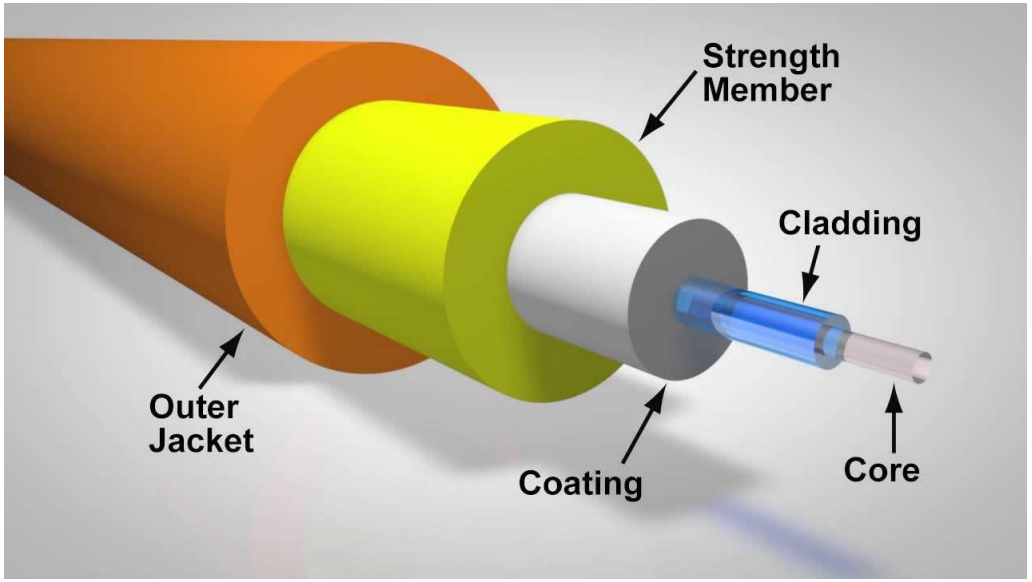
Introduction to
OPTICAL FIBER TECHNOLOGY



OBJECTIVES

1. What is Fiber Optic Technology?

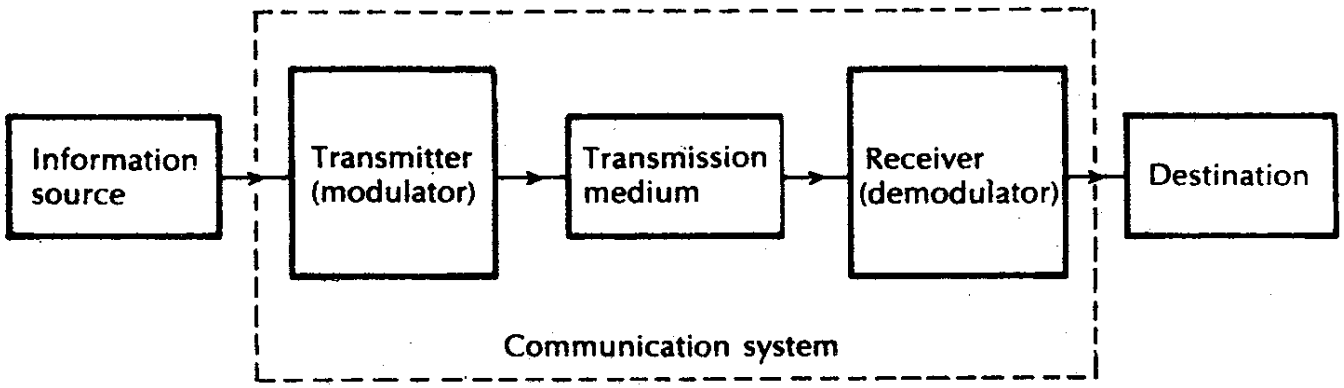
2. Why Fiber Optic Technology?

