

Basics of Wireless Networks

- **Network** – a collection of terminals, computers, servers and components which allows for the easy flow of data and use of resources among them(in case of wired environment)
- **Wireless network** – Any type of computer network that is wireless.

Allows us to connect our computer to a network using radio waves instead of wires.

- **Wireless network Architecture** – Defines the elements of the wireless network that participate in communication across the geographically distributed area.

The History and Evolution of Wireless Radio Systems

History of Wireless Radio Systems

- 1867 – Maxwell's predicted existence of EM Waves.
- 1872 - Marlon Loomis was issued a U.S. patent for a crude type of aerial wireless telegraph .
- 1887 - Heinrich Hertz performed laboratory experiments, that proved the existence of electromagnetic waves.
- 1890 – Branly developed Coherer (apparatus for detecting radio waves)
- 1896 – Marconi demonstrated wireless telegraph.
- 1897 – “Birth of radio” by Marconi and he started “Marconi station” on needles island to communicate with the English coast.

contd....

- 1898 – Marconi experimented on tuned communication . Wireless telegraph connection between England & France established.
- From 1895 to 1901 Marconi experimented with a wireless telegraph system.
- December 12, 1901 - Marconi sent a message (the signal was a repetitive letter “s” in Morse code) from Cornwall, England to Signal Hill, St. John’s, Newfoundland—the first transmission across the Atlantic Ocean.
- 1902 – First bidirectional communication across Atlantic.
- 1909 – Marconi awarded Nobel prize for physics.

Evolution of wireless radio system

- Early AM wireless system
- First Broadcast
- Modern AM
- Development of FM
- Evolution of Digital Radio
- Cellular telephone concept.

Early AM Wireless Systems

- A typical early wireless transmitter is shown in Figure 1–1.
- The wireless transmitter would emit a signal of either long or short duration depending on the length of time the telegraph key was closed.
- The transmitted signal was the electromagnetic noise produced by the spark-gap discharge. This signal propagated through the air to a receiver located at some distance from the transmitter.
- The inductance & capacitance used to tune the output frequency of the spark gap.
- Due to the nature of the spark gap emission , maximum output occurs at a very low frequency.
- At the receiver, the detected signal was interpreted by an operator as either a dot or a dash depending upon its duration.
- Using Morse code, combinations of dots and dashes stood for various alphanumeric characters. This early wireless transmission form is now known as amplitude modulation (AM) and in particular, on-off keying (OOK).

