Communication Switching Systems

Course Code: ETU07402
Florent Morice Mtuka
Mobile: +255 764 281 463
Email: Mtukaf@yahoo.Com
Electronics & Telecommunication Engineering

Telephone Network Organization

Lecture 05

Lecture Contents

- 5. 1. Introduction
- 5. 1 Network planning
- 5. 1.2. Types of networks
- 5.1.3. Routing Plan
- 5.1.4. Numbering Plan
  - 5. 1.4.1. ITU recommendations in numbering
  - 5. 1.4.2. International numbering plan
  - 5. 1.4.3. National numbering plan
  - 5. 1.4.4. Numbering plan in Tanzania

5. 1. Introduction

5. 1. Introduction

- From initiating the network to the extension of the network as the subscriber/traffic increases, network planning plays a vital role in effectively delivery ***Network services***.
- **The Network Services**: The capabilities often collectively referred to “as intelligence” within the network are listed below.

5. 1. Introduction

- **Switching**. The process of interconnecting incoming calls or data to the appropriate outgoing channel called destination. *(Various switching methods were discussed in previous Lectures*).
- **Routing**. The ability of the network to select a path to connect calling and called subscriber for telephone conversations or providing path for data transfer between source and destination
- **Flow control.** The ability of a network to reject traffic. Managing the rate at which traffic enters a network. ***A network without effective flow control procedures becomes very inefficient***.

5. 1. Introduction

- **Security.** There are two ways of providing security of the network.

  1. To increase the security of operation in presence of faults.

  2. preventing unauthorized access to the network and the data it carries. This may be achieved by pass words, data encryption and providing limiting factors in accessing the network.

- **Security.** There are two ways of providing security of the network.
  - *To increase the security of operation in presence of faults.*
  - *Preventing unauthorized access to the network and the data it carries.*

    (Achieved by pass words, data encryption and providing limiting factors in accessing the network.)

5. 1. Introduction

- **Signalling.** A signalling system link (coordinates) the variety of switching system, transmission system and subscriber equipment in a telecommunication network to enable the network to function as a whole. *Signalling System will be discussed in lecture 03*.
- **Traffic management**. The ability of the network to keep track of traffic levels.
  - Short term basis, it can be used to support dynamic routing and flow control.
  - Over a long term: It is used in network Planning/design to identify requirement for upgrade or optimization.

5. 1. Introduction

- **Accountability.** This includes charging, billing, accounting and inventory control. This is the ability of the network to track the users of the network.
- **Administration:** It is related to the ability to identify the load of a network and providing corresponding upgrades, extension of networks facility. It also includes the sales strategy, investment planning etc.
- **Inter-networking:** The ability of the network to perform the functions needed to communicate with and across other networks. Including providing necessary resources for inter-networking.

5.2. Network planning

5.2. Introduction to Network planning

A national wide telecommunication network is large and complex; hence it requires special plans to govern the design of network. The plans are independent and are affected by the predicted/planned growth rate of subscribers/Services. More specific network planning includes :

- **Routing plans**
- **Numbering plans**
- **Charging plan**
- **Transmission plan**
- **Signalling plan**

