

The ISDN Technology – Characteristics and Objectives

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The idea of Integrated Services Digital Network (ISDN) appeared at the beginning of the 70-ies in Europe. The rapid development of new technologies in telecommunications started off its realization and standardization in Bulgaria too.

1. What is the idea of ISDN?

The idea of ISDN in general is transmission of different types of information: voice (typical for telephone networks), data (typical for computer networks) and image (typical for the TV networks, but the transmission is one-way) using one and the same transmission media. Special attention is paid to the quality and reliability of transmission - the network is built on digital bases, but using the existing telephone network, even when it is still an analogue one. The network provides some entirely new services: calling number identification, automatic waiting on busy line and connecting after it is released, switching to another number, conference mode etc. Different terminal equipment (TE), handling the respective functions, is connected through one and the same slot (mixed communication).

Actually two networks exist in ISDN: one for the transmission of integrated information and a second for links control. The control network is logically separated from the data network and ensures building and disintegration of the line as well as other controlling functions. The channels for integrated data transfer are called B-channels. The control information is transferred over the D-channel. The D-channel controls all the available B-channels in parallel. The method is called Common Channel Signaling and the control itself is called Outslot Signaling.

Two types of ISDN exist: with Basic Access and with Primary Access. The Basic Access network consists of two 64 kbps B-channels and one 16 kbps D-channel, so the total capacity of the network is 144 kbps. The Primary Access network has 30 B-channels and one D-channel, all being with 64 kbps. The total rate is 2 Mbps.

The interface between ISDN user's TE and the network is marked as ISPBX - ISDN Private Branch Exchange.

The broadband ISDN (B-ISDN) is comparatively new and is used mostly for image transfer (for example video conferences or LANs interconnection). The B-ISDN provides data rate exchange of hundreds of Mbps.

ISDN follows the OSI structure of ISO. It provides transport services between two TEs. The B- and D-channels work in parallel and are accessible through a common point TSAP (Transport Service Access Point). The separation of the two types of channels is transparent for the user; they have their own protocols for levels 2 and 3. Each independently attached unit receives its own TSAP to access the transport level. Each participant in ISDN has only one NSAP point (Network Service Access Point) for the network level access.

The standardized digital communication has to meet the following basic requirements:

- voice, data, video and text to be transmitted on the same line;
- only one connector plug is needed;
- decrease of costs on transmitting non-voice messages;
- connection of private installations as branches;
- decrease of time, needed for call setup.

The telecommunication companies in different countries are aiming at uniting the already existing separate networks and the future ones in a single network so to decrease the costs and increase the efficiency of links.

ISDN draws the interest towards itself of both public and private exchanges (PABX). It is transmission media independent, enables both new and old TE to be used and integrates all current and future network services.

2. ISDN Standardization

The question of standardization is of particular importance. With the implementation of ISDN a new generation of TE is created, which to satisfy the requirements for integrated services networking and to perform different functions in public and private networks. On the other hand the attachment of standardized and specific units to the ISDN network has to be possible.

CCITT has already accepted to a certain extent the standards for levels 1 and 2 of the OSI model of ISDN. ETSI (European Telecommunication Standards Institute) and ECMA (European Computer Manufacturers Association) are working on standardization of level 3 on European scale (EURO-ISDN). A borderline step in the introduction of the EURO-ISDN has been made by several European countries by introducing their own variants of the D-channel protocol on level 3, such as the protocols of the German Post 1TR6 and the French protocols VN2/VN3.

CCITT gives the following recommendations for ISDN:

- I.100 - general recommendations,
- I.200 - definition of services,
- I.300 - network aspects,
- I.400 - physical aspects and transmission protocols,
- I.500 - interfaces within the network,
- I.600 - principles for network maintenance.

The physical level of the network is formed according to recommendations I.430 and I.431 for ISDN with Basic and Primary Access respectively. On the D-channel protocol Q.921 is used for level 2 (LAPD) and Q.931 - for level 3. On channel B the HDLC X.75

symmetrical protocol is used for level 2 (LAPB) and ISO 8280 (X.25) – for level 3. Level 4 is brought out as X.224 interface.