3. How Optical Transmission fulfills the need?

4. Why Optical Fibers?

5. Present & Future OFC- Systems

General Communication Link



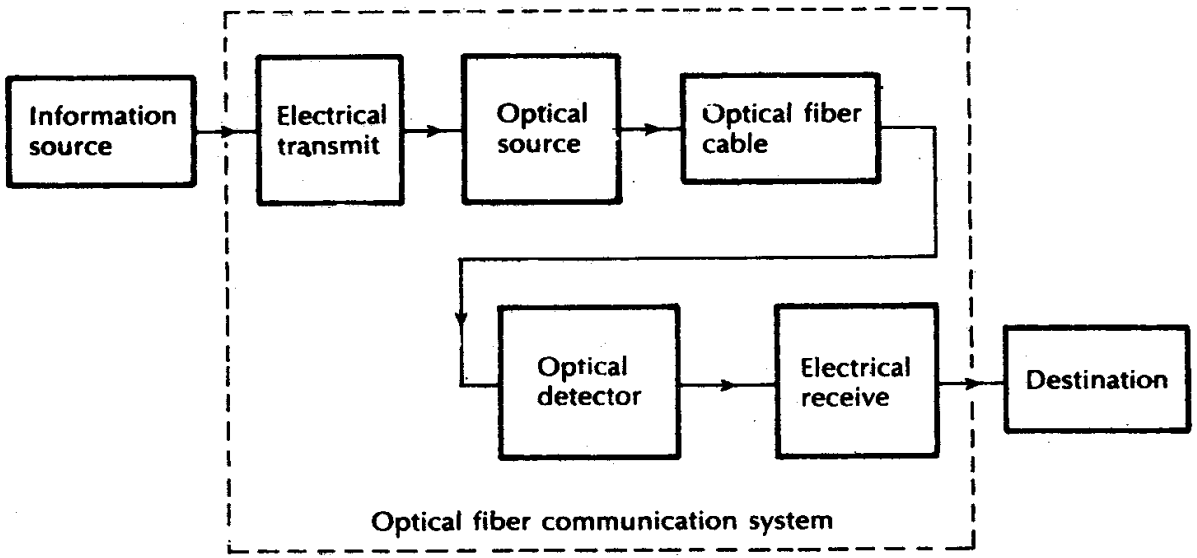
- **Information Source**: provide electrical signal, usually derived from a massage signal which is not electrical (sound, data)- *Analog/digital*
- **Transmitter** : Comprises of electronic components - convert the signal into suitable form for propagation over the transmission medium- *often achieved by modulating the carrier*.
- **Transmission Medium**: A pair of wires, coaxial cable or a radio link through free space down which signal is transmitted to the receiver - *channel*.
- **Receiver**: Signal is transformed into original electrical signal (*demodulation)* before being passed onto the destination.

What is Fiber Optic Technology?

* Also called **Lightwave Technology**

- Fiber Optic Technology uses light as the primary medium to ***carry information***.
- The light often is guided through ***optical fibers.***
- Most applications use ***invisible (infrared) light***.

Optical Fiber Communication System



- **At the transmitter section, the electrical signal is converted into an optical signal using an optical source *(intensity modulation)*.**
- **The modulated optical signal is transmitted through optical fibers to the receiver.**
- **At the receiver end, the optical signal is reconverted to the electrical signal for further processing *(demodulation)* before passing onto destination.**