5.2.1. Generic Network Planning Process

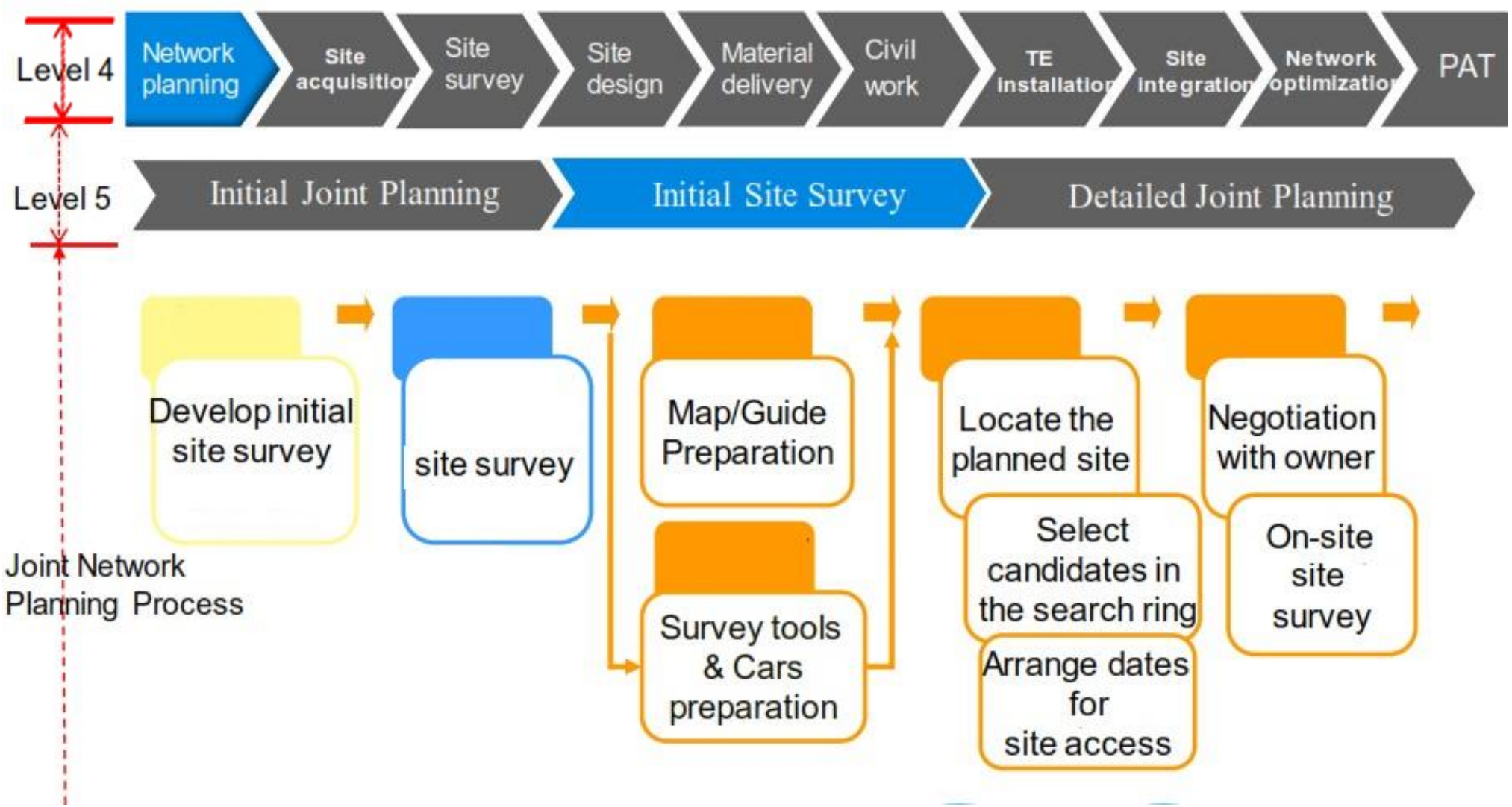

Figure 5.1:Generic Network Planning Process

5.3. Traffic Routing in the National Network

5.3. Traffic Routing in the National Network

- Routing in Communication Switching systems refers to successful connection between any two exchanges in the network.
- The function of traffic routing is the selection of a particular circuit group, for a given call attempt or traffic stream, at an exchange in the network.
- The choice of a circuit group is affected by availability of downstream elements of the network on a quasi-real-time basis.
- Routing planning refers to the procedures to determine which path in a network are assigned to particular connections.

5.3. Traffic Routing in the National Network

- For effective routing of a call, some form of interconnection of switching exchanges are required.
- These interconnections are called Network Topology
- In general there three basic Network Topology
  - *Mesh-connected network*
  - *Star topology.*
  - *Hierarchical networks.*

5.3.1. Mesh connected network

- This is also called fully connected topology.
- The mesh topology requires N(N – 1)/2 connections.

Example

100 nodes requires

100((100-1)/2*

4950 link required.

