The University of Sydney

AUSTRALIA

School of Electrical and Information Engineering

Advanced Communication Networks

Chapter 2

An Overview of Integrated Service Digital Networks (ISDN)

Based on chapter 5 of Stallings ISDN-4e book

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2.1 Integrated Digital Network (IDN)

- Public telephone and telecommunications networks are rapidly evolving to the exclusive use of digital technology.
  - Competitive desire to lower costs
  - Improve the quality of voice transmission and networking services
- The evolution to the existing telecommunications networks and specialized carrier facilities to integrated digital networks is based on two technological developments:
  - Digital switching
  - Digital transmission
- Both technologies are well established. But IDN provided a revolutionary idea of integrating the functions of these two.
- As the use of distributed processing and data communications has grown, the evolution of an all-digital network has been pulled by the need to provide a framework for ISDN.

Switching

The circuit-switching nodes of the network make use of digital time-division switching techniques rather than analog space-division switching techniques.

Trunk (Carrier) Transmission

Digital transmission technology is used on the multiplexed trunks between switches, although either analog or digital signaling may be used. Each trunk carries multiple voice and/or data channels using synchronous time-division multiplexing.

Subscriber Loop

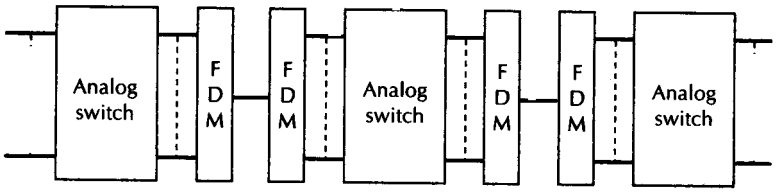
Digital transmission technology may also be used between the subscriber and the switch to which the subscriber attaches over the "subscriber loop." This implies that digitized voice is employed and that full-duplex digital transmission over the subscriber loop is used.

Control Signaling

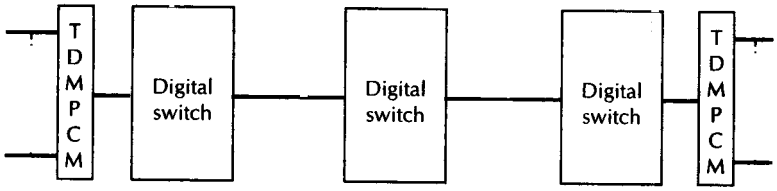
Common-channel signaling over a packet-switched network embedded into the public telecommunications network is used. Packets contain messages used for routing, monitoring, and control.

