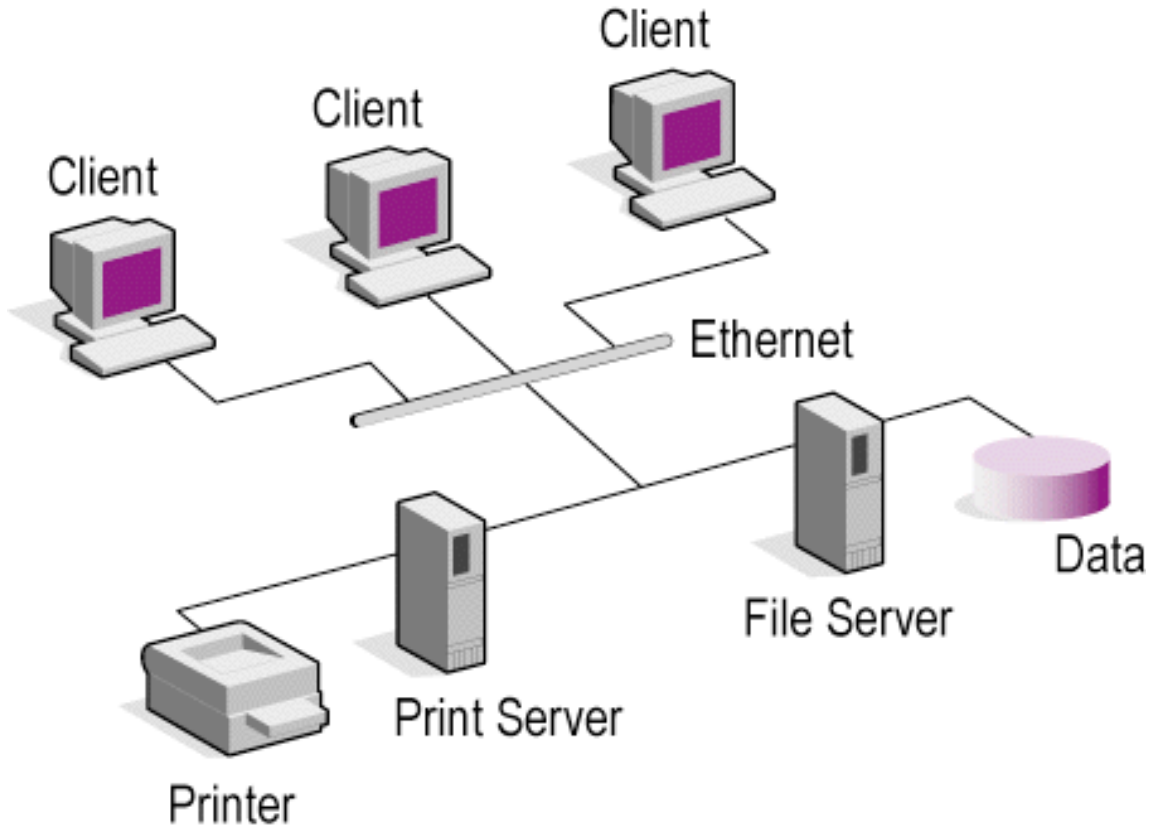
C3 Network

Hands-on with Filius

Part 1 : Network Infrastructure

Hosts, NIC, Medium

Hosts and Nodes



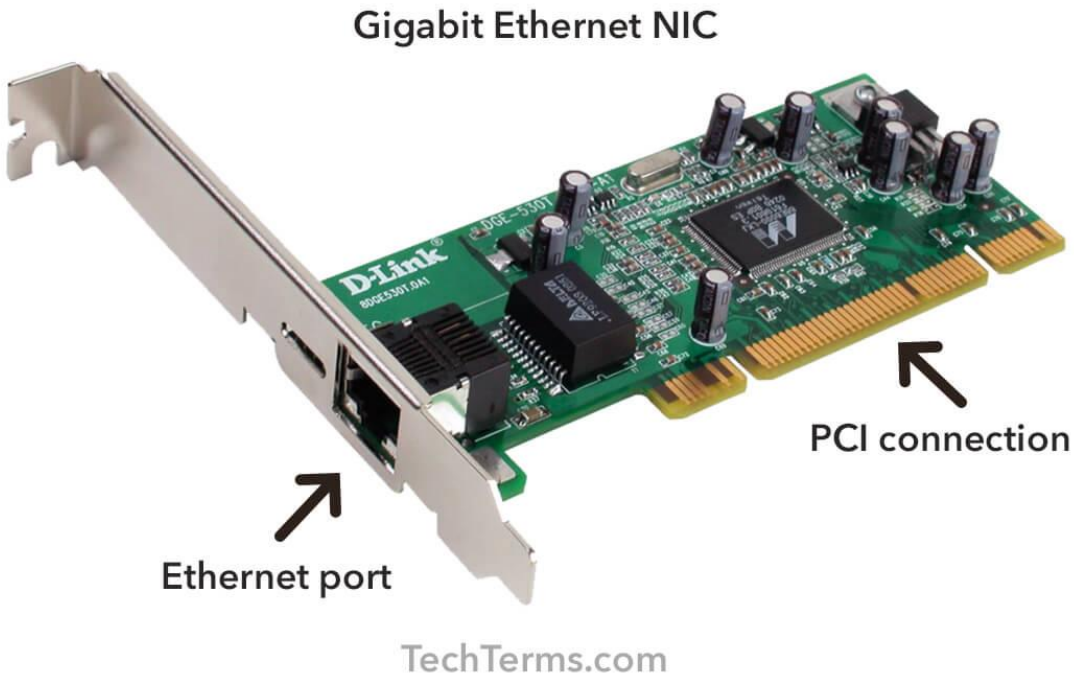
What are Hosts ?

- Hosts are servers and clients

What are Nodes ?

- Every network device must have at least one node
- Examples : Network Interface Card (NIC),
  Wifi, Bluetooth or Infrared Ports

Network Interface Card (NIC)



Network Medium Types

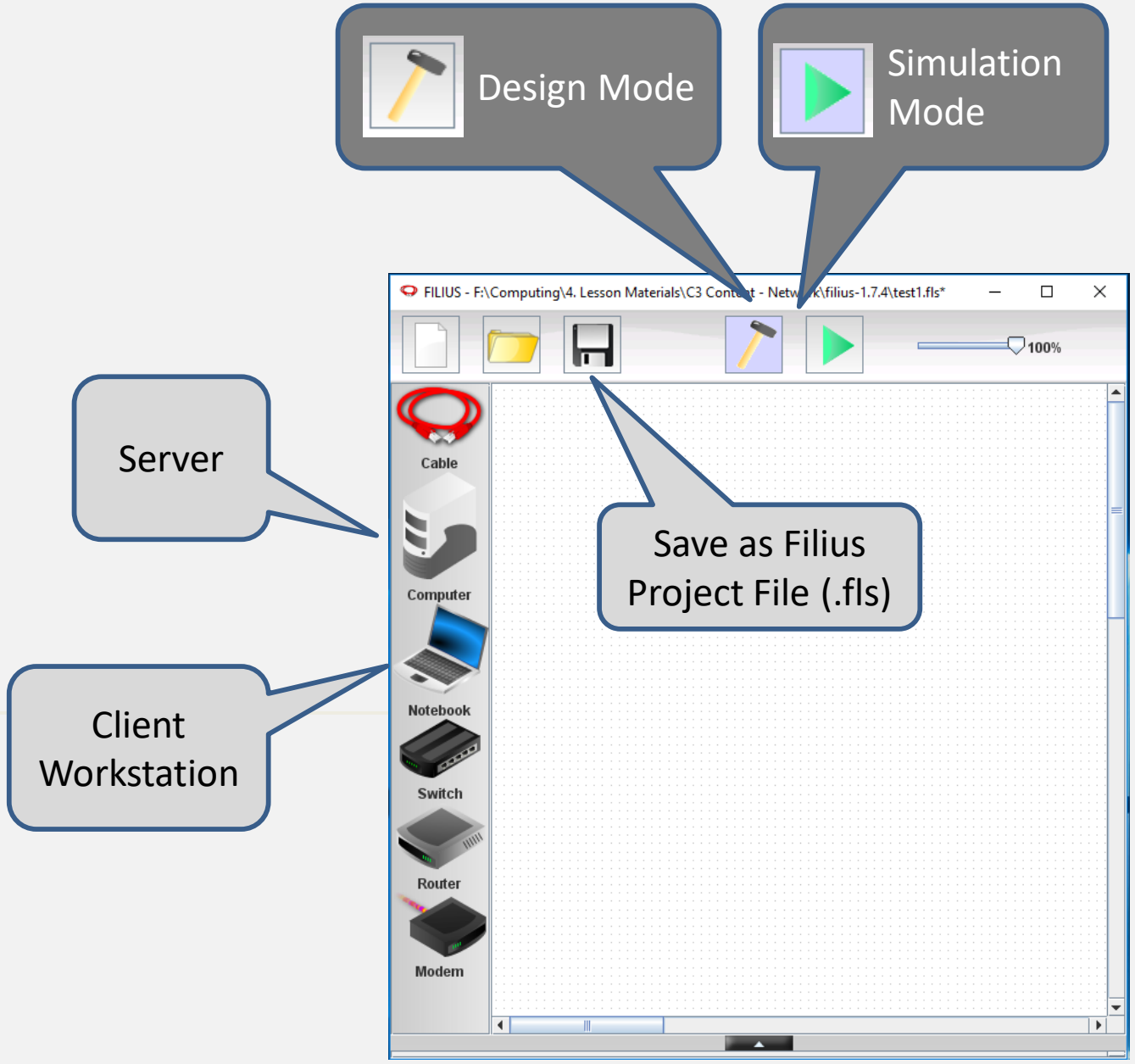
Introduction to Filius

FILIUS was developed by the University Siegen, Germany, for enhancing the teaching of computer networks.

Launch of the program either by **filius.exe** or **filius.jar** and select the language used.

Drag-and-drop the components to workspace. Esc to deselect.

Delete to remove. *Double-click* (or *Right-click*) to configure the component.

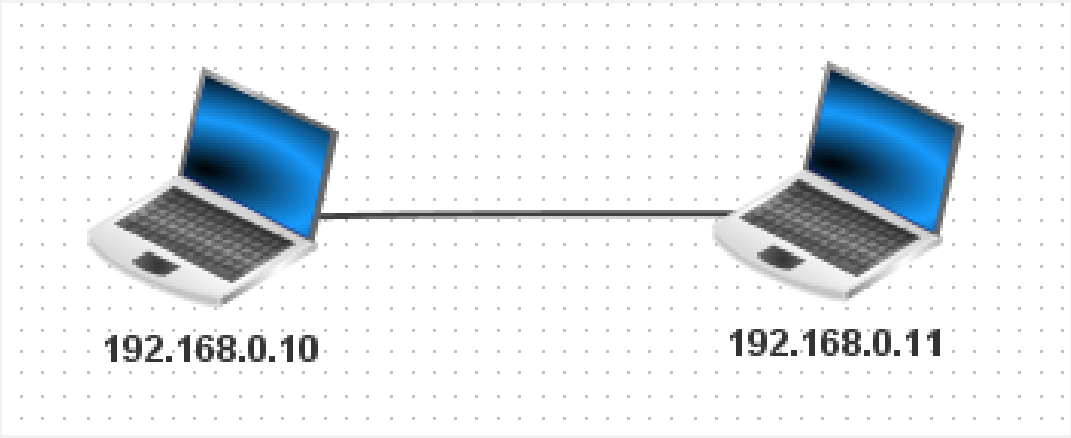


Hands-on 1:

Construct a Peer-to-Peer Network

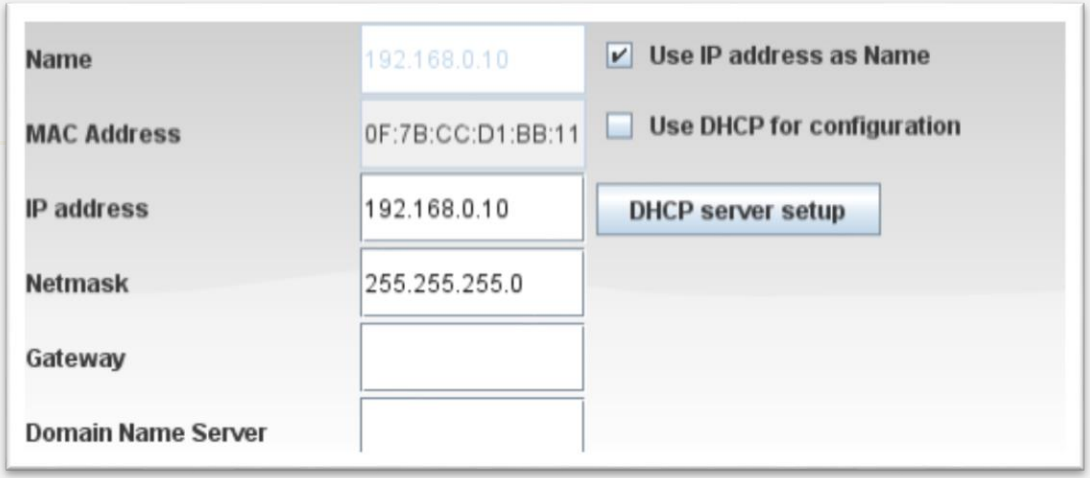
Construct a Peer-to-Peer Network

Create a simple network with two linked Notebook.



Configure the IP addresses of the Notebooks to 192.168.0.10 and 192.168.0.11.

Using the subnet mask 255.255.255.0 ensures that both computers are part of the same network.

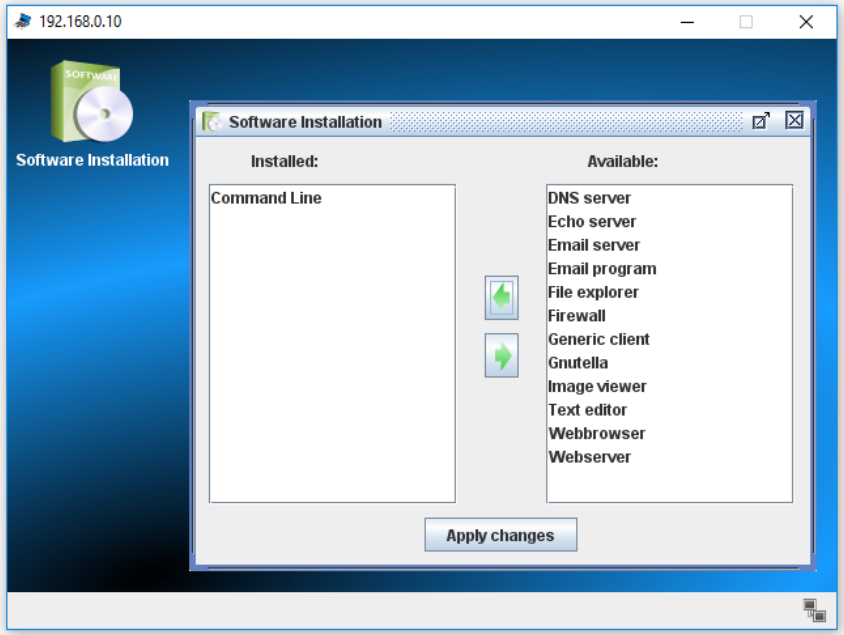


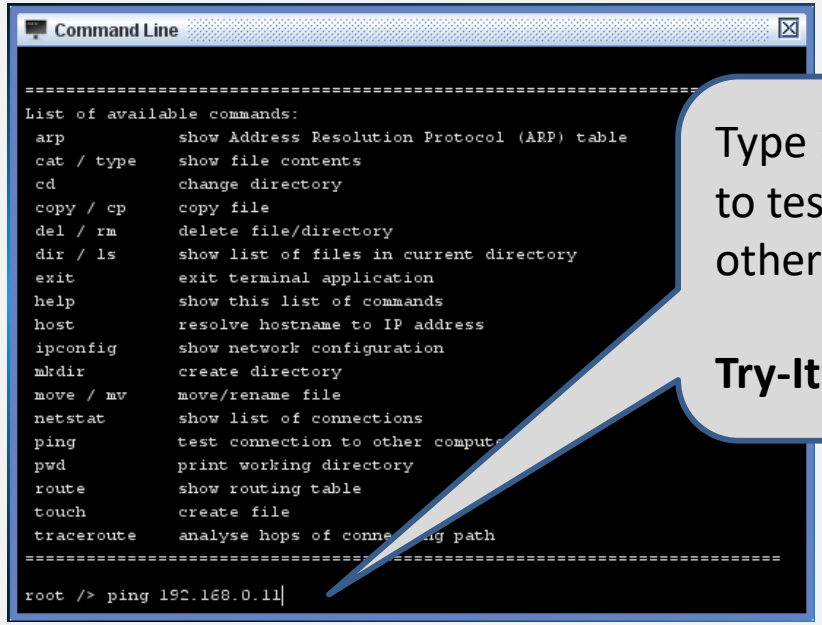
A crossover cable is used.
https://community.fs.com/blog/patch-cable-vs-crossover-cable.html

Construct a Peer-to-Peer Network

[Simulation Mode ]

Click and select the Notebook with IP address 192.168.0.10 to install the Command Line on this Notebook.





Type `Ping 192.168.0.11` to test the connection with the other Notebook.

Try-It : `ipconfig`

```
root /> ping 192.168.0.11
PING 192.168.0.11 (192.168.0.11)
From 192.168.0.11 (192.168.0.11): icmp_seq=1 ttl=64 time=217ms
From 192.168.0.11 (192.168.0.11): icmp_seq=2 ttl=64 time=102ms
From 192.168.0.11 (192.168.0.11): icmp_seq=3 ttl=64 time=104ms
From 192.168.0.11 (192.168.0.11): icmp_seq=4 ttl=64 time=103ms
--- 192.168.0.11 packet statistics ---
4 packet(s) transmitted, 4 packet(s) received, 0% packet loss
```

Success!
All 4 **packets** are transmitted and received.

