ISDN

Digitising of the telephony-networks offered the chance to integrate all existing telecommunication services (voice and data services) to one network.
The **I**ntegrated **S**ervices **D**igital **N**etwork
ISDN offers circuit-switched connections (for either voice or data) in increments of 64 kbit/s, and packet-switched connections (for data).
Prior to ISDN a packet switched network named X.25 was the preferred network for data transmission. For example cash dispenser use X25 access. ISDN now offers access to the X.25 Network via the telephone line.

Types of ISDN access

:

- **Basic rate access 2B+D**
  2x 64kb/s B + 1x 16kb/s D
  Basic rate access offers two circuit switched bearer channels 64kb/s each plus one packet switched data channel with 16kb/s
  The D-channel is also used to transfer the messages necessary for call set-up and management of the circuit switched B-channels.

- **Primary rate access 30B+D**
  30x64kb/s B + 1x 64kb/s D
  Primary Rate access offers 30 circuit switched bearer-channels 64kb/each plus one packed switched data-Channel with 64kb/s

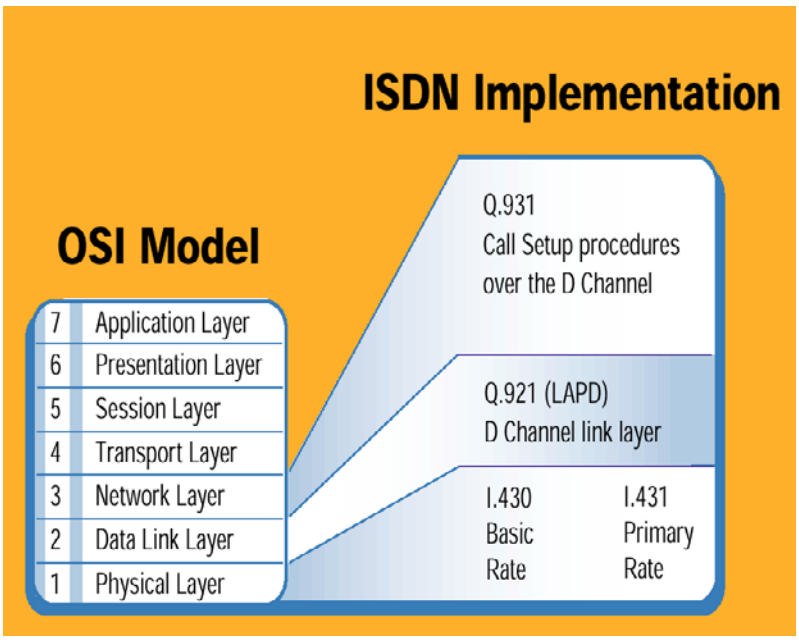
OSI-layers:

ISDN-standards are organized as the OSI-Layer model.