Different functional groups have been defined in the CCITT model, each of them covering similar users' functions of ISDN. The NT1 (Network Termination) functional group realizes the connection on the side of the public network. NT2 ensures different TE for ISDN to make use of the cable. For example a private telecommunication installation is a complex and powerful functional group NT2.

Sample point S is the boundary between NT2 and TE1 or TA (Terminal Adapter), i.e. the interface of the user towards ISDN. The S-point in Primary Access ISDN is usually used to connect to mainframe. The S interface performs levels 1 and 2 in the OSI model and satisfies the increasing number of standards on level 3.

Sample point T separates NT2 from NT1. When TE is directly attached to the public network in point NT1, point S coexists with T. S and T are to a great extent internationally standardized.

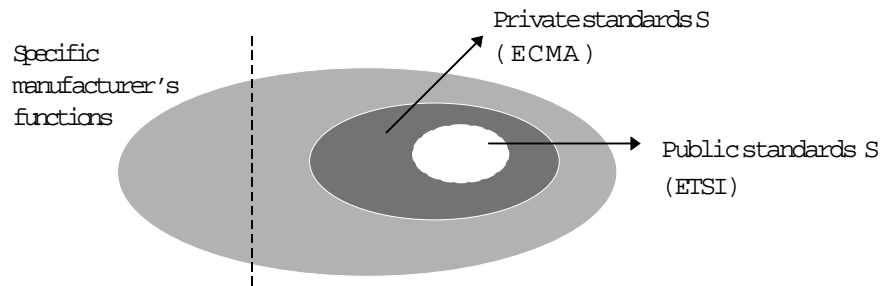


Fig. 1

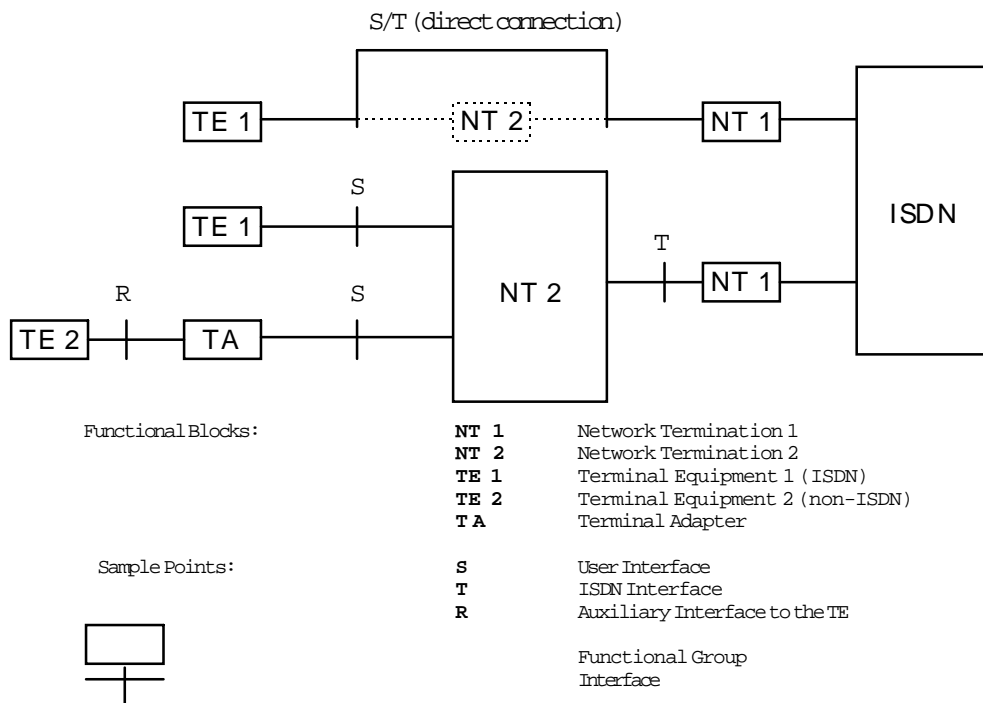


Fig. 2

One of the major objectives of people, working on the problems of standardization is the compatibility of TE, i.e. TE from different manufacturers to be used both in public and private networks. ETSI is the responsible in Europe for the standardization of public ISDN, hence for T and S/T interfaces. ECMA takes part in standardizing private networks and defines the S and Q interfaces (links between ISDN installations).