What is a **packet**?
https://computer.howstuffworks.com/question525.htm

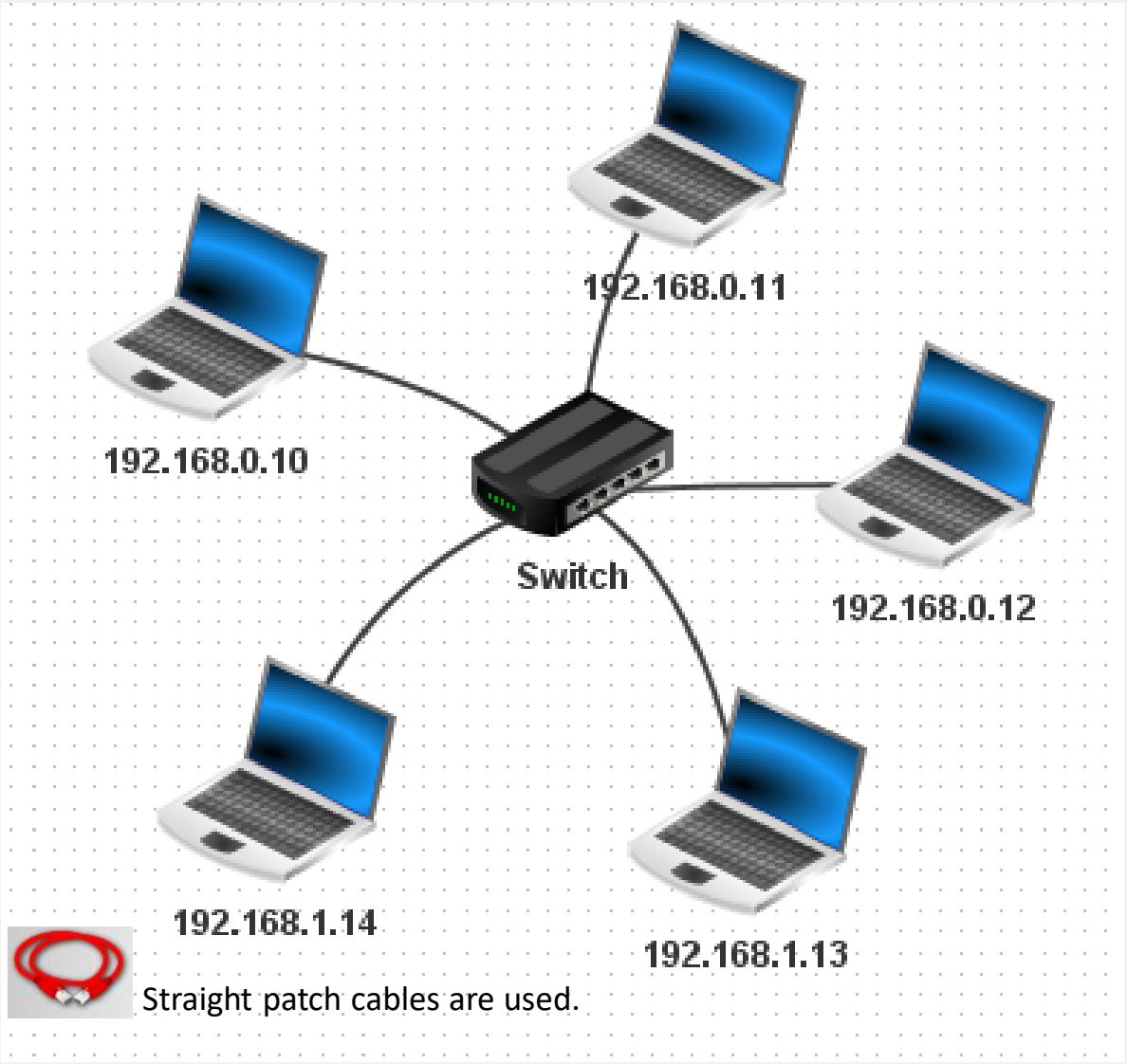
Try-It : *Using a switch for Peer-to-Peer Network*

Use a switch to connect some Notebooks together.

Check the connections using `ping` in the Command Line.

Note that 192.168.1.13 and 192.168.1.14 are located on a separate network.

Try to `ping` *each other from different notebooks.*



Secret of Subnet Mask
https://www.youtube.com/watch?v=yLeuGOOrUvo

Peer-to-Peer Network

Advantages	Disadvantages
No need for a network operating system	Because each computer might be being accessed by others it can slow down the performance for the user
Does not need an expensive server because individual workstations are used to access the files	Files and folders cannot be centrally backed up
No need for specialist staff such as network technicians because each user sets their own permissions as to which files they are willing to share.	Files and resources are not centrally organised into a specific 'shared area'. They are stored on individual computers and might be difficult to locate if the computer's owner doesn't have a logical filing system.
Much easier to set up than a client-server network - does not need specialist knowledge	Ensuring that viruses are not introduced to the network is the responsibility of each individual user
If one computer fails it will not disrupt any other part of the network. It just means that those files aren't available to other users at that time.	There is little or no security besides the permissions. Users often don't need to log onto their workstations.

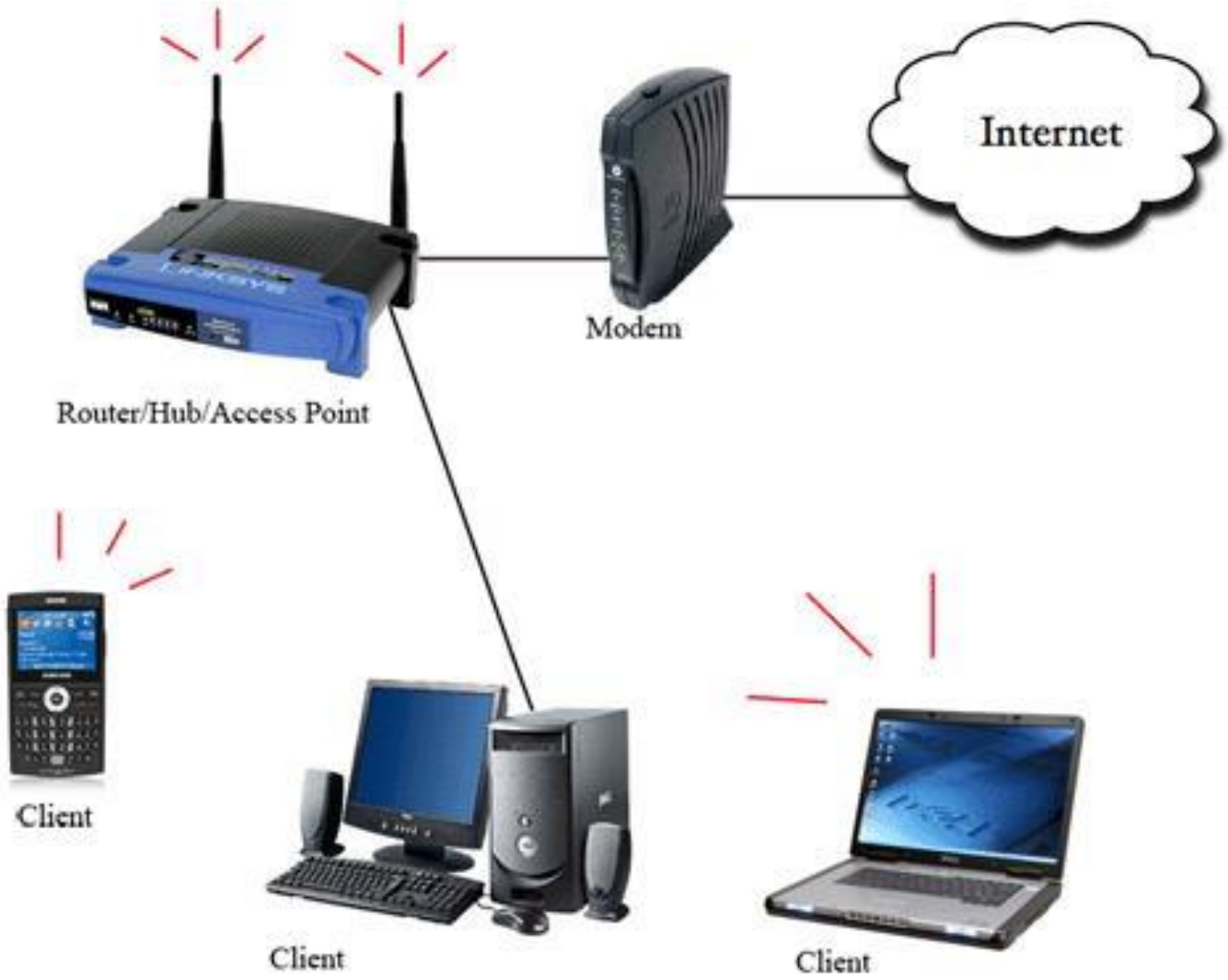
https://www.teach-ict.com/gcse_new/networks/peer_peer/miniweb/pg5.htm

Part 1 : Network Infrastructure

Network Types

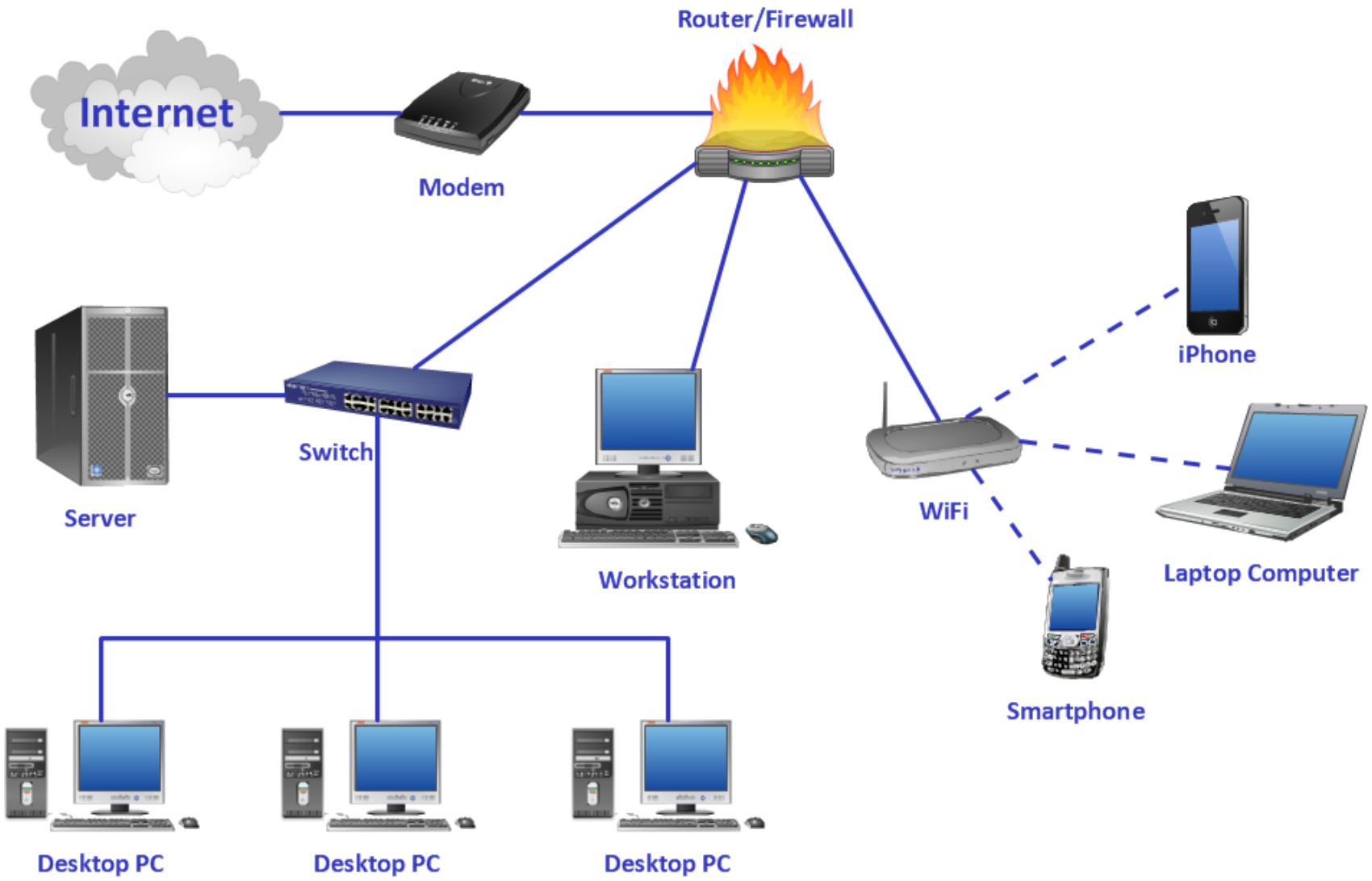
Networking

- Simplest: Peer-to-Peer Network
- Most familiar: Personal Area Network (PAN or Home Network)



Local Area Network (LAN)

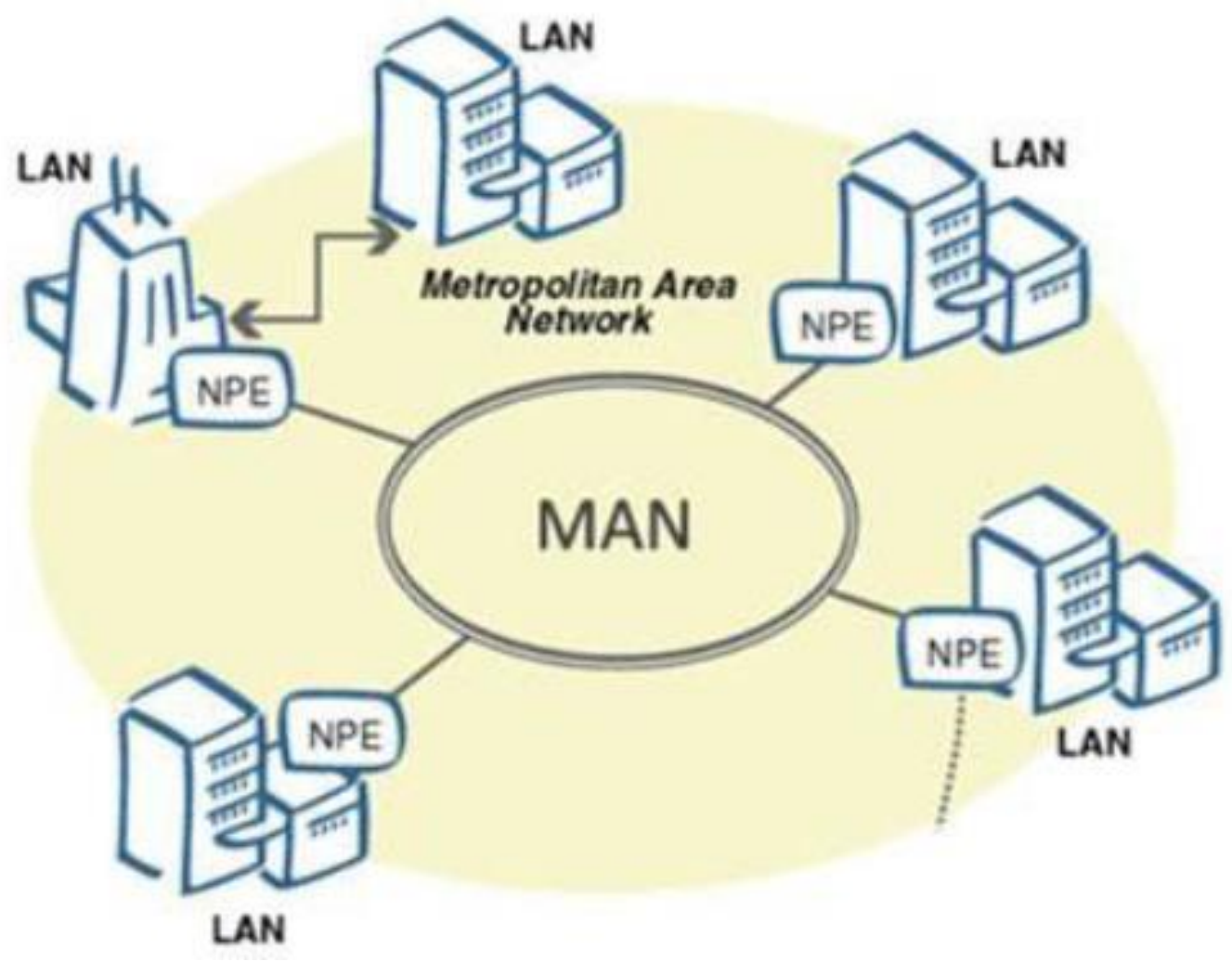
A local area network (LAN) need include equipment for internet access.



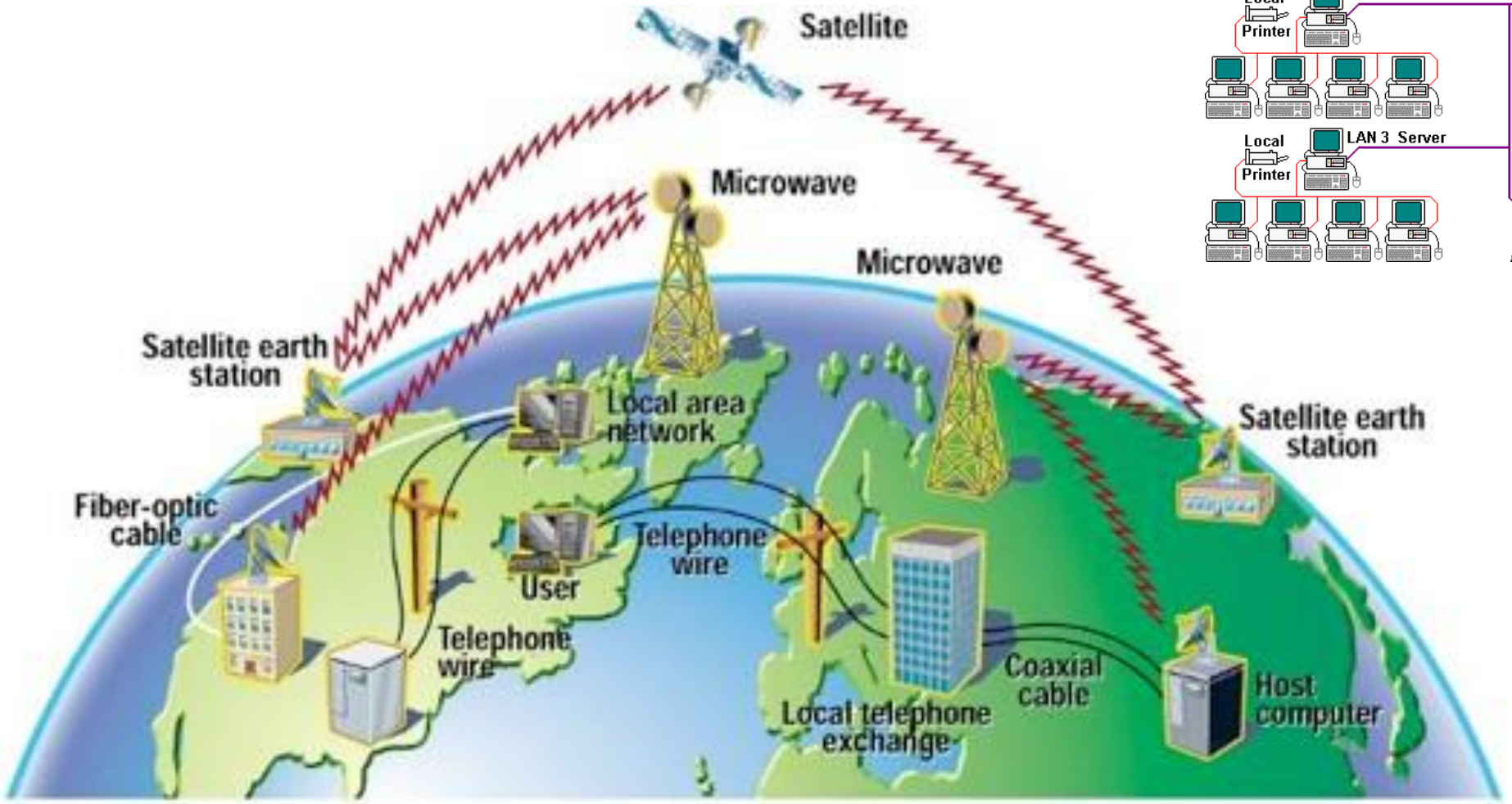
Metropolitan Area Network (MAN)

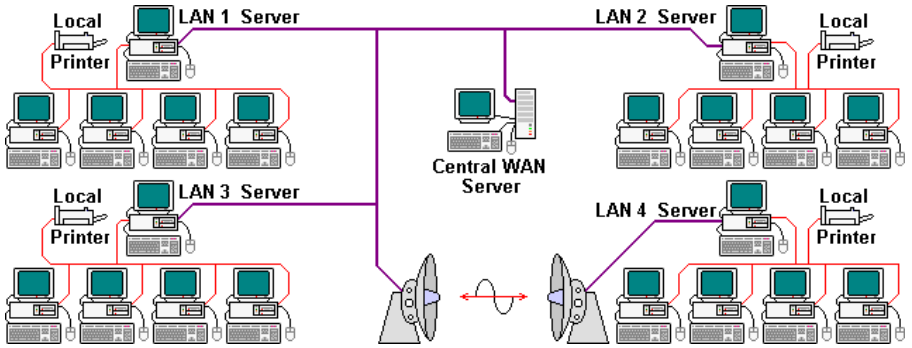
Metropolitan Area Network (MAN) covers a geographical area larger than LAN but smaller than WAN.

