# Group 3 AoL Computer Networks

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Class: LB02

Topic: Networking Media / Topology, IP Addressing & Subnetting, Routing, Application Layer (HTTP/SMTP - Web/Email)

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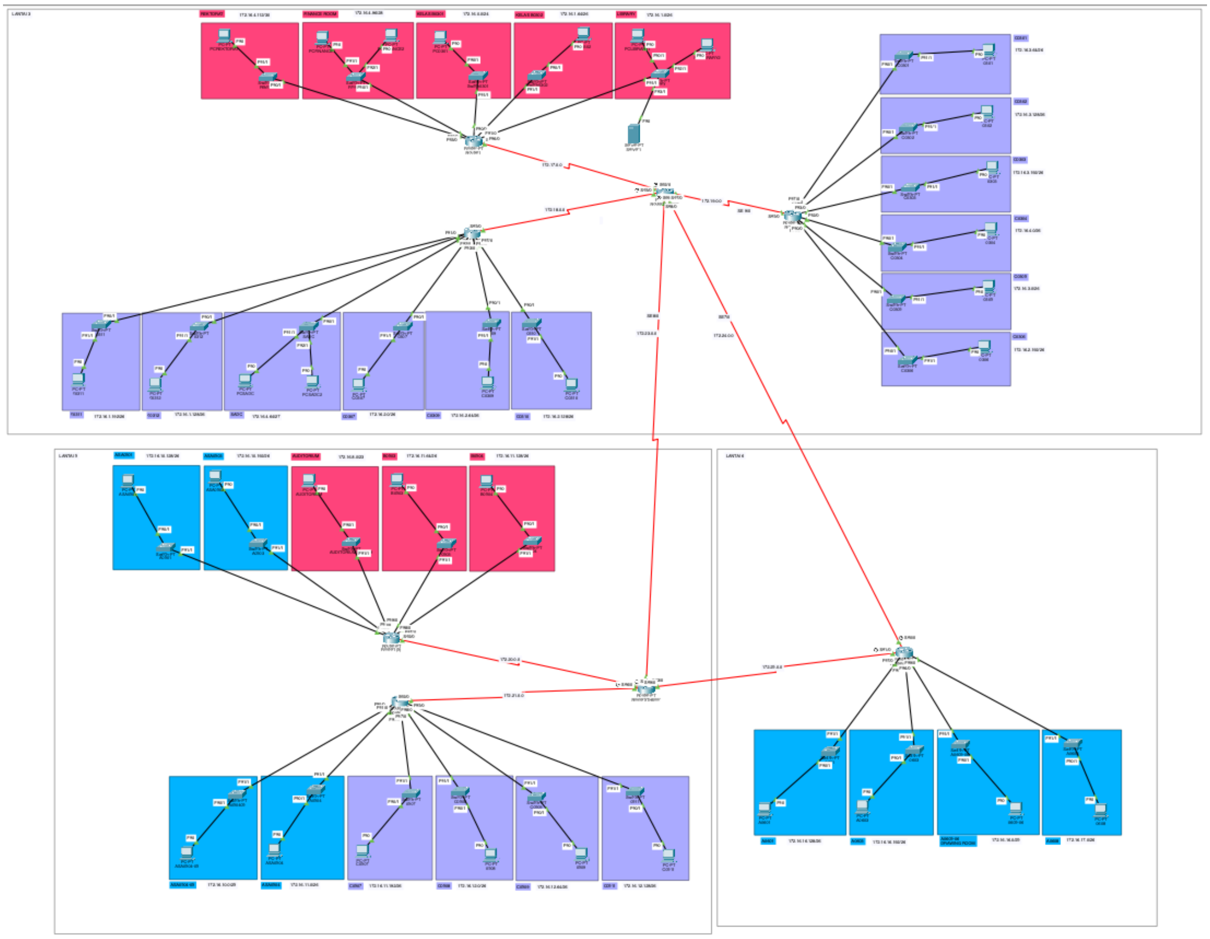
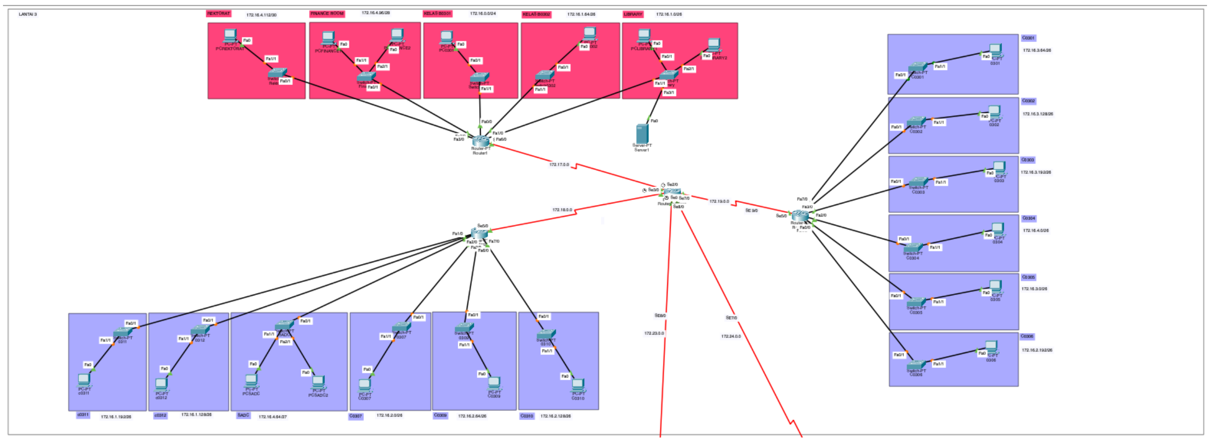
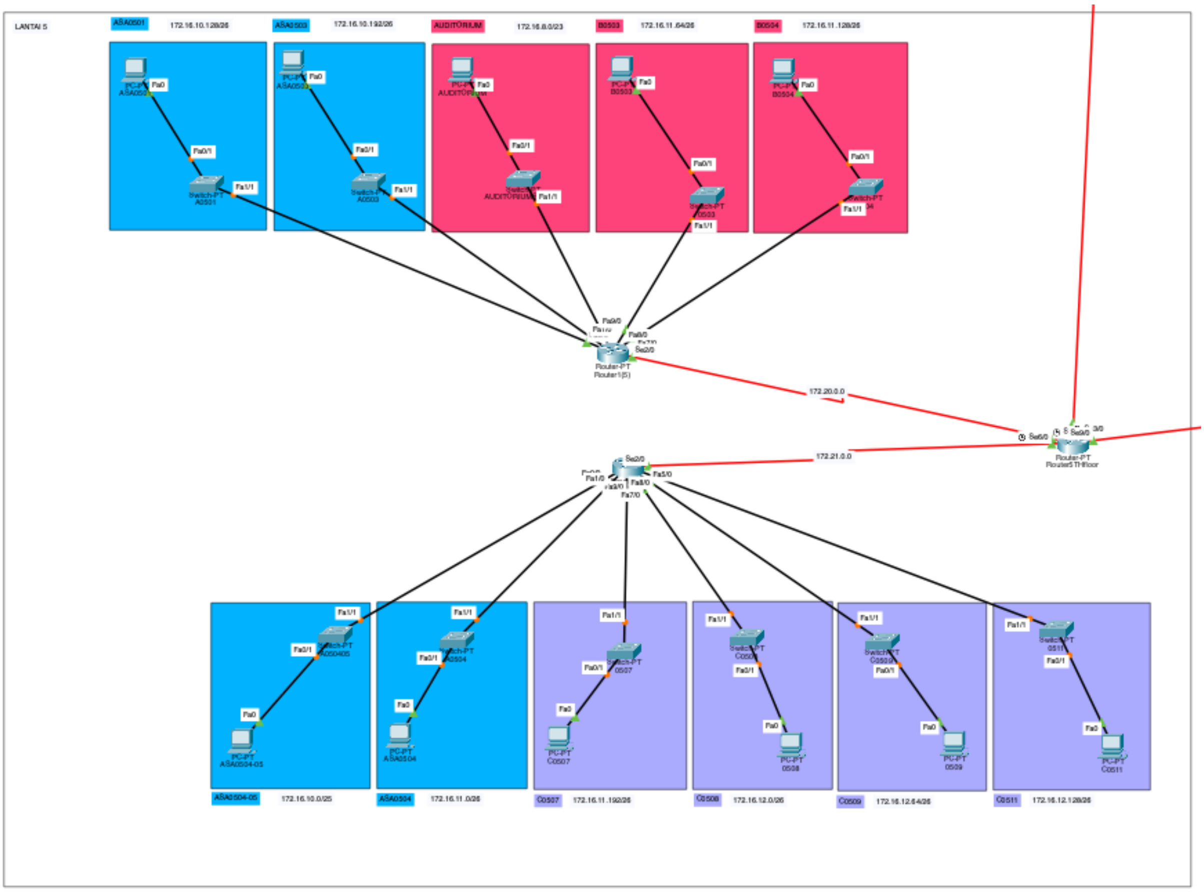
## Cisco Packet Tracer