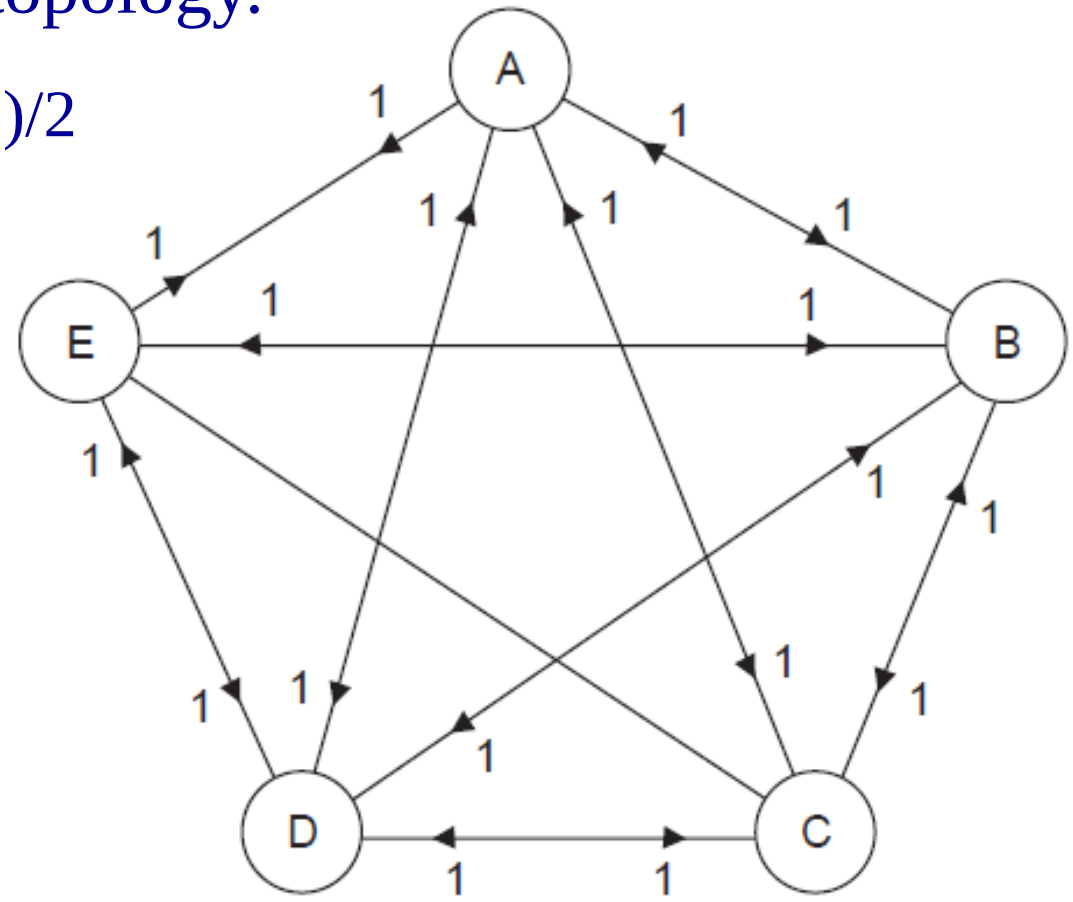

Figure 5.2:Mesh connected network

5.3.2. Star topology

- **In star network** the number of lines is equal to the number of stations.
  - Star connection utilizes an intermediate exchange called a Tandem exchange (TE).
  - Communications between Exchanges is through the TE.
  - Once the number of Exchanges served by TE increases, they are divided into smaller networks.

