Study and Testing of

Different Types of Transmission Media (Wires)

CSE 2213 : Data and Telecommunication Lab

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1 Theoretical Background

1.1 Transmission Media Overview

Transmission media refers to the physical path through which data signals travel from one device to another in telecommunications and computer networks. There are several types of transmission media, including twisted pair cables, coaxial cables, and optical fibers, each with its own structural design and functionality.

1.2 Types of Transmission Media

Unshielded Twisted Pair (UTP) Cable :

- UTP cables consist of pairs of wires twisted together. Each pair is twisted to reduce electromagnetic interference (EMI) from external sources and crosstalk between the wires.
- These cables are widely used in Ethernet networks and telephone lines due to their affordability and ease of installation.
- **Structure :** UTP cables have four twisted pairs of copper wires. They do not have shielding, which makes them more vulnerable to interference but also cheaper.

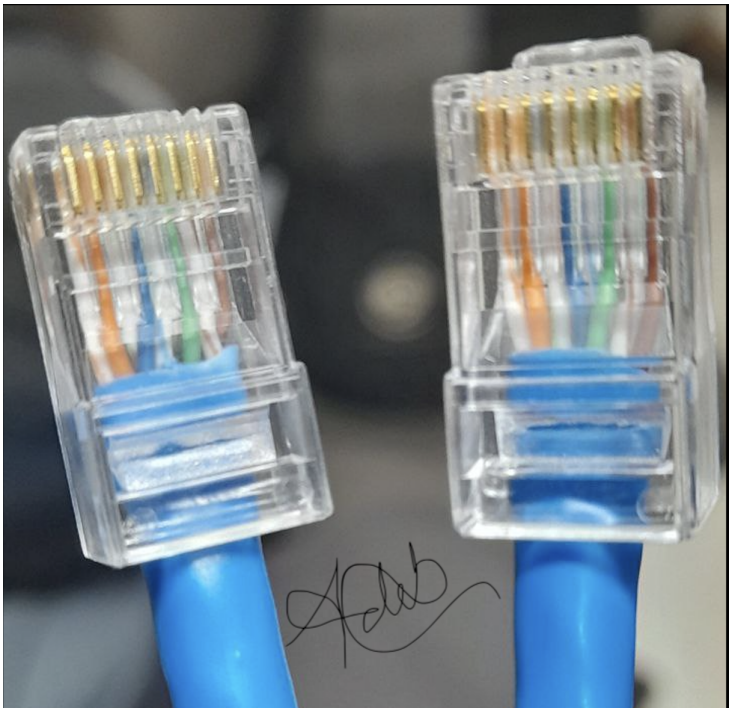


FIGURE 1 – Unshielded Twisted Pair (UTP) Cable

Optical Fiber Cable :

- Optical fiber cables use light to transmit data. They are made of a core that transmits the light signals, surrounded by a cladding that reflects light within the core to prevent signal loss.
- Optical fibers offer high-speed data transmission with minimal loss and are ideal for long-distance communication.
- **Structure :** The structure of an optical fiber cable consists of a glass or plastic core, cladding, and a protective outer layer.

FIGURE 2 – Optical Fiber Cable

1.3 Wiring Layout of UTP

Standard : UTP cables (e.g., Cat5e, Cat6) typically follow the TIA/EIA-568-B standard, specifically T568-B configuration for Ethernet. They contain four twisted pairs (eight wires) terminated into RJ45 connectors.

T568-B Wiring Layout (most common for Ethernet) :

- Pin 1 : White/Orange
- Pin 2 : Orange
- Pin 3 : White/Green
- Pin 4 : Blue
- Pin 5 : White/Blue
- Pin 6 : Green
- Pin 7 : White/Brown
- Pin 8 : Brown

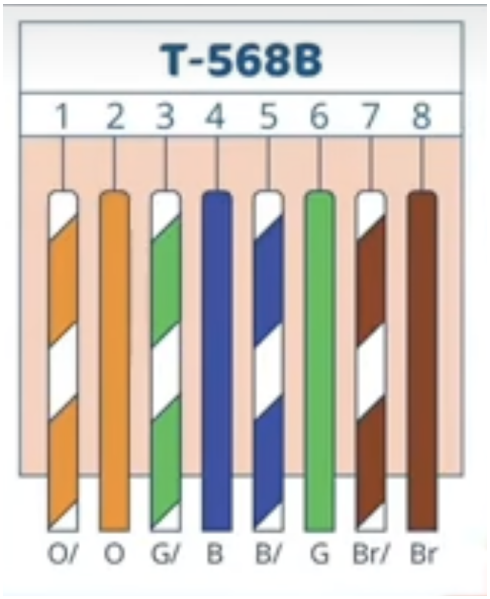


FIGURE 3 – T-568B Standard Wiring Layout for UTP Cable Termination (RJ-45 Connector)

1.4 Optical Fiber Cable Wiring Layout

Structure : Optical fiber cables do not use electrical wiring like UTP but transmit light through a core. They typically have one or more fibers, each with a core and cladding, and are terminated with connectors like SC, LC, or ST.

Wiring Layout :

- **Single-Mode Fiber (SMF) :** One fiber for transmission (Tx) and one for reception (Rx) in a duplex setup. For example, an LC duplex connector has two fibers : one sends data, the other receives.
- **Multi-Mode Fiber (MMF) :** Similar duplex setup but with a larger core for shorter distances.

