

CO-223

LABORATORY SESSION 1

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1. Links

➤ Twisted pair cables

Twisted pair cables are made of simple copper wires. These are mainly used in communication networks. (Telephone networks and Ethernet) In order to reduce the electromagnetic induction between two wires while transmitting (cross talk), both wires are insulated and twisted around each other. By using two wires together each wire cancel out each one's magnetic field. 'Twisting', enhance this cancelling effect. As the requirement there could be multiple connections. Therefore, few number of twisted pairs (most times four) can be included in a single cable. There are mainly two types of twisted pair cables.

1. **Unshielded Twisted Pair cable (UTP cable)**

2. **Shielded Twisted Pair cable (STP cable)**

1. Unshielded Twisted Pair cable (UTP cable)

This type is the ordinary twisted pair type. In order to reduce the cross talk the number of twists per length also defined for this type. UTP are less expensive than other networking cable types. It is an advantage of using UTP cables. The influence of electrical interference higher than other type of network cable. The distance between signal boosts are shorter than some other network cables. Those can be considered as disadvantages of UTP cables. UTP cables are usually installed using Registered Jack – 45 (RJ-45). There are also standards of UTP, called T-568A and T-568B. T-568A was introduced in 1995. T-568B was introduced in 2002 replacing T-568A.



Figure i: RJ-45

<http://www.computernetworkingnotes.com/network-media-and-topologies/connector-types.html>

Commonly used UTP cable types

- **Category 1** — Not suitable for transmitting data. Only for telephone communication. Made of 1 twisted pair.
- **Category 2** — Speed is about 4 megabits per second (Mbps). Made of 2 twisted pairs.
- **Category 3** — Speed is about 10 Mbps. Made of 4 twisted pairs
- **Category 4** — Speed is about 16 Mbps. Made of 4 twisted pairs

- **Category 5** — Speed is about 100 Mbps. Made of 4 twisted pairs
- **Category 5e** — Speed is about 1000 Mbps (1 gigabit per second [Gbps]). Made of 4 twisted pairs
- **Category 6** — Currently the fastest transmitting link for UTP. Made of 4 twisted pairs

2. Shielded Twisted Pair cable (STP cable)

The only physical difference when compared to UTP is each pair is wrapped in metallic foil. This type is specified for Ethernet network installations as its shielded twisted pairs can transmit data with a minimum amount of interference. Metallic shield must be grounded. Otherwise, metallic foil would act as an antenna and might pick up unwanted signals. STP cables usually installed with STP data connector. However, STP cables can be installed using RJ connectors too. A huge disadvantage of this type is its expensiveness.

- ✓ When we consider about twisted pair cables there are two types for networking purposes. They are **straight-through cables** and **cross-over cables**. Both types are identical by their appearance. But the functionality is different.
- ✓ **Straight-through cables** have identical ends and cross-over cables have different ends. Straight-through cables are used as patch cords (cords use between stations and switches/nodes) in Ethernet connections.
- ✓ **Cross-over cables** are used when connecting two hubs or when connecting two Ethernet devices without a hub. Figure 2 explains the functionality of these two types comparatively.

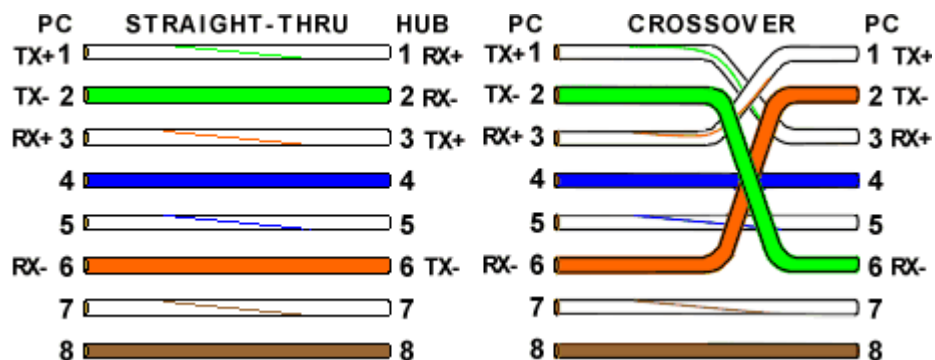


Figure ii: Straight through and cross over types

<http://www.incentre.net/tech-support/other-support/ethernet-cable-color-coding-diagram/>

As it is shown in figure 2, TX (transmitter) pins are connected to the corresponding RX (receiver) pins, plus to plus and minus to minus. With respect to the connecting devices, cross-over or straight-through cables should be applied.

