Department of Computer Science and Engineering

Islamic University of Technology (IUT)

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Laboratory Report

CSE 4412: Data Communication and Networking Lab

Name	**: Mirza Mohammad Azwad**
Student ID	**: 200042121**
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Title: Introduction to different transmission media and crimping of RJ45 Connector to UTP cable

Objective:

1. Introduction to different guided media such as UTP, Coaxial Cable, Optical fiber.
2. Internal arrangement of UTP cables.
3. Different Wiring patterns Standards such as T568A or T568B.
4. Different types of cabling for UTP such as straight through, crossover, and rollover, and their usage.
5. Procedure to crimp RJ45 connector to UTP cable.
6. Procedure to check the connection.

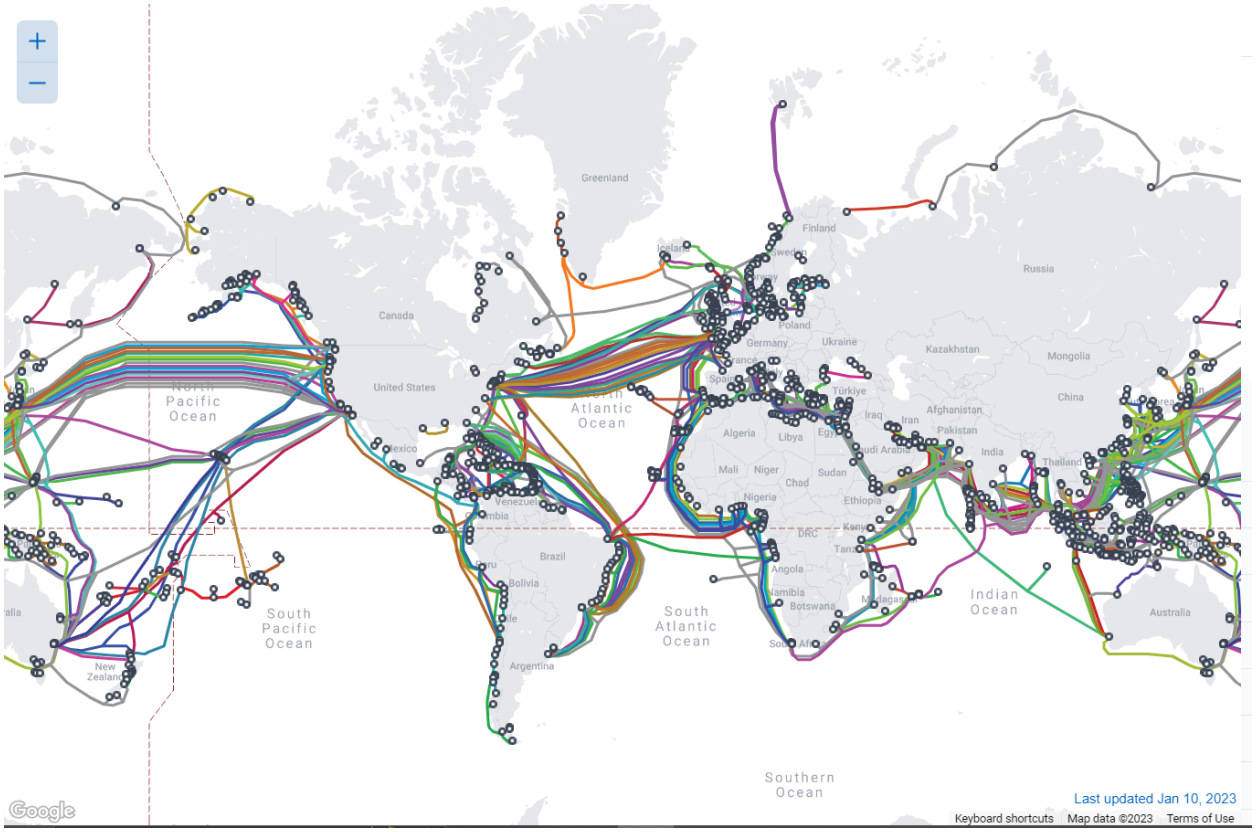
Devices Used in the experiment:

The devices used were an RJ45 Crimping Tool to perform various tasks such as cutting the cable and adjusting the crimpable connectors. We had CAT6 cables, basically Unshielded Twisted Pair cables which are often regarded as RJ45 cables with CAT cables as the subset of the RJ45 cables. We had RJ45 Crimpable Connectors to place as wire-heads. We also had a cable tester test the output of the cables to check if the wire alignment is proper or not.

