT) permits totally new types of traffic and has all the characteristics of a fundamentally new telecommunications network.

Statement 58

**The narrow-band ISDN must be regarded as a fundamentally new telecommunications network.**

The major new characteristics introduced with the ISDN are:

- New transmission speed of 64 kbit/s in the B channel
- Two B channels on the same subscriber line
- Transparency of the circuit switched B channels
- Outband signalling via a separate 16 kbit/s D channel
- Inter-exchange common channel signalling

These characteristics are well-known, but their significance is that in combination they present a powerful new communications medium to subscribers, and that individually any one could be exploited as a new networking capability.

Statement 59

**Each one of the new ISDN characteristics is so powerful as to open up a whole range of:**

- **new forms of traffic and new services**
- **technically better or more economical solutions for existing forms of traffic and services**

This range of capability and individual new features encompassed in the ISDN may be seen as one of the main reasons for the markedly different approaches to narrow-band ISDN introduction being taken by network operators in different EC countries, as reported in Chapter 3.

5.1 Different Attitudes Towards Narrow-band ISDN in Europe

As indicated in Chapter 3, European network operators are agreed on the basic principle of ISDN, as defined in CCITT, as an evolving replacement of the existing telephone network - with newly defined interfaces and terminals developed to exploit new network features.

Statement 60

**In principle all European network operators regard ISDN on a long term basis as a Status I network, with the ultimate objective of bringing digital communications, including digital telephony, to all households (both business and private).**

However, perhaps because the narrow-band ISDN (unlike the broad-band ISDN) does not require a totally new physical network, or because it offers the opportunity to solve some current network problems, the introduction philosophy for the narrow-band ISDN in all EC countries appears to be based on commercial criteria; some operators have adopted a demand-based strategy for ISDN, others appear to be basing introduction on eventual equipment replacement in the mature telephone network.

But, as was argued in Chapter 4, Status I networks cannot be commercially justified in their introductory phases 0 and 1. Genuine customer demand cannot have sufficiently developed for new services, and equipment replacement occurs to extend the life of a mature network, not to establish a new one.

Statement 61

> **A fundamental issue for the European Community is whether, from the outset, and throughout the Community, the narrow-band ISDN is regarded as a true status I network.**

While the long term target is unanimously agreed, for the initial introduction period the national network operators have differing philosophies and marketing strategies. Whereas, if the narrow-band ISDN was recognised by all operators as a fundamentally new status I network for the entire population, then important aspects of introduction philosophy would follow automatically:-

- ISDN introduction cannot be demand-based, since new demand cannot pre-exist for a status I network in phase 1.

- ISDN introduction cannot be "dedicated" to existing demand (eg traffic transferred from existing data networks) since this is characteristic of status II networks which do not establish new potential.

- ISDN introduction cannot be commercially justified in its initial phases, because the investments must be treated as largely infrastructural and justified through broader national or community economic arguments.

A demand-based strategy will follow the patterns already established in the national dedicated networks. It will perpetuate the wide variety of existing data networks, terminals, and services in each country. Each network operator will see the important new characteristics of ISDN through the perspective of his own existing networks. Individual characteristics will assume a different importance for each carrier, leading to different introduction strategies and different physical implementations.

Statement 62

**Network operators in EC countries currently show different attitudes to narrow-band ISDN. In general the full ISDN characteristics are not being promoted; different countries emphasise different selected new characteristics of the ISDN in a status II network fashion.**

5.1.1 Emphasis on data circuit speed in ISDN

Some network operators (and significant sections of the EDP industry) appear to attach most importance to the availability of transparent transmission at up to 64 kbit/s over a single B-channel; they expect the main initial applications of the ISDN to be the exploitation of this feature for computer-based systems.

This attitude to ISDN classes it primarily as a new status II network; an appropriate introduction philosophy in this case would be:-

- demand-based;
- oriented to a special customer group (not the general public);
- reliant on EDP terminal developments, rather than sponsoring new ISDN terminals.

The result of this introduction philosophy for narrow-band ISDN would be merely to incorporate with the telephone service a dedicated circuit-switched data network with a new higher speed.

Statement 63

**European network operators can introduce dedicated status II networks based simply on national demand-oriented philosophies, with bilateral agreements for international introduction. Activities at Community level in this situation would be limited to possible support for covering network demand in some countries.**

5.1.2 Emphasis on additional signalling channel use in ISDN

From the various new characteristics of the narrow-band ISDN, some network operators place initial emphasis on the separate signalling D-channel and its potential, via customer virtual circuits for data transmission and various teleservices such as teletex, videotex access, telecommand, telemetering.

Since the D-channel shared for these applications operates at 16 kbit/s it would also be possible to support such traffic in existing telecommunications networks (either the PSTN or dedicated data networks). The promotion of this particular aspect of ISDN in its early phases cannot provide either a commercial justification or a general economic case for introducing the ISDN network as envisaged in CCITT.

Statement 64

**Transmission via the D-channel in the ISDN does not in principle introduce significant new capability for customers (or for industry) which could not be realized on existing networks. Community level activity in this area would only be appropriate in ensuring that all countries were able to cover an established demand.**

5.2 Interworking of ISDN with Existing Networks

It was pointed out in Chapter 3 that in the introductory Phase 1 of a new status I network, the value of the network to each subscriber depends directly on the total number of subscribers in the network - and that interworking between the new network and existing networks can assist in building the number of correspondents.

Typical examples of this process would be interworking between the mobile telephone network and the PSTN, or between the Teletex service and the existing Telex network.

It must be recognised that for the new network this interworking is only an expedient to shorten its phase 1, and that a possible danger must be avoided. This arises when interworking with an existing network which was restricted to some special group of users: in this case there may be a tendency to market the new network only to the same group, although its true potential is quite different from the existing network. For the ISDN, it is not interworking with the PSTN which carries this risk (since that has a universal subscriber group) but rather the interworking with existing "dedicated" data networks. Although this is necessary and appropriate, network operators should be careful not to establish the ISDN as a better version of the dedicated network-orientated in coverage, specifications and cost levels primarily to the rather limited customer group which uses today's data networks.

Statement 65

**With proposed ISDN interworking with existing restricted data networks, and initial marketing to the special groups using those networks, there is a risk that the universal ISDN will not develop in Europe.**

## 5.3 ISDN Customer Base

Many network operators expect that initial demand for ISDN will arise chiefly through PABX traffic. This may be because the larger businesses operating PABXs are also customers for existing data networks and for "advanced" services in general. But it should be recognised that the dominant characteristic of ISDN - the combination of all the main new features defined in CCITT - is not so important for PABX based users, since the PABX does not fundamentally rely on a public ISDN network to offer such feature combinations (ie two channels; integration of voice, text and data transmission; parallel signalling). A PABX could offer integrated service by employing, for example, a dedicated circuit switched data network at 64 kbit/s. It is the subscriber with a single main line connection who will realise unique capabilities through the ISDN.

Statement 66

| |
|---|
| **If demand-based introduction strategies for ISDN are followed, targetting PABX traffic initially, there is a risk that universal ISDN needs will not be addressed sufficiently early in Europe. A genuine demand for ISDN may then arise only following terminal and service developments from elsewhere (eg USA or Japan).** |

While network operators have not established a clear view on the ultimate target customer base for ISDN (or on the appropriate initial services and terminals to offer) and hope for significant early use via PABXs there is a risk that specifications and markets for terminals will develop entirely differently for main line connection and for connection behind a PABX. This might encourage a continuation of the current trend for proprietary terminal types to be required purchases for connection to particular PABX models - a trend which could impact customer choice more acutely for text and data applications than today with the telephone.

Statement 67

| |
|---|
| **It is important for the Community that as large a market as possible is established for ISDN terminals specified for connection at ISDN main lines in Europe.** |

.4 Effects of the Diverse Approach to ISDN in EC Countries

In earlier sections of this chapter various commercial justification approaches to the introduction of ISDN have been examined and it is concluded that the basic factors for network development, discussed in Chapter 4, are likely to recurr - namely that consistent targetting of a network at any special existing market demand will tend to prevent the natural emergence of a truly new and broader based demand.

Statement 68

**The varied approaches of network operators towards introducing ISDN, and particularly the tendency to seek a current demand-based justification, run the risk that demand for the universal ISDN as defined in CCITT will not emerge, and that ISDN networking will remain "dedicated" to restricted customer groups.**

In Chapter 3 the examination of current technical plans for ISDN in the EC countries identified more differences than commonality, although in many detailed areas a number of network operators have not yet come to firm decisions.

On the other hand a few network operators have published firm ISDN introduction plans, which differ in many service details. These implementations, particularly in terms of service features developed for the current generation of exchanges, can be expected to persist for around 10 years.

Clearly without some coordinating action at the Community level, as further network operators specify their chosen solutions in the next few years the situation could become worse.

Statement 69

**The opportunity to take steps for a common European approach towards ISDN still exists, but only for a narrow time window of one or two years. If these steps are not taken, the different approaches of the network carriers will lead to a situation which cannot be harmonised at least until the mid-1990's.**

Among the differences which could lead to a seriously unharmonised ISDN situation in the Community may be listed:-

- different technical specifications of field trials and the possibility of their development as public services;

- the variety of bearer services, particularly those provided via the D-channel;

- the variety of supplementary services, many dependent on exchange support and advanced network signalling;

- interworking with different existing (data) networks;

- variety of telematic services, and associated facilities.

Statement 70

**Up to 1995 the current approach of network operators is unlikely to produce any international service on the ISDN beyond 3kHz telephony.**

Figure 6 shows possible interconnection structures for ISDN networks. A significant factor for international ISDN working will be the complexity of signalling required to select a standardised service and bearer capability across the inter-network interface point N.

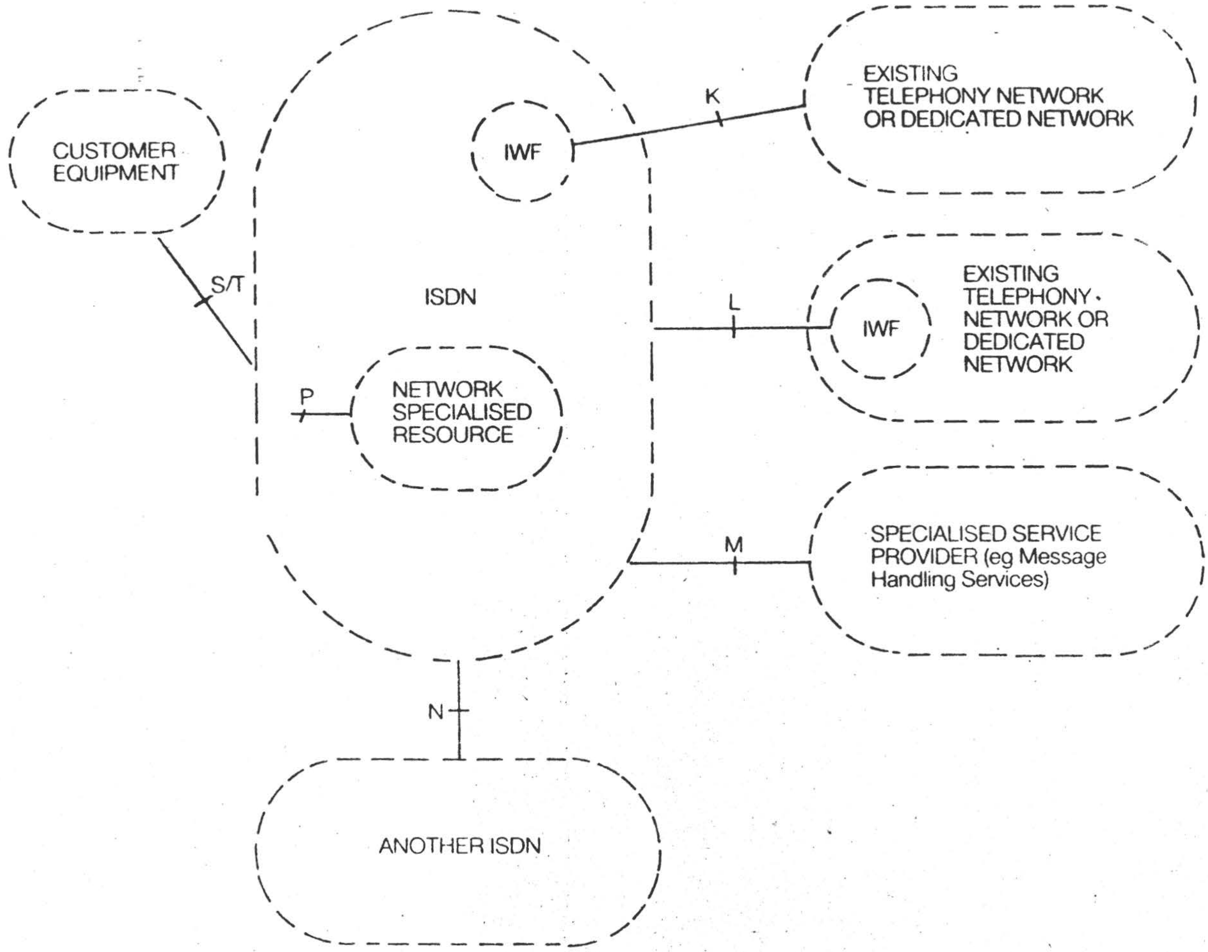
In addition to the technical differences in network specification, more commercial issues can also significantly affect harmonisation potential, such as:-

- marketing orientation to different inital customer bases;

- different tariffing policies for ISDN, particularly in relative tariffing versus existing networks.

