Communication Switching Systems

Communication Networks and Switching

Course Code: ETU07402

Lecture 02

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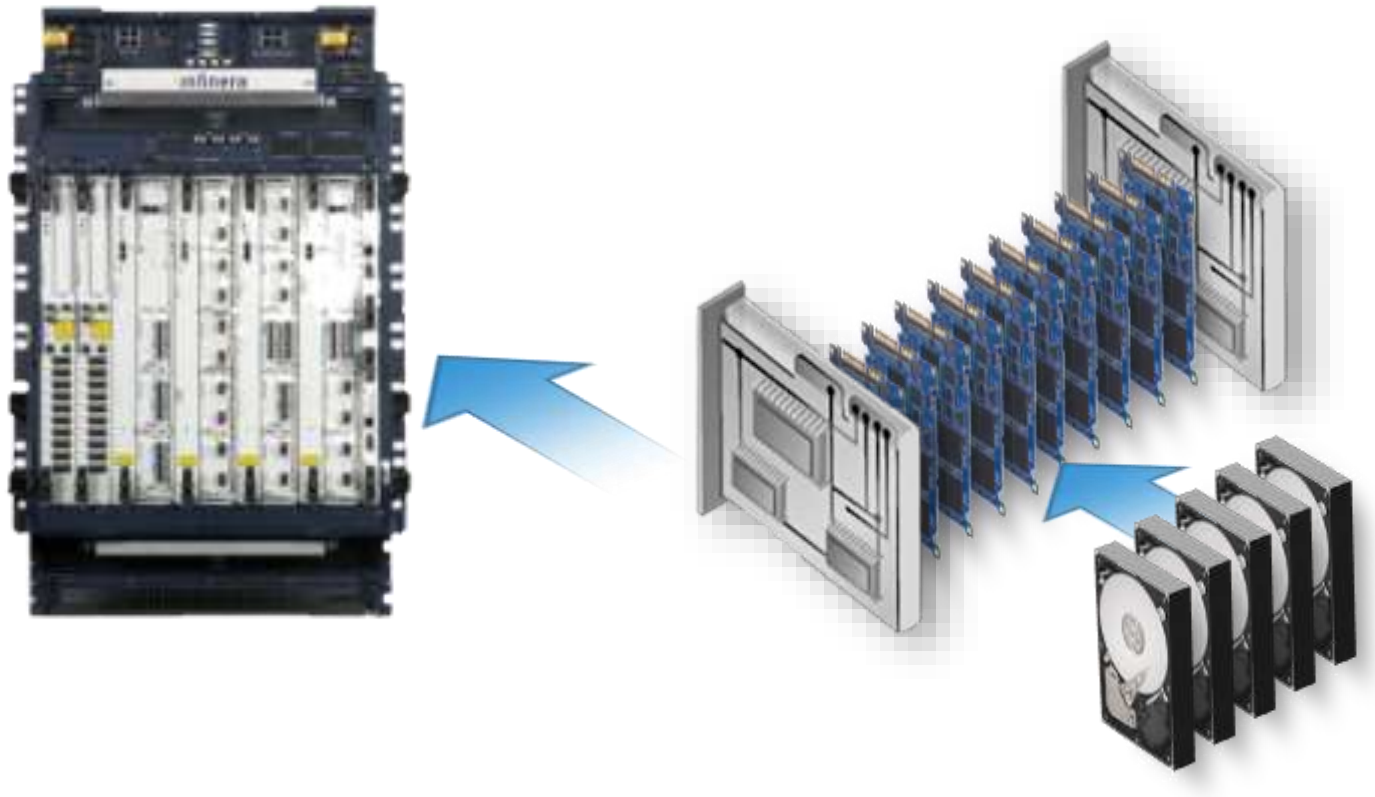
Electronics & Telecommunication Engineering

Lecture 02



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2.0: Introduction To Digital Switching Systems

- Most digital switching systems have a quasi-distributed hardware architecture
- They maintain control of the switching functions through an intermediate processors.
- Employ multiprocessor subsystem (For easy understanding of communication and control process)
- Digital switching system Architecture is very complex with many subsystems.
- Have min. software necessary for implementation of call processing for all levels of control structure
- Various call processing functions are performed by using interface controllers; these includes:
  - Call Identification
  - Call Routing,
  - Path Setup Between Subscribers,
  - Digital Translation,
  - Call Status,
  - Billing Etc.

2.1. Call Processing

Call Processing: the basic steps involved in processing a call.

For any switching system design, the range of signals that has to be interchanged between a terminal and system is considered. These signals described in signal exchange diagram. There are two types of diagrams used to represent the sequence of events between the subscriber and exchanges. They are ***Signal Exchange Diagram*** and ***State Transition Diagram***

