Let's have a tour of some advanced technologies such as ISDN …GSM …GPRS and TCP/IP

Objectives

- At the end of this session, you will be able to:
  - Understand ISDN network from a perspective of network components and different ISDN flavor of services
  - Understand the concept of cell and impact of cell size in GSM
  - Understand frequency reuse concept in GSM
  - Understand GSM network evolution, network architectural composition and GSM identifiers
  - Understand the steps followed in Mobile registration, mobile originated call [MOC] and mobile terminated call [MTC]
  - Understand the concept of roaming in GSM
  - Understand GPRS network enhancement on the top of GSM
  - Understand the role of SGSN and GGSN in GPRS network
  - Understand the features of GPRS network
  - OSI and TCP/IP protocols, devices and addresses
  - Understand the logical and physical representation of internet today
  - Understand the dataflow transfer in computer network with applications of mail transfer

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Agenda

- ISDN network: features, network, flavors
- GSM Network: Cell size and its impact
- GSM Network architecture
- GSM identifiers
- GSM call scenarios: Mobile registration, MOC and MTC
- GPRS network architecture
- Computer Network: LAN, MAN, WAN
- OSI and TCP/IP protocol
- Networking devices and addresses
- Internet: Physical layout
- Client and Server: Mail protocol example

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

ISDN

WHY ISDN?

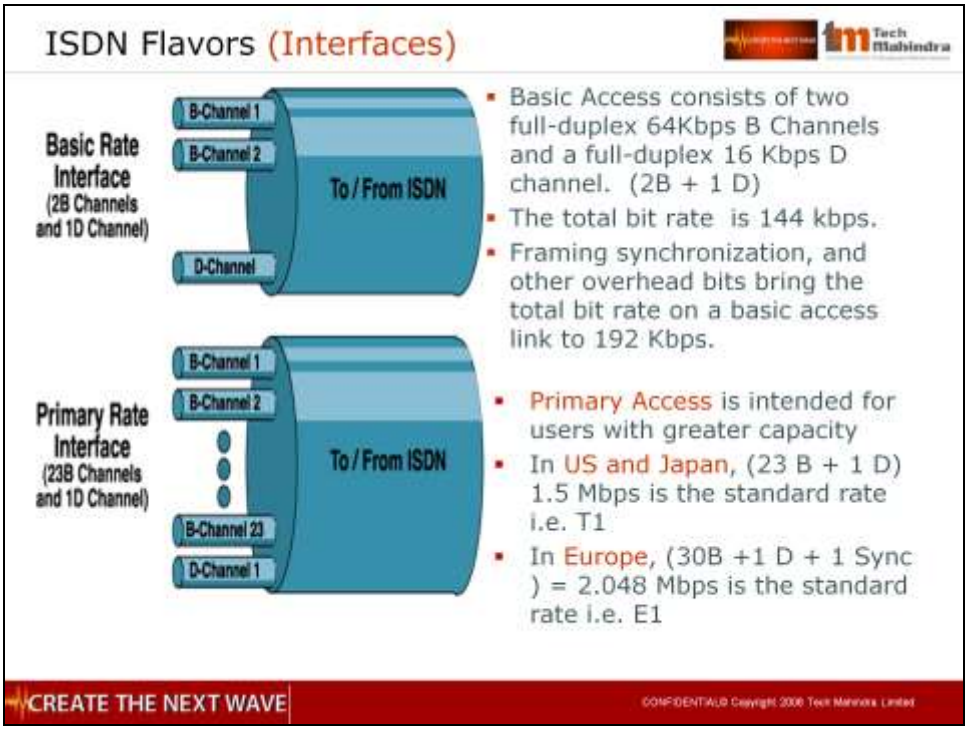
What is ISDN?

I : Integrated S : Services
D: Digital N : Network

ISDN is a High speed, Fully digital, Telephone service; Easily controllable and configurable End to End Digital service in PSTN

All at the COST of a bit more MONEY

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited



======

The basic service is intended to meet the needs of most individual users, including residential subscribers and very small offices.
It allows simultaneous use of voice and several data applications, such as internet access, a link to central alarm service, facsimile, teletex and so on.

These services could be accessed through a single multifunction terminal or several separate terminals.

In either case, a single physical interface is provided. Most existing two-wire local loops can support this interface.

- **Primary Access** is intended for users with greater capacity requirements, such as
  offices with a digital PBX or a LAN.
- The U.S., Canada, and Japan

makes use of a transmission structure based on

1.544 Kbps; this corresponds to the T-1 transmission facility of AT&T.

- In Europe, 2.048 Mbps is the standard rate, both of these data rates are provided as

a primary interface service.

- Typically, the channel structure for the 1.544 Mbps rate will be 23 B channels plus

one 64 Kbps D Channel and the 2.048 Mbps rate, 30 B Channels plus one 64 Kbps

D Channel.

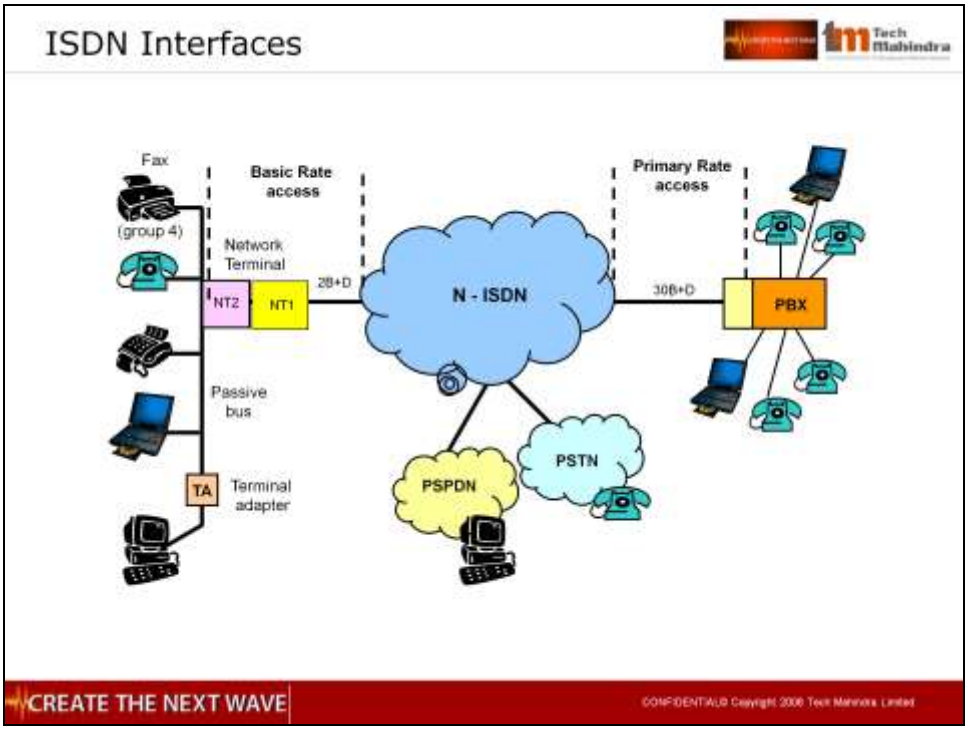
- It is possible for a consumer with lesser requirements to employ fewer B Channels,

in which case the channel structure is nB+D, where n ranges from 1 to 23 or from 1

to 30 for the two primary services.

- A customer with high data rate demands may be provided with more than one primary physical interface.
- In this case, a single D channel on one of the interfaces may suffice for all signaling needs, and the other interfaces may consist solely of B Channels (24B or 31 B).
- The primary interface may also be used to support H Channels.
- Some of these structures include a 64 Kbps D Channel for control signaling. When no D channels are present, it is assumed that a D channel on another primary interface at the same subscriber location will provide any required

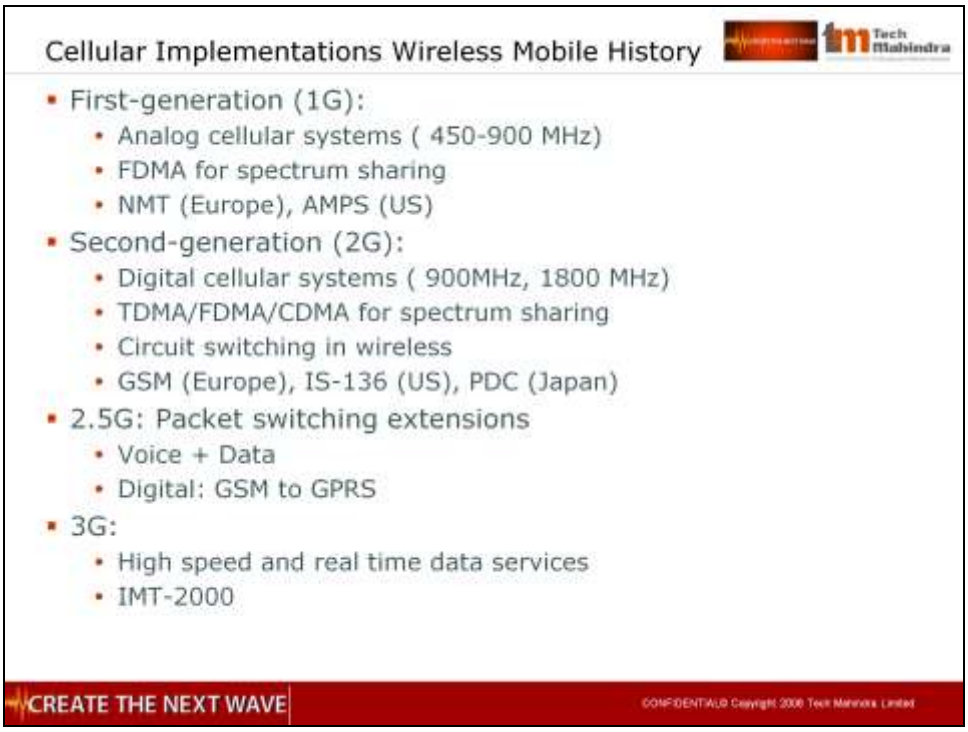
signaling.