Additionally, although only indirectly in the province of network operators, variety in digital interfaces for extension subscribers behind PABXs will be significant for harmonised terminal equipment markets.

Based on current national approaches, it seems that the prospects for new telecommunications services on an international basis becoming available soon in Europe via ISDN are poor; and that a




IWF = INTERWORKING FUNCTIONS

Figure 6 **ISDN Interconnection Reference Points**

Note: According to CCITT Recommendation I310, the specification of interfaces at K, L, M, N and P is for further study.

European wide market for ISDN terminals will not be able to develop in the next decade.

The technical specification for an ISDN terminal must be related closely to the services offered in the ISDN, both in terms of invoking appropriate services (through signalling) and exploiting these services for the user. Since, on current planning approaches, the service details of the ISDN are likely to vary in each EC country, different ISDN terminal specifications will follow.

Statement 71

**Before 1995 there is little chance of a European-wide market for new ISDN terminals, given current approaches to ISDN.**

Even if type-approval procedures in the Community move towards mutual recognition, the situation for the ISDN terminal market would not improve, since technical specifications would still differ between national networks.

It is appropriate now to note that the analysis of ISDN plans in Chapter 3, also observed a number of important common features amongst the intentions of network operators in EC countries. Among these were:-

- Adoption of the CCITT defined customer-network interface for basic and primary ISDN access;
- Introduction of inter-exchange signalling system (CCITT No. 7);
- Extensive implementation of digitisation in the current PSTN;
- Support for common telematic services (Teletex, facsimile), although lacking full definition.

Statement 72

**Digitisation in the PSTN is sufficiently advanced in all EC countries that this need not be an obstacle to the early introduction of ISDN in Europe.**

The agreement of all network operators that transparent 64 kbit/s B-channels will be provided via the CCITT standardised passive-bus interface for basic subscriber accesses (2B + D16), and via CCITT standardised primary access groups at 2 Mbit/s (30B + D64) means that there is a fundamental basis for a common European ISDN.

Statement 73

**Acceptance in principle by all EC network operators of the ISDN user-network interfaces (both basic rate and primary rate) as recommended by CCITT ensures the possibility of a European ISDN network.**

Although there is a fundamental acceptance of an ISDN in all EC countries, the variety of approaches currently being adopted are not converging on common services or implementation features, and this must be reflected in equipment requirements.

Statement 74

**The present diversity of ISDN approaches in EC countries implies little scope, over the next decade, for reducing the current fragmentation of equipment markets (for public exchanges, PABX, or terminals) or for developing any specific European industrial policy aimed at strengthening the competitiveness of the European telecommunications industry.**

A common plan for ISDN introduction should aim to:

- Reduce the variance between ISDN implementations in the Community;

- Reduce today's wide range of equipment for public switching, PABXs and terminals;

- Encourage broadband developments through a Community-wide broadband network with initial application for narrowband ISDN;

- Lead to greater competitive strength in the European telecommunications industry.

# 6. A COMMON PLAN FOR ISDN IN EUROPE

## 6.1 The First Step

The first step towards a Common Plan for ISDN introduction must be an agreement as to what type of network the narrowband ISDN will be.

Action Point 1

**The Community should agree to regard the narrowband ISDN as a Status I network targetted for universal penetration to all households.**

This means that the network will be oriented towards all customers, and not to any restricted group. A real acceptance of this view must include agreement on the need for an infrastructure commitment justified on the basis of the potential for innovation, the influence on the economy, and the industrial aspects, rather than one based on customer demand.

This agreement would be a major step forward.

## 6.2 The Need for Joint Action

We believe that this report has clearly shown that until now the Network Operators in their current planning have used an investment strategy which aims to follow demand to a large extent. We have explained that for Status I networks, which provide new terminals and services, the customer demand cannot exist until:

- the technical details of the network and services are defined, and
- the introduction philosophy is well published, so that terminal suppliers can take the risks associated with the development of new terminals in Phase 0.
  and
- a "critical mass" of subscribers is passed at the end of Phase 1.

The continuation of present policies would lead to an uncoordinated situation in which:-

- the large infrastructural differences within the Community would be perpetuated
- the opportunity for Community-wide technological innovation would be lost
- duplication of effort would occur in developing technical solutions to common problems, but the resulting equipments would also be incompatible
- different services would be offered, in response to the different existing dedicated network situations
- the opportunity for Community-wide markets would be restricted to transmission equipment, with ISDN exchanges and terminals having distinct national characteristics
- the application of ISDN would be restricted to the business world, delaying the spread of new information technologies to private households.

This uncoordinated situation is of significance because we are in the innovative introductory period of ISDN. If the ISDN had already reached Phase 2 of a Status I network, then a real demand for ISDN service would exist, and its further development could be handled quite effectively by demand-following investment strategies. This is the natural task of the Network Operators, who are accustomed to this responsibility.

In the introductory period, however, there is a real need for joint and coordinated action, and it must follow that activities in this period should involve the European Commission, since the issues at stake are so large.

Action Point 2

**The Community must agree to act jointly and in coordination throughout the introductory period of ISDN, to ensure a successful and early introduction.**

## 6.3 Extent of the Introductory Period

We define the introductory period for ISDN in terms of our Status I network, namely all activities until Phase 1 is completed.

This means:-

Phase 0 - Network definition, development of equipments, and investments needed before the connection of the first subscriber

Phase 1 - Continuing investment on an infrastructural basis, rather than demand following, until a critical mass of subscribers is passed.

The extent of the introductory period could be debateable, but after due consideration we believe that the self-sustaining critical mass of subscribers ought to be achieved within five years of connection of the first subscriber. The starting point for first subscriber connection we set at January 1st, 1988, recognising the situation in different networks, and accepting that some networks will be in motion before the start of the five-year plan. For the critical mass of subscriber connections, we estimate 5% of the telephone subscriber population in each country at the end of 1983. This critical mass is related to the attainment of the ultimate objective of penetration to all households in each network considered, and the use of 1983 figures (or 1984 if available) allows us to be quantitative. It is also evident that ISDN access must be widespread throughout each country if the ultimate penetration to all households is to be achieved.

Action Point 3

**The Community should agree that the infrastructure investment (Phases 0 and 1) for the introduction of ISDN in all Member States should:**

- **Create an installed capacity of ISDN main lines equal to 5% of the number of analogue telephone subscribers (at the end of 1983)**

- **Give equal access from 80% of the surface area and 80% of the population of each country**

- **Achieve the above criteria in a five-year programme by 1993**

- **Create full interconnectivity of national ISDNs by 1993.**

These objectives are realistically feasible, and are within the ranges already announced by some countries. Beyond this threshold level for narrowband ISDN, network carriers will be able to follow real customer demand, in Phase 2.

With Phase 2 investments proceeding at a slightly greater rate, due to continuing reductions in equipment costs, this plan is in fairly close accord with some earlier planning propositions, notably a suggestion by Sagatel that a penetration of ISDN to 20% of telephone subscribers could be achieved by the year 2000.

6.4 Definition of the Common Plan

Statement 75

**All of the major new characteristics of ISDN should be introduced in the Community from the outset.**

This is because the universal availability of a standardised network interface at an early stage is vital in creating a terminal market where mass production benefits can apply. The CCITT-recommended user-network interface, the S-interface passive bus, should be used, together with basic and primary rate access capabilities. The major distinguishing features of ISDN have already been identified in Chapter 5.

In addition to the objectives of:

- coordinating an introduction schedule which leads to a similar situation in all Member States;

- establishing international links to create a Community-wide ISDN avoiding national islands,

the common plan should:

- support Community-wide teleservices in Phase 1 which are a simple but useful set from the wide range of ISDN possibilities.

To achieve all this, a period must be allowed for further definition of the Common Plan - however, the time available is limited.

Action Point 4

**The Community should establish the details of the Common Plan, in cooperation with Industry, and CEPT, by the end of 1986.**

Statement 76

**The Common Plan must be published on a widely-available basis, and must include:-**

- **a complete technical definition of the network, services and terminals to be supported in Phase 1.**

- **an agreed, and resourced, infrastructure programme.**

Within each country, Network Operators may introduce additional network features, provided that the basic services, features and interfaces of the Common Plan are adhered to.

Our recommendations for the features necessary to support the early and rapid introduction of ISDN on a Community-wide basis are given in Chapter 7, and an appreciation of the economic considerations is given in Chapter 8.

# 7. COMMUNITY-WIDE FEATURES FOR RAPID ISDN INTRODUCTION

## 7.1 Network Strategy

In accepting the view that the narrowband ISDN is a Status I network, targetted for universal penetration to all households, it becomes obvious that ISDN has a very intimate relationship with the analogue PSTN, and that the infrastructure proposed in the Common Plan is really the beginning of the replacement of the analogue telephone network.

The requirement of the Common Plan for equal access to 80% of the population and 80% of the country's surface area by 1993 means that overlay techniques must be used, involving remote concentrators and multiplexors, segregated digital transmission routes, numbering and charging constraints, as discussed in Chapter 3.

However, the use of overlay techniques must not create a separate overlay network, since the existing PSTN must evolve into the new ISDN, through common network infrastructure wherever possible and compatible numbering and routing.

Action Point 5

**For Phase 1 of ISDN, an overlay strategy should be adopted, based on the structure of the analogue telephone network but not creating a separate new overlay network. The PSTN will evolve into ISDN through common network infrastructure and compatible numbering and routing.**

As defined in CCITT, the ISDN is foreseen to have a 15-digit numbering plan ultimately. For Phase 1, however, the ISDN subscribers must fit within the national telephone numbering plan. This will require a continuous review of the national plan to anticipate and provide for customer service even in areas where there is no more capacity in the present numbering plans. A proposal for terminal addressing is given later in this Chapter which will impose further pressure on the national numbering plan, and which will make the continuous review of numbering even more of a priority issue.

Action Point 6

**A continuous review of telephone numbering plan allocations for ISDN will be essential during Phase 1, to cope with the pressure on numbering which will not be fully relieved until a longer national number is introduced, as foreseen by CCITT.**

The timescale for planning national Phase 1 networks is very short if the Common Plan is to be achieved.

Action Point 7

**For each country and for the Community as a whole, implementation plans must be agreed at latest by the end of 1986, covering:-**

- **the structure of the ISDN exchanges within each country**
- **the configuration of the exchanges into a nationwide network**
- **the international gateways for ISDN in each country**
- **the Community-wide international digital infrastructure**
- **the national and international introduction of common channel signalling system No 7.**

7.2 Services

Statement 77

**Whilst the Network Operators often regard telecommunications services from the point of view of the network facilities and characteristics, it must be remembered that, for the user, telecommunications is represented by the functions and facilities of terminals.**

Telecommunications services can be divided into bearer services and telematic services, as discussed in Chapter 3. For the bearer service of 64 kbit/s (transparent, circuit switched), standardisation applies to D channel protocols at the first three layers - D1 to D3 - and to the B channel layer B1. Protocol relationships for layers B2 to B7 are open to the users choice. For defined telematic services, however, standardisation applies to all layers B1 to B7. All functions of the network and terminal are standardised sufficiently to allow worldwide "open" communications.

As shown in Chapter 3, there does not currently exist a harmonised specification or schedule of introduction for Community-wide teleservices, due to the wide variety of basic and supplementary services proposed in the different networks, and the influence of services already provided on dedicated networks.

Teleservices can be divided into three categories:-

- Services offered by the network
- Services offered via the terminal, but with network support
- Services which are offered by the terminals without network support.

An example of the first category might be re-routing on busy or ring back when free. The second category would include a voice to data "swap" during a call, with network transmission path adjustment. The third category would include simple end to end facsimile transmission. (Note that we are not considering Value Added Network Services at this point, since they are essentially conducted over a call connection between a user and a service provider, in which the connection itself can be categorised into one of the three classes defined above).

During Phase 1 of the ISDN Common Plan, we recommend that common services be based on the transparent 64 kbit/s circuit switched bearer only, with common telematic services being provided wholly by terminal capabilities, without additional network support.

Since the terminal is so important to subscriber appreciation of the available communications services, a small number of standardised Community-wide teleservices should be actively supported, to encourage customer take-up of ISDN in Phase 1. Since the timescale foreseen is 1988 to 1993, the services must be able to be carried by means already standardised by CCITT, or capable of early agreement within CEPT. In particular, Phase 1 teleservices should not require international use of CCITT No 7 Integrated Services User Part (ISUP), which will not be standardised in time for the Common Plan definition in 1986.