Pin No.	Signal	T-568A	T-568B
1	Transmit+	White/Green	White/Orange
2	Transmit-	Green/White or Green	Orange/White or Orange
3	Receive+	White/Orange	White/Green
4	N/A	Blue/White or Blue	Blue/White or Blue
5	N/A	White/Blue	White/Blue
6	Receive-	Orange/White or Orange	Green/White or Green
7	N/A	White/Brown	White/Brown
8	N/A	Brown/White or Brown	Brown/White or Brown

Table 1: Color codes and usages

- ✓ **Auto-MDIX** – The term MDIX stands for “Media Dependent Interface with Crossover.” The standard wiring for hubs and switches is known as MDIX. In certain devices, if auto-MDIX settings enable, it is possible for hardware to correct errors it-self, regarding the connecting cable. Therefore, it is not important to worry about whether it is straight-through or cross-over type, in such systems. This auto correcting ability is known as “Auto-MDIX”.

➤ Optical fibers

Optical fibers or fiber optic is refers to a medium or a method of transmission of information by pulsating light beams at a high frequency. This medium can be glass or plastic strands or fiber.

Core is the place where light travels. The diameter of this can be about 10-70 microns. This is usually made of ultra-pure glass.

Cladding is an optical material that keep the light signal inside the core by total internal reflection effect. This part is also made of ultra-pure glass.

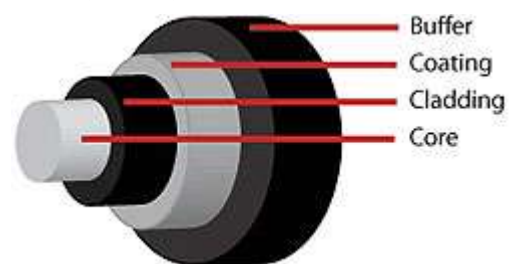


Figure iii: Fiber optic cable internal structure
<http://www.multicominc.com/training/technical-resources/single-mode-vs-multi-mode-fiber-optic-cable/>

Coating is the protecting outer part. This is also known as jacket. This is made of protective plastic covering.

Buffer provides mechanical protection and flexibility to the cable. This helps to protect cable from moisture and other damages.

Fiber optic cables are very popular, even if those are very expensive. The reason is there is neither electromagnetic interference nor frequent amplification while transmitting signals. And fiber optics are very famous for high speed data transmitting too. Those can transmit large amount of data in no time with a little transmission power.

There are two types of fiber optic cables.

1. Single mode fiber optic cable
2. Multimode fiber optic cable

Single mode fiber optic cable

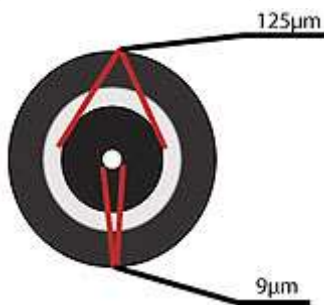


Figure iv: Single mode fiber optic cable
<http://www.multicominc.com/training/technical-resources/single-mode-vs-multi-mode-fiber->

The diameter of the core of single mode optic fiber is small. Therefore, only one mode of light can propagate through this type. Because of this the number of reflections created inside the core decreases and that causes for the increment of distance that the signal can travel through. Therefore this type is used often for long distance transmitting.