Use of digital technology in public telecommunications networks

Implication of IDN



(a) Nonintegrated

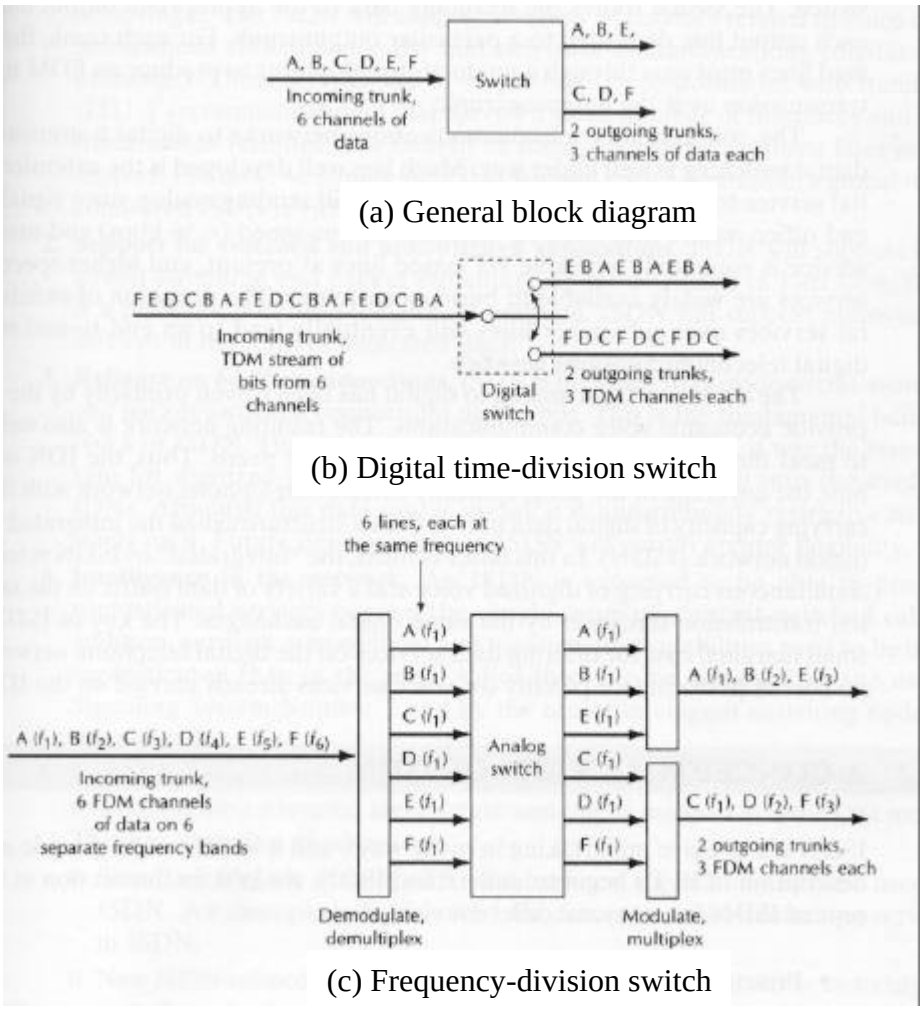


(b) Integrated

Integration of transmission and switching

- **Traditional telephone networks (a)**
  - Separately designed and administrated transmission and switching systems.
  - Demultiplexing and demodulating are necessary at each switching center.
  - A repeated process results in an accommodation of noise as well as cost.
- **Integration of transmission and switching systems (b)**
  - Achievable when both systems are digital.
  - Using PCM modulation and TDM multiplexing.
  - Switching without decoding along the way.
  - Separate multiplex/demultiplex channel banks are not required.

IDN Architecture (An Example)



Example of digital versus analog switching

- **The architecture for the equivalent analog system (c) is considerably more complex than digital system (b).**
  - Channels are fed into a space-division analog switch which is only capable of switching signals from a collection of input lines to a collection of output lines.
- IDN combines the coverage of the geographically extensive telephone network with the data carrying capacity of digital data networks in Integrated Services Digital Network (ISDN).
  - Simultaneous transmission of digitized voice and data on the same digital transmission link and by the same digital exchanges.

2.2 A Conceptual View of ISDN

Looking at the concepts of ISDN from the following viewpoints:

- **Principles of ISDN**
- **Evolution of the ISDN**
- **The User Interface**
- **Benefits**
- **Services**
- **Architecture**

• Principles of ISDN

- Support of voice and non-voice applications using a limited set of standardized facilities
  - defines the purpose of ISDN and the means of achieving it
- Support for switched and non-switched applications
  - both circuit-switched and packet-switched connections
  - also supports non-switched services in the form of dedicated lines
- Reliance on 64-kbps connections
  - fundamental block of ISDN
  - chosen because it was the standard rate for digitized voice
- Intelligence in the network
  - sophisticated services beyond simple setup a circuit-switched call
  - sophisticated network management and maintenance capabilities
  - use of SS7 and intelligent switching nodes in the network
- Layered protocol architecture
  - user access to ISDN protocol is a layered architecture that can be mapped to OSI model
    - Already developed standards for OSI may be used for ISDN (e.g. X.25)
    - New ISDN standard can be based on existing ones (LAPD based on LAPB)
    - Standards can be developed independently for various layers and functions
- Variety of configurations
  - More than one physical configuration is possible for implementing ISDN

ISDN evolved from IDN but
"I" in IDN → **I**ntegration of digital transmission and switching facilities, whereas
"I" in ISDN → **I**ntegration of voice and data transmission services.

