1)

a. Explain about space switch and time switch and discuss about its limitations.

Space switches:

Cross point matrix connects incoming and outgoing PCM highways. Different channels of an incoming PCM frame may need to be switched by different cross points in order to reach different destinations.Crosspoint is a 2 input AND gate. One input is connected to incoming PCM highway and another to connection store that produces a pulse at required instants.

Figure below shows space switches with k incoming, m outgoing PCM highways carrying n channels. The connection store for each column of cross points is a memory with an address location for each time slot which stores the number of the cross point to be operated in that time slot. This number is written into the address by the controlling processor in order to set up the connection.

The numbers are read out cyclically in synchronism with incoming PCM frame. In each time slot, the number stored at corresponding store address is read out and decoding logic converts this into a pulse on a single lead to operate relevant cross point. Since a cross point can make a different connection in each of n time slots, it is equivalent to n cross points in a space division network.

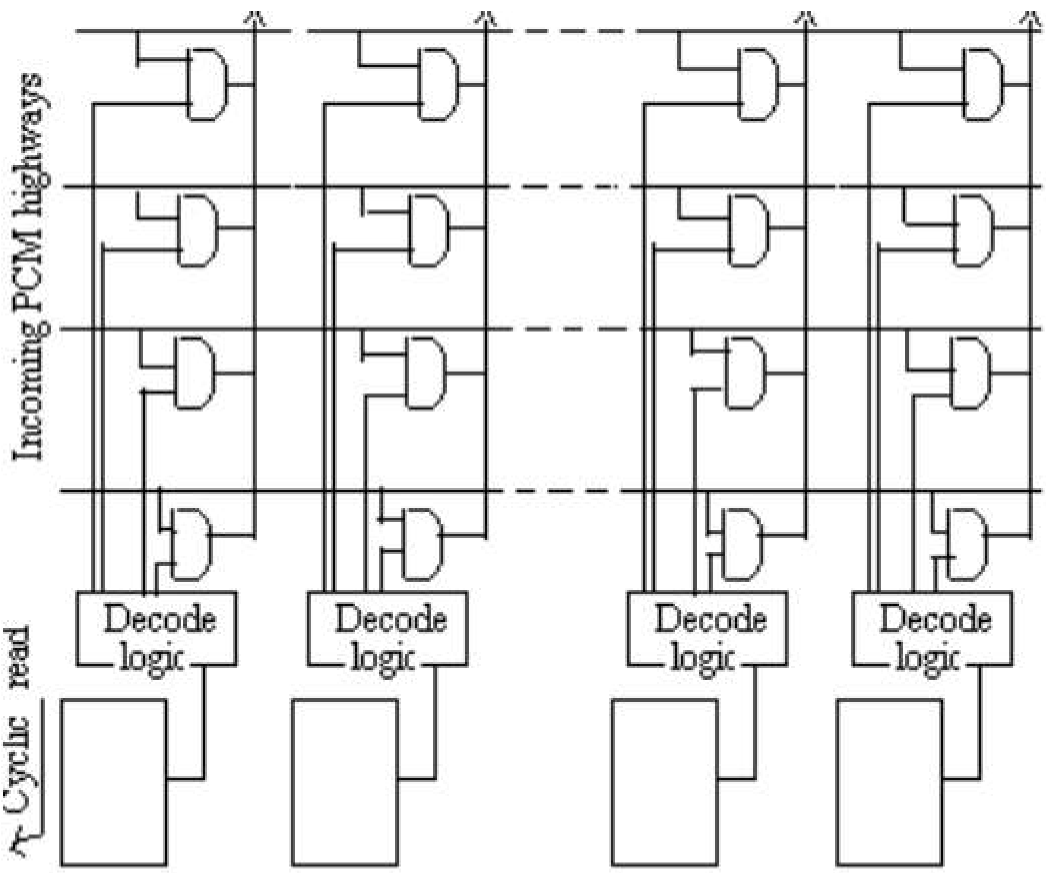


fig. Space switch

Time switches:

Time switch connects an incoming n-channel PCM highway to an outgoing n-channel PCM highway. Since any incoming channel can be connected to any outgoing channel, it is equivalent to a space-division cross point matrix with n incoming and outgoing trunks.

Time slot interchange is carried out by means of two stores, each having a storage address for every channel of the PCM frame.

Speech store consists of data of each of the incoming time slots (i.e. its speech sample) at a corresponding address. Each address of the connection store corresponds to a time slot on outgoing highway. It contains number of time slot on incoming highway whose sample is to be re-transmitted in that outgoing time slot. Information is read into the speech store cyclically in synchronism with the incoming PCM system; however random access read out is used. The connection store has cyclic read out, but writing is non-cyclic.

To establish a connection, the number (X) of the time slot of an incoming channel is written into the connection store at the address corresponding to the selected outgoing channel (Y). During each cyclic scan of the speech store, the incoming PCM sample from channel X is written into address X. During each cyclic scan of the connection store, the number X is read out at the beginning of time slot Y. This is decoded to select address X of the speech store, whose contents are read out and sent over the outgoing highway.

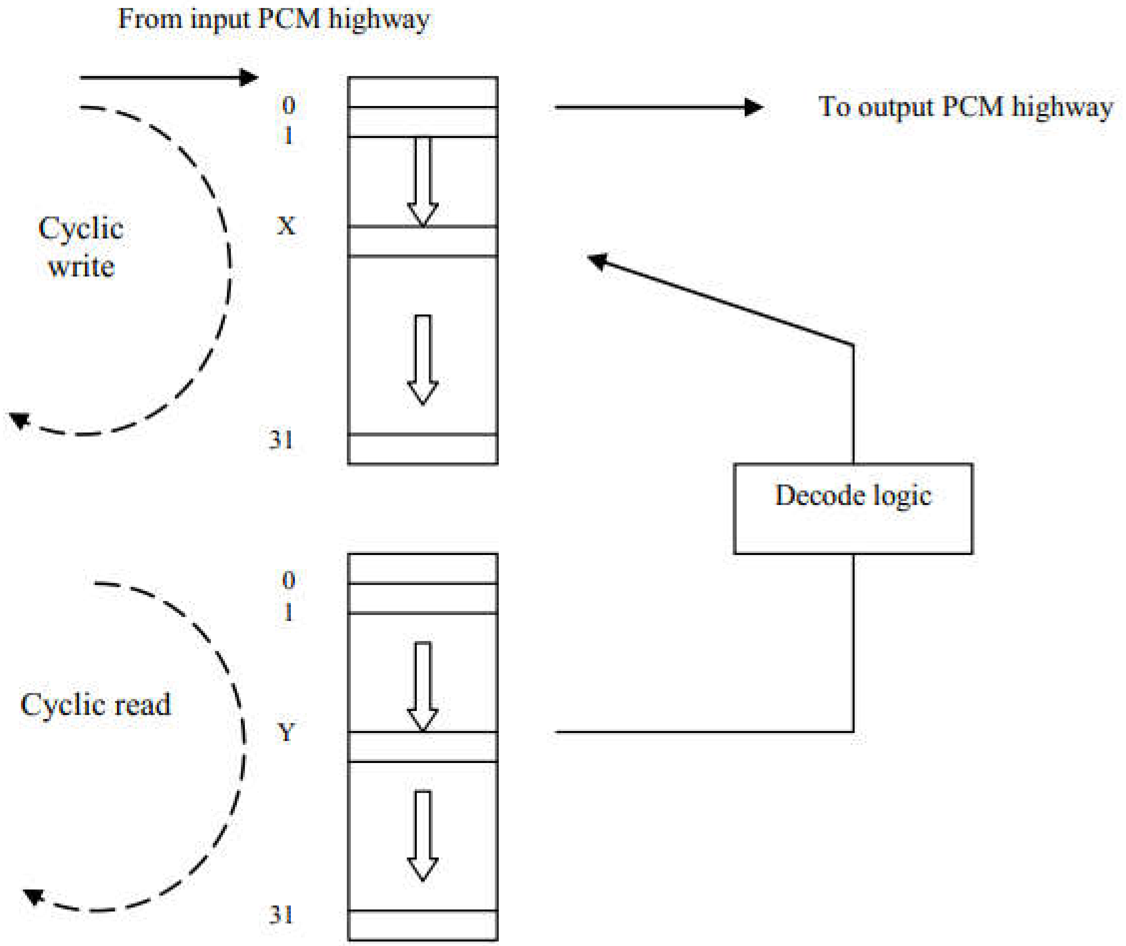


Fig. Time switch

b. **Explain STS and TST switching network in detail.**

The figure below shows a *Space-Time-Space (S-T-S) switching network.* Each of the m incoming PCM highways can be connected to k links by cross points in the A switch, and the other ends of the links are connected to the m outgoing PCM highways by cross points in the C switch. Each link contains a time switch. To make a connection between time slot X of an incoming PCM highway and time slot Y of an outgoing PCM highway, it is necessary to select a link having address X free in its speech store and address Y in its connection store. The time switch is set to produce a shift from X to Y.

