UNIT II DIGITAL SWITCHING SYSTEMS

Time switching – space switching – STS and TST switching –digital switching system hardware – principles of switching system software organizational processing software – switching in networked environment – ISDN.

Unit II Digital switching Systems

A switch transfers signals from one input port to an appropriate output. A basic problem is then how to transfer traffic to the correct output port. In the early telephone network, operators closed circuits manually. In modern circuit switches this is done electronically in digital switches. If no circuit is available when a call is made, it will be blocked (rejected).When a call is finished a connection teardown is required to make the circuit available for another user. Basic function of any switch is to set up and release connections between transmission channels on an "as - needed basis"

Switching is all about the movement of traffic from one part of the network to another. Switching systems Connect end-systems to switches, and switches to each other. The usual connections that a digital switching system is required to establish are

1. Line- to- line (L-L) connections
2. Line- to- trunk(L-T) connections
3. Trunk- to- line (T-L) connections
4. Trunk- to- trunk (T-T) connections

All these connections are established through the switching matrix of a digital switching system. Since this represent the basic 'fabric' of a switch, the term switching fabric is sometimes used to describe the elements that establish network paths through switch.

Architecture of digital switch consists of two main elements viz. time and space for performing time division switching (TDM) and Space Division Switching (SDM).Other than the space switch and time switch, there exists time space-time switch, space time-space switch etc. which combines functionality of both of these types.

2.1 Space Switching

When we consider Space switching there is a dedicated path (two parallel wires) established between the caller and called subscribers for the entire duration of call in the exchange by the switch. It was originally designed for analog networks, but is used currently in both digital and analog switching. This means then the conversation is going on the switch create the link between two sides. At that time only that call is going in the path.

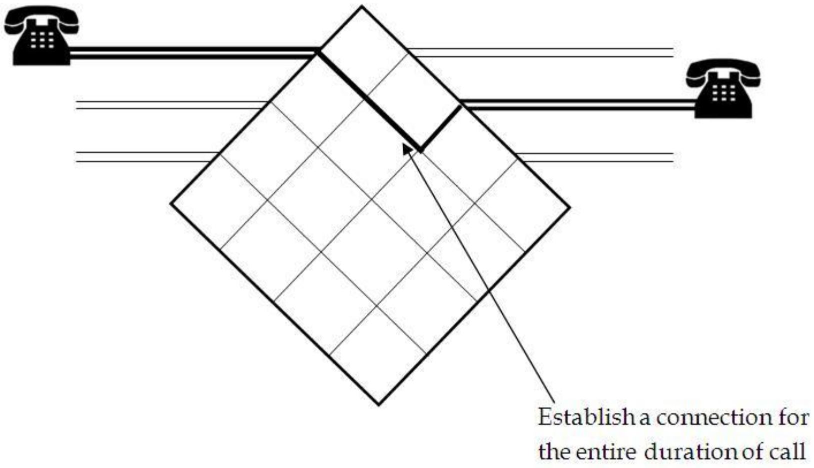

Figure 2.1 Space switch connection

2.1.1 Space-division switching

In space-division switching each input takes a different physical path in the switch matrix depending on the out-put. Hence, when a connection is established througha space switch matrix, a permanent physical contact is made on the matrix of cross-points. The connection willbe maintained throughout the call duration. This technology can be primarily developed to accommodate analog transmission. Broadly speaking, space-division switching can be classified into three types: manual, electro-mechanical, and stored-program control.In Manual swictching, Upon requesting a connection, the operator would manually connect the appropriate jacks using a loop cordwith a loop plug on each end.The second generation of space-division switching systems was electro-mechanical. Two common types of such systems were step-by-step (also known as the Strowger switch in honor of its inventor) and crossbar switches.The basic concept of this switching element is shown in fig 2.2.

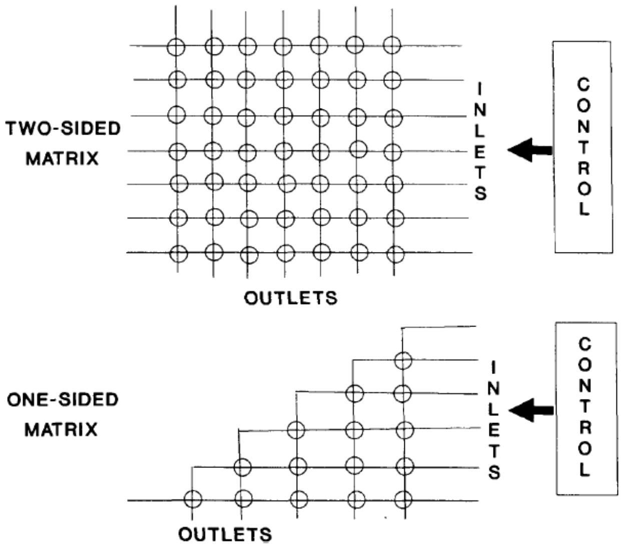

Figure 2.8. Space-divisi

Figure 2.2 Space division fabric

It consists of physical crosspoints which can be connected via control signals. For present day digital switching systems ,these control signals are provided by microprocessor actuated controller. Currently 1ESS, 1AESS, 2ESS and 3ESS switches employ space-division switching.

The S Switch Two basic configurations for the S switch are shown in fig 2.2

Two-sided matrix. This allows a two-sided connection of an outlet to an inlet. For instance, the connection of outlet 1 to inlet 3 and the connection of 1 to outlet 3 can be established simultaneously, thus allowing reciprocal connections.

One-sided matrix. This allows only a one-sided connection between an an inlet; sometimes it is referred to as a **folded matrix.**

In this type of arrangement, the redundant side of the fabric is removed.More sophisticated types of controllers are needed that can keep track of one-sided connections since reciprocal connections cannot be supported by a folded or nonredundant - matrix scheme.

These two configurations by no means represent the only schemes that are employed currently. A variety of other arrangements are often used in which the amount of network availability can be predicted by eliminating certain crosspoints. The S switch connects a path through the network that is maintained throughout the duration of the call, and the T switch (discussed later) maintains a path only during a specified time slot.

The S switch also provides a "metallic" or a real metal connection between the inlets and the outlets, whereas a T switch provides a path through the network via memory assignments. Different types of connections through the switching network require different numbers of cross-points. For instance, a four-wire trunk connection that needs two simultaneous paths will require two cross-point connections.