- **Evolution of ISDN**
  - Evolution from telephone IDNs
    - IDN developed for and evolving within existing telephone network.
    - The telephone networks have the dominant role in ISDN (not PSN, sat.).
  - Transition of one or more decades
    - The introduction of ISDN services will be done in the context of existing digital facilities and existing services (protocol conversion, etc.).
  - Use of existing networks
    - Now the interface to packet-switched services is X.25. With the introduction of fast PS and VC control, new interface will be needed.
  - Interim user-network arrangements
    - The lack of digital subscriber loops might delay digital services.
    - With the use of modem, etc. existing analog facilities support ISDN serv.
  - Connection at other than 64 kbps
    - The basic channel for circuit switching
    - The rate is unnecessarily high with new voice digitizing technologies
    - The rate is too low for many digital data applications

ITU-T Recommendation I.120 (1993)

I.120

1 Principles of ISDN

1.1 The main feature of the ISDN concept is the support of a wide range of voice and non-voice applications in the same network. A key element of service integration for an ISDN is the provision of a range of services using a limited set of connection types and multipurpose user-network interface arrangements.

1.2 ISDNs support a variety of applications including both switched and non-switched connections. Switched connections in an ISDN include both circuit-switched and packet-switched connections and their concatenations.

1.3 As far as practicable, new services introduced into an ISDN should be arranged to be compatible with 64 kbit/s switched digital connections.

1.4 An ISDN will contain intelligence for the purpose of providing service features, maintenance and network management functions. This intelligence may not be sufficient for some new services and may have to be supplemented by either additional intelligence within the network, or possibly compatible intelligence in the user terminals.

1.5 A layered protocol structure should be used for the specification of the access to an ISDN. Access from a user to ISDN resources may vary depending upon the service required and upon the status of implementation of national ISDNs.

1.6 It is recognized that ISDNs may be implemented in a variety of configurations according to specific national situations.

2 Evolution of ISDNs

2.1 ISDNs will be based on the concepts for telephone IDNs and may evolve by progressively incorporating additional functions and network features, including those of any other dedicated networks such as circuit-switching and packet-switching for data so as to provide for existing and new services.

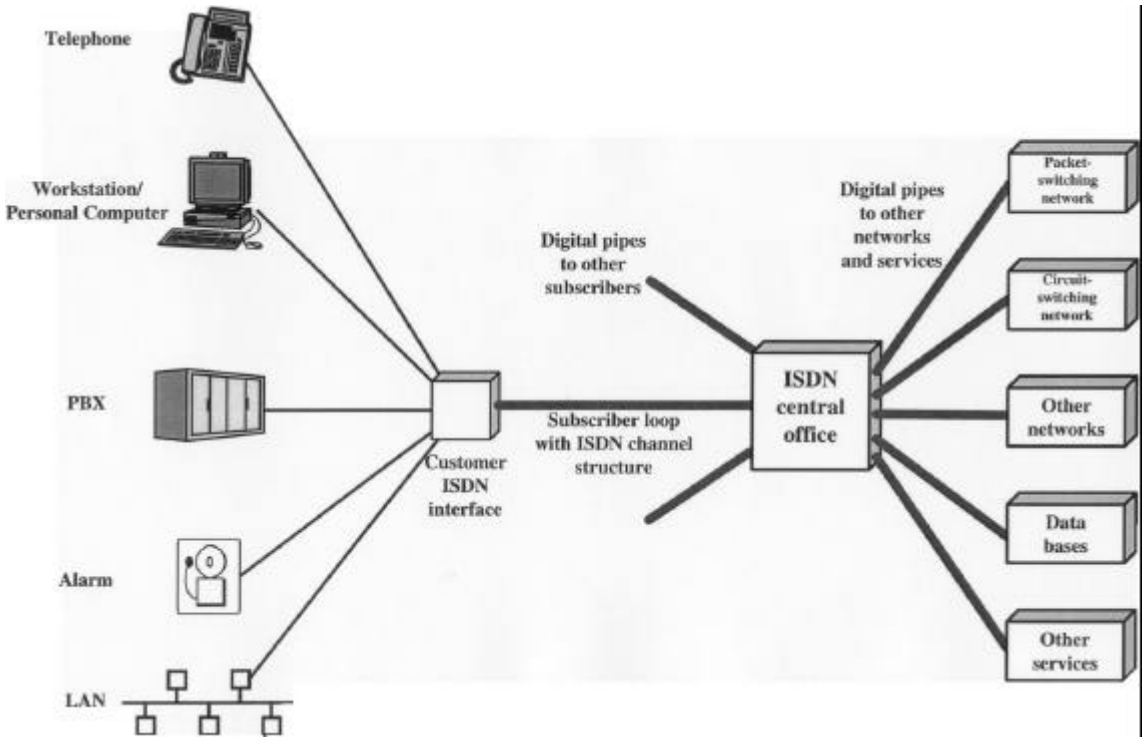
2.2 The transition from an existing network to a comprehensive ISDN may require a period of time extending over one or more decades. During this period arrangements must be developed for the networking of services on ISDNs and services on other networks.

