Modulation

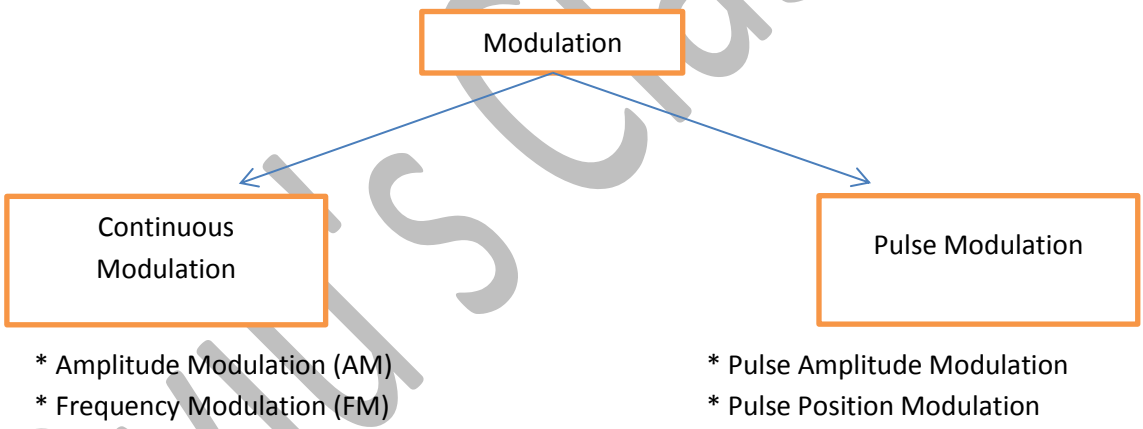
It is defined as the process by which some characteristic of a signal **carrier** is varied in accordance with the instantaneous values of the **modulation** (information) signal.

For example, if Amplitude of the carrier signal is varied w.r.t to information signal it is termed as Amplitude Modulation. And if Frequency is altered it is known as Frequency Modulation.

Need for Modulation

- Practicality of length of antenna. L=λ/4. Since a carrier of high frequency is being used, it eliminates the requirement to have very high antenna.
  Where λ is the wavelength of the wave used.
- Remove interference (noise). The modulation process is carried out by using a very high frequency **carrier** wave. This ensures the noise is removed to a very large extent.
- Transmitting process will become easy, since the information signal is converted to a format that is easy to transmit.

Types of Modulation



Electromagnetic Spectrum

It is defined as the range of all possible frequencies of electromagnetic radiation. Electro-Magnetic waves are waves in which both electric and magnetic fields vary simultaneously.

EM waves usually is used in applications like Spectroscopy. But it also finds application in communication technologies.

EM waves are **Transverse** waves. Waves can be classified as Transverse or Longitudinal waves. Transverse waves are those where in the particles in the **medium vibrate in a direction perpendicular to the direction** of the propagation of waves. On the other hand, Longitudinal waves are those where particles in the **medium vibrate in the same direction as that of the direction** of propagation of waves.

EM waves are **Non-mechanical waves**. Waves which does not require medium for propagation of are known as Non-mechanical waves.

EM Spectrum

The waves can be arranged in terms of highest frequency or highest wavelength. From highest frequency to lowest frequency, the EM waves are