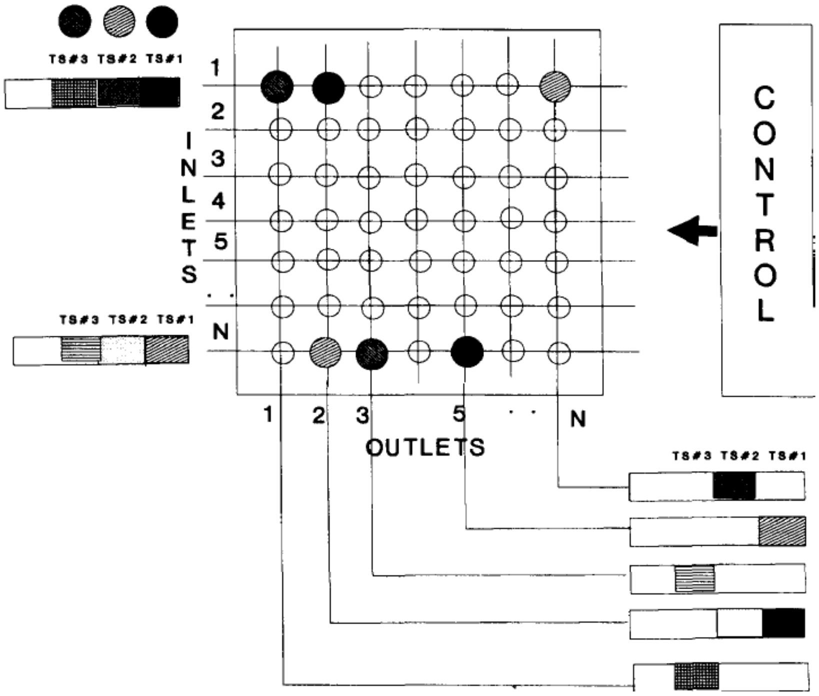

Figure 2.3 S-switch

The impact of an S switch on a time-multiplexed bit stream, also referred to as a time slot (TS), is shown in Fig. 2.3. The left-hand side of the figure shows various time-slot intervals labeled TS 1, TS 2, TS 3. The trace of a path through the S switch of the TS 1 time slot follows; the contact points for this time slot are shown by solid circles. The control signal actuates contacts 1, 2 and N, 5. As a result of this operation, the TS 1 signal entering inlet 1 will depart outlet 2, and similarly the signal entering inlet TV will depart outlet 5 for this time interval. This example illustrates that the S switch provides a metallic path through the switching fabric for a known interval of time.

2.2 Time Switching

Time division switching involves the sharing of cross points for shorter periods of time. This paves way for the reassign of cross points and its associated circuits for other needed connections. Therefore, in time division switching, greater savings in cross points can be achieved. Hence, by using dynamic control mechanisms, a switching element can be assigned to many inlet-outlet pairs for few microseconds. This is the principle of time division switching. Time division switching uses time division multiplexing to achieve switching. Two popular methods that are used in time division multiplexing are (a) the time slot interchange (TSI) and (b) the TDM bus. In ordinary time division multiplexing, the data reaches the output in the same order as they sent. But TSI changes the ordering of slots based on the desired connections. The de-multiplexer separates the slots and passes them to the proper outputs. The TDM uses a control unit. The control unit opens and closes the gates according to the switching need. The principle of time division switching can be equally applied to analog and digital signals.

2.2.1 The time-division switching

The time-division switching fabric is now a de facto standard for designing modern digital switches. The most important advantage of the time switching fabric, besides lower cost, is that unlike space-division switching fabric, it allows sharing of the cross-points. A conceptual illustration of a typical time division fabric is shown in Fig. 2.4. The concept of time division has been around for years, mostly employed in transmission products. Its use as a switching fabric is more recent. The time-division switching fabric can be considered to be a memory system that assigns different memory locations for different time slots, and it is referred to as time slot interchange (TSI) memory. This type of "soft" assignment allows sharing of cross-points for short periods. The memory allocation or TSI is controlled by fabric controllers.

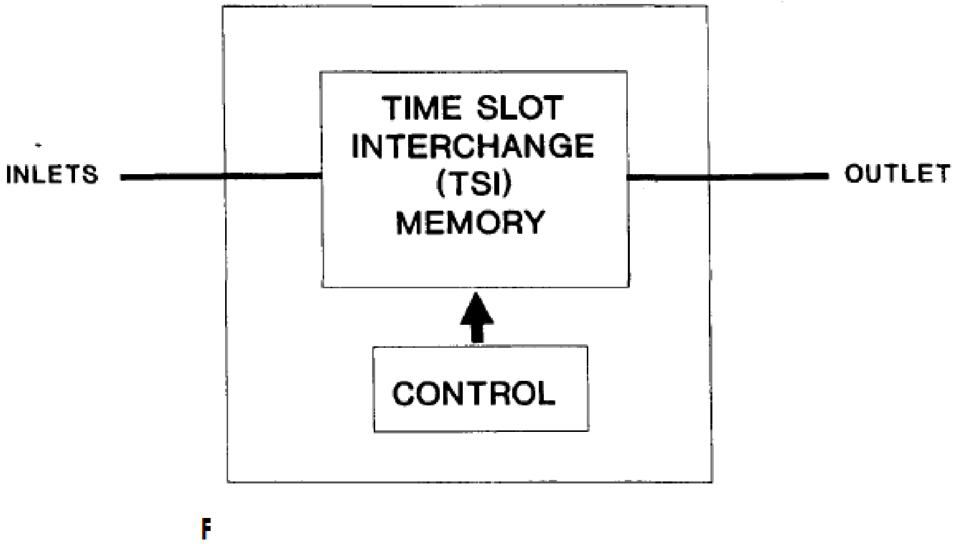

Figure 2.4. Time-division switching fabric T

2.2.2 The T Switch

The T switch is currently considered to be the basic and important element of the digital switching system's switching fabric. The basic concept of the T switch is shown in Fig. 2.5. There are N inlets and N outlets, numbered 1 to N. Assume that time slots TS 2 and TS 1 are entering inlet 1; time slots TS 22 and TS 21 are entering inlet 2; etc. Since the TSI scheme is nothing more than a memory rearrangement system, complete flexibility in reassignments of different time slots to different outlets can be accomplished via controller commands, as shown. This type of TSI reassignment is done continuously during the duration of a call, in effect, allowing sharing of cross-points and hence making the switching fabric more economical.