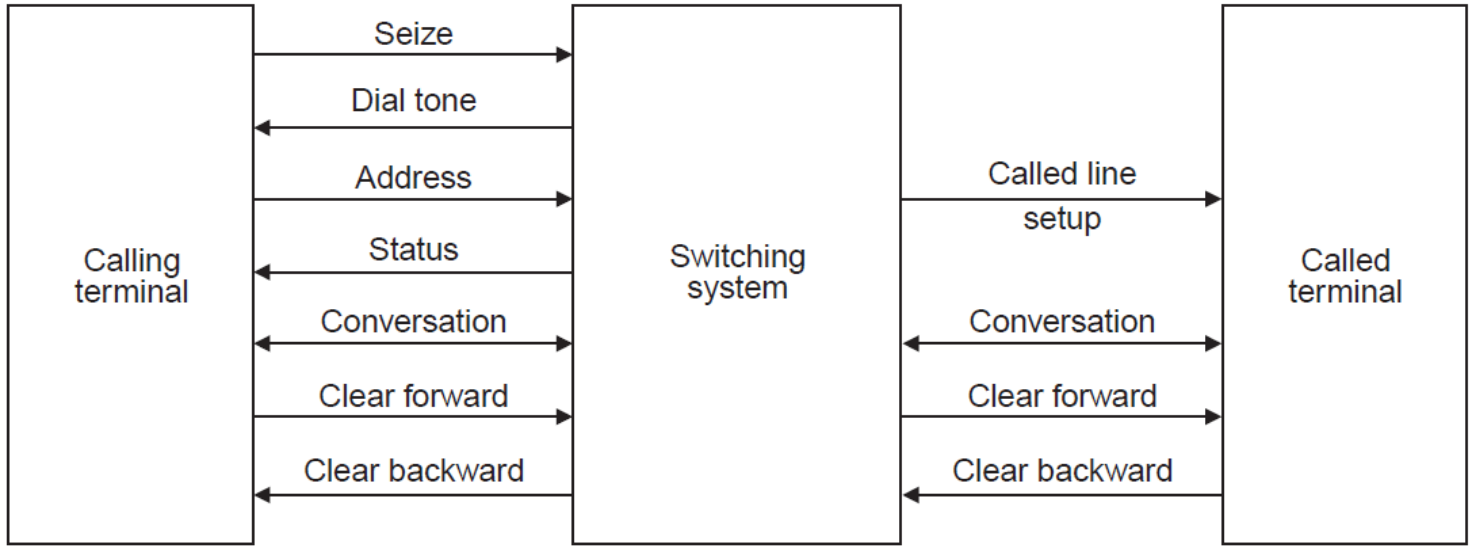


Figure 2.1:Signal Exchange Diagram

2.1.1. Basic steps to process a call

The sequence of call processing between subscribers are described below

- **Idle State:** At this state, the subscriber handset is in ‘on-hook’ condition. *(The exchange is ready to detect the call request from the subscriber)*
- **Call request identification:** The exchange identifies a line requiring for a service. (*When the handset is lifted, current flows in the line called seize signal indicates the call request)*
- **Providing Dial Tone:** Once the seize signal is received, an exchange sends a dial tone to the calling subscriber to dial the numbers.
- **Address Analysis:** Once the first digit received, the exchange removes the dial tone and collect all numbers. *(Address is analysed for the validity of the number, local, STD or ISD etc. If the number is invalid, a recorded message may be sent to the calling subscriber and terminates call request.)*
- **Called Line Identification:** The exchange determines the required outgoing line termination from the address that it has received

2.1.1. Basic steps to process a call

- **Status of called subscriber:** The called line may be busy or free or unavailable or even out of service.
- **Ringing:** Once, the exchange finds the called subscriber is free, power ringing is provided to the called subscriber and audible ringing to the calling subscriber.
- **Path setup**: When the called subscriber lifts his handset, the line is looped and ringing is removed. Once the conversation started, the exchange completes the connections between the subscribers.
- **Supervision**: The exchange supervises the connection to detect the end of the call for charging.
- **Clear signal**:. Once the need for connection is over, either customer may replace his handset. (The line current seize and provides a clear signal to exchange.
  - **Forward signal:** If the calling subscriber replaces his phone set,
  - **Backward signal**: If called subscriber do first,

2.1.2. Signal exchange - diagram

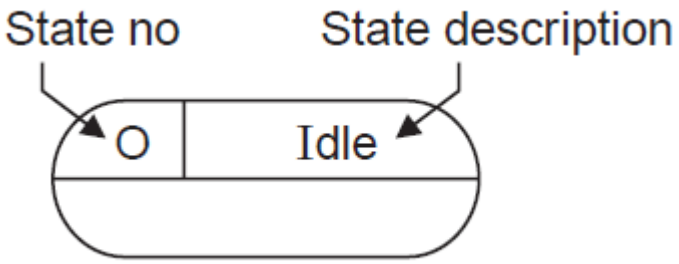
Normally, once the conversation is over, the exchange will be at idle state. But in general, there are two types difficulties arises.

- **Called subscriber held (CSH).** This condition arises when the called subscriber replaces the hand set but the caller does not. In this case, the caller does not originate a call or receiver a call.
- **Permanent loop condition (PL).** This condition occurs when the caller replaces the phone but the called subscriber does not. Now, a loop present between called and exchange and it results in busy tone to a another call to the same called subscriber.

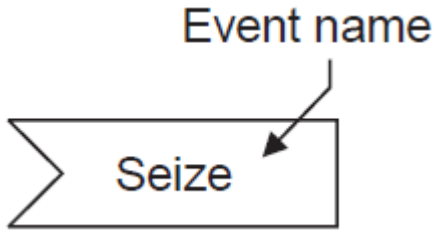
- **Take Note:** In electromechanical system, the above conditions are removed by manual disconnection. In modern ESS systems, a time out process is used.

2.1.3. State Transition Diagram

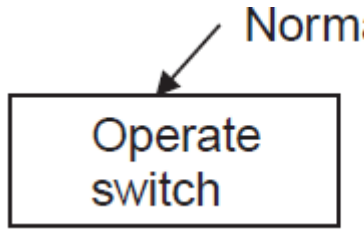
- **The state transition diagram (STD)**: specifies the response of a control unit to any sequence of events.
- STD helps the Telecommunication Switching designer to consider all possibilities of event occurrence.
- Diagrams below shows the basic symbols used in a state transition diagram

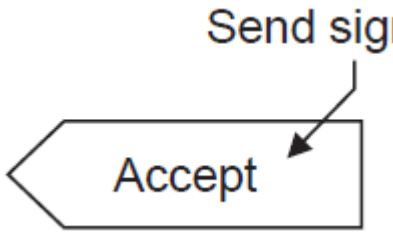


(a) State box

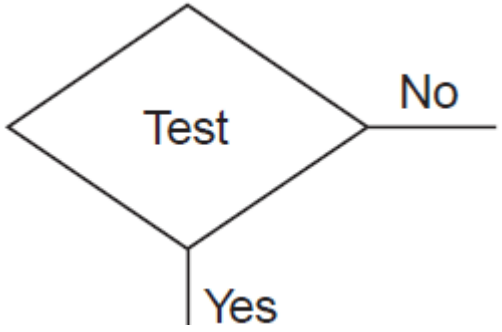


(b) Event box

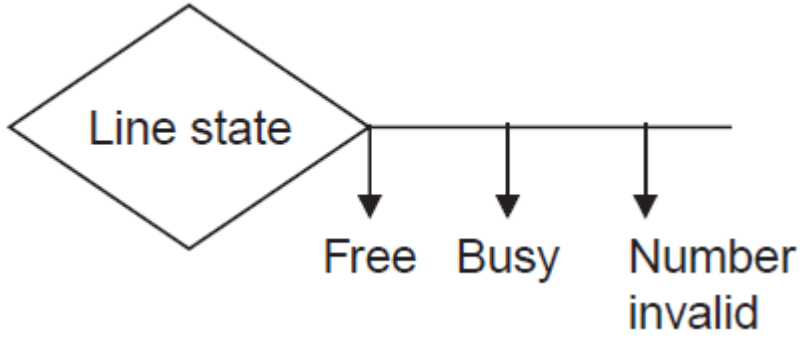




(c) Action boxes



(d) Decision box



(e) Multiple decision box

(f) Connector (to other diagrams)