Theory:

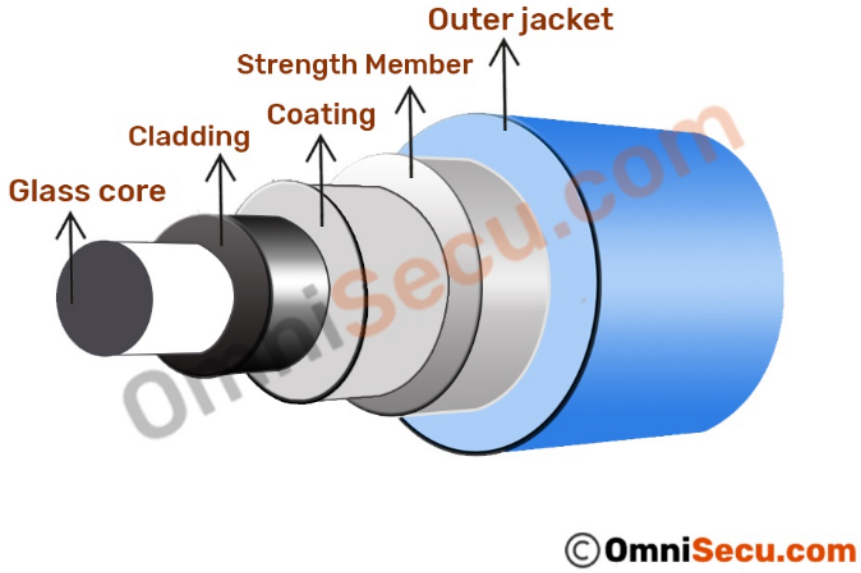
In this lab, we were primarily introduced to Unshielded Twisted Pair(UTP) Cables in order to perform different forms of LAN cabling for a local network connecting multiple devices with different topologies. This local network may be fed the internet connection by a dedicated ISP allowing the devices connected to the local network to access the internet.

While it wasn't discussed in detail in the lab, Coaxial Cables and Optical fiber cables are other forms of cabling that tend to be more suited for transmitting over longer distances. These different wires are essential to the Physical Layer of the OSI model. Optical fiber cables transmit data as a series of concentrated light beams or pulses to represent bits through glass fibers, the advantage of which is less interference and can transmit across large distances without the need for booster stations, unlike coaxial cables which are also copper cables similar to UTP and are also used for long-distance communication. The internal arrangement of coaxial cables involves two concentric copper cables that allow bidirectional transmission of data across different frequency bands to simulate full duplex transmission. Here we also understand that the coaxial cables have multiple frequency bands or channels per cable and are broadcast in nature so it requires a switch or a router to route the packets with respect to frequencies to control the flow of data between devices. Coaxial Cables can transmit data with speeds up to 100Mbps. Optical fibre cables are even better for long range transmission and this makes them interestingly suitable for undersea submarine cables that connects the entire world to the internet via various servers located at different regions of the world. To have a glimpse of it:



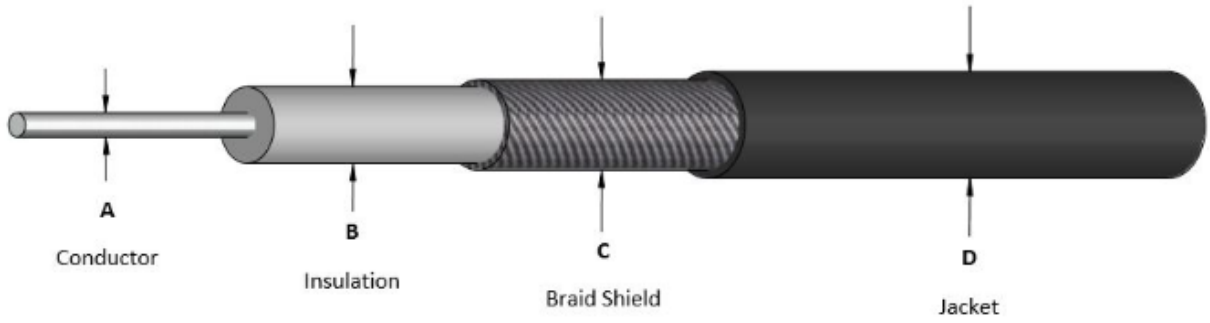
This image has been taken from Submarine Cable Map at submarinecablemap.com. The reduced need for repeaters or booster stations is contributed by the fact that the light pulses suffer from less electromagnetic interference So the repeaters can be placed far away, yet the signal travels with integrity. Also optical fibers are faster and can transmit at speeds upto 100s of Gbps.

The image below for optical fiber cables have been taken from omnisecu.com

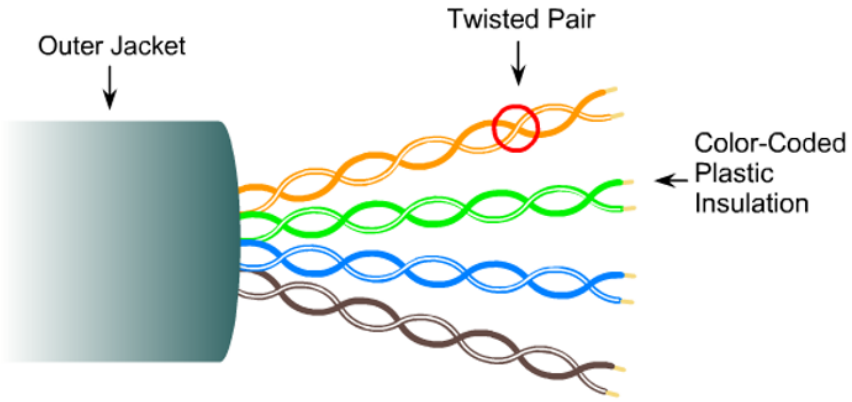


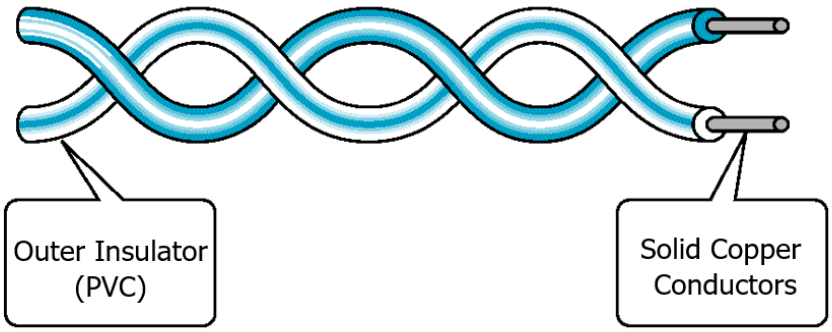
Next we observe the structure of Coaxial Cables taken from

Now let's consider the internal arrangement of UTP cables taken from epectec.com



Finally let's observe the internal arrangement of UTP cables:





The images were taken from the slide provided in the class lecture.
The main issue with coaxial and twisted pair cables is that they tend to suffer from the most electromagnetic interference. This occurs as the flow of electrons tend to produce small magnetic fields and magnetic fields can be cause the flow of electrons. This interrelationship produces an unwanted effect as the magnetic field produce by the flow of electrons naturally or by man-made devices tends to disrupt the flow of electrons in coaxial and twisted pair cables

