# CCNA Lab – LAN Segment

## Topology Overview

PC-1 and PC-2 are connected to the same physical cable via their **Network Interface Cards (NIC).** This physical topology is called a **LAN segment** and is a foundational building block of a network called a **Local Area Network (LAN)**. By itself, this topology could also be considered a LAN.

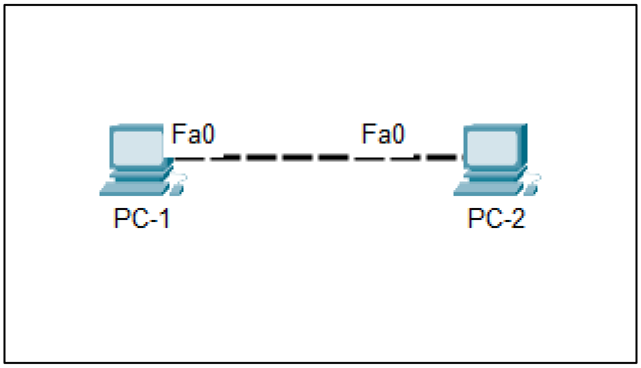


*Figure X – Lab Topology*

PC-1 has data to send to PC-2 and will use the LAN segment  to transport it. Before the data can be placed on the wire for transmission, it must be placed inside of a **frame**. Think of the frame as the only container suitable to transit the physical wire. The data being sent cannot be placed on the wire in the same way you would not place a written letter in a mailbox without first placing it in an envelope.

PC-1 will take the data, place it in a frame, then place it on the wire. This is an overly simplified explanation for the purpose of developing an initial mental model to build on.

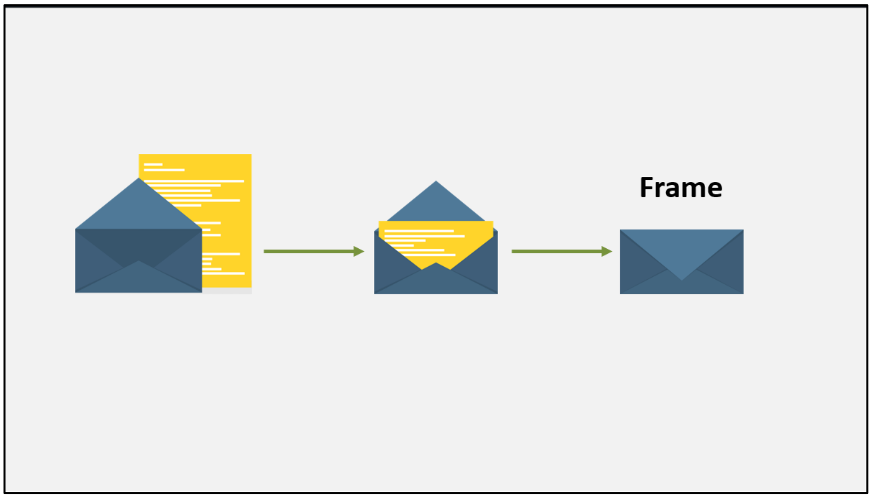


*Figure 2 – Abstract Image of Data Being Placed in a Frame*

a. Instruct PC-1 to send data to PC-2 by using the **Ping** command from PC-1's Command Prompt.

```
C:\> ping 192.168.1.2
```

**Observe**

PC-2 at 192.168.1.2 replies to the ping acknowledging receipt of the data.