2.1.3. State Transition Diagram

- **State boxes;** are labelled with state number and state description. The combination of the present state and a new event defines a task and performing this results in next state. Sometimes more than one state occurs, the choice depending on external information.
- Event boxes. The intended arrow of the symbol indicate whether the event corresponds to the receipt of forward or backward signal. The forward signal and backward signal refers to the flow of signal from calling to called or vise versa through exchange respectively.
- **Action boxes:** The rectangular box represents the action taken on the event. The protruding arrow indicates whether the signal is sent forward or backward.
- **Decision boxes**. The diamond shaped box is used where two divisions are possible. For multiple decisions, symbol shown in Fig. (e) is used.
- **Connectors**. This symbols are used to connect one flow chart to another diagram

2.2.3. State Transition Diagram

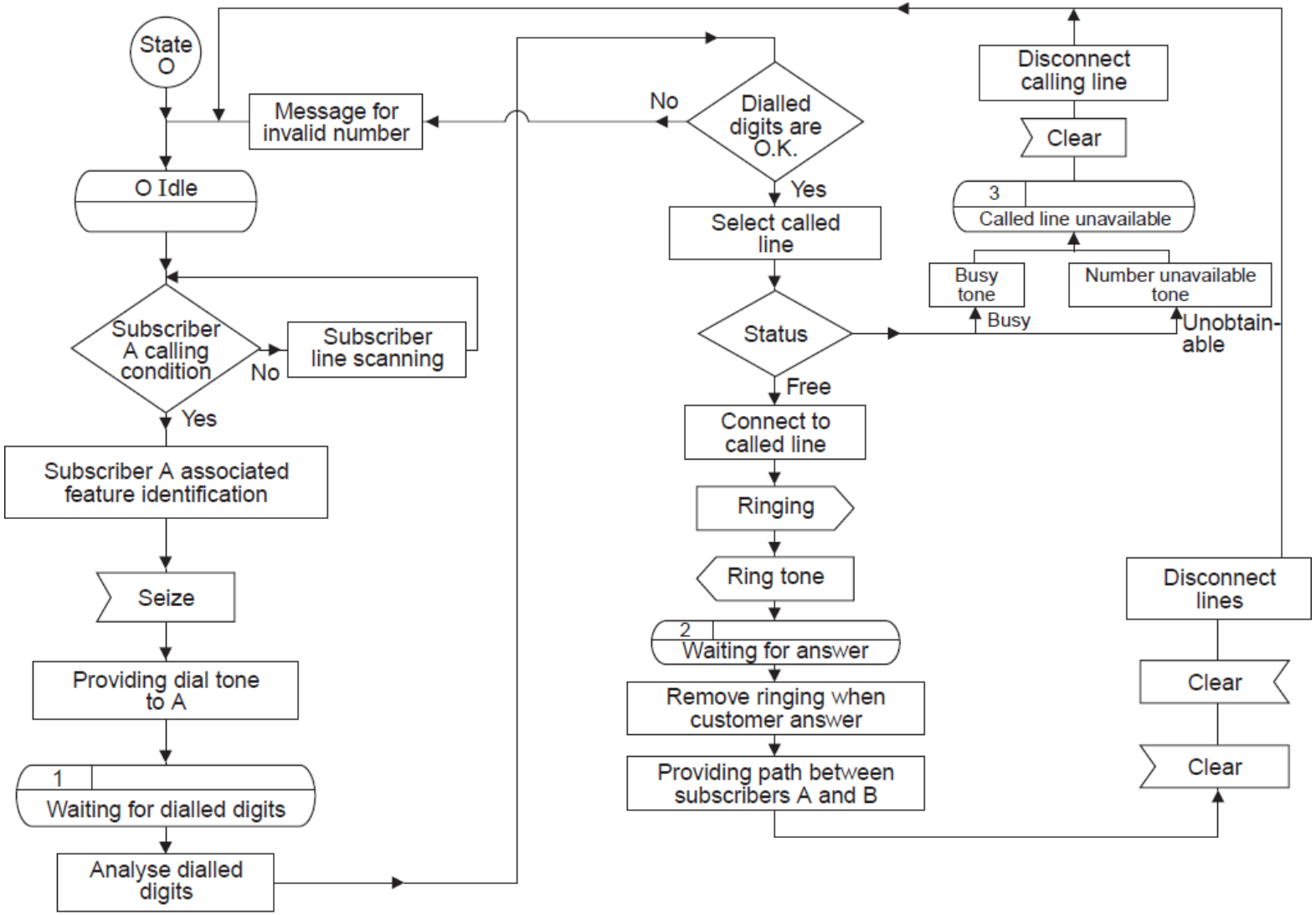


Fig 2.3. Example: a typical S.T.D diagram for local call ie subscriber A calling subscriber B

2.2. Hardware Configuration

- The ***Computer Controlled Switching*** commonly referred as ***Electronic Switching System*** (ESS) offers greatest potential for both voice and data communications.
- ESS hardware is broadly divided into many subsystems each performs respective functions such as
  - Line And Trunk Access,
  - Line Scanning,
  - Message Interpretation,
  - Switching Communications,
  - Path Setup Between Subscribers,
  - Line Supervision,
  - Line Termination,
  - Billing Providing Advanced Features
  - System Maintenance.