Action Point 8

**To encourage subscriber take-up of ISDN in Phase 1, the Community should agree to standardise a small but useful set of Community teleservices for Phase 1, which should:**

- **use only 64 kbit/s transparent circuit switched bearer service**

- **be terminal-based, without dependance on network support, other than the use of the D channel for control of connections.**

- **be addressable internationally using CCITT No 7 Telephone User Part (TUP) only.**

Action Point 9

**Subscribers should also be able to use non standardised, but approved, compatible terminals which are suitable for particular purposes, have terminal-based facilities, and are able to communicate over the transparent 64 kbit/s bearer without further network support.**

The use of packet switched services on the D channel is deliberately excluded from Community-wide support in Phase 1, because of the wide variation in national interpretations of these services, and because the constraints on speed and format in the D channel means that these services can just as well be carried on existing networks, such as the analogue PSTN, or dedicated data networks, in Phase 1.

Action Point 10

**We propose the following four "Community teleservices":-**

- **Digital voice**
- **64 kbit/s text (based on teletex recommendations)**
- **64 kbit/s facsimile (based on Group 4 recommendations)**
- **64 kbit/s mixed mode text and fax (based on teletex mixed mode).**

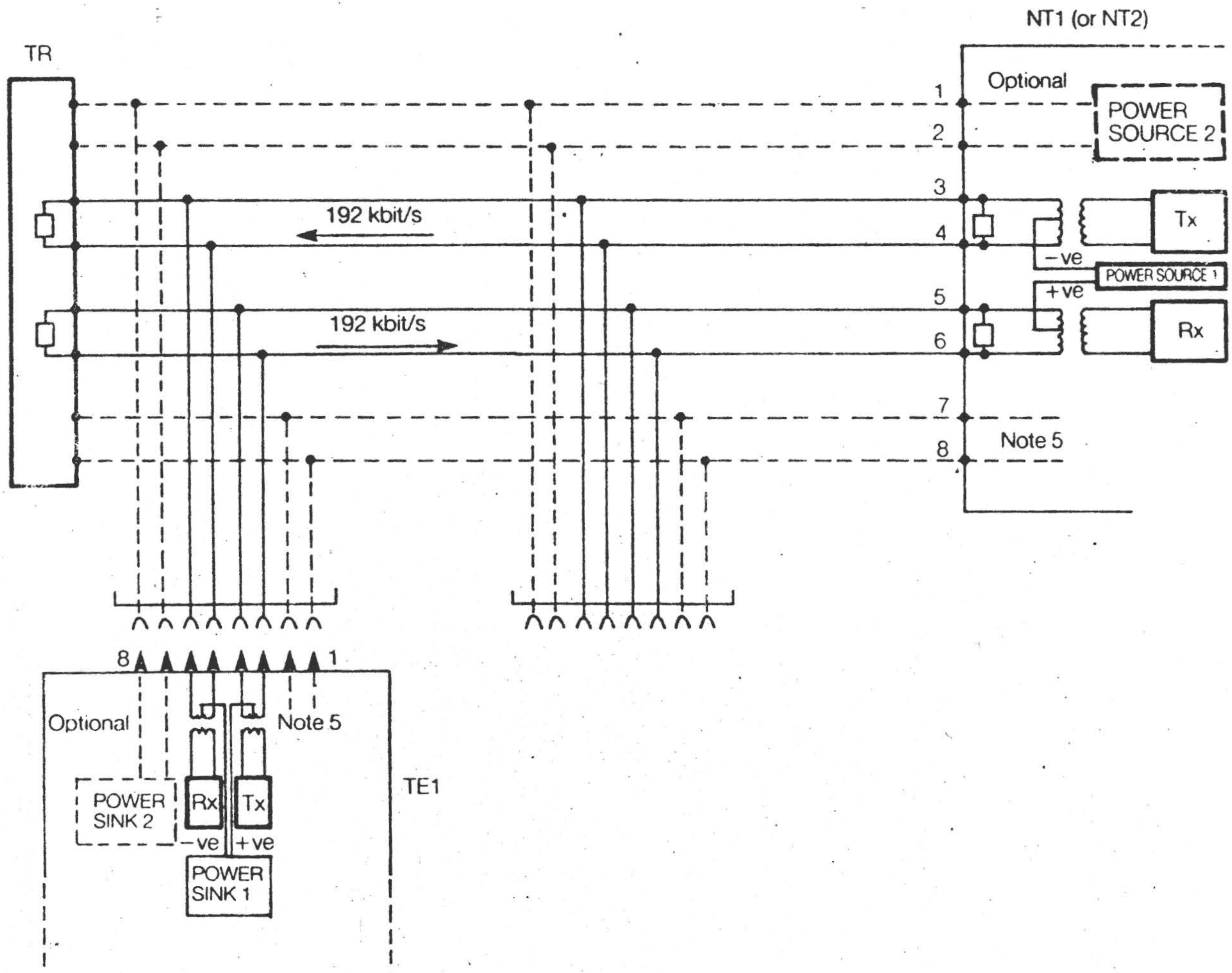
7.3 Terminals

The introduction of the standardised teleservices offers the possibility of introducing terminals - we call these "Community Terminals" - which could be sold by manufacturers throughout the whole Community. It would also be an important contribution to stimulating the Community-wide market for telecommunications equipment, and indirectly for services.

Standardisation does not necessarily mean that the Community Terminals themselves must be uniform, but that the communication parameters of layers B1 to B7 must be standardised, together with the use of the S-interface passive bus, including power feeding arrangements (see figure 7), and D channel protocol for call connection (see Action Point 16).

Action Point 11

**Terminals to utilise the Community teleservices should be developed co-operatively by European industry, avoiding duplication of efforts in basic technologies through joint pre-competitive research, but allowing supplier initiative in product design and supply.**




## Figure 7 **Typical Arrangement of the S Passive Bus**

Note 1: CCITT Recommendation I430 allows the above arrangements for short or extended passive buses. Terminating resistors are shown here included in the NT1 (or NT2), and in a separate termination TR at the distant cable end.

2: Terminal TE1 is able to interface directly to the passive bus.

3: Power Source 1 may not always be provided. When provided, the normal power level is a Network Operator option, but under emergency conditions, at least 420mW at 40V is available (with polarity reversed to indicate emergency).

4: Power Source 2 is a Network Operator option.

5: Leads 1-2 at TE may be used for power transfer between TE's. At the NT, the corresponding leads (7-8) are unused.

Action Point 12

**All Community Terminals should use the CCITT user-network S-interface and be capable of S-passive bus operation. This will ensure a substantial market for S-interface devices and justify the investment needed in developing S-interface integrated circuits.**

Within the Community, several digital telephones are already being specified or developed for field trials by different Network Operators. As explained in Chapter 3, differences in pre-existing PSTN transmission plans could cause the digital phone specifications to differ sufficiently that they are not directly compatible between networks. The introduction of a digital voice terminal Community-wide offers an opportunity for harmonisation.

Action Point 13

**The Community Digital Voice Terminal characteristics should be defined as part of a harmonised transmission plan for Europe, so that the voice terminal can be compatible with any of the Community networks.**

As pointed out in Chapter 3, the CCITT definitions of telematic services were originated for earlier networks with lower speeds, and are not specifically valid for 64 kbit/s transmission. However, the extension of the definitions to 64 kbit/s operation is quite straightforward.

More difficulty may be experienced in selecting from the range of possible options within the definitions, to achieve a service which is useful for customers, yet sufficiently simple to allow terminals to be produced in volume for Phase 1.

Action Point 14

**The Community Terminals for text, fax and mixed-mode should be defined by extension of existing teletex and Group 4 facsimile recommendations to allow operation at the new speed of 64 kbit/s, and by selection of a single set of features and characteristics which allows simple but effective communications for Phase 1.**

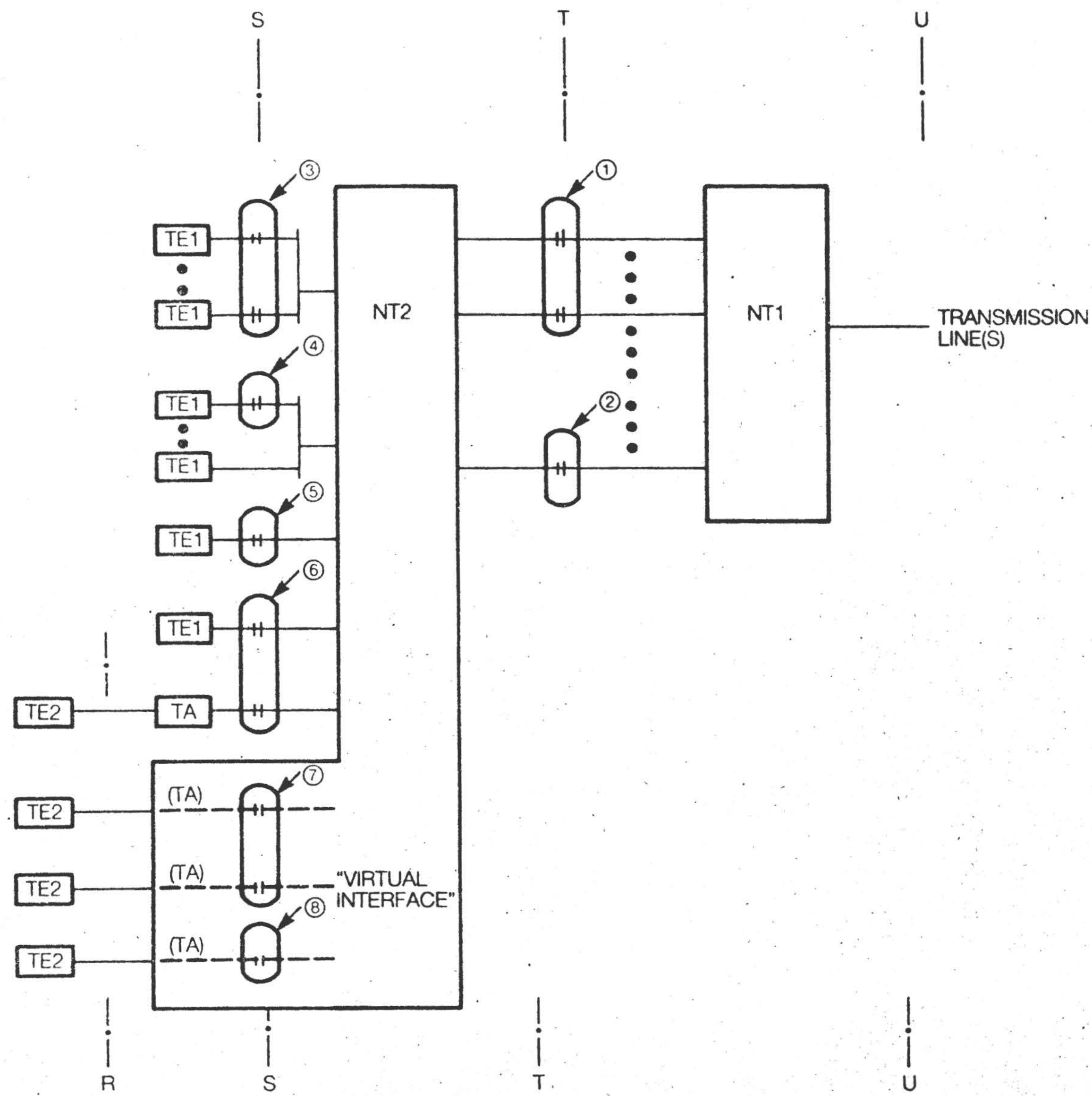
The use of non-standardised terminals directly or via terminal adaptors is discussed in a later section.

## 7.4 Addressing

It is a characteristic of the S-passive bus that a number of terminals of the same or of different services can be connected. In a fully-developed ISDN, there are elegant methods of differentiating between the different possible services by use of service compatibility indicators within the D channel connection set up protocols, or possibly by use of the subaddressing capability of the protocol, or even by means of user-to-user communications via the D-channel protocol prior to establishing the B-channel connection. Figure 8 shows some of the subtleties of identifying devices by ISDN numbering when the full range of ISDN support features is available.

However, for an early introduction of Phase 1 in the Common Plan, it will not be possible to rely on the full elegance of later phases. Rather, it is necessary to use a simple addressing method which can be compatible with the introduction of more sophisticated methods later on, but which can be implemented through simple versions of CCITT No 7 signalling already in use or planned.

It is also necessary for the addressing method to allow the interworking of terminals in different networks, for example voice or data calls from the analogue PSTN to an ISDN terminal, where it is not possible to pass forward any compatibility indication from the analogue network.




## Figure 8 **Examples of Devices Identified by ISDN Numbers**

CCITT Recommendation I330 allows an ISDN number to identify:

1. A particular multiple of interfaces at reference point T
2. A particular interface at T
3. DDI to all of the interfaces at an S-bus
4. DDI to a particular physical interface on an S-bus (still for further study by CCITT)
5. DDI to a particular physical interface at an S point
6. DDI to a particular multiple of interfaces at S points
7. DDI to a particular multiple of interfaces at "virtual" S points
8. DDI to a particular "virtual" S interface

If it is necessary to use manual operation at the ISDN passive bus to distinguish between voice and data calls from the PSTN, there will be several negative factors holding back Phase 1 ISDN growth:

- Communications between PSTN and ISDN will tend to be limited to voice calls only,
- Automatic working between terminals will be restricted to connections with ISDN terminals at both ends,
- The chance for ISDN to interwork with, or replace, the telex or teletex networks will be much reduced.