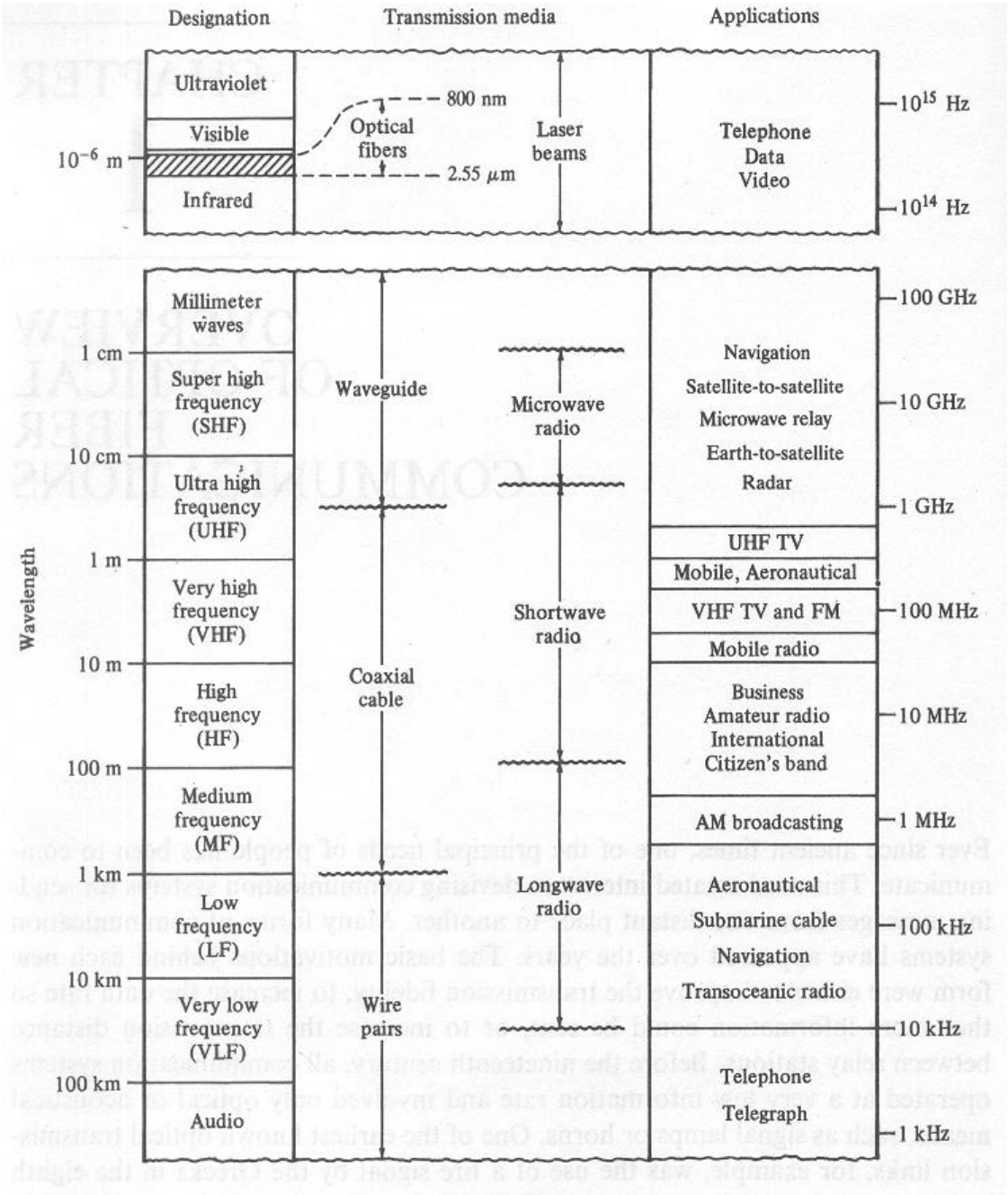
Importance Fiber Optic Technology?

During past three decades, many **remarkable** and **dramatic** changes took place in the electronic communication industry over the Globe..

- A phenomenal increase in **voice**, **data** and **video** communication - demands for ***larger capacity*** and ***more economical*** communication systems.

- **Lightwave Technology*: Technological route for achieving this goal***

. ***Most cost-effective way*** to move ***huge amounts of information*** (voice, video, data) ***quickly and reliably***.



The Electromagnetic Spectrum

How Optical Transmission fulfill the need?

For good communication a system needs to have following things.

(1) **Bandwidh (BW)**
(2) **Good signal to noise ratio (SNR) i.e. low loss**

Since the bandwidth of a system is more or less proportional to the frequency of operation, use of higher frequency facilitates larger BW.

- *Wider the bandwidth, the greater its information carrying capacity*.

- The information carrying capacity of a communications system is directly proportional to its bandwidth;

The BW at optical frequencies is expected to be 3 to 4 orders of magnitude higher than that at the microwave f requencies (1GHz to 100GHz).