2.2. Hardware Configuration

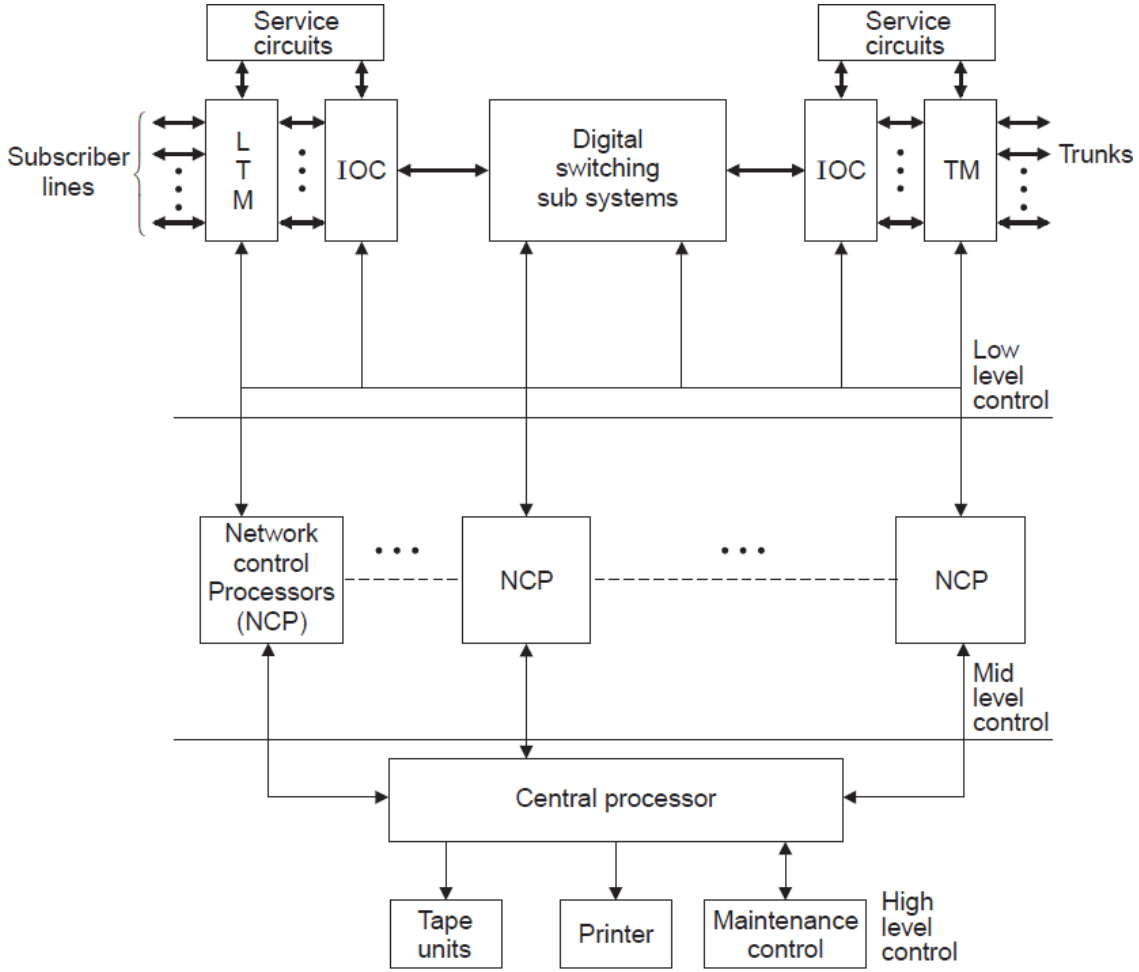
- Typical ESS have the following consist of the following four main key components
  - Computer
  - Memory or storage
  - Programming capability
  - An extremely rapid switching component.

Table 2.1 control and its subsystems

Low level control	**Mid level control**	**High level control**
Line Terminating module	Network control processors	Central processors
Trunk module		Tape units
Input/output controller		Printers
Service circuits		Maintenance control

2.2. Hardware Configuration

- Most switching systems employ multiprocessor subsystems architecture ie AXE–10 (Sweden), DMS-10 (Canada), E–10 (France), No. 5 ESS (USA) EWS D (Germany) and the NEAX (Japan).



- LTM : Line terminating modules,
- TM : Trunk modules,
- IOC : Input/Output controller,
- NCP : Network Control Processors.

Figure 2.4: Hardware architecture of digital switching system (ESS).

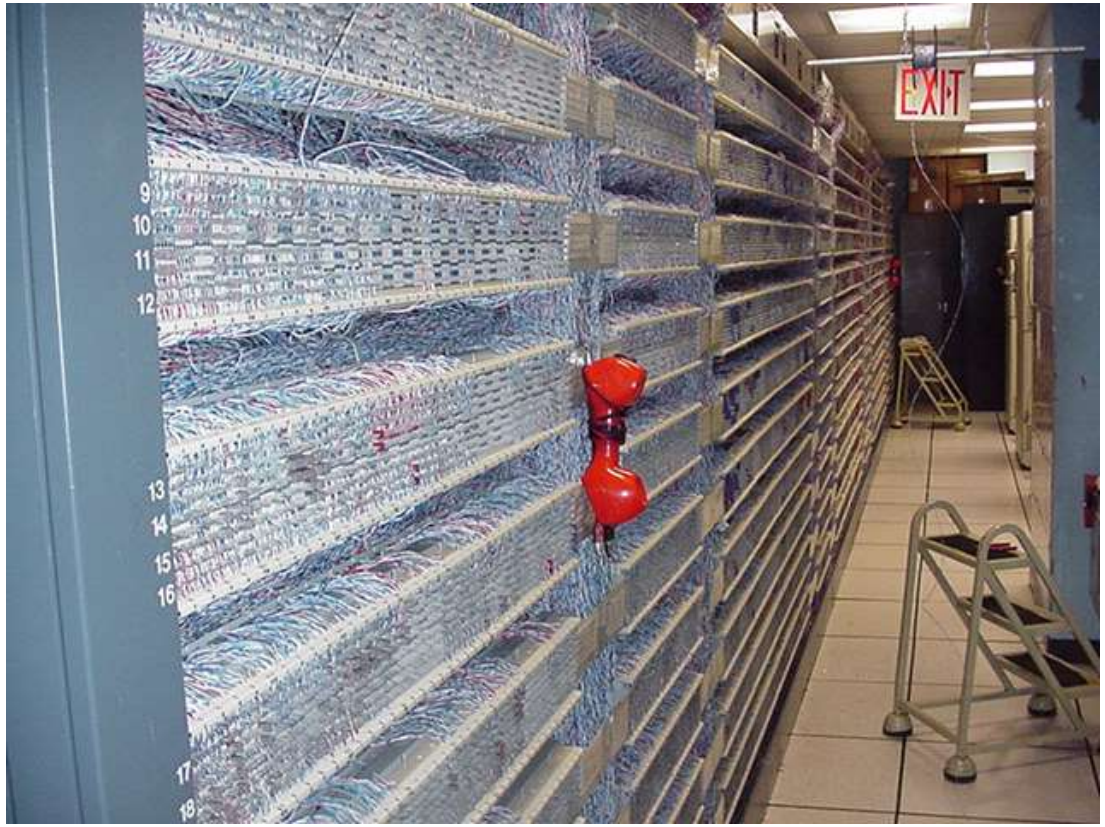
2.2.1. Low level control.

- **Low level control.** This level associated with subscriber lines, trunks, selective circuits, Input/output controller and digital subsystems. The line terminating module and trunk modules are microprocessor based and communicate with subsystems through the IOC. The IOC interpret the incoming messages and takes necessary actions and communicate to the NCP.