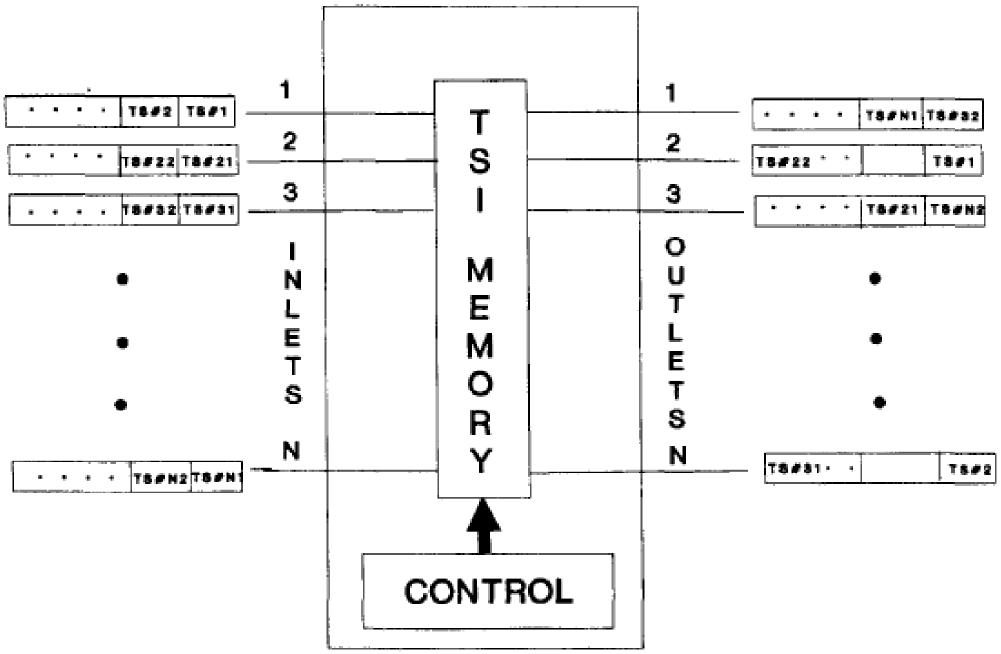

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Figure 2.5 T switch

2.3 Space-Time-Space (STS) Switching

One objective in the design of a modern digital switching system is to re-duce costs and improve the switching efficiency of the fabric. Obviously there is a practical limit to the size of a single switching stage that can be effectively utilized. At present, various combinations of S switches and T switches are used to accomplish the above objective. One combination uses an S switch followed by a T switch and a final S switch. This arrangement, referred to as STS fabric, is shown in Fig. 2.6. This particular arrangement depicts N x M (meaning N inputs and M outputs) size, with NS switches separated by MT switches. In an STS switching fabric, a path through the network is established via smart network controllers that link an incoming time slot with an outgoing time slot. This type of time slot linkage is then dynamically updated throughout the duration of a call.

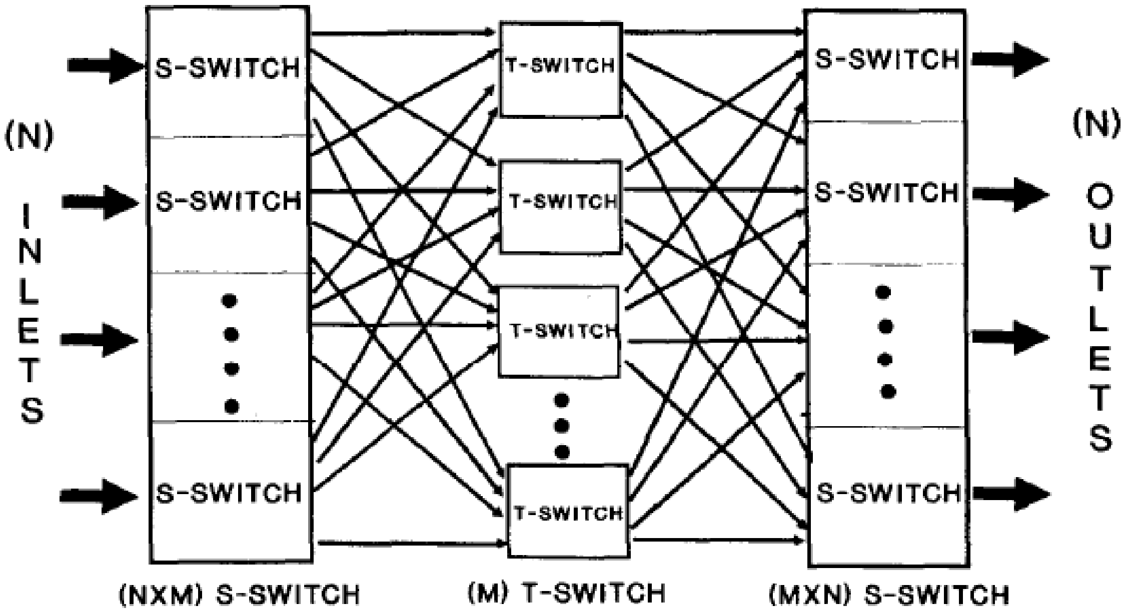


Figure 2.6 Space-Time-Space Switching

2.4 Time - Space-Time (TST) Switching

One of the most popular switching fabric arrangements currently deployed by digital switching systems is based on time-space-time (TST) architecture, as shown in Fig. 2.7 An incoming time slot enters a T switch; a path is hunted through the S switch for an appropriate outgoing time slot; and once identified, the path through the switching fabric is established and dynamically updated throughout the duration of the call. One of the basic advantages of the TST architecture over the STS architecture is that it can be implemented at a lower cost, since T switches are less expensive than S switches and under heavy traffic offer more efficient utilization of time slots with lower blocking probabilities.

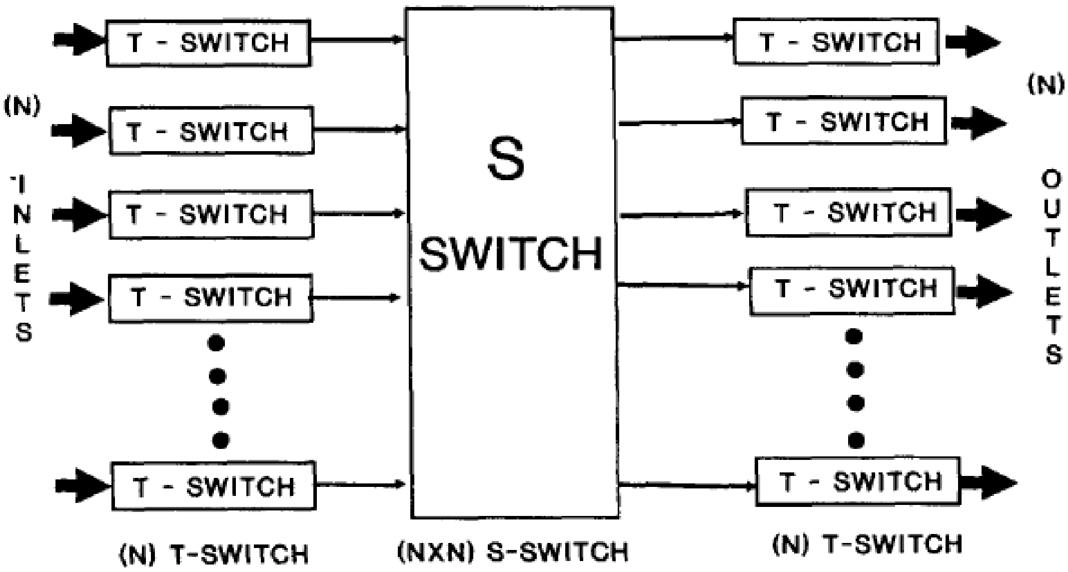
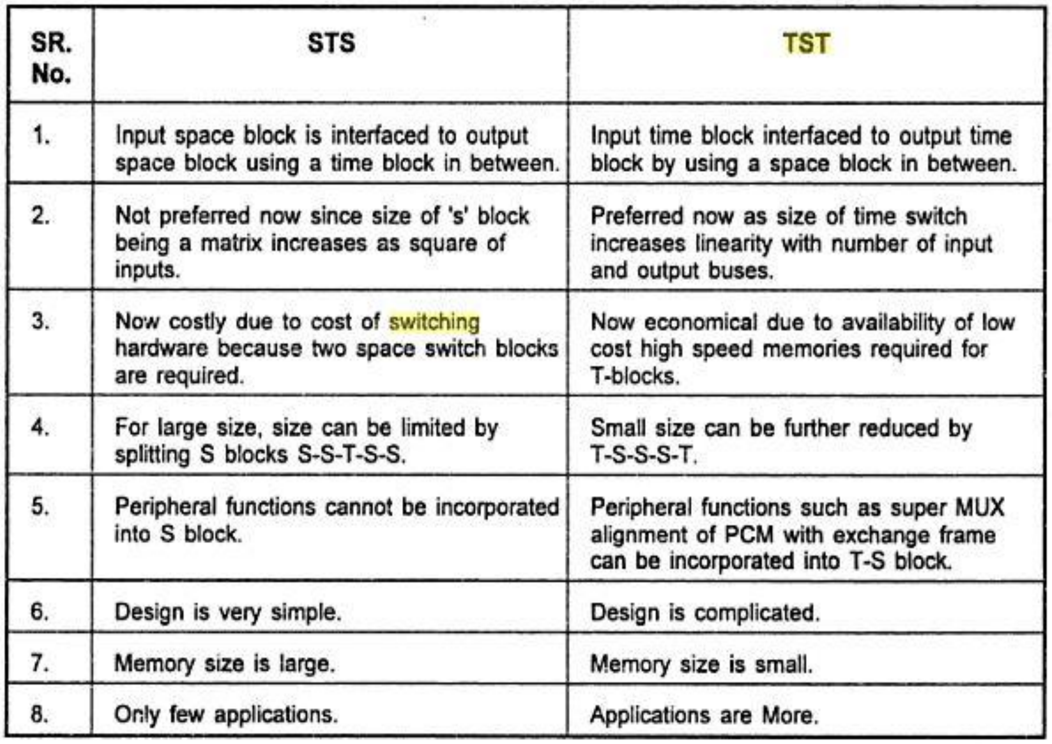