- A system with light as carriers has an **excessive bandwidth** (*more than 100,000 times than achieved with microwave frequencies***)**

Communication Channel Capacity

Communication Medium	Carrier Frequency	Bandwidth	2 way voice Channels
Copper Cable	1 MHz	100 kHz	< 2000
Coaxial Cable	100 MHz	10 MHz	13,000
Optical Fiber	100 –1000 THz	40 THz	>3,00,000 or

Advantages of Optical Fiber

- **Wide Bandwidth: Extremely high** information carrying capacity (~GHz)
  - 3,00,000 voice channels on a pair of fiber
  - Voice/Data/Video Integrated Service
  - 2.5 Gb/s systems from NTT ,Japan; 5 Gb/s System Siemens
- **Low loss** : Information can be sent over a **large distance**.
  - Losses ~ 0.2 dB/km
  - Repeater spacing >100 km with bit rates in Gb/s
- **Interference Free**
  - Immune to Electromagnetic interference: ***No cross talk*** between fibers
  - Can be used in harsh or noisy environments
- **Higher security** : No radiations, Difficult to tap
  - Attractive for Defense, Intelligence and Banks Networks

Advantages of Optical Fiber: Contd..

❖Compact & light weight

- Smaller size : Fiber thinner than human hair
- Can easily replace 1000 pair copper cable of 10 cm dia.
- Fiber weighs 28gm/km; considerably lighter than copper
- Light weight cable

❖Environmental Immunity/Greater safety

- ***Dielectric***- No current, No short circuits – Extremely safe for hazardous environments; attractive for ***oil & petrochemicals***
- Not prone to lightning
- Wide temperature range
- Long life > 25 years

❖Abundant Raw Material : optical fibers made from ***Sand***

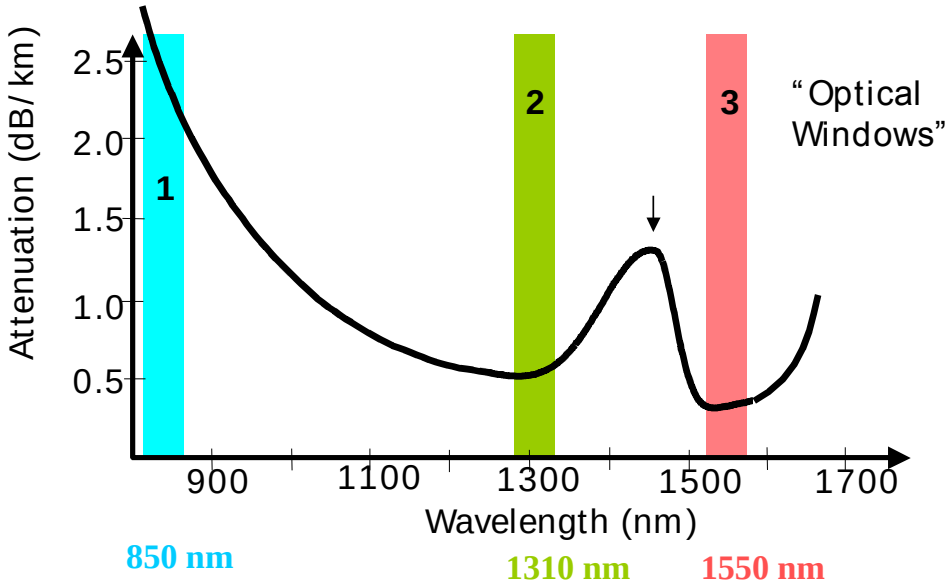
- Not a scarce resource in comparison to copper.

Some Practical Disadvantages

- Optical fibers are relatively **expensive**.
- **Connectors very expensive**: Due to high degree of precision involved
- Connector installation is **time consuming and highly skilled operation**
- Jointing (Splicing) of fibers requires **expensive equipment and skilled operators**
- Connector and joints are **relatively lossy**.
- Difficult to **tap in and out** (for bus architectures)- need expensive couplers
- Relatively careful handling required

WAVELENGTHS OF OPERATION

Attenuation in Silica Fibers



OFC- Systems

❖ **Currently installed Systems**: operating at 1310 nm window

- Low loss; minimum pulse broadening
- Transmission rate 2-10 Gb/s
- Regeneration of Signal after every 30-60 km
  - ➢ Conversion of O-E-O signal