•**Terminal Equipment** refers to subscriber equipment that makes use of the ISDN.
•**Terminal Equipment Type 1 (TE1)** refers to devices that support the standard ISDN interface.
•**Terminal Equipment Type 2 (TE2)** encompasses existing non-ISDN equipment. Such equipment requires a terminal adapter (TA) to plug into an ISDN interface.

NT2 so called Network terminator 2 is a customer premises switching equipment installed by service provider at customer premises.
NT1 (subscriber line terminator) …

Let’s move onto GSM and GPRS which almost everybody of us are familiar with ….



1G systems (analogue) : TACS (UK), AMPS (USA)

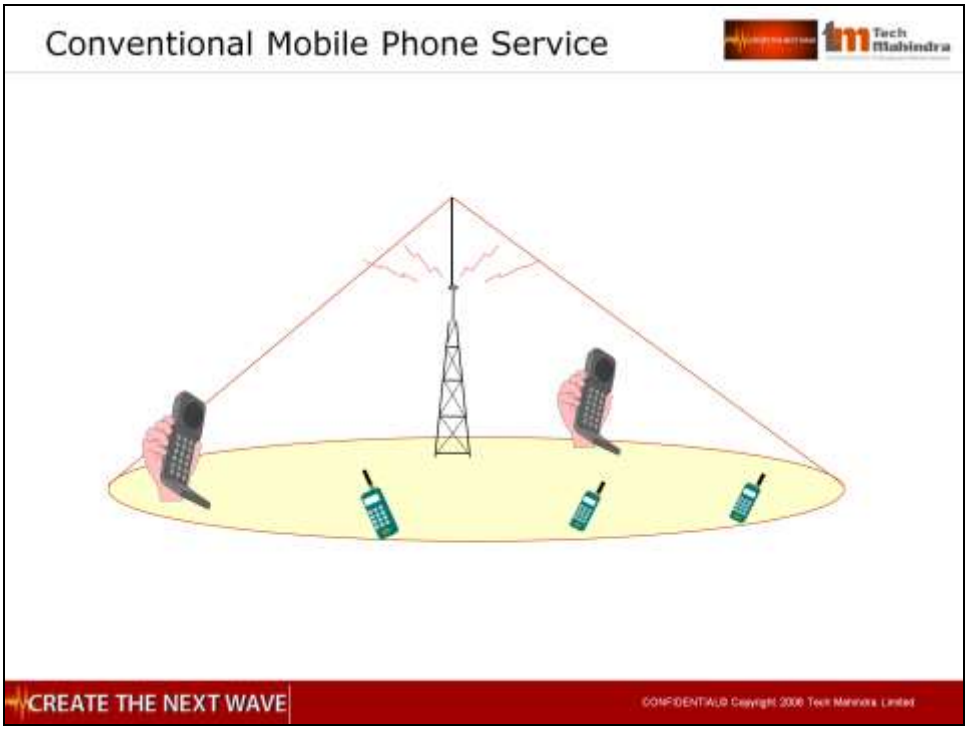
2G systems (digital) : GSM (Europe), TDMA (USA)

2½G systems : GPRS (Europe)

3G systems : UMTS (Europe), CDMA 2000 (USA), TD-SCDMA (China)

aiming for a global standard to

allow worldwide roaming but unlikely to happen



Cellular Concept: Motivation

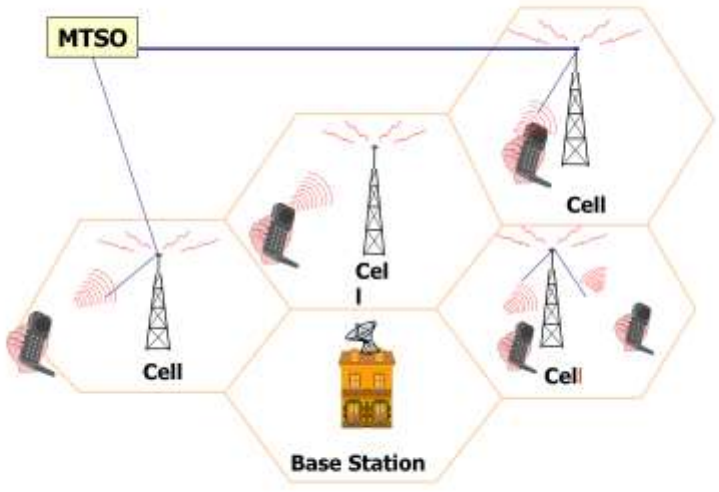
Early mobile radio systems used to have large coverage with single, high-powered transmitter.

Because of the finite spectrum allocation to an operator and no frequency re-use due to interference limits the customer base.

Need was : High capacity i.e. more number of users with limited spectrum as well as wide coverage.

And the Solution was Cellular mobile …i.e. divide large area into smaller cells

Cellular Telephone Service: Mobile- to-Mobile

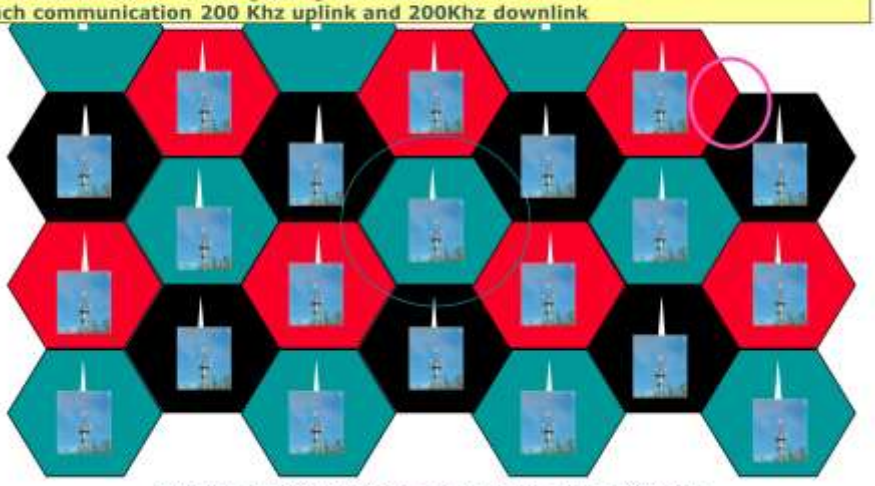


PTC _ PITA Telecoms Conference & Exhibition

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Cellular Radio – Infinity illusion

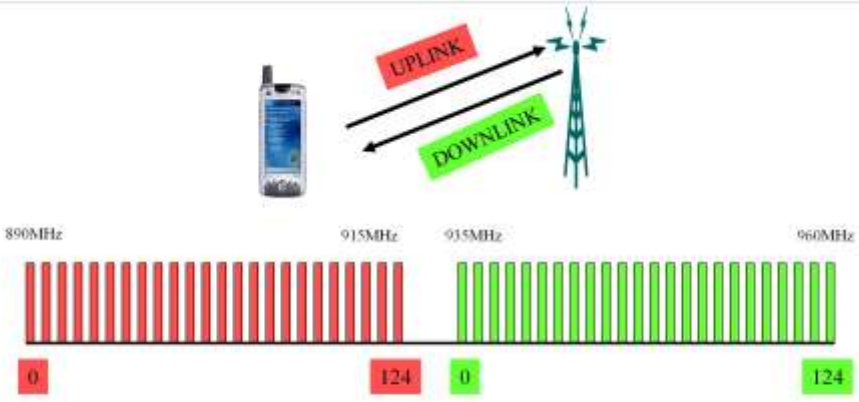
- A combination of SDM, FDM and TDM
- Two separate frequency bands used for Tx and Rx
- Sender and receiver sequences shifted by 45MHz and 3 time slots
- Predefined time slot for signaling channel
- Each communication 200 Khz uplink and 200Khz downlink



