

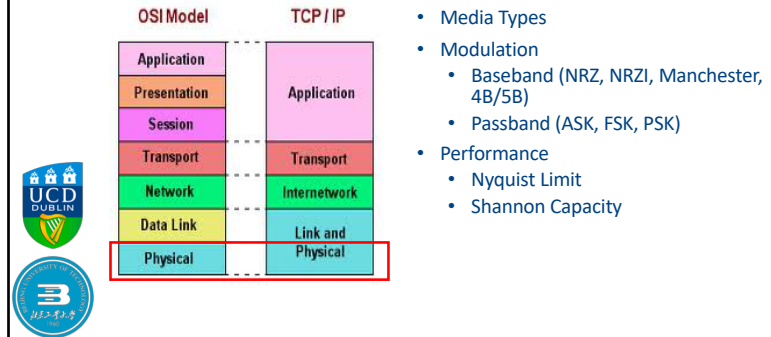
Dr SABER Takfarinas  
takfarinas.saber@ucd.ie

COMP2009J  
Computer Networks

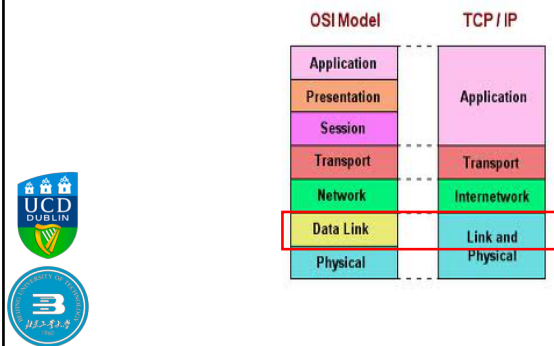
## Address Resolution Protocol



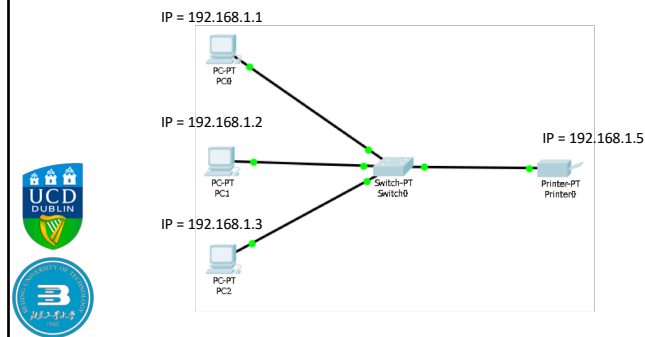
## Last Week



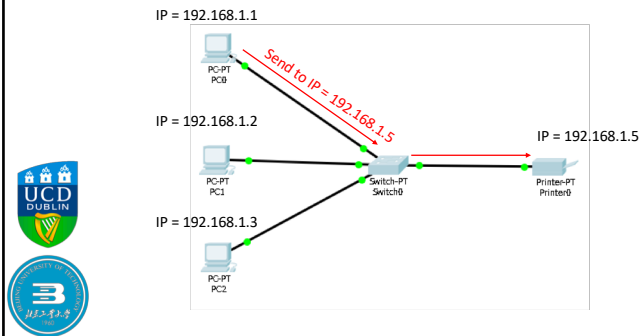
## This Week: Layer 2, Part 1: Addressing



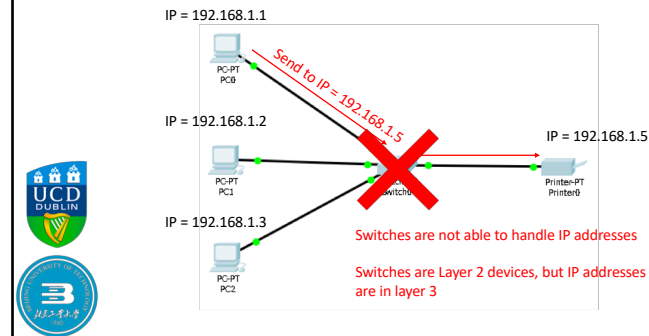
## Remember this LAN from Practical 2?