- **Subscriber lines** (connected to digital switching system through the Main Distributing Frame (MDF)) are continuously scanned to detect the state of the subscriber. Once the subscriber lifts handset, the line scanning program detects this state and reports to the IOC. The IOC is the primary peripheral controller and it controls all peripherals associated with call or trunk processing. At this level, all the requests of incoming and outgoing trunks are handled. Furthermore, any advanced features to be incorporated in a digital switching system also handled at this level using IOC.

2.2.1. Low level control

- The **MDF** is a termination point within the local telephone exchange where Exchange and terminations of local loops are connected by jumper wires. All cable copper pairs Providing services to Subscriber are terminated and Distributed at the MDF within the local exchange.



2.2.2. Mid level control.

- **Mid level control.** is associated with NPC and associated circuits.
- The IOC is controlled by the NPC.
- Many NCP’s are used depends on the size of the digital switching system. A dedicated bus system is usually required for the processors to communicate with one another. Specific messaging protocols are used to communicate between processors.
- For messaging between the peripherals and external systems, most digital switching systems utilize standard Signalling protocols such as signaling system 7 (SS7), X.25 and X.75. Thus this is the most important level of control any digital switching system.
- Distributed processing are performed at this level.

2.2.3. High level control.

- **High level control.** It is associated with central processor (Computer) to organizes the entire network control sub processors. It includes the following subsystems:-
  - Call accounting subsystems (CAS),
  - Call processing subsystems (CPS).
  - Digital switching subsystems (DSS).
  - Digital subscriber's switching subsystem (DSSS),
  - Local administration (LA),
  - Maintenance control subsystems (MCS);
  - Management statistics subsystems (MSS),
  - Message transmission subsystems (MTS),
  - Signal interworking subsystems etc.

2.2.3. High level control

- In real time operation, the processor determines the state of a call by reading data from memory.
  - **Line Store.** In this memory, the status of the line is stored.
  - **Call Record**. All the call processing data's such as origin of a call, path of a call, duration of a call and clearing of a call are stored.
  - **Translation Tables.** This is a look-up table required to decode routing digits into suitable routings. Hundreds of translation tables are built for a switching system which stores data for Equipment number (EN) to directory number (DN) and for DN–to–EN translation. Also it consists of, features related to a particular subscriber, data to route the call based on the first 3 digits dialed, area code translation, international call translators etc.
  - **Map of the switching network**. There are two techniques for selection junctors.
    - **Map-in-memory**. In this technique, the memory contains a bit for each link. If it is set to 1 the link is free and if this bit is set to zero, the line is busy.
    - **Map-in-network.** In this technique, the junctor itself contains a one bit memory element, which is read by the path setup program to check whether it is free.
    - The map-in-network consumes more time, but more advantages when several processors controlling the system.