2.3 In the evolution towards an ISDN, digital end-to-end connectivity will be obtained via plant and equipment used in existing networks, such as digital transmission; time-division multiplex switching and/or space-division multiplex switching. Existing relevant recommendations for these constituent elements of an ISDN are contained in the appropriate series of recommendations of CCITT and of CCIR.

2.4 In the early stages of the evolution of ISDNs, some interim user-network arrangements may need to be adopted in certain countries to facilitate early penetration of digital service capabilities. Arrangements corresponding to national variants may comply partly or wholly with I-Series Recommendations. However, the intention is that they not be specifically included in the I-Series.

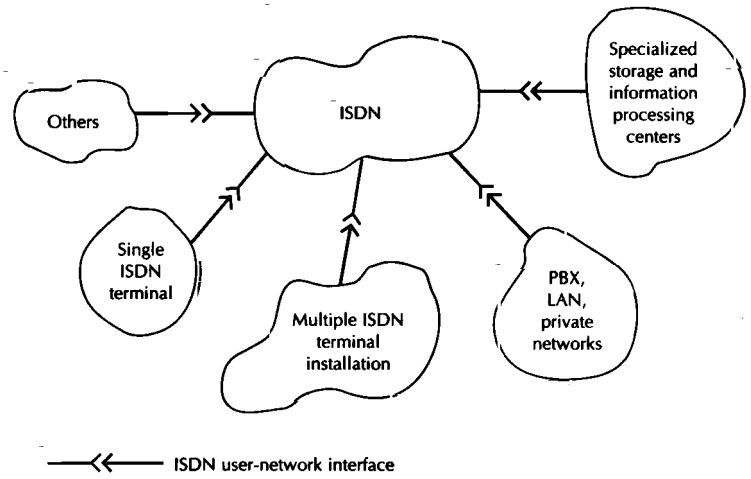
2.5 An evolving ISDN may also include at later stages switched connections at bit rates higher and lower than 64 kbit/s.

The User Interface



Conceptual view of ISDN connection features

- User has access to ISDN via a local interface to a digital “pipe”.
- Pipes of various sizes are available to satisfy different needs.
- Pipe to the user’s promises has a fixed capacity but the traffic on the pipe may be a variable mix up to the capacity limit.
- ISDN requires control signals to instruct how to sort out the time-multiplexed data and provide the required services.
- Control signals are multiplexed onto the same digital pipe.
- A user may employ less than the maximum capacity of the pipe and will be charged according to the capacity used.



ISDN user-network interface examples

- Recommendation I.410: more than one size of pipe is needed.
  - A single terminal (e.g., a residential telephone)
  - Multiple terminals (e.g., a res. tel., PC, and alarm system)
  - A network of devices attached to a LAN or PBX (ISDN gateway)

- **Objectives**

The objectives of the activities for developing a worldwide ISDN are

  - Standardization
  - Transparency
  - Separation of competitive functions
  - Leased and switched services
  - Cost-related tariffs
  - Smooth migration
  - Multiplexed support