❖**Future OFC Systems**: 1550 nm band

- Silica has lowest loss, increased dispersion

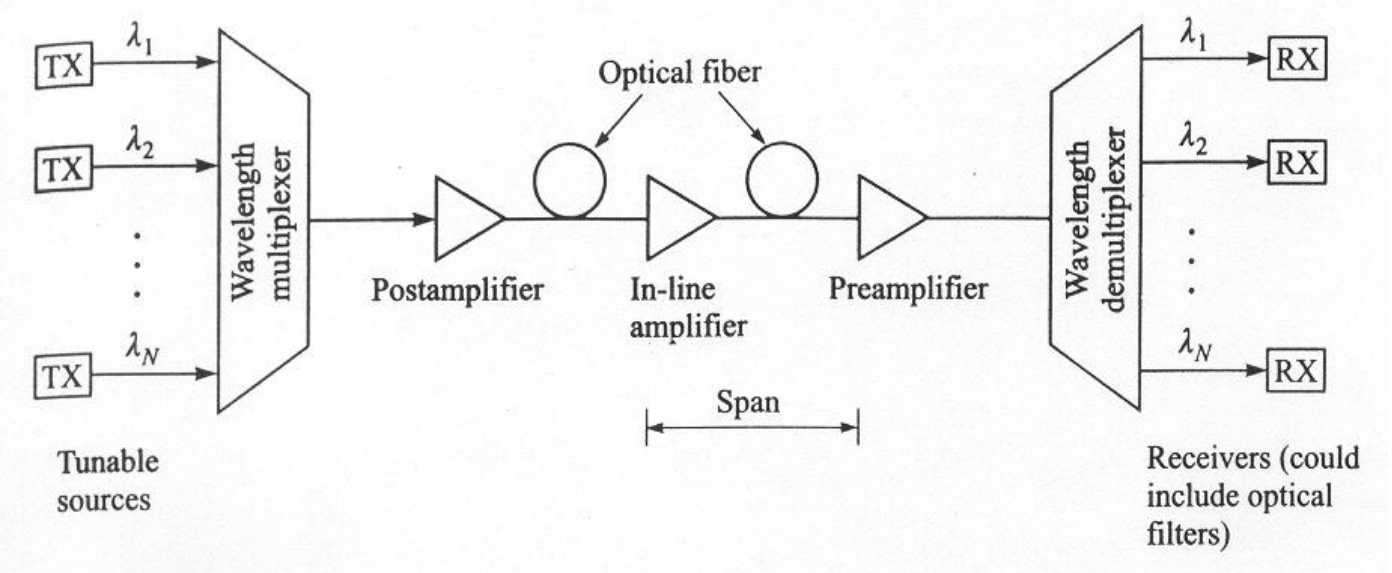
▪ Design of **Dispersion Shifted Fibers**

- ➢ Lowest loss and Negligible dispersion

▪ **Erbium Doped Fiber Amplifier**

- ➢Direct amplification of optical signal
- ➢Flat gain around 1550nm low loss window
- ➢BW ≈12,500 GHz ; Enormous potential

WDM/DWDM Concept



Typical WDM network containing various types of optical amplifiers.