Ideally, 3 different frequency sets are sufficient

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

GSM Uplink Downlink



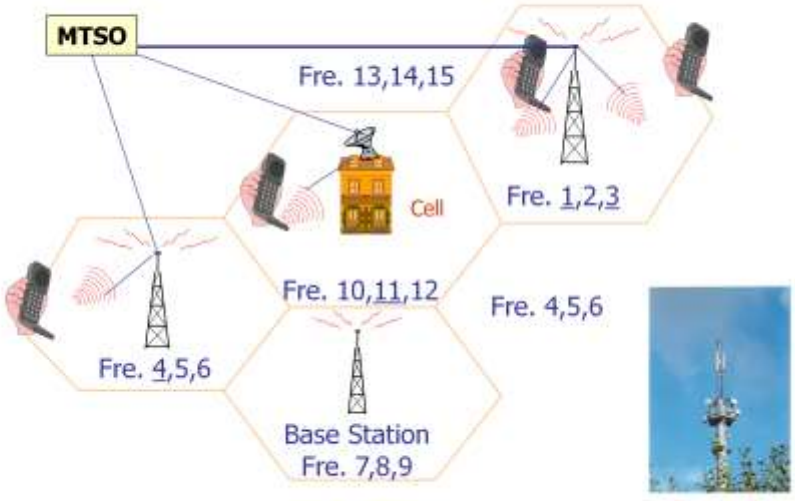
GSM900 : 880 - 915 MHz paired with 925 - 960 MHz

GSM1800 : 1710 - 1785 MHz paired with 1805 - 1880 MHz

GSM1900 : 1850 - 1910 MHz paired with 1930 - 1990 MHz

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

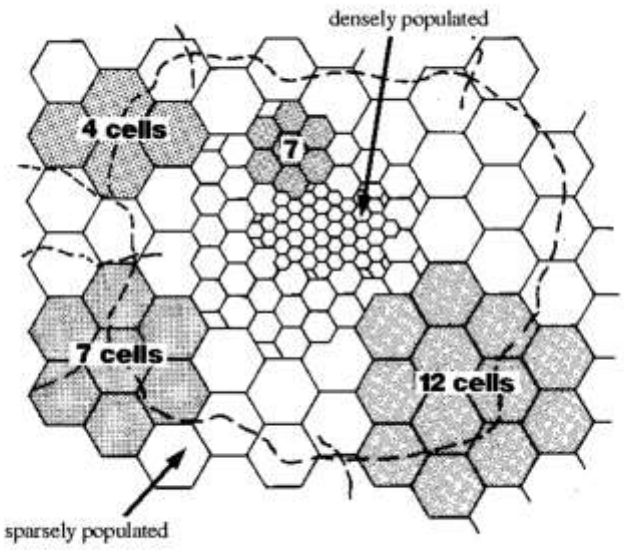
2G Mobile: Frequency Split



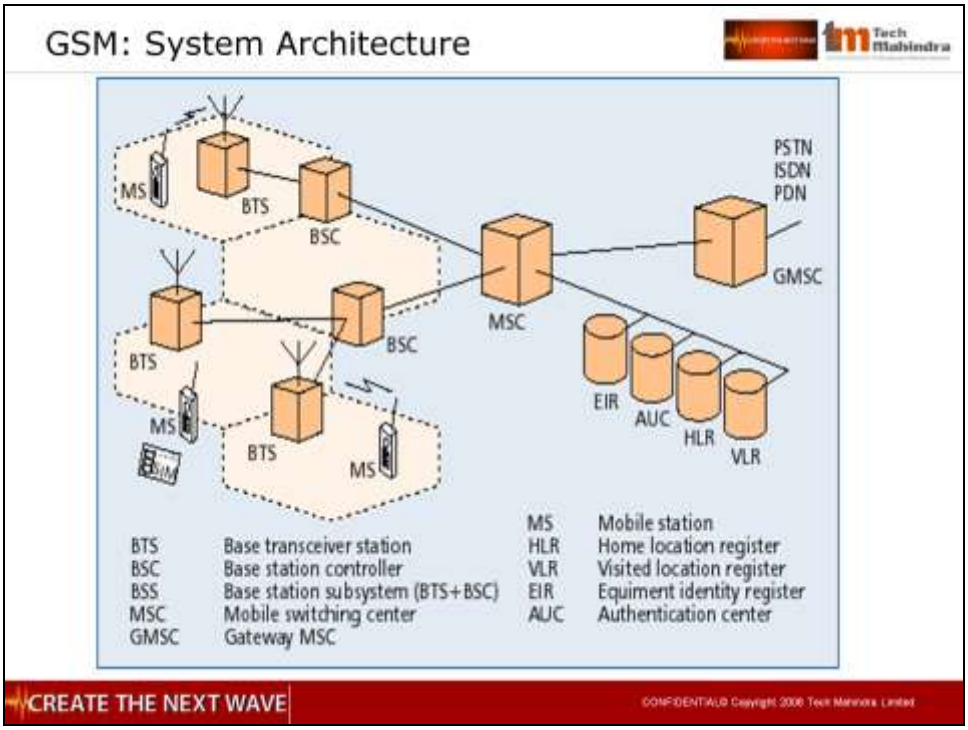
PTC _ PITA Telecoms Conference & Exhibition

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Cell Size



CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited



Gateway Mobile Services Switching Center (GMSC)

Point of call entry into the PLMN (for calls terminating in this network from PSTN or other mobile network)

Mobile Switching Center / Visitor Location Register (MSC/VLR)

Usually integrated in one box
High Capacity Switch
Works like a normal exchange
Responsible for
- Setting up & controlling voices calls & SMS
- Handover & Location Update
- Charging and accounting

Base Station Controller (BSC)

Handles all BTS under observation
Manages the radio network and handover from one cell to another

Base Transceiver Station (BTS)

Responsible for sending and receiving radio signals to / from mobiles
Quality Measurements and Power Control

Mobile Station (MS)

Two parts
- Mobile Equipment = Phone instrument
- SIM card = Subscriber Identity Module, a smart card

Home Location Register (HLR)

Database that stores and manages subscription related information
Semi-Permanent Data
- Mobile number, SIM number, services

Dynamic Data
- VLR identity, active services like forwarding

Authentication Center (AuC)

Database of authentication keys , ciphering keys and algorithms for both authentication and ciphering
one record per SIM card

Equipment Identity Register (EIR)

Maintains Mobile Equipment's serial number
In terms of
- Black List
- Grey List

White List

ExTRA Notes

=======

GMSC

Gateway Mobile Services Switching Center
Like a normal exchange
Point of call entry into the PLMN (for calls to mobile)
Interrogates HLR for identifying current location of the mobile
Routes call to the MSC where the mobile is present
Has charging and accounting functions built

MSC/VLR

Mobile Switching Center / Visitor Location Register
Usually integrated in one box
Like a normal exchange
Responsible for
- Setting up & controlling calls including SS & SMS
- Handover & Location Update
- Controlling the BSC
- Equipment Identity Control
- Charging and accounting

BSC

Base Station Controller
Handles all BTS
Manages the radio network
Manages connectivity to Mobile stations including handovers
Administers the BTS & the radio characteristics
Works like a remote unit (slave-switch) of the MSC/VLR

BTS

BTS stands for **B**ase **T**ransceiver **S**tation
Radio equipment responsible for sending and receiving radio signals to / from mobiles
Quality Measurements
Power Control
Broadcasting system information & paging
Receiving channel requests from mobile
Implements radio hopping

MS

Mobile Station
Two parts
- Mobile Equipment = Phone instrument
- SIM card = Subscriber Identity Module, a smart card

Radio equipment
Signaling and speech coding
signal strength measurements
Power Control

HLR

Home Location Register'
Database that stores and manages subscription related information
- Semi-Permanent Data
  - Mobile number, SIM number, services
- Dynamic Data

VLR identity, active services like forwarding
Handles interrogation for locating a mobile
Charging function
Authentication of access

AuC
Authentication Center
Database of authentication keys and authentication algorithms
Contains one record per SIM card
Generates a random number, a ciphering key (for encryption) and a signed response
Authentication is performed in MSC
Ciphering is performed by the BTS
Implementations vary

EIR
Equipment Identity Register
Maintains Mobile Equipment's serial number
Maintains three lists
- Black List
- Grey List
- White List

Consults the lists and returns information of which list the mobile is on
Used for controlling calls from stolen mobiles and faulty mobiles

GSM Identifiers

MSISDN

Mobile Station ISDN number
Number that can be dialed from a mobile/telephone
Country Code (**CC**) + Network Destination Code (**NDC**) + Subscriber Number (**SN**)

IMEI

International Mobile Equipment Identity
Unique identity of hand-set

LAI

Location Area Identity
Key element for location update

IMSI

International Mobile Subscriber Identity
Unique identity of a SIM card / subscription
Mobile Country Code (**MCC**) + Mobile Network Code (**MNC**) + Mobile Subscriber Identification Number (**MSIN**)
The key field for billing

TMSI

Temporary Mobile Subscriber Identity
Security mechanism
Avoids usage of IMSI as an identity over the air
Allocated by MSC

CREATE THE NEXT WAVE

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

IMEI : Type Approval Code (**TAC**) + Final Assembly Code (**FAC**) + Serial Number (**SNR**) + Software Version Number (**SVN**)

LAI : Mobile Country Code (**MCC**) + Mobile Network Code (**MNC**) + Location Area Code (**LAC**)

With this we come to an end of GSM network. Now let's have a look as GPRS network.