Objectives

- **Standardization**
  - to provide universal access to the network
  - movable ISDN-standard equipment and use of layered protocol
  - to allow users to select equipment from multiple suppliers
- **Transparency**
  - digital transmission service is independent of the contents of data
  - users can develop new applications and protocols
  - user-provided encryption methods can be employed simply
- **Separation of competitive functions**
  - ISDN does not preclude competitive functions from basic ones
  - some countries desire certain enhanced services be offered competitively (e.g., videotex, electronic mail)
- **Leased and switched services**
  - ISDN should provide both leased and switched services
  - to allow users to optimize on the basis of cost and performance
- **Cost-related tariff**
  - one type of service does not subsidize others
  - price distinctions related to the cost of providing specific performance and functional characteristics of a service
- **Smooth migration**
  - ISDN evolution must coexist with existing equipment and services
  - specific capabilities required: pre-ISDN terminals to interface to ISDN, inter-network protocols, and protocol converters
- **Multiplexed support**
  - accommodating user-owned PBX and LAN equipment

ISDN Benefits and Services

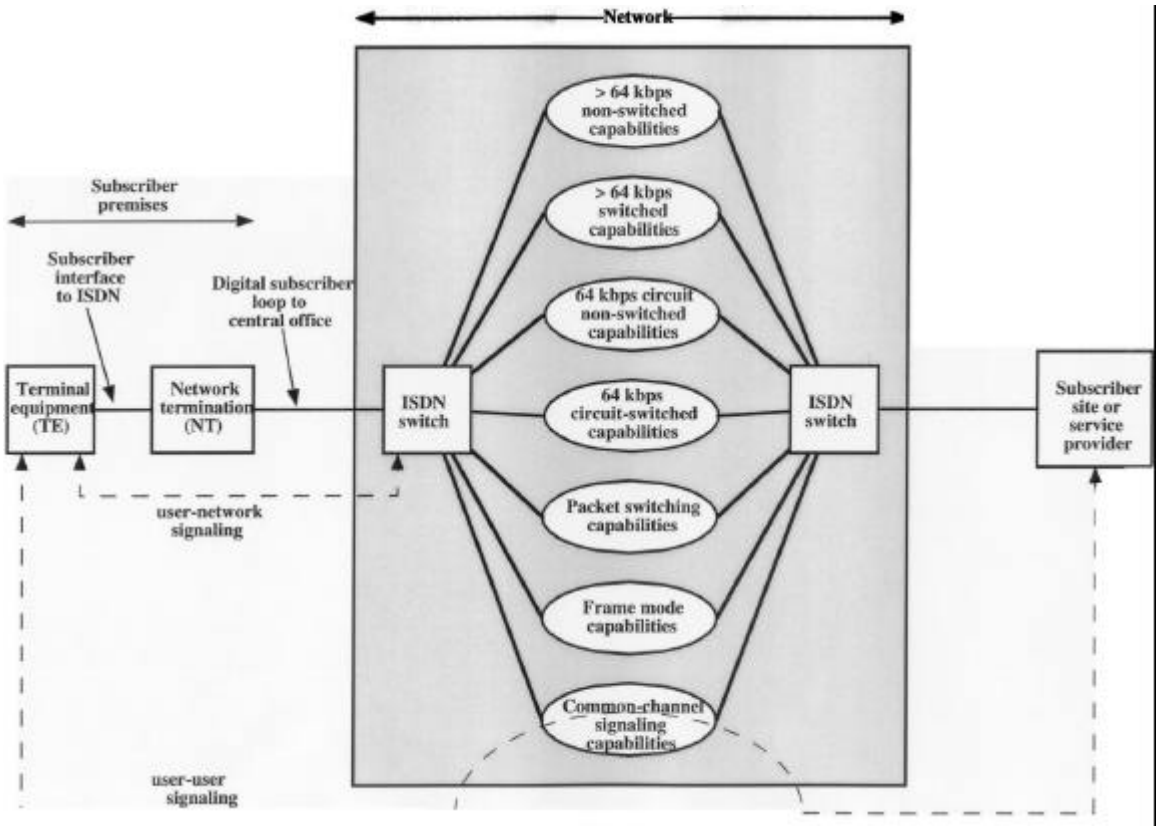
Benefits

- The principle benefits of ISDN to the customers can be expressed in terms of cost saving and flexibility.
- Integrated voice and data means that the user does not have to buy multiple services to meet multiple needs.
  - Access charges to a single access line only
  - purchasing services based on actual needs
  - product diversity, low price, and wide availability of equipment
  - slow changes in ISDN recommendations; low risk for users

Services

- A variety of voice and data applications are available:
  - *Facsimile*: fast digital facsimile standards
  - *Teletex*: fast exchange of correspondences between terminals
  - *Videotex*: an interactive information retrieval service
- Most of these services can be provided with a transmission rate of 64 kbps or less. For higher rates B-ISDN will be used.
- ISDN is an intelligent network.
  - By use of a flexible signaling protocol, ISDN provides a variety of network facilities for each service.