- **Gamma rays** – also known as Gamma Radiation. It is the EM radiation with the highest frequency. Gamma radiation is ionizing radiation. They are produced by the decay from high energy states of atomic nuclei (gamma decay). Gamma radiation can be produced artificially similar to the process of X-ray generation. Gamma rays have frequencies higher than 10 exahertz ($>10^{19}$). Gamma rays are known to kill cells. They are increasingly used to kill cancerous cells.
    - **Ionizing Radiation**: It is radiation composed of particles that individually carry enough energy to liberate an electron from an atom or molecule without raising the bulk material to ionization temperature.
- **X Rays** – X-rays were discovered by William Roentgen. He produced these rays by bombarding electron to an element having high atomic number say Tungsten or Copper. X-rays can carry enough energy to ionize atoms and disrupt molecular bonds.
  Radiography is the use of X-rays to view a non-uniformly composed material such as the human body. By using the physical properties of the ray an image can be developed which displays areas of different density and composition.
- **Ultraviolet Rays** – It is part of EM spectrum where the wavelength is greater than X-rays. This portion of the spectrum is so named to represent that portion of the spectrum that has frequencies higher than those the Humans identify as the colour violet.
  The ozone layer in the stratosphere is known to block the UV rays from reaching the earth. There are three types of UV rays
    - UV A- Recent evidences link this radiation exposure to changes in structure of DNA. This is unaffected by ozone and most of it reaches earth surface.
    - UV B- Is blocked by ozone.
    - UV C- Almost all of it is blocked by either ordinary air or ozone.
- **Visible Light** – This is the portion of the EM spectrum that is visible to the human eye. Electro Magnetic radiation in this range of wavelengths is called visible light. The wavelength range is 400nm-700nm. Newton divided the spectrum into seven colours VIBGYOR (from highest frequency to lowest frequency).
  Nobel Physics Prize 2011 was awarded to Saul Perlmutter, Adam Riess and Brian Schmidt. This team had proved that the universe is simply not expanding but expanding at a much faster rate.
  They had taken the help of the **Redshift** phenomena to prove this theory. Redshift happens when light seen coming from an object that is moving away proportionally increased in wavelength, or shifted to the red end of the spectrum.
- **Infrared** – This includes most of the thermal radiation emitted by objects near room temperature. These are known as heat waves. Much of the energy from the sun arrives on Earth in the form of Infrared radiation. Infrared waves help in maintaining earth's warmth or average temperature through the greenhouse effect.
- **Microwave Radiation** – These are EM waves that are produced by Oscillating circuit or a magnetron. This is used in RADAR applications.
- **Radiowaves** – This is the region having longest wavelength. The frequency extends from 3kHz to 300 GHz. These waves are used in communication.

Types of EM Spectrum

- **Paid Spectrum –** This portion of the EM Spectrum corresponds to spectrum that needs to be purchased or rented/leased. Like the frequency band of 800MHz, 900MHz (used for CDMA and 2G) in India has to be leased.
- **Unpaid Spectrum –** This portion of the EM Spectrum corresponds to spectrum that need not be purchased or rented/leased. This corresponds to frequencies like 2.4GHz in which Wifi works (in India). Other frequency ranges includes 902-928MHz, 1880-1900MHz, 2483-2500MHz, 5150-5350MHz and 5725-5775MHz.

Different generations in wireless telephony

- **1G**-Refers to the first generation of wireless telephone technology. These are analog telecommunication standards. This differentiates it from 2G which uses digital radio signals.
- **2G** – This was wireless telephony using digital radio waves. It was this generation that introduced data services starting with SMS text messages.
- **2.5G** – It is used to describe 2G systems that have implemented the packet switched domain in addition to the circuit switched domain. GPRS (General Packet Radio Service) is usually termed as 2.5G which usually provides data rates of 114Kbps (max).
- **2.75G** – With the introduction of EGPRS, the data rates got increased to 384Kbps (max). This technology was also known as EDGE (enhanced data rates for GSM evolution).
- **3G** – This is a set of standards used for mobile devices and networks that comply with the **International Mobile Telecommunications-2000** specifications provided by the International Telecommunication Union.
  To meet the IMT-2000 specifications, a system is required to provide peak data rates of atleast 2Mbps. The access technology used is **Wideband CDMA** whereas the switching used is either **circuit/packet**. In India the frequency being used is 2.1GHz.
- **4G** - This is a set of standards used for mobile devices and networks that comply with the **International Mobile Telecommunications-advanced** specifications provided by the International Telecommunication Union.
  To meet the IMT-Advanced specifications, a system is required to provide peak data rates of 100Mbps. Two systems are commercially available that implements 4G. These are the **WiMax** and the **Long Term Evolution (LTE)**.

Difference between 3G and 4G

	3G	**4G**
Frequency Band	2.1GHz	2.3GHz
Data Rates	Upto 2Mbps	20Mbps and more
Access Technology	Wideband CDMA	Multicarrier CDMA
Switching	Circuit Switching	Packet Switching

Policies in India

When India opened its market in 1991, investments started flowing in to various sectors. The Government of India in 1994 released its first policy on National Telecom.