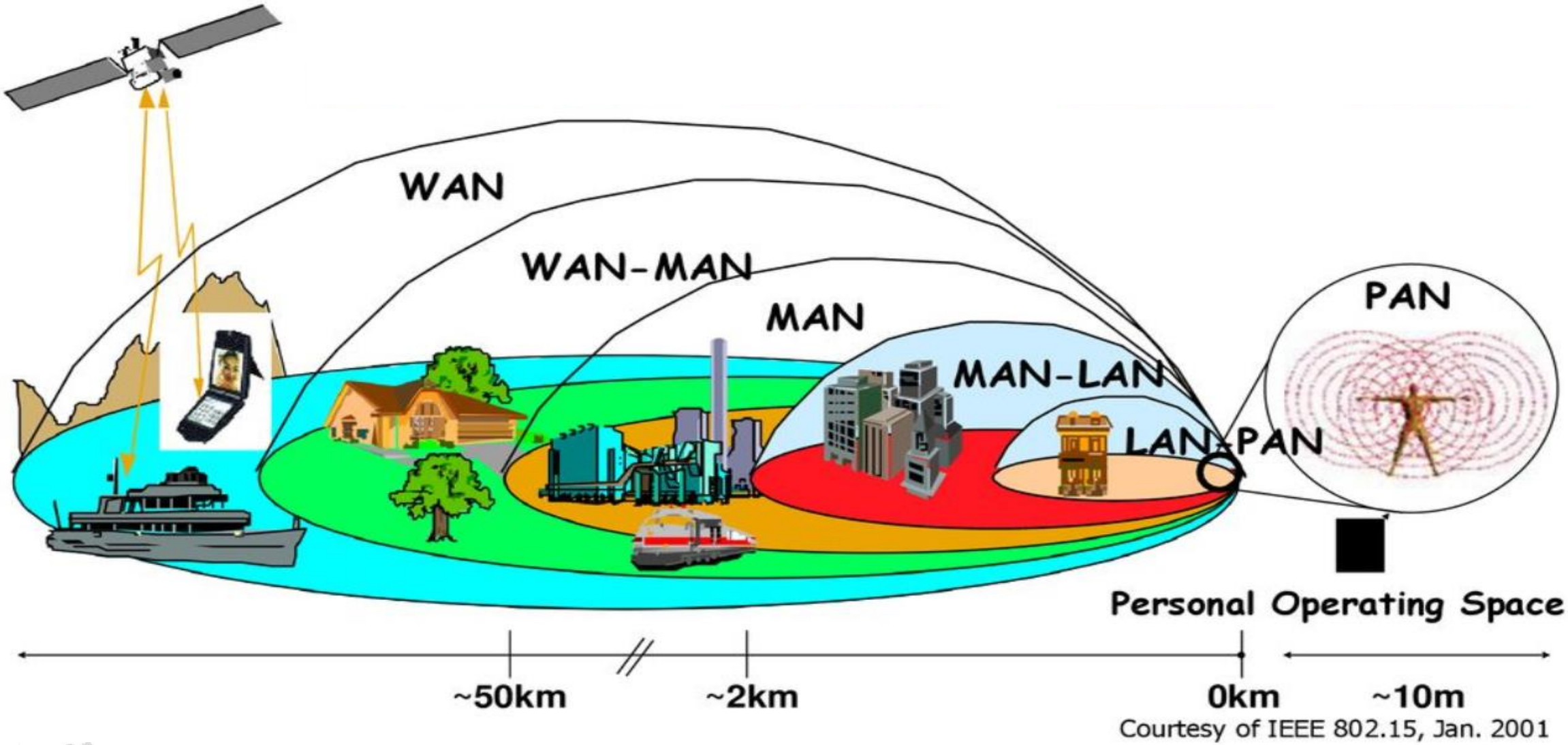
It can be considered as a network of of LANs.

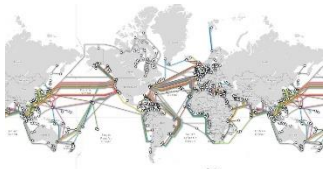


Wide Area Network (WAN)









Undersea Cables
https://youtu.be/IlAJJI-qG2k

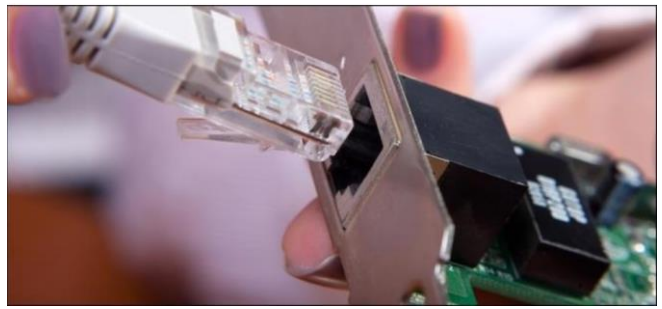
Network Types
https://youtu.be/4_zSIXb7tLQ

Part 1 : Network Infrastructure

Network Device 1 : A Switch

Network Switch and MAC Address

- A switch is a layer 2 network device that connects and allows a group of devices to communicate using their unique Media Access Control (MAC) addresses of their Network Interface Card (NIC).
- 48 bits hexadecimal = 2^{48} = approx. 2.8×10^{14} unique MAC addresses
- The switch maintains a table of the MAC addresses of the devices connected to the its ports.

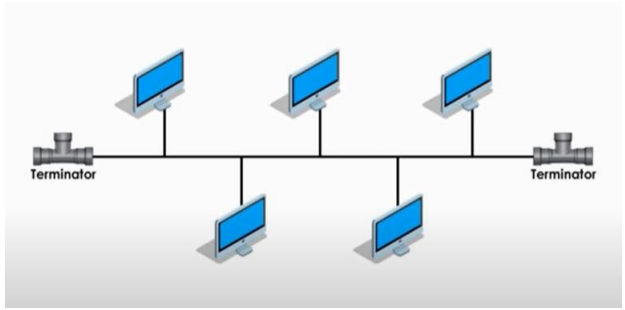


MAC: 00-16-EA-06-6C-3E

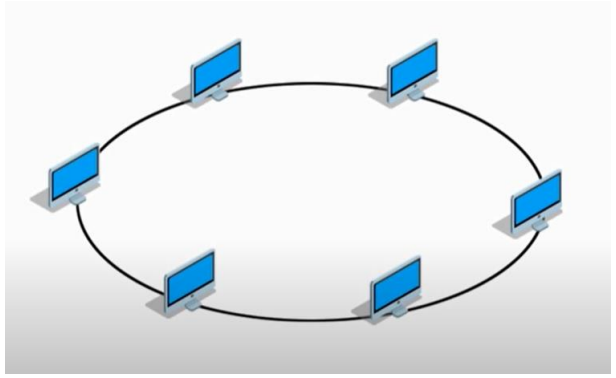
- 4/8/16/24/48 ports
- Ethernet/Fiber

What is MAC address?
https://youtu.be/UrG7RTWIJak

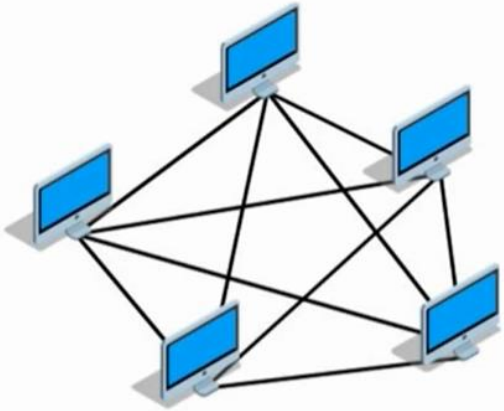
Topology: How to connect a group of devices?



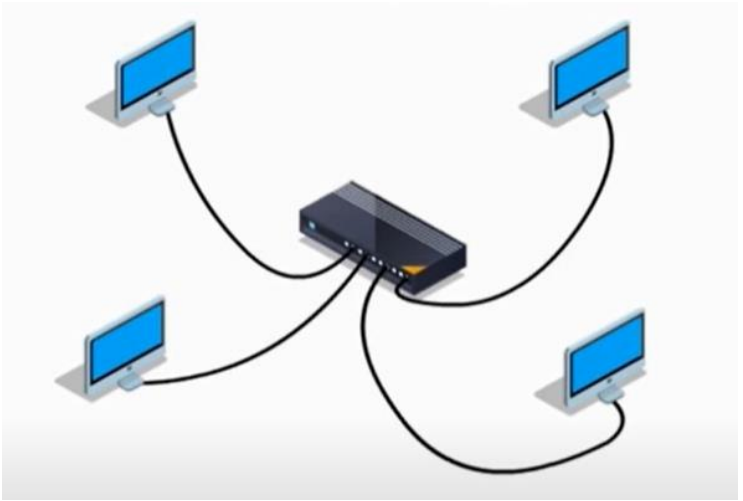
Bus Topology



Ring Topology



Meshed Topology



The **star topology** is most commonly used in a LAN where each node's NIC is connected directly to a network switch.

7 LAN Topologies
https://youtu.be/T5xQJk-Aamk

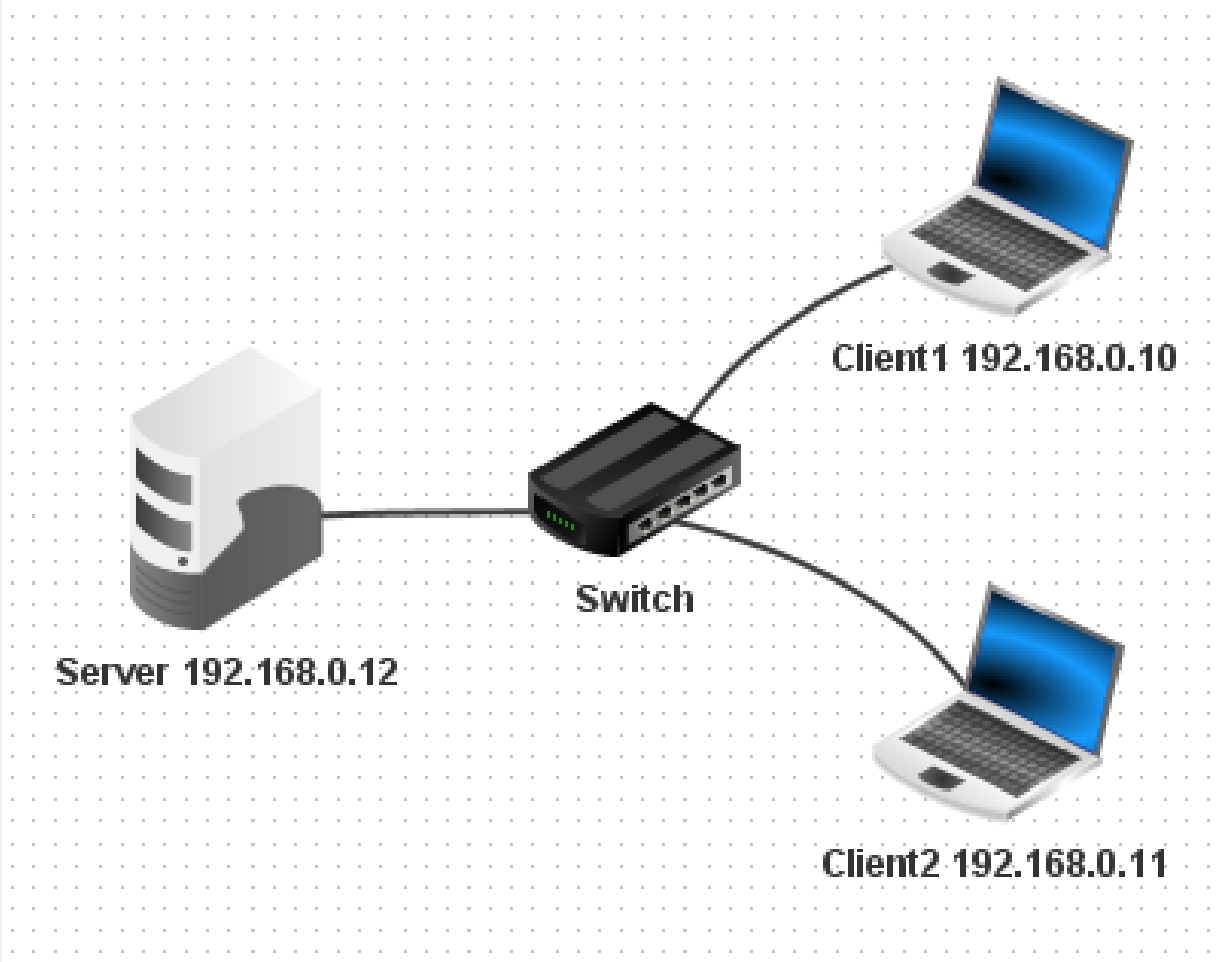
Hands-on 2:

Construct a Local Area Network (LAN)

Construct a Server-Clients Network

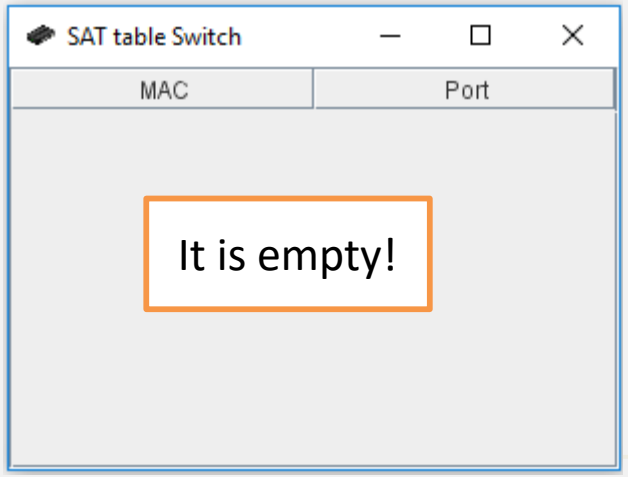
Connect a Server to two client Notebooks using a network switch.

Configure the IP address of the Server as 192.168.0.12 and using the same subnet mask 255.255.255.0



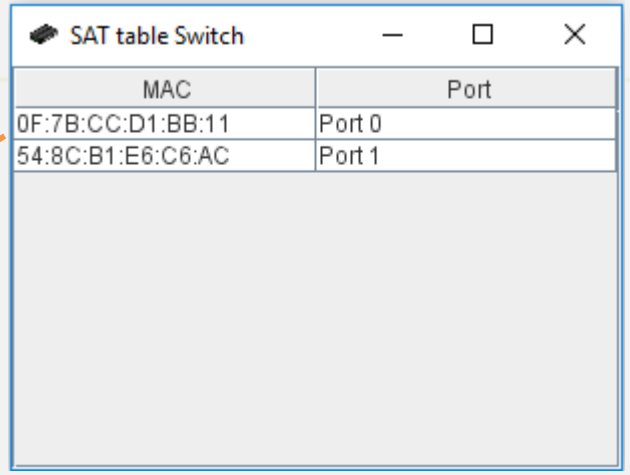
Source Address Table (SAT) of the Network Switch

1. Click on the switch to check the SAT table.



2. Using the Command Line in Client1 and type `Ping 192.168.0.11` to test the connection with Client2.

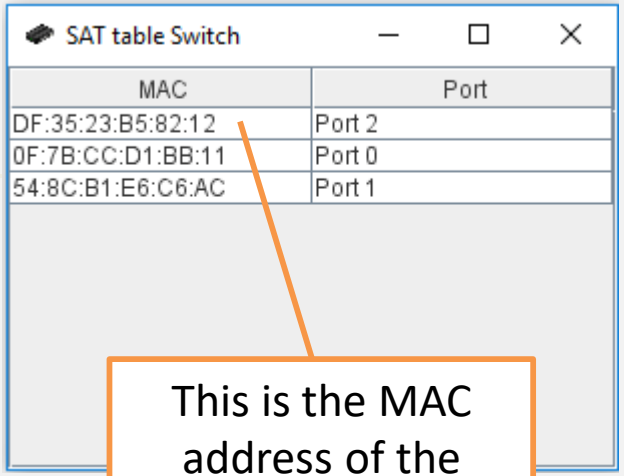
Click on the switch to check the SAT table.



These are the MAC addresses of Client1 and Client2.

3. Test the connection with the Server by typing `Ping 192.168.0.12`

Click on the switch to check the SAT table.

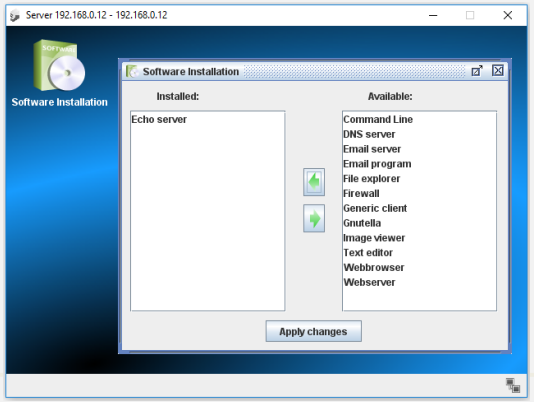


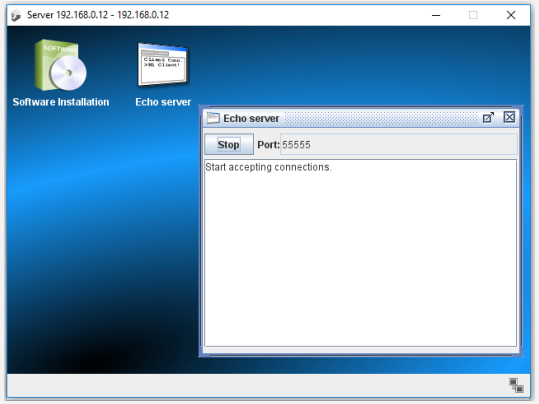
This is the MAC address of the Server.

How a switch builds Source Address Table dynamically?
https://youtu.be/DukuFSZH9Qw

Install Echo Server and Generic Client for Messaging

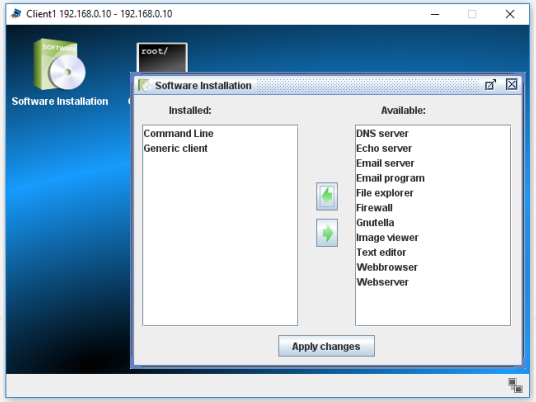
1. Click on the Server to install and Start the **Echo Server** using port `55555`.

