Semester: V | Subject: Computer Network | Academic Year: 2023-24

Module -2

Physical Layer: Communication mechanisms and Electromagnetic Spectrum

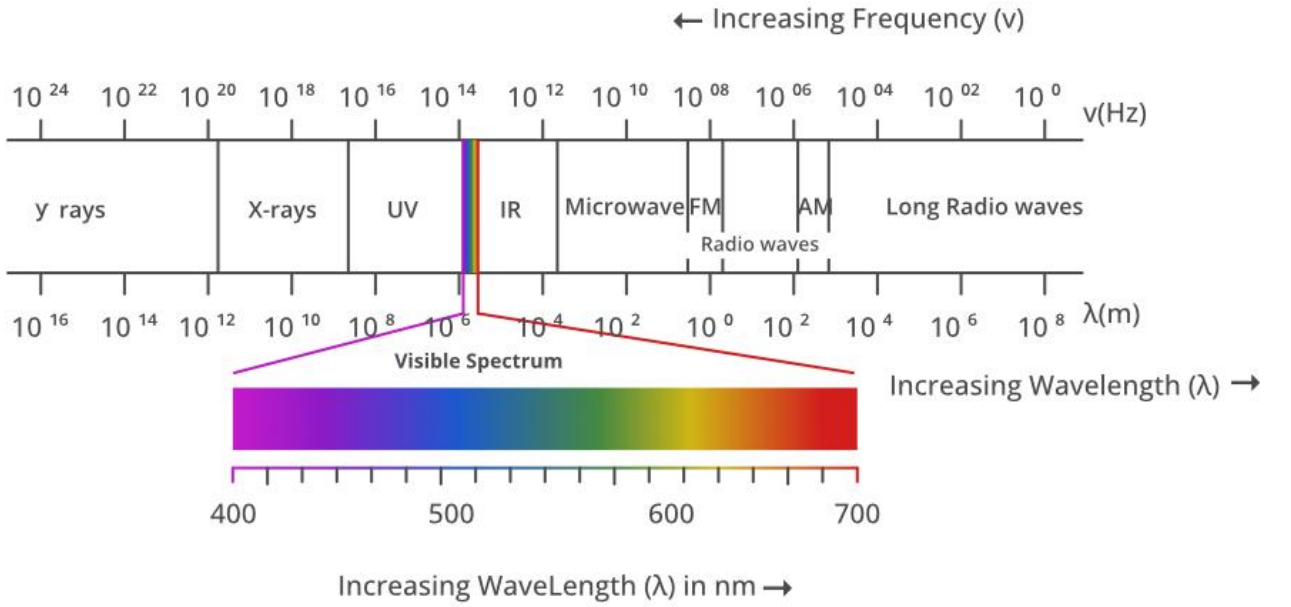
Physical layer in the OSI model plays the role of interacting with actual hardware and signaling mechanism. Physical layer is the only layer of OSI network model which actually deals with the physical connectivity of two different stations. This layer defines the hardware equipment, cabling, wiring, frequencies, pulses used to represent binary signals etc.

Physical layer provides its services to Data-link layer. Data-link layer hands over frames to physical layer. Physical layer converts them to electrical pulses, which represent binary data.The binary data is then sent over the wired or wireless media.

Electromagnetic Spectrum

The **electromagnetic spectrum** is a collection of frequencies, wavelengths, and photon energies of **electromagnetic waves** spanning from 1Hz to 1025Hz, equivalent to wavelengths ranging from a few hundred kilometres to a size smaller than the size of an atomic nucleus. The **electromagnetic spectrum** can thus be described as the range of all types of electromagnetic radiation in basic terms. In a vacuum, all electromagnetic waves travel at the same speed as light. For different forms of electromagnetic waves, however, the wavelengths, frequencies, and photon energy will vary.

Radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, gamma rays, and cosmic rays make up the full range (**electromagnetic spectrum**) in decreasing order of frequency and rising order of wavelength.