Multimode fiber optic cable

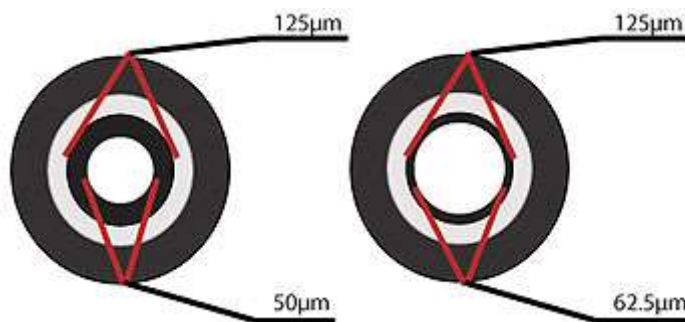


Figure v: Multimode fiber optic cable
<http://www.multicominc.com/training/technical-resources/single-mode-vs-multi-mode-fiber-optic-cable/>

Multimode fiber optic cables have relatively large diametric core which helps to multiple modes of lights to propagate. Therefore, the amount of data that passes through at a given time increases. Because of the high dispersion of this type of fiber, the quality of the signal is reduced over long distances.

SFP transceiver



Figure vi: SFP transceiver

<https://www.perle.com/products/sfp-optical-transceiver.shtml>

The meaning of SFP is **S**mall **F**orm-factor **P**luggable. The SFP converts the serial electrical signals to serial optical signals and vice versa. SFP modules are hot swappable.

Fiber LC



Figure vii: Fiber LC

<http://www.computernetworkingnotes.com/network-media-and-topologies/connector-types.html>

The meaning of LC is Local Connector. These connectors are used for single-mode and multimode fiber-optic cables. FC connectors offer extremely precise positioning of the fiber-optic cable with respect to the transmitter's optical source emitter and the receiver's optical detector.

➤ Co-axial cables

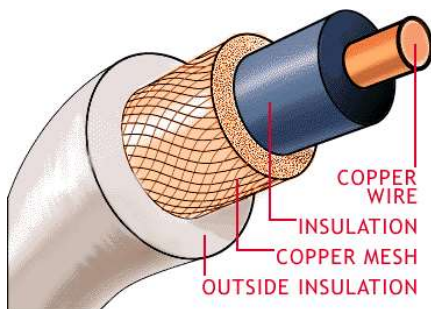


Figure viii: Co-axial cables

<http://searchnetworking.techtarget.com/definition/coaxial-cable-illustrated>

Co-axial cables are a kind of copper cables that includes one physical channel that carries the signal surrounded (after a layer of insulation) by another concentric physical channel, both running along the same axis. These are mostly used in cable TV networks and local area networks.

➤ Wireless-links



Wireless links means a linkage between systems without any physical connection.

Example: Wi-Fi, Bluetooth

2. Systems/nodes

When considering about a network, there are devices such as computers (end systems), routers, Ethernet switches and hubs.

➤ End systems



PCs, Smart phones, any smart device, printers, sensors and many items are known as end systems of a network.

Figure ix: End systems

<http://www.computerhope.com/jargon/r/router.htm>

➤ Routers



Figure x: Wireless router

<http://www.computerhope.com/jargon/r/router.htm>

Router is a device that can receive, analyze and transmit data through wireless or wired links from a network to another. It may also be used to convert the packets to another network interface and perform other actions relating to a network.

Routers can make their own decisions according to situations based on an instruction table configured by human. There is a port named 'console port' in order to give instructions to the router. (To configure the routing table) This console port is linked by a cable which has an end of serial cable and RJ-45 end. Serial end is connected to the PC and other one is connected to the console port of router.

➤ Switches and hubs



Figure xi: Switch

http://www.diffen.com/difference/Hub_vs_Switch

Switch is a device that can connect many devices together in a computer network. It's a control unit that turns the flow of electricity on or off in a circuit. Switch is an advanced device than hub. Speed is about 1 Gbps.

Hub is an electronic device that can connect multiple devices together to exchange data. Speed is about 10 Mbps.