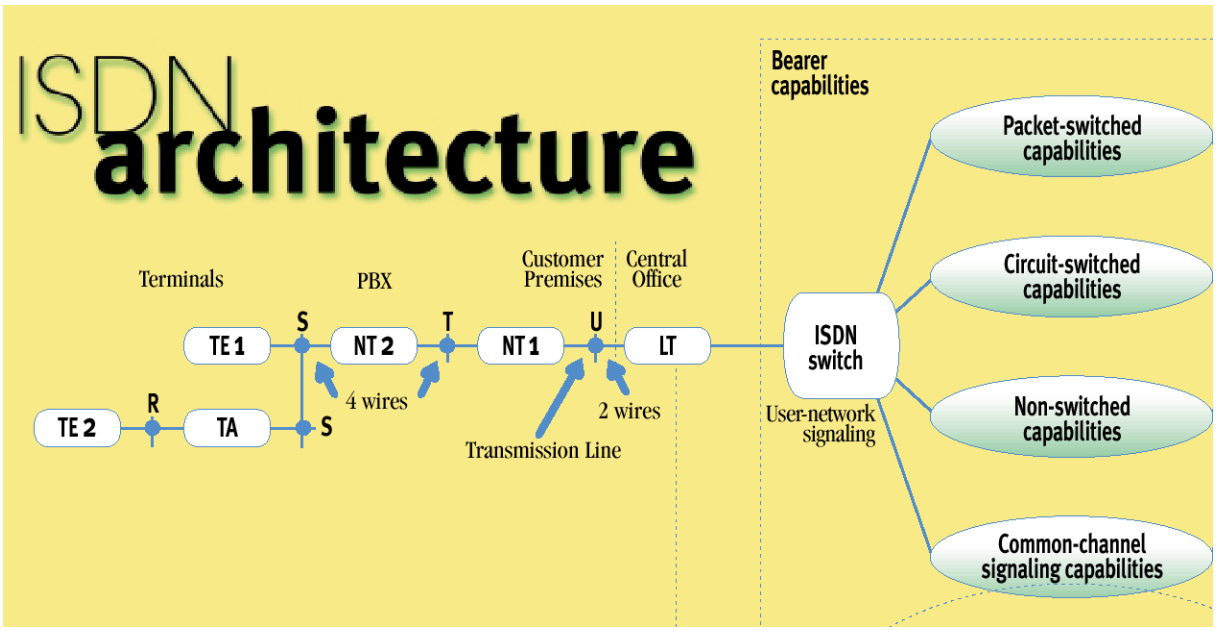
Layer1 (Physical Layer)
defines electrical and mechanical properties of the ISDN-interface like Plug, voltages bit rates and transmission code used

Layer 2 (**Data link layer**)
defines the data packet structure in the D-Channel
A protocol named HDLC is used in Layer 2.

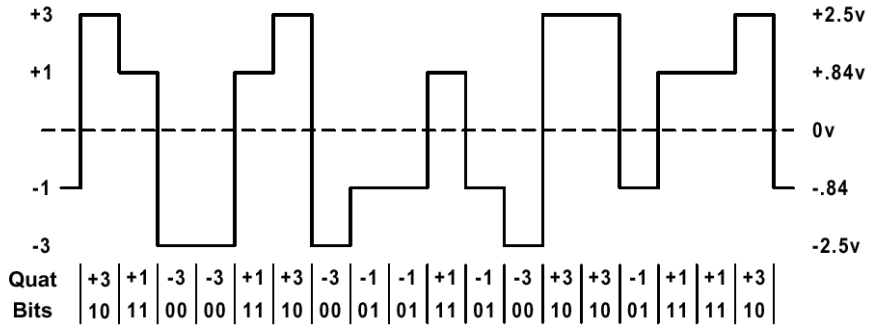
Layer 3 (**Network Layer**)
Layer defines the protocol used for call set up using layer 2 packets sent from the Telephone to the central switch and vice versa.



Physical layer (Layer1)
Basic rate interface:



To transfer a bit rate of 2x64kb/s plus 16kb/s over the telephone line a base-band modem pair named **L**iner **T**erminator and **N**etwork **T**erminator is used. The transmission code 2B1Q needs the frequencies 0 to 80kHz on the telephone line.



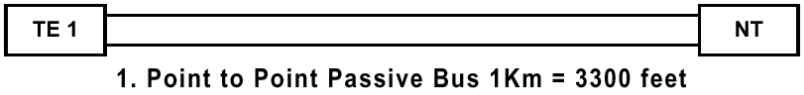
The Network Terminator is provided by the telecom company and offers an interface named S-Interface to connect telephones and other ISDN-devices

S -Interface

The S-Interface is a 4 wire interface using twisted wire pairs for transmit and receive direction.

