

Optical Network Design for Connecting CS College to Central Office

NAME : KAREEM ABD ELTAWAB HAMAD ABD ELGHNY

ID / 202205181

Assumptions and Requirements

1. **Distance:** The central office is 10 km away from the college.
 2. **College Building:**
 - Four floors.
 - Each floor has four labs (16 labs total).
 - Each lab needs to be connected to the network.
 3. **Power Budget:** The power budget must be between 13 and 28 dB.
 4. **Objective:** Design a cost-effective optical network.
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Network Design

Components

1. **Optical Fiber:**
 - Single-mode fiber (SMF) with an attenuation of 0.35 dB/km at 1310 nm.
 - Total fiber length = 10 km + internal building connections (~2 km estimated).
 - Total attenuation due to fiber = (12 km) * (0.35 dB/km) = **4.2 dB**.

2. Transceivers:

- Use SFP transceivers with a power budget of 20 dB (typical range 13-28 dB).
- Operating wavelength: 1310 nm.
- Cost: Approximately \$50 per unit.

3. Optical Splitters:

- 1:16 splitter for the labs.
- Insertion loss of 13 dB (worst case).

4. Patch Panels and Connectors:

- 2 dB loss per connector pair (4 connector pairs total).
- Total connector loss = $4 * 2 \text{ dB} = \mathbf{8 \text{ dB}}$.

5. Internal Cabling:

- Estimated length = 2 km with 0.5 dB/km attenuation.
- Total attenuation = $2 \text{ km} * 0.5 \text{ dB/km} = \mathbf{1 \text{ dB}}$.

6. Optical Amplifier (if required):

- Not required as the total losses are within the power budget.

Link Power Budget Calculation

1. Loss Budget:

- Fiber attenuation = 4.2 dB.
- Splitter loss = 13 dB.
- Connector loss = 8 dB.
- Internal cabling = 1 dB.
- **Total Loss = $4.2 + 13 + 8 + 1 = 26.2 \text{ dB}$.**

2. Power Margin:

- Transceiver budget = 28 dB (max).

- Remaining margin = $28 - 26.2 = 1.8 \text{ dB}$ (acceptable).
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Topology and Architecture

1. **Topology:** Point-to-multipoint (P2MP) architecture.
 - Central office connects to a single optical splitter located in the college.
 - Each splitter output connects to individual labs.
 2. **Internal Network:**
 - A riser cable connects each floor's labs to the splitter.
 - Horizontal cabling connects labs on the same floor.
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Cost Estimation

1. **Optical Fiber:**
 - $12 \text{ km} * \$0.25/\text{m} = \3000 .
2. **Transceivers:**
 - $16 \text{ (1 per lab)} + 1 \text{ (central office)} = 17 \text{ units}$.
 - $17 * \$50 = \850 .
3. **Optical Splitters:**
 - $1 \text{ splitter} * \$100 = \100 .
4. **Connectors and Patch Panels:**
 - Estimated cost = \$200.
5. **Miscellaneous:**
 - Installation and labor = \$1000.

Total Cost = $\$3000 + \$850 + \$100 + \$200 + \$1000 = \5150 .

Conclusion

The proposed optical network satisfies the requirements with a total power budget of 26.2 dB, which is within the acceptable range of 13-28 dB. The design uses cost-effective components to connect all 16 labs to the central office at a total cost of approximately \$5150.