The manufacturers of telecommunication installations offer some specific services to their customers, which are mostly interesting for the PABX' s users but not for the public network. Those specific private services are standardized by ECMA. The result is that the standard for the S interface within the boundaries of ECMA covers much larger number of functions, but it has to remain compatible with the S/T interface of the public network.

Two types of protocols for TE (level 3) are defined in the CCITT recommendations for additional services control: pulse and functional. The pulse protocol does not require the TE to know anything about the call and the handling of the additional service; the "intelligence" is in the network itself. The communication between the TE and the network is with impulses, interpreted and handled by the network. The pulse protocols make possible the early introduction of additional ISDN-services.

The specific services, requiring "intelligent" interworking between the TE and the network cannot be realized by pulse protocols. The functional protocol, used in that case, requires that the TE receives information about the called additional service, as it does part of the handling. The communication between the TE and the network is by functional messages. In that case the TE is more intelligent and takes over most of the line management.

3. What are the opportunities ISDN proposes?

There is a great variety of services in ISDN such as: calling party identification, calls selection, call redirection, holding back of line, service identification, flexible bandwidth on demand, use of D-channel backup, etc. Automatic identification of the TE participating in the communication is done, so that the information is received by the appropriate unit. ISDN is also used in telemarketing, alarm signaling, disaster recovery. Faster call setup is possible in ISDN because of out-of-band signaling.

Here are some more special services ISDN offers.

3.1. Calling Party Identification

On messaging, the incoming calling party number is identified and is made available to the receiving party as a part of the incoming request. This number can be used for applications such as automatic customer record retrieval, customized call handling, call distribution to specialized participants (agents), customer call-back, dial-up systems security. ISDN calling party identification is delivered with additional per call information. It includes dialed number identification and service identification. This gives customers much more information before accepting the call.

3.2. Call Redirection

Selected calls can be distributed by ISDN customers to alternate locations using the "dialed number identification" or the "calling party number identification" services. When a call is delivered to a customer premises where it cannot be promptly handled, ISDN customer equipment can release the unanswered call and return it to the network by issuing a standard ISDN busy line indication. This will cause the network to redirect the call to a predetermined by the customer overflow location. The call setup time for the calling party is not perceptibly increased since the network invokes immediately and automatically the

alternate destination call redirection (ADCR) service. Calls are completed regardless of whether either location is an ISDN one.

The ADCR service can be used as a call distributor on network base to help customers balance the load or distribute the incoming calls based on real-time events. It also helps more incoming calls to be completed in case of network access facilities or premises malfunctions. Any call completion problems related to traffic surges, long abnormal call holding times, local agent disruptions etc. are treated by ADCR.

3.3. Calls Selection

ISDN customer can dedicate selected B-channels for a specific service when working in real-time, or share it on demand among several services. Channels are allocated to incoming and outgoing call requests on a FIFO basis. Overflow and peak traffic resources can be shared among combined services, eliminating the need for special dedicated overflow circuits. These circuits are used to handle bursts of traffic for each service and are idle the rest of the time. Customers of ISDN can control access to network services, for example, handling traffic peaks for a high priority service by limiting the use of a lower priority one. The benefit is savings for the customer because fewer facilities are required.

3.4. Flexible Bandwidth on Demand

The service is proposed in ISDN Primary Rate Interface. On customer's demand B-channels can be bundled into groups of 1, 6 or 24 channels. Bandwidth of 64 Kbps, 384 Kbps or 1536 Kbps is offered respectively. The request for bundling is made during the call setup. Customers no longer need to maintain dedicated broadband or data facilities, hence costs are cut. Broadband channel bundling to 384 Kbps or 1536 Kbps on demand is particularly convenient for high-quality color video teleconferencing, computer graphics, CAD, image and data transfers.

3.5. D-Channel Backup

The D-channel backup service improves access reliability for ISDN customers. The arrangement is with two D-channels: an active and a spare one. If the prime D-channel fails, the backup one takes over immediately. All stable calls are maintained and normal call handling is resumed.