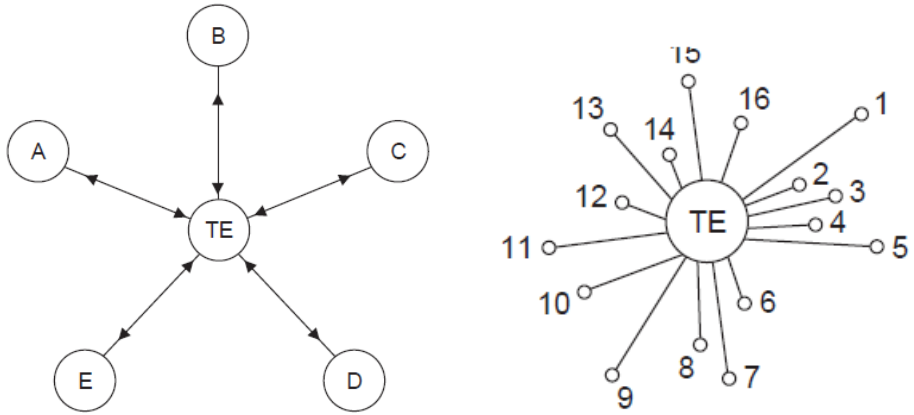

Fig. 5.2:Mesh connected network

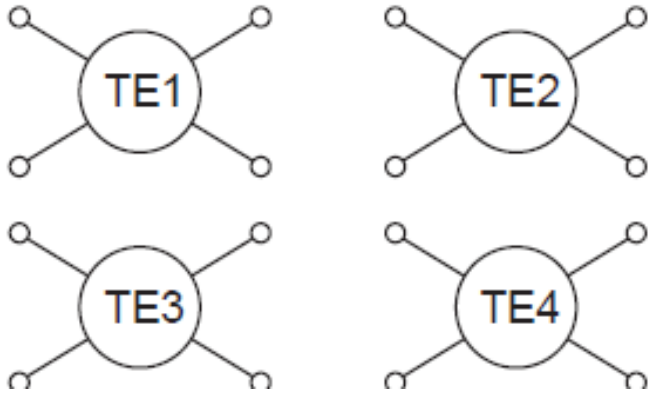

Fig. 5.3:Area with multi TE

5.3.3. Hierarchical networks

- A number of Star networks are Connected by using an additional TE, leading to two level star network.
  - An orderly construction of multilevel star networks leads to hierarchical networks.
  - Hierarchical networks are capable of handling heavy traffic with minimal number of trunk groups.

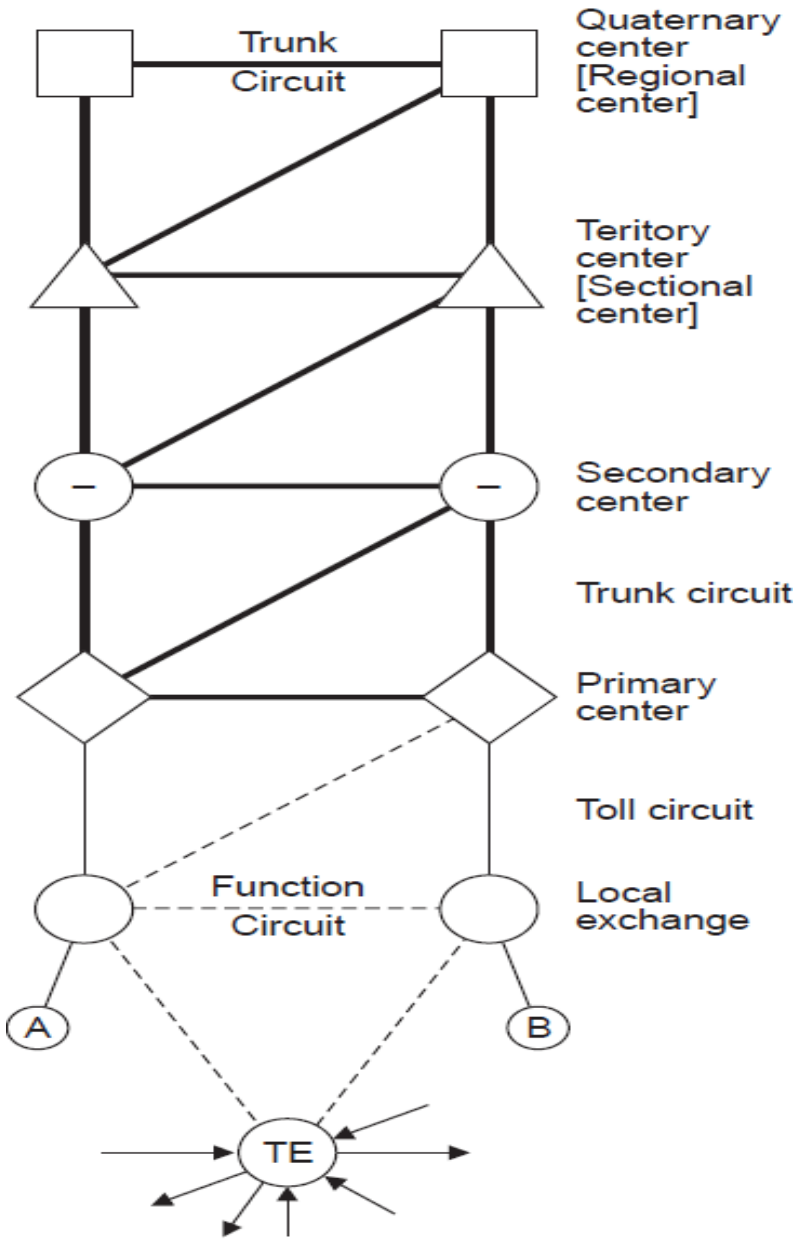

Fig. 5.4:Area with multi TE

5.3.3. Hierarchical networks

- The hierarchical network requires more switching nodes, but achieves significant savings in the number of trunks.
- Determination of the total number of trunk circuits in entire network is determined by amount of traffic between pair of Exchanges.
- Motivation for hierarchical switching structures is efficiency of circuit utilization.