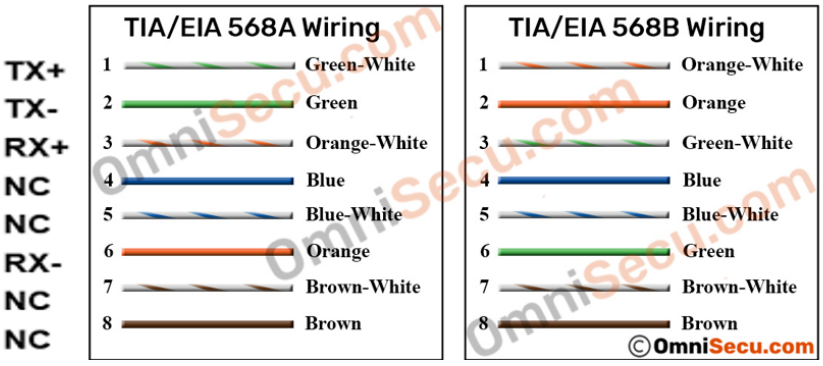
causing signal disruption or interference resulting in unwanted noise which corrupts the data being transmitted and hence the data transmitted over longer distances as the electrons get weaker then its more susceptible to disruption requiring the need for booster stations. These cables have different approaches to help minimize this issue. Coaxial cables were not discussed in class but the approach to minimzing noise for this is the use of braided wires. These wires have an insulted layer that attempts to stop electromagnetic interference which is further enclosed by a metal foil braid sheet which tends to absorb EMI which is then further covered with an insulating jacket. Optical fibers don't tend to suffer from these types of interference except in very long distances where light pulses become weaker. Since optical fibers transmit data via photons instead of electrons they are less susceptible to interference.

Finally, we were taught in class regarding the unshielded twisted pair. They tend to minimize interference in 4 ways:

- An outer jacket consisting of insulating material to minimize access of electromagnetic interference.
- An outer layer of PVC enclosing the copper conductor underneath to reduce the interference further via the PVC. These PVCs are color coded.
- Next the different standards for wire combinations to be used such as T568A or T568B aims to increase the distance between the transmitting wires to reduce the chances of interference due to neighbouring wires. These standards operate via the use of color coded wires which we would discuss in detail soon. This form of interference reduction and the next point was discussed in class.
- The twisted wires also carry nearly equal and opposite amount of current through them such that the noise due to neighbouring wires is almost cancelled out. The twisting also aids in rejection of external noise.

Typically CAT3 through CAT7 are used for LAN connections to connect devices to the internet. While CAT1 is strictly for analog signals and CAT2 can transmit both analog and digital signals. Currently CAT5 and CAT6 cables are more in use.

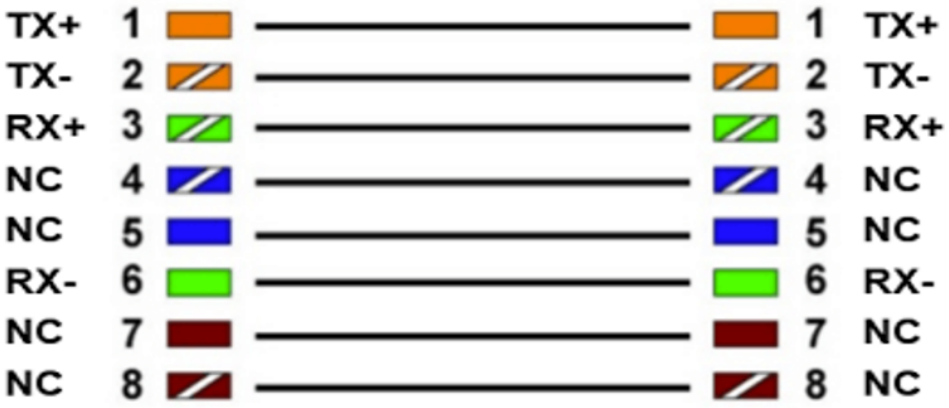
The two different standards for the internal arrangement of wires are TIA/EIA 568A and TIA/EIA 568B. Where TIA/EIA stands for Telecommunications Industry Association/Electronic Industries Alliance. The image for these standards is shown below:



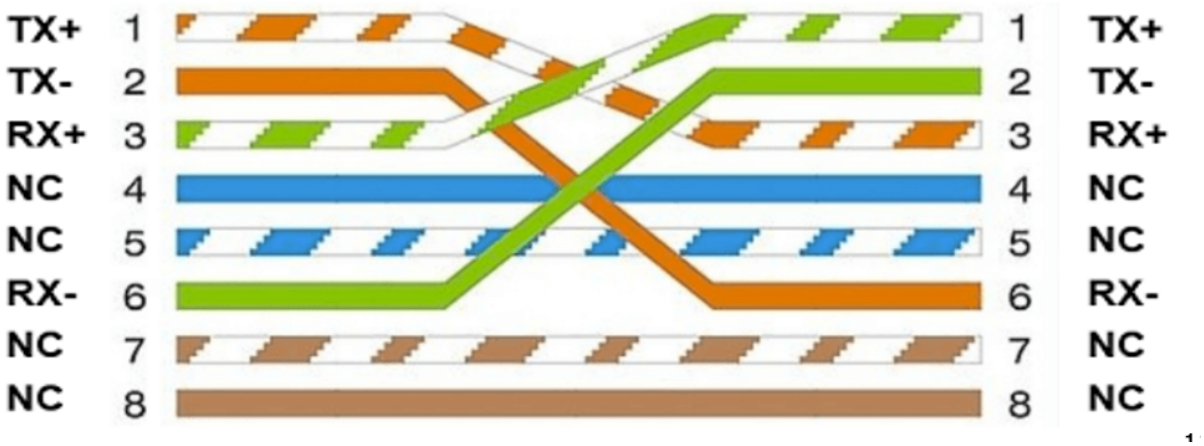
The images for cabling are taken from OmniSecu.com.

For 568A we use the green and green-white cables for transmitting and the orange and orange-white cables for receiving. And for 568B, its the exact opposite with orange and orange-white cables for transmitting and green and green-white cables for receiving. The cable can be connected in 3 different ways which are **straight-through**, **roll-over** and **cross-over**. The difference between the three lies in the standards they used in the ends of the cable. If the same standard is used in the transmitting and the receiving ends then its straight through cabling, if the opposite standards are used then its cross-over cabling. To demonstrate two images are shown below:

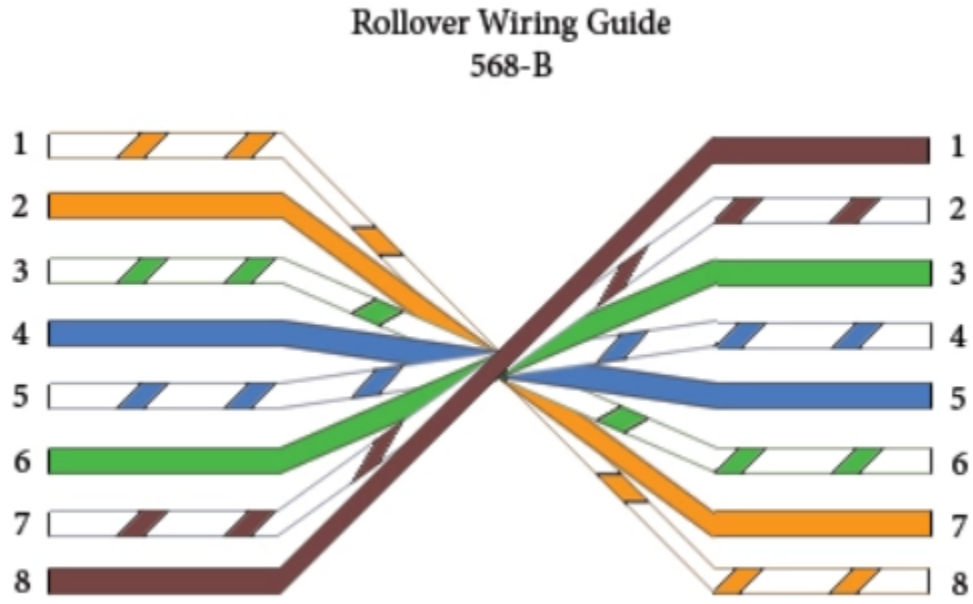
For Straight Through:



For Cross Over:



The images were taken from the slide provided in the class. The Roll over cable is less frequently used but the idea is basically such that pin 1 is connected pin 8 and pin 2 to pin 7 and so on. So essentially the wire arrangements are effectively reversed. The example shown below is for 568B but the same idea applies to 568A.