ISDN Architecture



ISDN architecture

- ISDN supports a new physical connector for users, a digital subscriber line, and a variety of transmission services.
- Physical interface provides a standardized means of attaching to the network.
- The interface supports a *basic* service consisting of three time-multiplexed channels, two at 64 kbps and one at 16 kbps.
- In addition, there is a *primary* service that provides multiple 64-kbps channels.
- For both basic and primary service, an interface is defined between the customer's equipment (TE) and a device on the customer's premises, known as a network termination (NT).

- The subscriber line is the physical path from the subscriber's NT to the ISDN central office.
- ISDN central office connects subscriber lines to the digital network, providing access to lower-layer transmission facilities:
  - Circuit-switched capabilities
    - same facility provided by other digital-switched telecom. net's (64 kbps)
  - Non-switched capabilities
    - a 64 kbps dedicated link, higher rates in B-ISDN using PVC in ATM tx
  - Switched capabilities
    - high speed (>64 kbps) switched connections using ATM in B-ISDN
  - Packet-switched capabilities
    - resembles packet-switched service provided by other data networks
  - Frame-mode capabilities
    - a service that supports frame relay
  - Common-channel signaling capabilities
    - used to control the network and provide call management

2.3 ISDN Standards

- The controlling body for standardizing ISDN was ITU-T.
- The first ISDN standard, G.705, emerged in 1980.
- The first set of ISDN specifications, called I-series, was published in 1984.(start of developing ISDN-related equips.)

Definition of ISDN (1984, 1988):

An ISDN is a network, in general evolving from a telephony IDN, that provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services, to which users have access by a limited set of standard multi-purpose user-network interfaces.

CCITT Recommendation G.705 (1980)

INTEGRATED SERVICE DIGITAL NETWORKS (ISDN)

The CCITT

considering

(a) the measure of agreement that has so far been reached in the studies of Integrated Digital Networks (IDNs) dedicated to specific services such as telephonv, data and also of an Integrated Services Digital Network (ISDN),

(b) the need for a common basis for the future studies necessary for the evolution towards an ISDN,

recommends

that the ISDN should be based on the following conceptual principles:

(1) The ISDN will be based on and evolve from the telephony IDN by progressively incorporating additional functions and network features including those of any other dedicated networks so as to provide for existing and new services.

(2) New services introduced into the ISDN should be arranged to be compatible with 64-kbit/s switched digital connections.

(3) The transition from the existing networks to a comprehensive ISDN may require a period of time extending over one or two decades.

