DHRUV GARG 16 BCE 1190

NETWORK AND COMMUNICATION

DIGITAL ASSIGNMENT 1

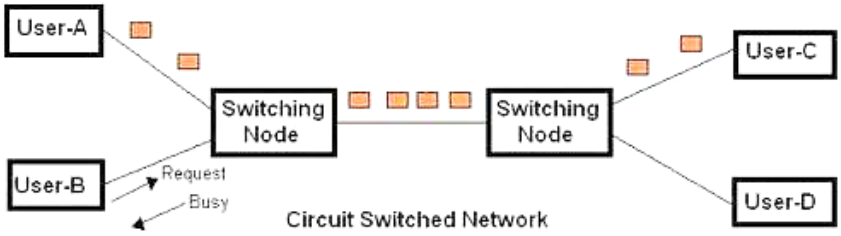
SWITCHING PROCESS

Switching is the method by which data is transferred from an input port to an output port of an intermediate exchange switch. There are two methods of switching:

A. Circuit switching

Circuit switching is primarily used in telephone networks and not in computer networks. In circuit switching,

i. An end-to-end circuit (path) is first reserved using a separate signalling protocol
ii. Data transfer proceeds only after the circuit establishment phase
iii. All data of that session passes through the same circuit
iv. No other user can use this circuit till this session is completed
v. No signalling information is sent along with the data
vi. Circuit is released after data transfer using the signalling protocol



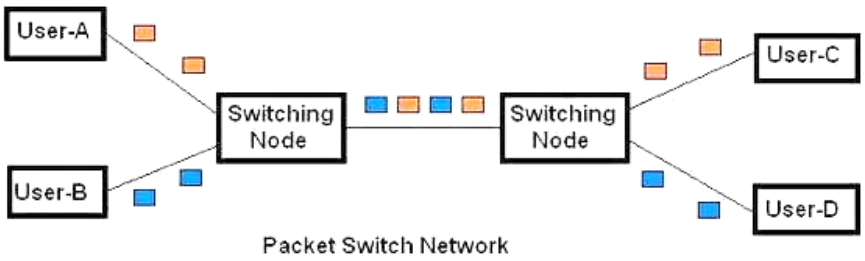
B. Packet switching

Packet switching is the process of transmitting data in small units called as packets. This switching method used in data networks for computer communication. In packet switching,

i. There is no end-to-end circuit reservation
ii. A packet consists of a header (containing signalling/addressing information) and data
iii. Each packet has signalling information in the form of source and destination addresses in the packet header.
iv. Signalling information is used by intermediate data exchange devices to route packets.
v. Exchange devices like routers and switches use a store and forward approach for transmitting packets from an input port to an output port
vi. Link utilization is efficient because there is no end to end reservation of telecommunication links and multiple connections can simultaneously share the link.

Virtual circuit based switching is used especially at the data link layer, to switch packets inside switched WAN networks.

Datagram switching is simpler and more widely used than VC based switching. Datagram based packet switching is the fundamental technique used in the Internet for end-to-end routing of packets at the network layer, between remote communicating computers.



