Information

ISDN

Overview

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1 Introduction

This document gives an overview of the principles of ISDN, describes the relevant interfaces and signaling protocols, depicts the various ISDN services and supplementary services and also explains the EWSD structure to support such ISDN environments.

Information is also provided on the necessary ISDN customer premises equipment (CPE), giving appropriate product examples.

ISDN stands for Integrated Services Digital Network and has been standardized by the ITU-T and ETSI with the target to enable:
- compatible ISDN traffic across national borders
- a free terminal market on the basis of standardized terminal interface definitions.

The ISDN standards define various services (bearer and teleservices) and additional supplementary services, which can be controlled by the subscriber by means of the functional and/or keypad protocol.

The main characteristics of ISDN are:
- integration of the different telecommunication services (voice, text, data, image) on one subscriber access line
- integration of existing separate networks supporting these different services
- digital telephone network (as the prerequisite for ISDN)
- transparent digital transmission at 64 kbit/s within the network
- two standardized access types at the subscriber interface:
  - basic access providing for 2 communication channels (B-channels) and the signaling channel (D-channel)
  - primary rate access comprising 30 B-channels and the D-channel
- ‘D-channel protocol DSS1’ on the access line
- ‘Common channel signaling system No.7’ including the ISDN user part (ISUP) within the network
- end-to-end signaling (SCCP, TCAP) for supporting more sophisticated supplementary services.
2 ISDN User Network Interface

2.1 Reference Configuration

One of the prerequisites to be met before ISDN can be introduced is the digitized network up to and including the terminal equipment. For the subscriber access line the ITU-T has defined functional groups with intermediate points. The tasks that the individual subscriber and exchange functional groups have to perform have also been specified to ensure compatibility between the different exchanges and terminal equipment.

The following reference points are defined by the ITU-T (see Fig. 2.1):

- **R**: Connection of conventional terminals
  2-wire interface as a transition point from terminal equipment with an analog interface. The ISDN interface is available only if a terminal adapter TA has been installed.

- **S**: Bus connection for ISDN terminals
  4-wire interface (plug-in connection) between the network termination NT and ISDN terminal device. The subscriber can connect any terminal, provided it has an S-interface and is approved by the PTT.

- **T**: Connection of ISDN private branch exchanges (ISPBX)

- **U**: Transmission interface
  2-wire interface between the digital exchange and the network termination.

- **V**: Logical interface between physical transmission and higher layers.

![Fig. 2.1 Reference configuration](image-url)
2.2 **EWSD ISDN Access Line**

ITU-T/ETSI define the user-network interface both for the basic access (BA) and for the primary rate access (PA). These specifications are based on the OSI reference model. They do not relate only to the physical characteristics of those interfaces but also, for example, to access options and protocols. In particular, the specified interfaces guarantee the following:

– connection of different terminal equipment for different services
– portability of terminal equipment
– independent development of the technologies, configurations and installations for terminal equipment and networks

Whereas the basic access can be used to support the connection of customer premises equipment (CPE) at the S/T- and T-reference point, the primary rate access is specified to connect CPE via the T-reference point.

The S-interface is a 4-wire bus and allows the connection of up to 10 internationally standardized plug-in sockets for the operation of 8 terminals *(see Fig. 2.2)*.

The adaptation of the S-interface to the U-interface is performed by the network termination NT1/2, which must be powered by the mains. In the event of power failure only one terminal device can be kept operational deriving the necessary energy from the local exchange.

The maximum length of the S-bus depends on the specific CPE configuration and can vary from 150m to 1000m.

The requested terminal types are addressed during call setup by the called number and the requested service, which is encoded in the 'Compatibility Information Elements' bearer capability (BC), high layer compatibility (HLC), and low layer compatibility (LLC) for end-to-end compatibility.

The T-interface is used for the connection of 'ISDN Private Branch Exchanges (ISPBX)'. ISPBXs with low public traffic can be connected via the basic access, bigger ISPBXs, with more public traffic are connected via the primary rate access; both BA and PA are operated in 'point-to-point' configuration.
Fig. 2.2 ISDN terminal configuration
### 2.3 EWSD ISDN Access Types

ISDN provides for the following two types of access (see Fig. 2.3):
- basic access (BA)
- primary rate access (PA)

An ISDN basic access comprises a bandwidth of 160 kbit/s and includes:
- two 64 kbit/s communication channels B(1) and B(2)
- the 16 kbit/s signaling channel (D-channel)
- synchronization

The communication channels B(1) and B(2) have the same characteristics and can be operated independently from each other to transmit voice, text, data or image simultaneously. The B-channels are transparent to the type of transmitted information.

The D-channel is used for exchanging call processing information between the terminal and the exchange. It can also be used for packet data transmission (up to 9.6 kbit/s) in accordance with X.31, Case B (D-channel access).

In contrast to existing public switched telephone networks, ISDN provides the opportunity to operate a variety of different services over the same access line (basic access), e.g. interrogating the newest products on the market via videotex and simultaneously discussing them on the other channel.

The ISDN primary rate access, is used for connecting larger ISDN private branch exchanges, and provides 30 communication channels (B-channels) and one signaling channel (D-channel). It is commonly referred to as “30B+D”. Operating speeds for the B-channel are the same as for BA. The D-channel provides for 64 Bits/s and is only used for signaling.