1. Radio Waves

- The rapid travel of charged particles across conducting wires causes these waves.
- Radio, television, and telecom signals are transmitted through them.
- These waves have a frequency range of around 3kHz to 300MHz.
- In the ultrahigh-frequency (UHF) band, cellular phones employ radio waves to convey voice communication.
- Radio picks up radio waves that are broadcast by radio stations. Radio waves can be emitted by gases and stars in space. The majority of radio waves are used for TV and mobile communication.

2. Microwaves

- Microwaves are a type of electromagnetic radiation that has a frequency of a few gigahertz (GHz).
- Klystrons, magnetrons, and Gunn diodes are unique vacuum tubes that produce them.
- Microwaves are commonly utilised in aviation navigation due to their short wavelengths.
- These rays are employed in microwaves, which aid in the heating of meals in homes and offices. It's also used by astronomers to figure out and understand the structure of surrounding galaxies and stars.

3. **Infrared Rays**
   - Infrared waves are produced by hot bodies and molecules and are thus referred to as heatwaves.
   - Infrared rays are near the low-frequency or long-wavelength end of the visible light spectrum.
   - The greenhouse effect caused by these rays is critical for maintaining global warming and average temperatures.
   - Greenhouse gases such as carbon dioxide and water vapour trap these radiations in the earth's atmosphere.
   - Night vision goggles make use of these radiations. Infrared light generated by objects in the dark can be read and captured by these devices. Infrared light is used to trace interstellar dust in space. Infrared radiation is emitted by electronic devices and is commonly employed in remote switches for a variety of household gadgets.

4. **Visible Rays**
   - Visible rays are **electromagnetic waves** that can be seen with the naked eye. They are the most common type of electromagnetic waves.
   - These can be found in the frequency range of 4×10^{14}Hz–7×10^{14}Hz or the wavelength range of 400nm–700nm.
   - The visible light rays reflected or released from the objects around us assist us in seeing the world, and the range of visible radiation is different for different creatures.
   - Devices that emit light in the visible area of the **electromagnetic spectrum** include bulbs, lamps, candles, LEDs, tube lights, and so on.

5. **Ultraviolet Rays**
   - Although the sun is the primary source of ultraviolet radiation on Earth, the ozone layer absorbs the majority of UV energy before it reaches the atmosphere.
   - UV radiation has a wavelength of 400nm–1nm.
   - These radiations are emitted by special lamps and extremely hot bodies, and in big numbers, they can cause significant injury to humans. It tans the skin and creates burns.
   - Because these radiations may be focused on tiny beams, they are used in high precision applications such as LASIK or laser-based eye surgery.
   - UV lamps are used in water purifiers to eliminate microorganisms that may be present in the water.
   - When working with UV welding arcs, welders use special goggles to protect their eyes.

6. **X-Rays**
   - This electromagnetic radiation is found outside of the ultraviolet (UV) region of the **electromagnetic spectrum** and is extremely valuable in the medical field.
   - The wavelength range of X-ray radiation is 1nm–10^{-3}nm.
   - By blasting a metal target with high-energy electrons, X-rays can be produced.

- X-rays are a diagnostic technique in medicine that can be quite helpful in the treatment of some types of cancer. To find the source of the problem, a doctor utilises an x-ray scanner to scan our bones or teeth. Overexposure to x-rays can cause harm or death to the organism's healthy tissues. As a result, extreme caution must be exercised when dealing with x-rays.
- At the airport checkpoint, security agents utilise it to search through passengers' luggage. X-rays are also emitted by the universe's heated gases.

7. **Gamma-Rays**
   - The universe is the largest gamma-ray generator.
   - These rays are in the **electromagnetic spectrum**'s higher frequency region.
   - Gamma rays have wavelengths ranging from 10^{-12}m to 10^{-14}m.
   - Radioactive nuclei release high-frequency radiations, which are also created during nuclear processes.
   - Gamma rays have a wide range of medical applications, including the destruction of cancerous cells. Gamma-ray imaging is a technique used by doctors to examine the insides of patients' bodies.