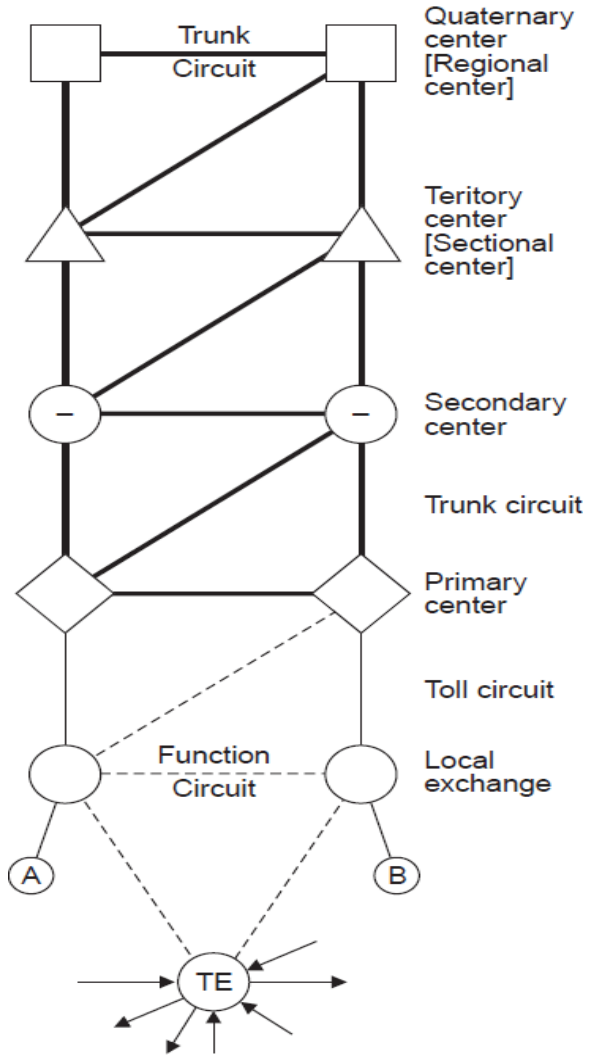

Fig. 5.4:Area with multi TE

5.3.4. Types of Network

There are three networks used for any services (voice or data transfer).

- **Public Switched Network**: It allows access to the end office, connects through the long-distance network, and delivers to the end point. Example:- TTCL, Tigo, Vodacom, Hallotel, SEACOM etc.
- **Private networks**: Many companies, depending on their size and need, create or build their own networks. If their networks are underutilized, they may give their network for hire or lease. These networks employ mixture of technologies.
- **Hybrid networks**: To provide a service, if an organization uses both private and public networks, the network is referred as hybrid network

5.3.5. Routing Scheme

A routing scheme defines how a set of routes is made available for calls between a pair of Exchanges. (fixed routing and dynamic routing schemes).

- **Fixed Routing Scheme**. Routing patterns in a network may be fixed, in that changes in route choices require manual intervention and it then represent a "permanent change" to the routing scheme.
- **Dynamic Routing Schemes.** Routing schemes incorporate frequent automatic variations. Such changes may be ***time-dependent***, ***Region/state/location dependent,*** and/or ***event-dependent***. The updating of routing patterns may take place periodically or a periodically, predetermined, depending on the state of the network or depending on whether calls succeed or fail.

5.3.5. Route Selection

- Route selection is defined as the action to actually select a definite route for as pacific call.
  - The selection can be sequential or nonsequential.
  - The decision to select a route can be based on the state of the outgoing circuit group or the states of the series of circuit groups in the route.
  - It can also be based on the incoming path of entry, class of service, or type of call to be routes. One example of the above is selective trunk reservation.

5.3.6. Call Control Procedures

- Call control procedures is defined as the entire set of interactive signals necessary to establish, maintain, and release connection between exchanges. Two types of call control procedures are described
  - **Progressive Call Control** uses link-by-link signaling to pass supervisory controls sequentially from one exchange to the next.
  - **Originating Call Control** requires that the originating exchange maintain control of the call setup until a connection between originating and terminating exchanges has been completed.

