University of Dhaka

Department of Computer Science and Engineering

CSE-2213: Data and Telecommunication Lab

Report on: Study and Testing of Different Types of Transmission Media (Wires) in Data and Telecommunication

Lab Group: Even

Members:

Mehedi Hasan (22)
Saad bin Asad (32)

1. Theoretical Background

Data and telecommunication networks rely heavily on various types of transmission media, commonly referred to as cables or wires, to transmit data signals. These media differ in their physical structure, signal transmission methods, and performance characteristics, making them suitable for different networking environments and applications. Understanding their construction, function, and wiring standards is crucial for effective network design, installation, and troubleshooting.

1.1. Types of Cable Structure and Function

a) Twisted Pair Cable: Twisted pair cable is the most common type of cable used in local area networks (LANs). It consists of pairs of insulated copper wires twisted together. This twisting helps to reduce electromagnetic interference (EMI) from external sources and crosstalk between adjacent pairs within the cable.

- **Unshielded Twisted Pair (UTP):** This is the most widely used twisted pair cable. It contains four pairs of twisted copper wires, each insulated with a plastic coating. UTP cables are categorized based on their performance for different data rates (e.g., Cat5e, Cat6, Cat6a, Cat7, Cat8).
    - **Function:** Primarily used for Ethernet networks, telephone lines, and video applications. It's cost-effective and easy to install.

b) Coaxial Cable: Coaxial cable consists of a central copper conductor, an insulating layer, a braided metallic shield, and an outer insulating jacket. The concentric layers are designed to protect the data signal from external interference.

- **Function:** Historically used for television signals (cable TV), but also for older Ethernet networks (10Base2, 10Base5) and some high-frequency applications. Its shielding provides good noise immunity.

c) Optical Fiber Cable: Optical fiber cable transmits data using light pulses instead of electrical signals. It consists of a very thin strand of glass or plastic (the core) surrounded by a layer of glass or plastic (the cladding) with a lower refractive index. A buffer coating protects the fiber, and an outer jacket provides overall protection.

- **Function:** Ideal for long-distance, high-bandwidth data transmission due to its immunity to electromagnetic interference, low signal loss, and high data capacity. Used extensively in backbone networks, data centers, and Fiber-to-the-Home (FTTH) deployments.
- **Types:**
    - **Single-Mode Fiber (SMF):** Has a very small core diameter () and allows only one mode of light to propagate. Used for long-distance, high-bandwidth applications.

    - **Multi-Mode Fiber (MMF):** Has a larger core diameter (50µm or 62.5µm) and allows multiple modes of light to propagate. Used for shorter distances within buildings or campuses.

1.2. Wiring Layout of UTP and Optical Fiber Cable

a) UTP Cable Wiring Layout (Ethernet Standards): Ethernet cables typically follow either the T568A or T568B wiring standards, which define the order in which the individual wires are terminated into an RJ45 connector.

- **T568B Standard (Pin-out from left to right, tab down):**
    - White/Orange
    - Orange
    - White/Green
    - Blue
    - White/Blue
    - Green
    - White/Brown
    - Brown
- **Straight-Through Cable:** Used to connect different types of devices (e.g., computer to switch, router to switch). Both ends of the cable are wired using the same standard (e.g., T568B on both ends). The transmit pins on one end connect to the receive pins on the other.
    - **End 1 (T568B):** WO, O, WG, B, WB, G, WB, B
    - **End 2 (T568B):** WO, O, WG, B, WB, G, WB, B
- **Crossover Cable:** Used to connect similar types of devices (e.g., computer to computer, switch to switch). One end is wired with T568A, and the other with T568B. This swaps the transmit and receive pairs.
    - **End 1 (T568A):** WG, G, WO, B, WB, O, WB, B
    - **End 2 (T568B):** WO, O, WG, B, WB, G, WB, B

b) Optical Fiber Cable Wiring Layout: Unlike UTP, optical fiber cables do not have a standard "pin-out" in the same sense. Instead, connections involve precise alignment of the fiber cores. The primary consideration for fiber optic cabling is ensuring proper polarity (transmit to receive) and minimizing signal loss at connectors and splices.