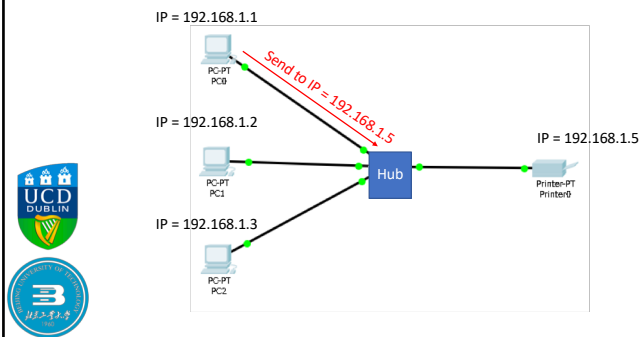
## PC0 Send a Packet to Printer0



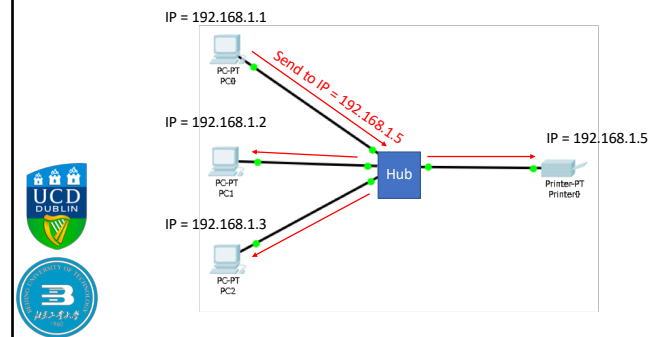
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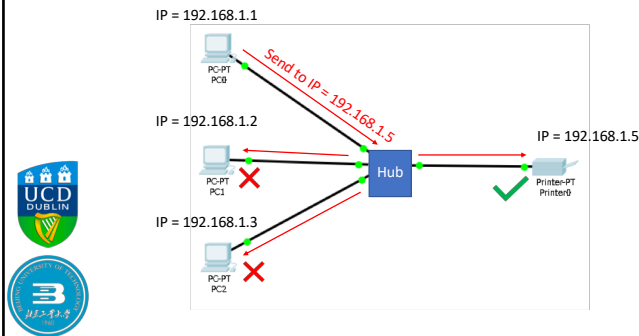
## Solution 1: Always Use a Hub



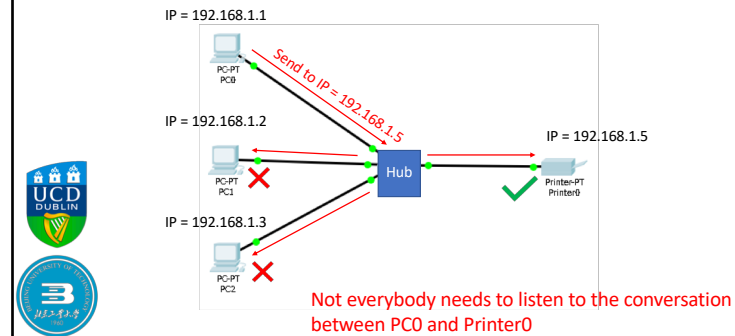
## Solution 1: Always Use a Hub



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### Solution 2: Using Mac Addresses

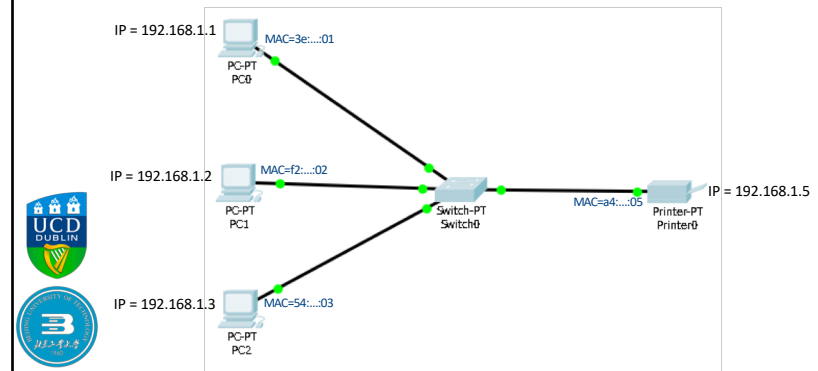
- Every Network Interface Card (NIC) has a unique Multiple Access Control (MAC) address of the Network Interface Card (NIC)