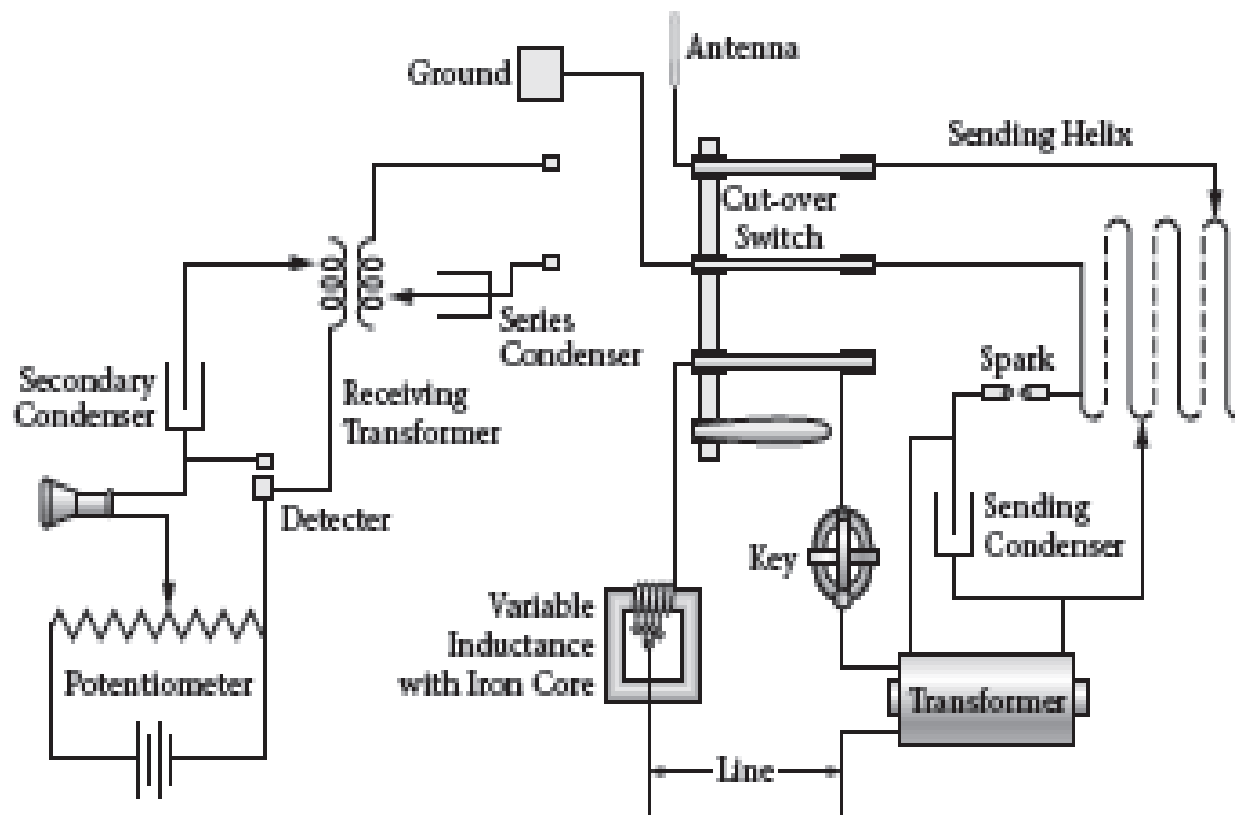


FIGURE 1-1 Typical early wireless transmitter.

Limitations

- Very low frequency transmitter
- Low power & unstable output
- Need bigger & high elevated antenna
- Modulated signal is very sensitive to noise.

Remedies

These limitations can be overcome by using next generator wireless transmitter.

The First Broadcast

- 1905 - Reginald Fessenden conducted experiments with continuous wave (CW) wireless transmissions at Brant Rock, Massachusetts, using 50-kHz high-frequency alternators built by General Electric.
- The output of this type of generator was much more stable than that of a spark-gap or Poulsen transmitter, allowing him to experiment with a continuous form of amplitude modulation.
- 1906 – He credited with transmitting the first radio broadcast.
- 1910 - U.S. Navy led a major effort to develop wireless radio for ship-to-ship and ship-to-shore communications.
- 1920 – (i)Decade of high-frequency or short-wave radio development.

Contd..

(ii) Marconi's research on radio wave propagation revealed that trans-atlantic radio transmission was feasible at frequencies much higher than that had previously been done.

(iii) vacuum-tube technology had improved to such an extent as to increase the upper-frequency limit of their operation.

- 1926 – trans-oceanic telephone calls were available via high-frequency radio transmission.
- 1930 – 1940

Saw more advancement in radio technology with the invention of television, radar, and vacuum tubes with the ability to generate “microwaves.”

Modern AM

- Amplitude modulation has been used for low-frequency radio broadcasting, shortwave broadcasting, low-definition television video-signal transmission, amateur and CB radio and various other low-profile services.
- Newer uses of AM include quadrature amplitude modulation (QAM or n-QAM, where n is a power of 2).
- QAM is a hybrid form of amplitude and phase modulation (PM) used for high-speed data transmission at RF frequencies.
- QAM is considered a digital modulation technique. Today, QAM is used extensively by broadband cable and wireless systems to achieve bandwidth efficiency.

The Development of FM

- 1920s - Major Edwin Armstrong worked on the principles of frequency and phase modulation
- late 1960s and early 1970s - FM broadcasting became popular.
- technological advances reduced the cost of consumer equipment and improved the quality of service.
- Many public safety departments were early adopters of FM for their communications.
- 1983 – AMPS(Advance Mobile Phone System) cellular telephone service, an FM-based system, was introduced in the United States
- Today FM is used –
 - for transmissions in the FM broadcast band
 - TV-broadcasting sound transmission
 - direct-satellite TV service
 - cordless telephones
 - every type of business band and mobile radio service.
- FM is capable of much more noise immunity than AM, and is now the most popular form of analog modulation.