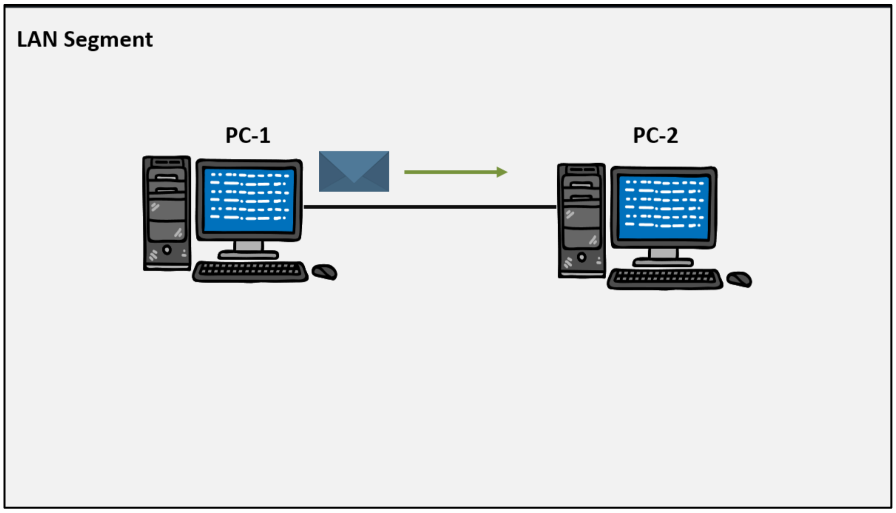


*Figure 3 – Abstract Image of Data Being Sent*

```
C:\>ping 192.168.1.2

Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time<1ms TTL=128
Reply from 192.168.1.2: bytes=32 time=1ms TTL=128
Reply from 192.168.1.2: bytes=32 time<1ms TTL=128
Reply from 192.168.1.2: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

*Figure 4 – Successful Ping from PC-1 to PC-2*

b. Connect PC-3 directly to this LAN segment.

## Observe

You are unable to connect PC-3 directly.

## Problem

PC-1 and PC-2 have only one NIC each and are already connected to the LAN segment so PC-3 cannot connect to either of them. There is also no way for PC-3 to connect  directly to the physical cable.

## Question

- How can we **extend the LAN segment** to allow PC-3 to use it?

## The Solution

A device called a **hub** can be used to extend the LAN segment. A hub has many ports, allowing multiple devices to connect directly to it, giving the illusion that **all the devices are connected to the same physical cable**. Compare *Figure 5* which depicts the physical topology vs *Figure 6* that depicts the illusion called a **logical topology**.

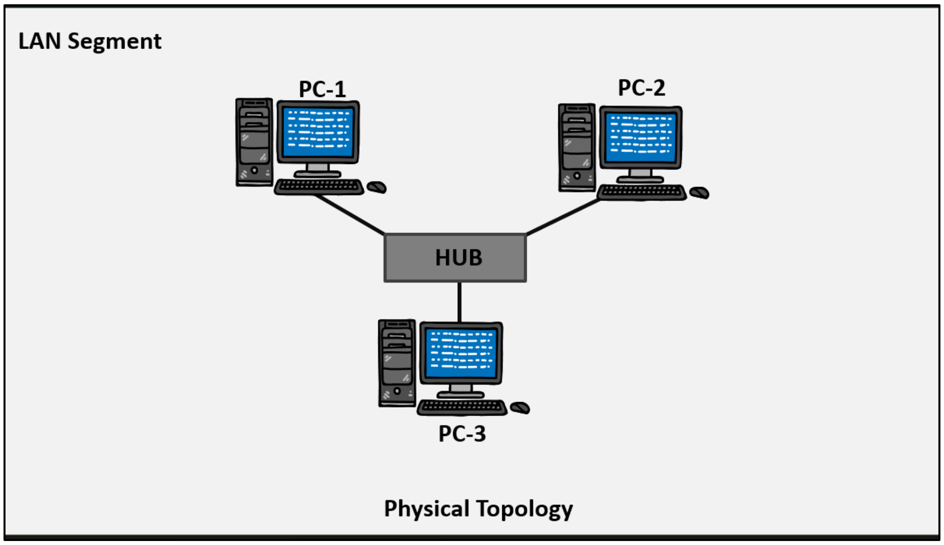


*Figure 5 – Physical Topology with Hub*

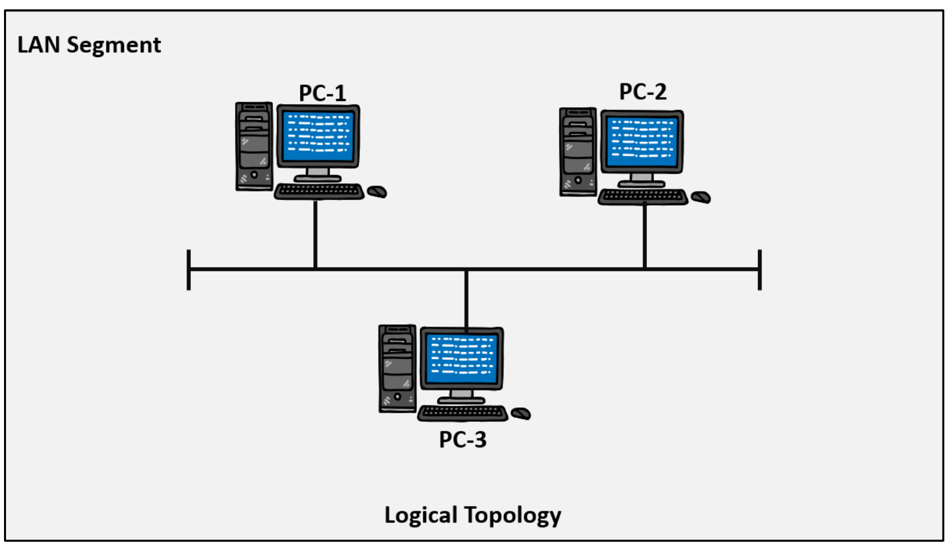


*Figure 6 – Logical Topology with Hub*

c. Connect all PCs to the hub using the **straight through cable**. This is the third cable option from the left.

PC-1 has data to send to PC-3.

### Question

- If PC-1 places a frame on the wire for PC-3, how does PC-2 know that it is not the intended recipient?
- How would PC-3 know the frame was intended for it?

### The Problem

With more than two devices connected to the LAN segment there must be a way to mark the frame with the identity of the intended device. This is similar to you placing the name of the intended recipient on the envelope you place in the mailbox.

### The Solution

A device's access to the LAN segment, its NIC, is assigned a unique value called a **Media Access Control (MAC)** address. The MAC is used as the unique **identifier** placed on the frame. Before being placed on the wire, a **frame must have a source and destination MAC address**.

When a device "sees" a frame on the wire, it checks the destination MAC to determine if it is the intended destination.

d. From Command Prompt, view PC-1 and PC-3's MAC addresses.