Future OFC- Systems

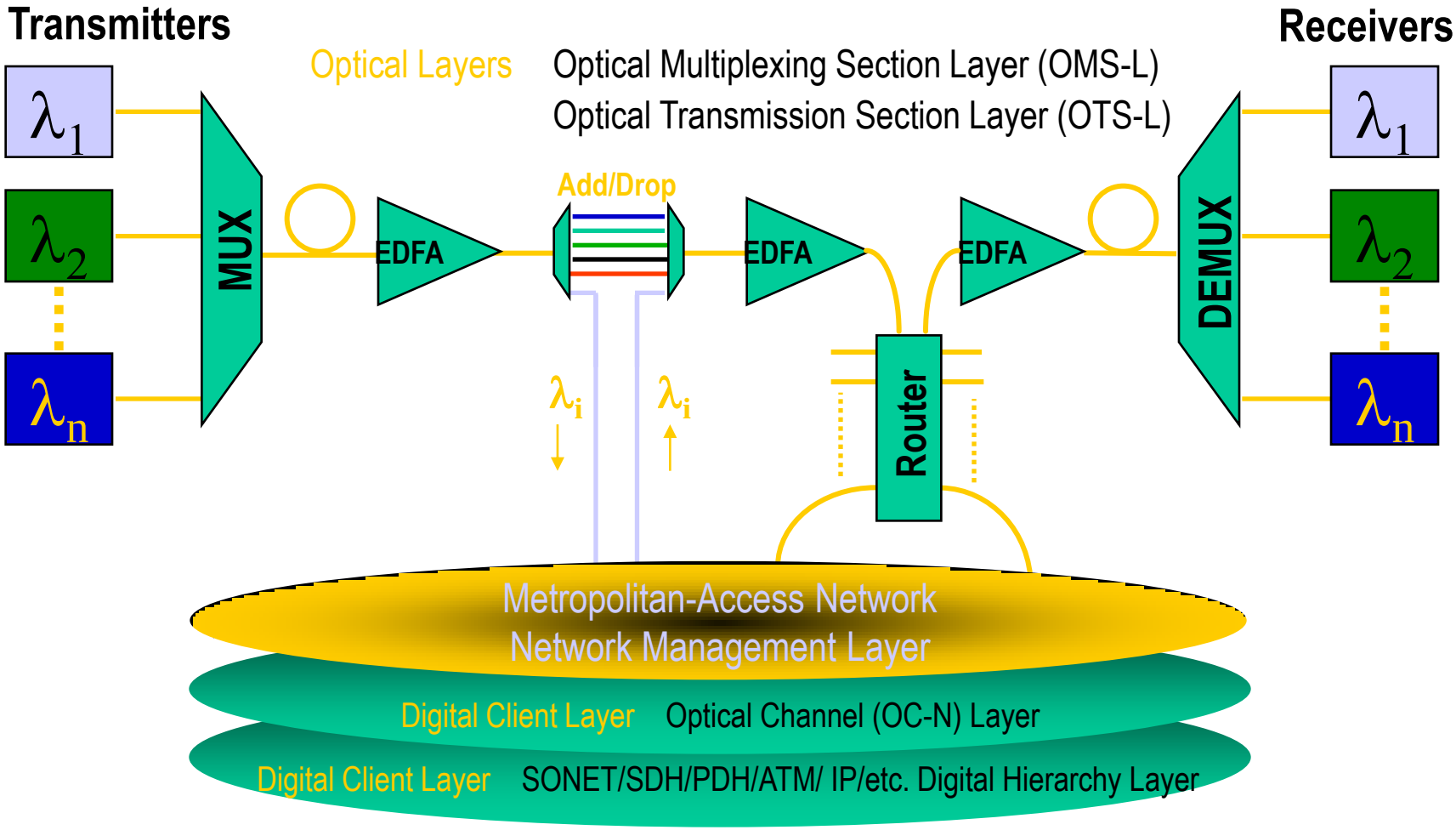
Coincidence of low-loss window & wide-BW EDFA

- Possibilities of WDM Communication Systems
- Soliton pulse transmission
- Capable of carrying enormous rates of information

Examples:

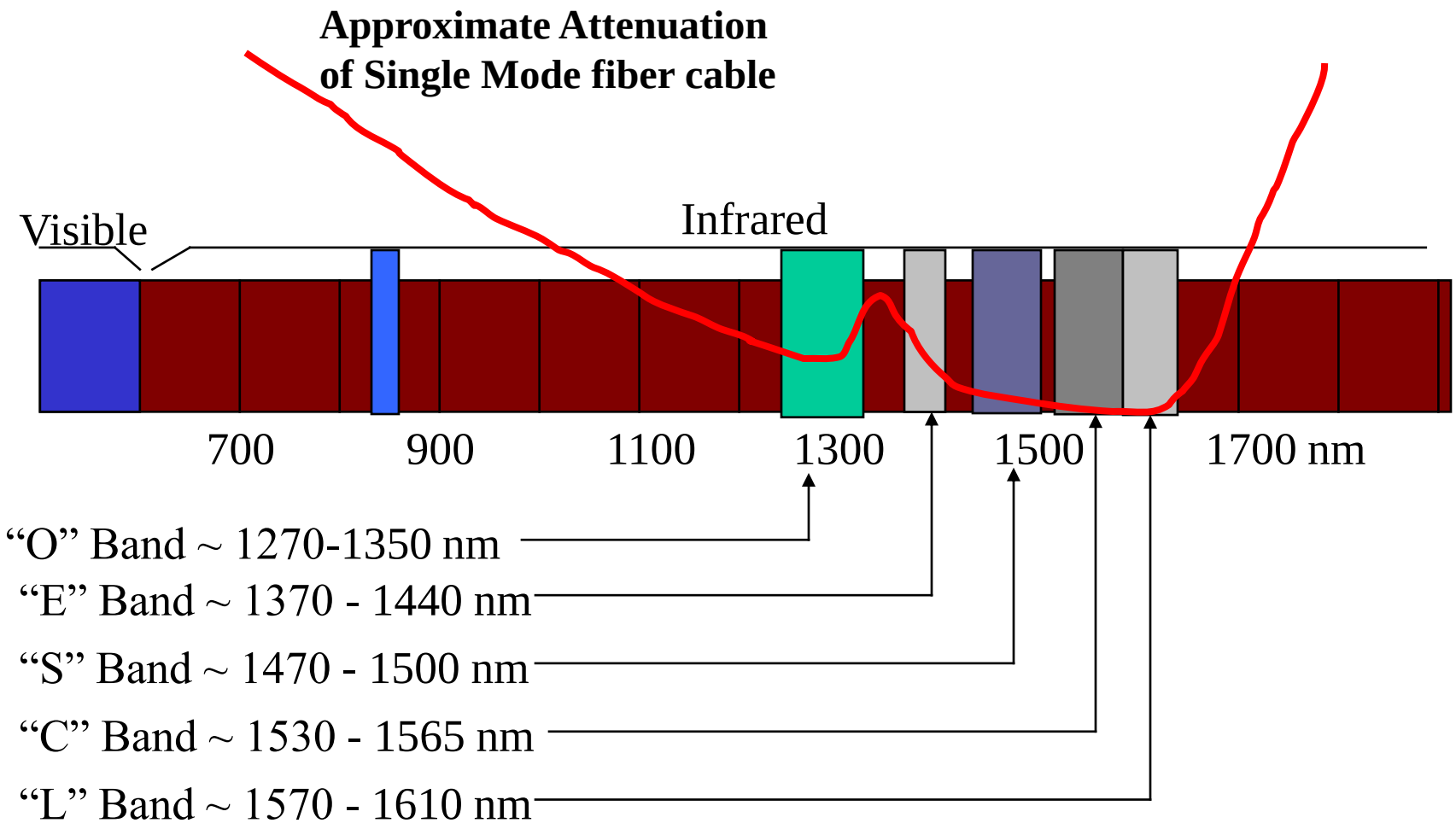
- 1.1 Tb/s over 150 km ; 55 wavelengths WDM
- 2.6 Tb/s over 120 km ; 132 wavelengths WDM