Basic and primary rate access can be provided on the copper wire pairs of existing subscriber lines as well as on parts of optical fibers.

---

**Fig. 2.3** ISDN access types

<table>
<thead>
<tr>
<th></th>
<th><strong>B(1)</strong></th>
<th><strong>B(2)</strong></th>
<th><strong>D</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BA</strong></td>
<td>64 kbit/s</td>
<td>64 kbit/s</td>
<td>16 kbit/s</td>
</tr>
<tr>
<td><strong>Voice, text, data, image</strong></td>
<td>Voice, text, data, image</td>
<td>Voice, text, data, image</td>
<td>Signaling, data</td>
</tr>
<tr>
<td><strong>PA</strong></td>
<td>64 kbit/s</td>
<td>64 kbit/s</td>
<td>64 kbit/s</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td></td>
<td></td>
<td>64 kbit/s</td>
</tr>
<tr>
<td><strong>Signaling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B(30)</strong></td>
<td></td>
<td></td>
<td><strong>Voice, text, data, image</strong></td>
</tr>
</tbody>
</table>

---
3 EWSD ISDN Signaling

In view of the wide range of services and features available in ISDN, very powerful signaling systems, more than those used for conventional communication systems, are needed to handle signaling functions
– between the exchanges
and
– between the exchanges and the terminal equipment/telecommunication systems.

The ITU-T has specified two systems for transmitting the signaling information (control information) in the ISDN (see Fig. 3.1):
– digital subscriber signaling system no.1 (DSS1, D-channel protocol) for use between exchanges and the terminal equipment
– signaling system no.7 (SS7) with ISDN user part (ISUP) for use between exchanges

---

**Fig. 3.1** ISDN signaling

| SS No.7: | Signaling system No. 7 |
| DSS1: | D-channel protocol |
| ISUP: | ISDN user part |
| ISPBX: | ISDN private branch exchange |
The D-channel protocol and the signaling via trunks are subdivided functionally into several protocol layers. The structure of these layers is controlled by the Open System Interconnection (OSI) reference model.

D-channel protocol

The D-channel protocol has the following three protocol layers:

- **Layer 1: synchronous bit transmission 16/64 kbit/s**
  The function of this layer is to activate, deactivate and operate the physical transmission section.

- **Layer 2: secure data transmission**
  Multiple addresses make it possible to operate several HDLC links in parallel and independently of one another via one physical channel (multiple LAP). This, in turn, enables signaling information to be exchanged simultaneously via a transparent NT with several terminal devices which are connected to the S-bus.

- **Layer 3: signaling**
  This layer defines the signaling processes involved in setting up and clearing down connections via the two B-channels of the basic access or via the 30 B-channels of the primary rate access, and also defines the procedures for processing the subscriber-related features. The layer-3 protocol does not depend on the physical access type (basic access or primary rate access), but has application-dependent variants for multiple-device and PBX connections.

Signaling via the basic access or the primary rate access is performed by means of the D-channel. The D-channel signaling protocol is a message-oriented procedure utilizing the standardized HDLC data transmission procedure.

An ISDN subscriber can be operated in two modes of D-channel protocol:

- **point-to-point configuration**
  Only one logical terminal device is connected to the access line, i.e., an ISPBX

- **point-to-multipoint configuration**
  Enables several terminal devices, which may be of different services, to be connected to the S-bus (multiple device configuration)

The differences in the protocols of these two modes of operation are reflected mainly in layer 2 (e.g., simultaneous operation of several parallel layer-2 connections in the point-to-multipoint configuration).

The special advantages of DSS1 are:

- international standardization
- applicability for all communication services
- short reaction times
Signaling system no.7

ISDN signaling via trunks is based on the specifications for common channel signaling system No. 7 (SS7). In accordance with ITU-T recommendations, the SS7 is organized into the following four protocol layers:

– Layers 1 - 3: message transfer

   The message transfer part (MTP) is used in SS7 by all user parts as a transport system for exchanging messages. One user part passes the messages to be transferred to another user part through the message transfer part. The MTP makes sure that the messages reach the addressed user part, and provides safeguarding against information loss, duplication, any changes of sequence and bit errors.

– Layer 4: signaling

   The ISDN user part (ISUP) contains the signaling functions for controlling connections, for processing services and features, and for administrating user channels. For transporting of signaling messages, the ISUP has interfaces to the message transfer part (MTP) and to the signaling connection control part (SCCP). End-to-end signaling is necessary for features such as ‘Completion of Calls to Busy Subscriber’ (CCBS) or ‘Completion of Calls on No Reply’ (CCNR).
4 EWSD ISDN Services

The primary aim of ISDN is to provide new digital services for voice and non-voice communication with high-value supplementary services, improved service quality and greater ease of communication.

The following types of ISDN services are available:
- bearer services
- teleservices
- supplementary services

Bearer services

Bearer services are used for unrestricted data, voice and text transmission as implemented hitherto in circuit-switched and packet-switched data networks (see Fig. 4.1). The technical specifications of these services cover the transmission functions of OSI reference model (seven layer reference model for Open Systems Interconnection) that is required for the transport of information. A bearer service only ensures the transport of information between the respective user-network interfaces.