Figure 2.7 Time-Space-Time Switching

Comparison between STS & TST networks



SR. No.	STS	TST
1.	Input space block is interfaced to output space block using a time block in between.	Input time block interfaced to output time block by using a space block in between.
2.	Not preferred now since size of 's' block being a matrix increases as square of inputs.	Preferred now as size of time switch increases linearity with number of input and output buses.
3.	Now costly due to cost of switching hardware because two space switch blocks are required.	Now economical due to availability of low cost high speed memories required for T-blocks.
4.	For large size, size can be limited by splitting S blocks S-S-T-S-S.	Small size can be further reduced by T-S-S-S-T.
5.	Peripheral functions cannot be incorporated into S block.	Peripheral functions such as super MUX alignment of PCM with exchange frame can be incorporated into T-S block.
6.	Design is very simple.	Design is complicated.
7.	Memory size is large.	Memory size is small.
8.	Only few applications.	Applications are More.

2.5 Digital switching system hardware

The hardware architecture of a hypothetical digital switch is shown in Fig.2.8. This hypothetical digital switching system is based on a quasi-distributed control architecture. Note that the architecture of a working digital switching system is very complex with many subsystems.

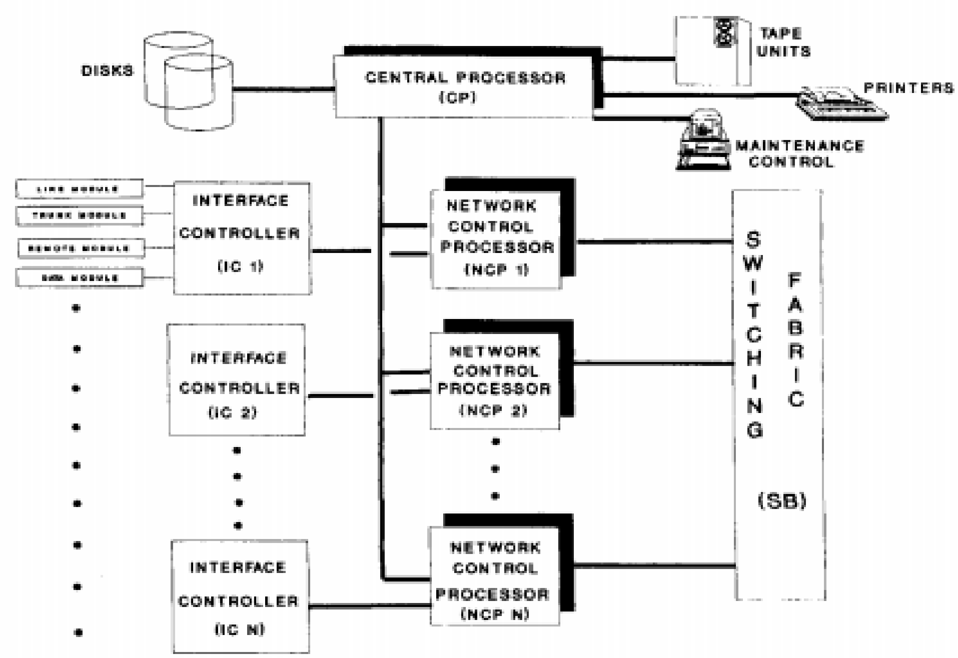


Figure 2.8 Digital switching system hardware architechture

Central Processor

A typical digital switching system usually employs a central processor (CP) as the primary processor, and it is always duplicated. Its function is to provide systemwide control of the switching system. It usually supports secondary processors, shown in Fig. 2.8, as network control processors (NCPs). The CP usually controls high-level functions of the switch and supports operation, administration, and maintenance (OA&M) functions. When critical faults occur in the switching system, usually the CP controls the system recovery process. The CP also maintains subscriber and office data. The billing system for the switch is usually supported by the CP.

Network Control Processors

The network control processors are the secondary processors. Usually, their purpose is to provide call processing functions and assist in setting up a path through the switching fabric. Since most digital switching systems switch calls via a time-space-time (TST) path for call connection, this hypothetical switch is assumed to do the same. The secondary processors are usually duplicated; and depending on the desired size of the class 5 central office, a digital switch may employ a number of such processors. These processors usually interface with the interface controllers (ICs) and provide medium-level call process.Generally, the secondary processors like the NCPs are associated with particular ICs. Usually a NCP keeps track of all calls that are controlled by its 1C and associated paths assigned for such calls. Usually the NCP interfaces with the CP or other NCPs to update call paths on a regular basis, so that other NCPs can get a "global" view of all calls.

Interface Controllers

Most digital switching systems employ a processor-based controller that acts as a concentrator of all incoming lines or trunks. These controllers use time multiplexed output to the NCPs and provide time-switching (T switch) functions. The number of such controllers in a switch depends on the engineered size of the central office (CO). Interface Controllers Most digital switching systems employ a processor-based controller that acts as a concentrator of all incoming lines or trunks. These controllers use time multiplexed output to the NCPs and provide time-switching (T switch) functions. The number of such controllers in a switch depends on the engineered size of the central office (CO).

Interface Modules

Different types of modules are employed in a digital switching system. Most common are the line modules (LMs) and the trunk modules (TMs). Depending on the design objectives of a digital switching system, a line module may terminate a single line or scores of lines. Most digital switching systems employ smart line cards that are processor-driven and can perform most basic call processing functions, such as line scanning, digit collection, and call supervision. The trunk modules interface different types of trunks to the digital switching system. Most digital switching systems employ special modules to connect ISDN and other digital services to the switch. They also employ specialized module interfaces to provide enhanced services such as AIN and packet switching. The number and types of modules deployed in a digital switching system are dependent on the engineering requirements of a class 5 switch.