3.6. User-to-User Information Forwarding

User-defined, per call information is passed through the network between originating and terminating call parties. Both parties have to terminate on ISDN Primary Rate Interface equipment. This user-defined information is associated with the standard call control messages and is delivered at the beginning of the call with the call request. Thanks to it an ISDN terminal can display the calling party name or a brief message when the phone rings.

Typical example of ISDN services' use are emergency response and disaster recovery centers organized in the USA and some European countries. Emergency response centers are computerized alarm monitoring organizations, using ISDN calling party and dialed number identification services to locate and respond to different emergencies such as break-ins, fire, heat and water crises etc. The calling party number of the customer indicates the location of the emergency. When a call is received at the emergency response center, a database immediately retrieves the customer's file based on the calling party identification. This file shows the agent the whole necessary information - the customer's name and address, a list of people to contact, how to handle the alarm etc. Automated ISDN calling party number identification has considerably increased the accuracy of the service as it eliminates human error as the major factor in false alarms.

Using ISDN services customers have gained accuracy of information, efficiency by shortening call holding time and faster call set-up, improved operation performance, reliability, and reduced costs. The ACD feature improves call completion and telecommunications reliability. Customer's revenues are increased by redirecting and completing calls formerly blocked by traffic surges, inefficiently engineered customer access facilities, or service disruptions. The broadband capabilities and user-to-user information transfer service of ISDN give customer the opportunity to create new services and markets.

4. INTERNET and ISDN

The basic difference between Internet and ISDN is that the former uses the packet switching principle of work while the latter – the channel switching one. The co-existence of the two networks requires more computer resources but offers some advantages too:

The server can service more customers than the number of the available B-channels, because customers share transmission lines. This increases the efficiency of the network.

Customers of the public ISDN pay just for the time of real transmission.

The TCP/IP protocols, perceived as "in fact" industrial standard in computer communications, offer services that can be used with ISDN too (for example, file transfer, terminal emulation, network resources management). The Internet protocol transmits data packets between the end-users as datagrams being the optimal way of communication for LANs while ISDN uses channel switching through public or private exchanges. This means that their services cannot be directly used by the IP. Network access shells have been created. Data transfer between the mainframe and the network is realized through the shell. The protocol, used in the shell, will depend on the respective network the mainframe is attached to.

IP expects a datagram service from the network. This interface doesn't have any primitives for the link control, so a driver undertakes totally the functions.

When no traffic is on the line, disruption of communication may occur on network level, but sessions on upper levels still exist and are not functionally affected.

The creation of shell for ISDN access under MS-DOS and UNIX control provides PC users, having so interface, with access to UNIX-servers. No difference is made whether the computer is attached directly to the ISDN or through a private exchange. The MS-DOS computers may work only as clients, while the UNIX ones can be servers at the same time.

The UNIX server can be a router in the Internet too. No network file system is needed for that; the Internet shell is enough. This way all TCP/IP applications are accessible for both MS-DOS and UNIX PCs. In addition, computers that are not attached directly to ISDN can communicate over it in case they are attached through Ethernet to an ISDN-Ethernet-IP router.

5. ISDN Communications Optimization

One of the fastest growing areas in data communications is ISDN routing. The field has now attracted all the leading internetworking companies, because efficient routing of LAN protocols over dial-up ISDN circuits gives their users an opportunity to derive the full potential cost savings that can be gained by using ISDN.

One of the main problems here is the fact that LAN protocols, particularly Novell IPX/SPX, were not designed for operation over dial-up circuits where it is important to keep call time to a minimum. They were designed for LANs where bandwidth is effectively free once the network has been installed. As a result they have no restrictions in their use of

polling to exchange management information. Much of this polling can be eliminated by the so called spoofing technique. It involves the reduction or elimination of polling transmissions over wide area links and the local emulation of the responses that devices at each end of the links expect to receive. The latter is necessary to keep sessions alive by giving devices the impression that the remote end of the link is communicating with them directly. Spoofing also involves maintaining of dialogue between remote devices which is necessary for the network to perform its function efficiently. As ISDN is often sold as a cheaper alternative to permanent leased circuits for linking remote offices into core backbone networks spoofing becomes very important as part of the broader subject of bandwidth management; a spectrum of techniques for making use of WAN links most cost effectively. This concerns especially dial-up services (ISDN in particular) where you pay for what you use. Besides spoofing, bandwidth management includes also data compression, techniques for minimization of bandwidth or time in long distance links transmissions, etc.