**Fig. 4.1** Bearer services
**Teleservices**

The teleservices are services for user-to-user and user-to-host communication, including specification of the communication functions of the terminals. They include teleservices as depicted in Fig. 4.2. Other teleservices (e.g., Eurofiletransfer, FTAM) are supported as application of bearer services. The communication functions comprise all the transmission functions and communication protocols of the OSI reference model for controlling the different communication processes.

**Teleservices:**

*Provide end-to-end communication*

![Teleservices Diagram](image)

- Telephony 3.1 kHz
- Telephony 7 kHz
- Telefax group 4
- Teletex
- Videotelephony
- Videotex
- Mixed mode

**Fig. 4.2** Teleservices
Supplementary services

The supplementary services augment the basic services, e.g., in terms of higher communication quality and enhanced communication convenience. All supplementary services may be individually assigned according to the needs of the ISDN subscriber. This set of supplementary services can be assigned to any bearer/teleservice and/or each subscriber number. The supplementary services can be subdivided into the following groups (see Fig. 4.3):

- number identification supplementary services:
  - CLIP (Calling line identification presentation), CLIR (Calling line identification restriction), COLP (Connected line presentation), COLR (Connected line restriction), DDI (Direct Dialing in), MCID (Malicious Call Identification), MSN (Multiple Subcriber Number), SUB (Sub-addressing)
- call offering supplementary services:
  - CF (Call forwarding - unconditional, busy, no reply)
- call completion supplementary services:
  - CH (Call hold), CW (Call waiting)
- multiparty supplementary services:
  - CONF (Conference call add-on), 3PTY (Three party service)
- community of interest supplementary services:
  - CUG (Closed user group)
- charging supplementary services:
  - AOC (Advice of charge - Setup, During, End)
- additional information transfer:
  - UUS (User to user signaling)
- rapid call set-up supplementary services
- call restriction supplementary services
- emergency supplementary services
- miscellaneous supplementary services

Fig. 4.3 Supplementary services
5 EWSD ISDN Structure

ISDN can be implemented in existing local EWSD exchanges very economically.

The ISDN-specific additions to the EWSD system affect the following hardware and software components:

Hardware components
- Digital subscriber line : SLMD = subscriber line module, digital
- Frame handler : multiplexes packet data transmitted via D-channel

Software components
- Firmware to control the SLMD subscriber line module and DIUD in LTG
- Software for the line/trunk groups for subscriber and trunk signaling
- Software for the common channel signaling network control
- Software in the coordination processor for central tasks
- Software for the frame handler and the connection support system

Fig. 5.1 EWSD structure in the ISDN
5.1 EWSD Structure for BA

The interface for the basic access (BA) is implemented in the digital line unit (DLU) to connect ISDN subscribers and small ISDN-PBXs. Since the DLU can also be remotely operated, ISDN-technology can be provided for low traffic areas.

The basic structure of the DLU in ISDN is the same as used for analog subscriber and therefore can be equipped with a mixture of analog and digital subscriber line modules. Each BA is connected to a SLCD (subscriber line circuit, digital) on a SLMD (subscriber line module, digital) using the 2-wire U-interface.

In a DLU with ISDN functions, information on the B-channels and on the packeted data is transferred from the SLMDs via channels of the 4096-kbit/s bus to the DIUD or DIU:LDID and vice-versa. The exchange of information between the group processors in the associated LTGs and the two processors on the SLMDs is regulated by the control for the digital line unit (DLUC).

There are two types of SLMD, one for the connection of 8 BA and an other enhanced SLMD (preferably used in new installations) for 16 BA.

The SLMD for 16 BA contains a control section, a line card processor (LCP), a system adapter processor (SAP) and an SLMD Control ASIC, Version 1(SCA1) (see Fig. 5.2).

The functions of the SLMD are as follows:
- transmitting the subscriber data on two-wire subscriber lines at a rate of 144 kbit/s
- 2/4-wire conversion
- transmission using the adaptive echo method
- automatic matching if the wires of the subscriber line are interchanged
- fulfilling transmission requirements
- controlling the activation/deactivation procedure
- remote-feeding of the network termination via the subscriber line
- short-circuit and ground supervision for the subscriber line
- providing protection against overvoltage conditions and external voltages
- switching over the subscriber line and the line circuit for test purposes
- controlling the data flow on the B- and D-channels with the aid of the line card processor
- redundant 4096-kbit/s bus with 2 x 64 programmable time slots for speech/data transmission (B-channel)
- assembling and disassembling the D-channel information, comprising signaling and packet data
- redundant collision bus for controlling packet data transfers in one time slot (Bd-channel) of each 4096-kbit/s bus
- exchanging signaling data with the DLUC via the redundant control bus by means of a single-chip microcomputer (SAP)
- providing support for DLU system maintenance, e.g. diagnosis, online supervision
Overview

Information ISDN

Fig. 5.2 Subscriber line module, digital (SLMD with 16 SLCDs)

AFE: Analog front end
DFE: Digital front end
ELIC: Extended line card interface controller
EPIC: Extended PCM interface controller
IDEC: ISDN D-channel exchange controller
LCP: Line card processor
NT: Network termination ISDN
RPFB: Remote power feeding, type B
SACCO: Special application communication controller
SAP: System adapter processor
SCA1: SLMD control ASIC Version 1
SLCD: Subscriber line circuit digital
TU: Test unit

Note: AFE and DFE are shared by four SLCD.