Optical Network System



EDFA = Erbium-doped fiber amplifier
MUX = Multiplexer
DEMUX = Demultiplexer

Bands in Light Spectrum

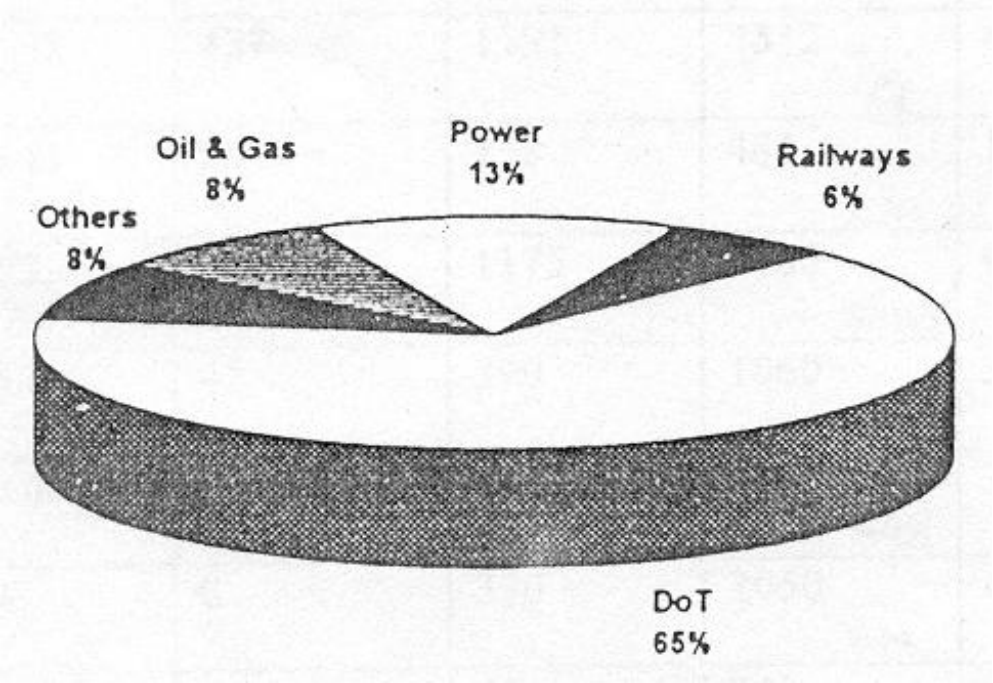


FORESIGHT…

☎ Lightwave Communication Systems Employing Rare Earth Doped Fibers and Soliton Pulses

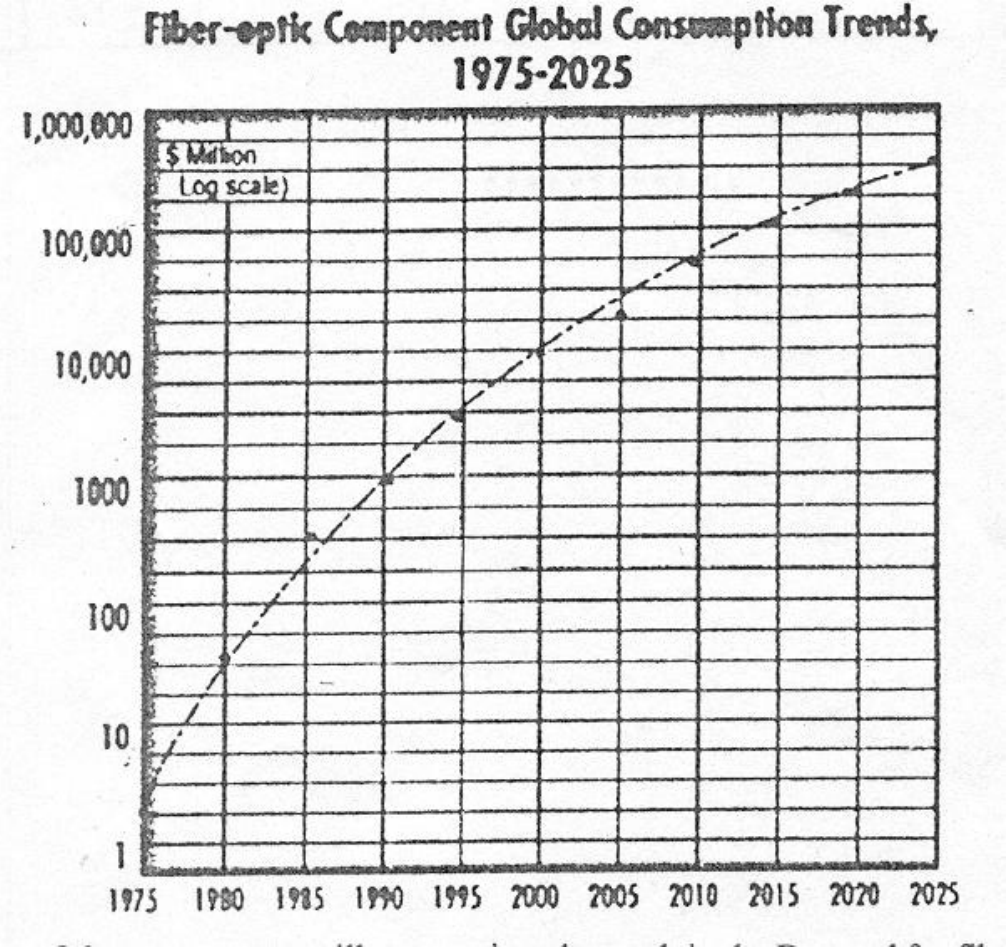
"ZERO LOSS & NEAR INFINITE BANDWIDTH "

Fiber Optics- Market Potential in India



Fiber Optics market potential in India.

Fifty Years of Fiber Optics



THANK YOU