2.3. Hardware Configuration

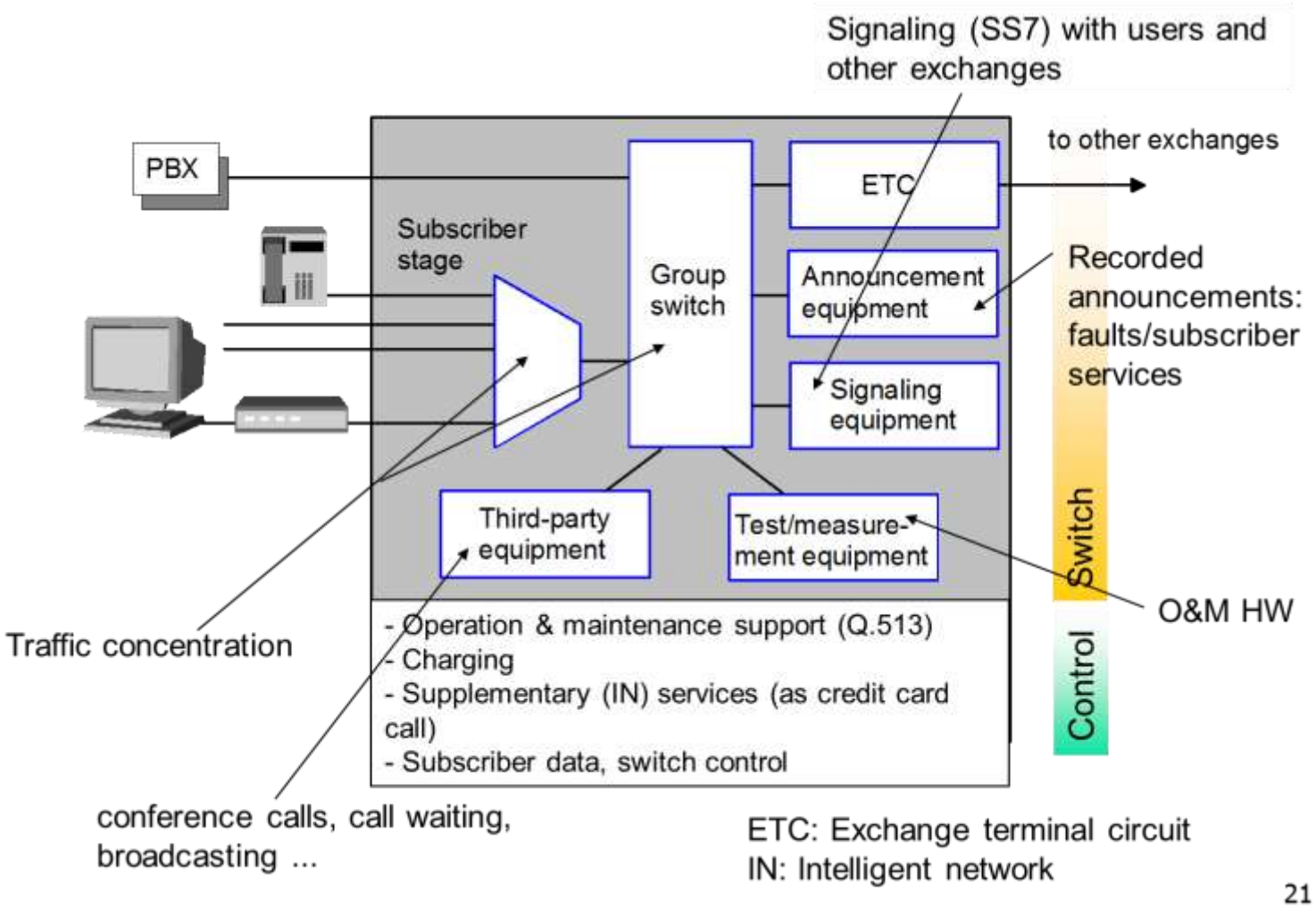
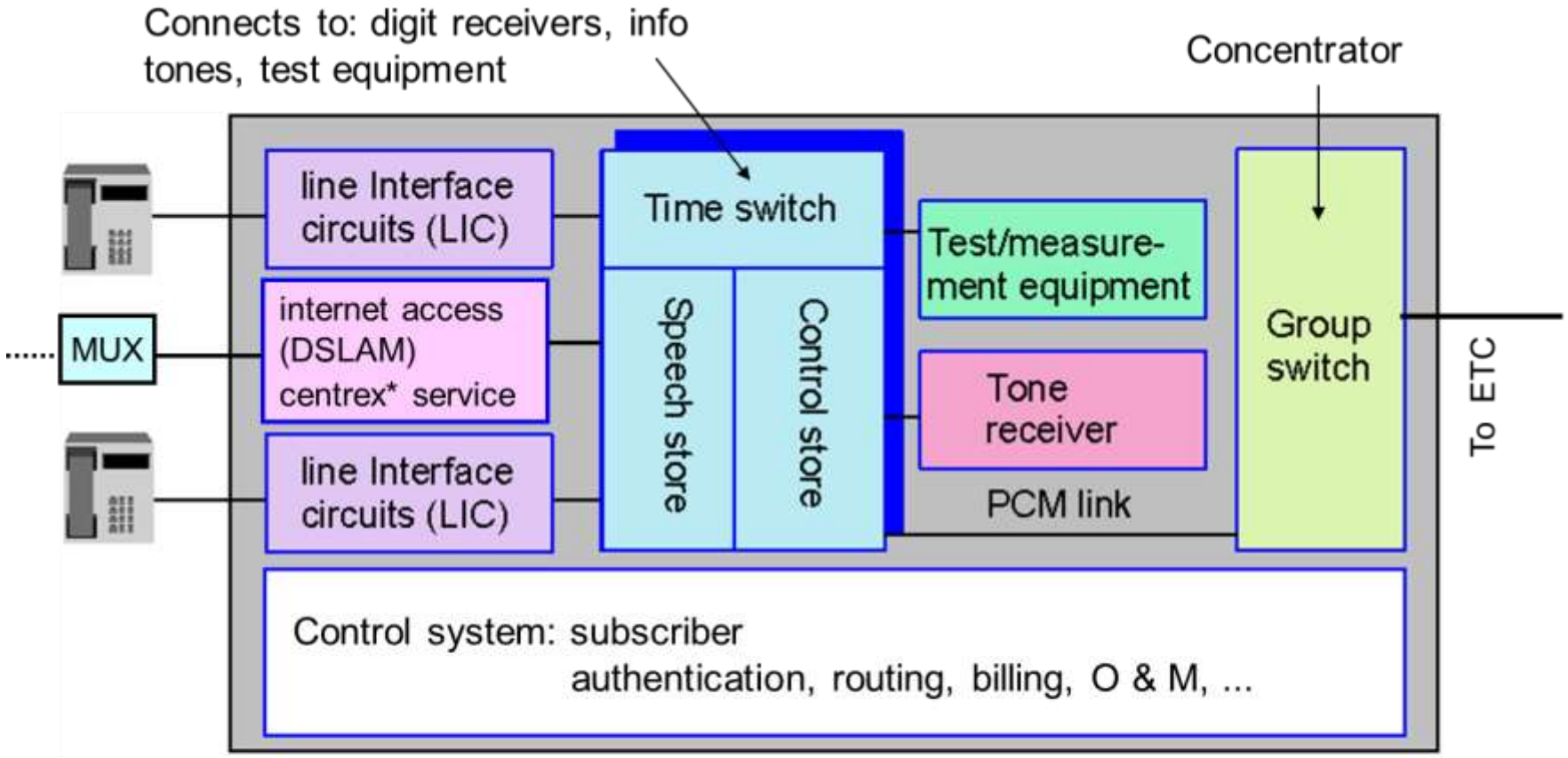


Figure 2.4:Modern local exchange

2.3. Hardware Configuration



ETC: Exchange terminal circuit
Speech store: shift registers storing bits for time switching
Control store: gates guiding speech store switches
* leased PBX function from local exchange

Figure 2.5:Subscriber stage

2.3. Switching System Software Organization

- Software Programs plays a vital role ESS it enables a Switching system input data, to give outputs in a fraction of seconds, concurrent processing of many calls in real time and performs many other features.

- In addition to call processing, any exchange offers various facilities and many administrative tasks. To carry out these activities efficiently and effectively, the use of software is unavoidable.

2.3.1. Need for Software

	Basic Functions
1	Call processing
2	Network control
3	Signalling control
4	Maintenance and administration
5	Traffic recording

	Customer care services
1	Different modes of bill payment
2	CTD websites
3	Changed number enquiry services
4	Telephone reconnection service
5	Telephone address correction

Digital Switching System

	Support of new technologies
1	STM rings
2	Intelligent networks
3	Local network management systems
4	Microtunnelling
5	Centrex

To perform the above tasks, a large amount of software is required. Approximately 70% of the total software is used to perform basic functions. Only 0.1% of the total processing time is used by the 30% of the remaining service oriented software packages.

	Additional services
1	Answering machine services
2	Direct internet access services
3	Voice over P (VO P)
4	Accountless internet
5	Internet telephone

Fig. 2.6: Various activities of digital switching system.

2.3.2. Software Classification and Interfacing

- **Software Classification**: Basic Digital Switching software systems are classified as:
  - Maintenance Software
  - Call Processing Software
  - Database/Administration Software
  - Feature Software.
- **Software packages** are divided into modules, to perform specific task.
- The modules are grouped together to form functional units. Software modules are designed to meet specific requirement ie business, the location of telephone exchanges, customer needs, internal requirements, and parameterized design.
- **The parameterized design** includes hardware and software parameters ie NPCs, number of line controllers, number of subscribers to be serviced, number of trunks for which the exchange is engineered etc.
- **Software parameters**: are the registers associated with number and size of automatic message accounting (AMA), number and size of buffers for various telephony function and features used in exchanges.
- Thus, the parameterized design helps in designing software common to the similar types of exchanges.

2.3.2. Software classification and interfacing

- **Maintenance software**: Performs various activities and tests involved to maintain a switching system such as
  - Supervision of the proper functioning of the exchange equipment, trunks and subscriber lines.
  - Monitoring the database of line and trunk assignments.
  - Efforts for the system recovery in case of failure.
  - Automatic line tests, which permits maintenance persons to attend several exchanges from one control location.
  - Effective diagnostic programs and maintenance strategies used to reduce the maintenance cost.
- **Call processing software**: Responsible for call processing and interfacing with the translation data, office data, automatic message accounting and maintenance programs: The call processing functions are controlled by a Central Processor; which also performs maintenance & administration, signalling, network control functions.