Action Point 15

**Automatic discrimination between different terminal types connected to an S-passive bus is necessary for efficient traffic handling and unattended operation. In Phase 1, this discrimination should not be based on compatibility indicators within the D-channel protocols, or on subaddressing, because this would involve international working methods which are not yet standardised.**

**The Community might try to achieve rapid agreement on CCITT No 7 ISUP signalling; alternatively, suitable discrimination can be achieved using the destination address.**

We propose that a common method of addressing terminals be adopted for Phase 1 throughout the Community. This method is amongst those already discussed and under consideration by CEPT.

Action Point 16

**The Community should agree that:**

- **The ISDN main line is identified by the second-last digit of the ISDN subscriber number.**
- **Selection between terminal types on the S-passive bus is identified by the last digit of the ISDN subscriber number.**

- **The last digit will be signalled forward to the passive bus within the D-channel protocol, (this is similar to the method of working for DDI-PABXs).**

This technique is simple, and, being part of the national numbering plan, it is under the control of the network carriers. It also provides a method for customers connected to the existing PSTN to select the correct terminal type for communication, even where there are several terminal types on a passive bus.

As mentioned earlier in this Chapter, this method imposes some pressure on the national numbering plan, but the effect should not be severe because:

- the number of ISDN subscribers will be low initially
- numbering plans are already intended to increase from 12 digits nationally (CCITT E.163) to 15 digits (CCITT E.164),
- remote access and overlay working will in any event require continual monitoring of the numbering plan, and special treatment of ISDN subscribers, throughout Phase 1.

The addressing method only allows differentiation of terminal types, rather than individual terminals. However, this is not felt to be a disadvantage because:

- for telephones, with the greatest chance of several similar terminals being used on the passive bus, the subscriber himself can determine with which terminal he will answer incoming calls (and the Community Voice Terminal specification must allow for this kind of operation)

- for other terminal types it is less likely that several terminals will be used on the passive bus, but in this event an automatic priority order of answering can be equipped in the terminals.

- a change from one service to another after the set-up of the B-channel connection is still possible by means of in-band signalling from end to end, or by verbal or in-band textual agreement.

- no restriction is placed on the simultaneous use of B-channels, and multifunctional terminals can be implemented either as a single device address with in-band change of the service used, or as a dual-port device with different address digits.

Action Point 17

**We propose the following standardised addressing, Community-wide:**

**Last digit**

| | | |
|---|---|---|
| **0** | **-** | **Community digital voice terminal** |
| **1** | **-** | **Community text terminal (64 kbit/s)** |
| **2** | **-** | **Community fax or mixed mode terminal (64 kbit/s)** |
| **3** | **-** | **Spare for future Community Terminals** |
| **4** | **-** | **Spare for future Community Terminals** |
| **5** | **-** | **Spare for national allocation** |
| **6** | **-** | **Spare for national allocation** |
| **7** | **-** | **Analogue Terminal Adaptor** |
| **8** | **-** | **X21 Terminal Adaptor (64 kbit/s and 2.4 kbit/s)** |
| **9** | **-** | **Unspecified Terminal (using transparent 64 kbit/s)** |

Publication of the ISDN subscribers number in a directory will obviously be required, either in a separate ISDN directory, or more probably as part of the PSTN directory, at the Network Operators choice. In either situation, the publication of the full list of ISDN numbers used by each subscriber will immediately show what kinds of devices are being addressed, and a PSTN subscriber, for example, would immediately know whether an analogue terminal adaptor is available or not.

The method is equally applicable for DDI calls to S-passive buses behind a PABX, where individual extensions can be identified. Figure 9 shows the numbering allocation more visually at any S-interface point.

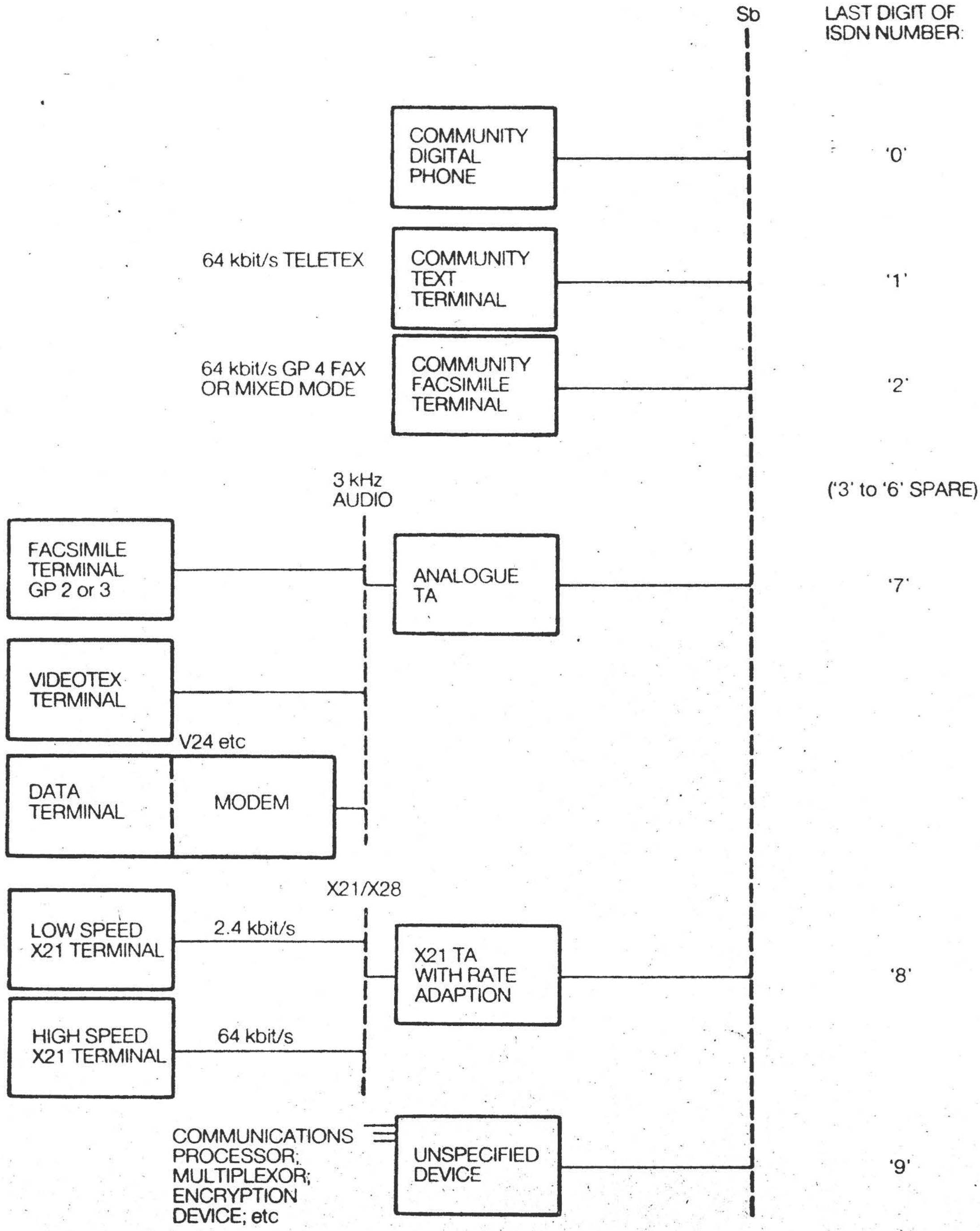



**Figure 9 Proposed Allocation of ISDN Numbering to Terminal Categories**

## 7.5 Terminal Adaptors

It will be of vital importance for the success of Phase 1 of the Common Plan, that the population of terminals with which inter-communication can take place shall be as great as possible, including existing terminals used on the PSTN or on dedicated data networks. Chapter 3 has shown the wide variety of arrangements for dedicated data networks, and there is no possibility of standardising the interworking arrangements Community-wide - interworking between ISDN and dedicated data networks must be a national or bilateral decision of Network Operators.

However, it is possible to standardise a method of operation for interworking with the PSTN, or for using existing analogue or X21 terminals on an S-passive bus.

Action Point 18

**The use of terminal adaptors during Phase 1 will increase the value of the network for customers who already have significant investments in existing terminals. Although these terminals will generally not utilise fully the speed of 64 kbit/s, they can continue to be used on an S-passive bus in parallel with Community Terminals.**

The benefits to the customer of this approach will arise from:

- extended use of existing high-cost terminals provided for PSTN

- ability to communicate with existing terminal population during transition to ISDN

- avoiding the need to retain separate PSTN connections for decreasing volumes of traffic on existing terminals.

The use of terminal adaptors for communication with PSTN is chosen in preference to a centralised interworking method within the network. A centralised solution would be difficult to agree internationally, and would involvé infrastructure to be provided in Phase 1 which would become obsolete when only ISDN terminals are used. In contrast, terminal adaptors will be introduced or phased out individually in response to particular customer needs.

Two terminal adaptors are proposed for Community-wide support, to enable already-standardised interfaces, particularly for X21 terminals and for Groups 2 and 3 facsimile modems, to be used on ISDN. The adaptors can be uniform physical devices for use in all Member States.

Action Point 19

**The Community should initiate the development of an Analogue Terminal Adaptor comprising a PCM codec, together with D-channel signalling arrangements for the S-passive bus interface. This will allow an analogue modem, or a terminal with in-built modem such as a facsimile terminal, to communicate with another similar device, either on the ISDN, or on the analogue PSTN. The analogue TA will be addressed by the last digit of the ISDN number, in Phase 1.**

The internationally standardised X21 interfaces are classified by speed classes (CCITT X.1). The most commonly used class within the Community today is class 4, namely 2.4 kbit/s. This is used in some countries also for teletex via a CSDN.

The speed of 64 kbit/s (class 30) is not much in use today, being found mainly on point to point connections, but it can be expected to become a valuable general purpose interface for ISDN.

There is a simple rate adaption scheme proposed for ISDN to adapt 2.4 kbit/s channels up to 64 kbit/s. In comparison to the D-channel signalling complexity, the rate adaption is easily implemented, and it is proposed that it is included (for 2.4 kbit/s adaption only) in all Community X21 TAs. The framing structure used enables the data rate to be easily determined, so that the adapter can automatically accommodate to either of the two speeds and handle incoming calls correctly. Use of the standardised rate adaption format should simplify interworking arrangements with national CSDN's.

A Community-wide agreement is required to extend the speed of X21 working to 64 kbit/s, particularly regarding the method of disconnection, which cannot be signalled in-band at this speed, and must be handled at a higher level, or via the D-channel.

Action Point 20

**The Community should initiate the development of an X21 Terminal Adaptor which provides D-channel signalling arrangements for X21 terminals operating at 64 kbit/s, and also provides automatic rate adaption at 2.4 kbit/s, using the format recommended by CCITT.**

No terminal adaptor is proposed to interface directly with V-series terminals. This is because there is no agreed adaption method directly between the V-24-type signalling levels and the 64 kbit/s data stream. Such terminals normally work over the PSTN via modems, which may be connected to the analogue TA already proposed. The analogue TA also provides a more universal solution, catering for different modulation schemes which may be used in various national networks, whereas a directly interfacing adaptor would effectively contain a "pseudo-modem" which would cause regulatory problems, as well as compatibility approval problems within each network. Another factor is the trend, in currently available terminals, for the modem function to no longer be a separated device, but a relatively simple function incorporated on a pcb card within the terminal. All these factors point to the use of an analogue TA, rather than a V-interface adaptor.

For X25-interface terminals, a Community-standardised terminal adaptor is not proposed within Phase 1. This is because of the variety of methods involved in different networks for handling packetised traffic, with various degrees of integration scenarios proposed over B or D-channels. No doubt the arrangements for X25 traffic can be clarified and implemented with some uniformity in Phase 2, but for Phase 1 of ISDN, we believe the handling of packetised traffic must be for individual or bilateral arrangements by the Network Operators.

Action Point 21

**No terminal adaptor is proposed for V-series or X25 interfaces. The former can use a modem plus the analogue TA, whilst the arrangements for handling X25 terminals and for interworking with dedicated data networks using packet switching must remain a national or bilateral matter for Phase 1 of the Common Plan.**

Terminals or other communicating devices which are addressed by last digit '9' in the Phase 1 numbering plan are "Unspecified Devices". This allows the flexibility for establishing closed groups of users employing compatible but non-standardised devices, such as communications processors, encryption devices or proprietary terminals. These devices must be able to use the Phase 1 ISDN in the same manner as the Community Terminals, namely by correct D-channel interfacing for call control, with transparent use of the B-channel.

Action Point 22

**The Community should support connection to the Phase 1 ISDN of "Unspecified Devices" approved for use in meeting particular customer requirements. "Unspecified Devices" may include any terminal or terminal adaptor which is able to interwork directly with the S-interface or passive bus. It is the user's responsibility to ensure that terminals addressed in this way - via last digit '9' - can communicate compatibly.**

## 7.6 Basic Access

Basic access for ISDN refers to the provision of a local loop transmission system, able to connect the user-network S-interface into the ISDN exchange or remote connection point.