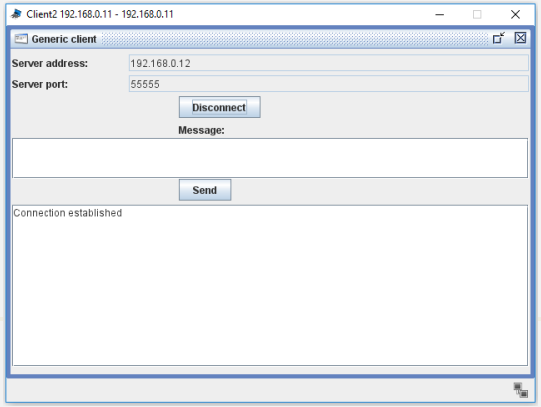




2. Install the **Generic Client** on both the client Notebooks.

Connect to the Server at `192.168.0.12` and port `55555`.





3. Send any message to the Server and it will echo back.

Observe the **green lines** simulating the transmission over the cables.

Server-Client Network

Advantages	Disadvantages
All files are stored in a central location	A specialist network operating system is needed
Network peripherals are controlled centrally	The server is expensive to purchase
Backups and network security is controlled centrally	Specialist staff such as a network manager is needed
Users can access shared data which is centrally controlled	If any part of the network fails a lot of disruption can occur

https://www.teach-ict.com/gcse_new/networks/peer_peer/miniweb/pg3.htm

Part 1 : Network Infrastructure

Network Device 2 : A Router

Router

- A router is a layer 3 network device that routes the data from one network to another network or the Internet using the Internet Protocol (IP) addresses.
- A router is essentially the **gateway** of the network.
- The router maintains a routing table of the known **IP addresses** and the possible paths.

Enterprise Router

Hub, Switch, & Router Explained - What's the difference?
https://youtu.be/1z0ULvg_pW8

Hands-on 3:

Connecting Local Area Networks (LANs)

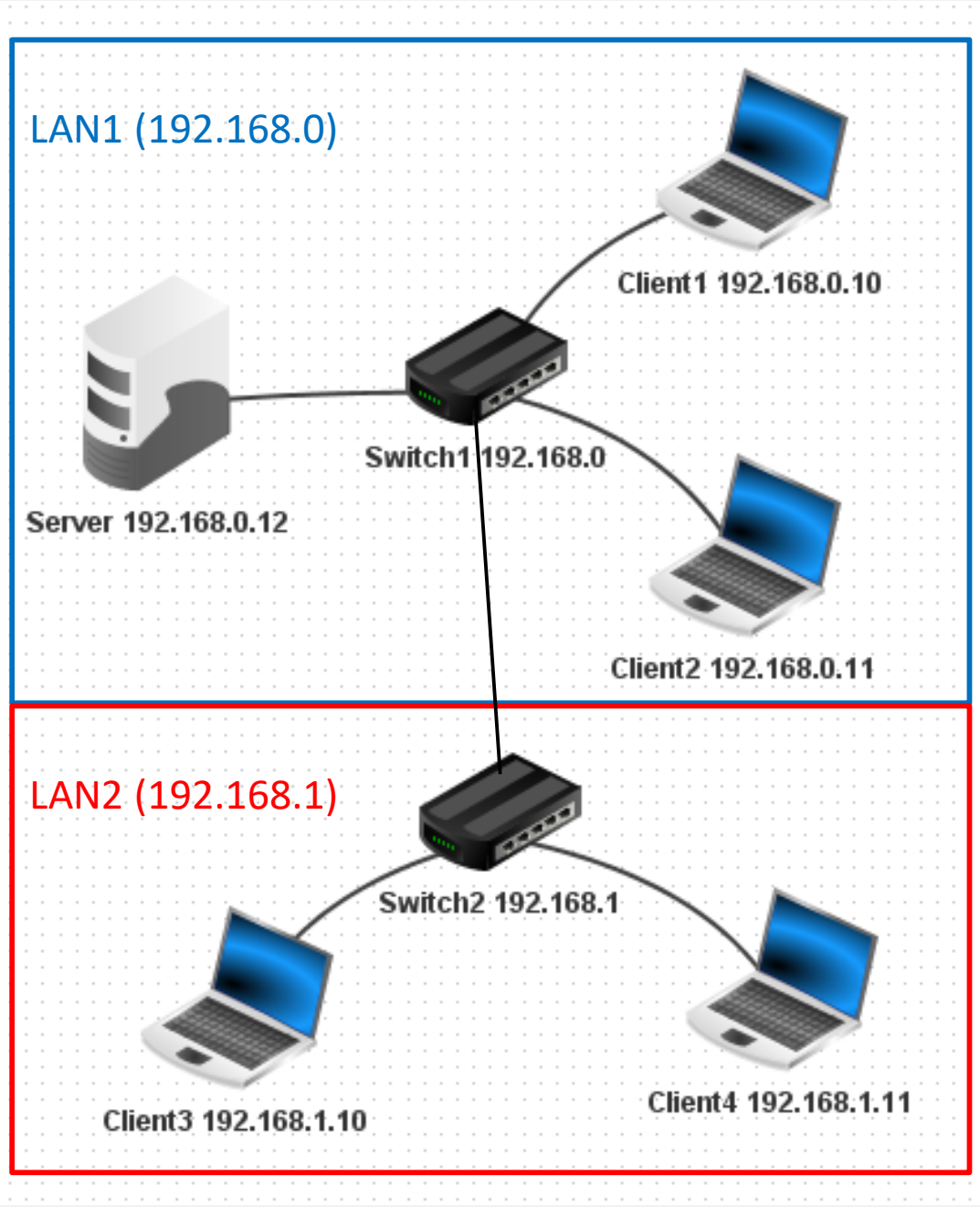
Connecting two LANs

Construct a second network LAN2 which consists of a switch and two Notebooks; configure the Network ID of LAN2 as 192.168.1

Connect the two LANs using a cable to link the switches together.

Check for connectivity by *pinging* each other from the Command Line in the Notebooks.

There is no connection !!!



Connect LANs with a Router

Use a router to connect the two switches. Configure the IP addresses of the two Network Interface Cards (NICs) in the router :

NIC1 : 192.168.0.1

NIC2 : 192.168.1.1

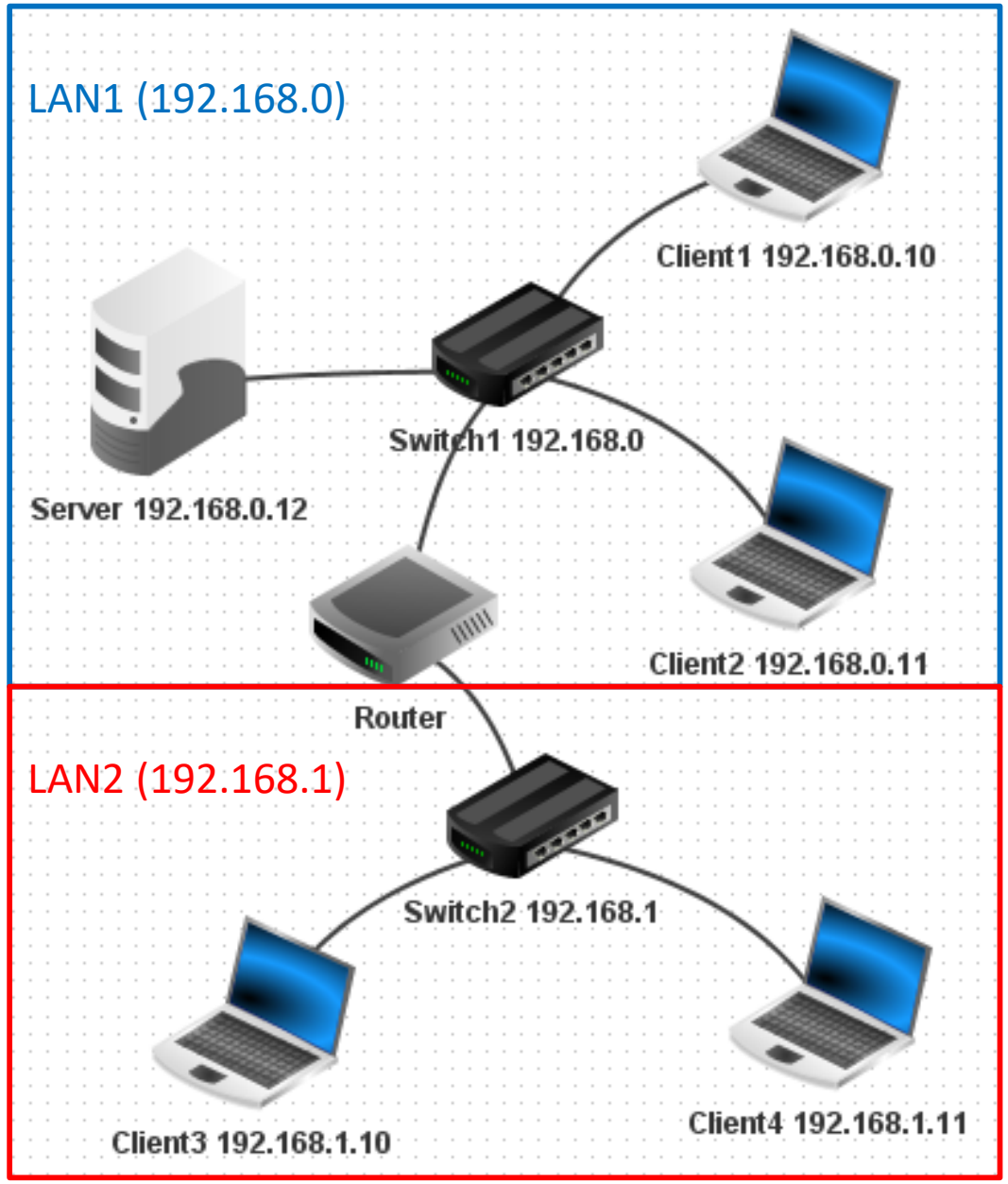
Configure the **Gateway** for all the Notebooks and Server in the LANs:

Gateway for LAN1 : 192.168.0.1

Gateway for LAN1 : 192.168.1.1

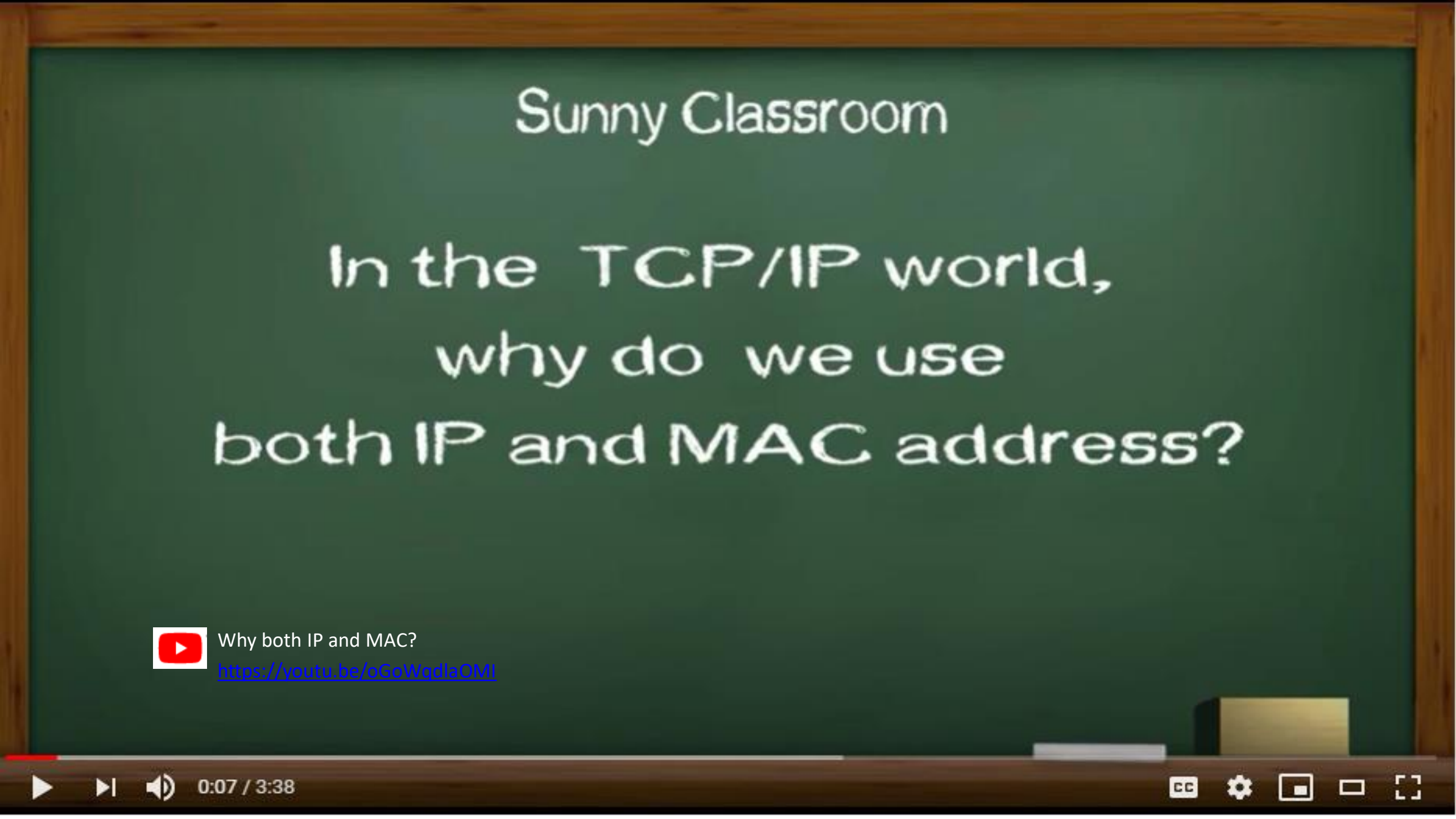
Ping for connectivity. Observe the **green lines** simulating the transmission over the cables.

There is connection !!!



Part 2 : Network Addressing

- MAC and IP Addressing



Why both IP and MAC?
https://youtu.be/oGoWqdlaOMI

Hands-on 4:

Simulating the World Wide Web (WWW)

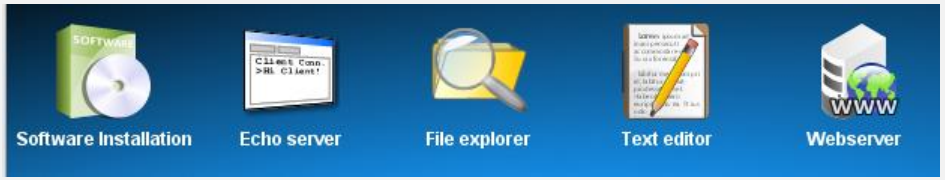
How does the internet works?
https://youtu.be/7_LPdttKXPc

The difference between the Internet and the Web
https://youtu.be/UVkT59PmRdo

Installing a Web Server

Use the network set up in **Hands-on 3** and configure the server to be a WWW Server.

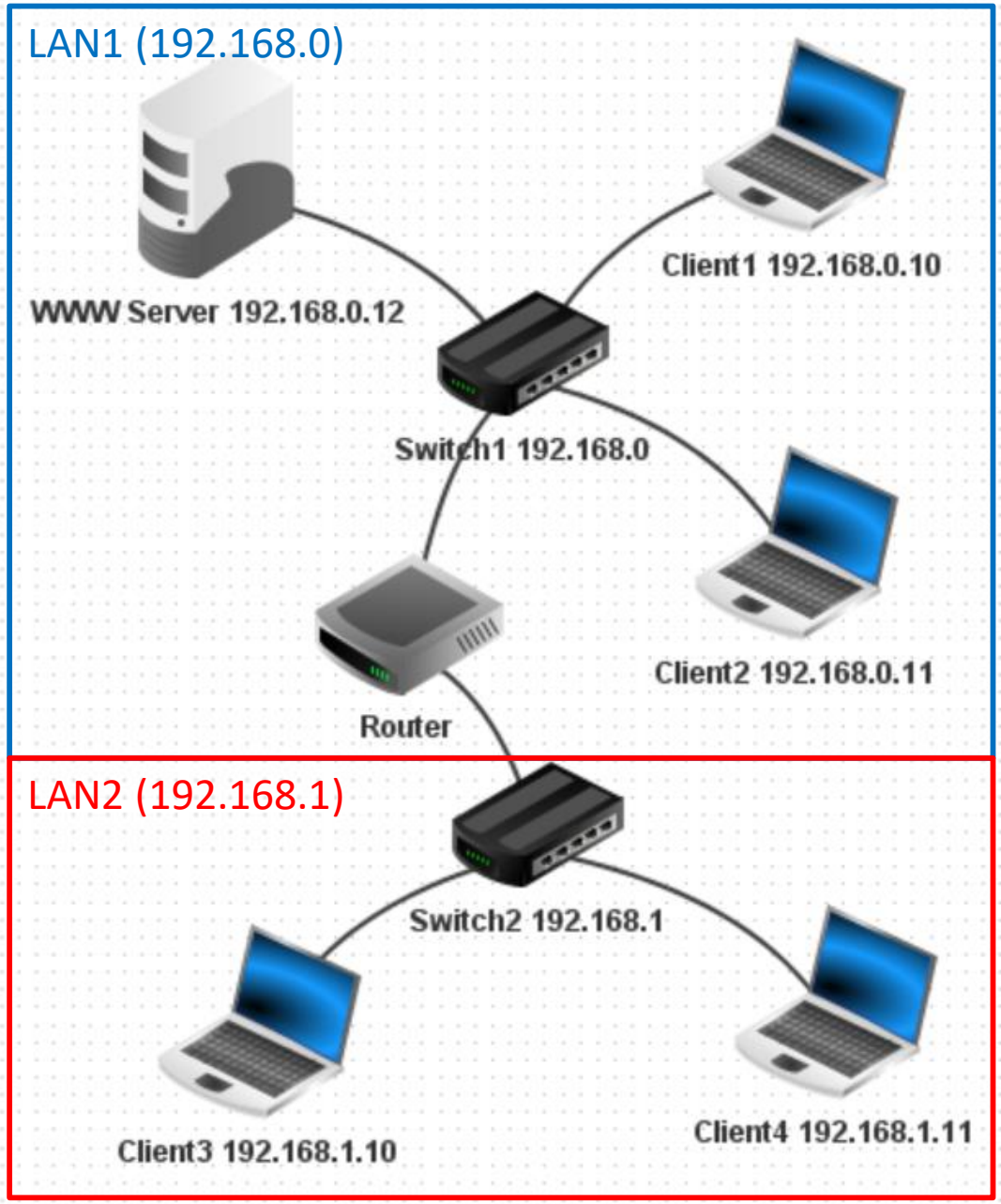
Install the **Webserver**, File explorer and the Text editor on the WWW Server.