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5.2 EWSD Structure for PA

In addition to the basic access, the primary rate access (PA) is also available in EWSD ISDN. The PA in EWSD is connected to a standard subscriber LTG. Medium size and large ISPBXs can be connected via up to four PAs per LTG each with a transmission rate of 2,048 MBit/s to one LTG.

5.3 Open Access Network Interface

EWSD ISDN open interfaces also encompass the standardized ETSI V5.1 interface for the connection of access network multiplexes to an ISDN switch. It allows the connection of up to 15 basic accesses to the EWSD.

According to the idea of open interfaces, any standardized access network multiplexer can be connected to an EWSD ISDN switch. The subscriber gets the same services as subscribers who are connected directly.

5.4 Frame Handler with Access to the Packet Network

EWSD ISDN supports the packet mode services for data communication on the B- as well as the D-channels providing the user with X.25 services. In a first step all D-channel packet data of one DLU are concentrated on 2 Bd DLU-channels per DLU.

The frame handler will be introduced in EWSD, if
- higher packet data concentration is required (packet data flow per DLU far below 64 kbit/s)
- switched Bd-channels are required on the packet handler interface

The frame handler function in EWSD is implemented with a specific LTG type (LTGH). The LTGH is installed in exchanges where ISDN subscribers in the basic access (BA) use the D-channel for packet data (terminals with X.25 user interface).

EWSD ISDN works together with the packet handler via ETSI standardized packet handler interface (ETS 300 099).
6 Establishing a Customer Application Center

This section is a guideline for creating a Customer Application Center. It includes suggested applications for the room, layout and the necessary equipment.

It is very important to demonstrate the benefits of ISDN to end users so that they realize how much ISDN can enhance their day-to-day activities. The most popular applications recommended for the installation of a Customer Application Center within a reasonable budget are:

- Desktop video conference via PC
- Teleworking (voice and non-voice services)
- On-line services/Internet access

By combining more than one application on each terminal you establish credibility and an accurate picture of how the real world works. Customers will be able to see how ISDN Customer Premises Equipment (CPE) works on a platform in order to enhance productivity.

6.1 Layout of Customer Application Center

Once you decide on the applications and the equipment has been identified, you need to determine the design of the Center. This includes cabinet/counter requirements, room design, layout, arrangement of applications in the room. Each end of an application will use approximately three feet of counter-surface and will require space under the counter for computers and cables. In order to make the applications more “real”, you may want to separate the “A” and “B” sides of the application. By separating one desktop video conference party from the other, the demonstration is enhanced and it allows your customers to view one end or the other. The demonstration can be further improved by contacting Siemens to host the remote location of an ISDN desktop video conference.

You can also take your ISDN applications to local conferences and shows, especially computer shows. This allows you to demonstrate applications to the public and actually lets you target specific industries. This response is usually very positive and generates sales of ISDN services.

The information on the following pages provides a complete list of equipment that is needed to demonstrate each application that has been previously identified.
The necessary hardware equipment configuration could be as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Product name</th>
<th>Vendor</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>Basic system PCD-5H/133</td>
<td>Siemens Nixdorf</td>
<td>PCD-5H/133 Pentium RAM 32 MByte Hard disk 850 MByte CD-Rom Drive WIN'95</td>
</tr>
<tr>
<td>ISDN Telephone</td>
<td>Profiset 50 ISDN</td>
<td>Siemens</td>
<td></td>
</tr>
<tr>
<td>ISDN Telephone</td>
<td>Gigaset 1054 isdn</td>
<td>Siemens</td>
<td></td>
</tr>
<tr>
<td>Telefax Gr.4</td>
<td>Fax 790</td>
<td>Siemens</td>
<td></td>
</tr>
<tr>
<td>Video Telephone</td>
<td>ISDN-VIEW</td>
<td>Siemens</td>
<td>to plug in board with camera, cable, software</td>
</tr>
<tr>
<td>Network Termination</td>
<td>ISDN-NTBA</td>
<td>Siemens</td>
<td>Euro-NT1 line code 2B1Q</td>
</tr>
</tbody>
</table>

This configuration allows presentation of basic and supplementary services.

Tab. 6.1 Hardware equipment configuration of a Customer Application Center
Application: Desktop Video Conference (via PC)
Potential markets/applications:
Education, Finance, Government and Working at Home
This demonstration is a PC-based video conference using 128 kbit/s (both B-channels) for audio and video. The ISDN-VIEW system allows meetings to be held with participants around the world. This application should be included in your Customer Application Center because it is very inexpensive and easy to implement in already existing 480 PC workplaces. It features Application Sharing which enables a person working at home to share software applications with a colleague even though the software is not on the home PC. This is a very popular benefit of the program.
The ProShare systems has been upgraded to the H.320 standard which means that it is compatible with numerous other video vendors using the H.320 standard. This offers you the option of calling many different locations to demonstrate desktop video conference. Some of these vendors are: PictureTel, Vtel and EyeTel.