The image was taken from computercablestore. A straight through cable is typically used to connect devices to switches or routers that has intelligent packet-switching technologies which help monitor how different packets are transmitted across different routes determined by the switch or router without having the cable determine it. The switch/router determines which device acts as the sender or the receiver. A cross-over cable is primarily used to connect computers directly or to directly connect one router to another or one switch to another. It was also used in hubs in the past which did not have packet-switching abilities. This is typically used in topologies that connect computers directly together such as mesh, ring and bus topologies. The

roll over cabling is less typically used. They are used in to connect computers to devices with console in presence of a DB-9 adapted which is labelled as TERMINAL.

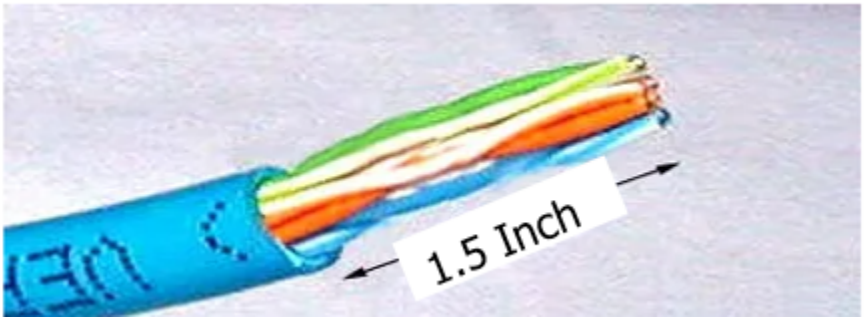
Working Procedure:

Next we observe the working procedure for the experiment we performed. First we used the RJ45 Crimping tool to strip the wire using the double blade. The wire was stripped upto 1.5 inch approximately. Upon stripping the wire we seperated the four twisted pair and removed their twisting. We then aligned the wires after removing the twist and then pinching tightly with our index and thumb fingers we grouped them together as per the 568A standard or the 568B standard. In our case, we used both standards on both ends to establish a cross-over connection. After grouping the wires we had to even the wire-heads so that they are all of the same level. We did that by cutting the group of wire with single blade side of the RJ45 crimping tool. Upon the wire-heads being evened we carefully inserted the RJ45 connector ensuring that each wire goes through appropriate guides and reaches the copper conductors at the tip of their respective guides. It has to reach the end of guide to be in contact with the copper conductor near the tip. After that we used the RJ45 crimping tool to insert the RJ45 connector into the 8P or 8 point area of the crimping tool, basically where the connector fitted properly. We had to hold the wire and connector tightly in place until it was inserted into the crimping tool. And then after inserting into the 8P area we had to press the connector all the way down ensuring that it is not locked. Upon pressing all the way down the connector head was firmly in place. Upon preparing the cable it was tested using the cable tester.