The Evolution of Digital Radio

- 1936 - The first experimental broadband coaxial cable was tested
- 1941 - the first operational L1 system that could handle 480 telephone calls was installed in Microwave radio relay systems developed in tandem with broadband coaxial cable systems.
- 1947- The first microwave relay system was installed between Boston and New York
- 1951 - AT&T's coast-to-coast microwave radio relay system was in place by Microwave relay systems which had lower construction and maintenance costs than coaxial cable .
- By 1970s, AT&T's microwave relay system carried 70% of its voice traffic and 95% of its broadband television traffic.

Contd..

- Most of these systems used analog forms of modulation, although simple digital modulation forms like binary frequency shift keying (BFSK) existed.
- 1970s and 1980s - microwave digital radio technology and digital modulation techniques provide increased data rates over the same radio channel .
- Many of the analog and digital microwave relay systems in use became backup systems with newly installed fiber-optic cables.

Contd..

- Many service providers of point-to-point connectivity were employing microwave and millimeter-wave radio transmission systems that use the most modern digital modulation techniques to obtain high data rate links.
- Cellular operators were using economical point-to-point microwave radio systems to backhaul aggregated bandwidth signals to a common network interface point from both remote and not-so-remote cell sites.
- Wireless Internet service providers (WISPs) are using digital radio equipment designed for the Unlicensed National Information Infrastructure (U-NII) bands for point-to-point and point-to-multipoint systems that provide high bit-rate Internet connections to their customers.

Contd..

- The television broadcasting industry is in the process of transitioning to a high-definition television (HDTV) standard for over the-air broadcast that uses a digital transmission system.
- the oldest analog cellular systems (these systems are in the process of being phased out) are digital, and all of the newest wireless LAN, MAN, and PAN technologies use complex digital modulation schemes.

The cellular telephone concept

- Evolved from earlier mobile radio networks.
- The first mobile radio was used by police department or other law enforcement agencies.
- One way mobile radio system operating at 2Mhz – used to page the police cars.
- 1968 – FCC asked for a proposal with high capacity, efficient mobile phone system.
- AT & T proposed core idea of cellular system.

The development of modern telecommunications Infrastructure

- The wireless networks and systems have the basic function of connecting users to public Switched Telephone network(PSTN) or the Public Data Network(PDN).
- So it is necessary to examine- what these 2 public networks are ? & How they have evolved?