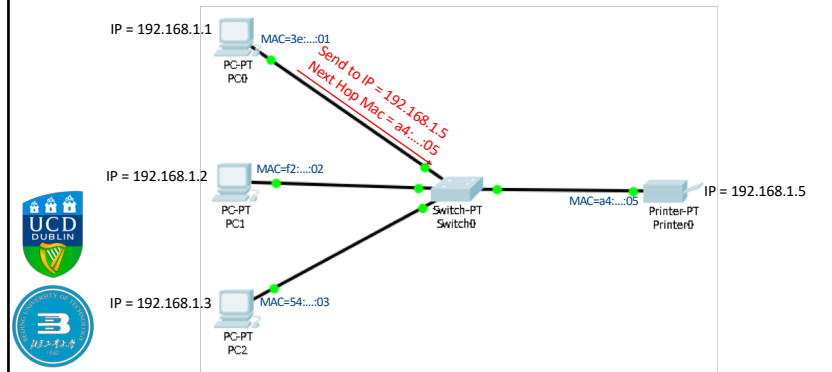
Network Interface Card (NIC)

- Solution:
  - Use the IP address for the final destination
  - Use the MAC address for the next hop

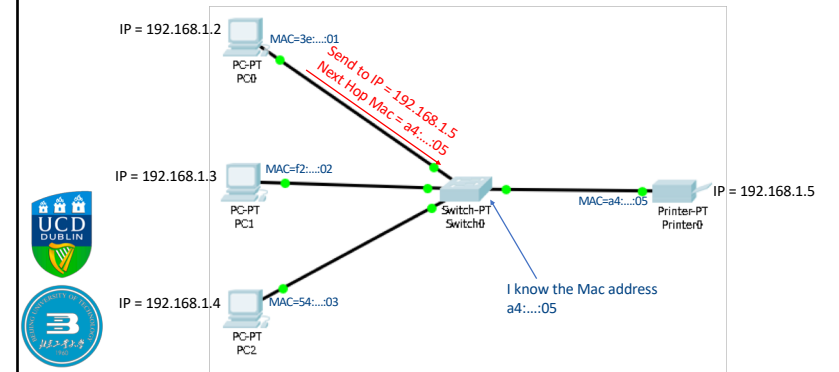
### Solution 2: Mac Address for Next Hop