5.3.7. Alternative routing

- When an exchange has the option of using more than one route to the next exchange, an alternative routing scheme can be used.
- Alternative Routing takes place when all ***appropriate circuits in a group*** are busy. Several circuit groups may be tested sequentially.
- The circuit order is fixed or is time-dependent.
- There are two types of alternative routing available
  - *When there is a choice of direct circuit groups between the two exchanges.*
  - *When there is a choice of direct and indirect routes between the two exchanges.*

5.4.. Numbering Plan

5.4. Numbering Plan

- The numbering plan is used to identify the subscribers connected in a telecommunication network.
- The main objective to standardize the number length wherever practical according to ITU recommendations. Other objectives includes
  - To meet the challenges of the changing telecom environment
  - To meet subscriber needs for a meaningful and user-friendly scheme
  - To reserve numbering capacity to meet the undefined future needs.

5.4.1. ITU Recommendations in numbering

- **Recommendation E.164** provides the *number structure* and *functionality* for three categories of numbers used for international public telecommunication network.
  - **National telephone services** An international public telecommunication number also referred as the National Significant Number (NSN).
    - *NSN consists of the country code (CC), national destination code (NDC) and the subscriber number (SN).*

5.4.1. ITU Recommendations in numbering

- **Global telephone services** An international public telecommunication number for global telephone service consists of *3 digit country code* and *global subscriber number*.
  - *The country code is always in the 8XX or 9XX range.*
- **International networks** An international public telecommunication number for international networks consists of 3digits *country code*, *a network identification code* and a *subscriber number*.
  - *The country code is always in the 8XX range. The identification code is one to four digits.*

5.4.1. ITU Recommendations in numbering

- **Recommendation E.123** defines a standard way to write telephone numbers, email addresses and web addresses.
- **Recommendation E.162** describes that the originating country must analyze a maximum of seven digits of the E.164 international number. When a number is being analyzed, it will be done according to this recommendations.

5.4.2. International Numbering Plan

- standard international framework, subscribers from different countries can call each other.
- This plan makes it possible to access all countries with the same country code anywhere in the world
- has to be implemented irrespective of a country's national numbering plane

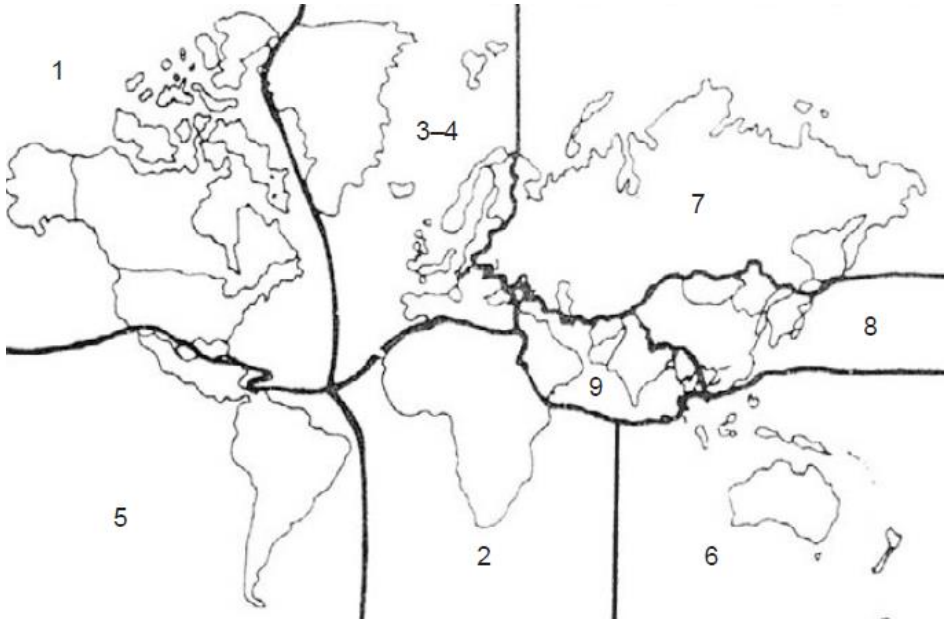

Fig. 5.5. World numbering zones..

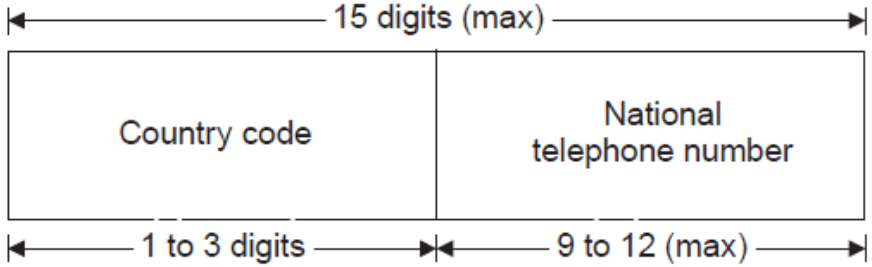

Fig. 5.6. International telephone number.