Application: Internet Access/On-line services
Potential markets/applications:
Education, Finance, Working at Home and Government
This demonstration is PC-based and requires a card for ISDN access. The most effective way to demonstrate ISDN access to an on-line service is to set up two identical systems. Enhance one system with an ISDN card. Once both systems are at the same location in a database (the same home page on the Internet), select an image, and press enter at the same time to illustrate the speed of ISDN. The ISDN connection will be approximately five times faster than the other.

Application: Teleworking
Potential markets/applications:
Education, Finance, Government, Real Estate and Insurance
Teleworking identifies the possibilities of a home workstation connected to the ISDN. The application is an ideal example for using the different feature descriptions of ISDN. Attention should be drawn to non-voice services such as file transfer, on-line service and application sharing.
7 ISDN Customer Premises Equipment (CPE)

The purpose of this section of the document is to:
- provide an overview of the types and manufactures of CPE
- show how a terminal adapter works with ISDN
- provide an overview of how the various network terminations can be used

At the end of this section is a current partial listing of ISDN CPE that Siemens has tested and/or used successfully with the EWSD System. At present there are hundreds of ISDN CPE products on the market, with new product announcements being made every week. When looking at CPE that is not on this list, a key feature to look for is compatibility with ISDN. In general, if a particular CPE product is truly compatible it should work with the EWSD System.

ISDN CPE takes on a variety of sizes and shapes and can be subdivided as follows:
- ISDN terminal equipment
- terminal adapters
- network termination

7.1 ISDN Terminal Equipment

ISDN telephone
The ISDN telephone is the further development of the analog telephone apparatus to the digital. ISDN telephones are subdivided in two types of equipment to support 3.1 kHz and/or 7 kHz telephones. The basic difference between ISDN and other systems is its improved speed quality resulting from the use of a broader bandwidth. At the same time a terminal adapter for a V.24 interface can be integrated into the telephone. The V.24/X.21 function can use B-channel and D-channel simultaneously for data communication.

ISDN videotelephone
Videotelephones consist of a telephone, camera and monitor. The camera is normally attached permanently to the monitor housing and is directed at the user. In addition to this integrated camera, a document camera can be used to transmit text or pictures.

ISDN videoconference set
The ISDN videoconference set is similar to the conventional videoconference set except that it is connected to the ISDN and thus uses the ISDN as an information carrier.

ISDN videotex
Videotex provides the transmission of the text, graphics, photographic quality pictures and sends information from a central data base to a subscriber terminal. Videotex is currently implemented in ISDN by means of an appropriate PC.
**ISDN telefax**

Telefax Group 4 provides end-to-end fax communication using standardized picture, resolution and communication protocols. The ISDN features can only be fully utilized for telefax of the new Group 4. A group 4 brings higher speed and better quality than other fax equipment.

**ISDN-PC**

Observe the following when connecting a PC to ISDN to use the communication services of the digital network:

- ISDN access
- physical connection between the PC and ISDN access
- communication software for the service which is to be used

The PC access to the digital network can be made with ISDN modems (adapter), terminal adapter or ISDN cards. The ISDN cards are inserted in a free PC slot and provide an S-interface. In addition to this, the communication software must be installed on the PC’s hard disk (ISDN PC = ISDN PC card + software). This normally involves software systems of modular structure. These systems consist of a basic component, which provides the common functions for the different modules (e.g. management), and various software modules, which can be combined to suit each individual case depending on the service required (e.g. file transfer, videotex, telefax,...).

**ISDN private branch exchange (ISPBX)**

ISPBXs are private switching systems which are connected to the public telecommunications network for external communication. ISPBXs are not only limited to the telephone service, but also provide transport services for the entire office communication (speech, text, data and image transmission). The capacity of an ISPBX depends on the individual manufacturer.
7.2 Terminal Adapters

Terminal adapters (TAs) carry out necessary adaptations, and are needed for the following two reasons:
- existing terminal equipment - in particular, expensive equipment with interfaces (for example: a/b, V.24 (X.21 bis), X.21, etc.) - can be used until replaced
- users are given a firm planning basis for acquiring terminal equipment during the transitional period before ISDN is implemented in their local network

These terminal adapters form the link between non-ISDN capable terminal equipment and the S-interface of the ISDN basic access. They allow existing terminal equipment to continue in use, and thus reduce investment by the user in converting to ISDN. However, when a TA is used, it is not always possible to exploit the full range of ISDN features (e.g. the high transmission rate), if these are not supported by the terminal equipment. Fig. 7.1 is an overview of the classes of terminal adapter.

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**Fig. 7.1** Overview of terminal adapter classes
7.3 Network Termination

The network termination (NT1) in the equipment overview can be divided into the following two classes:

- basic access NT1(BA)
- primary rate access NT1(PA)

In the ITU-T standards, mention is also made of an NT2 or of function NT2.

![Diagram of user station with labels: TE1: ISDN terminal equipment, TE2: non-ISDN terminal equipment, TA: terminal adapter, NT: network termination.]