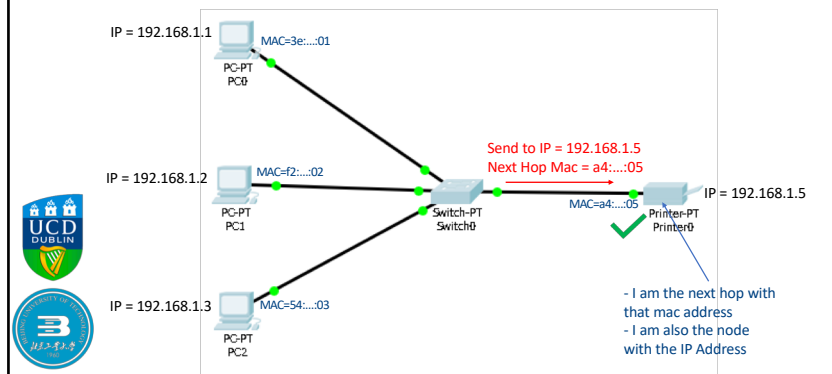
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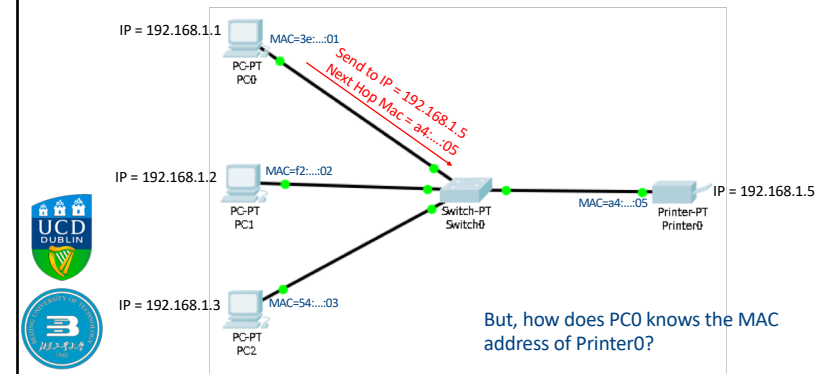
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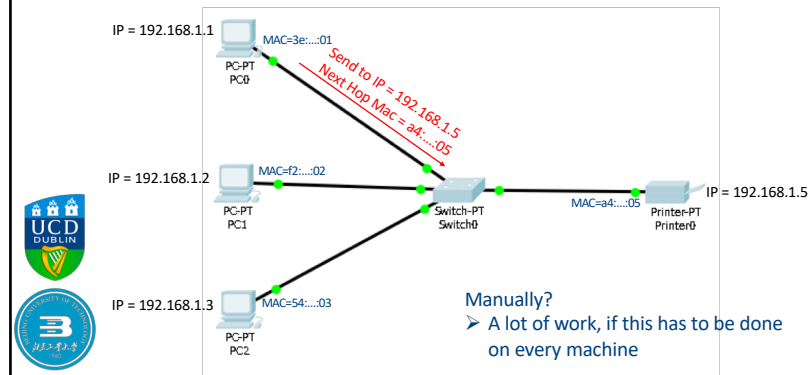
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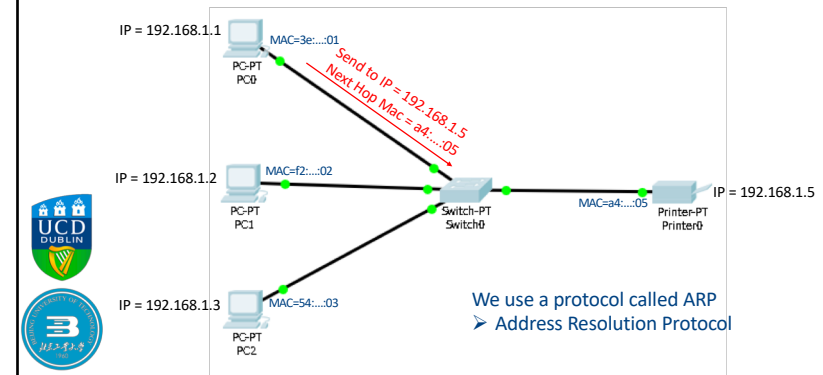
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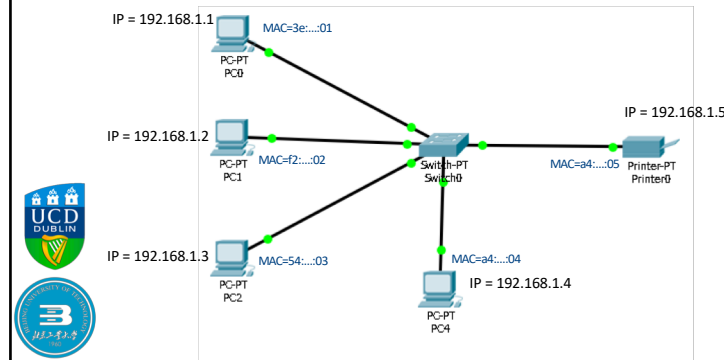
### How did PC0 Know the MAC of Printer0?



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### Let's Consider a New Computer PC4

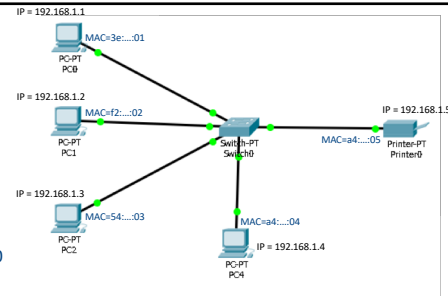


### PC4 is New

- PC4 knows only two things:
  - Its IP address is: 192.128.1.4
  - Its Netmask is: 255.255.255.0

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- PC4 knows only two things:
  - Its IP address is: 192.128.1.4
  - Its Netmask is: 255.255.255.0
- Let's assume that PC4 wants to send a message/packet to Printer0
  - PC4 knows that Printer0 is at IP = 192.168.1.5
  - But, PC4 cannot send the message to Printer0 right now!
  - Because, it does not know the MAC address of Printer0



## ARP Tables

- Every computer uses an ARP Table to track corresponding IP and MAC addresses
- PC4 ARP Table is empty
  - PC4 just joined the network and does not know anyone



| PC4: ARP Table |     | Printer0: ARP Table |     |
|----------------|-----|---------------------|-----|
| IP             | MAC | IP                  | MAC |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |

## ARP Tables

- PC4 needs to send an **ARP request**
  - Who has IP = 192.168.1.5?



| PC4: ARP Table |     | Printer0: ARP Table |     |
|----------------|-----|---------------------|-----|
| IP             | MAC | IP                  | MAC |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |