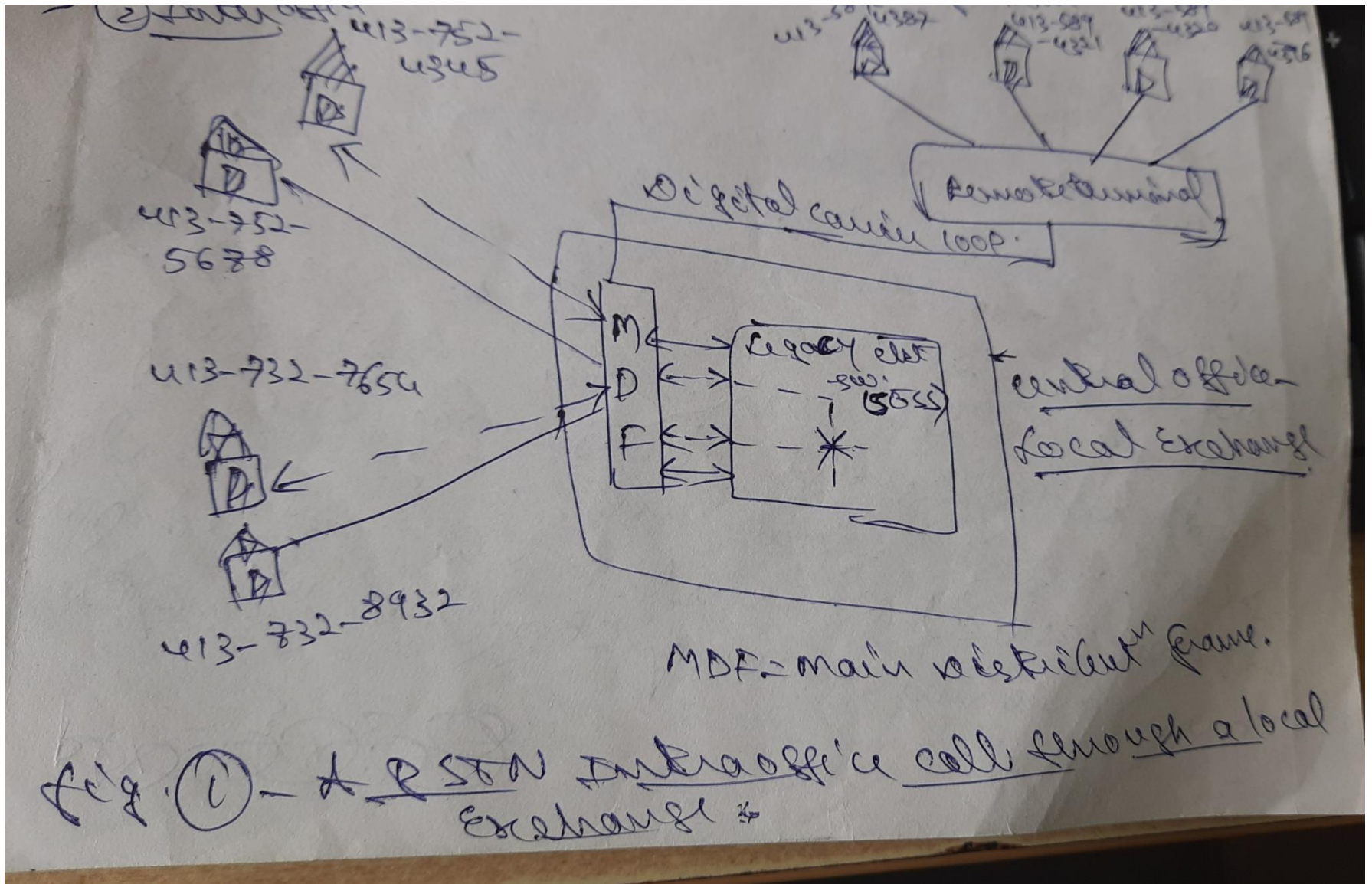
The Public Switched Telephone Network(PSTN)

To explain the physical infrastructure of the PSTN, it is necessary to consider the various pathways of communication available through the system.