Action Point 23

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| **In each country, the network termination for basic access, NT1, should offer the S-interface passive bus recommended by CCITT, with transparent circuit switching of two 64 kbit/s B channels and signalling via a 16 kbit/s D channel.** |

Chapter 3 has shown that there are several different local loop transmission systems under development. These have arisen because of the different electrical characteristics of local area telephone distribution practices used in different networks, and because of different requirements for the degree of penetration of the local loop plant by Network Operators. Nevertheless, Chapter 8 will show that the Community can only afford two local loop transmission system developments for economic effectiveness in integrated circuit manufacture. Some effort must be made to reduce the number of developments in progress.

Action Point 24

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| **Although it does not seem practicable to achieve a single "U-interface" standard, the Community should try concertedly to restrict the number of different NT1 types by agreeing to develop and use only a few transmission systems on the local loop.** |

The implementation of the local loop transmission system at the ISDN exchange end is complicated by the variety of exchange switching equipment used within the Community. Ten different digital switching systems are identified in Chapter 2. Any attempt to standardise on a U-interface will result in different implications for the different suppliers, since in most cases the local loop transmission system is included physically on the line circuit cards of the exchange. This means that changes in implementation, for example the adoption of a "Community" set of integrated circuits for the local loop, may impact on supply voltages, electrical interference, and other fundamental aspects of the exchange equipment practice and basic technology.

Statement 78

**A reduction in the number of switching systems used within the Community would be desirable (and may be economically inevitable), but it is unrealistic to expect that this will happen for Phase 1 of the Common Plan.**

Because of the different switching systems involved, and the aspects of line maintenance, which require an isolation point between the local loop and the terminal at the subscribers premises, the NT1 should remain the responsibility of the Network Operator. The separation between NT1 and NT2 is a vital factor in creating a market for terminals which can be used in all Community countries. It is necessary to give this support to terminal suppliers during Phase 1 to allow terminal innovation so that the take up of ISDN will be successful. There may be some scope for Network Operators to provide terminals with integral NT1 functions during Phase 2, if this is allowed by regulatory conditions in their countries at that time, but they must refrain from this offering during Phase 1 or else the S-interface terminal market will never materialise.

Action Point 25

**The Community should agree that the NT1 function is kept separate from the NT2 or the terminal, at least in Phase 1, to encourage a Community-wide terminal market to form. The NT1 will be a national physical equipment which is the responsibility of the Network Operator.**

The number of basic accesses to be used within the Community is yet to be defined, but if the view of ISDN as a Status I network with eventual penetration to all households is accepted, it follows that the number of basic access channels will ultimately exceed the number of primary rate access channels by a factor of at least 10. For Phase 1, bearing in mind the potential usefulness of ISDN to small businesses which do not require a sophisticated LAN or PBX, it may be appropriate to assume for planning purposes an equal number of B channels provided via basic or primary rate access. This may be influenced in some networks by the degree of remote concentrator or multiplexor use.

Action Point 26

**The Community should investigate the possible development of a remote access equipment, which could be used Community-wide, to provide a number of basic accesses to local loops, concentrated or multiplexed onto a primary rate system to the ISDN exchange. (the basic accesses would use the Community U-interface and local loop transmission system if this can be achieved)**

## 7.7 PABX Access

### 7.7.1 Interface at the extension behind a PABX

The regulatory policy on PABXs differs within the Community, but in general the Network Operators do not have a direct influence on the internal technical solutions of PABXs. (It should be remembered here that a LAN may also have all the characteristics to count as an NT2 within ISDN, and that the term PABX, used for simplicity in this report, should be interpreted as including LAN, or mixed LAN-PABX, solutions wherever this is appropriate).

Statement 79

**Despite the lack of direct regulatory influence on the internal solutions at PABXs (or LANs with access to ISDN), strong support by the Community for the S-interface passive bus and for the Community Terminals and teleservices will influence industrial developments.**

The success of ISDN Phase 1 depends on the Community Terminals and teleservices being used by PBX customers as well as basic access customers, and this means that the S-passive bus should be available also behind a PABX. A true ISDN-PABX should be able to provide the S-interface at any or all extensions. This does not mean that the local loop transmission system has to be used - the PABX (or LAN) can use any appropriate technique to provide internal transmission - but the interface presented at the extension should conform to Community S-interface standards.

Action Point 27

**The Community should influence PABX (or LAN) suppliers to offer the capability of an S-interface passive bus at extension lines, with full compliance with Community standards (including last digit addressing for discrimination of terminal types).**

7.7.2 Primary rate access

Primary rate access is expected to be used for the majority of PABXs. Even if only a few access channels to ISDN are required, it is expected that primary rate access will be cheaper to install and maintain than even a few separate basic access systems. The primary rate access should be capable of exploitation for routing private circuits, access to CSDN or PSTN, as well as for ISDN circuits. (Customers may wish to retain some local access channels to PSTN in Phase 1 if their ISDN access is to a remote exchange area and charging group.)

Action Point 28

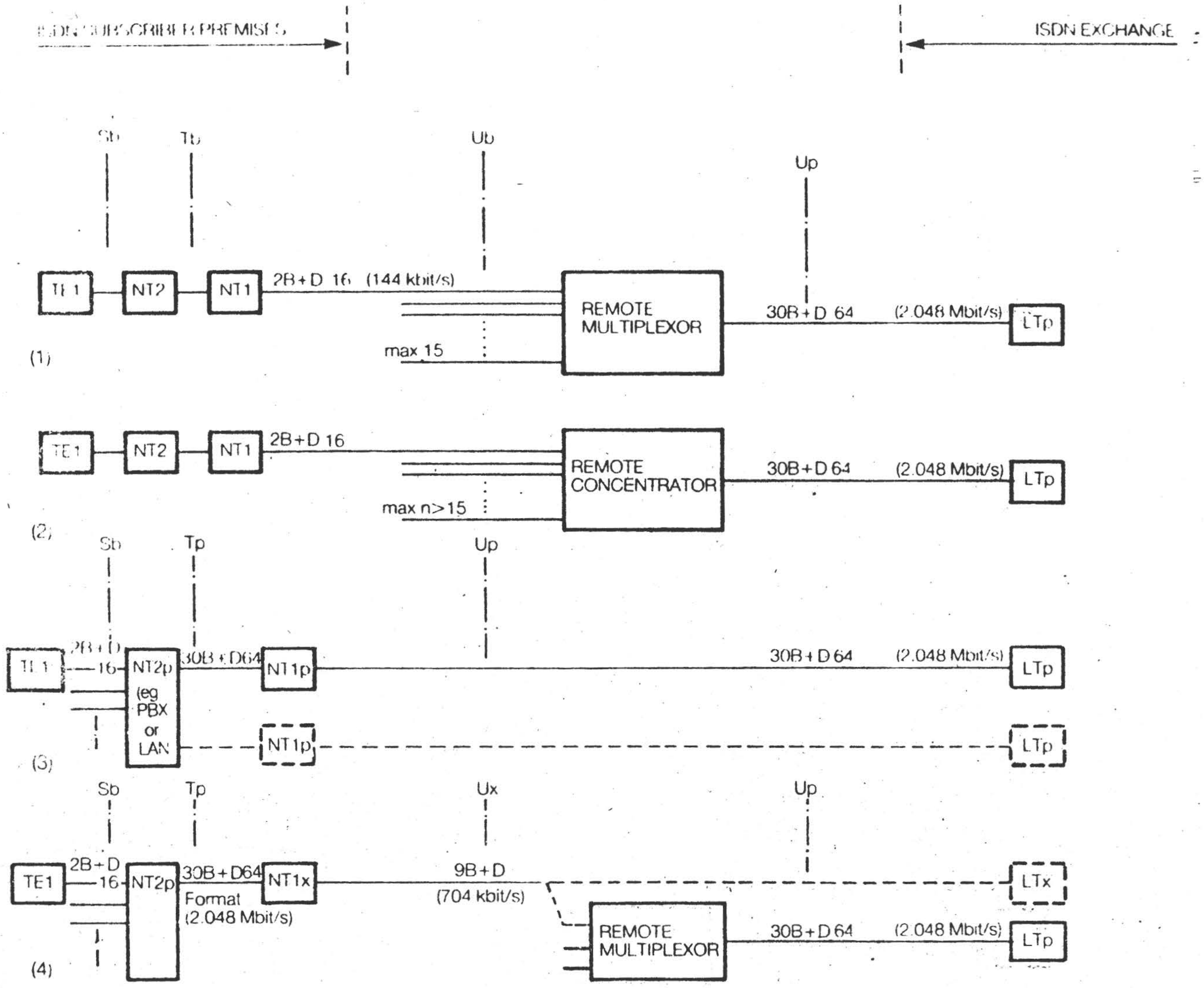
**In each country, the primary rate access of 30 B channels of 64 kbit/s with signalling via a D channel of 64 kbit/s, should be offered at the line rate of 2.048 Mbit/s, and to CCITT recommendations. Flexibility of usage of the channels will be a customer requirement.**

Not all PABXs will require 30 access channels, even with mixed usage, and therefore smaller groupings of channels should be available. Some combinations of channels offer simple multiplexing, in which there is no attempt to combine the D channel signalling, there is simply a sharing of the 2.048 Mbit/s line. For example, three groups of 9B + D would occupy a total of 30 channels; four groups of 6B + D would occupy 28; or five groups of 5B + D would occupy 30 channels. If any such schemes are used, with non-standard bit rates (the potential is shown in figure 10) then the interface presented at the customer PABX should still appear as a 30 B + D format at 2.048 Mbit/s, but with some channels unused. The tariff implications of small channel groups are discussed in a later section of this Chapter.

Action Point 29

**Smaller channel groups, such as 9 or 10B + D should also be available to encourage the takeup of ISDN at smaller PABXs in Phase 1. However, even if non-standard transmission arrangements are used to provide these groups, the interface to the PABX should still appear at 2.048 Mbit/s as for the 30 B + D interface, but with some channels unused.**

The line side of an NT2 which accepts primary rate access, is a T interface point, shown as Tp in figure 10, to distinguish it from the basic access interface point Tb, also shown. The NT2 itself is designated NT2p to indicate its primary access nature. At its extensions the basic S interface, Sb, is provided.




## Figure 10 **Applications of Primary Rate Transmission**

1) Remote Multiplexor, converting a Primary Rate circuit into up to 15 basic accesses

2) Remote Concentrator, converting a Primary Rate circuit into more than 15 basic accesses

3) Primary Rate access to subscribers premises, with PBX or LAN performing NT2 function. (not all of the 30B channels may be active)

4) Non-standardised rate access to subscribers premises. (This arrangement should still present 2.048 Mbit/s to the NT2, with a limited number of B channels active)

There is room for debate on whether the NT1p function should be combined with NT2p, since some equipment economy could result. However, current practice is for primary rate access to a PABX to be a full duplex binary interface at 2.048 Mbit/s, rather than at a line transmission rate and coding (interface Up in figure 10) which may be a national option. Also, the use of the binary interface allows different line systems, such as fibre optics, to be used in future; allows comparable primary rate access to private circuits or inter computer links; and provides a maintenance separation point for the Network Operator.

Action Point 30

**The network termination for primary rate access, NT1p, must be separate from the PABX (or other NT2p) at least in Phase 1. This provides easily maintainable access, and allows PABX design to be independant of Network Operator's transmission techniques. This will help to encourage a Community-wide marketplace in PABXs. The NT1p will be a national physical equipment which is the responsibility of the Network Operator.**

Action Point 31

**The Community could also agree to develop a common design of small ISDN-PABX for use in Phase 1 as a stand-alone PABX for small customers, or as a separate switch for a specialised group of users at a larger PABX. The design could have commonalities with digital concentrators used for remote access in Phase 1 (and referred to in Action Point 26).**

## 7.8 International Working

International working should be introduced as early as possible during Phase 1. Digital international circuits will be required, but in some cases it will be possible to obtain these circuits by using digital transmission over already existing radio or cable routes. In other cases, international digital circuits may be provided by satellite, particularly for regions which are isolated or have low traffic (see Chapter 8). The use of satellites for national switched ISDN circuits is best avoided, due to the possibility of two such circuits being involved in an international connection.

Ultimately, an international broadband overlay network is envisaged, possibly provided on fibre optic cable. This could carry narrowband ISDN channels for communication and signalling, as well as broadband communications channels.