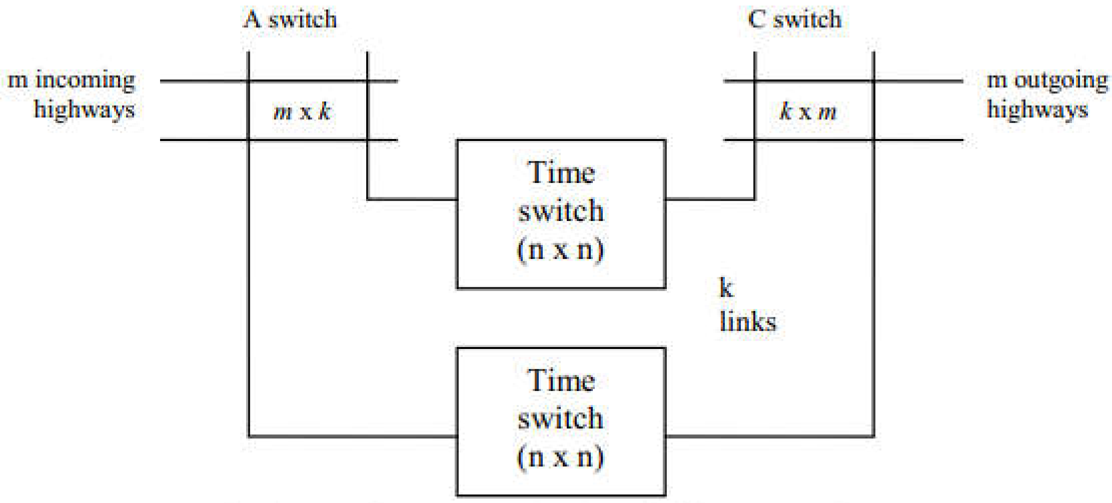


Fig. Space-time-space (STS) switching network

Time-Space-Time (T-S-T) switching network:

Each of the m incoming and m outgoing PCM highways are connected to a time switch. The incoming and outgoing time switches are connected by the space switch. To make a connection between time slot X of an incoming highway and time slot Y of an outgoing highway, it is necessary to choose a time slot Z which is free in the connection store of the incoming highway and the speech store of the outgoing highway. The connection is established by setting the incoming time switch to shift from X to Z setting the outgoing time switch to shift from Z to Y and operating the appropriate cross point at time Z in each frame.

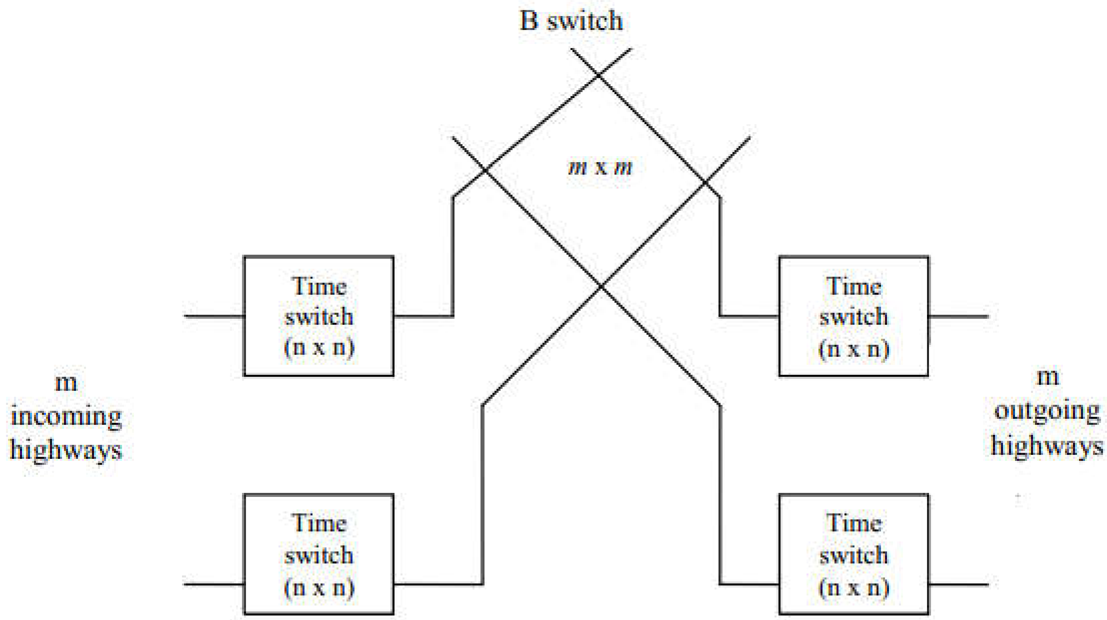


Fig. Time-space-time switching network

2) Explain synchronization and frame alignment of PCM signals in digital exchange.

If all exchange clock pulse generators are in perfect synchronism, there will be time differences between the starting instants of different PCM frames entering a digital exchange. To solve this problem, the line terminating unit of a PCM junction stores the incoming digits in frame-alignment buffer. Digits are read into this buffer at the rate, f_a, of the incoming line beginning at the start of each frame. They are then read out at the rate f_b of the exchange clock, beginning at the start of the PCM frame of the exchange.
To cater to the maximum amount of misalignment between a digital line system and the exchange, the aligner must have a buffer capacity of at least one frame. This introduces delay additional to that caused by time switching. A frame alignment buffer caters perfectly to a constant misalignment.

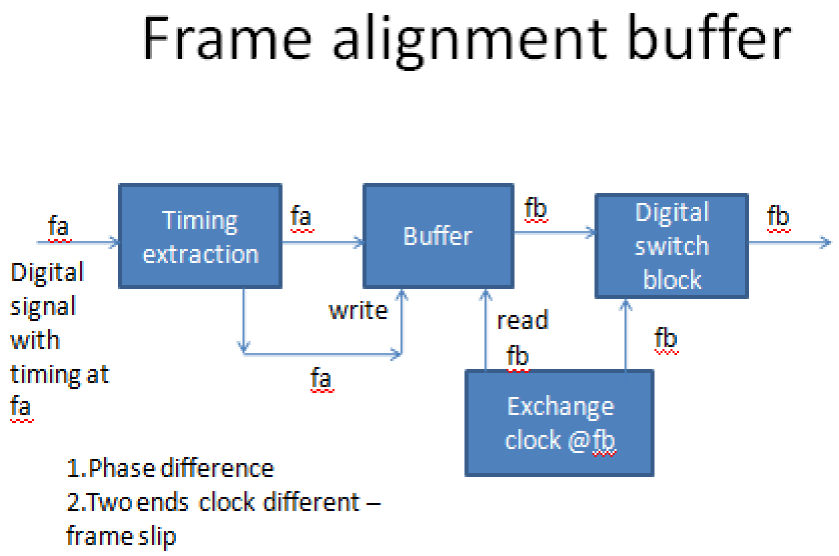


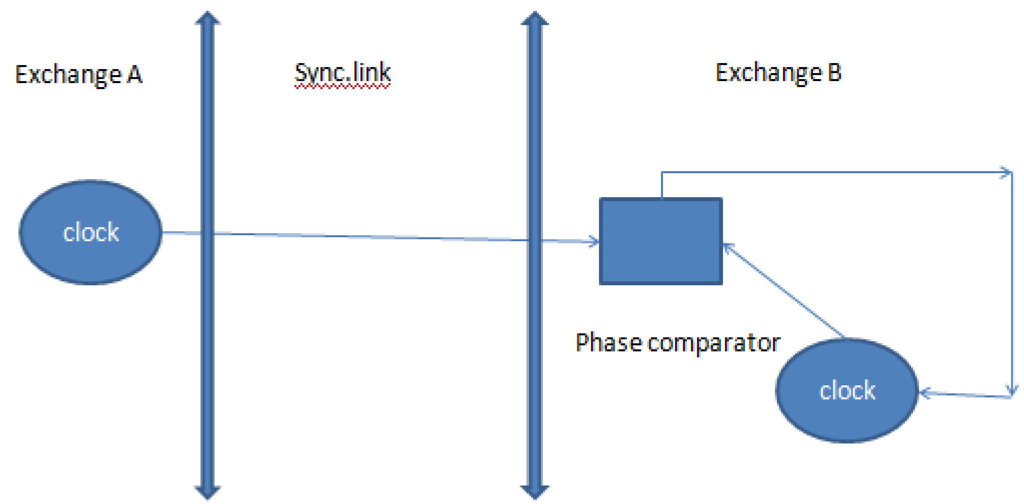
Fig 6.11 Frame alignment of PCM signals entering a digital exchange

However if the exchanges at the two ends of a line have slightly different clock frequencies, the contents of the buffer will change until it either overflows or empties. If the buffer overflows, its contents are erased so that it can start refilling. If the buffer empties completely, the contents of the previous frame are repeated to refill it. In either case, a complete frame is in error. This is known as frame slip. Of course, slip can also arise from malfunctions in switching or transmission systems.