Switching Fabric

Most digital switching systems employ at least one space or S switch. The concentrators in the ICs are usually time or T switches. The S switch is usually accessible to all NCPs. In some cases, the switching fabric is partitioned for use by different NCPs. In either case, a dynamic image of the entire network usage/idle status for the switching fabric is maintained by the CP of the digital switching system.

2.6 principles of switching system software

A good understanding of the hierarchy of software currently employed by many modern digital switching systems is important. Most of today's digital switching systems employ quasi-distributed hardware and software architectures. The control structure of a digital switching system can usually be divided into three distinct levels. This topics elaborates on the software employed in a hypothetical digital switching system at different levels of control.Figure 2.9 shows levels of control along with some details of minimum software architectural functions that may be necessary for each level of control. From a digital switching system analyst's point of view, it is essential to understand the high level software architecture of a digital switch before attempting to analyze it.Low-level details are not essential, since the objective is to analyze the digital switch, not to design it. However, details on software engineering practices are essential for software analysis.

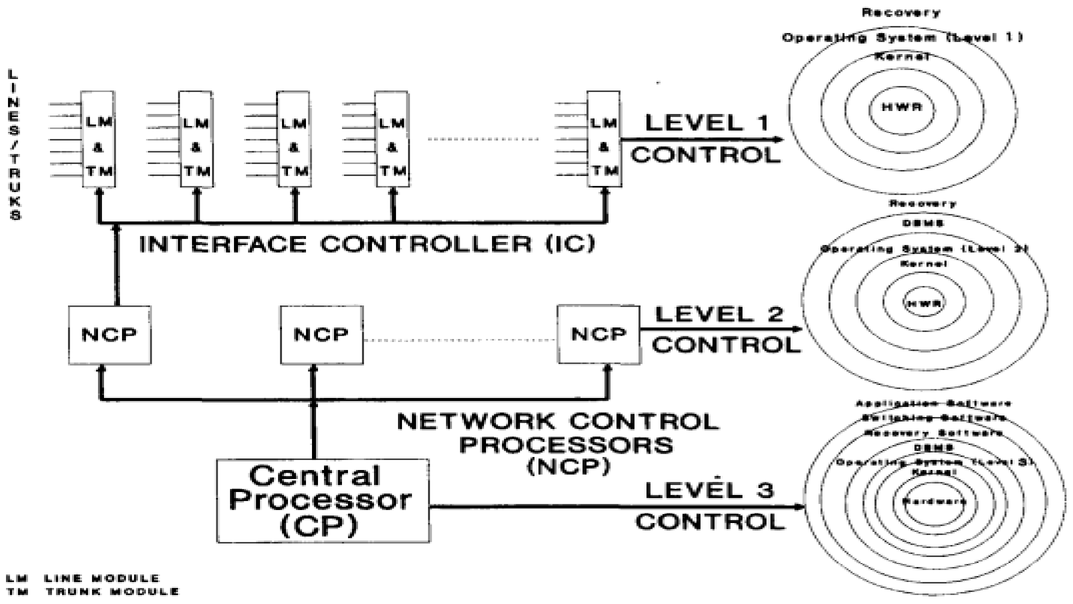


Figure 2.9 Basic software architecture of a typical digital switching system

Operating Systems

Every digital switching system has an operating system as a part of its software architecture. An operating system (OS) may be defined as software that manages the resources of a computer system or controls and tasks other programs. Sometimes these programs may be referred' to as control programs, supervisory programs, executive programs, or monitor programs. In theory there are different types of operating systems, classified as serial batch systems, multiprogramming systems, timesharing systems, and the real-time systems. The operating systems employed by digital switching systems are real-time operating systems. This type of OS is required for digital switching systems since the very nature of telephony processing demands execution of tasks in real time. Typically, the real-time operating system for the digital switching system interacts with different layers of applications necessary to support telephony features and functions. Since practically all modern digital switching systems use quasidistributed architecture, the processor or controller for each subsystem may even use different OSs than the central processor does.

Therefore, it is conceivable for a digital switching system to employ more than one OS. Each subsystem may employ a different type of processor and therefore may employ different high-level languages for the development of its software. It is thus a challenge for the analyst to understand the operational and developmental environment of a digital switching system.

Kernel.

The kernel or the nucleus of an operating system comprises those functions of an OS that are most primitive to the environment. It usually supports the following functions.

- Process control and scheduling

- Main memory management

- Input/output control of requests for terminals and buffers

- Domain protection of main memory read/write operations etc.

Most of the real-time operating systems that control digital switching systems use priority interrupt systems. These interrupts are serviced by the kernel based on the importance of an operation. Of course, the interrupt and similar hierarchical controls are system-specific, but most give highest priority to system maintenance interrupts, since this ensures proper operation of the digital switching system, followed by other types of interrupts required for call processing and other ancillary functions. Most digital switching systems employ kernels that reside in the main memory.

Database Management

The databases that are employed in digital switching systems are usually relational and sometimes distributed. In simple terms, distributed databases imply multiple databases requiring data synchronization. The relational database systems use the relational data model in which the relationships between files are represented by data values in file records themselves rather than by physical pointers. A record in a relational database is flat, i.e., a simple two dimensional arrangement of data elements. The grouping of related data items is sometimes referred to as a tuple. A tuple containing two values is called a pair.A tuple containing N values is called an TV-tuple. A good example of a relational database system in a digital switching system is a database system that keeps cross-references of all directory numbers that are assigned to the line equipment of subscribers. When a particular subscriber goes off-hook, the line equipment is identified by the scanning program. The database is searched to find its associated directory number that identifies all characteristics of the line.In the hypothetical digital switching system developed for this book, each network control processor (NCP) is assigned a group of subscribers. Therefore,each NCP has a replica of the subscriber database for all other NCPs. Depending on the type of call, a NCP may be required to route calls through other NCPs. To accomplish this, the database information for all NCPs needs to be distributed and always kept synchronized.

Concept of Generic Program

Most digital switching systems support the concept of generic program similar to release in the computer industry. However, a generic program can be a little more involved than release. In the early days of stored program control (SPC) switching systems, the generic program was more or less the same for most telephone companies. Usually, the generic program contained all programs necessary for the switching system to function. It included all switching software, maintenance software, and specialized office data for the configuration of a central office (CO). The translation data were usually supplied by the tele phone companies. However, now it is sometimes more difficult to define exactly what a generic program consists of. Most of the modern digital systems have modular software structure. They usually have base programs or core programs that control the basic functions of the digital switching systems. On top of these programs reside different features and special options. Generally, the performance of a generic program is tracked for software reliability. Therefore, it be comes very important for an analyst to identify the exact software components that constitute a generic program. The components of a digital switching system's software that are kept common for a specific market or a group of telephone companies can sometimes be used to identify the generic program. Usually this set of programs can be labeled as a generic, base, or core release for a digital switching system. In general, generic programs contain operating system(s), common switching software, system maintenance software, and common database(s) software for office data and translation data management.