Action Point 32

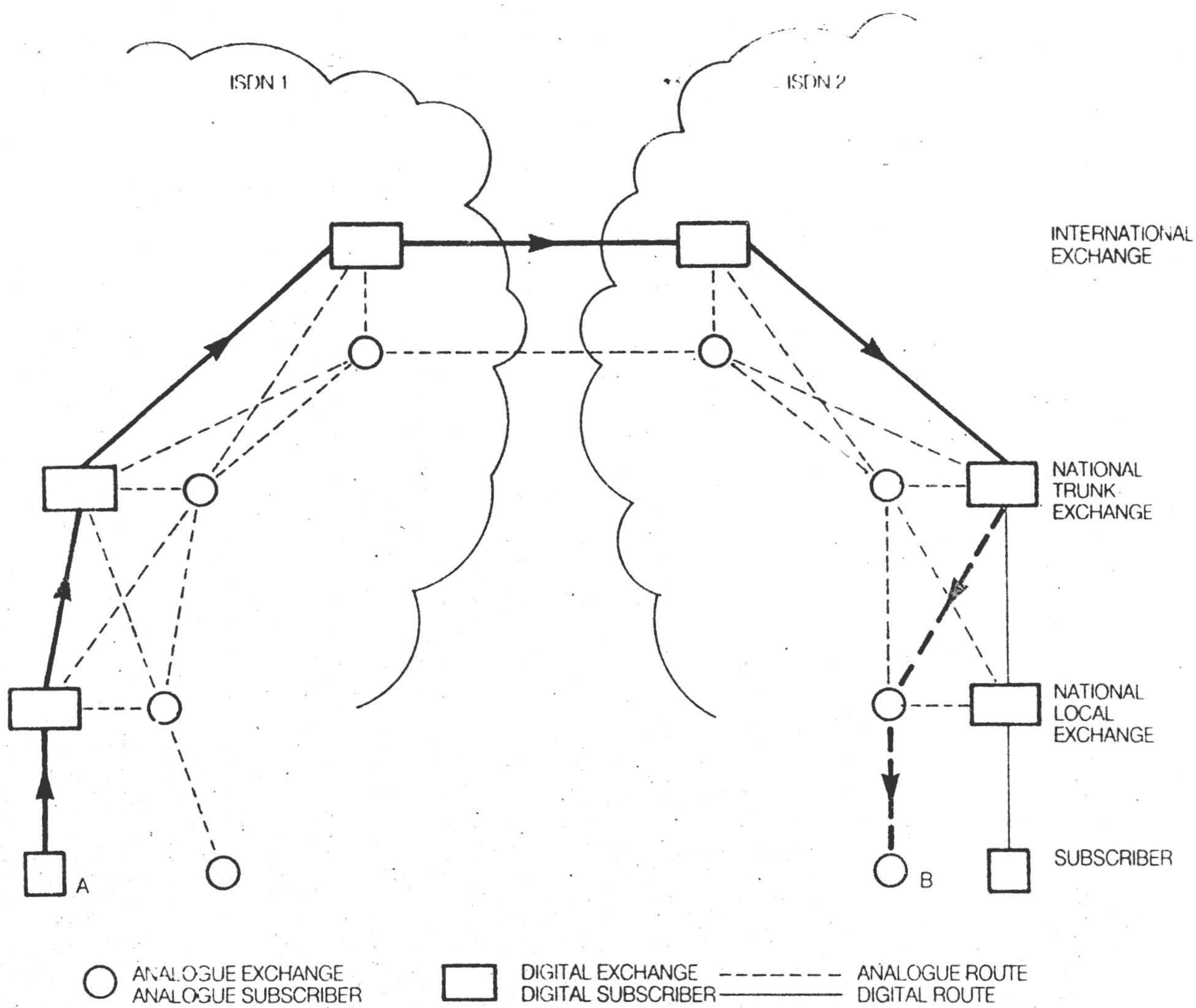
**The Community should agree, during the planning of Phase 1 infrastructure, to introduce digital international circuits as early as possible, but taking into account that they could form part of the proposed international broadband overlay network.**

In Phase 1, the destination terminal type is identified by its address rather than by service protocol indications. This avoids the need to pass service compatibility indications forward through international signalling.

However, since the ISDN numbering plan is integrated with the PSTN numbering plan, it is not possible to tell from the destination address alone whether the wanted number is an ISDN or a PSTN terminal.

One solution to this problem is shown in figure 11. When an international call request is originated from an ISDN terminal, the outgoing country must assume that the call may be for an ISDN terminal, and must route the call via a digital circuit group.

Similarly, an incoming country receiving a call request over a digital circuit group must assume that the originator may be an ISDN terminal, and must route the call onwards over digital circuit groups, at least until it may become apparent that the destination is a PSTN terminal.




## Figure 11 **Proposed Principle of International Routing**

Note 1. ISDN 1 cannot tell from the destination number whether subscriber B is analogue or digital, therefore it selects digital paths to ISDN 2, because subscriber A is digital.

2. ISDN 2 has to assume that originator A is digital, therefore it selects digital paths towards B until it determines that B is in fact analogue

If these procedures are adopted, it is also possible to allow analogue international traffic to overflow onto digital international circuits if this should prove necessary or expedient. This should only be done if sufficient digital capacity is available, as it is not permissible for digital traffic to be blocked from using the digital circuit groups

Action Point 33

**A simple strategy for international routing can be adopted, based on priority (or exclusive) access to international digital circuit groups from ISDN callers.**

7.9 Tariff Considerations

Tariff policies have always been regarded in principle as national matters, particularly where the absolute level of tariffs is concerned, but fundamental matters of tariff structure and tariffs for international circuits have been discussed more openly, certainly within CEPT working groups. The great influence of tariffs on user investments in terminals, and on user acceptance of ISDN generally, justifies discussion and action within the Community to harmonise tariff structures for ISDN, not only in the long term future, but also in Phase 1.

Statement 80

**With the introduction of cost-effective high capacity transmission systems, the importance of distance on the cost of connection is decreasing tremendously, and this effect is expected to continue.**

Statement 81

**For connections established via transparent 64 kbit/s B channels, the cost of a connection depends largely on the duration of the connection, rather than the communication speed or teleservice formats used by the terminals.**

Based on these facts, it should be possible to reach Community-wide agreement on general tariff principles for ISDN single 64 kbit/s B channel connections. It is not expected that agreement could cover the use of the D channel for user traffic in addition to signalling, because the proposed applications of the D channel vary widely in the countries concerned.

Action Point 34

**The general tariff principles for B channel connections should be:**

- **based on duration of the connection**
- **independent of the type of traffic**
- **relatively independant of distance**

The effect of independence of distance also applies to connections within the existing PSTN. A general tendancy of this effect would be to reduce the number of tariff zones used within a country. However, this is not practicable within the PSTN, as a reduction in the number of zones would result either in higher charges to customers for certain connections, or reduced overall income for the network carrier.

The introduction of ISDN has significant benefits for the customer, particularly in the reduction of transmission cost per bit, and could be taken as an opportunity throughout the Community to reduce the number of tariff zones applied to B channel connections. Because of the better "performance" of ISDN connections, the reduction in the number of zones need not automatically lead to a decrease in charges.

Action Point 35

**Because voice usage will dominate the network traffic in the foreseeable future, the tariffs for ISDN should be related to voice from the outset.**

Action Point 36

**The Community should try to achieve a Community-wide agreement that the maximum level of B channel tariffs should be equivalent to the highest national usage charges for an analogue voice channel for all national connections, with the exception of the cheapest existing zone in the PSTN, ie local calls.**

Action Point 37

**The Community should also try to achieve a Community-wide agreement that tariffs for international connections should be the same for all destinations within the Community. The inter national tariff rate should also be equivalent to the highest national usage charges for an analogue voice channel in a national connection.**

Statement 82

**The introduction of these two agreements would lead to a zoning policy for ISDN B channels consisting of only two zones:**

- **cheapest national zone, ie local area;**
- **Community zone, for all other national and Community-wide connections.**

Although the ISDN has the character of a replacement for today's PSTN, the rental and installation charges for an ISDN termination can be higher than for an analogue subscriber line, because of the higher performance of the ISDN main station and the higher costs of provision and equipment.

Action Point 38

**For the sake of uniformity of approach between the different network carriers, the Community should try to achieve Community-wide agreement that the monthly rental for an ISDN termination should have a maximum relationship to the monthly rental for an analogue line. For basic access, with two B channels, this maximum should not be more than three to five times the single line analogue rental. This figure may not be cost-covering in Phase 1, but should be set with a view to the long-term situation in Phase 2, when improved equipment costs should result in the cost of provision of ISDN service being comparable with that of analogue service.**

Action Point 39

**Similarly, the Community should try to agree a maximum relationship between the installation charges for an ISDN termination and an analogue line, even though this maximum may not be cost-covering in Phase 1.**

In most countries the rental charges for an analogue subscriber line connected to a PABX do not differ from those for a line connected to a single main station. With the introduction of primary rate access of up to 30 B channels in one transmission system, a new situation arises.

Action Point 40

**The Community should try to achieve a Community-wide agreement on a maximum relationship between the monthly rental for ISDN primary rate access and the monthly rental for ISDN basic access. This maximum should not be more than ten times the basic access rental.**

As already pointed out, the ISDN may be of great importance to small and medium size PABXs, and for these users, the capacity of 30 B channels would be unnecessarily large. A smaller offering, such as 10 B channels, would be suitable for such users, and there is some evidence that the cost of provision of full primary access may not exceed that of four or five basic accesses in most cases.

Action Point 41

**In order to stimulate harmony in the PABX market place and encourage the use of primary rate access for PABXs of appropriate size, the Community should try to achieve an agreement that the monthly rental charges for ISDN access with 10 B channels provided at primary rate does not exceed five times the monthly rental for basic rate access, even though this may not be cost-covering in all cases.**

## 8. ECONOMIC CONSIDERATIONS

### 8.1 The Effect of Scale

The sizes of the different national telephony networks were given in Chapter 1, and are summarised for convenience in Table 8. It can be seen that the overall size of the telephony networks in the Community totals to about 100M subscribers. Over the next decade, this total is expected to grow at a rate of 3 - 5% per annum, but switching equipment replacement programmes are expected to equal, or exceed, this rate of growth, making an annual purchasing requirement of 6 - 10% per annum. Countries with an accelerated programme of introduction of digital equipment will exceed this rate - for example, British Telecom has announced ordering programmes for digital switching alone of over 10% per annum in the immediate future.

The annual market for telephone switching equipment in the Community is thus roughly 10M lines, and most countries have plans for the bulk of equipment orders to be for digital equipments within the next few years. For planning purposes, therefore, this study assumes procurements of 10M lines per annum of digital equipment in the planning period of 1988-93.

Statement 83

**It is assumed that planned procurements of digital switching equipment are in the order of 10M lines per annum Community-wide in the period 1988-93.**

Several studies have investigated the economies of scale for manufacturing industry, and a recent report by Deutsches Institut für Wirtschaftsforschung, on the Economic Evaluation of the Impact of Telecommunications Investment in the Communities, considered that a production rate of at least 0.5M lines per annum was essential for economic manufacture of switching equipment. Furthermore, this economic minimum was expected to rise to 0.8 - 1.0M lines within a few years.

TABLE 8 Scale of the ISDN Common Plan

| | Number of PSTN Main Lines('83) (Millions) | Proposed Annual Average Rate of ISDN Introduction(1%) (Thousands) | Total ISDN Acccesses by 1993 (5%) (Thousands) |
|---|---|---|---|
| B | 2.8 | 28 | 140 |
| D | 25.0 | 250 | 1250 |
| DK | 2.5 | 25 | 125 |
| F | 22.0 | 220 | 1100 |
| GB | 20.0 | 200 | 1000 |
| GR | 3.4 | 34 | 170 |
| I | 16.5 | 165 | 825 |
| IRL | 0.6 | 6 | 30 |
| L | 0.14 | 1 | 7 |
| NL | 5.6 | 56 | 280 |
| | | Total 985 | 4927 |

This shows that the wide variety of switching equipment types throughout the Community, identified in Chapter 2, can still be supported economically at present, but that there will be economic pressures which may edge out some of the systems by 1993.

For ISDN lines, however, firm plans, Community-wide would total only a few hundred thousand lines per annum. This study proposes a Common Plan which would achieve 5% ISDN penetration over a 5-year period. At an annual rate of 1%, this would give a procurement of 1M ISDN lines per annum Community-wide.

It is generally accepted in the field of integrated circuit manufacture that a rate of 1M units per annum can provide significant economies of scale, which 100,000 units per annum cannot. Thus, if a unified specification can be achieved, there is an opportunity for terminal equipment manufacturers to obtain devices for the S-interface at prices wich reflect significant economies of scale.

It will not be possible to forecast accurately the numbers and types of terminal equipments which will be taken up by ISDN users during the 5 year period. However, as an indication of volumes, it is assumed that each ISDN access will require a Community Voice Terminal plus one other Community Terminal or Terminal Adaptor. This assumption strikes a balance between potential use of multiple voice terminals behind a PABX access, or possible use of ISDN access exclusively for telematics terminal traffic.

Statement 84

**Procurement of ISDN lines according to the Common Plan should be 1M lines per annum Community-wide. This allows economies of scale for S-interface terminal manufacturers.**

For switching equipment manufacturers, however, the situation is different. If the procurement rate of 1M ISDN lines is split between say 10 different switching systems, then none of the systems will be able to obtain integrated circuits for the line interface at prices which are economic in world-market terms. Even if manufacturers could agree to use a common set of IC's, there could be no economies of scale whilst each country uses IC's tailored to its own particular local loop transmission system.

