Optical Fiber Communication

Description
Components & design for optical fiber communication.

Intended audience: BS students.

Time: Wed 2:00-5:00 pm
Location: Lab
Course Instructor: Me

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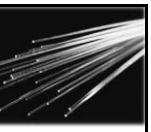
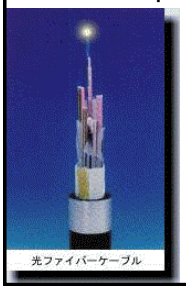


THE BOOK

Fiber Optic Communications



Author

JOSEPH C. PALAIS

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8 out of 12 questions

Introduction

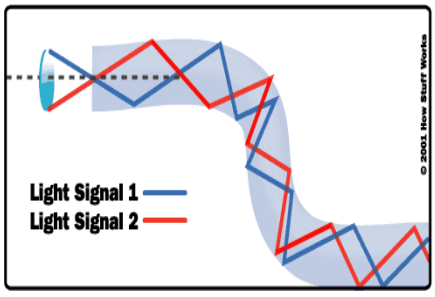
Optical Fiber

- It is a glass filament or wire which carries light.
- It is a cylindrical waveguide that operate at optical frequency.
- It confines electromagnetic energy in the form of light.

COMMUNICATION

- It may be broadly defined as the transfer of information from one point to another.

Total Internal Reflection in Fiber



INTRODUCTION

Light is the form of electromagnetic Wave just as radio waves, but with high frequency and shorter wavelength.

Spectrum	Frequency	Wavelength
Radio waves	100 KHZ to1 THZ	3KM to 300 μm
Infra Red light	1 THZ to 100 THZ	300 to 3 μm
Optical Communication	176 THz to 375 THZ	1.7 to 0.8 μm
1550 nm Window	193.5 THz	1.550 μm
1310 nm Window	230 THz	1.310 μm
850 nm Window	353 THz	0.85 μm
Visible Light	428 to 750 THZ	0.7 TO 0.4 μm
UV,X & γ rays	750 to 10 ^{7} THZ	0.4 to 3x10 $^{-6}$ μm

Historical Perspective

- Hollow Logs,
- Drum (different sizes),
- Wind Instruments (pipes)
- Hand signals
- Smoke signals
- Lamps (traffic signals)
- 1960 Laser : A major breakthrough
- 1970 Fiber

Historical Perspective

- The first optical fiber exhibited very high attenuation i.e. 1000 dB/Km. While coaxial cable losses were 5-10 dB/Km.
- Fiber losses were reduced to below 5 dB/Km.
- Development of fiber waveguides with optical frequencies at small wavelengths requires the development of all optical components.
- Laser Life at the start was 1000 Hrs & now is 100 years.
- At present 2 optical windows are in operation i.e. 1310 nm ,1550nm.

A Short History of Optical Telecommunications

Circa 2500 B.C. Earliest known glass
Roman times-glass drawn into fibers
Venice Decorative Flowers made of glass fibers
1609-Galileo uses optical telescope
1626-Snell formulates law of refraction
1668-Newton invents reflection telescope
1840-Samuel Morse Invents Telegraph
1841-Daniel Colladon-Light guiding demonstrated in water jet
1870-Tyndall observes light guiding in a thin water j
1873-Maxwell electromagnetic waves
1876-Elisha Gray and Alexander Bell Invent Telephone
1877-First Telephone Exchange
1880-Bell invents Photophone
1888-Hertz Confirms EM waves and relation to light
1880-1920 Glass rods used for illumination
1897-Rayleigh analyzes waveguide
1899-Marconi Radio Communication
1902-Marconi invention of radio detector
1910-1940 Vacuum Tubes invented and developed
1930-Lamb experiments with silica fiber
1931-Owens-Fiberglass
1936-1940 Communication using a waveguide

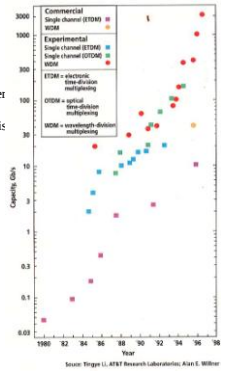
1876-Alexander Graham Bell

1970 I. Hayashi
Semiconductor Laser

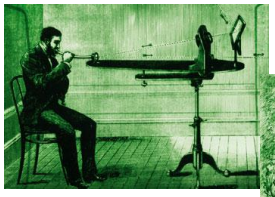
1876 First commercial Telephone

A Short History- Continued

1951-Heel, Hopkins, Kapany image transmission using fiber bundles
1957-First Endoscope used in patient
1958-Goubau et. al. Experiments with the lens guide
1958-59 Kapany creates optical fiber with cladding
1960-Ted Maiman demonstrates first laser in Ruby
1960-Javan et. al. invents HeNe laser
1962-4 Groups simultaneously make first semiconductor lasers
1961-66 Kao, Snitzer et al conceive of low loss single mode fiber communications and develop theory
1970-First room temp. CW semiconductor laser-Hayashi & Panis
April 1977-First fiber link with live telephone traffic-
GTE Long Beach 6 Mb/s
May 1977-First Bell system 45 mb/s links
GaAs lasers 850nm Multimode -2dB/km loss
Early 1980s-InGaAsP 1.3 μm Lasers
- 0.5 dB/km, lower dispersion-Single mode
Late 1980s-Single mode transmission at 1.55 μm -0.2 dB/km
1989-Erbium doped fiber amplifier
1 Q 1996-8 Channel WDM
4th Q 1996-16 Channel WDM
1Q 1998-40 Channel WDM
1998 Allwave fiber (Lucent Technologies)