Compared to the NT1, the NT2 is equipped with more “intelligence”. In other words, while the functions of the NT1 extend only to Layer 1 of the OSI model, the NT2 also handles Layers 2 and 3 (e.g. internal traffic of the connected terminal equipment at the NT2) of the OSI model. At present, for instance, the NT2 function is implemented in ISDN private branch exchanges (ISPBX).

**NT1(BA)**

The NT1(BA) forms the physical/electrical termination of the access line from the local exchange to the subscriber. At the basic access, the NT provides a series of functions. They include:

- Conversion of the signaling from the two-wire access line to the four-wire S-bus
- Echo compensation
- Conversion of the I.430 frame format to the 2B1Q transmission code
- Power supply for the terminals (telephones)
- If necessary, power supply for the telephone in the event of a power failure
- Support for the exchange in fault location (test loops)
- Support for accompanying test methods for determining transmission quality (CRC bit error rate)

A basic distinction must be made between the power supplied to the NT itself, and the power supplied by the NT to the S-bus for the connected terminals. A distinction must also be made between “normal condition” and “restricted condition”. “Restricted condition” is a situation in which the subscriber has suffered a power failure, but is still able to telephone (emergency power feeding) using a telephone apparatus (emergency telephone).
NT1(PA)

An NT1(PA) is used to connect an ISPBX to the primary rate access (PA). The NT1(PA) effects the transmission adaptation between the subscriber interface(s) and the line interface V. On the exchange side the access line is terminated by the line terminating equipment. At the S-interface, a 2,048 Mbit/s signal is passed to the subscriber. The entire data stream is constantly monitored for bit errors using the CRC4 method. In contrast to the NT1(BA), the NT1(PA) obtains its power from the ISPBX via a line specifically for this purpose.

The NT1(PA) is connected to the exchange in a point-to-point configuration only. There are two different types of connection to the exchange:
- standard connection
- remote connection

In many cases the function of NT1(PA) can be integrated in the ISPBX.
## 7.4 Product Examples

For further information on Siemens customer premises, please contact your nearest authorized Siemens representative.

**Tab. 7.1** ISDN telephones

<table>
<thead>
<tr>
<th>Product type</th>
<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISDN telephone</td>
<td>profiset 50 ISDN</td>
<td>Siemens</td>
<td>2-line display, loudspeaker, notebook, user guidance, hands-free facility</td>
<td>optionally with X.25 - and/or a/b-interface</td>
</tr>
<tr>
<td>ISDN telephone</td>
<td>GIGASET 1054 ISDN</td>
<td>Siemens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISDN telephone</td>
<td>Handset 2824</td>
<td>Alcatel Business System 54 Avenue Jean Jaures 92707 Colombes Cedex France Tel: +33147694769 Fax: +33147694744</td>
<td>2-line display, loudspeaker, notebook, user guidance, call charge display, hands-free facility</td>
<td>optionally with X.25 - and/or a/b-interface</td>
</tr>
<tr>
<td>ISDN telephone</td>
<td>SOPHO Set N271</td>
<td>Business Communication Unternehmensbereich der Philips GmbH Thurn- und Taxis Str.14 90411 Nürnberg Germany Tel: +4991123786804 Fax: +4991123786802</td>
<td>2-line display, loudspeaker, notebook, user guidance, DTMF signaling, call charge display, hands-free facility</td>
<td></td>
</tr>
<tr>
<td>ISDN telephone</td>
<td>FMN ISDN200</td>
<td>FMN Fernmeldetechnik GmbH 99734 Nordhausen Germany Tel: +493631560 Fax: +493631563435</td>
<td>2-line display, loudspeaker, notebook, user guidance, DTMF signaling, call charge display, hands-free facility</td>
<td></td>
</tr>
<tr>
<td>Product type</td>
<td>Product name</td>
<td>Supplier</td>
<td>Features</td>
<td>Remarks</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>PC board</td>
<td>AVM A1 plus</td>
<td>AVM Voltastr. 5 13355 Berlin Germany Tel: +4930467070 Fax: +493046707299</td>
<td>passive AT bus 2 B-channels MS-DOS, CAPI</td>
<td></td>
</tr>
<tr>
<td>PC board</td>
<td>ISDN S-com</td>
<td>Diehl ISDN Group Bahnhofstr. 63 71229 Leonberg Tel: +49715293290 Fax: +497152932999</td>
<td>Active AT bus V.92 bis compression fax group 3 option 2 B-channels, CAPI</td>
<td></td>
</tr>
<tr>
<td>PC board</td>
<td>Teles So</td>
<td>Teles GmbH Dovestr. 2-4 10587 Berlin Germany Tel: +49303992800 Fax: +493039928029</td>
<td>passive MS-DOS, 1 B-channel CAPI</td>
<td></td>
</tr>
<tr>
<td>PC board</td>
<td>SolIS</td>
<td>MBP Softwareentwicklungsgesellschaft Semerteichstr. 47-49 44141 Dortmund Germany Tel: +492319441407 Fax: +492319441600</td>
<td>2 B-channel analog modem analog fax data compression</td>
<td></td>
</tr>
<tr>
<td>PC board</td>
<td>ISDN Board A1</td>
<td>Siemens</td>
<td>passive MS-DOS, CAPI 2 B-channel</td>
<td></td>
</tr>
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</table>
### Tab. 7.3 ISDN Fax Group 4