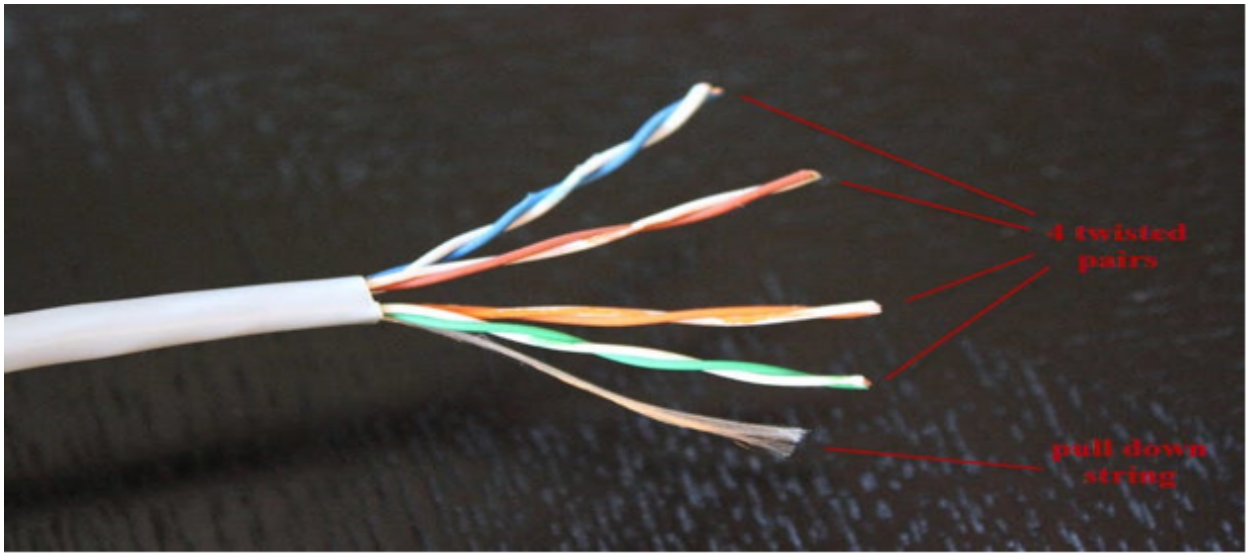
The cable tester produced signals and showed if it was transmitted and where it was transmitted by lighting up with green in the sender end when the data was sent and also lighting up with green in the appropriate receiver end upon receiving the data. The green light of the cable tester showed that the cable was properly configured while the red light showed that the cable was not properly configured. The cable tester had different modes to test for straight-through, cross-over and roll-over cabling. The green light in different pins showed that the cable was properly configured and the data was being properly transmitted.

Diagram of the experiment:

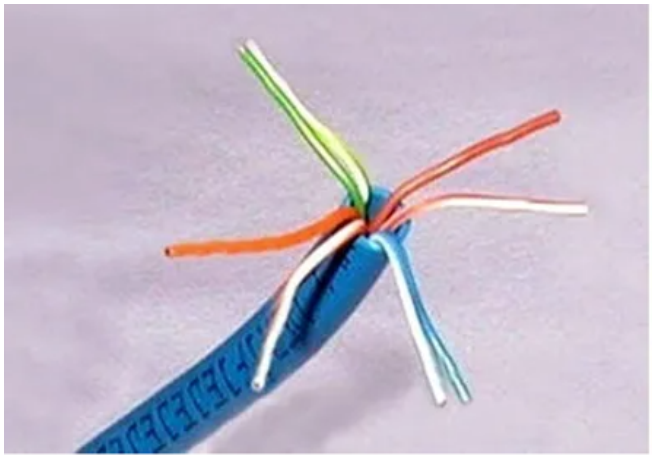
Stripped Wire



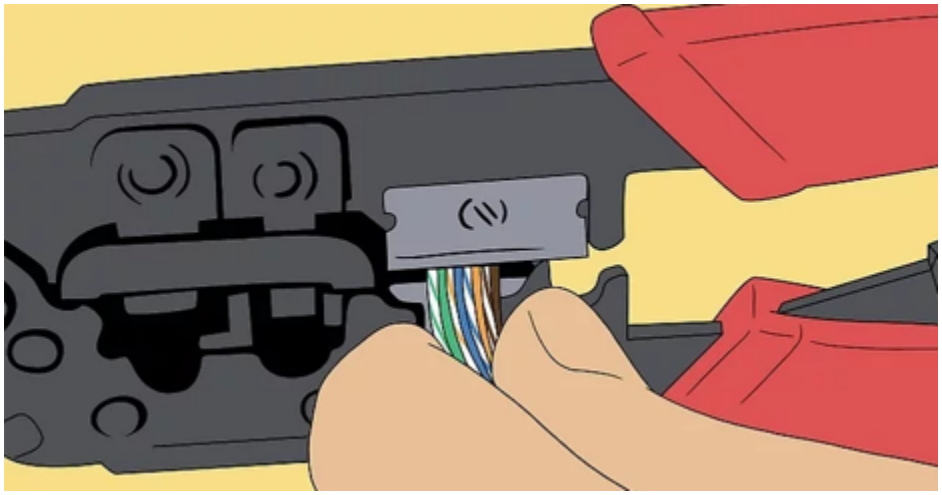
Wire spread and the string pulled down



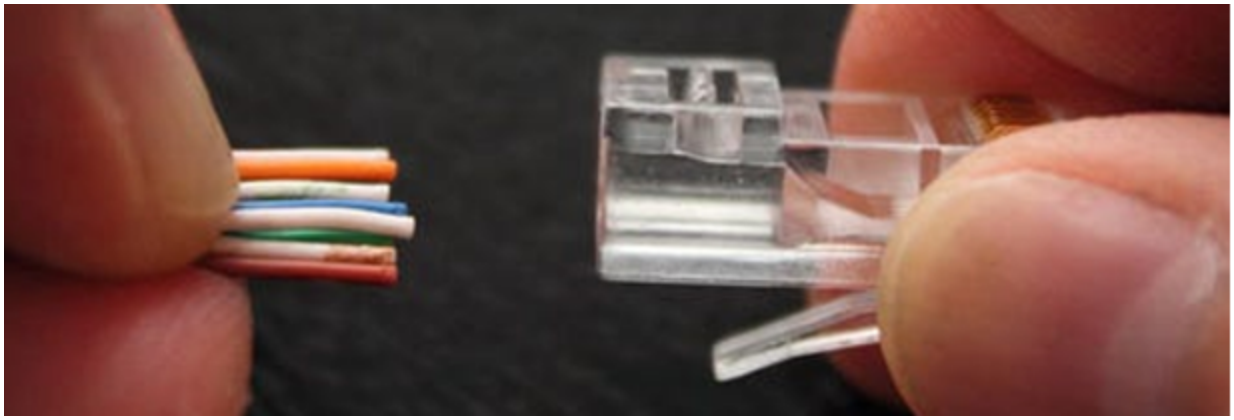
Untwist and align while pinching to keep the wires together



Cutting the tips using the single blade



Insert into the RJ45 connector ensuring that the cables enter the appropriate guides.



Using the crimping tool to ensure that the connector gets tightly adjusted with the cables

Finally to test if the alignment is correct we use the cable tester

We connect the cable we made to 2 ports present in the cable tester and test if the connection is working as expected. The cable test, tests each pin and a good wire should have its sheath, or the insulating portion placed into the RJ45 connector and the wires properly guided. It should be similar to the image given below:

The images were taken from the provided slide with the image for the tester taken from Ryans Computers official site.

Observation:

The cable needed to be stripped with using less force than expected. To properly strip the wire we had to rotate the crimping tool after biting with the double blades, it helps cut the insulating cover or the jacket in one go. The wires were twisted and we had to apply considerable force to keep the wires untwister and arranged as per the respective conventions of 568A and 568B. We had to level the wires so we had the cut the end with the single blade that helped cut things more smoothly than the double ended blade and required less force in comparison. We had to ensure that the wires were in appropriate places in the guides of the connector and tightly in contact with the conductor heads of the connectors. We then had to press the crimping tool upon insertion into the 8P or the wider connector point. We had to press the crimp fully to ensure that the connector was tightly connected to the wires. Then we pulled the connector slightly to ensure that the wire was properly connected.

The next series of observations involve the cable tester. The cable tested was present with our instructor, we took the wire to the instructor, he inserted the ends of the wire with the connector to 2 ports of the cable tester. Upon insertion he inquired about the type of our cabling to which we said cross-over and the mode was set to test the cross-over connection. The green lights showed that the connection was correct for a cross-over connection and the data was being transmitted properly.

Challenges:

The biggest challenge for me was aligning the wires and holding them together. It was challenging to control the amount of force required to strip the wire and level it in the two different steps. The other

challenging part was to insert the wires in appropriate guides of the connecting and ensuring that it actually reached the connector heads. I failed the first time I tried to reach the connector heads and when we took to test the cable, sir just gave it a pull and the wire came out indicating that the wire was not tightly connected. Then I used the same technique to test that the wire was tightly connected to the connector's connecting heads. Another challenge was that the crimping tool kept getting locked and I had to unlock the tool after every use which felt like a hassle. Lastly tightly pressing the connector head was also challenging as I didn't know how tightly I had to press and I feared that I might end up breaking the connector head which luckily didn't happen. In the second try, the cable was properly aligned and the test showed correct results.