➤ Ethernet interfaces

Ethernet is a Layer 2 technology that operates in a shared bus topology. Ethernet is a point-to-multipoint technology. As every traffic is broadcast over the whole network, each and every transmissions are received to all devices. Ethernet data link protocol doesn't inform about the lost packets while transmitting such as higher layer protocols (TCP/IP). RJ-45 cables are used mostly in these.

➤ Serial interfaces

Serial interfaces are communication interfaces that links two digital systems, and transmit data as a series of voltage pulses. (1 by high voltage and 0 by low voltage)

There are two types of serial interfaces.

1. Asynchronous (SCI) Serial Interface
2. Synchronous Serial Interface

Asynchronous (SCI) Serial Interface

In this type data is transmitted in a well-defined frame. Here 'frame' means a packet of bits which contain data and overhead (control bits). Usually, a frame contains a single start bit, seven or eight data bits, parity bits, and sometimes a stop bit. The start bit is used to signal the beginning of a frame and the stop bit signals the end of the frame. The parity bit is used to detect transmission errors. This type is known as 'asynchronous' because both devices do not need to synchronize their clocks before communicating.

Synchronous Serial Interface

In this case, the receiver cannot independently synchronize its reading of the data line with the transmitter's transmission rate. In order to receive data receiver need a signal. This is known as clock signal which informs the receiver when to start reading from the data line. Transmitter and receiver must synchronize their access to the data line to successfully transmit data.

➤ Wide-area network interfaces



Figure xii: Typical Network interface card

<http://study.com/academy/lesson/network-interface-card-nic-types-function-definition.html>

In most computers there network interface cards in order to establish a connection to a network. This connection might be a wired connection (Ethernet) or wireless connection (Wi-Fi). RJ-45 cable is used to have the wired link between network and the PC.

➤ Network of things or Internet of things

The meaning behind this term is inter-networking of physical things with the help of sensors, software, electronics and many other things. The physical things that mentioned above are remotely controlled or to be sensed with the help of networking structure. When consider about sensors there are many physical parameters that can be sensed by those sensing devices.

- ✓ temperature
- ✓ humidity
- ✓ vehicular movement
- ✓ lightning condition
- ✓ pressure
- ✓ soil makeup
- ✓ noise levels



Therefore, the sensors that can be used to sense above physical parameters have a range of variety. Converting the particular physical parameter to an electrical signal is the task done by sensors. 'Smart' concept play a main role in internet of things.

3. A network

➤ Wireless access point

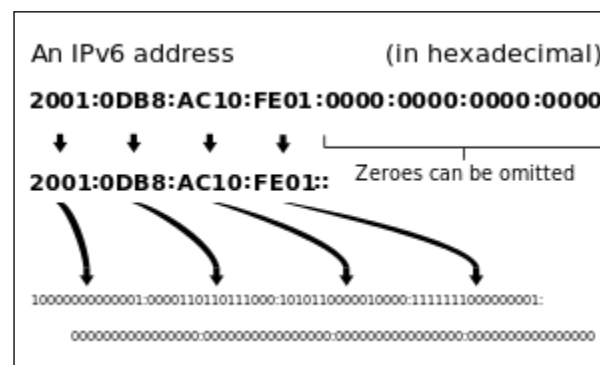
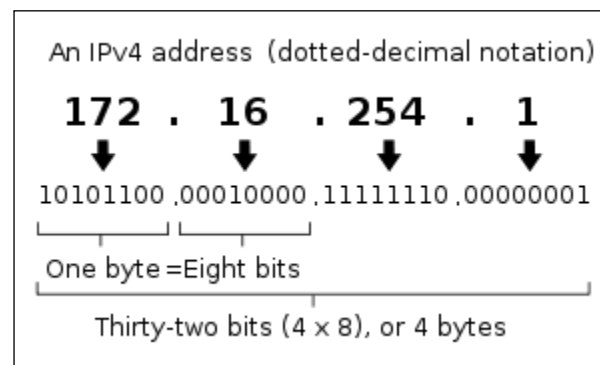
Wireless access point is a configured node or a hardware device connected to a Local Area Network (LAN). Wireless capable devices can connect to the network through this point. Wi-Fi and Bluetooth are the most popular methods in use. In most cases wireless access point is a Wi-Fi hotspot.