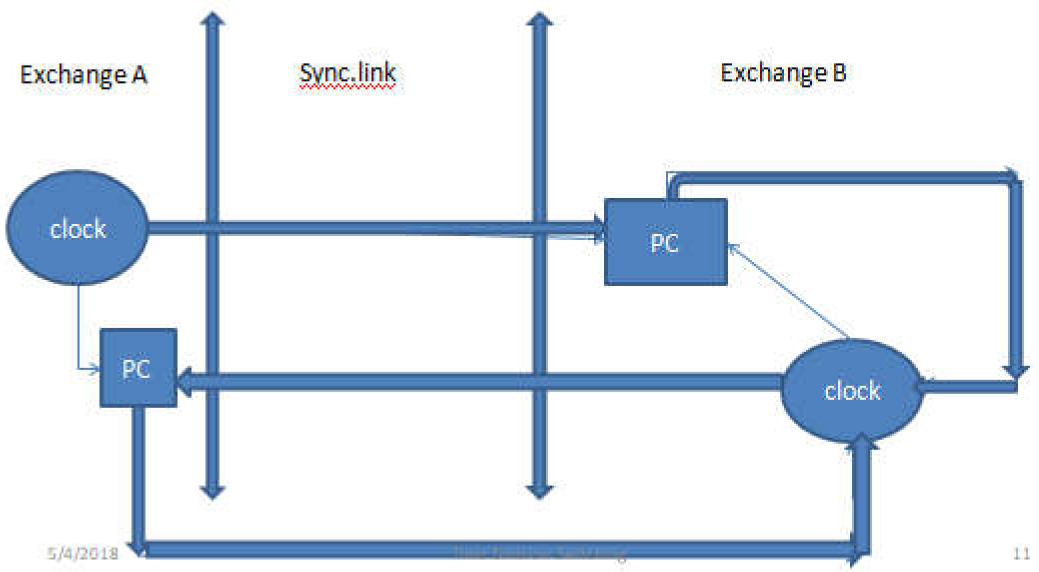
Synchronization networks:
In a synchronous digital network, just one or two atomic reference clocks control the frequencies of the clocks of all the exchanges in the network. This is sometimes called *despotic control.* For this purpose, a synchronizing network is added to PSTN in order to link the exchange clocks to the national reference standard.
The local clock in each exchange is provided by crystal oscillator whose frequency can be adjusted by a control voltage. This control voltage is derived from incoming digit stream on synchronizing link which is used to determine whether the exchange clock rate should be increased or decreased or left unchanged. Adjustments are made periodically as a single quantum

increase or decrease. This ensures that exchanges maintain the same long term average frequency, although short term deviations may occur. This is known as *mesochronous working.* Synchronizing links may be unilateral or bilateral. In first case, there is a master-slave relationship; the clock frequency of the exchange at one end of link is controlled solely by exchange at other end. In second case, there is a mutual relationship; each exchange influences the frequency of the other. The principles of these methods are shown in the figure below.

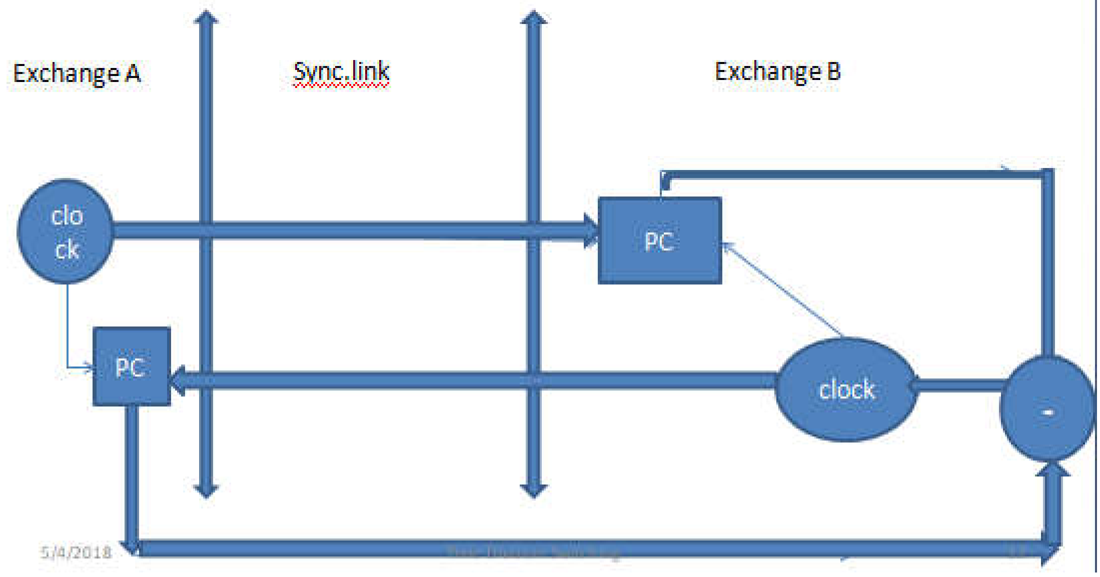
Single ended unilateral



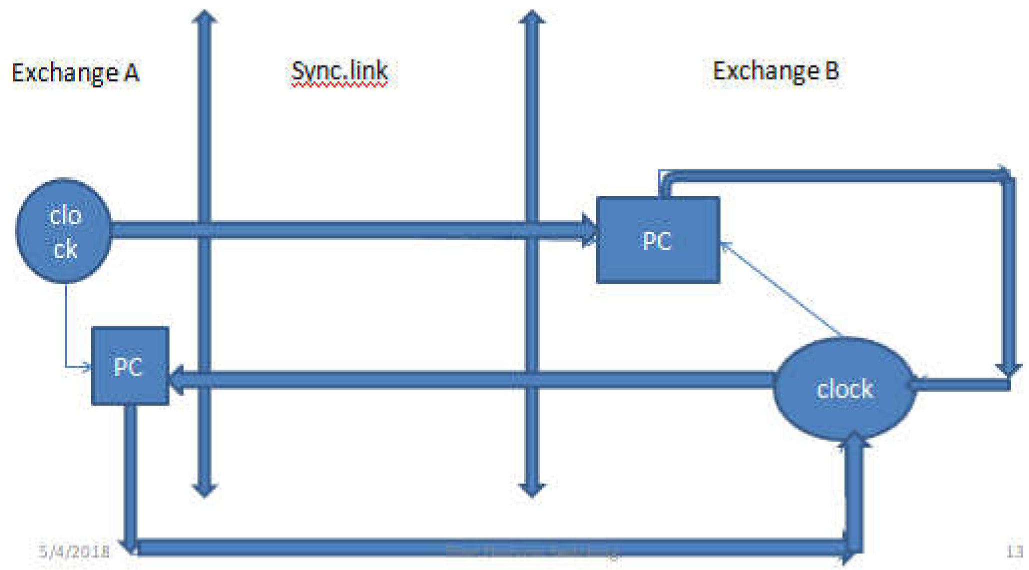
Single ended bilateral



Double ended Unilateral



Double ended Bilateral



3) Explain Basic software architecture with level 1 control, level 2 control and level 3 control of a typical digital switching system.

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. 5.1, 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. 5.1. 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.