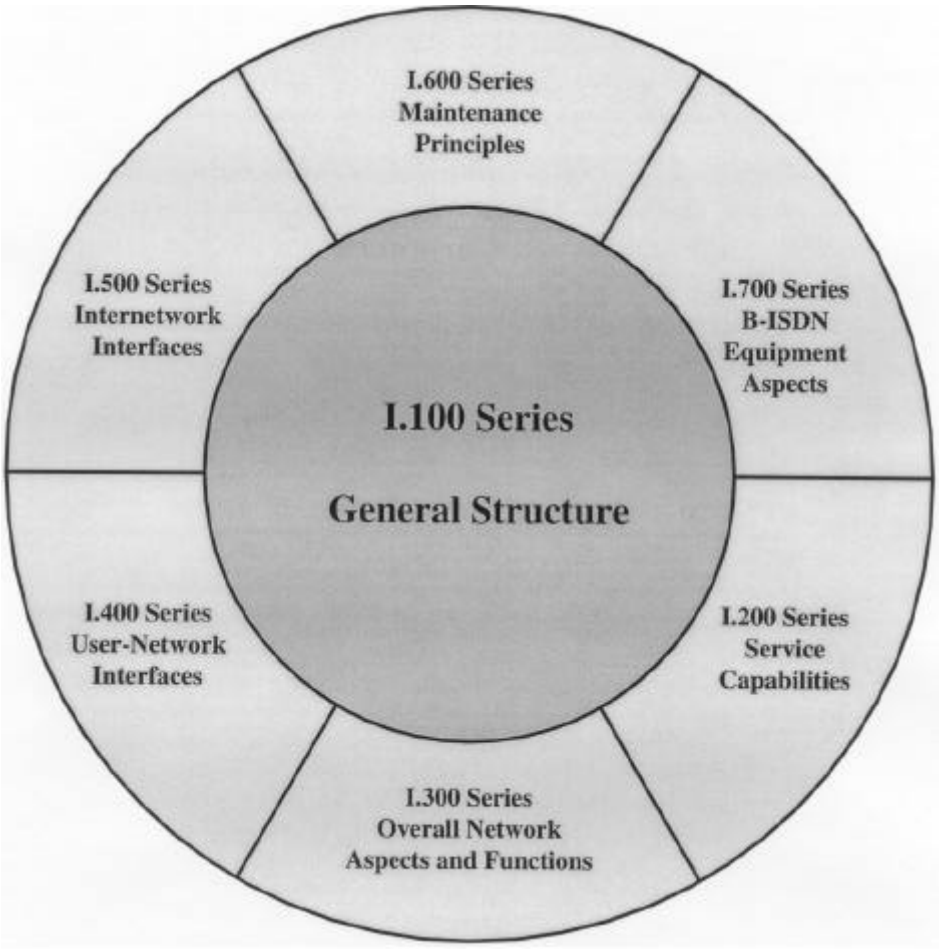
(4) During the transition period arrangements must be developed for the interworking of services on ISDNs and services on other networks.

(5) The ISDN will contain intelligence for the purposes of providing services features, maintenance and network management functions. This intelligence may not be sufficient for some new services and may have to be supplemented by either additional intelligence within the network, or possibly compatible intelligence in the customer terminals.

(6) A layered functional set of protocols appear desirable for the various access arrangements to the ISDN. Access from the customer to ISDN resources may vary depending upon the service required and on the status of evolution of national ISDNs.

Note–Existing relevant Recommendations for some of the constituent elements of the ISDN are contained in Series G, O, Q, and X Recommendations and also in relevant volumes of the CCIR.

The I-Series Recommendations



Structure of the I-series recommendations

Characterization of ISDN is centered on three main areas:

(1) The standardization of services offered to users, so as to enable services to be internationally compatible

(2) The standardization of user-network interfaces, so as to enable terminal equipment to be portable, and to assist in (1)

(3) The standardization of ISDN capabilities to the degree necessary to allow user-network and network-network inter-networking, and thus to achieve (1) and (2)

The I-Series Recommendations

- **I.100 Series-General Structure**
  - serves as a general introduction to ISDN
  - I.120 provides an overall description of ISDN
  - I.130 introduces terminology and concepts that are used in I.200
- **I.200 Series-Service Capabilities**
  - specifies the services to be provided to users
  - I.112-definition of the term *service*
    - That which is offered by an Administration or RPOA to its customers to satisfy a specific telecommunication requirement.
  - Three simple ITU-T services: telegraphy, telephony, and data
  - four newer ITU-T telematic services: teletex, facsimile, videotex, message
- **I.300 Series-Overall Network Aspects and Functions**
  - specifies how the network goes about providing services to users
  - a protocol reference model (based on OSI) is presented
- **I.400 Series-User-Network Interface**
  - deals with the interface between the user and the network
    - Physical configuration
      - how ISDN functions are configured into equipment
    - Transmission rates
      - data rates and combinations of data rates to be offered to the user
    - Protocol specifications
      - protocols at OSI layers 1 through 3 that specify the user-network interaction
- **I.500 Series-Internetwork Interfaces**
  - deals with various network issues that arises in attempting to define interfaces between ISDN and other types of networks
- **I.600 Series-Maintenance Principles**
  - provides guidance for maintenance of the ISDN subscriber installation, network portion of ISDN access, primary access
- **I.700 Series-B-ISDN Equipment Aspects**
  - covers functional and characteristics of ATM equipment