4. Addresses to interfaces in the network

➤ IP Address

IP Address – Internet Protocol address is a numerical label assignment to each device interface in a computer network that uses internet protocol for communication. Identifying the network interface and location addressing are the main functions of IP addresses. The designers of IP address designed this as a 32 bit number which is known as the IPv4 (Internet Protocol version 4) and still in use. As the growth of the internet, a new version was introduced in mid 2000s, which was named IPv6 (Internet Protocol version 6) and represented using 128 bits.

e.g. :- 172.16.254.1 (IPv4), and 2001:db8:0:1234:0:567:8:1 (IPv6).



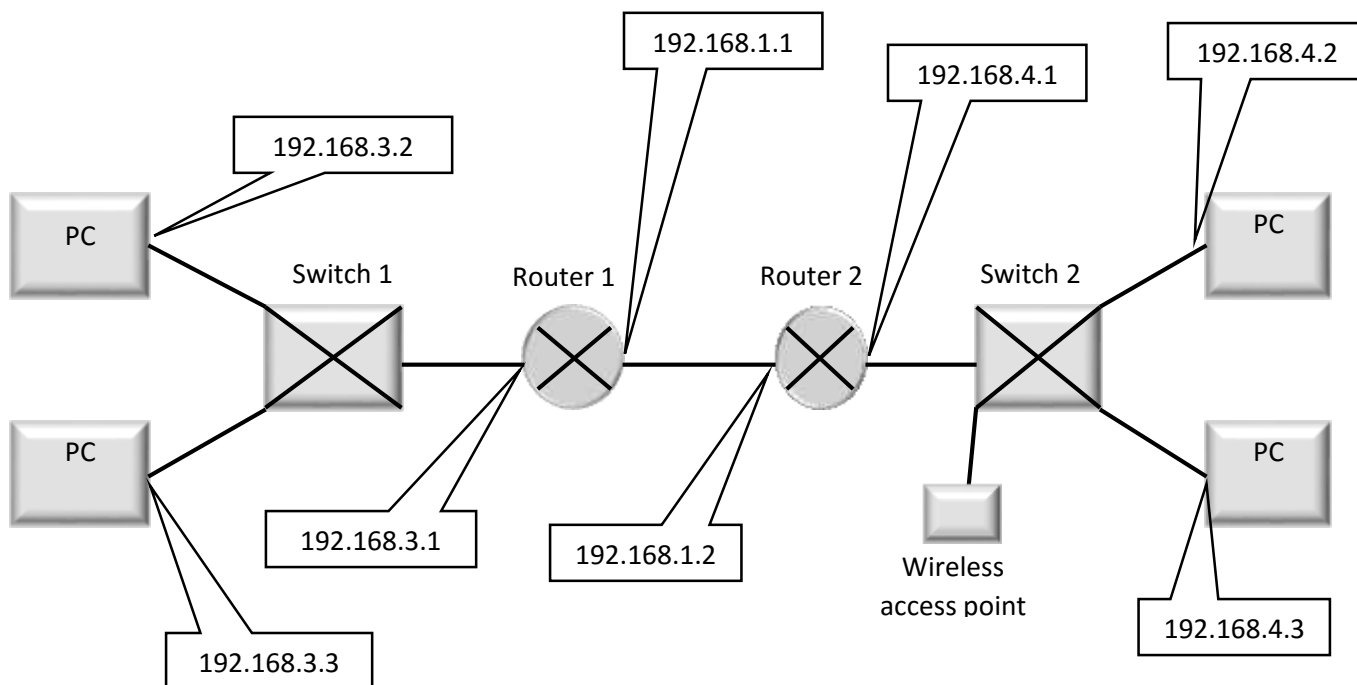
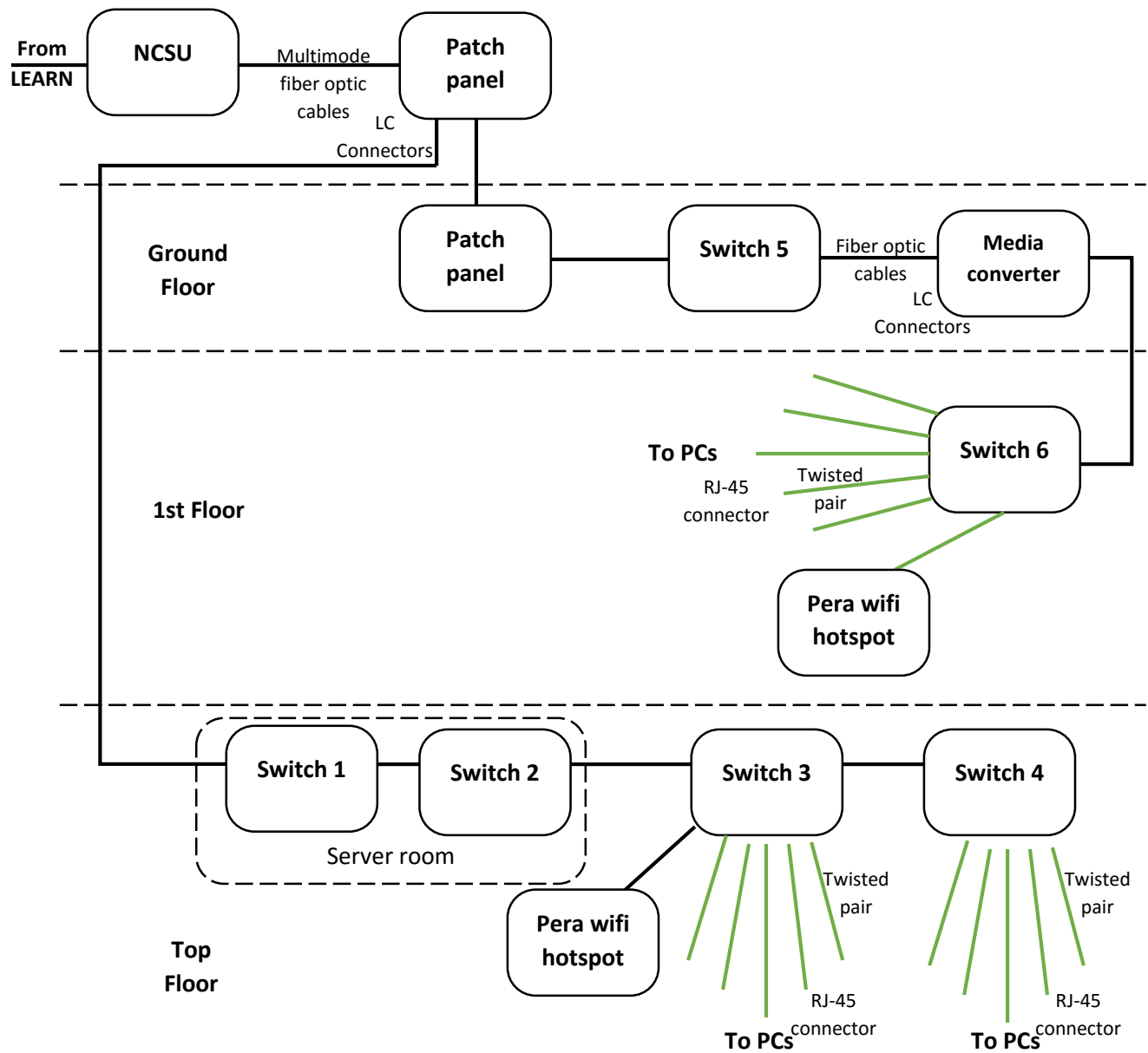