5.4.2. International Numbering Plan

Zone code	Zone	Example	
		Country	Country code
1	North America, caribbean (23 countries)	Canada United States	1 1
2	African continent (61 countries)	Egypt South Africa	20 27
3	Europe (34 countries)	Italy France	39 33
4	Europe (15 countries)	Germany United Kingdom (Czech Republic)	49 44 420
5	Central and South America (28 countries)	Costarica Brazil	506 55
6	Oceania, South Pacific (32 countries)	Malaysia Singapore	60 65
7	Former USSR (2 countries)	Khzakhsten Russian Federation	7 7
8	East Asia (21 countries)	Japan International free phone service Bangladash	81 800 880
9	Middle East, South-West Asia	India Pakistan Iraq Nepal	91 92 964 977

http://jntu.blog.com

***Table 5.1**. World numbering zones*

5.4.3. National Numbering Plane

- Each country decides for itself a kind of numbering plan to implement.
- A numbering plan may be ***open, semi open or closed***.
  - An ***open numbering plane*** or *non-uniform numbering scheme* allows variations in the number of digits to be used to identify the subscriber.
  - A ***semi-open plan permits number*** lengths to differ by almost one or two digits.
    - *This scheme is the most common used in many countries including Tanzania*

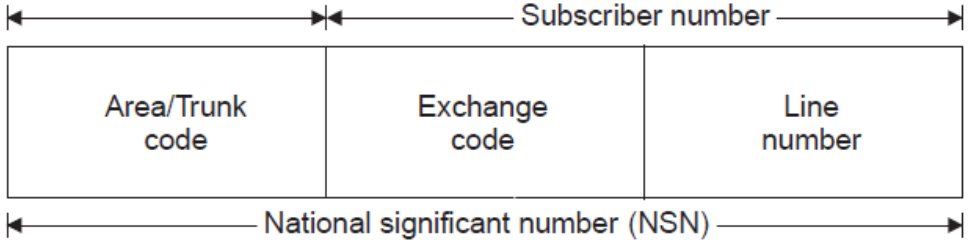

Fig. 5.7. National numbering format.

5.4.3. National Numbering Plane

- Each country decides for itself a kind of numbering plan it can implement.
- A numbering plan may be open, semi open or closed.
  - An ***open numbering plane*** or *non-uniform numbering scheme* allows variations in the number of digits to be used to identify the subscriber.
  - A ***semi-open plan permits number*** lengths to differ by almost one or two digits.
    - *This scheme is the most common used in many countries including Tanzania*

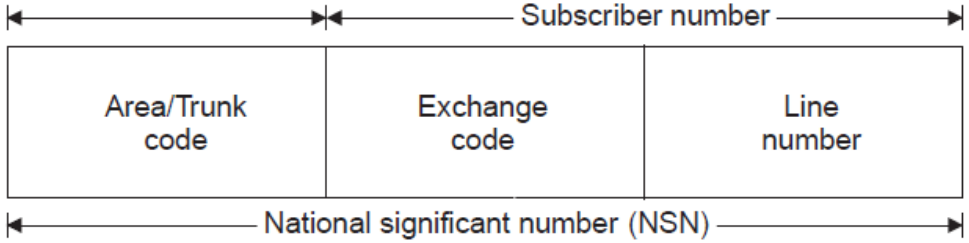

Fig. 5.7. National numbering format.

5.4..3. National Numbering Plane

Discussion

Numbering Scheme/Plan in Tanzania

5.4. Introduction to

Local Network Design

5.5. Introduction to Local Network Design

- Subscriber loop is the pair of wires connecting the subscriber to the local serving switch.
- Unwanted signals added with voice or data in channel are referred as transmission impairments. They are two types of Tx impairments
  - *static impairments* and
  - *Transient impairments* referred as systematic distortion and fortuitous distortion respectively

Static impairments	*Transient impairments*
Signal attenuation	*Echoes and singing*
Distortion	*Noise*
	Cross talk
	Fading and phase Jitter