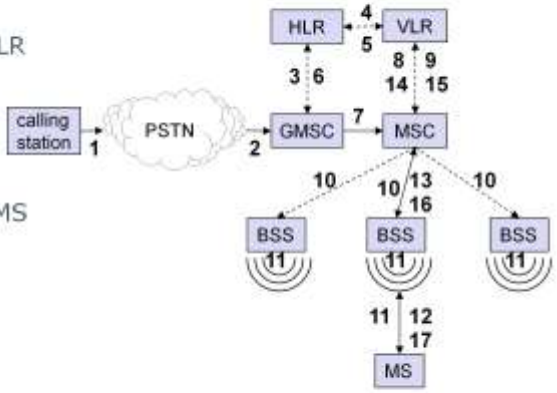
Mobile Registration

- Wherever you go our Network catches you
- Wherever mobile moves, the entry will be registered into the MSC/VLR in context and Pointer to VLR is stored in HLR
- In the nutshell, HLR is a single point of contact for every mobile

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Mobile Terminated Call [MTC]

- 1: calling a GSM subscriber
- 2: forwarding call to GMSC
- 3: signal call setup to HLR
- 4, 5: request MSRN from VLR
- 6: forward responsible MSC to GMSC
- 7: forward call to
- current MSC
- 8, 9: get current status of MS
- 10, 11: paging of MS
- 12, 13: MS answers
- 14, 15: security checks
- 16, 17: set up connection

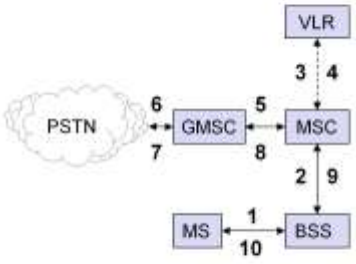


CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Mobile Originated Call [MOC]

- 1, 2: connection request
- 3, 4: security check
- 5-8: check resources (free circuit)
- 9-10: set up call

Paging is NOT necessary in this call

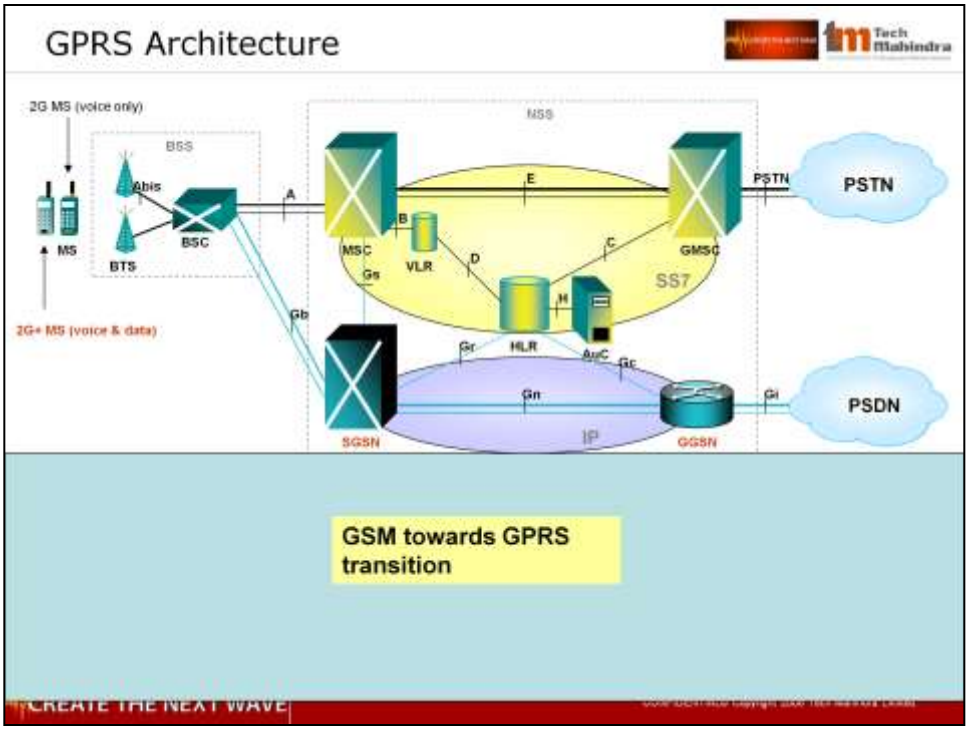


CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Roaming

- What happens in Roaming?
  - In a roaming scenario, mobile user moves from home network and go in some other operator's network and wanted to use services [may be incoming or outgoing]
  - In such scenarios, based on IMSI , operator would get to know as to which country and which operator a subscriber belongs to
  - Roaming network checks whether subscriber is allowed to roam by asking HLR of the home network and seek the information
  - If answer received is Yes, then subscriber is allowed else subscriber is denied
- What is the difference between National and International roaming?
  - National roaming → Operator other than home within a country
  - International roaming → Operator other than home outside a country

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited



GPRS stands for General Packet radio service. It is overlaid network on already existing GSM network with modification of component for GPRS compliance. With GPRS network , now one can have data services like www , ftp , mail , mms along with traditional GSM services like voice and SMS with GPRS enabled mobile.

GGSN

Serves as the interface to external IP networks which could be TCP/IP or X.25 network which see the GGSN as an IP router serving all IP addresses of the MSs

GGSN stores current SGSN address and profile of the user in its location register

It tunnels protocol data packets to and from the SGSN currently serving the MS

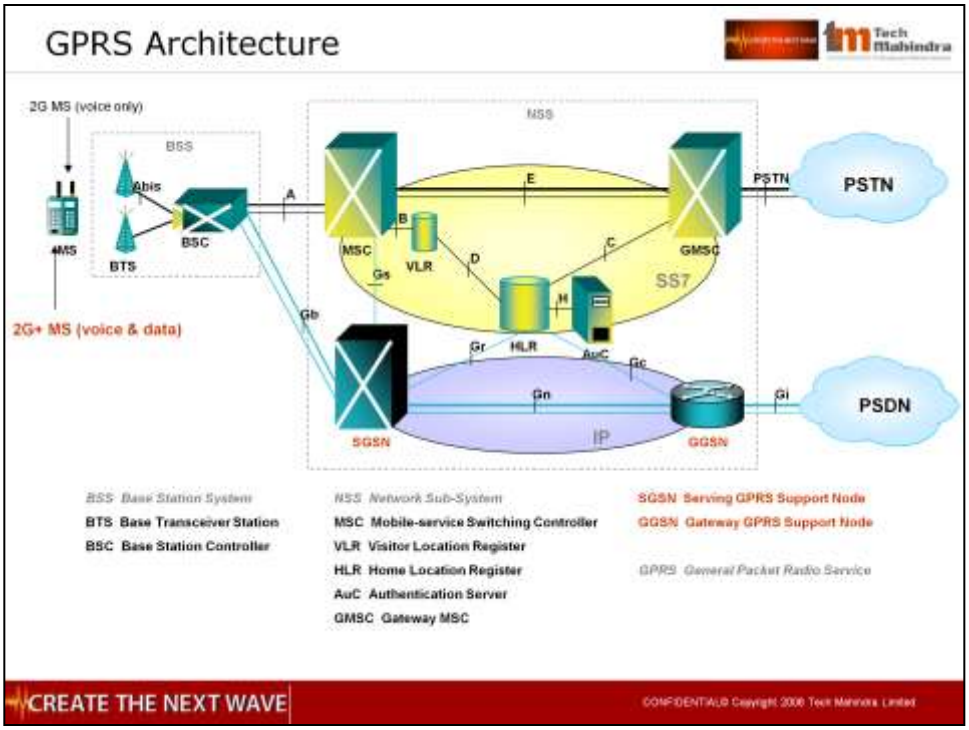
It also performs authentication and charging

GGSN can also include firewall and packet-filtering

mechanisms

SGSN

Analog of the MSC in GSM
Routes incoming and outgoing packets addressed to and from any GPRS subscriber located within the geographical area served by the SGSN
Location Register of the SGSN stores information (e.g. current cell and VLR) and user profiles (e.g. IMSI, addresses) of all GPRS users registered with this SGSN



GPRS stands for General Packet radio service. It is overlaid network on already existing GSM network with modification of component for GPRS compliance. With GPRS network , now one can have data services like www , ftp , mail , mms along with traditional GSM services like voice and SMS with GPRS enabled mobile.