2.3.2. Software Classification and Interfacing

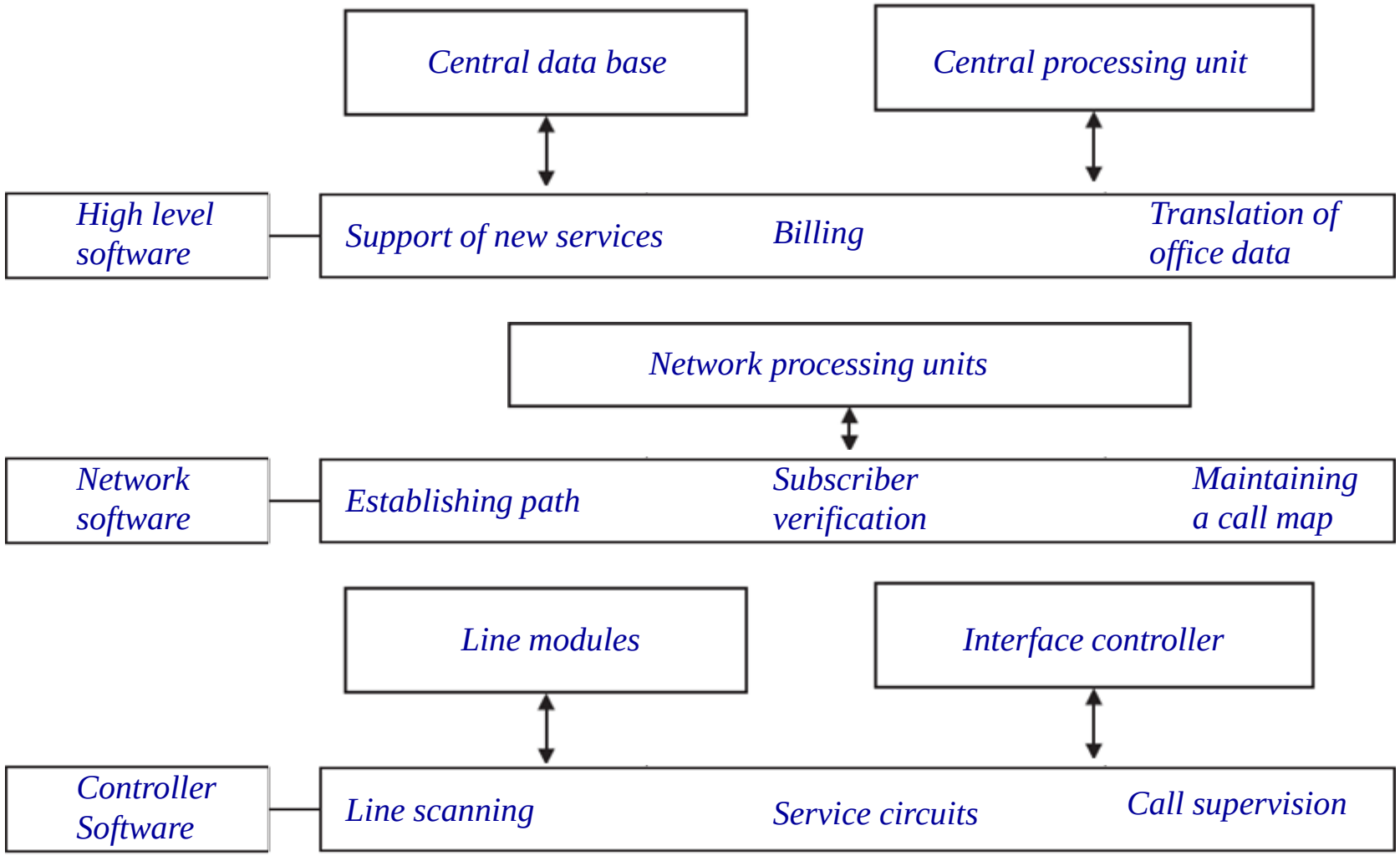


Figure 2.7: Call processing software levels.

2.3.2. Software Classification and Interfacing

- **Data base/Administration software**: The administration tasks includes
  - Alarm processing
  - Traffic recording
  - Change of numbers or area codes corresponding to the change in subscriber rate and Government policy.
  - Changing routing and routing codes. This decisions made on the traffic intensity of a particular exchange.
  - Generation of exchange management statistics.

- Most digital switching system employ a data base system to:
  - Record office information
  - Billing information
  - Software and hardware parameters
  - System recovery parameters
  - System diagnostics.