5.4.1 Subscriber Loop Design

- *Echos and Singing occurs as a result of transmitted signals being coupled into a return path and fed back to the respective sources. Coupling will be zero only when perfect impedance matching occurs.*
- *Noise is an unwanted electrical energy.*
- *Cross Talk The current from the battery in the subscriber loop (handset is off hook), large current flow causes electromagnetic fields and thus creates signal distortions in adjoining wires. Two types NEXT AND FEXT.*
- ***Signal Attenuation** energy loss in the line at a reference frequency, varies with frequencies and temperature over the transmission line.*
- ***Distortion** received at the receiver due to internal characteristics of the channel itself*

5.5.1 Subscriber Loop Design

Fundamental Characteristics

- *Battery enable dc signalling and to provide bias current for carbon microphone (-48V)*
- ***Overvoltage protection:*** *Protects of equipment and personal from lightning strikes and power line induction or shots.*
- ***Ringing*** *application of a 20 Hz signal at 86 V rms for ringer excitation.*
- *Supervision detecting the off hook/on hook and flow/no flow dc current.*
- ***Coding*** *in the case of digital end office, analog to digital coding and digital to analog decoding functions necessary.*
- ***Hybrid*** *for two wire to four wire conversion, hybrid in necessary*
- ***Test*** *Line test toward the subscriber disconnection of the switch*

5.5.1 Limiting Factors of Subscriber Loop Design

- There are two limiting factors to consider while designing a subscriber loop.
  - *Attenuation*
  - *voltage drop*
- The maximum allowable ***resistance in the subscriber loop***

$$R_m = \frac{V_b}{I_c}$$

- *where*

Rm = maximum allowable resistance of subscriber loop.

VB = Battery voltage

Ic = minimum current required for proper operation of carbon microphone

5.5.2 Limiting Factors of Subscriber Loop Design

- The ***loop resistance limit*** is calculated as

$$R_L = R_m - (R_B + R_T)$$

where R_T *= Telephone set resistance.*

Example 5.1.

The minimum current required for carbon microphone is 23 mA, battery voltage is 50 V, the battery resistance is 400 ohm and the telephone set resistance is 200 ohms, calculate the loop resistance limit.

Solution

$$R_m = \frac{50volt}{23mA} = 2200m\Omega$$

$$R_L = 2200 - (400 + 200) = 1600\,\Omega/1.6k\,\Omega$$

5.5.2 Limiting Factors of Subscriber Loop Design

- The maximum subscriber loop length is defined as the distance from the subscriber to the central office, is expressed as

$$L = \frac{\textbf{Loop resistance limit}}{\textbf{dc loop resistance}} = \frac{R_l}{R_{dc}}$$

- Maximum permissible loop length. The method of deterring the maximum subscriber loop length using the ***attenuation or loop loss*** is called the basic transmission design, the maximum loop length is calculated from the formula

$$L_m = \frac{\textbf{Attenuation limit}}{\textbf{loss per km}}$$

GAUGE NO (AWG)	diameter 'd' (mm)	Rdc (Ω/kM)	Attenuation or loss per km (dB/km)
19	0.91	26.39	1.68
22	0.64	52.95	1.35
24	0.51	84.22	1.05
26	0.41	133.9	0.69

5.5.2 Limiting Factors of Subscriber Loop Design

Example 5.2.

For a 24 gauge cable and a 1250 ohm loop resistance find the loop length. For the same wire gauge and a 6 dB loss, find the maximum loop length.

Solution

Sol. From the table 24 gauge cable $\boldsymbol{R_{dc}}$ *is 84.22Ω,and α 1.05dB/km*

$$R_m = \frac{\boldsymbol{R_l}}{\boldsymbol{R_{dc}}} = \frac{1250\Omega}{84.22\Omega/km} = 14.84\ km.$$

$$\boldsymbol{L_m = \frac{Attenuation\ limit}{loss\ per\ km} = \frac{6dB}{1.05dBkm} = 5.71\ km}$$

Reference book

1. Telecommunication Switching Systems and Networks, by Thiagarajan Viswanathan, PHI.
2. Telecommunication Systems Engineering, R. L. Freeman, 4/e, Wiley publication, 2010
3. Telecommunication Switching and Networks. By P. Gnanasivam, New Age International.
4. Telecommunication System Engineering, By Roger L. Freeman 4th Ed, John Wiley & Sons, Inc 2004

End of Lecture 05

Any Questions ?

Thank you Class for your Attention