GGSN

Serves as the interface to external IP networks which could be TCP/IP or X.25 network which see the GGSN as an IP router serving all IP addresses of the MSs

GGSN stores current SGSN address and profile of the user in its location register

It tunnels protocol data packets to and from the SGSN currently serving the MS

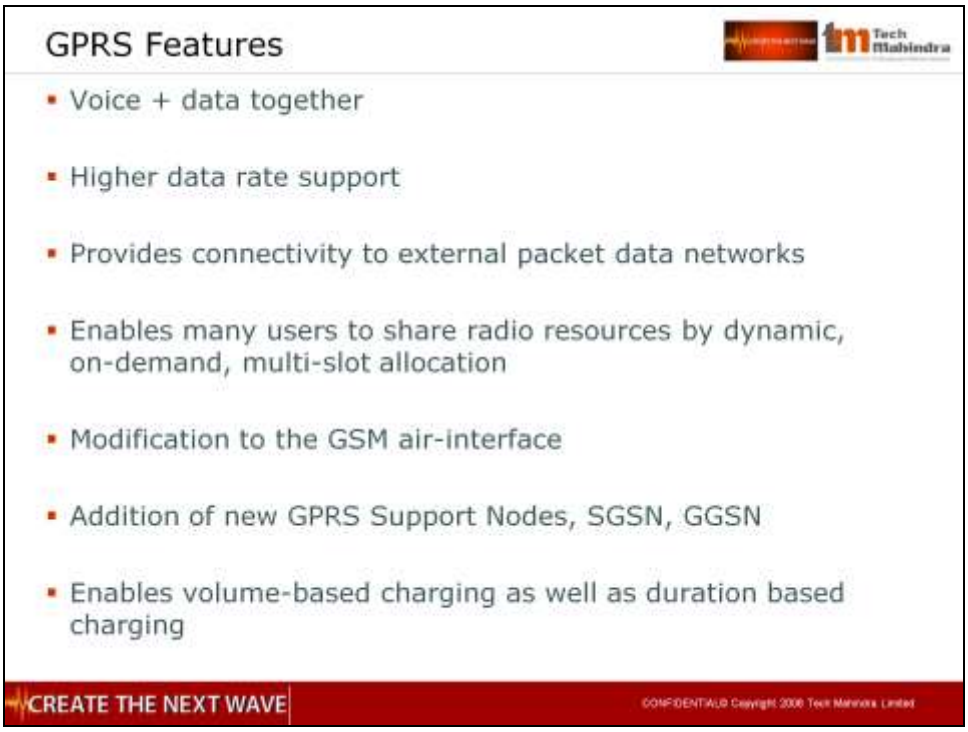
It also performs authentication and charging

GGSN can also include firewall and packet-filtering

mechanisms

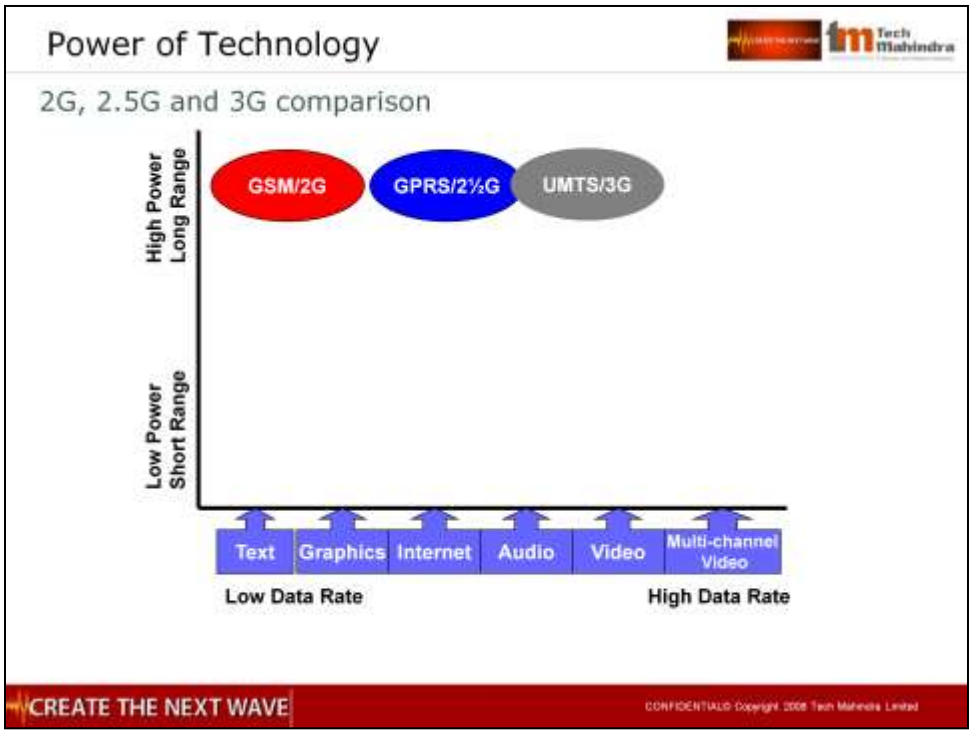
SGSN

Analog of the MSC in GSM
Routes incoming and outgoing packets addressed to and from any GPRS subscriber located within the geographical area served by the SGSN
Location Register of the SGSN stores information (e.g. current cell and VLR) and user profiles (e.g. IMSI, addresses) of all GPRS users registered with this SGSN



Always on

Circuit switching for voice and packet switching for data



Edge : Just after GPRS

1) A method of increasing the data rates on the radio link for GSM 3-4 times increase in data speeds over GPRS claimed

2) Different protocols and behaviour in the Base Station System same packet handling protocols in the core network

3) Introduces a new modulation technique and new channel coding scheme

UMTS (3G)

1) To cope with increasing volumes of traffic

and new capacity-demanding apps such as video streaming & music download

2) Developed as a global standard to assure international roaming

though now unlikely to be universal e.g. USA, China may use different standards

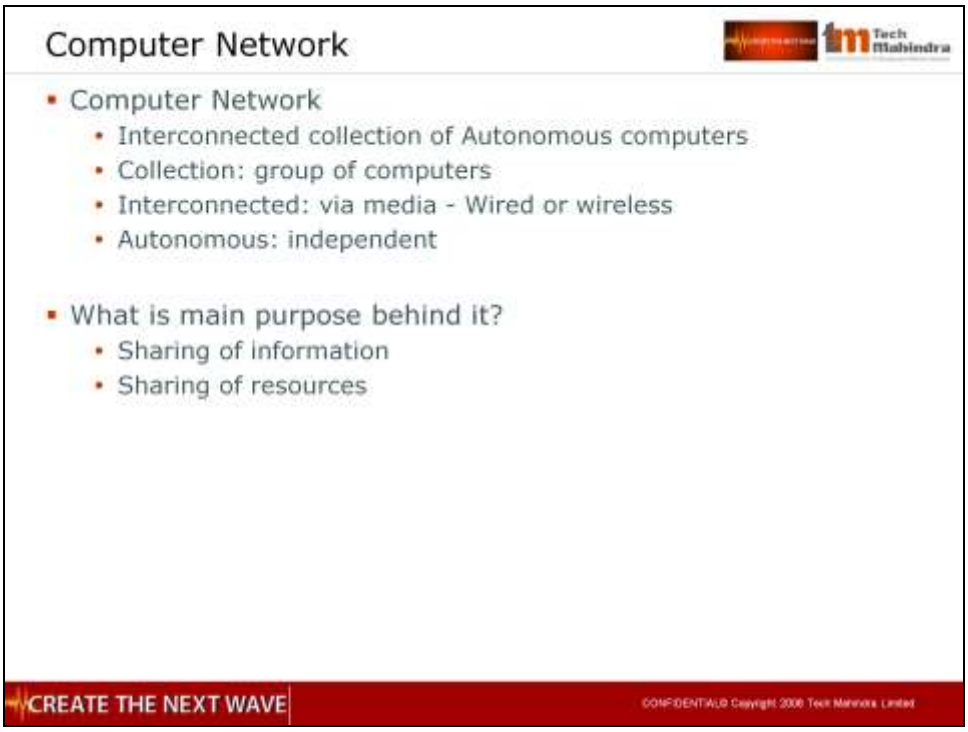
3) A development from GSM and CDMA – also known as W-CDMA

4) Auction of licenses for spectrum

extremely expensive to set up the new infrastructure needed

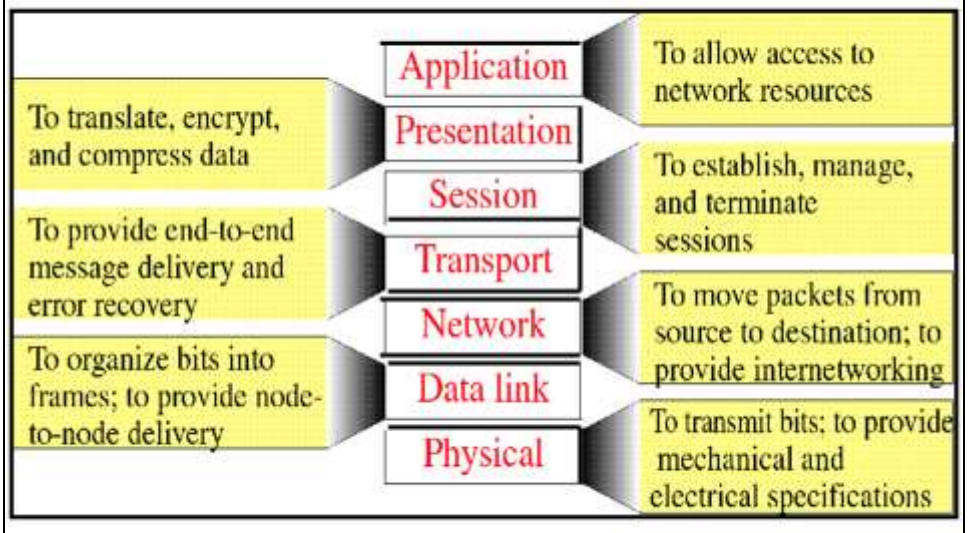
5) New handsets required : dual purpose handsets – have to be back-operable with GSM

With this we come towards an end of GPRS network. Now let’s have a look at computer network.