Spoofing is normally handled by routers on each LAN. The problem with IPX spoofing is that there are several types of IPX data packets that need spoofing, and only some of them are covered by the majority of routers.

The routing information protocol (RIP) and the service advertising protocol (SAP) packets are most often spoofed ones. RIP packets specify paths between LANs and help routers to keep their tables up to date, while SAP packets advertise the availability of servers, printers and other resources on a NetWare LAN. Other IPX packets that need to be spoofed are the serialization packets - Novell license numbers broadcasted by the NetWare servers against pirated copies, watchdog packets - checking for illegal usage of NetWare, SPX packets - an extension of IPX protocol, guaranteeing delivery of data.

Apart from IPX there are some less common protocols needing spoofing, such as Banyan Vines IP, Microsoft's WFW over TCP/IP, etc.

The need for spoofing does not concern just the network layer protocols (such as IPX), but can be required at any level at which messages are generated. Besides it can be applied at more than one level at a time, reducing or eliminating low level network polls and higher level communication between applications. The objective is spoofing to profitably prevent unnecessarily raised ISDN calls.

In order to keep ISDN call time to a minimum some other techniques are needed as well. The problem is that it is impossible to eliminate all transmission of data, not directly linked to an user's application because some management information has to be transmitted for the proper work of the network. However this can have a small impact on the network by compressing and sending it at the right time.

The information which is absolutely needed to be transmitted is the routing tables updates, as they age and eventually totally disappear. Over ISDN, the number of these updates should be kept to a minimum, meanwhile ensuring routers tables to be up to date. Besides these updates, the SNMP management systems also generate polls that should be minimized too.

There are three methods, used for transmitting the routing table updates and SNMP polls:

- timed updates - the longest used method, but it does not work well for ISDN. Updates are transmitted at preset intervals, consuming alone 20% on average of the total bandwidth, which is rather unacceptable;

- triggered updates - a better method, as updates are triggered only in case of some significant changes that have to be reported. The method is not applicable on large networks, because there are too many changes to be reported;

- piggyback updates - the optimum solution for ISDN networks. Polls and updates are only transmitted when an ISDN call for user data sending has already been raised. Exception is when either a link or a router failure isolates an ISDN router and the aim is

to bring it back into the network in case an alternative path exists.

What is the future application of ISDN?

ISDN plays an integral role in the development of intelligent networking and premises applications. Call redirection, network call queuing, and announcements require intelligent premises interaction. ISDN shares intelligence between the networks and premises in order to provide flexible and custom-oriented services. The introduction of new modern technologies - ATM, Frame relay etc. - in ISDN is a tendency in its future development.

In Bulgaria the Bulgarian Telecommunication Company has started the introduction of ISDN services in some public exchanges. Some state institutions and business customers will be the first attached to the network.

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Технология ISDN – характеристики и цели

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(Резюме)

Рассматриваются основные характеристики технологии ISDN – цифровой сети интегрированных услуг. Основное преимущество сети – передача разных типов информации: голоса, данных и изображений по одной и той же коммутируемой линии. Сеть обеспечивает некоторые совершенно новые услуги: идентификация вызывающего номера, автоматическое поджидание занятой линии, переключение на другой номер, перепратка и подборка вызовов, гибкость частотной ленты по заказу, режим конференции и др.

В связи с вопросом стандартизации цифровых коммуникаций даются определения функциональных групп NT1, NT2, интерфейсов S и T и их функций в соответствии с уровнями модели OSI. Особое внимание уделяется связи ISDN с Internet. Разница в принципе работы обеих сетей – переключение каналов и переключение пакетов – требует дополнительного компьютерного ресурса. Однако их совмещение даёт потребителям существенные преимущества.

Маршрутизация в ISDN является особо важной для оптимизации коммуникации в сети. Суть её в уменьшении или элиминировании полинга (запросов) в сети при помощи локальной эмуляции ожидаемых ответов (слуфинг).

Тенденция в развитии ISDN – использование новейших технологий: ATM, Frame relay и др.