<table>
<thead>
<tr>
<th>Product type</th>
<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISDN Fax Grp.4</td>
<td>Fax 790</td>
<td>Siemens</td>
<td>desktop model compatibility G3,G4 laser printout on plain paper resolution: 400dpi</td>
<td></td>
</tr>
<tr>
<td>ISDN Fax Grp.4</td>
<td>L 3300i</td>
<td>Canon Deutschland GmbH</td>
<td>desktop model compatibility G3,G4 laser printout on plain paper resolution: 400dpi</td>
<td></td>
</tr>
<tr>
<td>ISDN Fax Grp.4</td>
<td>Fax 4500L</td>
<td>Ricoh Europe</td>
<td>desktop model compatibility G3,G4 laser printout on plain paper resolution: 400dpi</td>
<td></td>
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</tbody>
</table>
### Tab. 7.4 ISPBX

<table>
<thead>
<tr>
<th>Product type</th>
<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISPBX</td>
<td>HICOM</td>
<td>Siemens</td>
<td>Different system sizes available up to 20,000 extensions DSS1 on BA/PA on trunk side and both BA and PA on extension side</td>
<td></td>
</tr>
<tr>
<td>ISPBX</td>
<td>4420 4205 4210</td>
<td>Alcatel Business System 54 Avenue Jean Jaures 92707 Colombes Cedex France Tel: +33147694769 Fax: +33147694744</td>
<td>native ISDN PABX, ISDN and analog sets up to 128/20 extensions</td>
<td></td>
</tr>
<tr>
<td>ISPBX</td>
<td>Varix 2000</td>
<td>DeTeWe 10997 Berlin Germany Tel: +493061041 Fax: +49061043344</td>
<td>up to 29,000 ports</td>
<td></td>
</tr>
<tr>
<td>ISPBX</td>
<td>MD 110</td>
<td>Ericsson</td>
<td>uses PA but also supports BA, most important supplementary services are supported</td>
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</table>
### Tab. 7.5 ISDN videoconference units

<table>
<thead>
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<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Video conference unit</strong></td>
<td>Videoset L</td>
<td>Siemens</td>
<td>S-interface 112 to 128 Kbit/s remote control camera</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>preset camera position Window technique</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>25'' monitor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Video conference unit</strong></td>
<td>Telesat cameros</td>
<td>SAT 25 quai Panhard et Levassor</td>
<td>Rollabout videoconferencing system including codec and ISDN card</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>75624 Paris Cedex 13 France</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +33140771212 Fax: +33145824679</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Video conference unit</strong></td>
<td>System 1000/4000</td>
<td>Picture Tel</td>
<td>Group videoconferencing system family of products</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>258 Bath Road Slough Berkshire SL1 4DX England</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +44753673000 Fax: +44753673010</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Video conference unit</strong></td>
<td>Single Net/ TwinNet</td>
<td>Entec</td>
<td>Videoconferencing rollabout with Windows user interface up to 128 Kbit/s and up to 2 Mbit/s, G728, G722, G711</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switzerland</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +4118131121 Fax: +411832527</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Video conference unit</strong></td>
<td>Trini Com 2000</td>
<td>Sony Deutschland GmbH</td>
<td>Rollabout videoconferencing system, window technique</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecknerstr. 20 50829 Köln-Ossendorf Germany</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +492215966534 Fax: +4922159668348</td>
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**Tab. 7.6 ISDN multimedia equipment**

<table>
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<tr>
<th>Product type</th>
<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISDN multimedia equipment</td>
<td>Videokit</td>
<td>Siemens</td>
<td>Add-on package with/without PC 486PC or higher and DOS5.0/Windows 3.1 required</td>
<td>1 or 2 PC boards, audio module, SW, camera, videoconferencing, share application</td>
</tr>
<tr>
<td>ISDN multimedia equipment</td>
<td>ISDN-View</td>
<td>Siemens</td>
<td>Add-on package with/without PC 486PC or higher and Windows 95 required</td>
<td>1 PC boards, audio module, SW, camera, videoconferencing, share application</td>
</tr>
<tr>
<td>ISDN multimedia equipment</td>
<td>Varix Videotel</td>
<td>DeTeWe</td>
<td>Complete system including PC</td>
<td></td>
</tr>
<tr>
<td>ISDN multimedia equipment</td>
<td>Teles-VISION B</td>
<td>Teles GmbH</td>
<td>Add-on package for PC low cost solution a board for ISDN, audio, video, data Pentium PC min. 60MHz and 8 MB RAM required</td>
<td></td>
</tr>
<tr>
<td>ISDN multimedia equipment</td>
<td>IDIP Camphone</td>
<td>Wendt &amp; Klütmann</td>
<td>Video communication system, up to 6 pictures integrated file transfer telephone directory</td>
<td></td>
</tr>
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</table>
## Tab. 7.7 ISDN terminal adapters