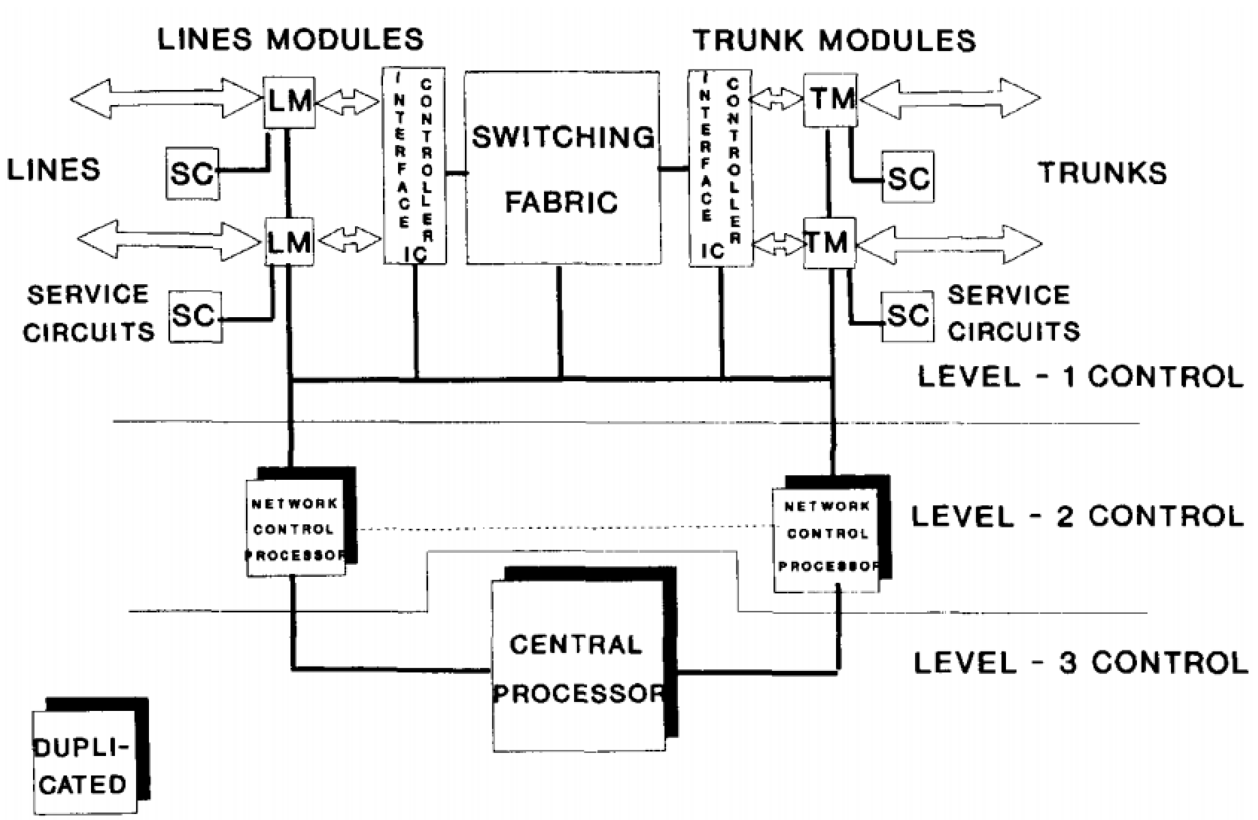
5. Software Architecture for Level 2 Control

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. 5.1, 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. 5.1 under level 2 control.

5.3.6. 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 database 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.



4)

a. **What is feature flow diagram? Draw feature flow diagram for feature activation, feature operation and feature deactivation for a call forwarding feature.**

Feature Flow Diagrams

The features employed in a digital switching system are usually very complex, and flow diagrams can help one to understand their functionalities. A simplified flow diagram for one of the most commonly used subscriber features, call forwarding (CF), is shown in Fig. 5.5. This feature has three modes of operation:

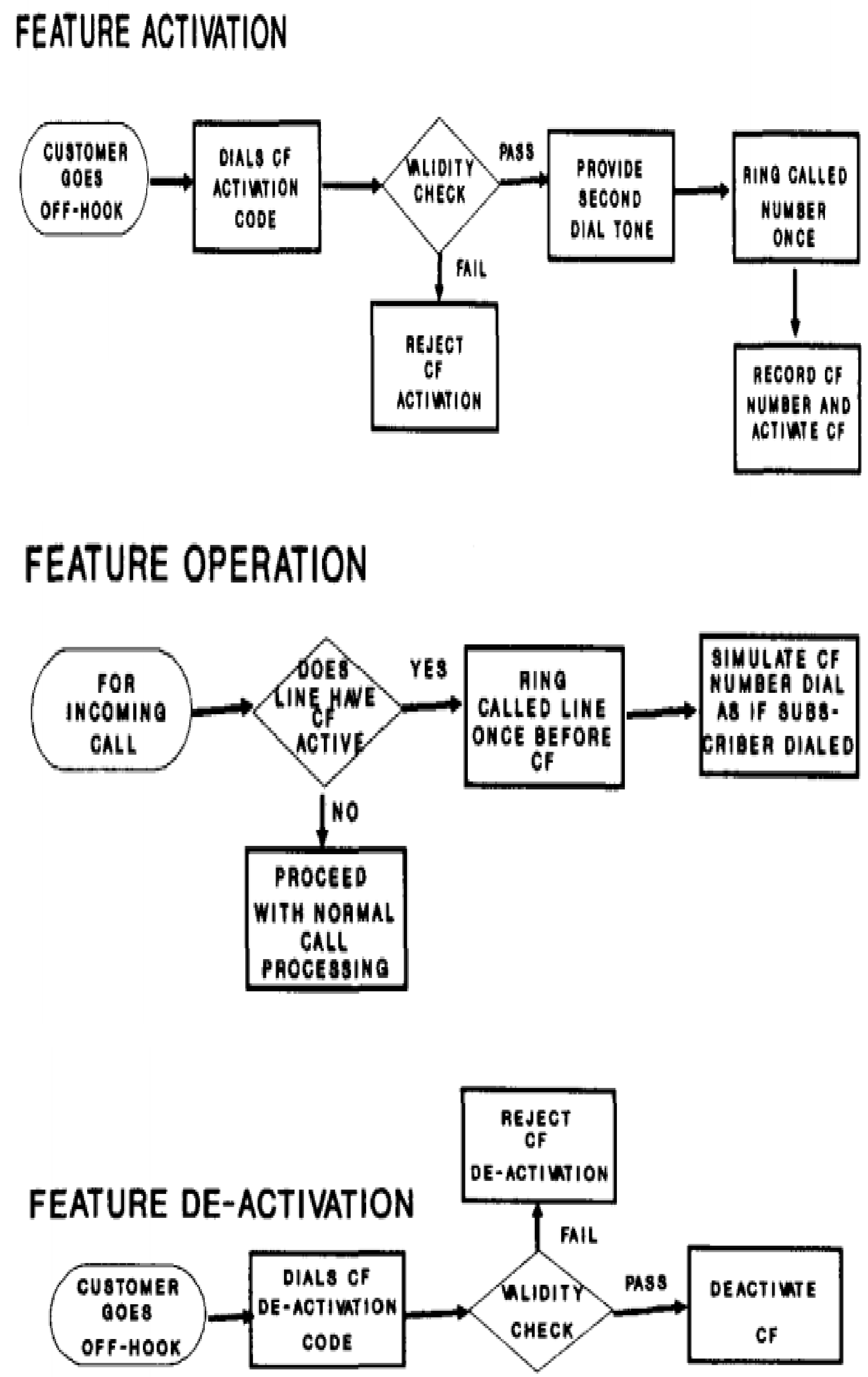


Figure 5.5. Simplified flow diagram for call-forwarding (CF) feature

Feature Activation.

The feature is activated when the customer goes hook and dials an activation code. The software checks for the correct validation code. If the activation code is wrong, the subscriber does not get the second dial tone. If the activation code is correct, the subscriber gets a second dial tone and is allowed to dial the call-forwarding telephone number. The call-forwarded subscriber line is rung once, and the number is recorded in the system memory for future use.

Feature Operation.

Now, suppose the subscriber receives a call on the line that has the CF feature activated. The system rings the called subscriber once and then forwards the call to a number previously recorded by the subscriber during feature activation.

Feature Deactivation.

This feature can be deactivated when the subscriber goes off-hook and dials the deactivation code. If the code is valid, the CF number is removed; otherwise, the deactivation request is ignored. Note that this was a very simplified flow diagram for a feature. The actual flow diagrams for some of the features are far more complex.

b. Explain software linkages during a call.

Software Linkages during a Call

The software linkages to these hardware subsystems will be discussed now. An example of possible software linkages required during a typical call is shown in Fig. 5.4. The line control programs scan the status of lines via the line modules and report the status to the network status program, which in turn works with the network control programs. The line control program also works with the line service circuit programs in providing dial tone, digit receivers, ringing circuits, etc., to the subscriber lines. The network control program orders a network connection through the switching fabric when a subscriber goes off- hook and completes the dialing of all digits for a call.

The call processing programs are usually responsible for call processing functions and interface with the feature programs, translation and office data, and automatic message accounting and maintenance programs. The maintenance program is responsible for system recovery, system iagnostics, backup, and other maintenance-related functions. All these functions are available during call processing.

Once the call processing program determines for the subscriber line the allowed features and attributes, it allows a call to be established through the switching fabric. The called subscriber may reside in the calling subscriber's digital switch or may be in another digital switch. If the called subscriber is not in the same digital switch, then an outgoing trunk is used to establish a connection to the other digital switch or tandem office.