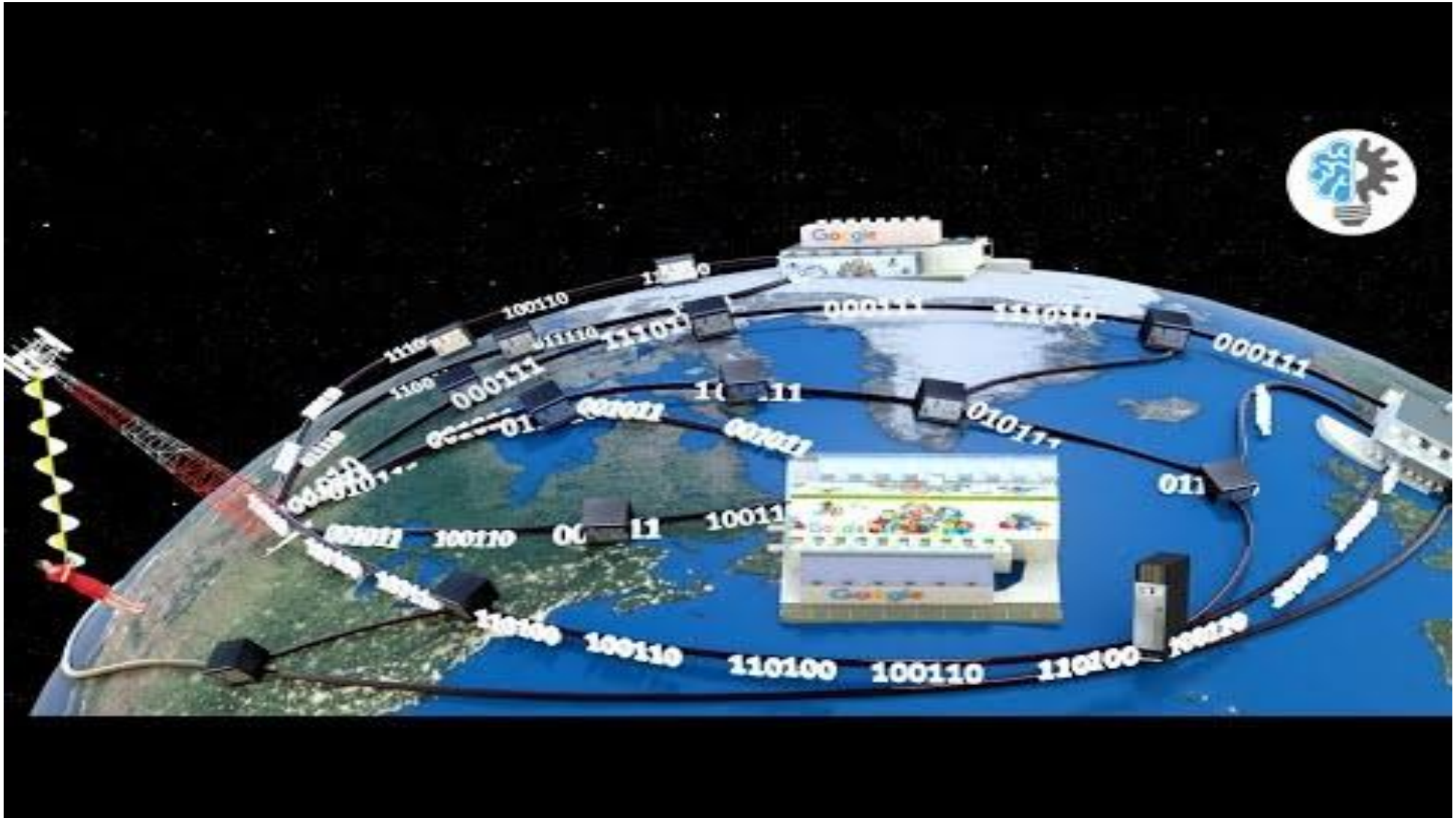
Install the **Webbrowser** on at least one of the Notebooks.

Start the **Webserver** and access the website from the Notebook's **Webbrowser** using the url:

`http://192.168.0.12`



How does the Internet works?

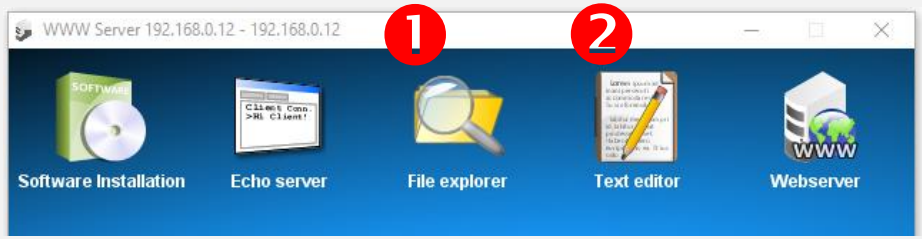


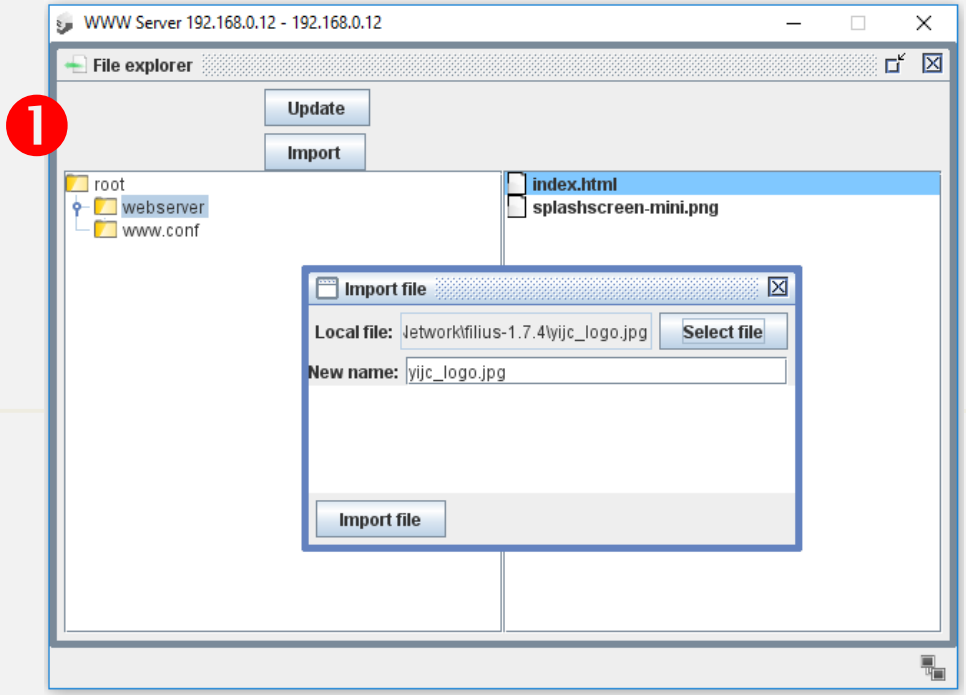
How does the Internet works? https://youtu.be/x3c1ih2NJEg

Try-It : Customise our Homepage

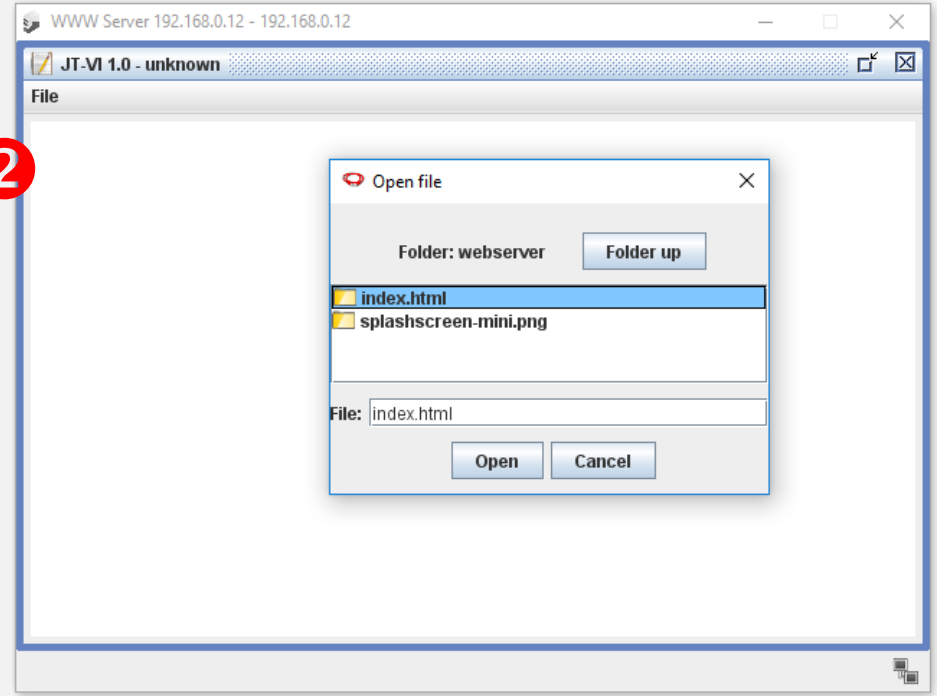
Using the Web Server in Hands-on 4

1. Upload `yijc_logo.jpg` using the **File explorer**.
2. Edit `index.html` using the **Text editor**.





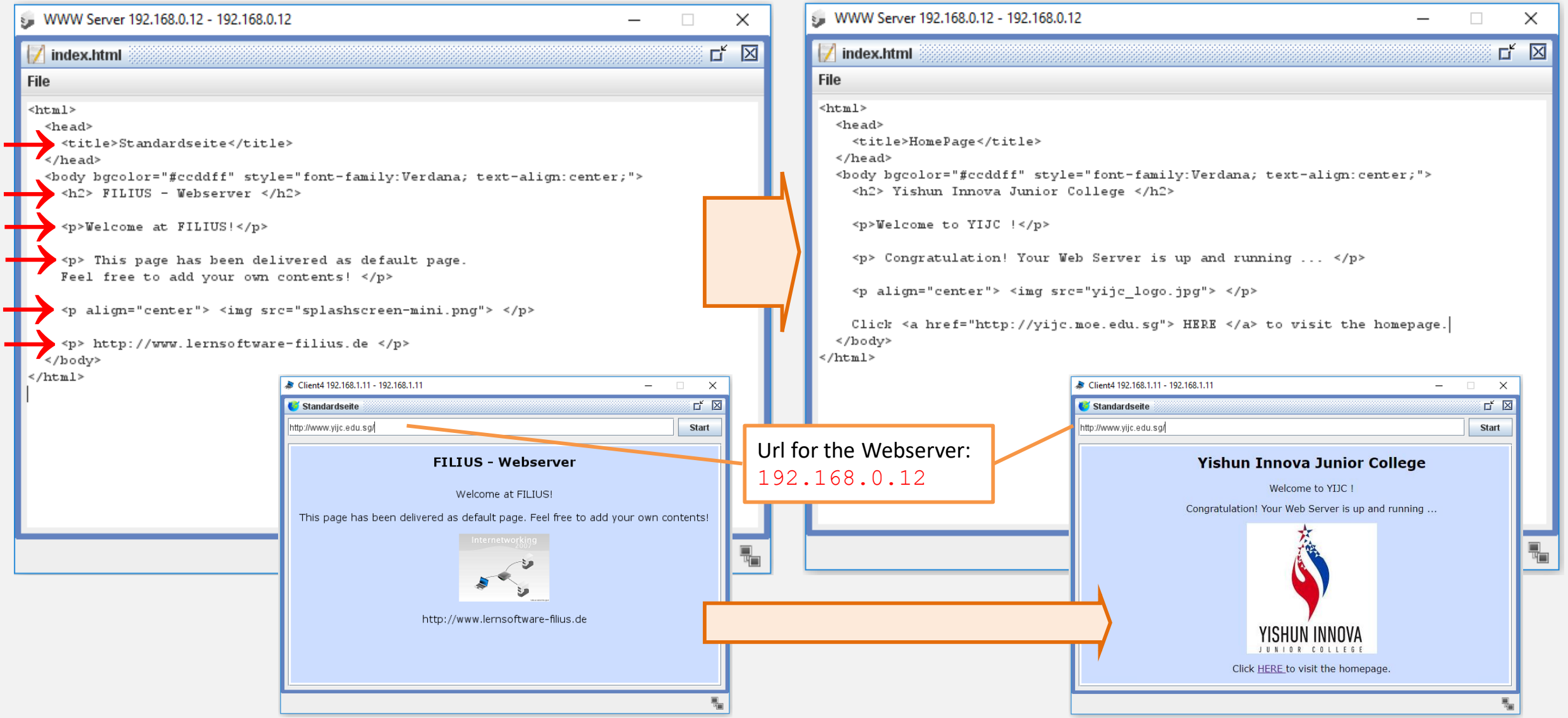
Import the `yijc_logo.jpg` file into the **webserver** folder.



Using the Text editor to open the `index.html` file within the **webserver** folder.

Modify according to the next slide.

Try-It : Simple HTML Editing

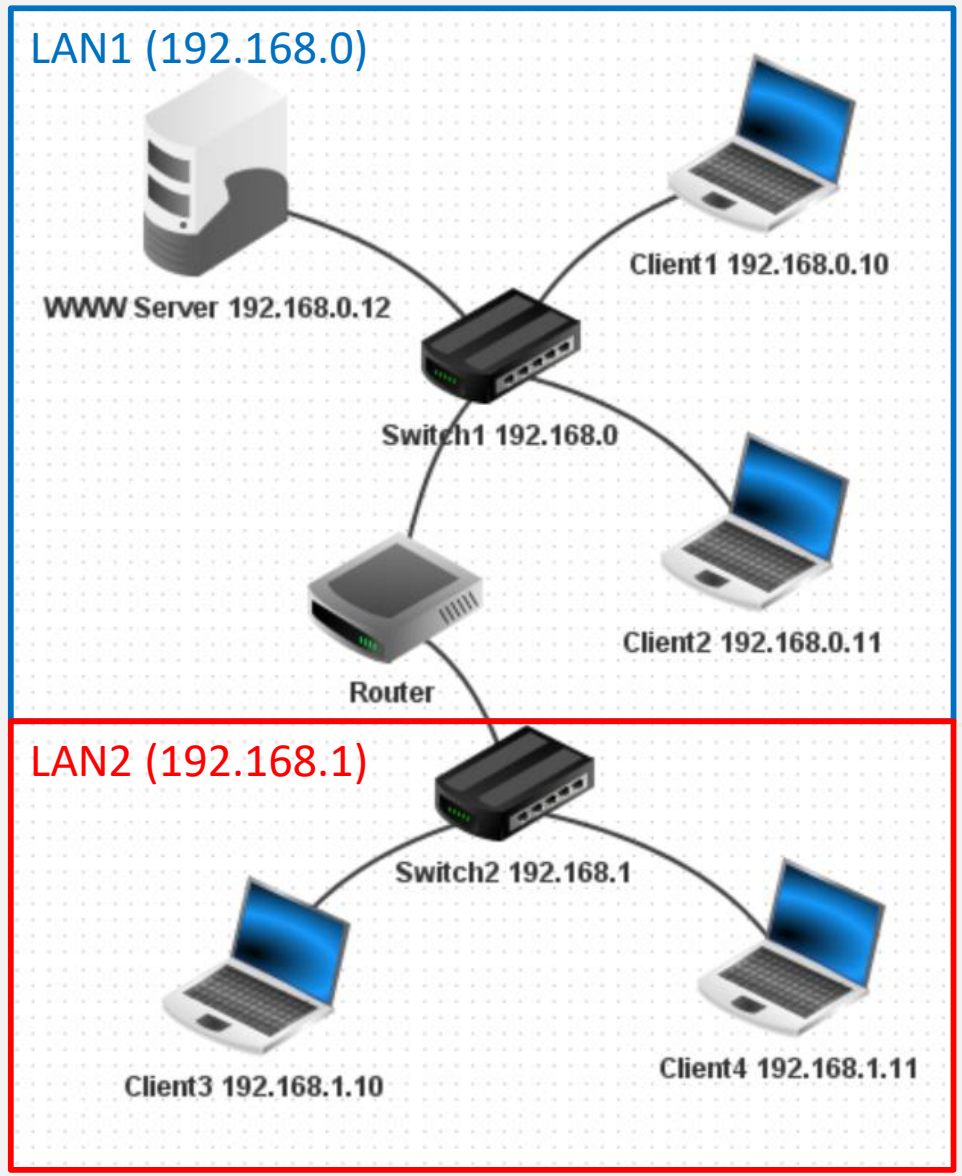


Hands-on 5:

Installing a Domain Name Server (DNS)

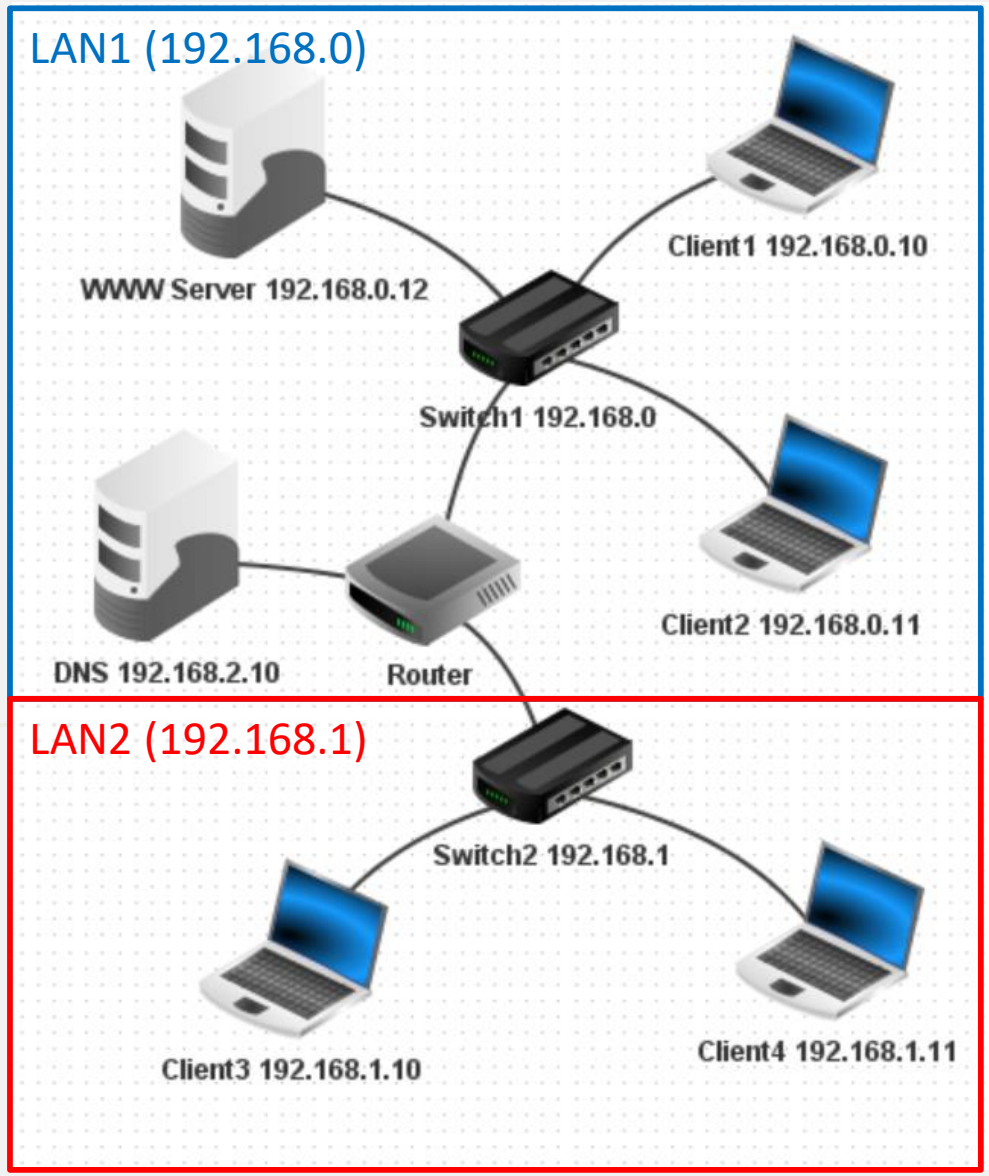
How the Domain Name Server (DNS) works?
https://youtu.be/mpQZVYPuDGU

Installing a DNS Server



Modify Hands-on 4 Network

1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

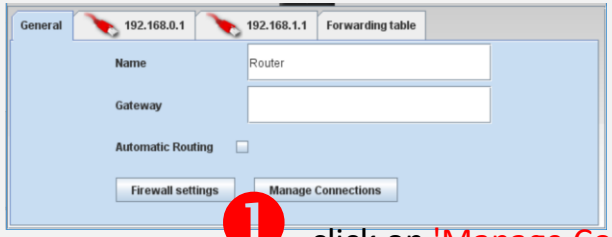


1. Add a NIC in the Router

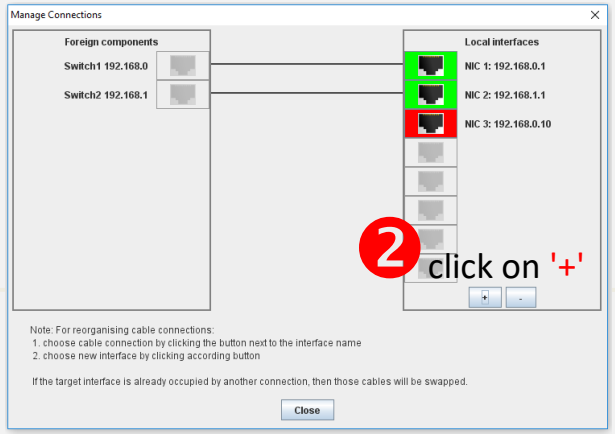
Modify Hands-on 4 Network

1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

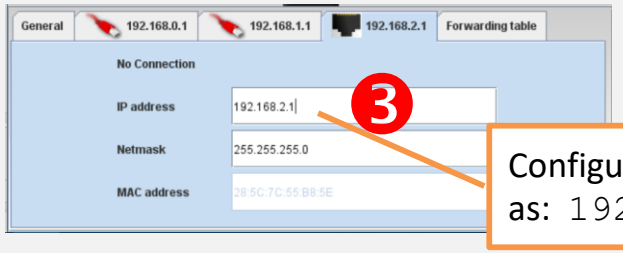
Click on the Router to add an additional NIC.