Salient features of National Telecom Policy -1994

- Private sector was identified as one of the actors in this policy. And accordingly, FDI was invited to help private companies.
- It was envisaged to make available Phone on demand.
- It was envisaged that all the villages will be connected (by landline) by 1997.
- In urban areas it was planned for 1 PCO for every 500 persons.

Salient features of New Telecom Policy -1999

- Since, now enough connectivity was reached through NTP 1994, it was again emphasized to provide telephones on demand by 2002.
- Rural teledensity was planned to be increased from 0.4% to 4%.
  Teledensity – it is the number of mobile/landline connections for every 100 individuals living in an area.
- Provide internet to District HQ by 2000.
- Most notably, the revenue generation from Telephony was changed. A new concept of **One time Entry fee** was charged and a **license fee based on Revenue** was initiated.
- Resources for meeting **Universal Service Obligation** would be through **Universal Access Levy**. This was mentioned in the policy itself.
  Universal Service Obligation - As per the Indian Telegraph Act 1885 (as amended in 2003 and 2006) Universal Service Obligation is defined as access to telegraph service to people in rural and remote areas at affordable and reasonable prices.
  Apart from the higher capital cost of providing telecom services in rural and remote areas, these areas also generate lower revenue due to lower population density, low income and lack of commercial activity. Thus normal market forces alone would not direct the telecom sector to adequately serve backward and rural areas. Keeping in mind the inadequacy of the market mechanism to serve rural and inaccessible areas on one hand and the importance of providing vital telecom connectivity on the other, most countries of the world have put in place policies to provide Universal Access and Universal Service to ICT.

Addendum to NTP 1999

Government, in the public interest in general and consumer interest in particular and for the proper conduct of telegraphs and telecommunications services, and also based on recommendations of TRAI in this regard has decided there shall also be the following categories of licences for telecommunication services:

i. **Unified Licence for Telecommunication Services** permitting Licensee to provide all telecommunication/ telegraph services covering various geographical areas using any technology;

ii. **Licence for Unified Access (Basic and Cellular) Services** permitting Licensee to provide Basic and /or Cellular Services using any technology in a defined service area.

Universal Service Obligation Fund

NTP'99 envisaged that the implementation of USO Obligation for rural/remote areas would be undertaken by all fixed service providers who shall be reimbursed from the USO Fund. Other service providers would also be encouraged to participate in USO provision subject to technical feasibility and would be reimbursed from the funds.

The **Universal Service Support Policy** came into effect from 01.04.2002. The guidelines for universal service support policy were issued by DoT and were placed on the DoT website www.dot.gov.in on 27th March 2002. Subsequently, the Indian Telegraph (Amendment) Act, 2003 giving statutory status to the **Universal Service Obligation Fund (USOF)** was passed by both Houses of Parliament in December 2003. Hence the USOF received the statutory status in 2003.

The **Rules for administration of the Fund** known as **Indian Telegraph (Amendment) Rules**, 2004 were notified on 26.03.2004.

National Telecom Policy 2012

After the devastating effect brought to Indian Telecom industry in the form of 2G scam and the subsequent quashing of licenses by the SC, the government felt that there has to be an organised effort to close all open ends.
Also the number of telephone connections, at the end of February 2012, was 943 million, as compared to 41 million at the end of December 2001. This growth has been fuelled by the cellular segment (mobile phones) which alone accounted for 911 million connections at the end of February 2012. The National Telecom Policy 2012 (NTP 2012) is conceived against this backdrop.

Salient features of the policy

- **License Reform** – The policy envisages a One Nation / One License across service / service area. As per the addendum to NTP'99 there are two types of licenses
    1. **Unified Licence for Telecommunication Services**
    2. **Licence for Unified Access (Basic and Cellular) Services**

  NTP '12 plans to remove this distinction.
- NTP '12 plans to **unbundle** Spectrum and License.
  Spectrum license (where the telecom company is expected to bid for the required spectrum). On the other hand, the license for the telecom company regards to the operating license for the company.
- **Spectrum Liberalisation**: it is planned to use any frequency to provide any technology. Currently, 2G works in the 900 and 1800 MHz. Whereas 2.1GHZ is used for 3G.
- **Broadband on Demand:** It is envisaged to achieve BoD by 2015.
- **Rural Teledensity is** planned to be increased to 70% from current 39% by 2017 and increase to 100% by 2020.