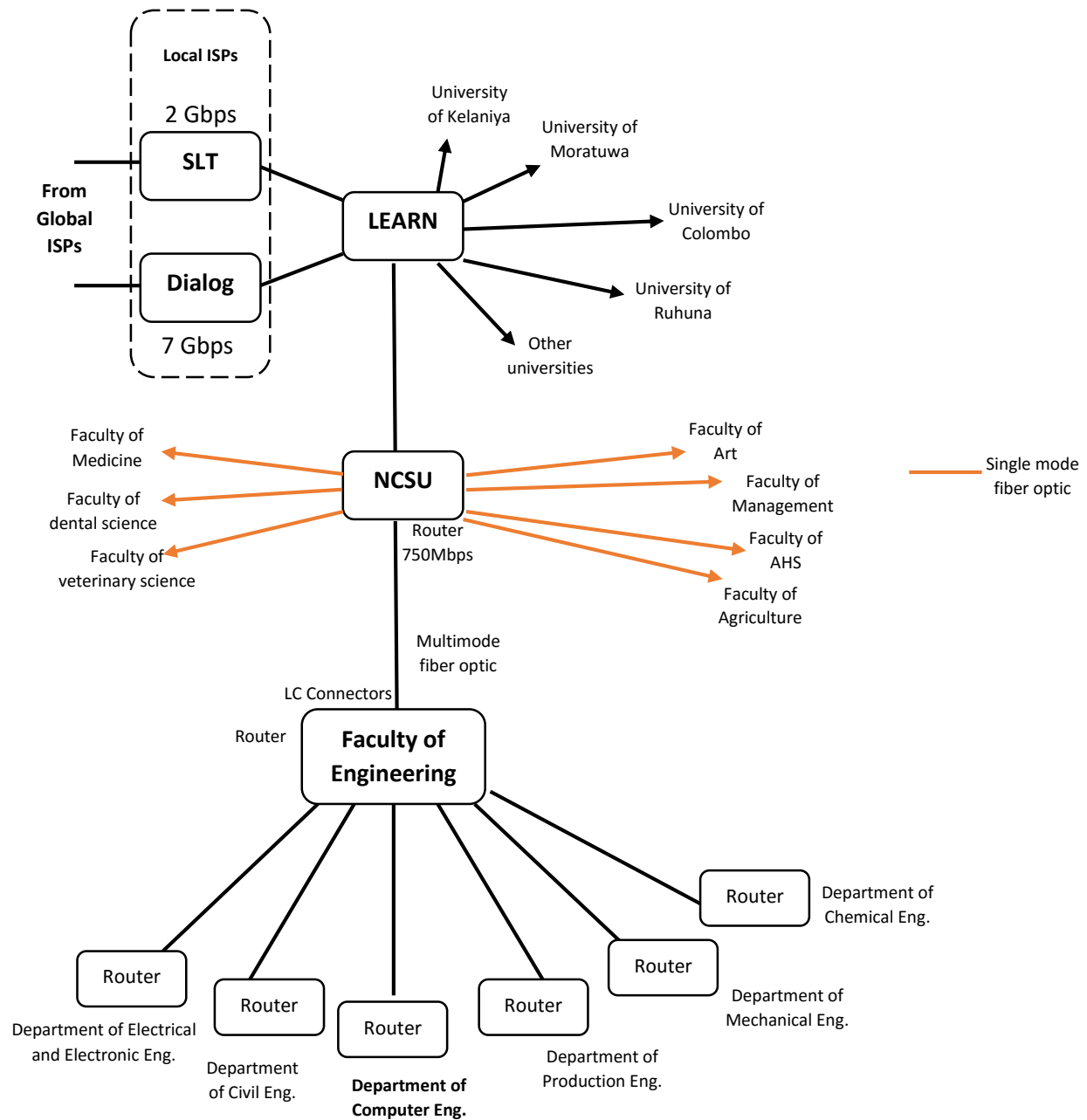
Figure 1: Addresses assigned to network interfaces

5. The department network



**Switch 1, 2, 6 and NCSU are router/switch combinations

6. The university network and the internet



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