Statement 85

**To obtain economies of scale in switching equipment for ISDN lines in the introduction phase, the Community cannot afford more than two local loop transmission systems, which preferably should be adopted by all countries and all suppliers.**

Despite all the technical discussions which elaborate on the differences between rival transmission systems and their applicable areas of coverage in different countries, there must be enough commonality in the local area distribution techniques currently used for a common solution to be devised which is applicable over a very large part of the Community. The two systems devised could perhaps be:

1) an echo-cancelling solution, adaptable to a wide variety of local loop characteristics throughout the Community

2) a very low cost system for short local loops, (which might also be applicable behind a PABX)

Economies of scale in the local loop transmission system would benefit NT1 costs, and help towards NT1 commonality, as well as benefitting the switching equipment costs.

8.2 System Cost Elements

The common practice of referring to switching equipment costs on a per-subscriber line basis leaves open many areas of switching system costs. The ratio of trunk circuits provided to subscriber lines, and trunk exchanges to subscriber exchanges will vary according to the network topology involved. the additional costs of network maintenance equipment and centres will vary according to national practice. Signalling systems used will also influence the switching equipment. For all these reasons, it must be recognised that any analysis based on cost per line must be subject to significant variations in different network applications.

Nevertheless, in order to estimate Community-wide infrastructure costs some approximations must be made.

Statement 86

**This study assumes an average price of digital switching equipment providing conventional telephony services to analogue subscriber lines as 300 ECU's per line, uninstalled. To allow for installation and a share of other network costs, an installed figure of 600 ECU's per line is assumed.**

Enhancements to this equipment are required to cater for ISDN working. A recent paper by British Telecom indicated that enhancements to System X to allow ISDN operation were required in the Digital Subscribers Line Unit, Multiplexer and Line Controllers of the Digital Subscribers Switching Subsystem, together with Remote Multiplexor developments and changes in the 2 Mbit/s Line Module and Module Controller, as well as software changes in the areas of the Maintenance Control Subsystem and the Call Processing Subsystem. It is clear that the development costs involved in introducing ISDN working must be considerable, even where the eventual provision of ISDN has already been foreseen.

It is not possible for us to estimate the magnitude of these R & D costs with any certainty, although some 100's M ECU's are involved, and this must be true for each of the different switching systems which are being enhanced for ISDN. The actual costs are not relevant to the analysis of the Common Plan, as the development programmes involved are already being undertaken by the various switching equipment suppliers, and are costs which will be incurred anyway.

The additional equipment cost per subscriber line is, however, a figure which is directly relevant to the Common Plan.

Statement 87

**Based on discussions with industry, an additional cost of 1200 ECU per subscriber line is assumed for provision of ISDN facilities in the initial phase. This figure includes the network termination NT1, and the subscribers transmission system, together with a share of exchange, national, and international overhead costs, such as signalling and maintenance facilities and special transmission arrangements such as remote working.**

The total of 1200 ECU is of comparable magnitude to other studies, notably those by Sagatel. The breakdown of costs assumed is roughly 20% for network termination, 50% for subscriber transmission system, and 30% for interexchange signalling and other overheads.

It is to be expected that after the initial 5 years of the Common Plan, the additional costs for ISDN will have fallen dramatically, and several sources forecast that ultimately the cost of provision of an ISDN line with two channel basic access will be comparable with that of today's single analogue line. This will result partly from improved technology and partly from the effects of line system savings, such as elimination of ringing and high-voltage feeding, on the overall switching equipment design. These lower costs will herald Phase 2 of the ISDN introduction, with operations becoming cost-covering and network growth being demand-based.

Statement 88

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| **It is expected that in Phase 2 of the ISDN introduction, the cost of provision of an ISDN basic access will be comparable with that of today's analogue subscriber line.** |

Statement 89

| |
|---|
| **No element of additional costs is assumed for local loop cabling, as it is expected that ISDN will be able to exploit existing local loops in the majority of cases, with only a few instances requiring regenerators or recabling in the local area.** |

The ability to use already existing local cabling is one of the primary forces which will enable the narrowband ISDN to be introduced world-wide.

8.3 Overall System Costs

The overall effect of the introduction of ISDN to the Common Plan of 5% penetration during the 5 years from 1988 onwards is estimated in Table 9, based on an additional cost of 1200 ECU per subscriber line (see Statement 87).

The basic IDN infrastructure, namely digital transmission nationwide between local exchanges, and the local exchange costs to support analogue subscriber lines, will be incurred by Network Operators according to the rate of deployment of digital facilities within their networks, which will differ in each case. There is some evidence to support the theory that the lowest overall costs of network provision will be achieved by an early introduction of IDN nationwide, thus eliminating much of the potential remote working which might otherwise occur. British Telecom's plans for network digitalisation have been significantly accelerated because of this view.

TABLE 9 Costs of the ISDN Common Plan

| | Number of ISDN Accesses by 1993 (Thousands) | ISDN Introduction Costs (additional to IDN costs) M.ECU |
|---|---|---|
| B | 140 | 168 |
| D | 1250 | 1500 |
| DK | 125 | 150 |
| F | 1100 | 1320 |
| GB | 1000 | 1200 |
| GR | 170 | 204 |
| I | 825 | 990 |
| IRL | 30 | 36 |
| L | 7 | 8 |
| NL | 280 | 336 |
| | | Total 5912 |

Statement 90

> **The costs for ISDN introduction additional to the costs of the basic IDN are estimated at nearly 6,000 M ECU's Community-wide, over the 5-year introductory period.**

It is not particularly relevant or helpful to try to relate these costs to the costs which may already have been estimated by Network Operators for ISDN introduction. Additional ISDN costs for a Network Operator depend on the philosophy for ISDN introduction as well as the philosophy for IDN, as was pointed out in Chapter 4. It is quite a feasible strategy for a Network Operator to introduce IDN on an economically justified piecemeal replacement basis, thus improving the network without the subscriber being aware of the change. It is also feasible for the Network Operator to delay the introduction of ISDN facilities until such time as the cost per subscriber line is equal to that for analogue telephony, so that again the facilities can be introduced piecemeal on an economically justified basis. This strategy incurs none of the additional costs of 1200 ECU per subscriber line estimated for ISDN in Table 9, but it is completely unacceptable as a Community-wide strategy because it adopts a delaying posture, following developments elsewhere, and not producing the benefits in potential for innovation, influence on the economy as a whole, industrial aspects, and business management generally which represent the whole purpose of the European Commission's Action Programme.

Statment 91

> **Some Network Operators may have already made forward planning provision towards the additional costs estimated for ISDN introduction in their network, but this will vary widely according to the philosophy behind their current plans for ISDN, outlined in Chapter 2.**

It is obviously the prerogative of the Network Operators to relate the estimated additional costs for ISDN to the scope of their individual finances.

The scale of costs identified above implicitly assumes the same relative positions of national networks in terms of telecommunications penetration. In some countries additional costs will be incurred in provision of the basic IDN infrastructure, which is not currently planned for implementation in a timescale compatible with the Common Plan. It may also be considered that additional expansion of the basic network size is desirable in some of the less favoured regions of the Community.

Statement 92

**Some Network Operators may incur other costs, in the provision of basic IDN infrastructure or the expansion of less favoured regions, if they are to be able to maintain a balance of telecommunications facilities in their networks.**

These costs cannot be assessed within the scope of this study.

8.4 International Working

The costs of handling international traffic are assumed to be included in the ISDN estimates above, but not the cost of provision of international digital circuits. It is useful to estimate the number of international circuits required for ISDN traffic, and this has been done in Table 10. It is assumed that the ratio of international to national traffic is the same for ISDN users as for telephony, being in the order 0.5%. Initial ISDN users are assumed to have high traffic, possibly 0.20E per line, and the occupancy of international circuits is also assumed to be high initially, possibly 0.75E per circuit. This gives a relationship between the number of ISDN subscribers in a network, and the total number of ISDN international circuits to all destinations. The figures in Table 10 do relate to existing networks, for example, the estimate of 1460 circuits from France

TABLE 10 Scale of International Circuit Provision

| | Number of ISDN Accesses by 1993 (Thousands) | Total Number of Digital International Circuits Required |
|---|---|---|
| B | 140 | 180 |
| D | 1250 | 1660 |
| DK | 125 | 160 |
| F | 1100 | 1460 |
| GB | 1000 | 1330 |
| GR | 170 | 220 |
| I | 825 | 1100 |
| IRL | 30 | 40 |
| L | 7 | 9 |
| NL | 280 | 370 |

is roughly 4.8% of the 1983 total of 30,000 international circuits which France had at that time. (It should be remembered that the Common Plan penetration of ISDN is keyed to the 1983 subscriber base.)

Statement 93

**An analysis of international circuit requirements indicates a significant number of international circuits must be provided to remain in step with the Common Plan.**

The implication of this statement is that there would be insufficient capacity available for an international overlay to be provided using satellite circuits exclusively. A ground-based international infrastructure is essential for the major part of the Community, although satellite circuits could prove economically and practically viable for those areas of the Community which are geographically isolated, and have lower traffic requirements, namely Ireland and Greece.

The ground-based international infrastructure could be provided by several alternative means, using new provision of digital radio or optical fibre carrier systems, or by converting existing analogue routes to digital operation.

The costs incurred in providing international digital circuits for narrowband ISDN will depend on the transmission medium chosen, which in turn may depend on the Community view of broadband ISDN.

8.5 Relationship to Broadband Proposals

Under Action Lines 2 and 4 of its Action Programme in Telecommunications, the Community is already evaluating proposals for an international broadband network, to be based on optical fibre transmission and optical switching systems. The international transmission system could be implemented in a timescale compatible with the 5 years of the Common Plan, since optical fibre transmission systems are already well-developed. Other aspects of the broadband network, such as subscriber distribution systems and, most particularly, optical switching devices and exchange systems, may still be many years in the future.

Statement 94

> **The international traffic for narrowband ISDN could form a basis of demand which may justify the provision of an international infrastructure of broadband fibre optic transmission systems.**

Obviously, the economic justification of the use of optic fibre systems rather than alternatives such as digital radio is outside the scope of the present study. Nevertheless, it seems intuitively correct to use the opportunity of creating an international infrastructure for narrowband ISDN as the basis of a first step towards a broadband network which will subsequently allow fuller exploitation of the fibre optic medium. This would be fully in line with the Community objective under Action Line 4 to prepare for the creation of a European optical fibre based broadband integrated communications network for providing multi-purpose videocommunications services.

The user-network signalling arrangements for narrowband ISDN provide a common channel signalling mechanism for call establishment. In this system, call set up messages are divorced from the communication channel which will ultimately be used, and the characteristics of that channel are defined within the call set up message sequence. This technique has been specified with a view to establishing broadband communications connections as readily as narrowband, and the system can be carried forward into the broadband switched network, when ultimately established.

Statement 95

> **Signalling arrangements for narrowband ISDN are directly applicable for establishing broadband communications also. This would enable a narrowband international network on fibre optics**

**to be gracefully extended to include broadband channels and switching.**

Broadband national networks will also be able to use narrowband ISDN signalling arrangements for call set up, although the use of common transmission line plant for narrowband and broadband circuits will be a matter for Network Operator implementation planning.

8.6 Scope for Community Economic Activity

8.6.1 Community Financial Instruments

It is well known that the penetration of telecommunications varies significantly between the various countries of the Community (figure 12), and even between different regions within individual countries. Less favoured regions have been significantly assisted by the Community's financial instruments, as shown in Table 11. The European Regional Development Fund (ERDF) the European Investment Bank (EIB), and the New Community Instrument (NIC) have contributed an average of 720 M.ECU per annum to telecommunications infrastructure projects in the three year period of the Table. Under Community Action Line 5 - "Making full use of modern telecommunications technologies for promoting the Communities least-favoured regions and developing their infrastructure" - the contributions in this field are intended to rise. They are geared to the future, in seeking to exploit the potential of new telecommunications technologies and are linked to projects of common European interest.