- **Simplex Fiber:** A single strand of fiber for one-way communication.
- **Duplex Fiber:** Two strands of fiber for two-way communication (one for transmit, one for receive). Connectors like LC, SC, ST, and MPO are used to terminate fiber optic cables. The "wiring" involves correctly polishing and aligning the fiber ends within these connectors to allow light to pass efficiently.
    - For duplex connections, it's crucial to ensure that the transmit fiber from one device connects to the receive fiber of the other device. This is often managed by color-coding or specific connector orientations.

2. Objectives

The primary objectives of this lab experiment are:

1. To understand the physical structure and functional differences between various types of transmission media, including UT Optical Fiber cables.
2. To learn and apply the T568A and T568B wiring standards for terminating UTP cables with RJ45 connectors.
3. To gain practical experience in crimping RJ45 connectors onto UTP cables to create straight-through and crossover cables.
4. To utilize a cable tester to verify the continuity, correct wiring, and identify any faults (e.g., opens, shorts, miswires, split pairs) in UTP cables.
5. To observe and understand the basic principles of connecting and testing optical fiber cables (if equipment is available).
6. To analyze the characteristics and suitability of each cable type for different networking scenarios.

3. Apparatus and Materials Required

The following apparatus and materials will be required for this experiment:

- **UTP Cable (Cat5e or Cat6):** Sufficient length for multiple practice runs.
- **RJ45 Connectors:** A box of connectors for UTP cable termination.
- **Crimping Tool:** For attaching RJ45 connectors to UTP cables.
- **Wire Stripper/Cutter:** For stripping the cable jacket and cutting wires.
- **Cable Tester (RJ45/RJ11):** A device to test UTP cable continuity and wiring.
- **Network Devices (Optional):** Two computers, a network switch, or a router to test connectivity after crimping.
- **Coaxial Cable (Optional):** A short length of coaxial cable.
- **BNC/F-Connectors (Optional):** For coaxial cable termination.
- **Coaxial Crimping Tool (Optional):** For coaxial connectors.
- **Optical Fiber Cable (Optional):** Short lengths of single-mode and multi-mode fiber.
- **Fiber Optic Connectors (Optional):** LC, SC, or ST connectors.
- **Fiber Optic Stripper (Optional):** For stripping fiber optic cables.
- **Fiber Cleaver (Optional):** For precise cutting of fiber ends.
- **Visual Fault Locator (VFL) or Fiber Optic Power Meter (Optional):** For basic fiber optic testing.
- **Safety Glasses:** Essential when working with fiber optics.

4. Experimental Procedure

The general steps followed to execute and test different types of cables are outlined below. Specific procedures for fiber optic cable termination and testing may vary significantly based on available equipment and expertise.

4.1. UTP Cable Preparation and Termination:

1. **Measure and Cut:** Cut a desired length of UTP cable.
2. **Strip the Jacket:** Carefully strip about 1 inch of the outer jacket from both ends of the UTP cable using a wire stripper, being careful not to nick the inner insulated wires.
3. **Untwist and Straighten:** Untwist the four pairs of wires and straighten each individual wire.
4. **Arrange Wires (T568A or T568B):** Arrange the wires according to the chosen wiring standard (T568A or T568B) for the type of cable you are creating (straight-through or crossover). Ensure the wires are flat and in the correct order.
5. **Trim Wires:** Trim the ends of the wires straight across, ensuring they are all the same length and approximately 0.5 inches from the jacket edge. This length allows them to reach the end of the RJ45 connector.
6. **Insert into RJ45 Connector:** Carefully insert the arranged wires into the RJ45 connector, ensuring each wire slides into its correct pin slot and the cable jacket enters the connector body for strain relief. Verify the wire order before crimping.
7. **Crimp the Connector:** Place the RJ45 connector with the inserted wires into the crimping tool. Squeeze the handles firmly until the connector is fully crimped, securing the wires and the jacket.
8. **Repeat for Second End:** Repeat steps 2-7 for the other end of the cable, ensuring the correct wiring standard is applied for the desired cable type.