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BEFORE 3G

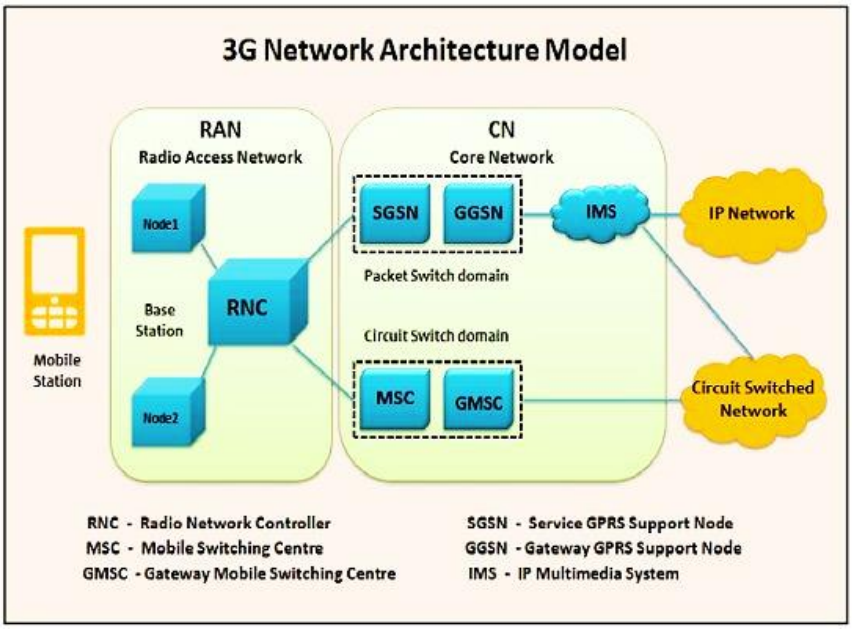
First generation (1G) was based on analog system. It was less secure and only had voice communication. With the second generation (2G) of mobile communication, digital communication was introduced. However, it was still designed only for phone calls. 2G inherently used circuit switching. It used multiple access schemes like GSM and CDMA. An intermediate standard 2.5G was introduced when the realization dawned that people wanted phones for both voice and data communication. With GPRS, packet switching was introduced, which was more suited for the internet. GPRS provided data speeds up to 50kbps and EDGE provided speeds up to 200kbps.

3G – HYBRID SWITCHING TECHNIQUE

3G is a generation of standards for mobile telecommunication services that provides the ability to transfer both voice and data (music downloads, emails and instant messaging) over the same network, simultaneously. It delivers broadband capacity, supports larger number of voice and data customers of lower incremental cost than its predecessor 2G. 3G uses **circuit switching for voice communication**, and **packet switching for data communication.**

In market implementation, 3G downlink data speeds defined by telecom service providers vary depending on the underlying technology deployed; up to 384kbit/s for WCDMA (Wideband Code Division Multiple Access), up to 7.2Mbit/sec for HSPA and a theoretical maximum of 21.6 Mbit/s for HSPA+ (High-Speed Packet Access). Universal Mobile Telecommunications System (UMTS) model was the successor to GSM. The UMTS uses the W-CDMA, TD-CDMA, or TD-SCDMA air interfaces in which **WCDMA is the most popular air-interface technology for the UMTS.**

The hybrid switching technique used in 3G can be understood from its architecture:



1. **User equipment**: Any device that uses data and voice - mobile phones, tabs or computers.
2. **Radio Access Network (RAN):** Bridges the gap between the mobile station and the core network.
3. **Core Network (CN):** It provides the main processing and management of subsystems.
   The core network is divided into two parts:
   a. **Circuit Switched Domain:** It uses Circuit Switched Network in which dedicated link or channel is provided for a particular time slot to set of users.
   MSC – Mobile Switching Centre manages circuit switched calls.
   GMSC – Gateway MSC acts as an interface between external and internal networks.
   b. **Packet-switched domain:** It uses IP Network where IP's are responsible for transmitting and receiving data between two or more devices.
   SGSN (Serving GPRS Support Node): Plays a role in mobility management, session management, and interaction with other areas of the network.
   GGSN (Gateway GPRS Support Node): Can be considered as a very complex router and handles the internal operations between the external packet switched networks and UMTS packet switched network.
4. **IMS (IP Multimedia Subsystem):** Delivers IP multimedia services.

Features and advantages of 3G

The WCDMA gives additional advantages **of high transfer rate**, and increased system capacity and communication quality by statistical multiplexing. The WCDMA utilizes **efficiently the radio spectrum**, because the CDMA technique enables all base stations to use the same frequency. In the WCDMA system, the data is split into separate packets, which are then transmitted using packet switching technology, and the packets are reassembled in the correct sequence at the receiver end by using the code that is sent with each packet. The UMTS systems are designed to provide a range of data rates, depending on the user's circumstances, providing up to **144 kbps for moving vehicles**, up to **384 kbps for pedestrians** and up to **2 Mbps for indoor or stationary users.** The3G basically focused on multimedia applications such as video calling, videoconferencing for mobile phones, improved capacity, world roaming, low cost, better compatibility and high speed data.