<table>
<thead>
<tr>
<th>Product type</th>
<th>Product name</th>
<th>Supplier</th>
<th>Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal adapter</td>
<td>DCI 740</td>
<td>Siemens</td>
<td>Interfaces: V.24 V.35 V.36 X.21</td>
<td></td>
</tr>
<tr>
<td>Terminal adapter</td>
<td>1182 VX Dual/TA 1182 SV</td>
<td>Alcatel Business System 54 Avenue Jean Jaures 92707 Colombes Cedex France Tel: +33147694769 Fax: +33147694744</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal adapter</td>
<td>Euries series</td>
<td>Elmeg Vöhrumer Str. 30 31228 Peine Germany Tel: +4951719090 Fax: +495171909444</td>
<td>Interfaces: a/b V.24 X.25 via D-channel</td>
<td></td>
</tr>
<tr>
<td>Terminal adapter</td>
<td>TA X.21 bis TA V.24 TA X.25D</td>
<td>Sedibauer W.Sedibauer Str. 2 94481 Grafenau Germany Tel: +498552410 Fax: +49855241265</td>
<td>Interfaces: X.21 V.24 X.25 via D-channel</td>
<td></td>
</tr>
<tr>
<td>Terminal adapter</td>
<td>TA-d TA-dd</td>
<td>CPV Stollmann 22714 Hamburg Germany Tel: +4908908880 Fax: +49089088444</td>
<td>Interfaces: X.21 V.24</td>
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### Tab. 7.8  ISDN network termination

<table>
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<th>Product type</th>
<th>Product name</th>
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<th>Features</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>NT(BA)</td>
<td>SANTIS -ab</td>
<td>Siemens Switzerland Ltd</td>
<td>Line code 2B1Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freilagerstrasse 39</td>
<td></td>
<td>2 a/b interfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +41-1-495-5039</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: +41-1-495-5414</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT(BA)</td>
<td>Euro-ISDN-NTBA</td>
<td>Siemens</td>
<td>Line code 2B1Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S42024-A260-C2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT(PA)</td>
<td>ULAF-2</td>
<td>Siemens Switzerland Ltd</td>
<td>Line code 2B1Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freilagerstrasse 39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: +41-1-495-5039</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: +41-1-495-5414</td>
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## 8 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>BA</td>
<td>basic access</td>
</tr>
<tr>
<td>BC</td>
<td>bearer capability</td>
</tr>
<tr>
<td>CCBS</td>
<td>completion of calls to busy subscriber</td>
</tr>
<tr>
<td>CCNC</td>
<td>common channel signaling network control</td>
</tr>
<tr>
<td>CCNR</td>
<td>completion of calls on no reply</td>
</tr>
<tr>
<td>CPE</td>
<td>customer premises equipment</td>
</tr>
<tr>
<td>DIU:LDID</td>
<td>digital interface unit for local DLU interface, module D</td>
</tr>
<tr>
<td>DIUD</td>
<td>digital interface unit for DLU</td>
</tr>
<tr>
<td>DLU</td>
<td>digital line unit</td>
</tr>
<tr>
<td>DLUC</td>
<td>control for DLU</td>
</tr>
<tr>
<td>DSS1</td>
<td>digital subscriber signaling system no.1</td>
</tr>
<tr>
<td>ETSI</td>
<td>European Telecommunications Standards Institute</td>
</tr>
<tr>
<td>HDLC</td>
<td>high-level data link control</td>
</tr>
<tr>
<td>HLC</td>
<td>high layer compatibility</td>
</tr>
<tr>
<td>ISDN</td>
<td>integrated services digital network</td>
</tr>
<tr>
<td>ISPBX</td>
<td>ISDN private automatic branch exchange</td>
</tr>
<tr>
<td>ISUP</td>
<td>ISDN user part</td>
</tr>
<tr>
<td>ITU-T</td>
<td>International Telecommunications Union</td>
</tr>
<tr>
<td>LAP</td>
<td>link access procedure</td>
</tr>
<tr>
<td>LLC</td>
<td>low layer compatibility</td>
</tr>
<tr>
<td>LTG</td>
<td>line/trunk group</td>
</tr>
<tr>
<td>MTP</td>
<td>message transfer part</td>
</tr>
<tr>
<td>NT</td>
<td>network termination</td>
</tr>
<tr>
<td>OSI</td>
<td>Open System Interconnection</td>
</tr>
<tr>
<td>PA</td>
<td>primary rate access</td>
</tr>
<tr>
<td>PBX</td>
<td>private branch exchange</td>
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<tr>
<td>SCA1</td>
<td>SLMD control ASIC Version 1</td>
</tr>
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<td>SCCP</td>
<td>signaling connection control part</td>
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<td>SLCD</td>
<td>subscriber line circuit, digital</td>
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<tr>
<td>SLMA</td>
<td>subscriber line module analog</td>
</tr>
<tr>
<td>SLMD</td>
<td>subscriber line module, digital</td>
</tr>
<tr>
<td>SN</td>
<td>switching network</td>
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<tr>
<td>SS7</td>
<td>signaling system no.7</td>
</tr>
<tr>
<td>TA</td>
<td>terminal adapter</td>
</tr>
<tr>
<td>TCAP</td>
<td>transaction capabilities application part</td>
</tr>
<tr>
<td>TE1</td>
<td>ISDN terminal equipment</td>
</tr>
<tr>
<td>TE2</td>
<td>non-ISDN terminal equipment</td>
</tr>
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</table>