## ARP Tables

- PC4 needs to send an **ARP request**
  - Who has IP = 192.168.1.5?
- PC4 wants to ask all the computers in the LAN
  - Which MAC address it will use to broadcast the request?



| PC4: ARP Table |     | Printer0: ARP Table |     |
|----------------|-----|---------------------|-----|
| IP             | MAC | IP                  | MAC |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |

## ARP Tables

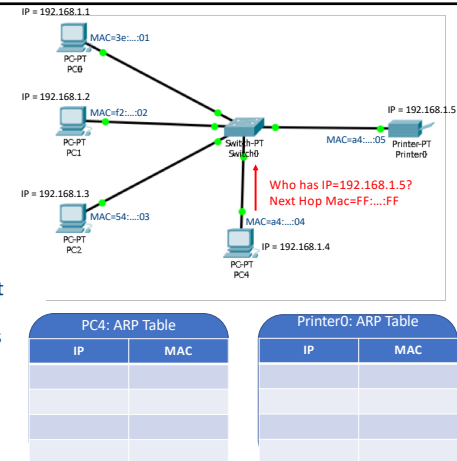
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  - Who has IP = 192.168.1.5?
- PC4 wants to ask all the computers in the LAN
  - Which MAC address PC4 will use to send the request to all its neighbours?
  - The broadcast Mac address FF:FF:FF:FF:FF:FF



| PC4: ARP Table |     | Printer0: ARP Table |     |
|----------------|-----|---------------------|-----|
| IP             | MAC | IP                  | MAC |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |
|                |     |                     |     |

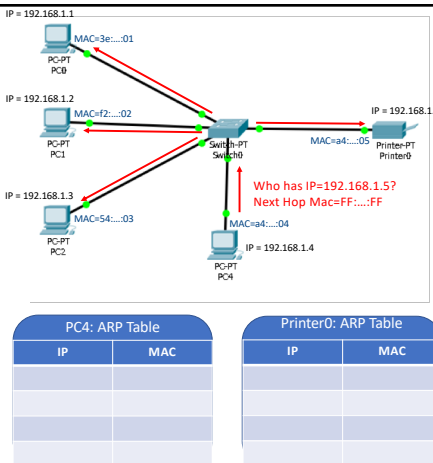
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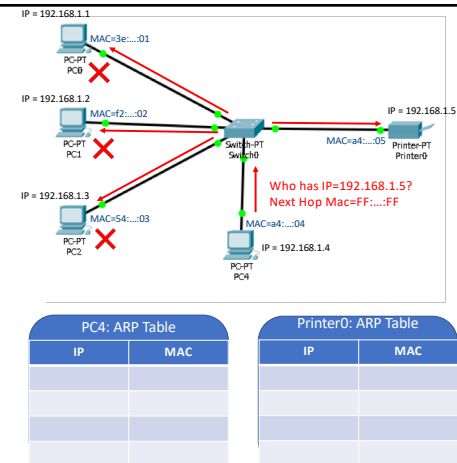
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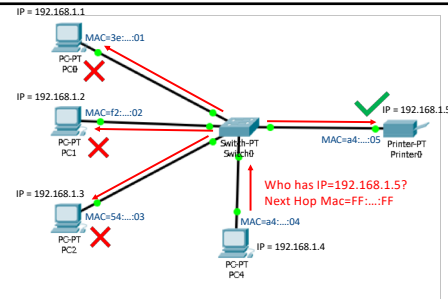
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  - The IP address is not theirs
  - Ignore the message



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  - I need to do something

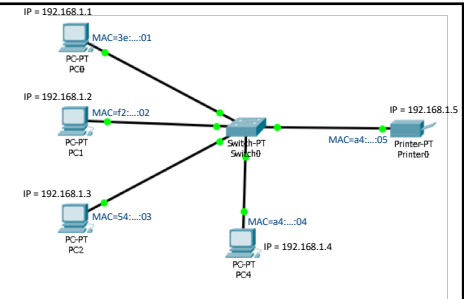


| PC4: ARP Table |     |
|----------------|-----|
| IP             | MAC |
|                |     |
|                |     |
|                |     |

| Printer0: ARP Table |     |
|---------------------|-----|
| IP                  | MAC |
|                     |     |
|                     |     |
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  - It is its IP address
  - I need to do something
    - Save information about PC4