Under this condition, the proper type of outgoing trunk is selected and assigned a proper trunk circuit for signaling and supervision. When the called subscriber answers the phone, a talking path is established through the switching network while the line and the trunks are constantly scanned for disconnect from either side. If the subscriber resides in the same digital switch/ the special internal line and trunk circuits are used to complete and monitor the call. See Fig. 5.3 for a basic call model. If the called subscriber resides in the same digital switch, the call is classified as an intraoffice call; if the called subscriber resides outside the digital switch/ the call is termed an interoffice call.

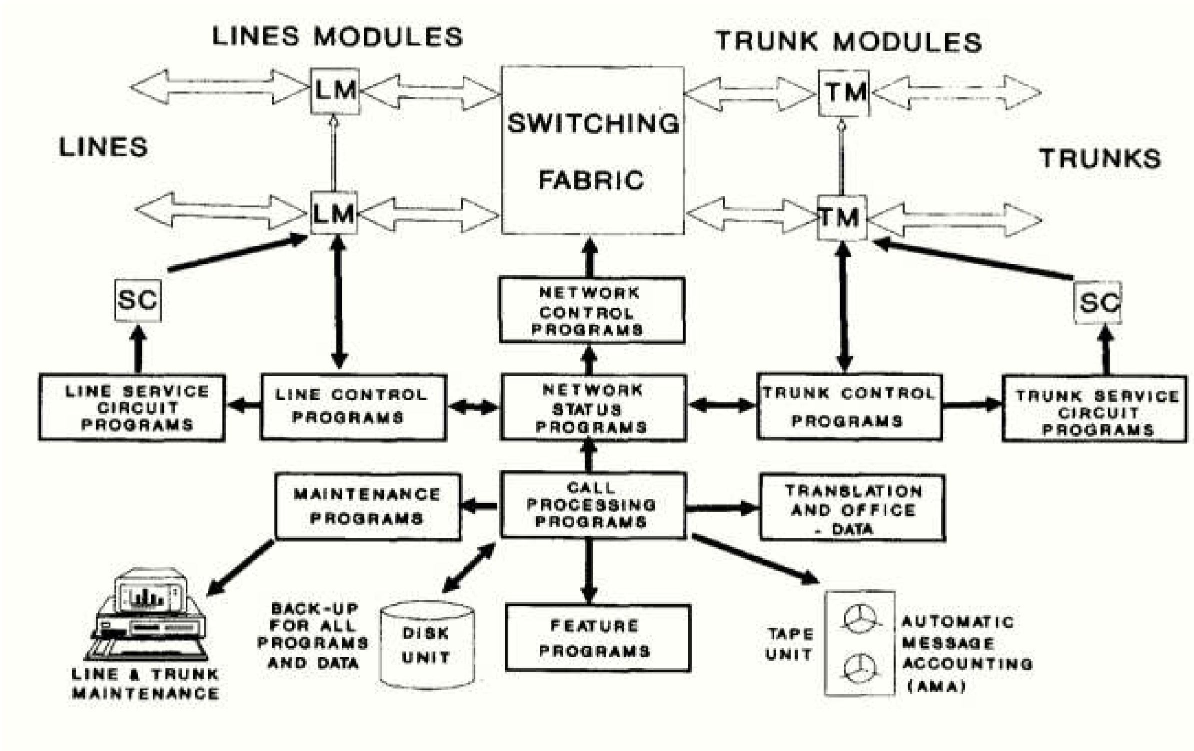


Figure 5.4. Software linkages required during a typical call

5)

a. **Explain Organizational interfaces of a digital switching system central office.**

Interfaces of a Typical Digital Switching System Central Office

Most of the common interfaces needed for a digital switching system central office are shown in Fig. 7.1. The maintainability of a CO depends on satisfying the needs of all these and other interfaces. A group of COs is usually assigned to a switching control center (SCC), in the Bell Operating Companies environment, but local maintenance personnel are also involved in maintaining COs. The next level of maintenance is assigned to the electronic switching system assistance center (ESAC) in parallel with the maintenance engineers. Maintenance engineers are not involved with daily maintenance but oversee resolution of recurrent maintenance issues. The ESAC organization usually controls generic upgrades, patching, operational trouble reports (OTRs), and interfaces with the supplier's regional technical assistance centers (RTACs) and technical assistance centers (TACs) to solve unusual and difficult maintenance problems. Note that this is only a typical arrangement and will vary with telephone companies and switching system products. But most telephone companies support different levels of digital switch maintenance. These other departments interact with a digital switch:

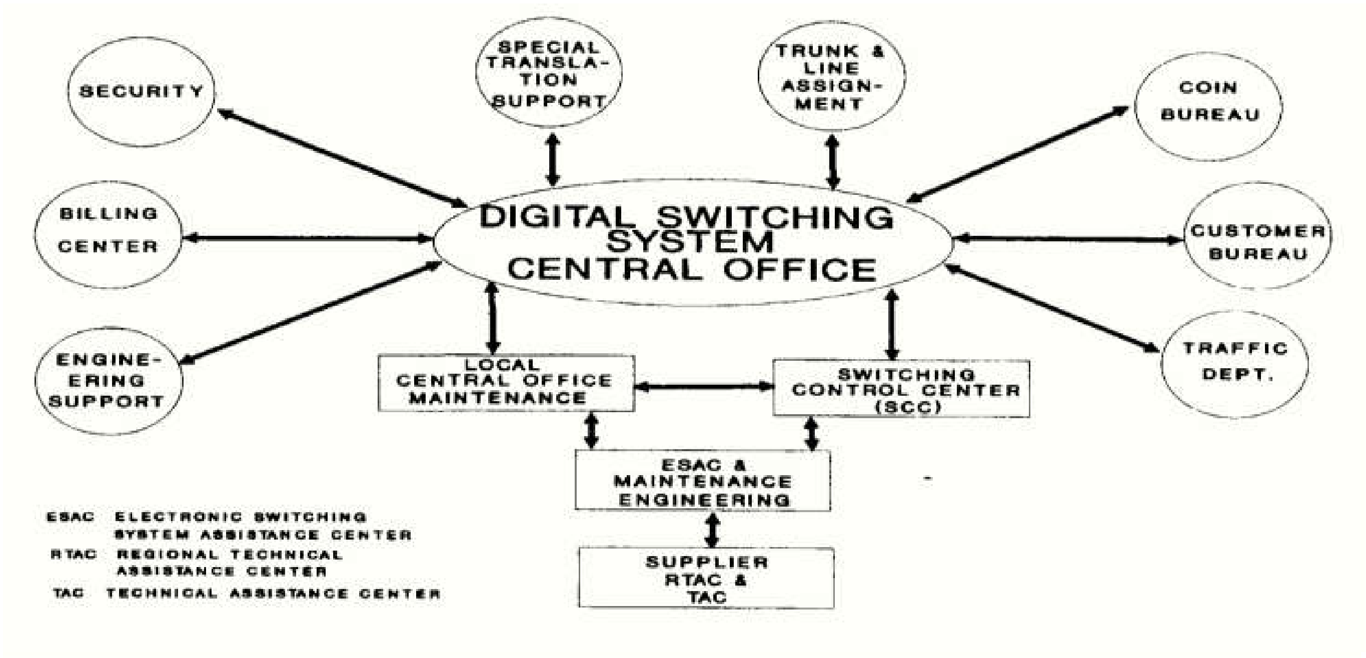


Figure 7.1. Organizational interfaces of a typical CO

- *Engineering support:*

This department writes specifications for a new digital switch and engineers' additions to the existing CO. This department also interfaces with the supplier's engineering department, CO plant department, and traffic department with the objective of issuing accurate engineering specifications for a new digital switch installation or addition.

- *Billing center:*

The billing center is responsible for processing automatic message accounting (AMA) or billing tapes from a CO to produce customer bills. Currently, billing information can also be transmitted directly to the billing center.

- *Security:*

This department provides security services for the digital switching system to prevent unauthorized entry and fraudulent use of the telephone service.

- *Special translation support:*

This group provides support in establishing unusual translations for COs that provide special services for large corporations with complete call routings, trunk translations, etc.

- *Trunk and line assignment:*

This group's main function is to assign lines and trunks to a digital switch's line equipment and trunk equipment, respectively. It also maintains database of line and trunk assignments.

- *Coin bureau:*

Usually, coin equipment is maintained by a separate department since coin telephones employ different instruments and often different operators. Special coin collection signals and special line translators are also employed. However, the department works through SCCs and

ESACs to
correct any coin-related problems.

- *Customer bureau:*

This department is usually the single point of contact for telephone customers with requests for
telephone connection, disconnection, reconnection, and telephone problems. It usually works through the trunk and line assignment groups and the SCCs.