```
C:\> ipconfig /all
```

### Observe

The output of the command displays various pieces of important information; however, the focus is each device's MAC address or physical address as identified in the output.

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address................: 5254.0046.AC7B
   Link-local IPv6 Address.........: FE80::205:5EFF:FE39:23D1
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.1.1
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     0.0.0.0
```

*Figure 7 – PC-1 ipconfig /all Output*

PC-1 now has a method to signify that the frame is intended for PC-3. It will mark the frame with PC-3's MAC address in the destination field.

### Question

- How does PC-1 learn PC-3's MAC address?

### The Problem

Remember that a source and destination MAC address are required on a frame being placed on the wire. A sending device knows its own MAC address to use as the source; however, it would not necessarily know the destination device's MAC address. This is like how you would not inherently know the mailing address of a person you are sending a letter to, if you have never sent them mail before.

### The Solution

The solution is simple. The sending device will ask which device has the destination IP address and request its MAC address. The process of asking is done using the **Address Resolution Protocol (ARP)**.

You instruct PC-1 to send a ping to 192.168.1.3, PC-3. PC-1 asks, **"Who has IP address 192.168.1.3?"** This question is called an **ARP request**. PC-3 will reply to the request with its MAC address. This response is called an **ARP reply**. ARP enables a device to resolve a known address, the IP address, to a MAC address, hence the name.

*Figure 8* shows the ARP request and reply. The full packet capture is included in the lab download.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 0.000000 | 0.0.0.0 | 255.255.255.255 | DHCP | 342 | DHCP Discover - Transaction ID 0xb021dd0a |
| 2 | 0.990907 | 52:54:00:46:ac:7b | Broadcast | ARP | 42 | Who has 192.168.1.3? Tell 192.168.1.1 |
| 3 | 0.991587 | 52:54:00:62:65:fb | 52:54:00:46:ac:7b | ARP | 42 | 192.168.1.3 is at 52:54:00:62:65:fb |

*Figure 8 – Packet Capture of ARP*

PC-1 can use ARP to learn PC-3's MAC to use as the destination of the frame.

### Question

- What destination MAC is used for the frame containing the ARP request?

### The Problem

All communication between devices, including ARP, is placed in a frame. A frame requires a source and destination MAC address. ARP serves the purpose of asking for the destination's MAC address, but there is still no destination MAC address to place in the frame containing the ARP request. It is a chicken-and-egg scenario**.**

### The Solution

The destination MAC used in this case would be **FFFF.FFFF.FFFF**, or the **All F's MAC**. This MAC address, called the **broadcast MAC**, addresses **all devices** unlike a **unicast** MAC that addresses a specific device. It serves a purpose similar to saying, "Hey, this message is for everyone here**."**

In the current scenario, all devices on the segment will receive the ARP request, but only the device with the requested IP address will respond with an **ARP reply**. *Figure 9* shows the All F's broadcast MAC being used.

```
> Frame 2: Packet, 42 bytes on wire (336 bits), 42 bytes captured (336 bits)
> Ethernet II, Src: 52:54:00:46:ac:7b (52:54:00:46:ac:7b), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Address Resolution Protocol (request)
```

*Figure 9 – Packet Capture of All F's MAC*

e. On PC-1, view the ARP table then ping PC-3. View the ARP table after the successful ping.