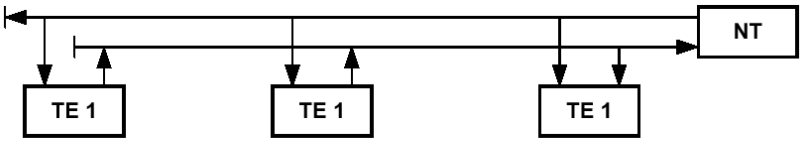
Options of ISDN cabling

a) **Point to point**
One terminal is connected to the NT



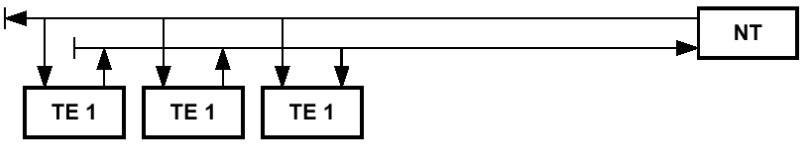
1. Point to Point Passive Bus 1Km = 3300 feet

b) **Short passive bus:**
Up to 8 **T**erminal-**E**quipments are connected to the NT via a bus-wiring. The bus has to be terminated on each end with 100 Ohm and the bus wire length is max. 200 meter



2. Point to Multipoint Short Passive Bus 200m = 667 feet

c) **Extended passive bus:**
Nearly the same as the short passive bus but the network terminator is located in larger distance to the terminal equipments.
In this configuration distance between the Terminal Equipments to each other is limited to 50m

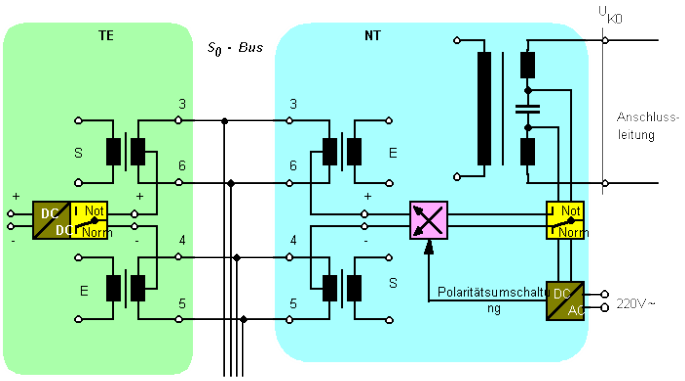


3. Point to Multipoint Extended Passive Bus 1000m = 3300 feet

For b) and c):

- Maximum TE connection cable length: 10m
- Maximum NT connection cable length 3m
- The bus has to be terminated by a resistor of 100 Ω.

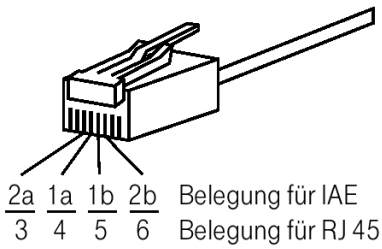
Power supply:
The NT needs a local power supply (230V) and powers all telephones connected to the S-interface.
In case of power a failure it is possible to sustain an emergency service. During emergency service NT is powered by the telephone centre and is able to supply only one telephone.
Polarity of power supply on the S-Interface is reversed to signal emergency situation.



The emergency telephone has to be configured so that it is marked as the one phone powered even in case of power failure.

Plug:

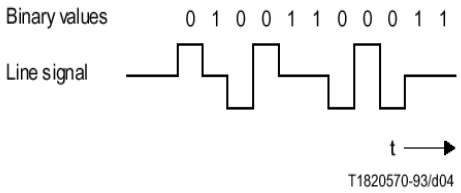
Modular plug RJ45 is used.
The same plug used for Ethernet but with different wire pairs.



Pin	TE	NT
1	NC	NC
2	NC	NC
3	Transmit+	Receive+
4	Receive+	Transmit+
5	Receive-	Transmit-
6	Transmit-	Receive-
7	NC	NC
8	NC	NC

Line Code

Inverse AMI (**A**lternate Mark **I**nversion is used. A Binary**0** is represented by a voltage of +0.75V or – 0.75V altering.
A binary **1** is represented by 0V.
The 0V during a binary 1 is resulting from TEs high impedance state during a 1.