- *Traffic department:*

The main responsibility of this group is to model and study telephony traffic through a digital
switch. It recommends the addition and removal of trunks in a CQ based on the dynamics of traffic patterns. The group also interfaces with the engineering support group concerning trunk
estimates necessary for the installation of a new digital switch.

b. Explain System outage and its impact on digital switching system reliability.

System Outage and Its Impact on Digital Switching System Reliability

Digital switch outages represent the most visible measure of switching system reliability and affect maintainability. Various studies' have been conducted to better understand the causes of digital switch outages. Traditionally, the causes of outages have been classified into four categories:

- *Software deficiencies.*

This includes software "bugs" that cause memory errors or program loops that can be cleared only by major initialization.

- *Hardware failure.*

This relates to simplex and/or duplex hardware failures in the system which result in a system outage.

- *Ineffective recovery.*

This category includes failure to detect trouble until after service has been impaired and failure to properly isolate a faulty unit due to a shortcoming of the software and/or documentation.

- *Procedural error.*

In short, these are "cockpit" or craft errors which have caused loss of service. Examples may include inputting wrong translation data or taking incorrect action during repair, growth, and update procedures. Based on earlier studies of outage performance, an allocation of 3 minutes per year of total system downtime has been made to each of the above categories.
The most important finding in the switching system outage study was that over 40 percent of outages were caused by procedural errors directly related to digital switch maintainability issues.
To reduce digital system outage, a concerted effort is required in all four categories mentioned above. However, this chapter focuses on the reduction of system outages by proper digital switch maintenance, since currently this is the highest contributing category. The next few subsections elaborate on areas that need to be studied to improve digital switching system maintainability

6) Explain in detail the Strategy for Improving Software Quality in digital switching system.

A Strategy for Improving Software Quality

A strategy for improving digital switching system software quality is shown in Fig. 7.4. It is based on a process metric, defect analysis, and a continuous-improvement program. The importance of a good measurement plan cannot be overemphasized in the arena of software process improvement. A good example of software metrics is Bellcore's In-Process Quality Metrics and the field metric is Bellcore's Reliability and Quality Measurements for Telecommunications Systems [6] . These two measurement systems are used extensively in the United States by the telecommunications industry and are now being implemented in Europe. However, the methodology described here is independent of any measurement system, but depends on measurement systems that control software processes and field failures.

Let us consider this methodology in detail. Figure 7.4 shows five distinct processes. We begin at the top

1. Program for Software Process Improvement

This represents the heart of the system. Software processes for the digital switching system are usually large, complex, and multilocational. These processes must be formalized (i.e., documented) and base lined by putting them under a configuration management system. This will allow tracking of any changes to the process and help the process administrator to better understand the impact. A process change does not always improve a process, but a continuous improvement program (CIP) always does. The CIP strategy can vary greatly for different processes, projects, or products. The suggested strategy in this section assumes that the processes can be instrumented. The inputs to the improvement process are the thresholds established for different metrics. These thresholds are used to observe the impact of changes on all processes. A set of new thresholds is fed to the metric system when the process is changed, enforcing tighter thresholds when required. This feedback process is implemented continuously to improve the quality of the software process.

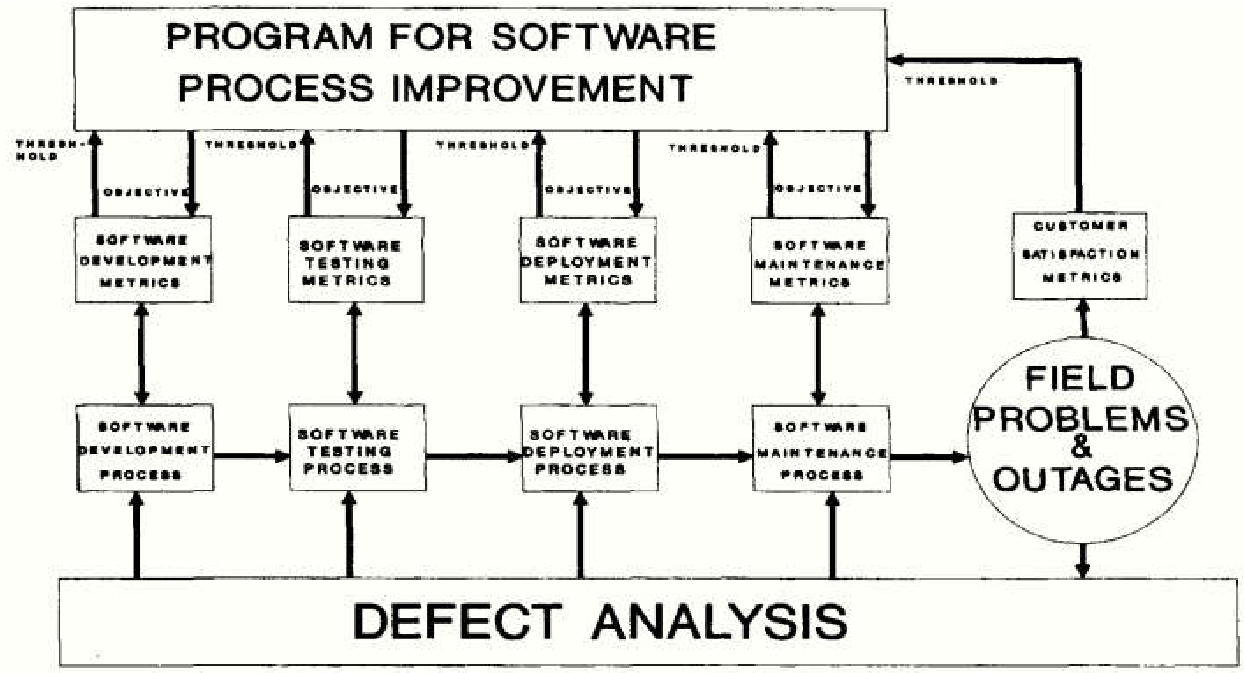


Figure 7-4. A strategy for improving software quality

a. **Software Processes**

The software processes shown in Fig. 7.4 relate to the software metrics discussed below. These include

1. Software development process
2. Software testing process
3. Software deployment process
4. Software maintenance process

- *Software development metrics:*

These metrics define measurements related to the life-cycle phases of a software development process. Typical life-cycle development phases include the software requirements process, highlevel design, low-level design, and software coding. These metrics measure the effectiveness of

these processes.

- *Software testing metrics:*

Software testing metrics measure the effectiveness of the software testing process. Typical measurements include the number of test cases planned versus the number of cases executed, testing effectiveness, coverage, etc., applicable to all test life cycles.

For digital switching systems the test life cycles can include unit testing, integration testing, feature testing, regression testing, and system testing.

- *Software deployment metrics:*

These metrics are collected during the deployment of a release in the CO. The most effective metrics in this category are the application success metrics and the number of patches applied at

the time of deployment. On occasion, during the application of a new release to a digital switch,

the upgrade process may fail; this type of information needs to be collected to improve the upgrade process. The number of patches applied during the deployment process also must be minimized.

- *Software maintenance metrics:*

These metrics are collected once the release is installed. The most important metrics are the number of software patches applied, number of defective patches found, and effectiveness of diagnostic programs.

- *Customer satisfaction metrics:*

These metrics are collected from the customers of the digital switching systems. Examples are
billing errors, cutoffs during conversation, slow dial tone, and other digital switch related problems

b. Defect Analysis

The defect analysis is a base process for this strategy. It drives the continuous improvement program. There are some well-defined methodologies for defect analysis [8], and the objective
here is not to define a new one. This strategy can function with any type of defect analysis methodology. After a release becomes functional in the field, it will eventually experience failures. Field failures are usually classified according to severity. Field failures that cause system outages are classified as critical, followed by less severe ones as major or minor.
A causal analysis of all failures especially critical and major ones is conducted first. After the analysis, the causes of failure are generally categorized as software, hardware, or procedural.
In the next step, each failing category is expanded into subcategories. Since the strategy described here is for software processes, the hardware and procedural categories are not covered
here. However, this strategy can be applied to hardware faults if the hardware development process can be mapped into life-cycle phases. Some procedural problems due to software procedures can be included in the sub categorization process.

7)

a. Explain Common characteristics of DSS.

Some Common Characteristics of Digital Switching Systems

Most commercial digital switching systems in the North American network exhibit some common characteristics. They are described here at a high level and do not pertain to a particular switch. Chapter 10 provides some high level details on some major digital switching systems that are currently deployed in North America.