4.2. UTP Cable Testing:

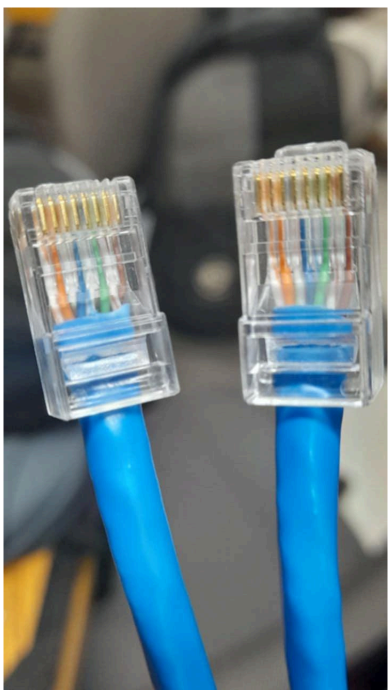
1. **Connect to Cable Tester:** Plug one end of the newly crimped UTP cable into the "Master" port of the cable tester and the other end into the "Remote" port.
2. **Power On and Observe:** Turn on the cable tester. Observe the sequence of lights on both the master and remote units.
    - **Correct Wiring:** For a straight-through cable, the lights on both units should illuminate in sequence (1-8) simultaneously. For a crossover cable, the lights will illuminate according to the swapped pairs (e.g., Master 1 lights up with Remote 3, Master 2 with Remote 6, etc.).
    - **Fault Detection:** The tester will indicate opens (no light for a specific pin), shorts (multiple lights for a single pin), miswires (incorrect light sequence), or split pairs (lights appear correct but internal pairs are swapped, which can be detected by advanced testers).
3. **Troubleshoot (if necessary):** If faults are detected, re-examine the crimped ends for proper wire order, full insertion, and secure crimping. Recrimp if necessary.

4.4. Optical Fiber Cable Testing (Basic, if applicable):

1. **Cleaning:** Always clean fiber optic connector end-faces before testing.
2. **Visual Inspection:** Use a fiber inspection microscope to check for scratches or dirt on the connector end-faces.
3. **Visual Fault Locator (VFL):** Connect a VFL to one end of the fiber. Observe if light is visible at the other end. Any breaks or sharp bends in the fiber will show light leakage.
4. **Power Meter/Light Source:** For more accurate testing, use a fiber optic light source and power meter to measure the optical power loss (attenuation) over the cable length.

5. Experimental Results

5.1. UTP Cable Testing Results:



6. Discussion

This laboratory experiment provided invaluable practical experience in understanding, preparing, and testing different types of transmission media.

Through the hands-on process of stripping, untwisting, arranging, and crimping UTP cables, we gained a deeper appreciation for the precision required in network cabling. The T568A and T568B standards, initially appearing as simple color codes, became clear as essential guidelines for ensuring proper signal transmission and network interoperability. Creating both straight-through and crossover cables highlighted their distinct purposes in network connectivity, reinforcing the concept of MDI/MDI-X (Media Dependent Interface / Media Dependent Interface Crossover) in Ethernet.

The cable tester proved to be an indispensable tool. It allowed for immediate verification of our crimping work and, more importantly, provided instant feedback on common cabling faults like opens, shorts, miswires, and split pairs. This practical troubleshooting experience is critical for network technicians, as faulty cabling is a frequent cause of network issues. Understanding how the tester's sequence of lights corresponds to the wire map was a key learning point.

Observing the structure of coaxial and optical fiber cables, even without extensive termination, helped solidify their theoretical advantages and disadvantages. The robust shielding of coaxial cable explained its use in environments prone to interference, while the delicate nature and light-based transmission of optical fiber underscored its capacity for high bandwidth and long distances, along with the need for specialized handling and tools.

In summary, this lab provided a comprehensive overview of physical layer cabling, moving beyond theoretical knowledge to practical application. We learned that proper cable selection, meticulous termination, and thorough testing are fundamental to building reliable and high-performing data and telecommunication networks. The skills acquired, particularly in UTP cable crimping and testing, are directly applicable to real-world networking tasks.

7. Conclusion

This experiment successfully achieved its objectives by providing a practical study and testing of different types of transmission media. We gained a clear understanding of the structural and functional differences between UTP, Coaxial, and Optical Fiber cables. The hands-on experience of crimping UTP cables according to T568A and T568B standards, followed by testing with a cable tester, was particularly insightful. We learned to identify correctly wired cables and troubleshoot common cabling faults. This lab reinforced the critical importance of proper cabling techniques and the use of appropriate testing tools for ensuring reliable data and telecommunication network performance.