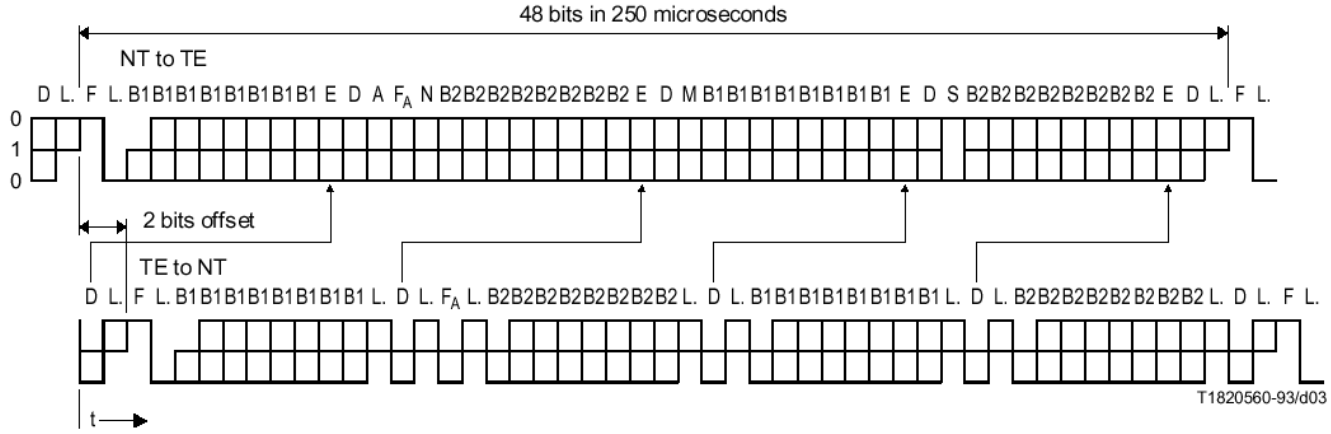
Altering + and – grantees a DC-current free signal.

FIGURE 4/I.430

Pseudo-ternary code – Example of application

Transmission frame

the length of a transmission frame is 250µs
In this time 48 bits are transferred.



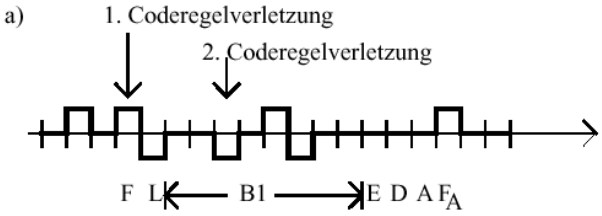
F	Framing bit	N	Bit set to a binary value N = $\overline{F_A}$ (NT to TE)
L	D.c. balancing bit	B1	Bit within B-channel 1
D	D-channel bit	B2	Bit within B-channel 2
E	D-echo-channel bit	A	Bit used for activation
F_A	Auxiliary framing bit (see 6.3)	S	Bit used for S-channel
		M	Multiframing bit

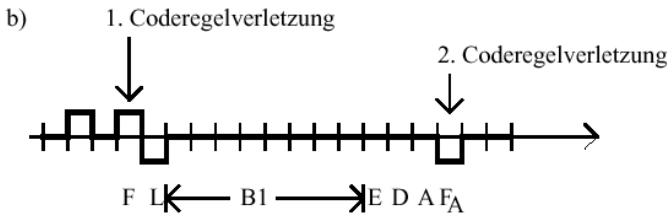
NT is the timing master generating the frames and the terminal equipment synchronize to that frames and send their frames with a delay of 2 bits.

Frame synchronization

Frame synchronization is signalled by AMI-Code rule violations.