- ***Dual capability***. Most digital switching systems covered, which are primarily class 5, can also have tandem/toll or class 4 capabilities.
- ***Termination capability***. Most of the large digital switching systems can terminate approximately 100,000 lines or 60,000 trunks.
- ***Traffic capacity***. In a distributed environment, this depends on the digital switch configuration, and it can go as high as 2,000,000 busy hour call attempts (BHCAs).
- ***Architecture—hardware***. Most digital switching systems have a quasi- distributed hardware architecture (see chapter 2 for definitions), since they all maintain control of the switching functions through an intermediate processor. All digital switching systems employ multiple processor subsystems.
- ***Architecture—software***. Most digital switching systems maintain a modular software design, sometimes through layering or through functionalities. They have operating systems under which application systems function. They all support database systems for office records,

subscriber records, administration records, etc. They all have maintenance subsystems that support diagnostic and switch maintenance processes. They also support billing systems for subscribers such as the automatic messaging system.

- ***Switching fabric***. Most digital switching systems utilize time-space- time (TST) mode for switching calls.

- ***Remote operation***. Most digital switching systems have remote switching modules (RSMs) to support switching functions in a remote location. And most remote switching systems have standalone capabilities, so if the main switching system (host) goes down, the remote units can still switch local calls.

b. Explain recovery strategy of DSS.

Recovery Strategy

The following is a possible recovery strategy for the hypothetical digital switching system developed for this book. An effective recovery strategy for this digital switch could be based on

a three-level scheme. These schemes can be based on the three control levels developed for this digital switch:

Level 1 Initialization (INIT 1)

This is considered the lowest level of initialization for the digital switch. This level of recovery initializes all components that function at level 1 control (see chapter 2). It is controlled and directed by the interface controllers which control line modules, trunk modules, and peripheral modules (PMs).

This INIT 1 recovery could be directed specifically to initialize defined line modules, defined trunk modules, and defined peripherals. This recovery strategy selectively initializes lines, trunks, or peripherals based on the severity of the problem. This recovery can be called local recovery, since it can initialize peripherals locally without impacting the operation of the entire digital switching system.

EXAMPLE

After a thunderstorm, a technician in a digital CO found 17 LMs, 5 TMs, and 2 PMs hung up (nonoperational). This was causing a partial outage and other operational difficulties. In this type of situation, it is appropriate for the technician to conduct a direct local recovery of these modules. Manual restoral would take too long. This type of recovery will have minimal impact on the rest of the digital switching system and will bring the digital switching system to normal operation by the low-level initialization of the digital switch.

Level 2 Initialization (INIT 2).

This type of recovery can be considered as a middle-level initialization for all components that function at level 2 control. This INIT 2 recovery could be directed specifically for initializing a specified network control processor and a group of network control processors. Because of the distributed architecture of this hypothetical digital switching system, each NCP controls a number of ICs. The ICs in turn control the line, trunk, and peripheral modules. If a NCP breaks down and the backup NCP cannot switch to active mode cleanly or if a duplex failure of a NCP pair occurs, then the operation of all ICs connected to the NCPs will be impacted. Under this condition, two types of recovery strategies need to be considered. If the problem is due to a NCP's switching from active mode to standby mode and the "switch" is not "clean," then the connected ICs may help to stabilize connections by running an INIT 1 initialization on the lines, trunks, and peripherals. If that does not help, then an INIT 2 needs to be run to initialize the NCP and associated ICs with connected LMs, TMs, and PMs. If the problem is due not to processor switching, but to a hard duplex failure in the NCP pair, then an INIT 2 needs to be run immediately. This will naturally impact all the connected ICs and associated LMs, TMs, and PMs. A multiple-NCP strategy will require initialization of a number of NCPs. Initialization of all NCPs would require a level 3 initialization.

EXAMPLE

The maintenance personnel tried to switch a NCP with its redundant side after the diagnostics for the NCP failed. The NCP switch was not successful, and the digital switch lost all calls

controlled by the NCP. A situation like this requires an INIT 2 initialization. This is considered a partial outage.

Level 3 Initialization (INIT 3)

This is the highest level of initialization for the digital switch. This level of initialization functions at level 3 control. This INIT 3 recovery could be directed specifically for initializing the central processor (CP) and all network control processors. This is the highest level of initialization, and it is run when the redundant CPs fail or the CP switch is not successful and the digital switching system cannot fully function with defective CPs. Under this initialization scheme, the recovery program tries to identify the problem with the last known good CP. It also seeks a "minimum" configuration for it to function. Since it cannot function fully, it will function with a reduced number of NCPs or no NCP at all, depending on the severity of the problem. Lower load or no load on the system will allow the CPs to be diagnosed effectively. Once the CP is fixed, the system will then run the INIT 2 process to synchronize all NCPs and bring them up on-line. This level of initialization will cause a total system outage.

EXAMPLE

A digital switching system starts experiencing slow dial tone, and after a time it runs an automatic INIT 2 initialization. This clears the slow-dial-tone problem, but the problem returns after a few minutes. The digital switch then starts taking repeated INIT 2's. At this stage, the technician initiates an INIT 3, which clears the problem. This type of condition usually occurs because of software corruption in the CP, and an initialization normally clears it. A thorough root-cause analysis of this type of outage needs to be conducted and the robustness of the system improved.

Manual Recovery

When repeated use of INIT 3 does not recover the system, manual recovery of the digital switch becomes essential. Under manual recovery, the generic program with the last known good office data and selected subscriber data is loaded in the digital switch. Then manual diagnostics or specialized diagnostics are used to recover the digital switch. This type of manual recovery scheme is digital switch-specific, but the basic idea is as follows:

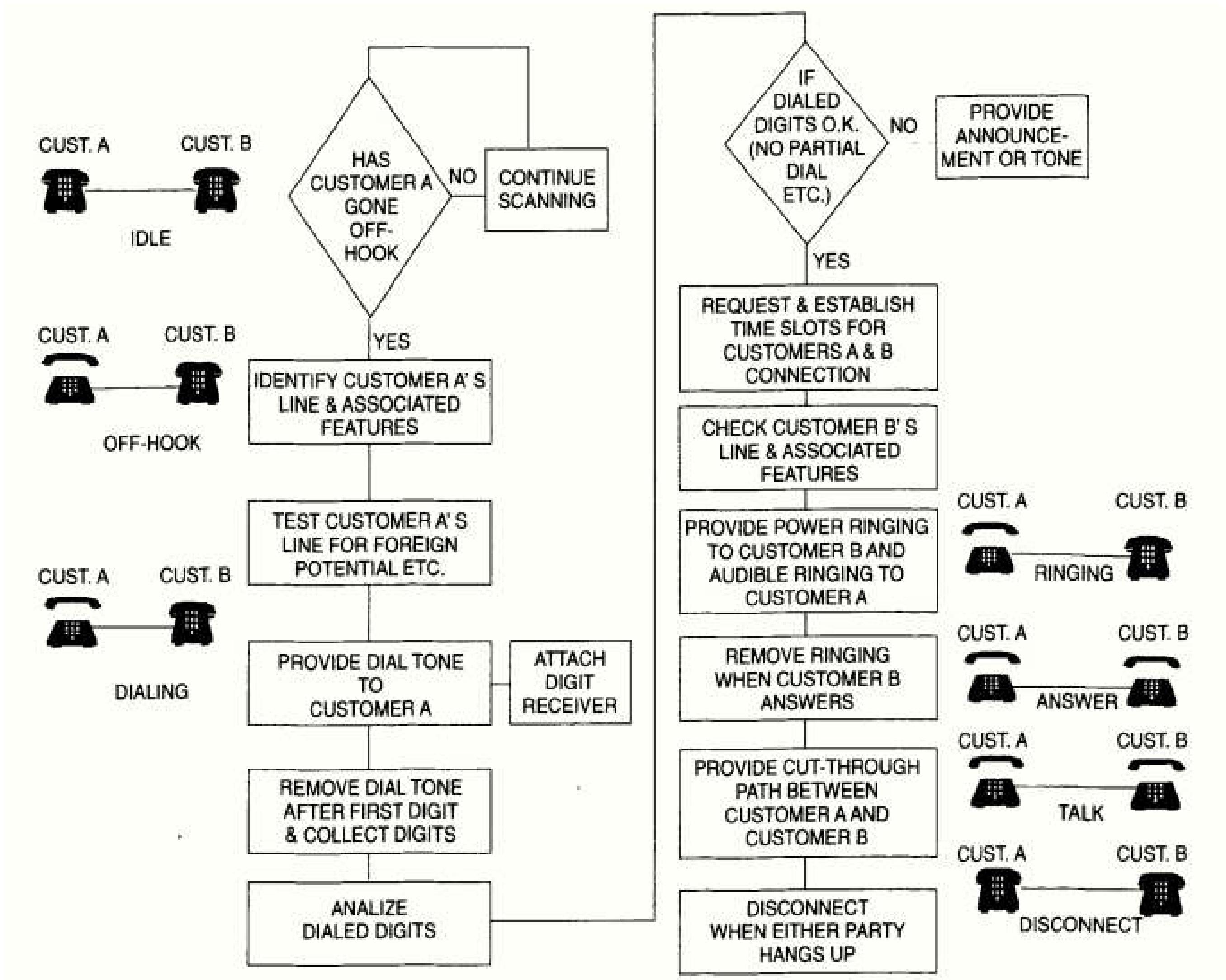
- Bring up the system with manual effort since automatic runs of INIT 1, INIT 2 and INIT 3 failed to bring the system back on-line.
- The current generic program and data may be corrupted; the system is updated with last known good generic program and data.
- Special diagnostic programs and techniques are needed to identify the Problem.