Disadvantages of 3G

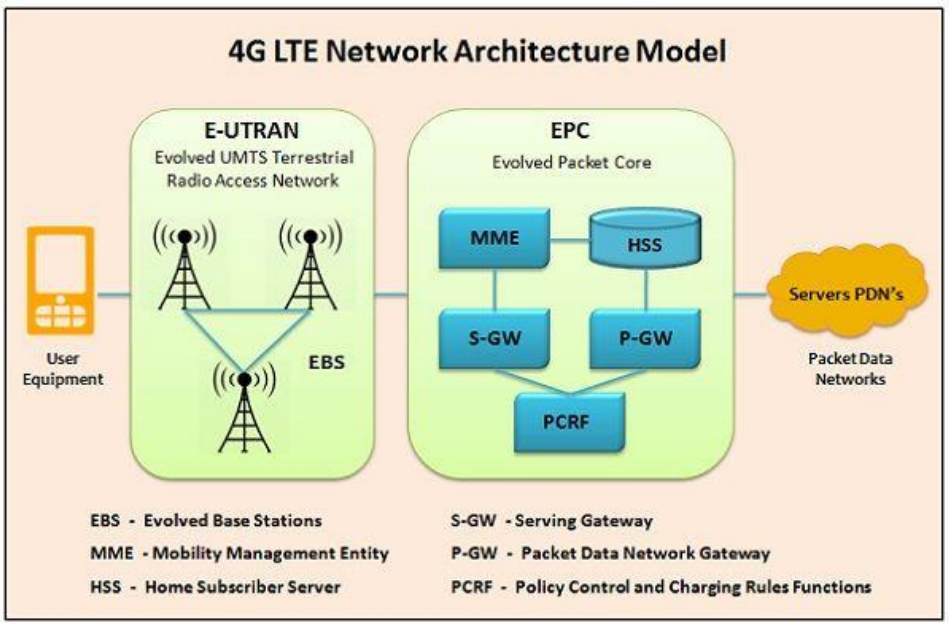
- The cost of cellular infrastructure, upgrading base stations is very high.
- Roaming and data/voice work collectively has not yet been implemented.
- Power utilisation is high.
- Requires closer base stations and are expensive.

4G – PACKET SWITCHING TECHNIQUE

4G stands for 4th Generation Technology, and it is an extension of 3G technology. It offers completely converged customised services (voice, data and multimedia) at **data rates of up to 100 Mbps** and pervasive mobile access for high-resolution mobile television, IP telephony, gaming services, video conferencing and 3D television.

The improved versions of existing technologies including GSM, GPRS, CDMA, W-CDMA, CDMAone, IMT-2000, Wireless LANs and Bluetooth are integrated into 4G. Versions of Mobile **LTE (Long Term Evolution)** and WiMAX (Worldwide Interoperability for Microwave Access) in unison support much less than 1 Gbit/s peak bit rate, are branded 4G by service providers. The key technologies that have made this possible are **MIMO (Multiple Input Multiple Output) and OFDM (Orthogonal Frequency Division Multiplexing)**. MIMO leverages spatial multiplexing to provide diversity gain while OFDM is more adept at managing channel distortion.

The packet switching technique used in the 4G network can be understood from its architecture:



1. **User Equipment:** Any device capable of establishing communication functions like mobile phones, tabs, computers, etc.
2. **Evolved UMTS Terrestrial Radio Access Network (E-UTRAN):** It controls radio communication between user equipment and EPC. LTE mobile can connect with just one cell and one base station at a time.
3. **Evolved Packet Core (EPC):** It communicates with internal and external packet data networks and IP multimedia subsystem.
    a. **HSS (Home Subscriber Server):** Contains all the information about all the network operator's subscribers in a central database.

b. **MME (Mobility Management Entity):** Handles the high-level operation by the signalling messages and HSS.
c. **S-GW (Signalling Gateway):** Performs mobility anchoring and forward data between the PDN gateway and base station.
d. **P-GW (Packet Data Network Gateway):** Performs operations like IP address allocation and packet filtering.
e. **PCRF (Policy and Charging Rule Function):** Controls the flow-based charging operations in the Policy Control Enforcement Function (PCEF).