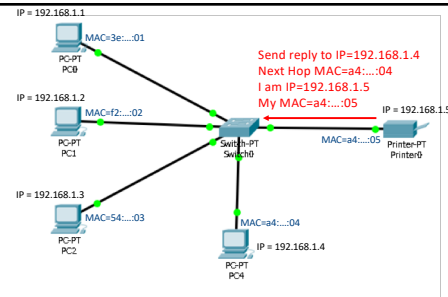


| PC4: ARP Table |     |
|----------------|-----|
| IP             | MAC |
|                |     |
|                |     |
|                |     |

| Printer0: ARP Table |           |
|---------------------|-----------|
| IP                  | MAC       |
| 192.168.1.4         | a4:....04 |
|                     |           |
|                     |           |

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  - It is its IP address
  - I need to do something
    - Save information about PC4
    - Reply to PC4

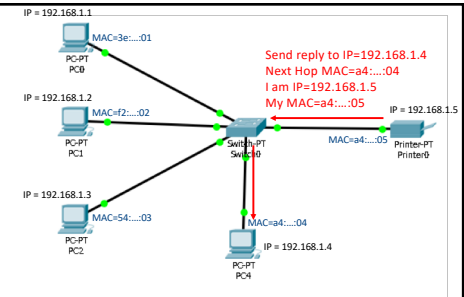


| PC4: ARP Table |     |
|----------------|-----|
| IP             | MAC |
|                |     |
|                |     |
|                |     |

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| 192.168.1.4         | a4:....04 |
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  - The IP address is not theirs
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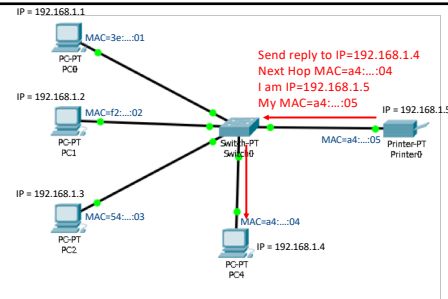
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| IP             | MAC |
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|                |     |
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|---------------------|-----------|
| IP                  | MAC       |
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|                     |           |
|                     |           |



## ARP Tables

- PC4 receives a reply
  - It is its IP address
  - It needs to add the corresponding MAC and IP addresses



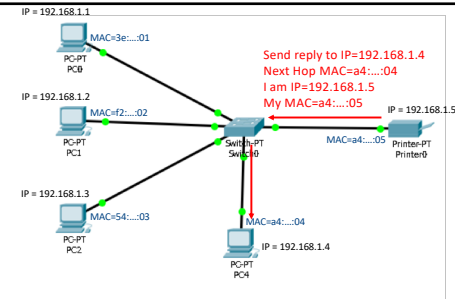
| PC4: ARP Table |     |
|----------------|-----|
| IP             | MAC |
|                |     |
|                |     |
|                |     |

| Printer0: ARP Table |          |
|---------------------|----------|
| IP                  | MAC      |
| 192.168.1.4         | a4:...04 |
|                     |          |
|                     |          |



## ARP Tables

- PC4 receives a reply
  - It is its IP address
  - It needs to add the corresponding MAC and IP addresses



| PC4: ARP Table |          |
|----------------|----------|
| IP             | MAC      |
| 192.168.1.5    | a4:...05 |
|                |          |
|                |          |

| Printer0: ARP Table |          |
|---------------------|----------|
| IP                  | MAC      |
| 192.168.1.4         | a4:...04 |
|                     |          |
|                     |          |



## PC4 Wants to Send a Packet to Printer0

- Can PC4 send a packet to Printer0 now?
  - Yes, it can!
  - It has the IP address of the destination
  - It also has the MAC address of the next hop

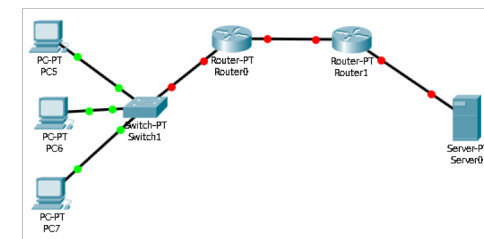
| PC4: ARP Table |          |
|----------------|----------|
| IP             | MAC      |
| 192.168.1.5    | a4:...05 |
|                |          |
|                |          |

| Printer0: ARP Table |          |
|---------------------|----------|
| IP                  | MAC      |
| 192.168.1.4         | a4:...04 |
|                     |          |
|                     |          |



## The reality

- MAC address is not only used in LANs with Switches
- They are used in any LAN (even to send messages between routers)



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