Introduction

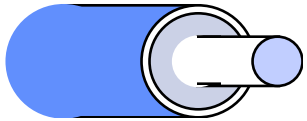
- Optical fiber cables are the newest and probably the most promising type of guided transmission medium for virtually all forms of digital and data communication applications including local, metropolitan, and wide area networks.

- With optical fibers, electromagnetic waves are guided through a media composed of a transparent material without using electrical current flow.

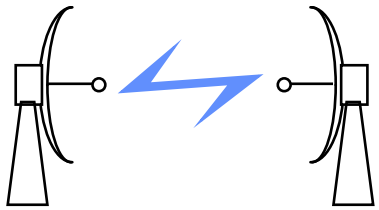
- With optical fibers, electromagnetic light waves propagate through the media in much the same way that radio signals propagate through Earth's atmosphere.

Transmission Media

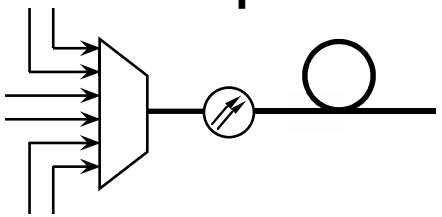
Twisted Pair
10 megabit/sec (10b/s)
1-10 kilometers



Coaxial Cable
-100 megabit/sec
1-10 kilometers



Digital Microwave Radio
-100 megabit/sec
10-100 kilometers



Fiber Optic Transmission Systems
Multimode: -100 megabit/sec
Singlemode: 10,000+ megabit/sec
10-100-10,000 kilometers

Long-distance and Capacity (2/3)

Capacity (Bandwidth): 800nm to 1700nm at attenuation < 3dB/km

Frequency(Hz):f, Light speed (m/sec) :C_0, Wavelength:λ (m)

$$f = \frac{C_0}{\lambda}, \quad (C_0 = 3.00 \times 10^8 \text{ m/s})$$

$$\lambda = 800\text{nm} \Rightarrow \frac{3.00 \times 10^8}{800 \times 10^{-9}} = 375 \times 10^{12}\text{Hz} = 375\ \text{THz}$$

$$\lambda = 1700\text{nm} \Rightarrow \frac{3.00 \times 10^8}{1700 \times 10^{-9}} = 176 \times 10^{12}\text{Hz} = 176\ \text{THz}$$

Optical Fiber Bandwidth: about 200THz! (=375 -176THz)

at attenuation < 3dB/km

Critical Angle

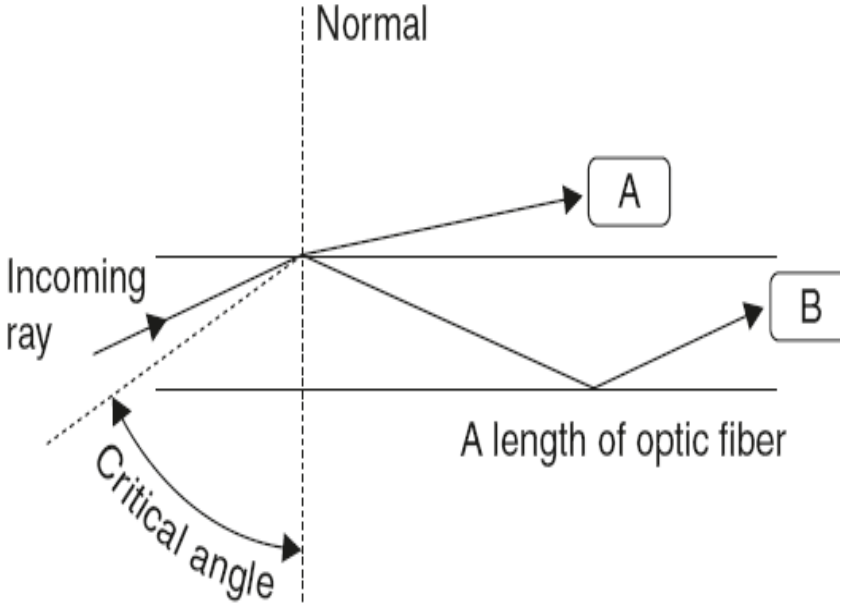
- The critical angle (θ_c) is the minimum angle of incidence at which a light ray may strike the interface of two media and result in an angle of refraction of 90^0 or greater.
- If the angle of refraction is 90^0 or greater, the light ray is not allowed to penetrate the less dense material.
- Consequently, total reflection takes place at the interface, and the angle of reflection is equal to the angle of incidence.
- Critical angle represent mathematically as

$$\sin\theta_1 = \frac{n_2}{n_1}\sin\theta_2$$

with $\theta_2=90^0$, θ_1 becomes the

Critical angle (θc), and

$$\sin\theta_c = \frac{n_2}{n_1}(1) \Rightarrow \sin\theta_c = \frac{n_2}{n_1} \Rightarrow \theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$



Total Internal Reflection

- It is an optical phenomena that occurs when a ray of light strikes a medium boundary at an angle larger than the critical angle with respect to the normal to the surface.

- If the refractive index is lower on the other side of the boundary no light can pass through, so effectively all of the light is reflected.

- However, if the light approaches the boundary at an angle greater than the critical angle, the light is actually reflected from the boundary region back into the first material. The boundary region simply acts as a mirror. This effect is called total internal reflection (TIR).

- The critical angle is the angle of incidence above which the total internal reflection occurs.