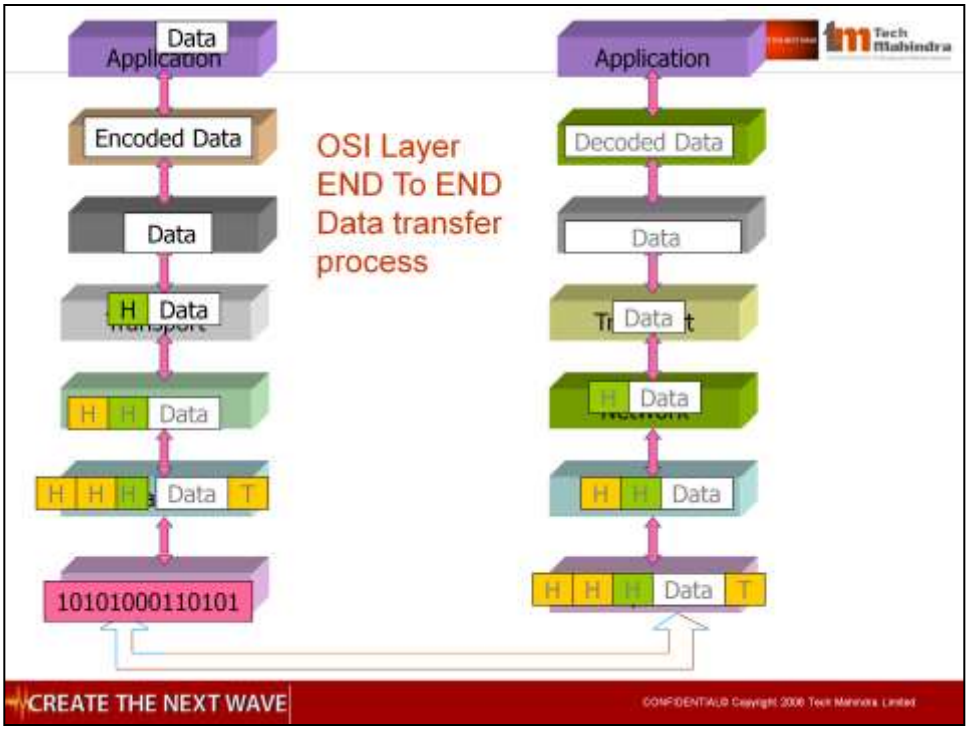


Autonomous … totally independent …democracy ….every body has equal access

OSI Layer Functions



CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

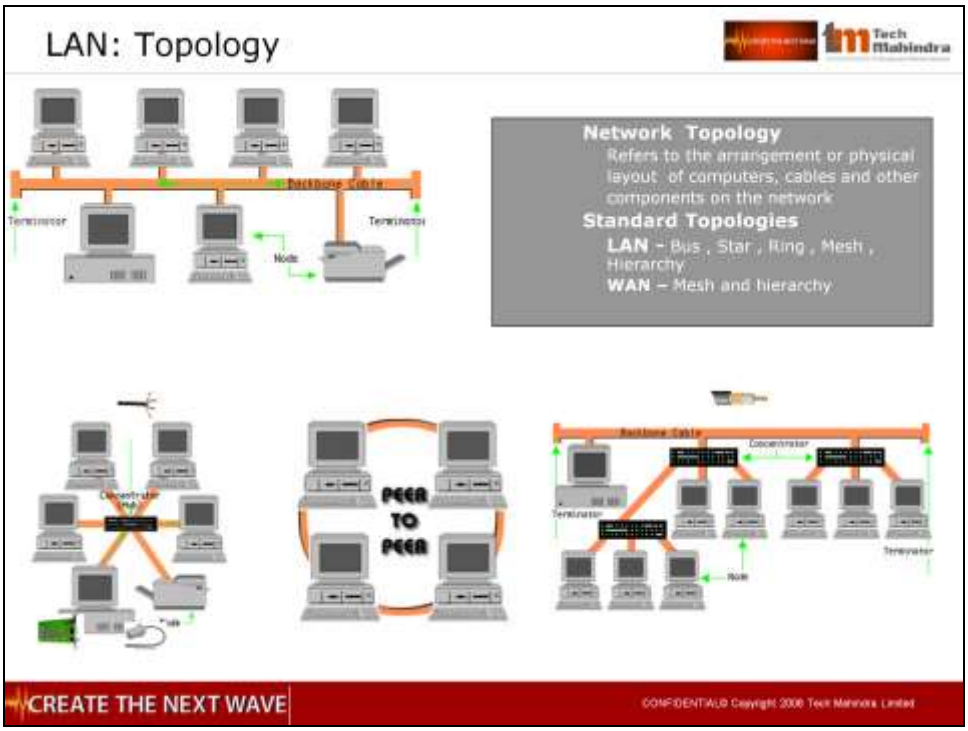


•Data Encapsulation

Application Layer - User interacts with the application he is using.
Presentation Layer - User data is encoded.
Session Layer - It transfers the data to transport layer while doing the token control
Transport Layer - It adds its own header and thus data *segment* is formed
Network Layer - It also adds its own header thus forming the *packet*
Data link Layer - It adds a header and tailer thus forming *frame*
Physical Layer - It transmits data in form of stream of bits

•Data Decapsulation

Physical Layer – It passes the incoming stream of bits to the data link layer
Data link Layer - It removes the data link header and tailer and passes the packet to the network layer
Network layer - It removes network layer header and passes the data to the transport layer
Transport layer - It removes transport header recognizes the data belongs to which application and passes the data to the session layer
Session layer - It passes the data in encoded form to the presentation layer
Presentation layer- It does the decoding and passes the data to the application layer
Application layer - The user at the application layer receives the data



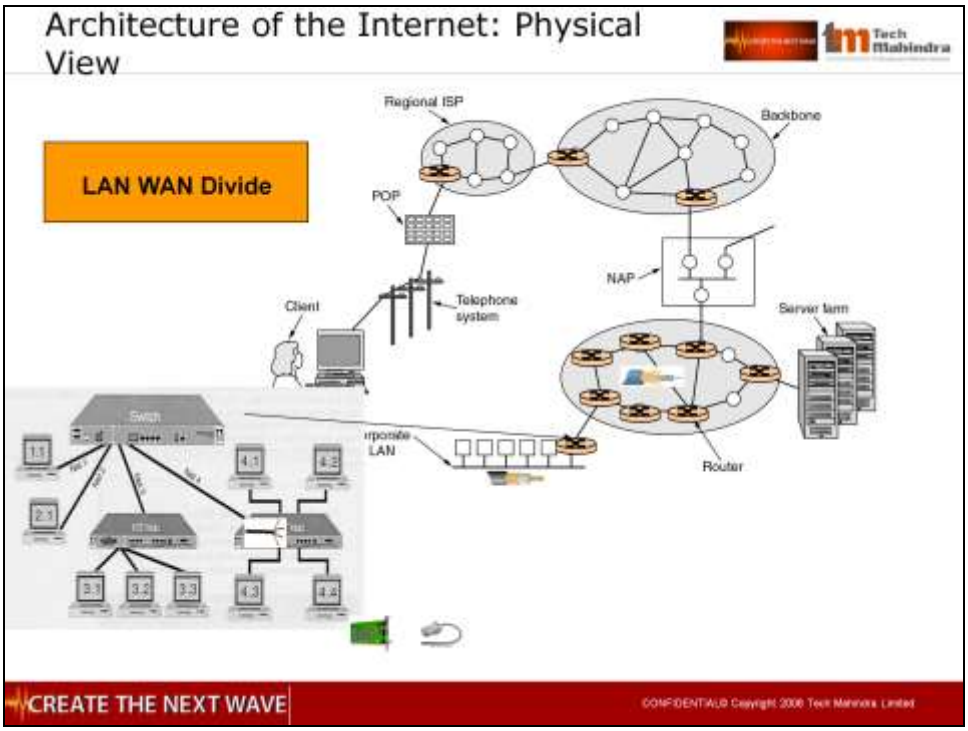
Based on scale and authority , there is a classification of networks called LAN, MAN and WAN

LAN is collection of computers/devices in a small area especially a campus of a company/institute. It has got a single authority for control.

Arrangement of computers/devices is called Network topology.

LAN uses “share a medium” mechanism so demands for protocols as to how to share. Unlike static multiplexing schemes like TDM,FDM etc. LAN uses dynamic multiplexing schemes. Famous amongst them is CSMA/CD ….Polite protocols , democracy – every body has equal right to access , sense for silence before you speak…If you find somebody speaking , abstain from specking .,…characteristics of Politeness. Nevertheless this is not the only protocol.