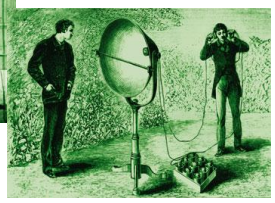


Bells Photophone



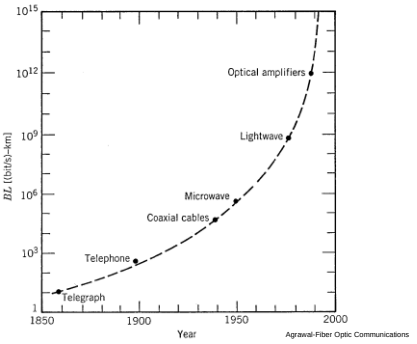
1880 - Photophone Transmitter

1880 - Photophone Receiver

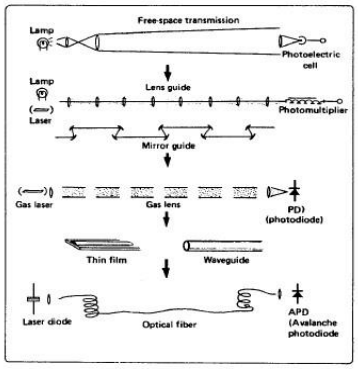


"The ordinary man…will find a little difficulty in comprehending how sunbeams are to be used. Does Prof. Bell intend to connect Boston and Cambridge…with a line of sunbeams hung on telegraph posts, and, if so, what diameter are the sunbeams to be…?…will it be necessary to insulate them against the weather…?…until (the public) sees a man going through the streets with a coil of No. 12 sunbeams on his shoulder, and suspending them from pole to pole, there will be a general feeling that there is something about Prof. Bell's photophone which places a tremendous strain on human credulity."
New York Times Editorial, 30 August 1880

Increase in Bitrate-Distance product



Approaches to Optical Communication



Why fiber?

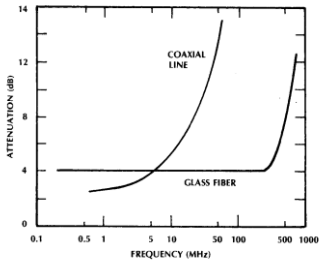
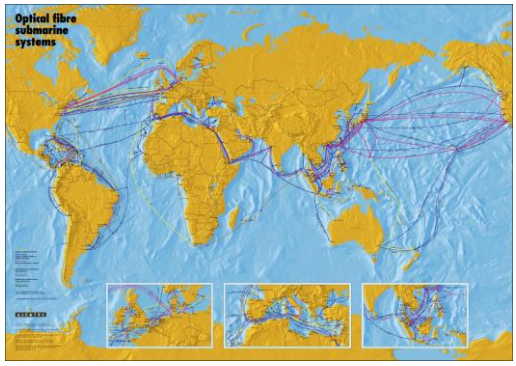


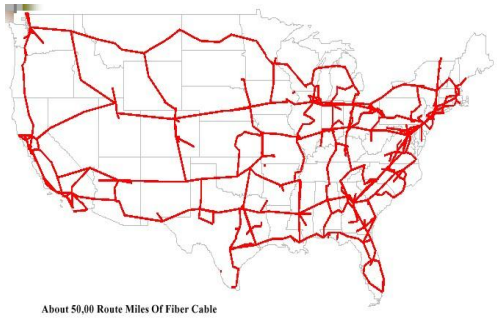
Figure 1-18 Effective attenuation of a 1-km length of coaxial line and glass fiber. The 3-dB bandwidth of the fiber is 500 MHz. (Coaxial line data from manufacturer's literature, Alpha Wire Corporation, Elizabeth, N.J.)

Palais-Fiber Optic Communications

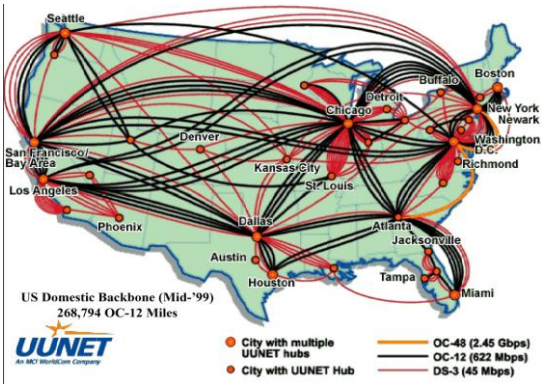
Global Undersea Fiber systems



Installed Fiber in US



About 50,00 Route Miles Of Fiber Cable



Example Metro network