Software Architecture for Level 1 Control

Level 1 is the lowest level of control. This level is usually associated with lines, trunks, or other low-level functions. Most of the software at this level is part of the switching software. As shown in Fig. 2.10, the interface controllers (ICs) are usually controlled by microprocessors and may have a small kernel controlling the hardware of the 1C. The ICs may have a small OS, labeled Operating System (Level 3) in Fig.2.10. The function of this OS is to control and schedule all programs that are resident in the 1C. Most of the ICs have enough intelligence to recognize proper functioning of hardware and software. The 1C can also conduct diagnostics of lines and trunks or other peripherals connected to it. More extensive diagnostic routines may reside in the central processor or in some cases in the 1C itself. In either case/ the central processor can run the diagnostic program itself or request a fault-free 1C to run it. The 1C will then run the diagnostics and forward the results to the central processor. The ICs may also be capable of local recovery. This means that in case of an 1C failure, the 1C could recover itself without affecting the entire digital switching system. The only effect will be on the lines and trunk or peripherals connected to the 1C undergoing a recovery process. Again, all this will depend on the design of the Ics and associated software. An analyst should be conversant with different types of design strategies that may be employed, since they will impact the reliability and functionality of the 1C.

Software Architecture for Level 2 Control

The intermediate or level 2 controls are usually associated with network controllers that may contain distributed databases, customer data, and service circuit routines. Obviously these functions are digital switching architecture dependent; many switching functions could be assigned at this level of control.In a quasi-distributed environment, the processors employed are usually of intermediate or mini size. The NCPs are usually independent of the central processor. As shown in Fig.2.10, the NCPs usually have their own operating system, labeled Operating System (Level 2). This OS has a kernel that controls the hardware and basic functionalities of the NCR At this level of control, usually a resident database system maintains the translation data of subscribers and other software parameters required to control the telephony functions of the NCP.System recovery at this level of control is crucial, since a failure of a NCP may impact a number of ICs (dependent on the design) and a large number of lines, trunks, and peripherals. The NCPs should be capable of self-diagnosis, and since they are duplicated, they must be able to switch to a working backup. As mentioned in earlier chapters, the use of NCPs is design-specific. A design may call for a dedicated NCP to act as a control NCP for all other NCPs, or each NCP may be designed to operate independently. The recovery strategy in each case will be different. In the first case, where one NCP acts as the control NCP, the control NCP is responsible for system recovery for all other NCPs. In the second case, where there is no control NCP, the central processor is responsible for the recovery process of all NCPs. There could be all kinds of recovery strategies involved in the system recovery process at this level. The analyst needs to understand what type of recovery strategy is being used, in order to better assess the reliability of a digital switching system.Consider the function of the NCP. A subscriber goes off-hook, the 1C receives an off-hook notification from the line module. The 1C requests details on the subscriber, such as allowed features and applicable restrictions. The NCP queries its database for this information and passes it back to the 1C. This type of action required by the NCP necessitates that the NCP maintain a subscriber database as well. This database is supposed to be managed and kept up to date with the latest information for each subscriber. This is shown as DBMS in Fig.2.10 under level 2 control.

Software Architecture for Level 3 Control

The highest or level 3 control is usually associated with the central processor of a digital switching system. Normally these processors are mainframe type computers. Usually, the CP of a digital switching system provides all high level functions. These high-level functions include the management of the data base system for office data, high-level subscriber data, software patch levels, feature control, and above all, system recovery in case of hardware or software failures. The main operating system of a modern digital switching system resides at this level and is labeled Operating System (Level 3) in Fig. 5.1. As mentioned earlier, this OS operates in real time and is multitasking (i.e., it can support more than one task at a time). This OS controls the database management system, switching software, recovery software, and all applications such as features, traffic management systems, and OS interfaces. Most CPs work in an active/standby mode. In this mode, one CP is always available to go into active mode if the active CP develops a fault. Indeed, there are different schemes for operating a redundant processor system to improve reliability and availability.However, for digital switching systems, the scheme most commonly employed is the one in which both processors execute instructions in a matched mode, and in case of a failure, the standby processor becomes active immediately. Other schemes are sometimes employed, such as hot standby, in which the standby processor is powered up and ready to take over the operation of an active processor. In this scheme, call processing can be impacted during the processor switchover. There is a third option, cold standby, in which the processor is not powered up, but can be brought on line in case of failure. This scheme is not used for CPs but is sometimes employed for less critical peripherals. Most of the maintenance and recovery functions of a switch are also controlled from this level.

2.7 Digital Switching System Software Classification

A conceptual diagram of typical digital switching system software is shown in Fig. 2.11. The basic software functionality of a digital switching system can be divided into five basic elements, and other functions can be derived from these basic elements:

- Switching software
- Maintenance software
- Office data
- Translation data
- Feature software

Switching Software.

The most important layer of software for a digital switching system usually comprises

- Call processing software
- Switching fabric control software

- Network control software
- Periphery control software

Switch Maintenance Software

This set of programs is used to maintain digital switch software and hardware. Examples of these types of programs include digital switch diagnostics, automatic line tests, system recovery, patching,and trunk tests.

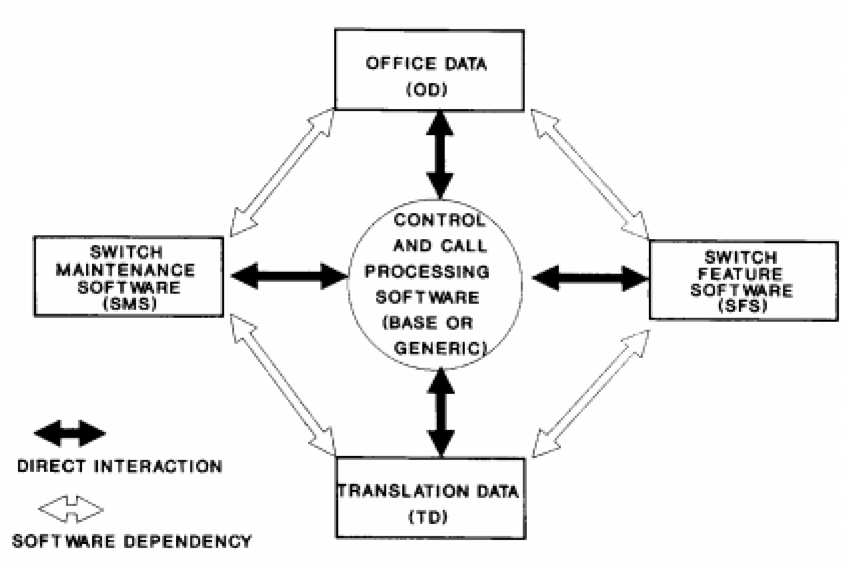


Figure 2.11 Classification of digital switch software

The recovery software of a modern digital switching system is usually distributed among its subsystems, since most digital switches have a quasi-distributed architecture. This strategy allows the system to recover more efficiently. In earlier SPC systems, the recovery scheme required the entire switching system to go down before if could be reinitialized to a working configuration.