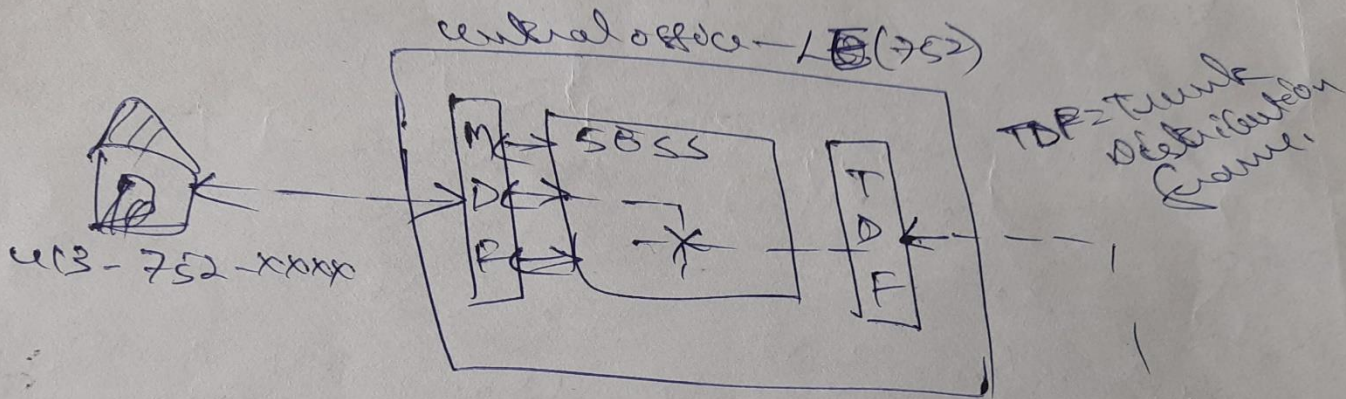
Two types of PSTN

- (i) Intra-office
- (ii) Inter-office

A PSTN Intra-office call through a local exchange

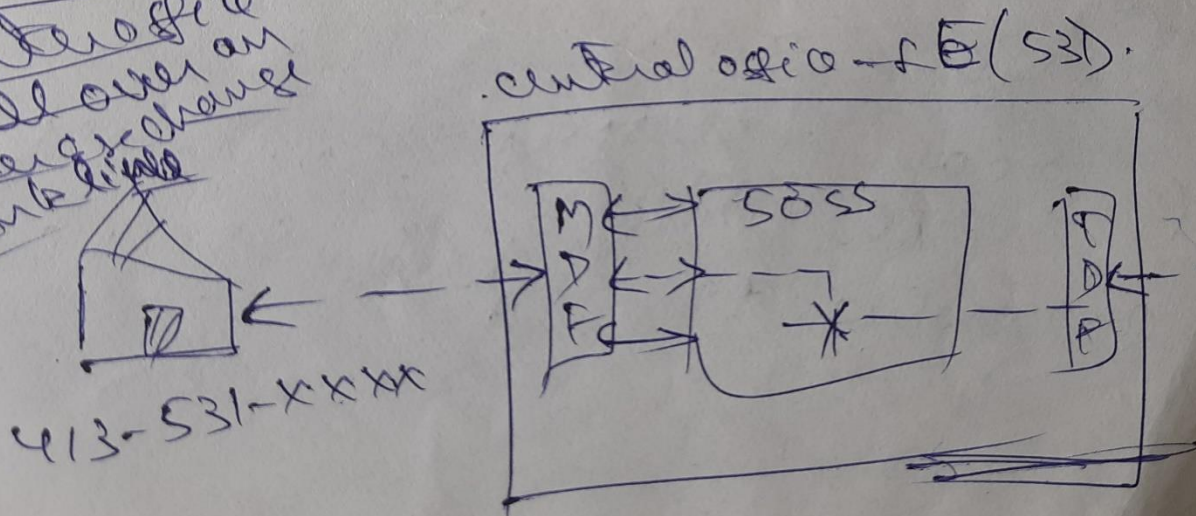


A PSTN inter-office call over an inter-exchange trunk line



Sub-exchange trunk line.

Fig 2.5
A PSTN
inter-office
call over an
inter-exchange
trunk line



➤ Signaling System #7

- The early PSTN USED “In – band “ signaling to set up inter-office and long distance telephone calls – This has many disadvantages.
- The system of using a separate facility or channel to perform the call routing function has developed.
- “Out of band “ signaling
- Today it is called CCIS(Common Channel Interface Signaling) or SS#7.