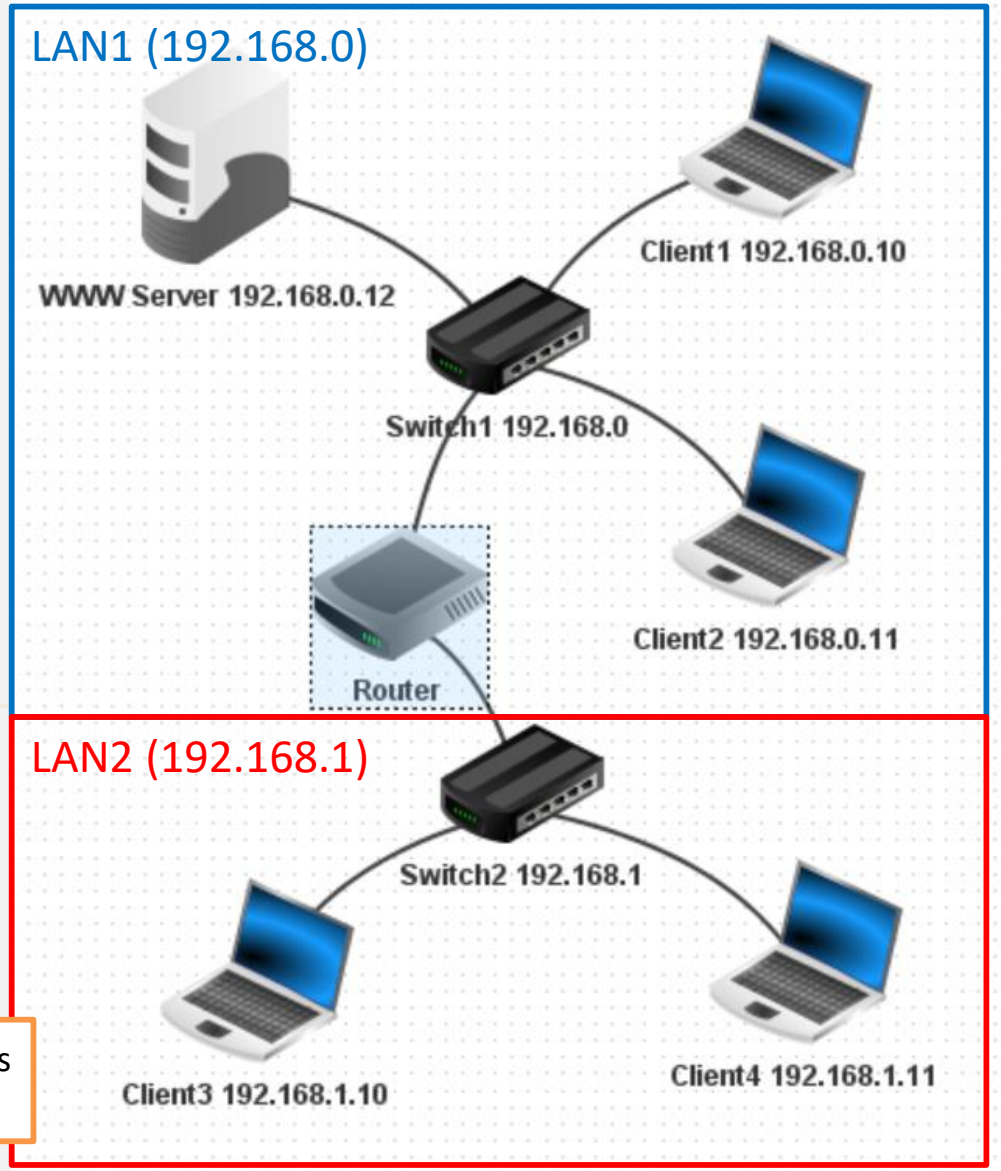
click on 'Manage Connections'



click on '+'



Configure NIC IP address as: `192.168.2.1`

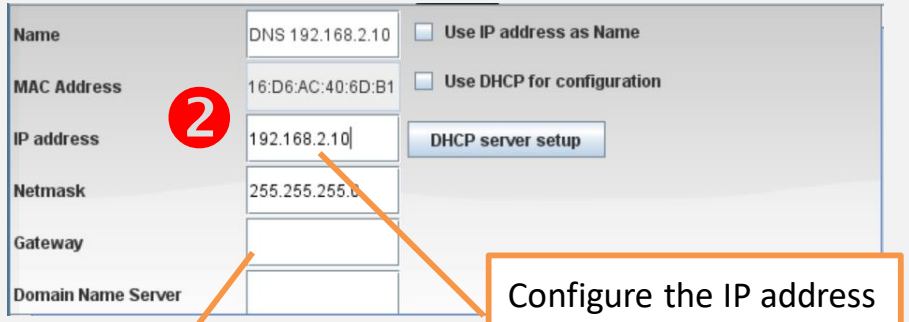


2. Add a Server

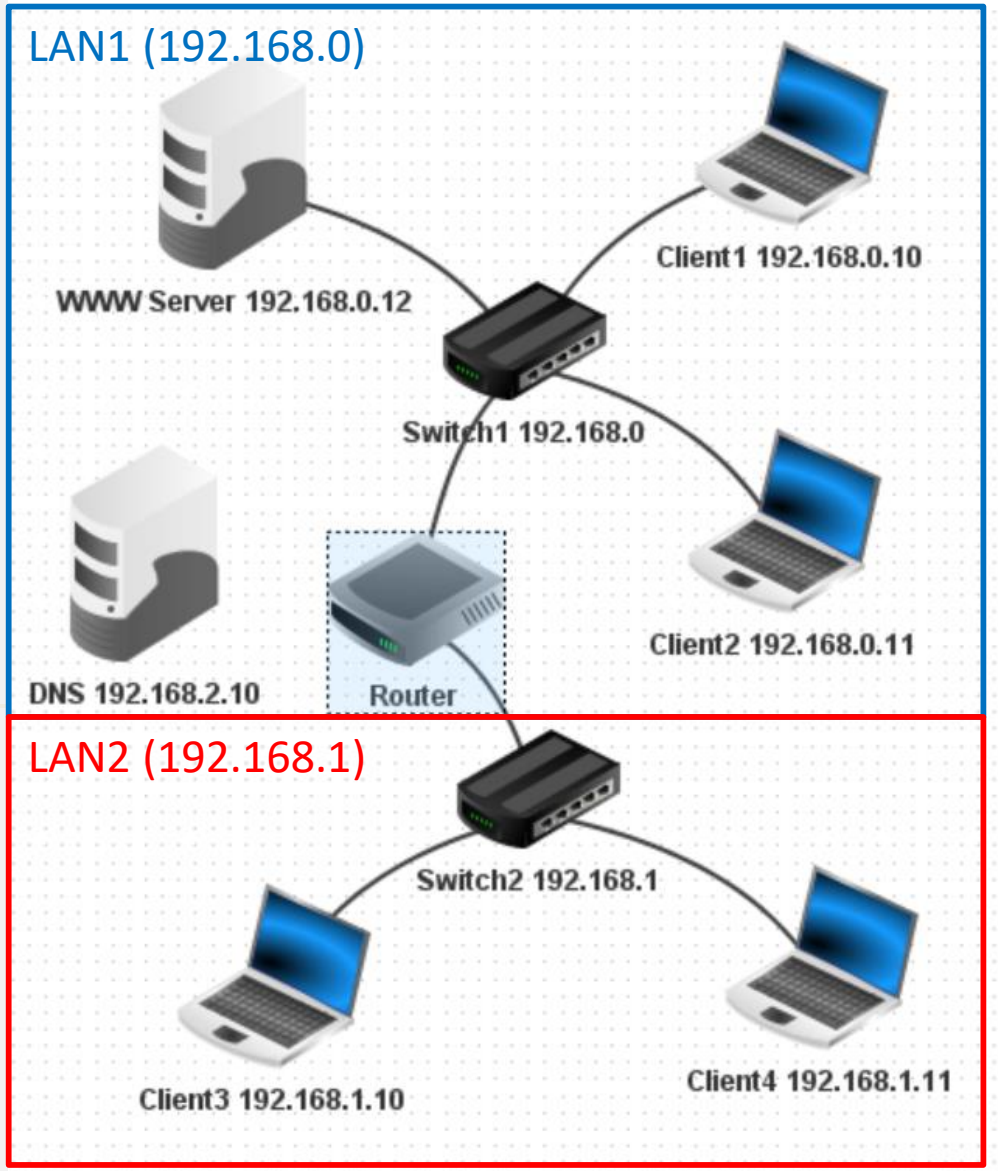
1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

❶ Drag-and-drop a Server on the Workspace. Configure the IP address of this Server as:

`192.168.2.10`



❹  Connect the Server to the Router with patch cable.



3. Setup DNS Server

1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

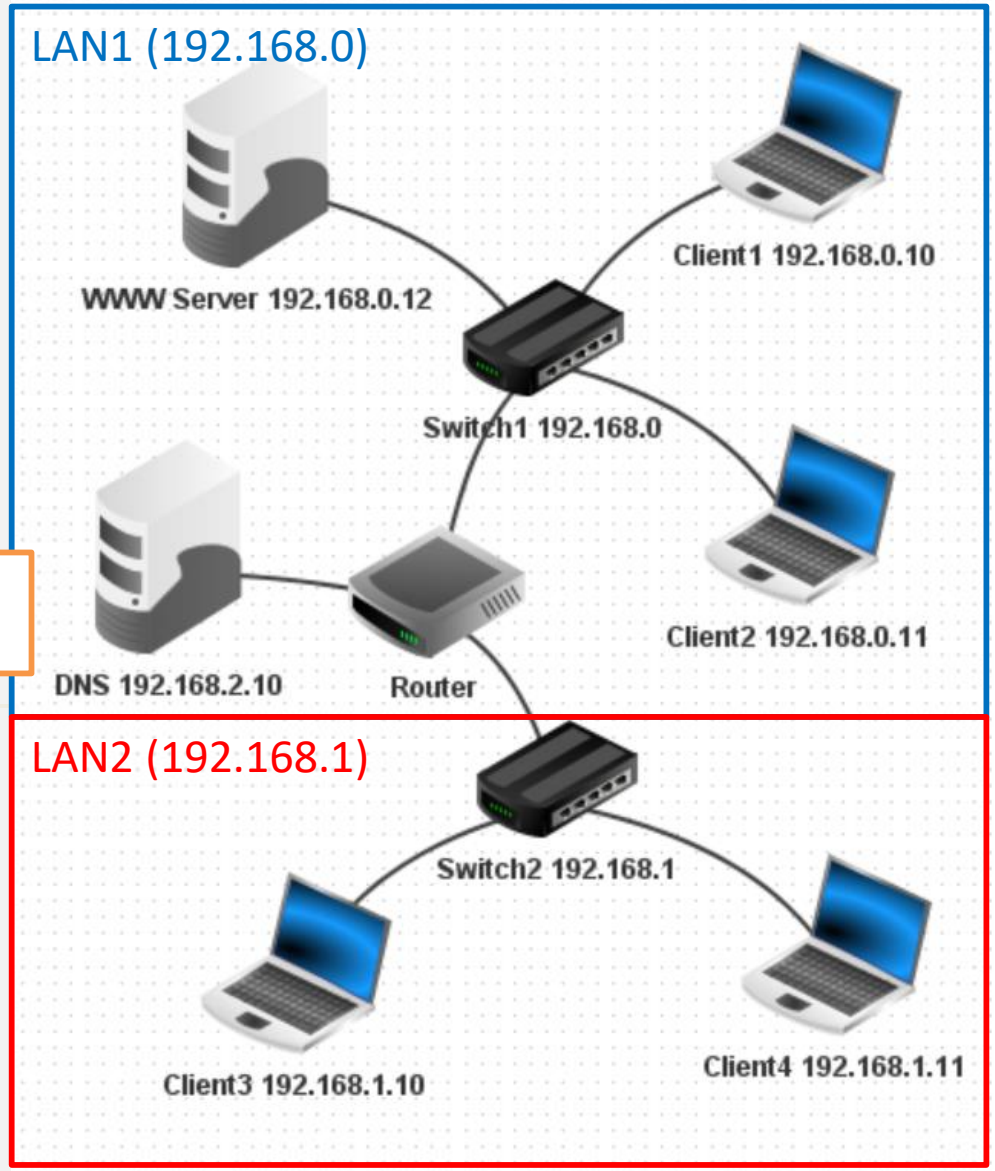
❶ In simulation mode, click on the Server to install the DNS Server program.

❷ Launch the DNS server program to add a new entry for the WWW Server:

❸ Domain name: www.yijc.edu.sg
IP address: 192.168.0.12

❹

Click Start to start the DNS Server.

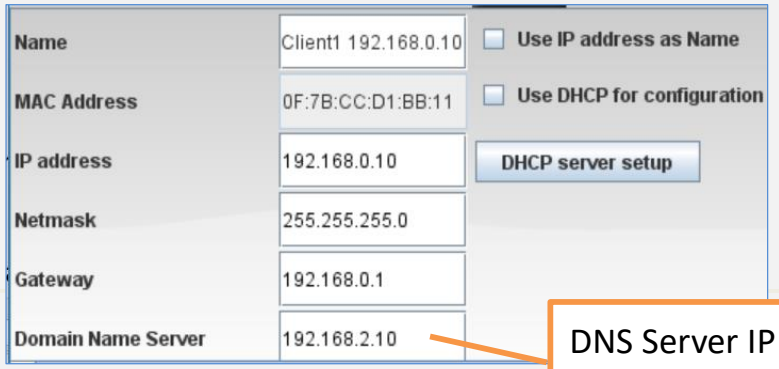


4. Configure all the Notebooks and Server

1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

❶ In development mode, click on every Notebooks and other Server to configure the Domain Name Server's IP address as:

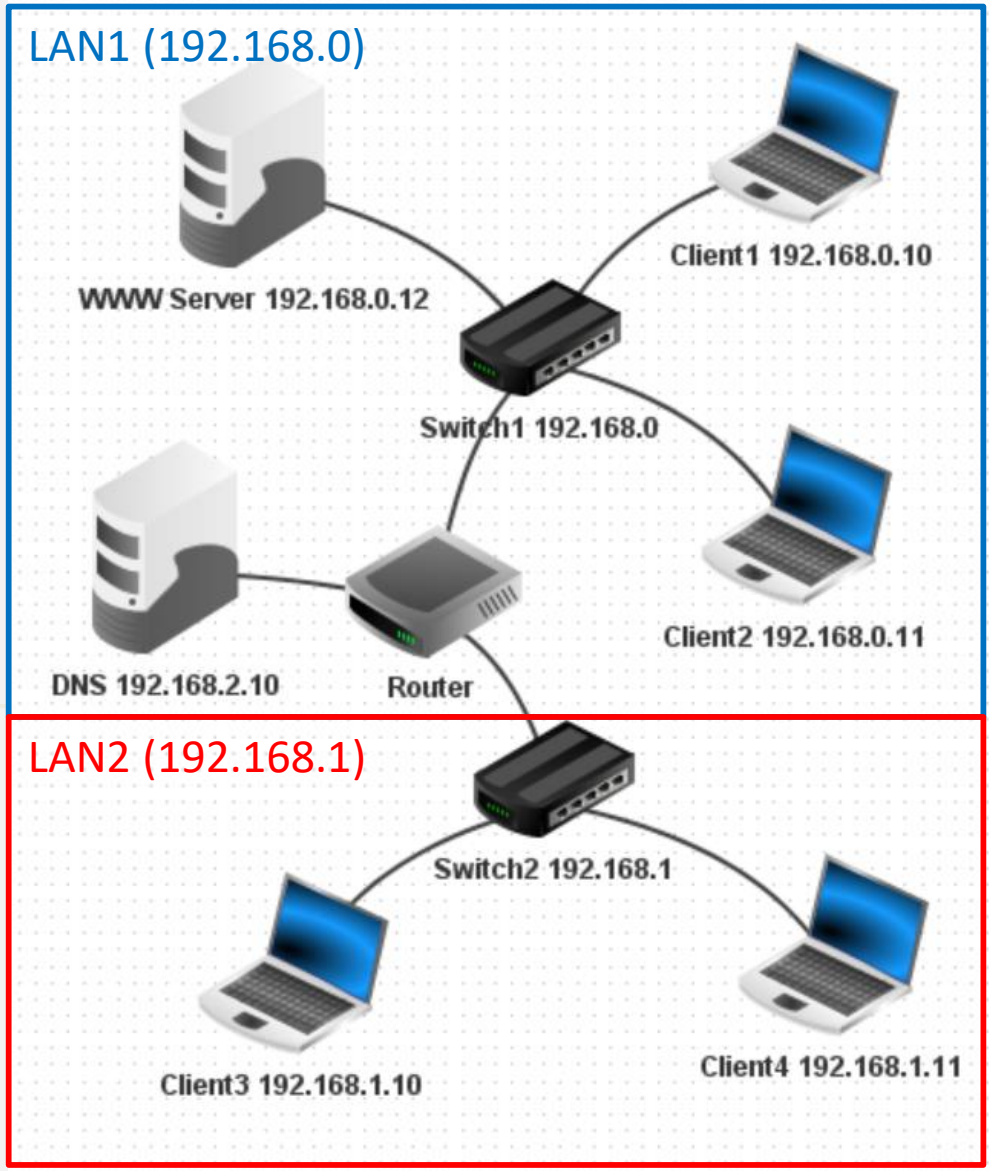
192.168.2.10



❷

DNS Server IP address: 192.168.2.10

❸ The DNS Server for the network is now ready for testing.