Patch Cable Configuration :

- **Straight-through :** Tx on one end connects to Rx on the other (e.g., Fiber A to Fiber B, Fiber B to Fiber A). This is achieved by crossing fibers in the patch cable (A-to-B, B-to-A).
- **Crossover :** Less common, as most equipment auto-detects Tx/Rx, but can be used for direct device-to-device connections by swapping Tx and Rx manually.

Connectors :

- SC : Square connector, push-pull mechanism.
- LC : Smaller, latch-based connector, common in high-density applications.
- ST : Bayonet-style connector, older but still used.

Optical Fiber Cable Structure :

- **Cable Jacket** – Protective outer cover.
- **Strengthening Fibers** – Provide tensile strength.
- **Coating** – Cushions the core and cladding.
- **Cladding** – Reflects light back into the core.
- **Core** – The path for light transmission.

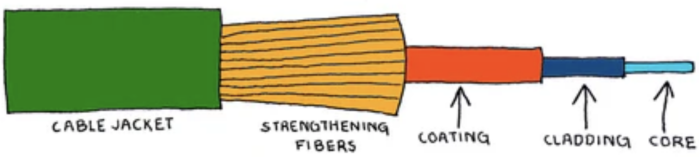


FIGURE 4 – Wiring layout of an optical fiber cable showing core, cladding

2 Objectives

- To study the structure and function of UTP and optical fiber cables.
- To compare their performance in terms of signal strength, speed, and error rate.
- To understand wiring layouts and their importance in reducing interference.
- To gain hands-on experience in testing and analyzing cable performance.

3 Apparatus and Materials Required

3.1 For UTP Cable

- UTP Cable (Unshielded Twisted Pair)
- Crimping Tool
- RJ-45 Connectors
- Cable Tester (for UTP)

3.2 For Optical Fiber Cable

- Optical Fiber Cable
- Fiber Stripping Tool
- Fiber Cleaver
- Fiber Optic Connectors (SC, LC, ST)
- Fusion Splicer or Mechanical Splice Kit
- Optical Power Meter and Light Source
- Network Switch
- Laptop/PC with network testing software

4 Experimental Procedure

The experimental procedure was carried out in the following steps :

4.1 Preparation of Cables

- We started by cutting both UTP and optical fiber cables to appropriate lengths.
- For UTP cables, we stripped the insulation off the ends of the wires to expose the inner copper wires.
- For optical fiber cables, we stripped the outer protective layer and carefully prepared the fiber ends for connection.

4.2 Cable Setup

- **UTP Cable Setup :** After stripping the insulation off, we untwisted the inside wires and arranged them in a special color order. The order starts from white_orange and ends at brown. We terminated the UTP cables with RJ-45 connectors using a crimping tool. The wires were connected according to the T568A or T568B standard.

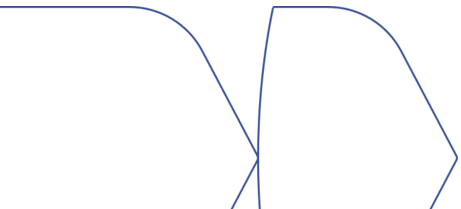
- **Optical Fiber Setup :** We connected the optical fiber cables using appropriate connectors and ensured proper alignment of the fibers.

4.3 Signal Transmission and Testing

- Both cables were connected to signal generators and receivers to test signal transmission.
- We sent a test signal through both the UTP and optical fiber cables, measuring the signal strength, loss, and distortion at the receiver.
- We also tested the cables for data transfer rates by connecting them to network interface cards (NICs) and measuring the speed using a network performance tool.

4.4 Error Detection

- We used diagnostic tools to measure the error rate in the data transmission over both UTP and optical fiber cables.
- These tools detected bit errors and other signal degradation issues during the transfer.



5 Experimental Results

FIGURE 5 – UTP Cable Testing

FIGURE 6 – A fiber optic fusion splicing machine showing the status of a splicing operation.

6 Discussion

Through this experiment, we gathered practical knowledge about the strengths and limitations of different transmission media :

- **UTP Cable :**
  - Cost-effective and easy to install.
  - Limited in terms of distance and speed.
  - Susceptible to electromagnetic interference.
  - Higher error rates in environments with high electronic noise.
- **Optical Fiber Cable :**
  - Offers superior performance in data transfer speed and signal quality.
  - Ideal for long-distance communication and high-speed networks.
  - More expensive and requires specialized equipment for installation and handling.
- **Practical Knowledge :**
  - Optical fiber is preferred for modern high-speed networks due to minimal signal loss over long distances.
  - UTP cables are more affordable and easier to install but best suited for shorter distances and low-performance demands.

7 Conclusion

In conclusion, both UTP and optical fiber cables have their advantages and are suitable for different use cases in data and telecommunication :

- **UTP Cable :** Ideal for cost-effective, short-distance communication but prone to interference and signal degradation.
- **Optical Fiber Cable :** Offers high-speed, long-distance communication with minimal interference and signal loss, making it suitable for high-performance networks.
- This experiment has provided a deeper understanding of the structures, functionalities, and performance characteristics of UTP and optical fiber cables, which are critical components of modern communication systems.

THE END