A digital switching system may employ a large number of programs that are external to the operation of the digital switch, such as operational support systems (OSSs), operator position support, and advanced features (e.g., ISDN/SCP AIN). These are not shown in Fig. 2.11 as separate items/ since they can be external to a digital switching system or may be implemented as a supported feature. Some parts of OSSs can even be viewed as ' part of digital switching system maintenance software.

The objective of Fig.2.11 is to provide the analyst with a clear picture of digital switch software. The objective of this chapter is to help the analyst better understand the software environment of a digital switch without getting distracted by functions that may not directly impact the reliability assessment of a class 5 digital switch.

The importance of software tools such as compilers, assemblers, computer-aided software engineering tools, and methodologies that are needed to develop produce, and maintain digital switching system software should not be ignored. They can impact the quality of software.

Office Data. The generic program, as described earlier, requires information that is specific to a particular digital switch to operate properly. Digital switching systems have suffered outages due to wrong or improperly defined office data. The easiest way to visualize office data is by comparing them to your personal computer (PC). For the PC to operate properly, the OS has to know what type of color monitor the PC is equipped with, so that correct drivers are installed; the size and type of hard disk installed so that it can access it correctly;types of floppy disks/mouse; and CD ROM. Similarly, the office data of a digital switching system describe the extent of a central office (CO) to the generic program. However, the office data are much more involved and also define software parameters along with hardware equipment. Some common hardware parameters are

These are some examples of software parameters:

- Number of NCP pairs in the CO
- Number of line controllers in the CO
- Maximum number of lines for which the CO is engineered
- Total number of line equipment in the CO
- Maximum number of trunks and types of trunks for which the CO is engineered
- Total number of trunks of each type in the CO
- Total number and types of service circuits in the CQ such as ringing units, multifrequency (MF) receivers and transmitters,and dial-pulse (DP) receivers and transmitters
- Size of automatic message accounting (AMA) registers

- Number of AMA registers
- Number and types of traffic registers
- Size of buffers for various telephony functions
- Names and types of features supported

These types of parameters are digital switching system-specific and CO-specific. The parameters can literally number in the hundreds and are generated from engineering specifications of a CO.

Translation Data. The translation data, also referred to as subscriber data, are subscriber-specific and are required for each subscriber. This type of data is generally generated by the telephone companies and not by the suppliers.In some cases, the suppliers may input translation data supplied by the telephone companies. However, the database and entry system for the translation data is supplied as part of the digital switching system software. Typical translation data may consist of:

- Assignment of directory number to a line equipment number
- Features subscribed to by a particular customer, such as call waiting, three-way calling, and call forwarding, etc.
- Restrictions for a particular customer, such as incoming calls only, no long-distance calls, certain calls blocked
- Three-digit translators that route the call based on the first three digits dialed
- Area-code translators that translate the call to a tandem office for 1+ call, which is followed by 10 digits
- International call translators that route the call to international gateway offices based on the country code dialed

Again, literally hundreds of translation tables are built for a CO before it can become functional. If the CO is a new installation, much of the information is provided by the traffic department of a telephone company. The data tables are generated in conjunction with the specification of a new CO. However, if the CO is a replacement for an earlier CQ then all existing data may be required to be regenerated in a different format for the new CO.

Feature Software.

As mentioned earlier, most features implemented in modern digital switching systems are offered through feature packages. Some of the feature packages are put in a feature group and are offered in a certain market or to a group of telephone companies. These features may be included in the base package of a generic release or, offered as an optional package. In either case, most of the features are considered to be applications for a digital switch.

They are engineered to be modular and can be added to a digital switch according to the requirements of the telephone company and associated CO Some examples of feature packages are

- Operator services b Centrex feature
- ISDN basic rate « STP extensions

- SCP database

Depending on the digital switching system, these feature packages can be extensive and large. The analyst of digital switch software should assess the extent of the feature package and its compliance with the requirements of telephone companies.

Software Dependencies.

Most telephony features of digital switching systems require specific office data and translation data for their operation. They depend on the generation of feature-specific office data and/or translation data. These dependencies are, of course, design-specific. Similarly, the maintenance programs may require a set of specialized office data and/or translation data for testing various functionalities of a digital switching system. These relationships are shown as a software dependency in Fig. 2.11, and direct interactions of a generic program are shown as solid arrows.

2.8 Switching in a Networked Environment

The evolution of networking for digital switching systems has followed a remarkably similar path to that of PCs and mainframe computers. The current trend in computing is toward distributed computing connected by networks with less emphasis on central computing units. This is precisely what is happening with digital switching systems. Customers are demanding greater flexibility in the introduction of new services with short development cycles and lower costs. Typically, new releases for digital switching systems are scheduled once or twice a year. Hence, the ability to introduce new features requires the use of adjunct processors where new services could be developed and provided quickly.

The concept of intelligent network or more recently advanced intelligent network has been evolving slowly since the 1970s when the concept of common channel signaling (CCS) was introduced. This type of out-of-band signaling opened the door for external control of digital switching system functionalities.

For instance, now a digital switch could send call routing information to another digital switch via a CCS link without the use of in-band signaling such as dual tone multifrequency (DTMF). In the 1980s, digital switches were given the ability to send queries and receive responses from external databases called service control points, and this opened the door to national 800 number services. Later versions of CCS called CCS signaling 7, or CCS7, added more capabilities to linking protocols and were adapted by the International Consultative Committee for Telegraphy and Telephone (CCITT) for international use. Currently CCS7 is the protocol for linking networked elements for digital switches.

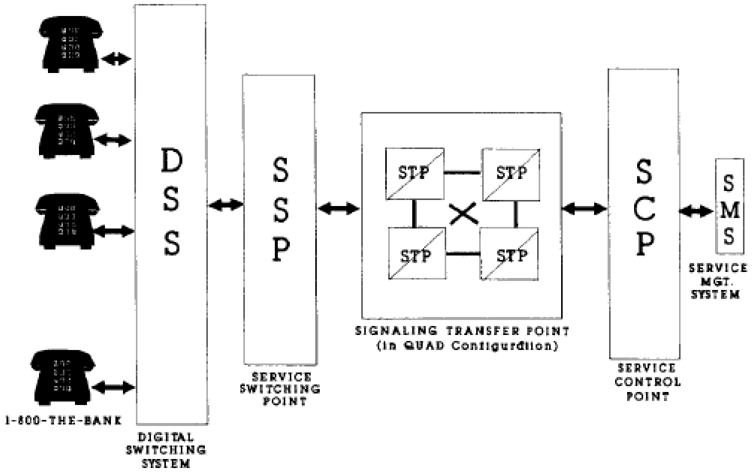


Figure 2.12 Networked switching

A typical scheme for networked switching is shown in Fig.2.12. The basic elements for such a networking scheme are as follows:

- **Service switching point** acts as a tandem switch and can identify calls that require special handling. It formats special call requests and forwards them to a database (SCP) seeking routing information. It obtains required information by working in conjunction with STPs.

- **Signaling transfer point** acts as a hub in a CCS7 network. It is a packet switcher for essages between CCS7 nodes and SCPs. It can also be considered a tandem switcher for signaling messages. It has the capability of translating and routing signaling messages.