Features and advantages of 4G

4G includes features like **scalability, flexibility, efficiency,** self-governance and security to support interfacing with different types of networks. LTE is completely an all IP based system. Since there are provisions in LTE for inter-operation with existing systems, there are various paths available to connect to LTE. An operator with a GPRS/EDGE network or aNon3GPP systems can connect to a LTE network. Due to this **increased flexibility,** LTE is the choice of majority of operators worldwide. By using Orthogonal Frequency Division Multiple Access (OFDMA), LTE will be able **to provide download rates of about 100 Mbps** for multi-antenna (2x2), multiple-input multiple output (MIMO) for the highest category terminals. For these terminals **upload rate is about 50 Mbps**. Moreover, it provides better **mobility, efficient radio usage, high level of security**, flexible spectrum utilization, **reduced delay/latency**, cost efficient deployment and various other advantages which makes LTE more reliable and user friendly.

Disadvantages of 4G

- Location coordination and resource coordination to add new devices is not adequate.
- Limited voice calls and services can be handled a time.
- Being a concentrated data service, it requires broad bandwidth.
- It doesn't provide good services in rural areas due to the requirement of the wireless network and 4G network isn't expanded well in those areas.

5G – (First official 5G specification was approved on 21/12/2017)

5th generation mobile networks are the **proposed next telecommunications standards** beyond the current 4G operating in the millimetre wave bands (28, 38, and 60 GHz). There is currently no standard for 5G deployments.

The Next Generation Mobile Networks defines the following requirements that a 5G standard should fulfil:

i. Data rates of tens of megabits per second for tens of thousands of users
ii. Data rates of 100 megabits per second for metropolitan areas
iii. 1 Gb per second simultaneously to many workers on the same office floor
iv. Several hundreds of thousands of simultaneous connections for wireless sensors
v. Spectral efficiency significantly enhanced compared to 4G
vi. Coverage improved
vii. Signalling efficiency enhanced
viii. Latency reduced significantly compared to LTE.

In addition to providing simply faster speeds, they predict **that 5G networks also will need to meet new use cases**, such as the Internet of Things, as well as broadcast-like services and lifeline communication in times of natural disaster.

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REASONS WHY 3G (HYBRID SWITCHING) IS SLOWER THAN 4G (PACKET SWITCHING)

Main reason:

A key change in 4G is the **abandonment of circuit switching**. 3G technologies use a hybrid of circuit switching and packet switching. Circuit switching is a very old technology that has been used in telephone systems for a very long time. The downside to this technology is that it ties up the resource for as long as the connection is kept up. Packet switching is a technology that is very prevalent in computer networks but has since appeared in mobile phones as well. With packet switching, resources are only used when there is information to be sent across. The efficiency of packet switching allows the mobile phone company to squeeze more conversations into the same bandwidth. 4G technologies would no longer utilize circuit switching even for voice calls and video calls. All information that is passed around would be packet switched to enhance efficiency.

Other reasons,

1. 3G It carries a lot of baggage like circuit switching mode and issues related to **backward compatibility** that impacts the way advanced radio features can be added to the base system.
2. The base system is **CDMA** which is now an **obsolete technology**. It might have been useful for lots of narrowband voice circuits but useless for high bitrate data and not easily scalable to support wider carrier bandwidths.
3. While **3G has only 5MHz bandwidth** (single carrier), **4G or LTE can have a bandwidth of 20MHz**. This is also a reason for higher speed on 4G.
4. **The modulation and coding scheme of 4G contains more symbols** (OFDM-in other words, more bits) than 3G which in turn increases the speed in 4G.