Wavelength Division Multiplexed (WDM) Systems
Transmission windows

Optical Window  1270-1350 nm
                1480-1600 nm

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WDM SYSTEMS

- Low Loss BW of Fiber 1.2 to 1.6 μm
  ⇒ 30 THz

- Capable of Carrying
  300,000 ch of 10 Mb/s

- Pulse width Required ~ few tens of fs
  (System employment is not practical)

- Easy to access the BW in
  WAVELENGTH DOMAIN
  than in Time domain
ITU G.692

Reference: 193.100 THz
→ 1552.524 nm

Spacing: 100 GHz (≈ 0.8 nm at 1552 nm)

DWDM
Typical WDM Network

Tunable sources

TX $\lambda_1$

TX $\lambda_2$

...$

TX \lambda_N$

Wavelength multiplexer

Optical fiber

Postamplifier

In-line amplifier

Preamplifier

Wavelength demultiplexer

Span

Receivers (could include optical filters)
DWDM Systems

- Capacity Upgrade
- Transparency
- Wavelength Routing
- Wavelength Switching
WDM Requirement

- Dispersion Shifted/Flattened Fiber
- Tunable / Multi-wavelength Lasers
- Broadband Optical Amplifiers
- Wavelength Dependent Optical Devices
BACKGROUND TECHNOLOGIES

- SOA or FIBER AMPLIFIER (EDFA)
- INTEGRATED OPTICAL SWITCHES / COUPLERS
- FIBER BRAgg GRATINGS (FBG)
- ARRAYED WAVEGUIDE GRATINGS (AWG)
Need for Optical Amplifier

- **Power Budget**
  - Data rate 10Gbps
  - BER $10^{-9}$
  - Tx Power 10dBm
  - Min Rx power $-45$ dBm
  - Fiber Loss 0.3 dB/Km
  - Repeater spacing ~ 200 Km

- **Rise Time Budget**
  - Data rate 10Gbps
  - DSF 1ps/Km/nm
  - DFB laser 0.01nm
  - Repeater Spacing 3000Km
Optical Amplifier Technology

- **Semiconductor Amplifier**
  - 1300 or 1550 nm band
  - High power output
  - Higher coupling loss
  - Integrable
  - Non-linearities

- **EDFA**
  - 1550nm ONLY
  - Low cross talk
  - High gain (25dB)
  - High power
  - Low coupling loss
  - Low noise
  - Polarization insensitive
Generic optical amplifier

Optical input signal -> Fiber-to-amplifier couplers -> Active medium -> Amplified optical output

Pump source
Erbium energy-level diagram