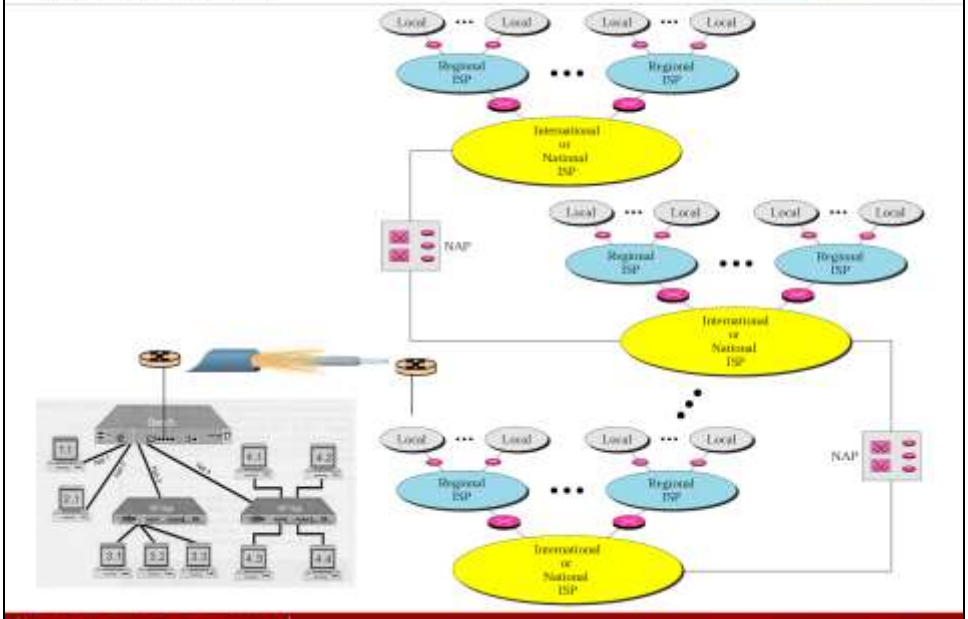
LAN : Topology used in LAN can be ….BUS ,Ring , Star , Hierarchy ….but preferred ones are star and Hierarchy



WAN is interconnection of LAN with the help of device on the edge of LAN called router. Routers are connected to each other using point to point links and they are arranged in combination of graph and tree to have good amount of redundancy as well as quick transfer by using shortest path.

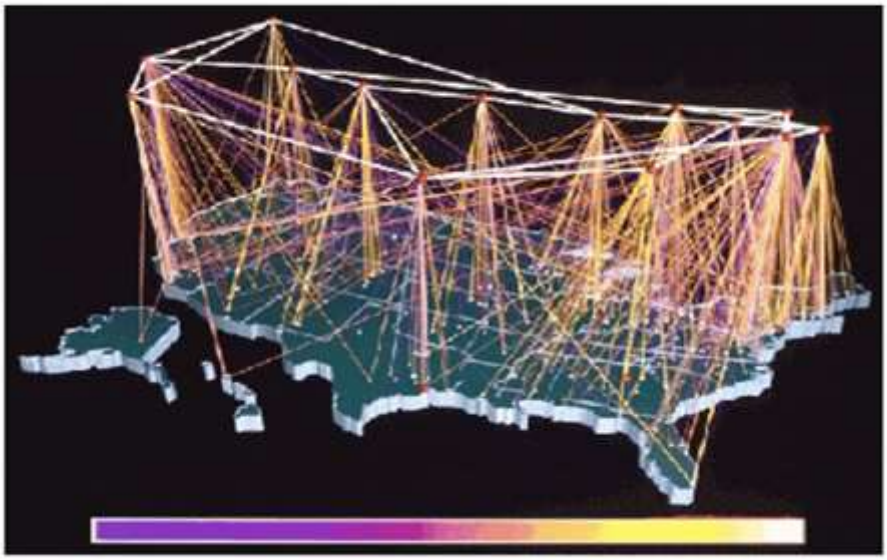
Interconnection of routers at various hierarchical levels forms the backbone of Internet.

Internet Today

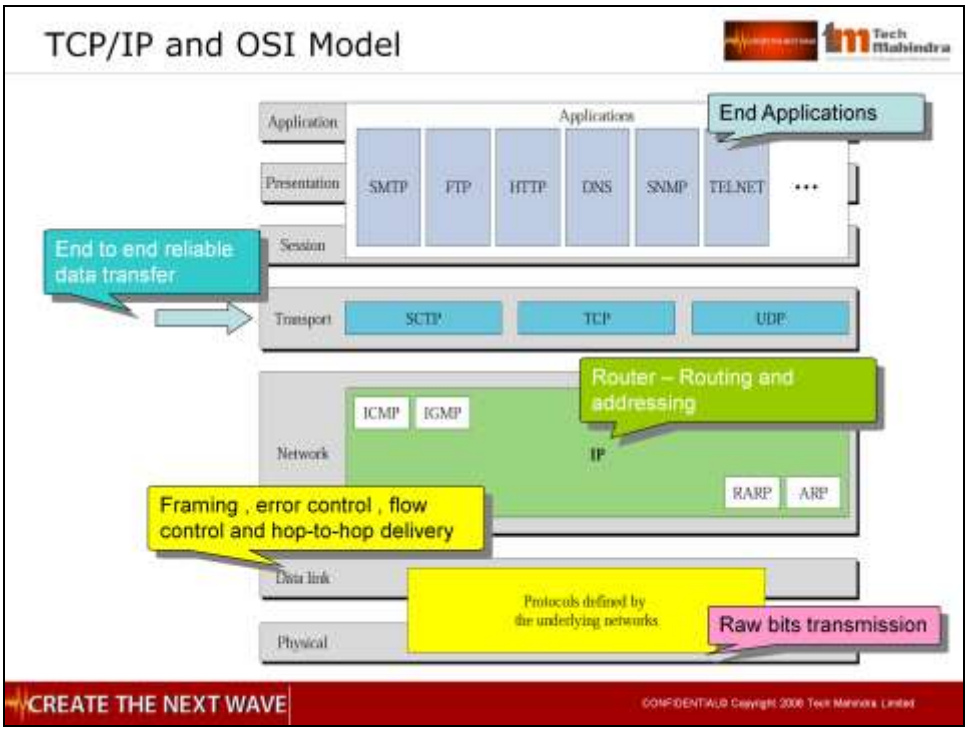


CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Internet USA Structure



CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited



When we want two heterogeneous systems to talk with each other there has to be protocol between them.
What is protocol ? Protocols are rules and procedures agreed upon by all parties for communication.
The TCP/IP protocol reference model was used in the ARPANET and is still in use in

its successor, the worldwide Internet.
It came to be known as the TCP/IP model after its two primary protocols: TCP and IP. It was first defined in 1974.
It the only language talked on Internet. By the way TCP/IP is not a single protocol but a suite of protocols. As you could see in above diagram at every layer there are certain protocols.

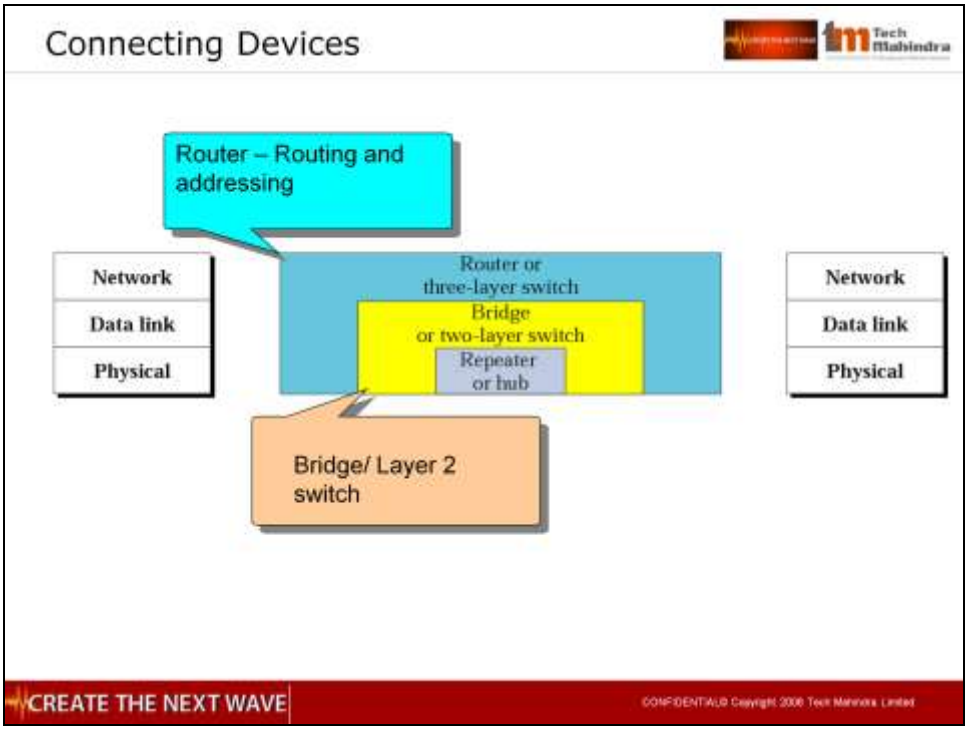
There are other standards/protocols existing.