### Observe

Before pinging PC-3, PC-1's ARP table is empty; however, after the ping the ARP table has been populated with PC-3's IP to MAC mapping.

```
C:\>
C:\>arp -a
No ARP Entries Found
C:\>
```

*Figure 10 – PC-1 Empty ARP Table Output*

```
C:\>arp -a
  Internet Address      Physical Address      Type
  192.168.1.3           5254.0062.65fb        dynamic

C:\>
```

*Figure 11 – PC-1 Populated ARP Table Output*

### Engineer Insight

After resolving an IP address to a MAC address, the device **temporarily** stores the mapping in its **ARP table** so it does not have to perform ARP resolution again each time it needs the MAC address.

f. Turn on Simulation Mode. From PC-1, ping PC-3 then watch the traffic flow.

### There's A Problem

The destination MAC is PC-3's; however, PC-2 still receives the traffic. Each time a device receives a frame, it must process it. If a device is constantly receiving frames not meant for it, it is wasting processing power.

g. Turn on Simulation Mode. On PC-1 and PC-2, start pings to the broadcast IP address 192.168.1.255.

```
C:\> ping 192.168.1.255
```

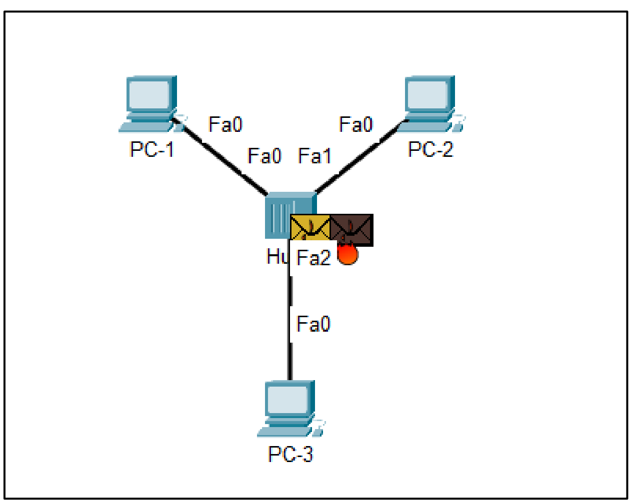


*Figure 12 – Collision on LAN Segment*

## There's Another Problem

The flame seen in the simulation represents a **collision**. A collision occurs when multiple devices transmit frames onto the same shared medium at the same time, causing the signals to interfere with each other. Imagine you and another person speaking at the same time. Neither can be clearly heard because you are speaking over each other. Your voices are colliding with each other.

A collision occurs within what is known as a **collision domain**. Currently, all devices in the topology are part of the same segment and collision domain. The addition of a second LAN segment not connected to the first creates a second collision domain. A frame from PC-1 would not collide with a frame from PC-4 because they are in different collision domains. Note that the initial topology, with just PC-1 and PC-2, is also a collision domain.

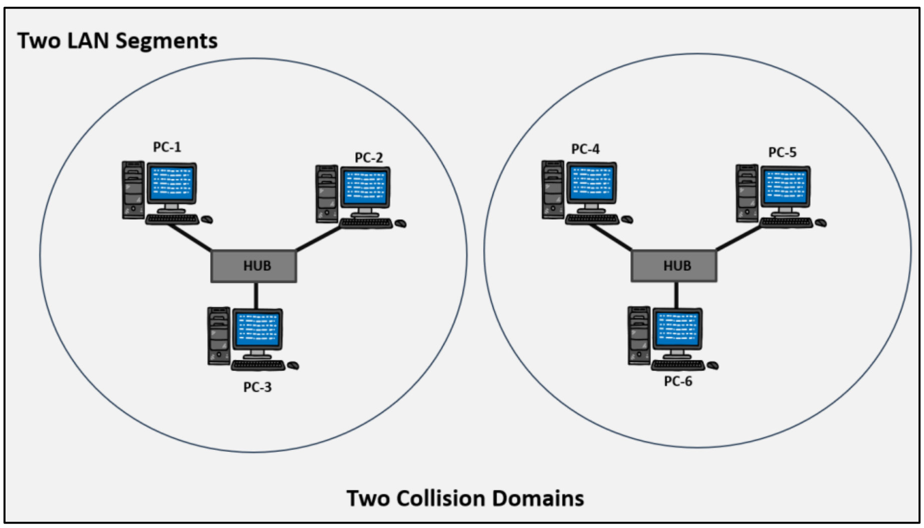


*Figure 13 – Two Collision Domains*

A hub was introduced to extend the network; however, the hub introduced its own set of problems.

## The Solution

To solve the shortcomings of using a hub to extend the LAN segment, a device called a **switch** was developed. Unlike a hub, which replicates traffic received on one port out all other ports and operates as one collision domain, a switch sends traffic only out the port connected to the intended destination. Each switchport is also its own individual segment and collision domain.