Service control point is a specialized database that can accept queries from network elements such as SSP and STP and retrieves routing information to support and calling cards.

Service management system provides operational support for database (SCP) owners for managing the database and routing calls through the network that require special handling.

The digital switching system forwards this number to the SSP, and then the SSP recognizes it as a call requiring special handling and queries the SCP database through STPs that act as hubs. The response containing routing information from the SCP is passed via the STPs back to the SSP, which then completes the call through the digital switching system. In simpler terms, the data stored in the SCP associates the 800 number to a particular central office (CO) and provide the SSP with routing information along with a local directory number associated with that 800 number. This type of networked arrangement allows the 800 number to be nationally used without any danger of conflict and uses the SMS to keep it updated all the time. The advanced intelligent network uses a similar networking arrangement, but the functionalities controlled and services provided go much beyond just querying the SCP for routing information.

2.9 ISDN

A good example of new technology that is built around digital switching systems is the integrated services digital network (ISDN). ISDN stands for Integrated Services Digital Network. It is a design for a completely digital telephone/telecommunications network. It is designed to carry voice, data, images, video, everything you could ever need. It is also designed to provide a single interface (in terms of both hardware and communication protocols) for hooking up your phone, your fax machine, your computer, your videophone, your video-on-demand system (someday), and your microwave. ISDN is about what the future phone network, and information superhighway, will look like (or would have looked like).

ISDN was originally envisioned as a very fast service, but this was a long time ago when it was hoped to have fiber all the way to your house. It turned out that running all that fiber would be too expensive, so they designed ISDN to run on the copper wiring that you already have. Unfortunately, that slowed things down considerably - too slow for quality video, for instance.

ISDN has been very slow in coming. The standards organizations have taken their time in coming up with the standards. In fact, many people consider them to be out of date already. But on the other side of the coin, the phone companies (especially in the U.S.) have been very slow at desiging products and services, or marketing them with ISDN in mind. Things are starting to pick up, but still very slowly.

ISDN is available now in many places, but it is not widely used. Further most of the products and services that people have forecast for ISDN still aren't available. For this reason many people say that ISDN also stands for "It Still Does Nothing".

B-ISDN

That brings is to B-ISDN. B-ISDN is Broadband ISDN. (The older ISDN is often called Narrowband ISDN.) This is not simply faster ISDN, or ISDN with the copper to your home finally upgraded to fiber. B-ISDN is a complete redesign. It is still capable of providing all the integrated services (voice, data, video, etc.) through a single interface just like ISDN was supposed to. But it will do it a lot faster than ISDN could. Of course, that copper to your house will still have to be replaced with fiber. But B-ISDN is still in development - it seems to be moving faster than ISDN, but it is still quite a ways off.

ISDN consists of three types of communications channels. They are:

1. Bearer channel (B channel)
2. Delta channel (D channel)
3. Hybrid channels (H channel)

These three ISDN channels are described below. B channel B channels are logical digital ‘‘pipes’’ which exist on a single ISDN line. B channel carry data and services at 64 kbps. It carries data in full duplex mode. Each B channels provide a 64 kbps clear channel, clear meaning that the entire bandwidth is available for data, B channels typically form circuit switched connections. B channel connection is an end-to-end physical circuit that is temporarily dedicated to transferring data between two devices. The circuit switched nature of B channel connections; combined with their reliability and relatively high bandwidth makes ISDN suitable for a range of applications including voice, video, fax and data. B channels are normally used for on-demand connection. As B channel operation based on circuit switching, it can be configured as semi permanent or ‘‘nailed up’’ connections. D channel D channel can be either 16 or 64 kbps, depending on the needs of the user. The primary function of the D channel is to carry control signalling and administrative information for B channels to set up and tear down the calls. The D channel uses packet switched connection. The packet switched connection are best adapted to the intermittent but latency sensitive nature of signalling traffic, accounting for the highly reduced call setup time of 1 to 2 seconds on ISDN calls. Unlike the B-channel, which can function as a simple ‘pipe’, the D channel is associated with higher level protocols at layers 2 and 3 of OSI model which form the packet switched connections. The D channel provides the signalling information that is required for caller identification. It also includes low-rate data transfer and applications such as telemetry and alarm transmission. H channels H channels are suitable for high data rate applications such as video, teleconferencing and so on.

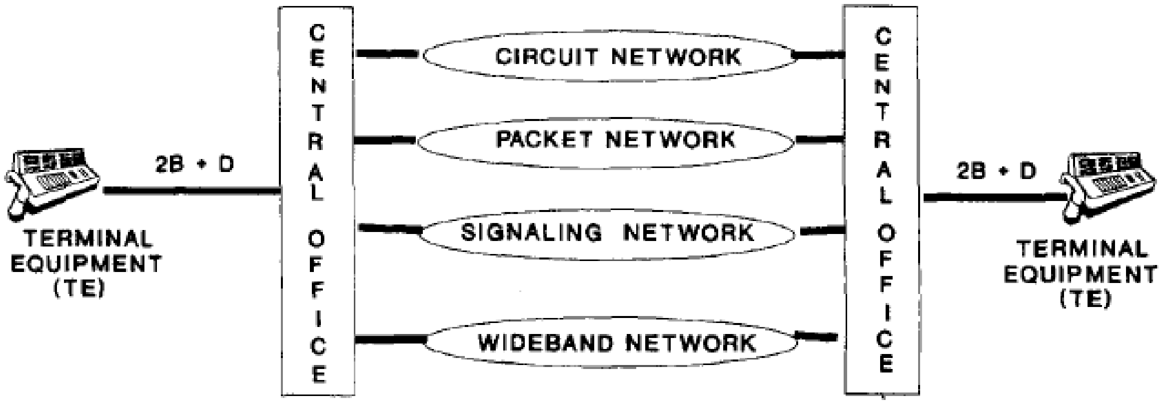


Figure 2.13 Basic ISDN Concept

As mentioned above, ISDN has evolved and is still evolving, and no attempt is made in this section to fully describe the ISDN technology.A high-level conceptual diagram for ISDN components is shown in Fig.2.13 . From a network analysis point of view, ISDN can be visualized as a parallel implementation of the circuit switching network, packet switching network, signaling network, and wideband switching network.

All these networks are connected through the central office (CO). These services are available to users via terminal equipment (TE). Users employ the specialized TE to communicate with the CO. The transmission between the user and the CO is purely digital via the B and D channels. The CO recognizes ISDN calls and separates the B and D channels. For a typical ISDN call, a connection request is sent from one CO to another via the D channel. As shown in Fig. 2.13, the D channel is further divided into a packet network and a signaling network. To initiate a connection, the signaling network sends a CCITT no. 7 protocol signal or a common-channel signaling (CCS) request to the other CO with particulars about a call. Once a connection is established between the two ISDN users, the B channel provides the digital speech path between users. At this stage the user is able to communicate with the other user via speech on channel B and data on channel D. With 2B + D service, users also have access to an additional B channel for data or voice. For analytical purposes, the wideband network could be used for wide band services such as video and Videotex in conjunction with fiber-optic connections.