The Network Elements of SS7 System

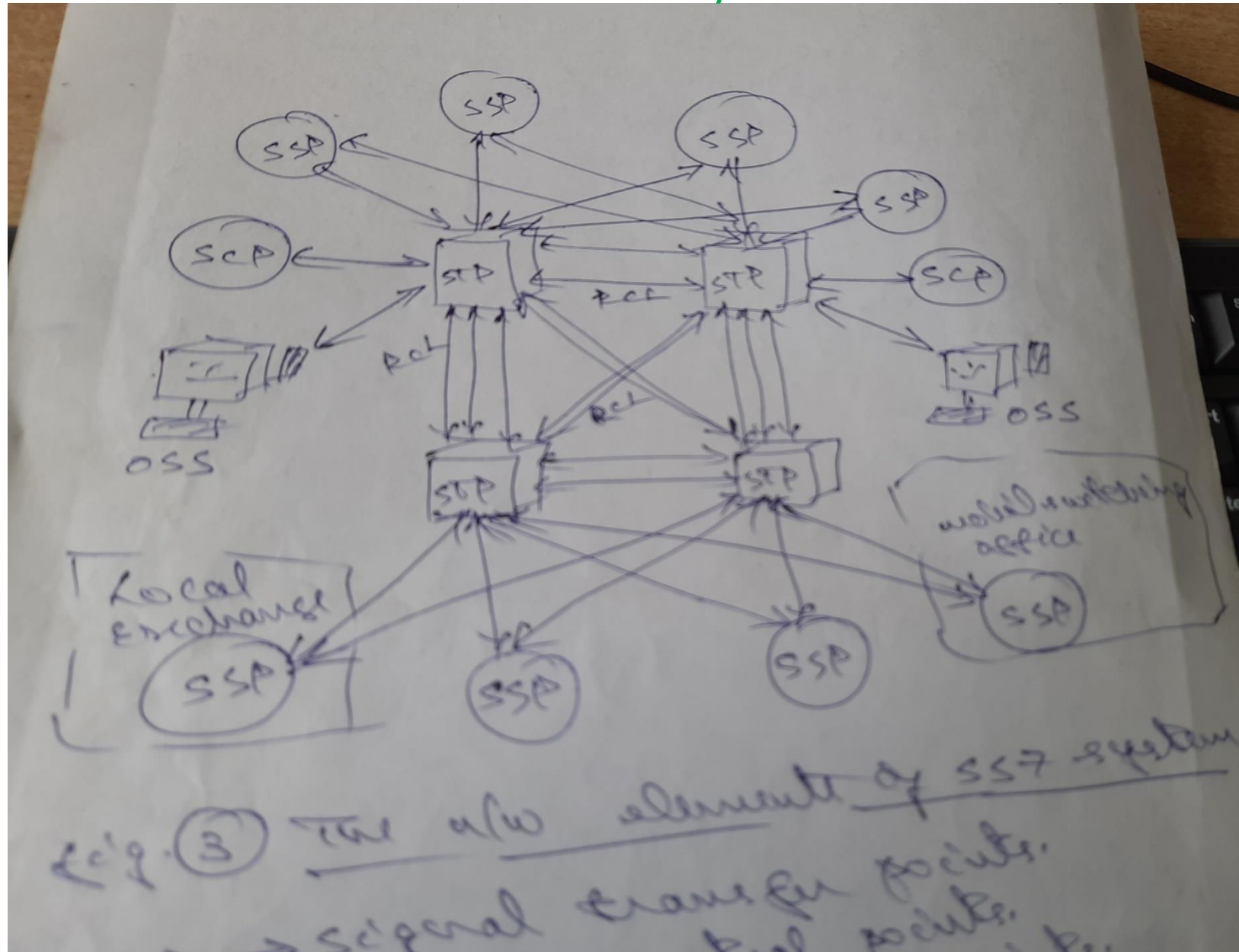


Fig. (3) The also element of SS7 system.

STP → Signal transfer points.

SCP → Service control points.

SSP → Service switching points.

OSS → Operations support systems.

RCT → Redundant comⁿ links.

- SS7 system is a packet network that consists of STP & Transmission facilities linking the STP's as shown in fig.3
- The STP's are connected to SSP's at local exchange and interface with the local exchange switch or mobile switching center in case of a PLMN(public land mobile network)
- SSP's convert signaling information to SS7 signaling Messages in the form of data packets that are sent over SS7 network.
- STP's serve as routers.
- RCL's between STP's provide SS7 network with a degree of reliability.
- SS7 provides 2 forms of services:-
 - **Circuit related** –Setting up & tearing down of circuits
 - **Non circuit related** –Access of information from data bases maintained by the network.
- SCP – Acts as interface between SS7 network and various databases maintained by telephone companies.
- NOC(Network operation center) is the maintenance center.
- All PSTN and PLMN's use SS7 for signaling operations within the network and between the network and other networks.