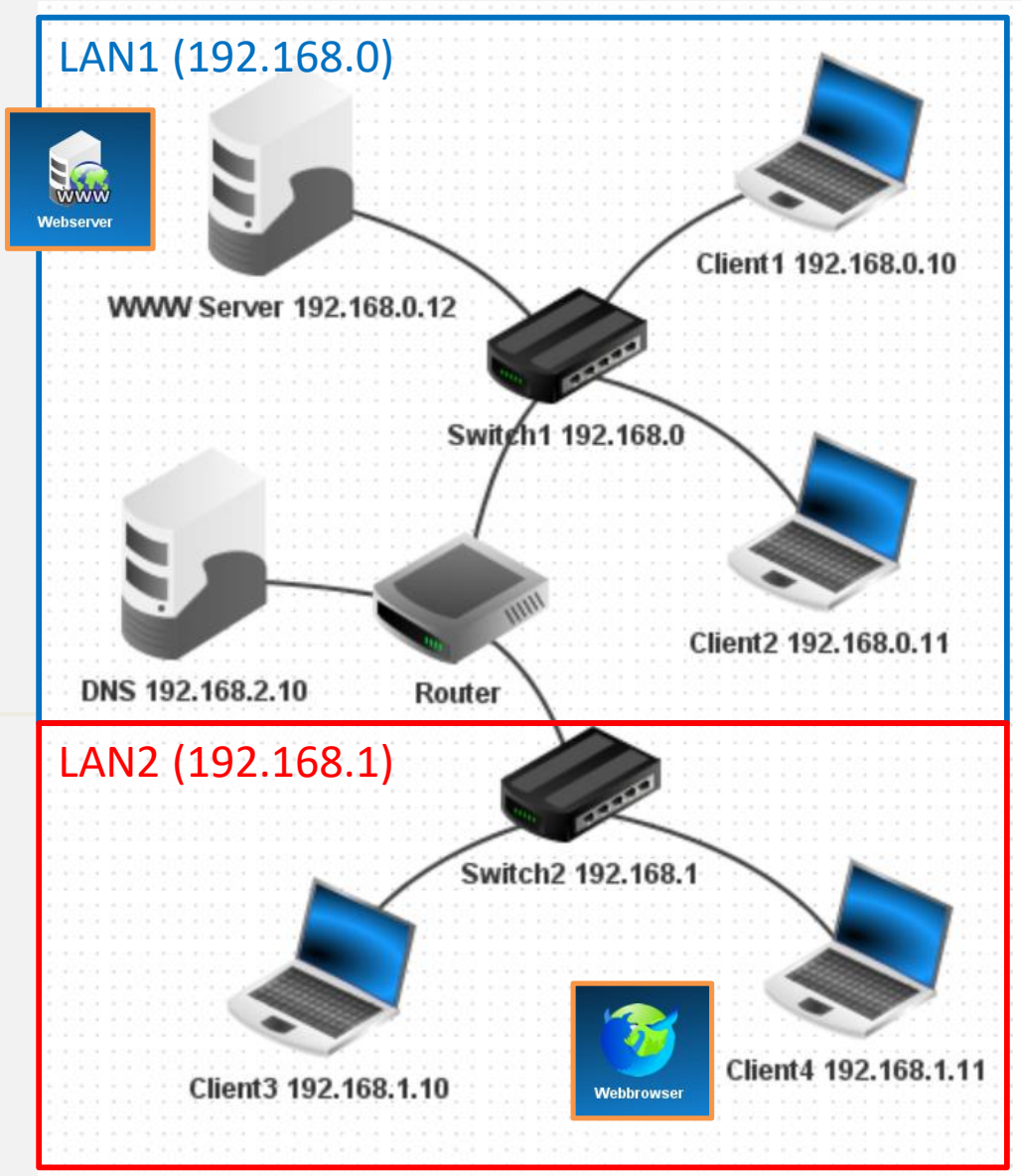
5. Test the network with the DNS Server

1. Add a NIC in the Router.
2. Add Server.
3. Setup the DNS Server.
4. Configure the DNS address for all other Server and Notebooks'.
5. Test the DNS Server.

In Hands-on 4, the Webserver and Webbrowser have been installed and tested.

Start the **Webserver** and access the website from the Notebook's **Webbrowser** using the following url:

```
http://www.yijc.edu.sg
```

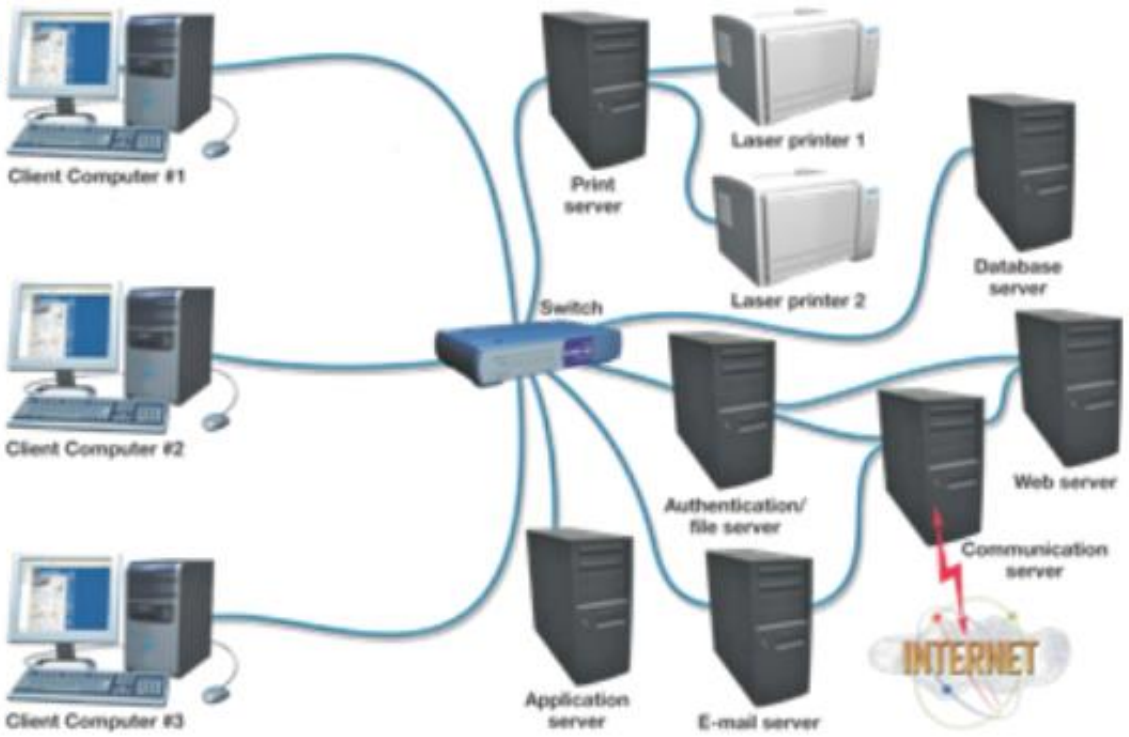


Part 3 : About Servers

What is a Server?
https://youtu.be/UjCDWCeHCzY

Servers

- Number and type of servers depend on network size and workload
- Dedicated server
  - Performs one specific function
- Authentication server
  - Keeps track of network logins and services available
- File server
  - Stores and manages files



Dedicated Servers

- Communications server
  - Handles communications between networks including the Internet
  - Often the only device on the network directly connected to the Internet
- Web server
  - Hosts a Web site available through the Internet

Dedicated Servers

- Print server
  - Manages client-requested printing jobs
  - Creates print queue (prioritizes print jobs)
- Applications server
  - Acts as a storage area for application software
- Database server
  - Provides clients with access to database information
- E-mail server
  - Processes and delivers incoming and outgoing e-mail

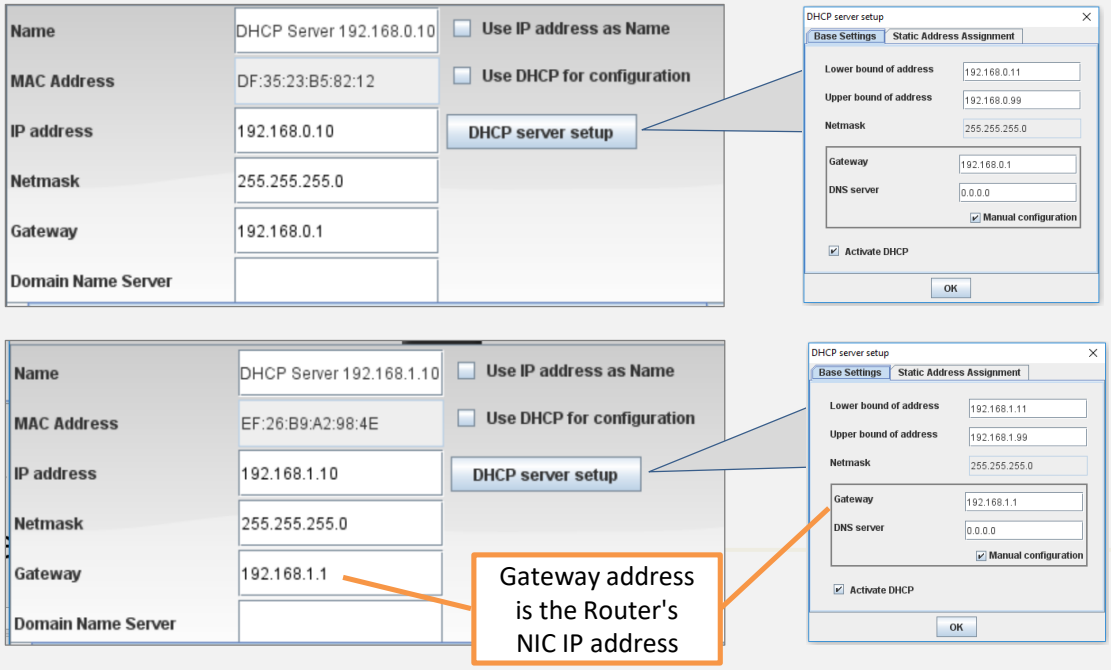
Hands-on 6:

Using DHCP Server

DHCP Explained – Dynamic Host Configuration Protocol
https://youtu.be/e6-TaH5bkjo

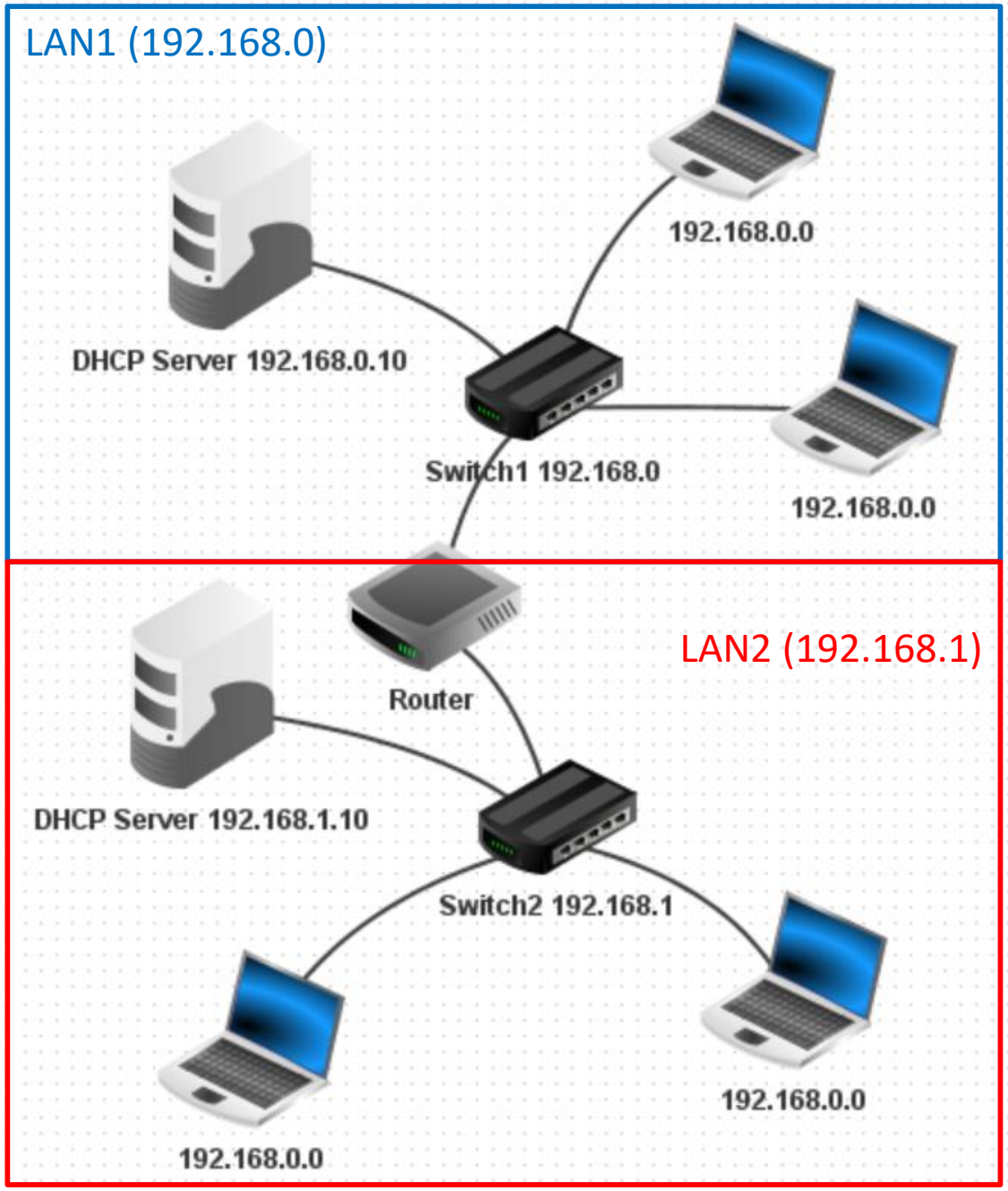
Using a DHCP Server

Set up the LANs as shown. Configure the two DHCP Servers as follows:



Configure all the Notebooks' IP addresses as 192.168.0.0 ☑ Use IP address as Name ☑ Use DHCP for configuration

Observe the simulating **green lines** when the IP addresses are auto-generated.



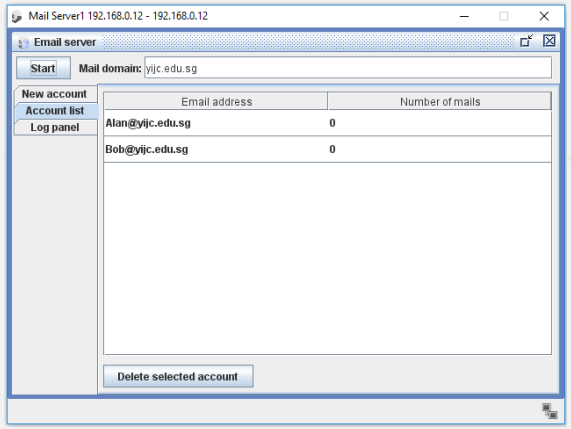
Hands-on 7:

Installing a Mail Server

What is SMTP - Simple Mail Transfer Protocol
https://youtu.be/PJo5yOtu7

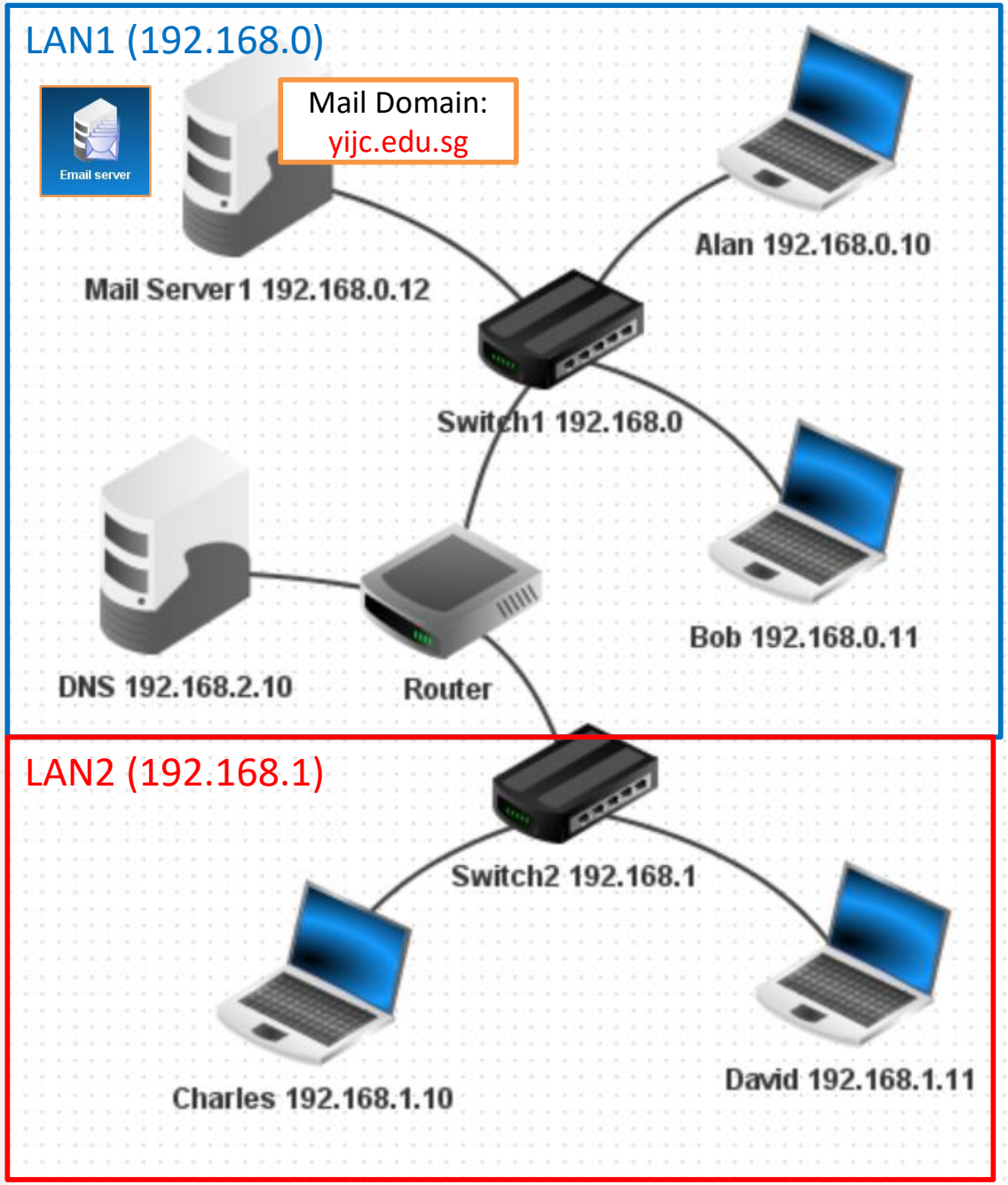
Installing a Mail Server

1. Install the Email Server Software on the Server.
2. Configure the Mail Domain as `yijc.edu.sg`
3. Create two new mail accounts for Alan and Bob



4. Click Start to start the mail server.

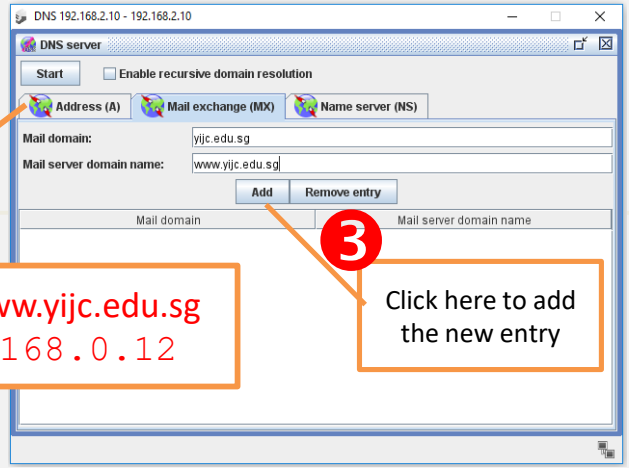
1. Install and configure Mail Server.
2. Configure Mail Exchange in DNS Server.
3. Install and configure Email program in client Notebooks.
4. Test the Mail service.