2.4. Popular Digital Switching Systems

2.5. Electronic Exchanges in Tanzania

NEAX Switching System

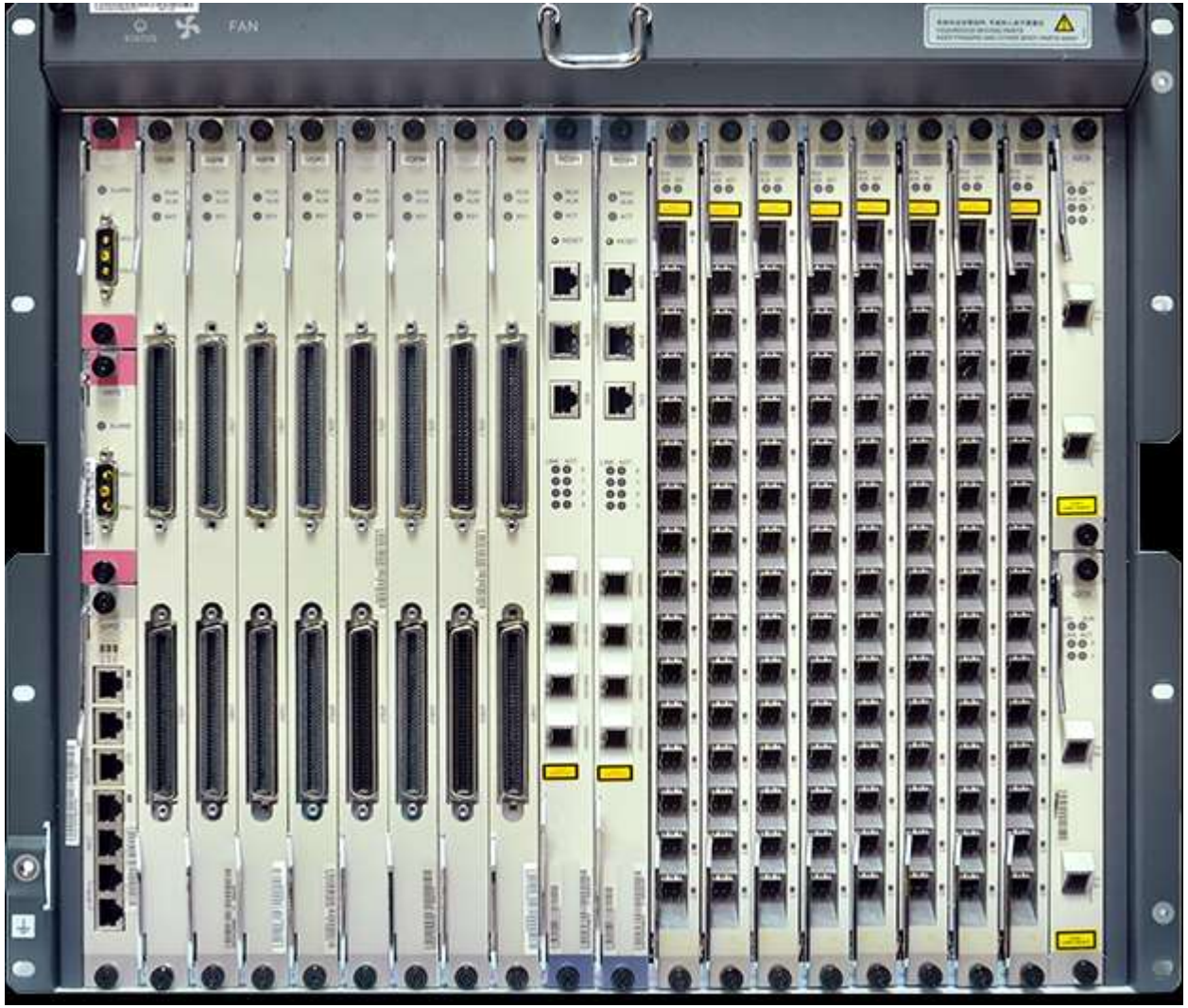
Backup Tape

2.5. Electronic Exchanges in Tanzania

AXE10 Switching System

2.5. Electronic Exchanges in Tanzania

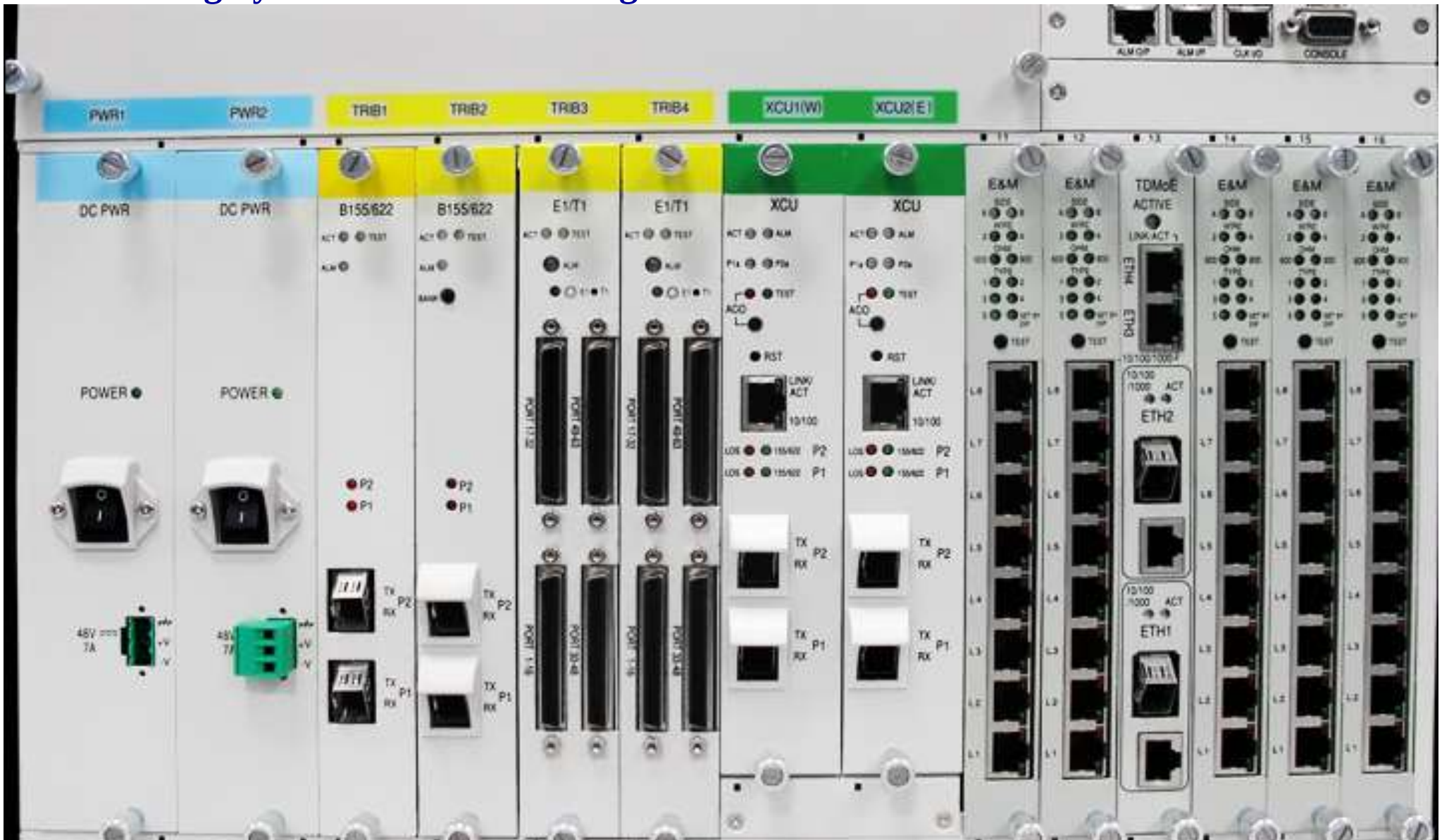
Huawei indoor Switch/Exchange (MSAN)



Huawei Outdoor Switch/Exchange (MSAN)

2.5. Electronic Exchanges in Tanzania

Typical Switching System Hardware Configuration



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End of Lecture 05

Any Questions ?

Thank you Class for your Attention