Statement 96

**The proposed Common Plan for ISDN will prove a suitable application for support from the Community financial instruments in the less favoured regions.**

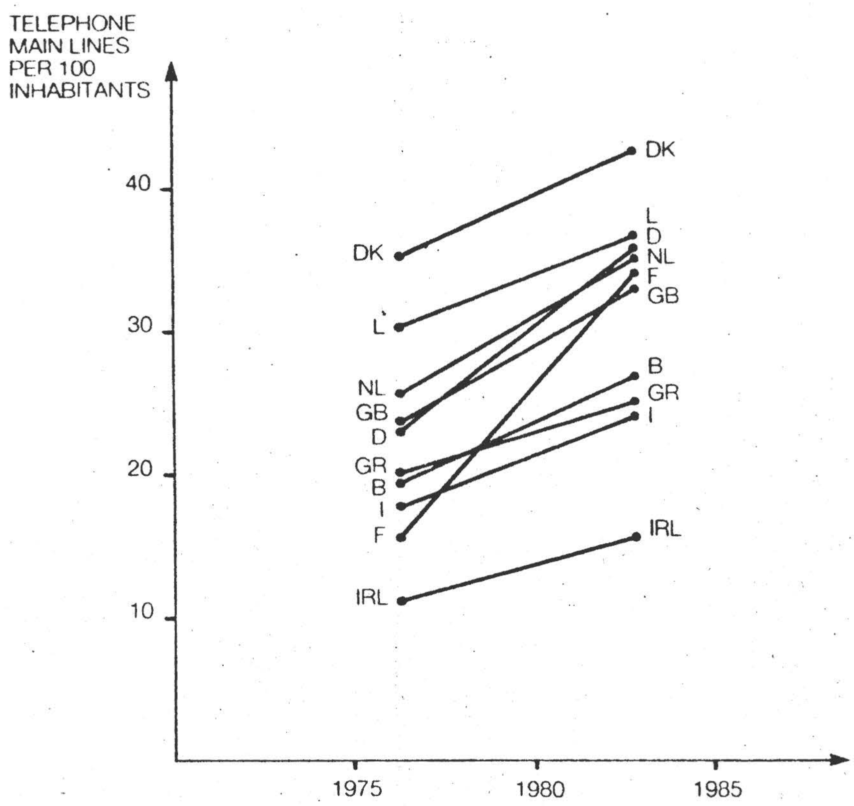


Figure 12 **PSTN Penetration within the Community**

TABLE 11 The Use of Community Financial Instruments for Telecommunications Infrastructure Applications, 1981-83

| | Approximate Total National Telecommunications Expenditure,'81-'83 M.ECU | Community Funding '81-'83 M.ECU | % Community Support '81-'83 |
|---|---|---|---|
| GR | 820 | 368 | 45% |
| IRL | 1060 | 455 | 43% |
| I | 8310 | 831 | 10% |
| GB | 7540 | 264 | 3.5% |
| F | 10640 | 266 | 2.5% |
| | | Total 2185 | |

## 8.6.2 Common Action on Research and Development

The potential benefits of common R & D solutions to the implementation of ISDN - particularly in the areas of integrated circuits and line transmission techniques - have already been outlined earlier in this Chapter. Potential benefits are also available in areas of terminal equipment, particularly in common standards and techniques for the "Community Terminals" identified in the Common Plan. Both these broad areas fall within the scope of Community Action Line 2 - "Common Action on Research and Development". There are opportunities for action both in the field of exchange of information and coordination, and the field of pre-competitive research. The latter area would have some relationship with ESPRIT projects, particularly those concerning microelectronics, although the ISDN telecommunications requirements are not directly transferable. More direct relationship exists with the Community programme for R & D in Advanced Communications - technologies for Europe (RACE). This programme is very forward-looking, and considers an Integrated Broadband Communication (IBC) network for implementation post-1995, but nevertheless the concerns of the IBC network reference model include the transition from narrowband ISDN, in which the narrowband international infrastructure will be of significance, as explained in Section 8.5 of this report.

If neither of these major programmes are considered sufficiently relevant to undertake work towards the ISDN Common Plan, then it should be considered whether the Community can define other methods of supporting the pre-competitive research needed for effective harmonisation in the ISDN areas described earlier.

Statement 97

**The Community should consider appropriate methods of sponsoring pre-competitive research and information exchange in the areas of ISDN technologies, to achieve the potential benefits in economy and harmonisation to which the Common Plan is directed.**

8.6.3 Harmonisation Programmes

Under Action Line 3, the Community undertakes "Action aimed at opening up the terminals market and developing Community solidarity towards the World at large". The terminal equipments proposed in the Common Plan would count as category (a) (new apparatus) for which a programme of common standards could be devised through joint activities of industry and the standards bodies, principally CEPT, together with a harmonised testing and approvals programme. A high priority should be given to the "Community Terminals" proposed in the Common Plan, which will be the first new terminals to exploit the digital infrastructure Europe-wide.

Statement 98

**Community harmonisation and approvals programmes will be directly relevant to the introduction of the Community Terminals proposed in the Common Plan.**

# 9. CONCLUSION

## 9.1 Placing the Study in Context

The European Commission in its Action Programme on telecommunications has recognised that telecommunications plays a major role in the economies of Member States. There is a direct effect in its own sector, which is comparable in size to the largest industrial sectors such as aerospace or electricity generation, involving an annual investment, Community-wide, of over 16,000 M.ECUs in 1981. There is an indirect impact which is also of great significance, because an increase in telecommunications facilities has a multiplier effect on business generally, influencing the management of business, its productivity, and competitiveness.

The role of telecommunications will clearly increase with the continuing innovations in technology, which are bringing new methods and capabilities into all areas of work and social activities. The markets for telecommunications infrastructure, terminals, and services will continue to grow at an accelerating rate.

The telecommunications industry within the Community is still strong, achieving an export surplus of 1.7 billion ECU in 1982. Nevertheless, there are well-known negative factors which prevent telecommunications from achieving its full potential. The fragmented nature of the individual national markets, and the multiplicity of suppliers, leads to duplication of research and development at the very time when system complexity is forcing up the R & D costs, and forcing down the system expected lifetimes. This makes the recovery of R & D investment an ever more speculative venture, since the market price for equipment developed is inevitably influenced by the worldwide competitive levels.

A particular difficulty identified by the Commission is the effect of uncertainties stemming from lack of consultation on common objectives at a Community-wide level. The inevitable uncertainty of forecasting, which of the many possible technologies, products and services will bring economic, industrial and social benefits within the sphere of each individual network is compounded by the dimension of international competition and compatibility. If there is no common view of the integration of terminals and services within Europe, then, almost inevitably, the provision of those terminals and services will differ sufficiently in the different networks that intercommunication will be inefficient, or even in some cases, impossible.

Against this background, the Commission has devised its Action Programme with the objectives of introducing new equipment and services more rapidly; stimulating European telecommunications production and service industries; and supporting the introduction of new technologies.

The present study fits within the context of setting medium and long term strategy objectives, and is oriented towards the development of new services through the rapid launching of narrowband ISDN at European level so as to ensure transnational compatible working for users, and the earliest possible establishment of digital connectability on a Community-wide basis.

Statement 99

**Within the context outlined above, this study has established that a Community-wide ISDN will not emerge until at least 1995 with the current introduction approach, and that even in this timescale there is no guarantee of any particular degree of network compatibility.**

Action Point 42

**The study outlines in some detail a Common Plan for ISDN in Europe which offers a route to digital connectability, new terminals and new services on a significant scale, Community-wide, by 1990**

9.2 Programme of Activities

Action Point 43

**By mid-1985, the Community should agree to act jointly for an early introduction of ISDN on the lines of the Common Plan. This involves recognition of infrastructure investment targets (5% telephone subscriber penetration, 80% geographical coverage, by 1993) chosen to support a substantial threshold of subscribers which can subsequently lead on to universal penetration.**

The forum of the Group for Analysis and Forward Study (GAP) provides an opportunity for early decision making to support the ISDN introduction plan at an outline level.

Action Point 44

**By the end of 1986, the Community should establish the details of the Common Plan, in cooperation with industry and CEPT. The plan must include a complete definition of the network infrastructure, terminals and services to be supported.**

An outline of the features necessary to support the early and rapid introduction of ISDN on a Community-wide basis is given in Chapter 7 of this report.

11. CEPT/Special Group on ISDN (GSI): "Report on ISDN Studies", 1982.

12. CEPT Special Group on ISDN (GSI): "Survey of plans for the introduction of ISDN in Europe", 1984.

13. GAP-8: "Brief Summary of CEPT Work on ISDN Standardisation" 17 January 1985.

14. Presentation: "ISDN plans for Belgium" GAP, 17 January 1985.

15. R David, A Termate, J Bauwens "Data Feature Implementation and ISDN-trial in the Belgium Network" XI International Switching Symposium (ISS '84) Florence, 7-11 May 1984.

16. Presentation: "ISDN plans for Germany" GAP, 17 January 1985.

17. J Claus "Telecommunications Developments - Deutsche Budespost on the Way to ISDN" IEE Conference on "The ISDN and its Impact on Information Technology", London, 14-16 January 1985.

18. W Standinger "A 64 kbit/s model network as a first ISDN approach" ISS '84 Florence 7-11 May 1984.

19. GAP-10: "ISDN in Denmark" 17 January 1985.

20. GAP-7: "Transparence des projects de la DGT" 17 January 1985/

21. Y Acquier: "RENAN: The French Pilot Project of ISDN" IEE Conference on ISDN 14-16 January 1985.

22. P Montandoin: "Le raccordement des abonnes pur le reseau a connexite numerique TRC 64" International Symposium on Subscriber Loops and Services (ISSLS '84) Nice 1-5 October 1984.

23. GAP-12 "British Telecom's Plans for introducing ISDN in the United Kingdom" 17 January 1985.

24. HR Brown: "BT's ISDN in the UK" IEE Conference on ISDN 14-16 January 1985.

25. Presentation: "ISDN Plans for Greece" GAP 17 January 1985.

26. GAP-11: "Plans for the Introduction of ISDN in Italy" 17 January 1985.

27. E Cancer, U DeJulio, M Romagnoli: "The ISDN in Italy: Background, Experiments, Plans" IEE Conference on ISDN 14-16 January 1985.

28. M Romagnoli, G Granello "New facilities in the Italian speech and data network" ISS '84 Florence 7-11 May 1984.

29. "Special Report on Italy" Communications International, June 1984.

30. Presentation "ISDN Plans for Ireland" GAP, 17 January 1985.

31. J M Dwyer "Consideration of strategies for exchange to subscriber linkage in an evolving digital situation" ISSLS '84 Nice 1-5 October 1984.

32. Presentation "ISDN Plans for the Netherlands" GAP 17 January 1985.

33. M Medina, J A Munoz: "Strategy of Evolution towards the ISDN in Spain" IEE Conference on ISDN, 14-16 January, 1985.

34. H Mahner "Application and Advantage of Communication Satellites in Europe" Forum '83, Geneva, October 1983.

35. E O Weiss (Chairman of INTUG) "ISDN - User and Social aspects" Forum '83, Geneva, October 1983.

36. T M Schuringa "The European Community Telecommunications Policy related to ISDN" IEE Conference on ISDN 14-16 January 1985.

37. A W Welsh, B R Kerswell "The future of the ordinary telephone in the UK" ISSLS '84 Nice 1-5 October 1984.

38. J O Wedlake "Customer Services for the next decade" Forum '83, Geneva, October 1983.

39. G Arndt, H Rothamel "Services in the ISDN" Communicate, January 1985.

40. K E Clarke "The impact of the ISDN on Information Technology" IEE Conference on ISDN 14-16 January 1985.

41. J Anderson, S C Fralick, E Hamilton, A G Tescher, R D Widergren "Codec squeezes colour teleconferencing through digital telephone lines "Electronics 26 January 1984.

42. J Lineback "The show must go on - on the desk" Electronics Week, 26 November 1984.

43. J B Jacob, J L Pernin " Raccordement D'abonnes Numeriques sur le Systeme E10, mise en place de la Premiere Phase du RNIS" Forum 83, Geneva, October 1983.

44. G Rathier et al "Integrated Services Digital Subscriber Connection Unit and ISDN Bearer Services" (System MT25) ISS, '84, Florence, 7-11 May 1984.

45. R A Boulter et al "Customer's Integrated Digital Access to new Communications Services" (System X), ISS '84, Florence, 7-11 May, 1984.

46. S Giorcelli et al "Experiment of ISDN facilities in a Proteo UT 10/3 Local Exchange", ISS '84, Florence, 7-11 May, 1984.

47. A Como et al "Implementation and Experiences of ISDN in AXE" ISS '84, Florence, 7-11 May 1984.

48. M Karsas, E Pietralunga "GTD-5C. A System for Local and Transit Applications - Evolution from a Basic Architecture" ISS '84, Florence, 7-11 May 1984.

49. S R Treves et al "System 12 Circuit and Packet Switching in an ISDN Environment" ISS '84, Florence 7-11 May 1984.

50. S Ribbeck, N Skaperda "EWSD as a basis for ISDN" ISS '84, Florence 7-11 May 1984.

51. M G Vry "A new Transmission System for ISDN access at 144 kbit/s" ISSLS '84, Nice, 1-5 October 1984.

52. M Y Levy, S R Surie "A new Line Coding Technique for Digital Subscriber Lines" ISSLS '84, Nice, 1-5 October 1984.

53. M J Carey, J M Yeomans "An Integrated Line Transmission System for the ISDN Environment" IEE Conference on ISDN, 14-16 January 1985.

54. J O Anderson "VLSI Implementation for the ISDN U-interface" IEE Conference on ISDN, 14-16 January 1985.

55. G Geiger, L Lerach "VLSI Chip Set Spurs ISDN System Innovation" IEE Conference on ISDN, 14-16 January 1985.

56. D Pinckard: "The Application and Design of 2 Mbit/s Wideband Switches" ISS '84, Florence, 7-11 May 1984.

57. H Bauch et al "Architectural and Technology Aspects of Broadband Switching" ISS '84, Florence 7-11 May 1984.

58. L G Ackzell: "Economic and Industrial Impact of ISDN in Europe" Forum '83, Geneva, October 1983.

59. C Ikhlef et al "An Interactive Routing Program for International Circuits" Second International Planning Symposium - "Networks 83", University of Sussex, March 1983.

60. E Lera, F Casali "Analytical Method for Cross-Sectional Planning of ISDN" Networks '83, University of Sussex, March 1983.