F-Bit is used for that purpose and has the same polarity as the pulse before.
To guarantee dc-current freeness a second code rule violation with opposite polarity (L-Bit) is sent after the F-Bit

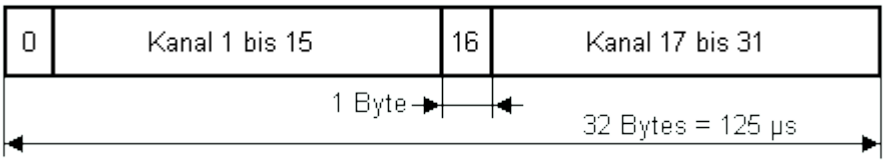




Primary Rate Interface

The primary rate interface provides 30 circuit switched B channels (30*64kBit/s) and one packet switched D-channel (64kBit/s).

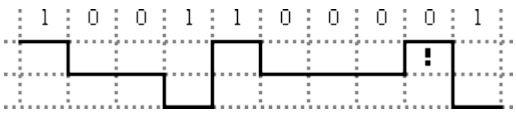
Timeslot 0 is used for frame synchronization.



For Primary Rate interface only a point to point cabling is allowed.

Line code:

HDB3



HDB3 is similar to AMI but with limited numbers of consecutive 0 allowed.
If more than 3 consecutive 0 would occur a artificial 1 is introduced and sent. This artifical 1 is eliminated by the receiver again.

Interface:

There are 2 types of interface in use:

a) Unsymmetrical Interface:
   A coaxial cable with impedance of 75 Ohm

b) Symmetrical Interface:
   Twisted pairs with a characteristic impedance of 120 Ohm.

ISDN-Services

Bearer services

Octet	Hex	8	7	6	5	4	3	2	1	Information element
1		0	0	0	0	0	1	0	0	Bearer capability
2		0	0	0	0					Length of Bearer capability (max. 13 octets)
3		1								
										Coding standard
			0	0						CCITT standardized coding as decribed below
										Information transfer capability
	80				0	0	0	0	0	Speech
	88				0	1	0	0	0	Unrestricted digital information
	89				0	1	0	0	1	Restricted digital information
	90				1	0	0	0	0	3,1 kHz audio
	91				1	0	0	0	1	7 kHz audio
4		0/1								
										Transfer mode
			0	0						Circuit mode
			1	0						Packet mode
										Information transfer rate
	40/C0		1	0	0	0	0	0	0	Packet mode call
	10/90		0	0	1	0	0	0	0	64 kbit/s
	11/91		0	0	1	0	0	0	1	2 x 64 kbit/s
	13/93		0	0	1	0	0	1	1	384 kbit/s
	15/95		0	0	1	0	1	0	1	1536 kbit/s
	17/97		0	0	1	0	1	1	1	1920 kbit/s

Supplementary services

Number Identification Services	MSN	Multiple Subscriber Number
	DDI	Direct Dialing-In
	SUB	SUB-addressing
	CLIP	Calling-Line Identification Presentation
	CLIR	Calling-Line Identification Restriction
	COLP	COnnected-Line identification Presentation
	COLR	COnnected-Line identification Restriction
	MCID	Malicious Call IDentification
Call Offering Services	TP	Terminal Portability
	CFU	Call Forwarding Unconditional
	CFB	Call Forwarding Busy
	CFNR	Call Forwarding No Reply
	CD	Call Deflection
	ECT	Explicit Call Transfer
Call Completion Services	CW	Call Waiting
	HOLD	Call HOLD
	CCBS	Completion of Calls to Busy Subscriber
Multiparty	CONF	CONFerence calling
	3TPY	Three-PartY service
Community of Interest and Call Restriction Services	CUG	Closed User Group
Charging Services	AOC-S	Advice Of Charge at setup time
	AOC-D	Advice Of Charge during the call
	AOC-E	Advice Of Charge at end of call
Additional Transfer Information Services	UUS	User-to-User Signaling (UUS1, UUS2, UUS3)

Exercises:

ISDN Layer1:
Measure the signal on transmit- and receive side of the S-Interface Bus using an oscilloscope during idle state and during an ongoing conversation.

Print out the transmission frame and mark the start and end of the frame.

Answer following questions:

- Level of the power supply voltage on the S-interface-bus
- Duration of a frame?
- Signal voltage?
- Bit length?
- Difference in the frames during idle state and conversation state?