Installing a Mail Server

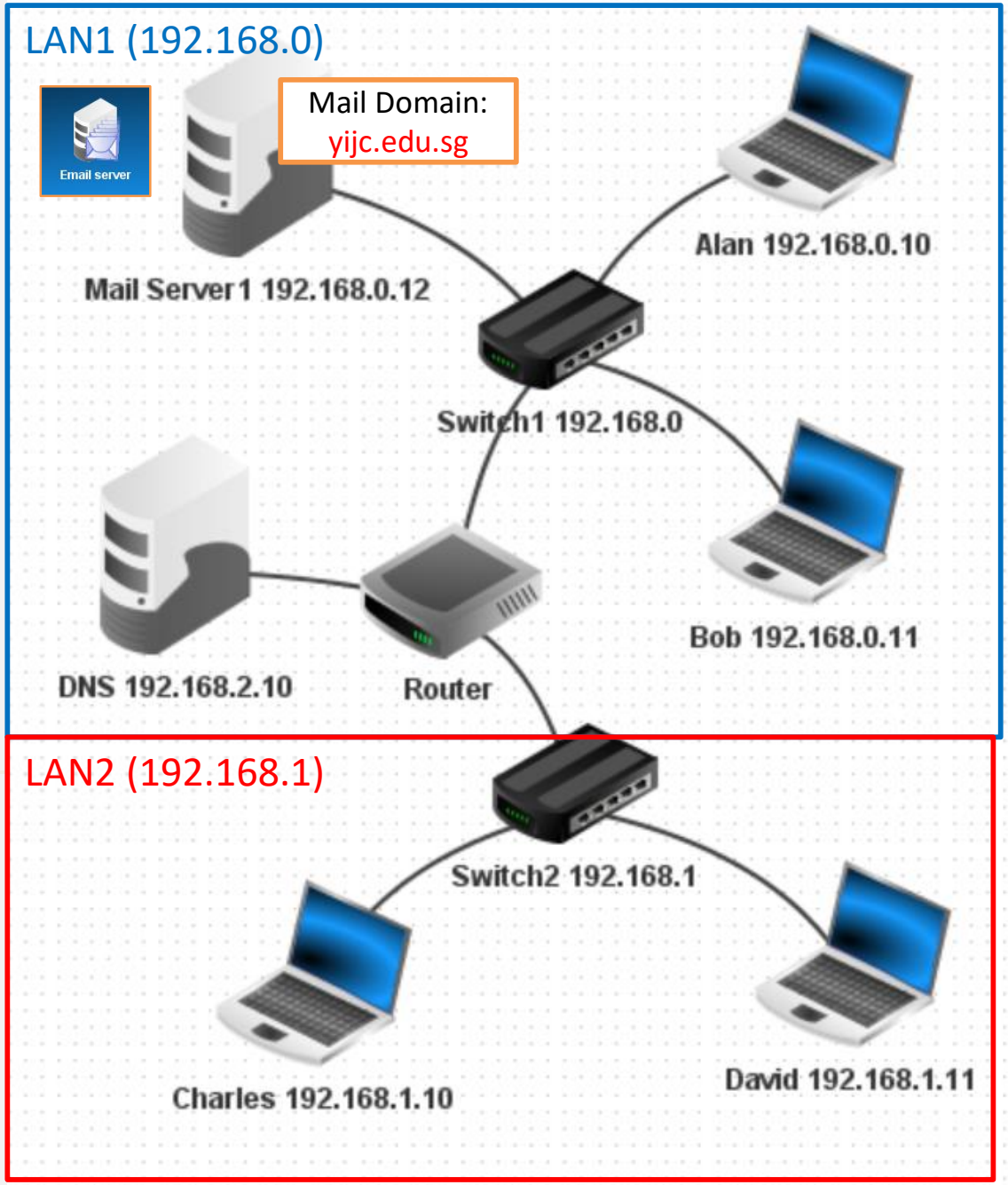
1. Select the Mail exchange (MX) tab in the DNS server.
2. Add a new entry with the Mail domain as `yijc.edu.sg`

   and the Mail server domain name as `www.yijc.edu.sg`



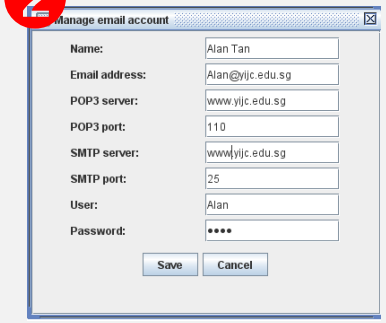
4. Click Start to start the DNS server.

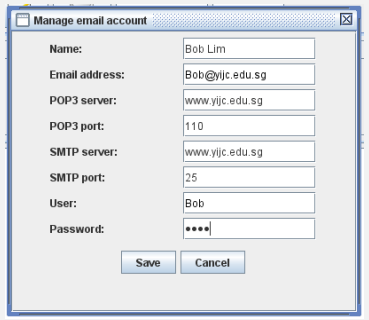
1. Install and configure Mail Server.
2. Configure Mail Exchange in DNS Server.
3. Install and configure Email program in client Notebooks.
4. Test the Mail service.



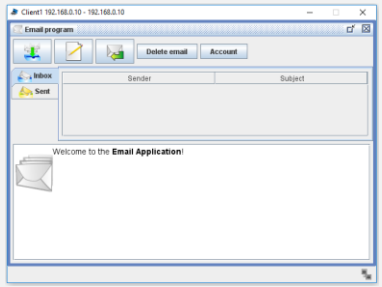
Installing a Mail Server

1. Install the Email program on Alan's and Bob's Notebooks.

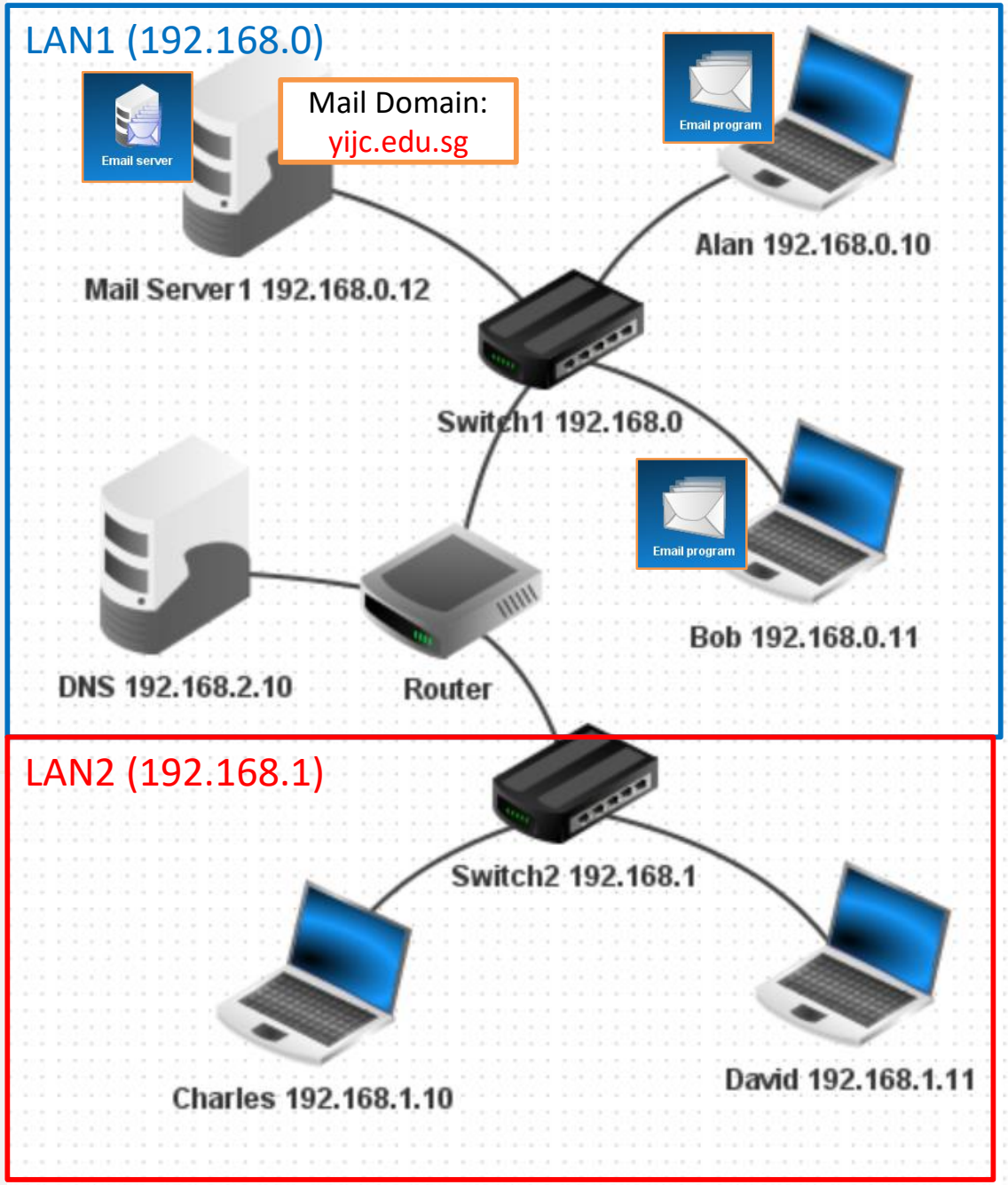
2. 

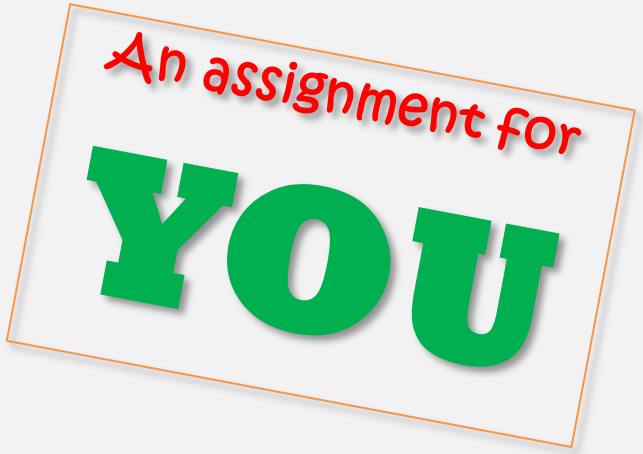


3. Test the mail service by sending emails between Alan and Bob. Observe the **green lines** simulating the transmission of the data.



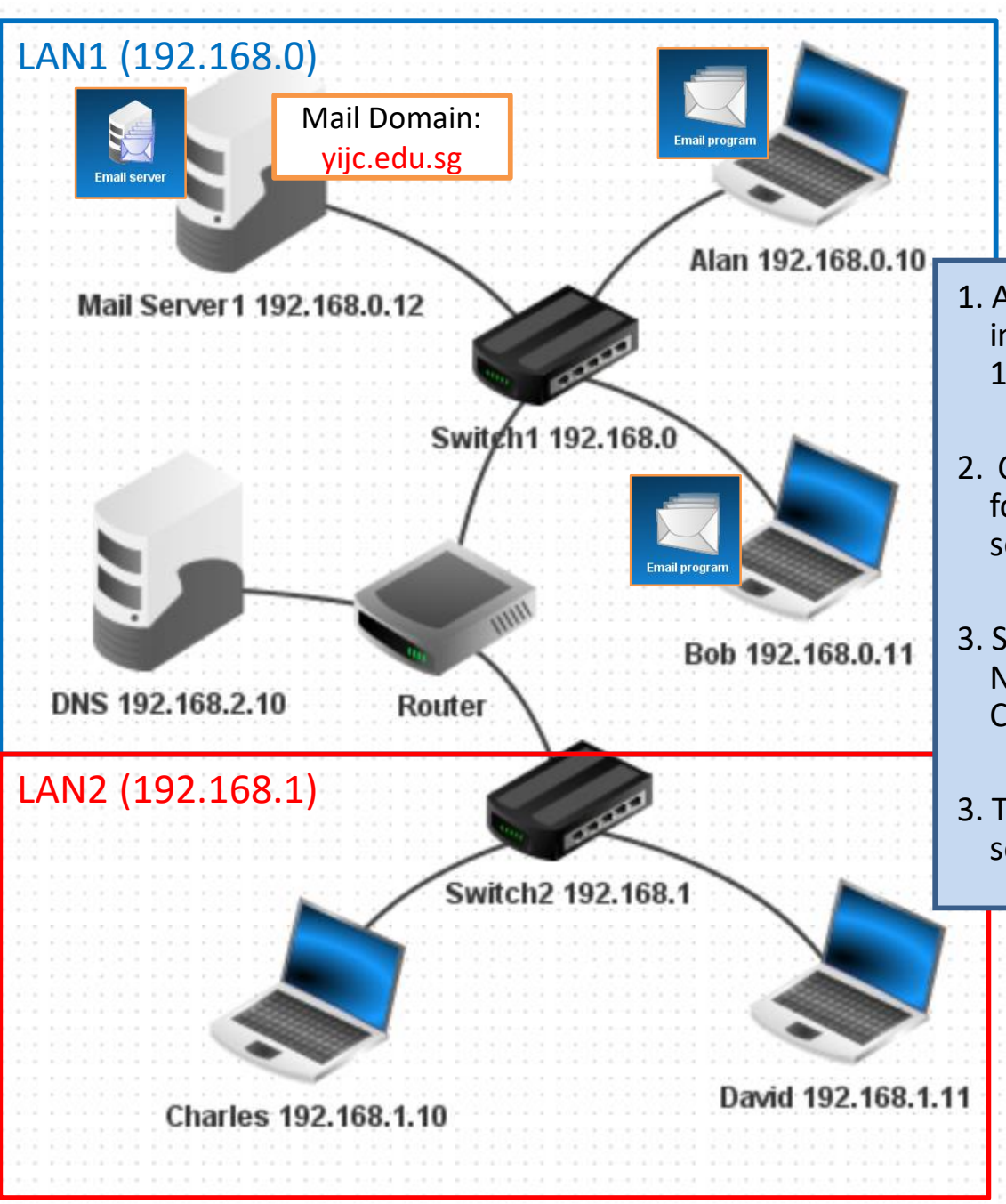
1. Install and configure Mail Server.
2. Configure Mail Exchange in DNS Server.
3. Install and configure Email program in client Notebooks.
4. Test the Mail service.



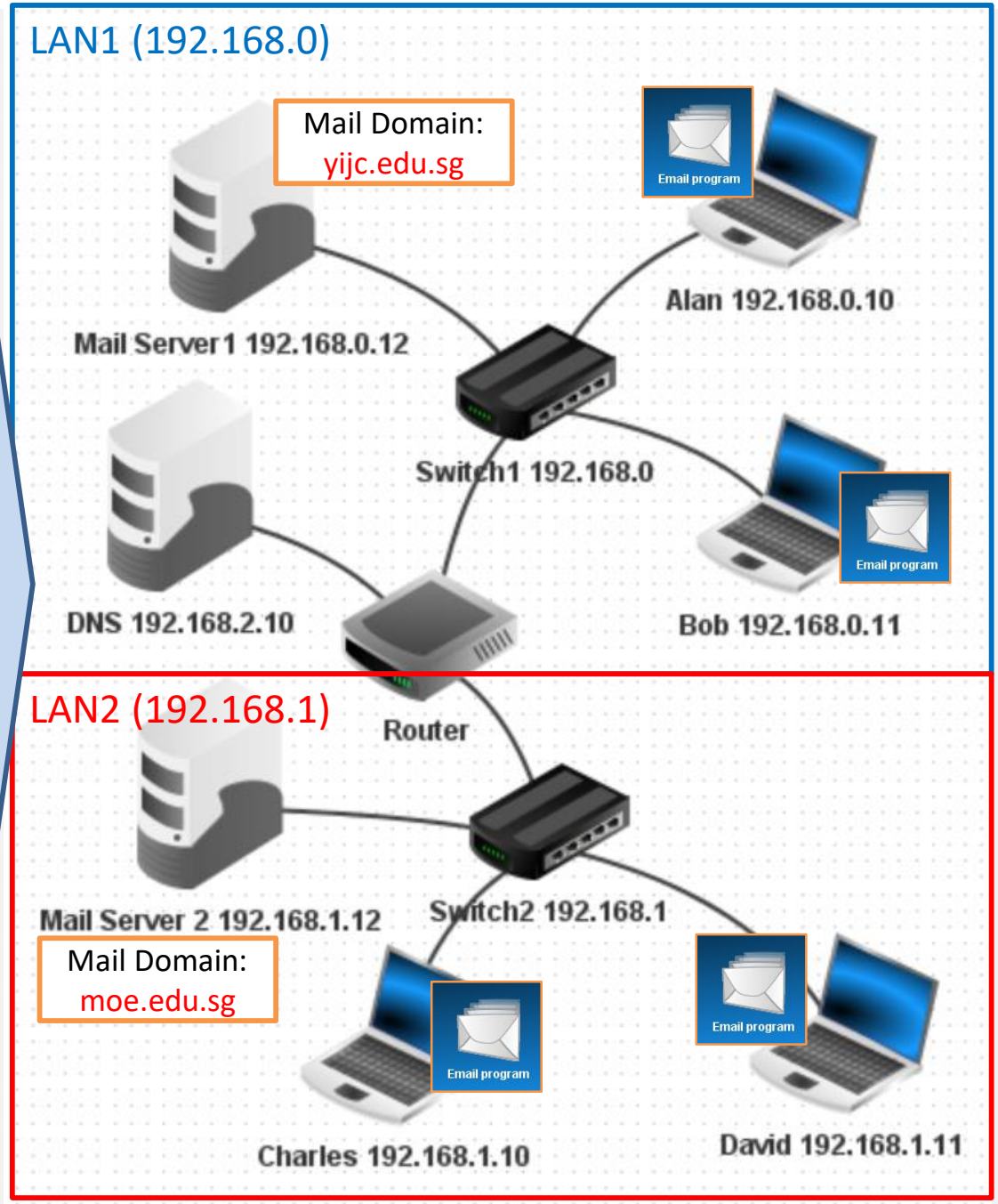


Hands-on 7 :

Try-It : *Installing another Mail Server*



1. Add a mail server in the LAN 192.168.1
2. Configure the DNS for the new mail server.
3. Setup two client Notebooks for Charles and David
3. Test the mail services



The End