- ISO’s i.e. Indian standard organizations OSI protocol suite
- IBM Systems Network Architecture (SNA)
- Novell NetWare
- Apple's AppleTalk

It is interesting to note that : TCP IP is a

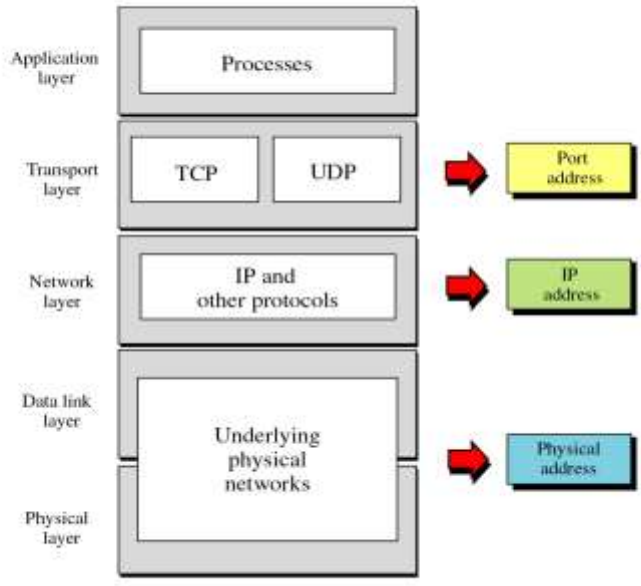
real implementation whereas ISO’s OSI is a model and on time line TCP/IP came first.

Application , Presentation and Session layer of OSI are kind of clubbed into one in TCP/IP and is known as application layer.
Functionalities of each layer are as shown in figure.
Presentation : Encryption and compression
Session : Maintain a session between two end entities



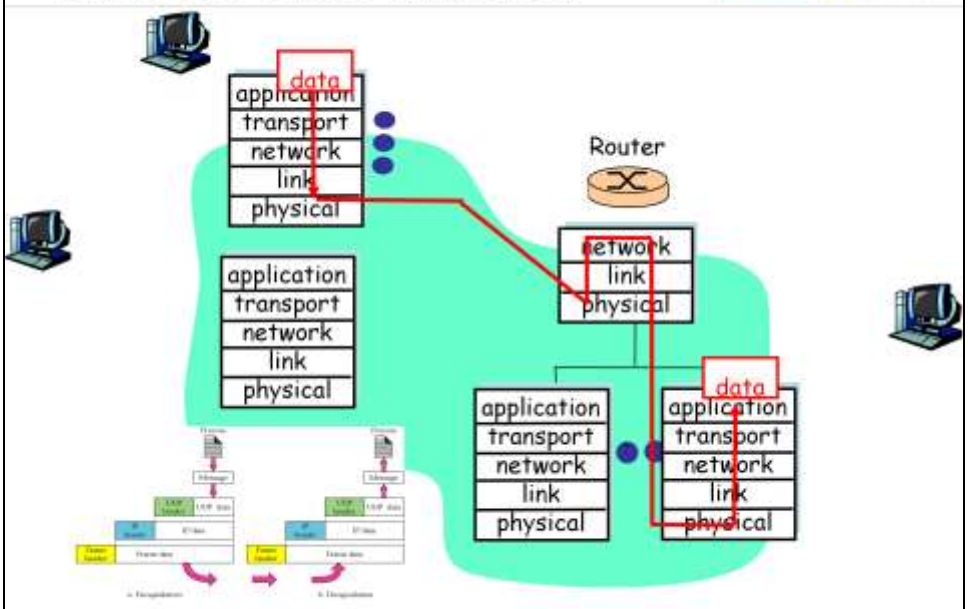
Router works at layer 3. Its main function is addressing and routing.
Bridge in a multiprotocol router within a LAN. It can understand multiple data link layer protocols.
Repeater and hub are physical layer devices. They do not have much intelegence as routers or switches do have.

Address and Context

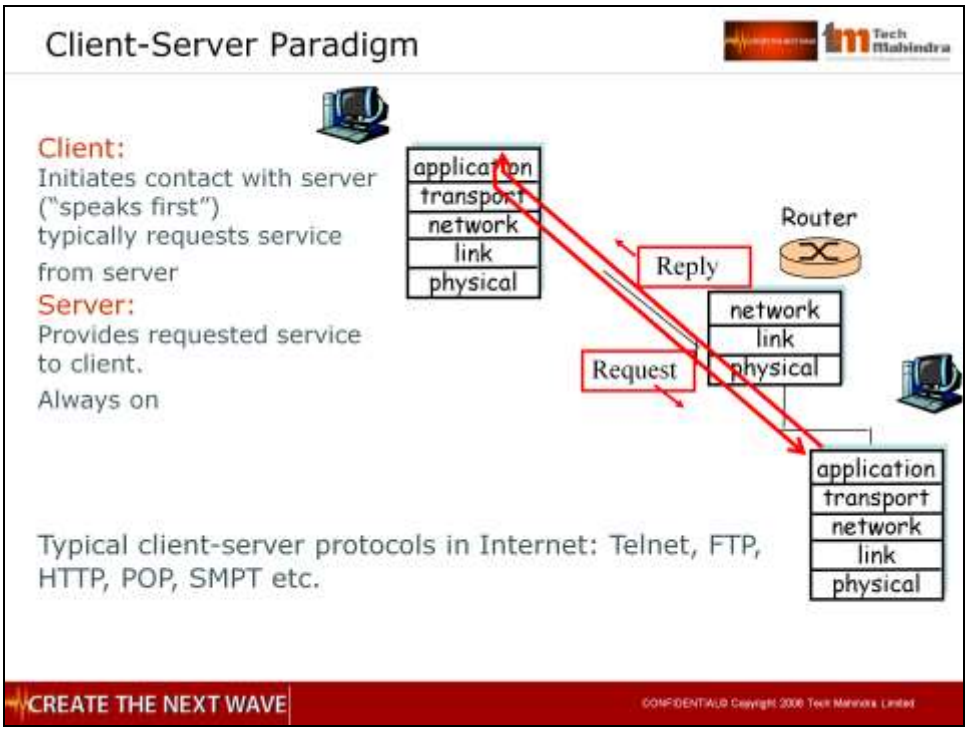


CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

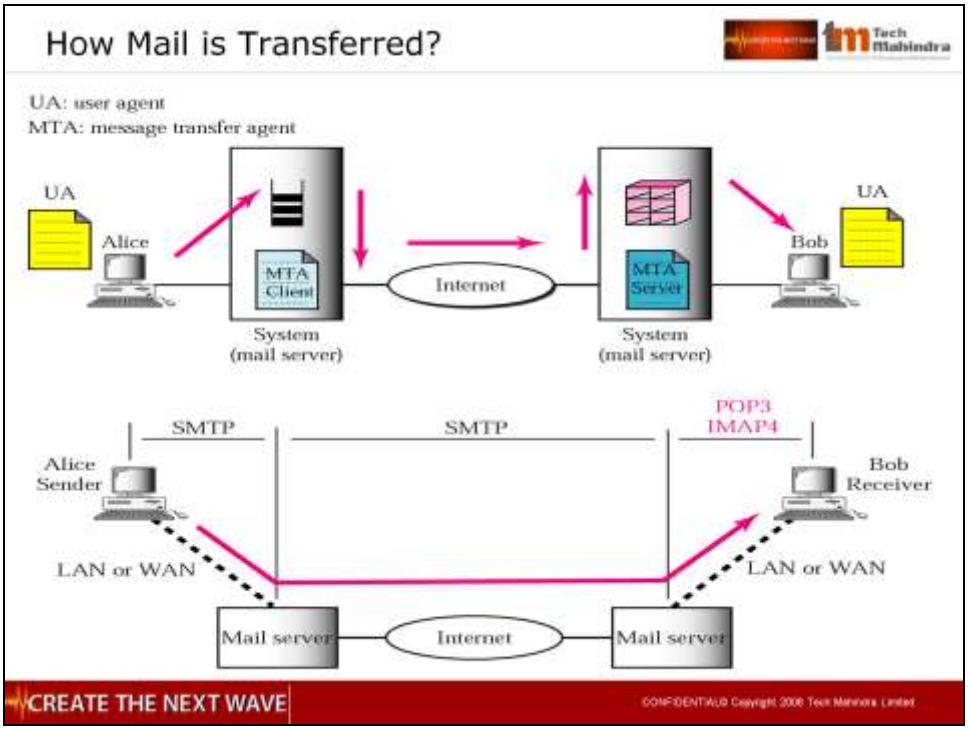
TCP/IP: How Data is Transferred?



CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited



Typical network app has two pieces: *client* and *server*



Some examples of command-driven user agents are mail, pine, and elm

Some examples of GUI-based user agents are Eudora, Outlook, and Netscape.

Give example of Tech Mahindra server system

Summary

- In this session, we have learned:
  - ISDN network components and different ISDN services such as PRI, BRI
  - Concept of cell and frequency reuse in GSM
  - GSM network evolution, network architectural composition and GSM identifiers
  - Process of Mobile registration, mobile originated call [MOC] and mobile terminated call [MTC]
  - Roaming in GSM
  - GPRS network enhancement on the top of GSM
  - Role of SGSN and GGSN in GPRS network
  - GPRS network features
  - OSI and TCP/IP protocols, network devices and addresses
  - Logical and physical representation of internet today
  - Concept of client and server with example of mail transfer

CONFIDENTIAL© Copyright 2008 Tech Mahindra Limited

Thank you

© Tech Mahindra Limited 2008

Tech Mahindra Limited confidential