8) With a neat flow chart explain the simple call establishment process with different call scenarios.

A flowchart for a typical call through a typical digital switching system is shown in Fig.
8.3. Most digital switching systems follow a similar scheme. However, note that not all digital

switching systems may follow exactly the call connection sequence shown in the flowchart, but these high-level functionalities are usually covered. Details of different types of calls are given in chapter\, and the software linkages required during a call are covered in chapter 5. The basic steps necessary to complete a simple call are as follows:

1. Detect off-hook condition.
2. Identify customer's line.
3. Test customer's line.
4. Provide dial tone to customer.
5. Provide digits analysis of dialed number.
6. Establish a path between the calling customer and the called customer.
7. Ring the called customer.
8. Detect answer and establish cut-through path.
9. Supervise both lines for disconnect.
10. Detect on-hook condition and disconnect



Simple more Call Through a DSS

- Line to Line Intra IC Call
- Line to Trunk Intra-IC Outgoing Call
- Line to Line Inter IC Call
- Line to Trunk Inter-IC Call

- Trunk to Line Intra-IC IGT Call
- Trunk to Line Inter-IC IGT Call

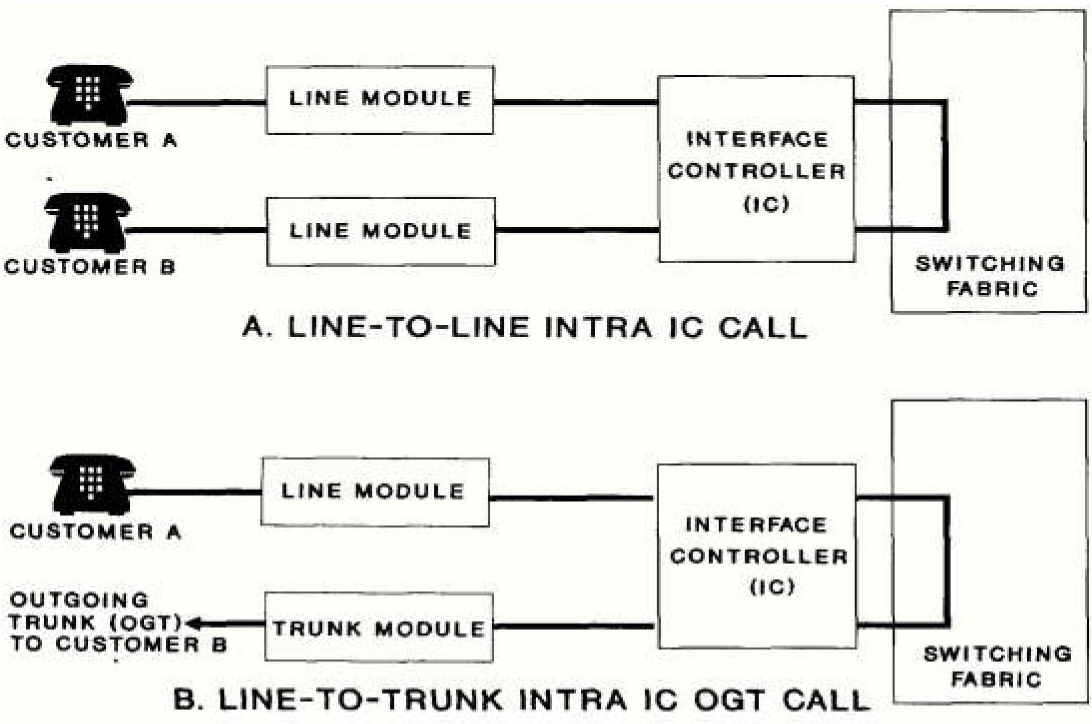


Figure 8.4. Calls within the same interface controller

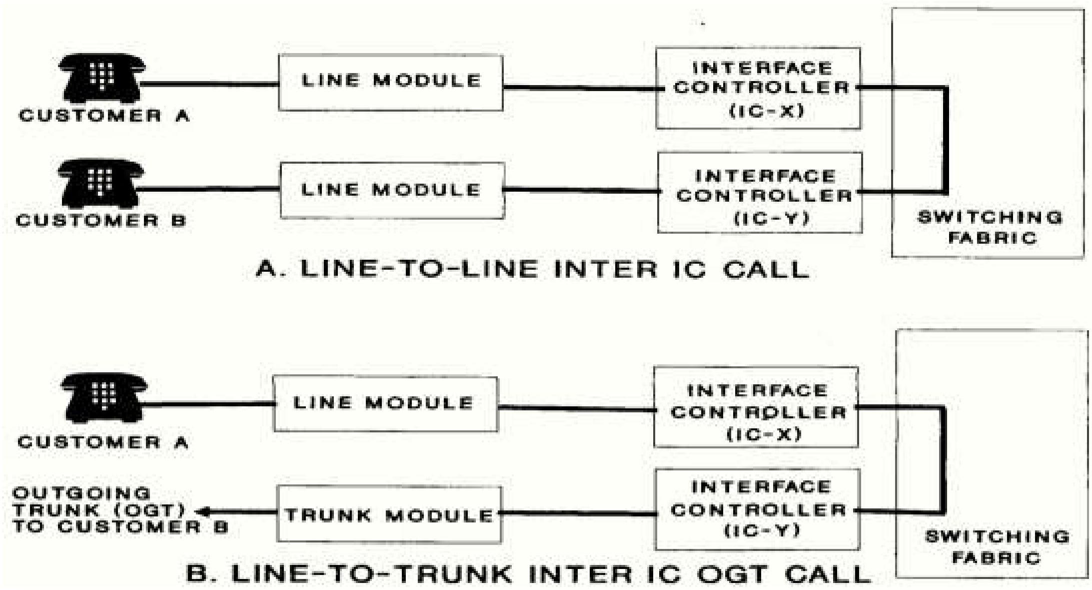
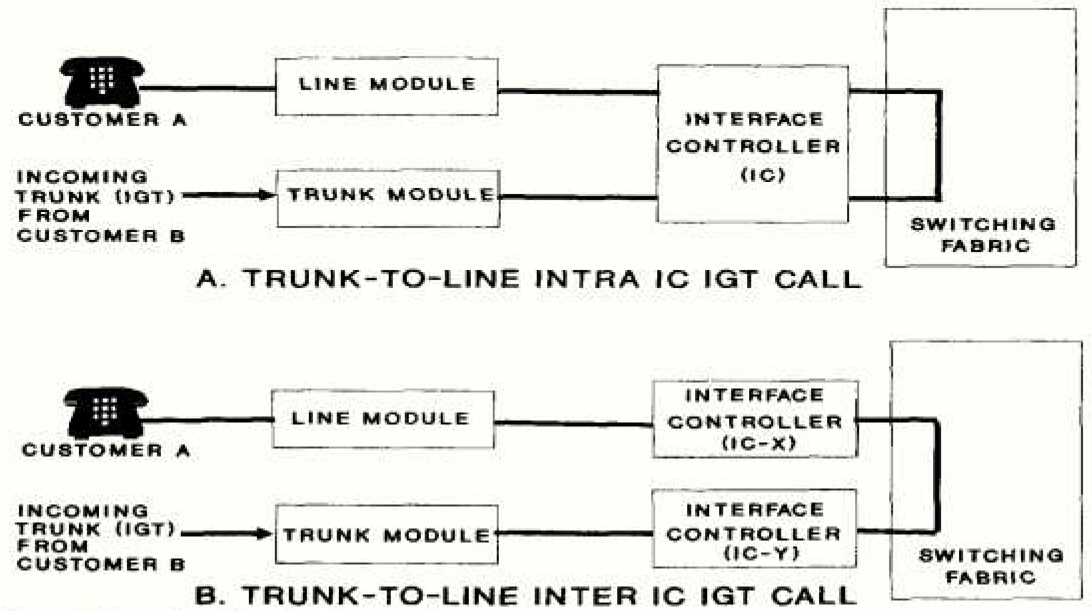


Figure 8.5. Calls between different interface controllers



- **Figure 8.6.** Incoming calls to interface controllers