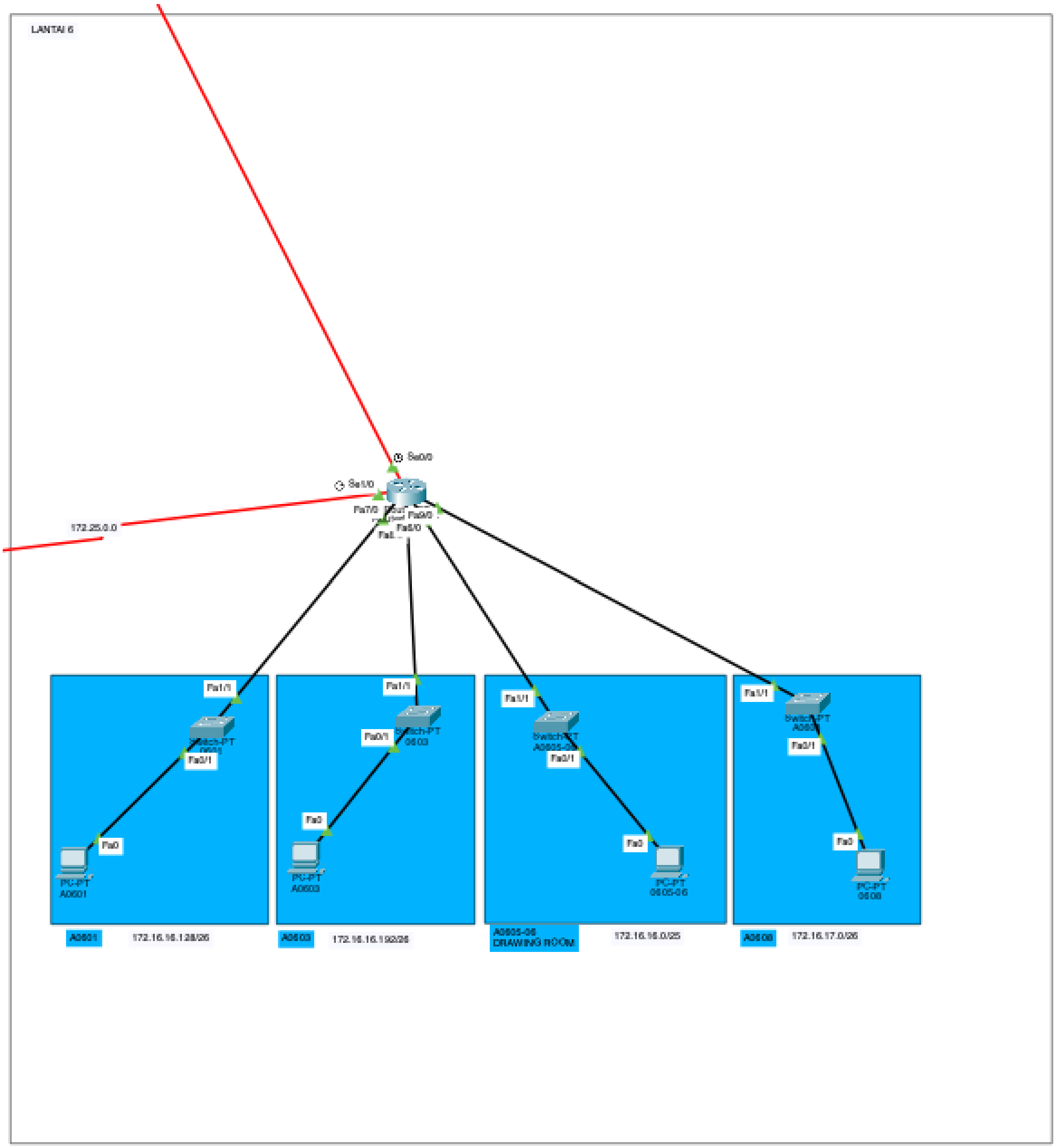
*3rd Floor*



5th Floor


LANTAI 5
ASA0501
172.16.10.128/26
ASA0503
172.16.10.192/26
AUDITORIUM
172.16.8.0/23
B0503
172.16.11.64/26
B0504
172.16.11.128/26
Router-PT
Router1(5)
172.20.0.0
172.21.0.0
Router-PT
Router5THfloor
ASA0504-05
172.16.10.0/25
ASA0504
172.16.11.0/26
C0507
172.16.11.192/26
C0508
172.16.12.0/26
C0509
172.16.12.64/26
C0511
172.16.12.128/26

6th Floor


LANTAI 6
Se0/0
Se1/0
172.25.0.0
Fa7/0
Fa9/0
Fa8/0
Fa1/1
Fa0/1
Fa0
PC-PT
A0601
PC-PT
A0603
PC-PT
0605-06
PC-PT
0608
Switch-PT
0603
A0601
172.16.16.128/26
A0603
172.16.16.192/26
A0605-06
DRAWING ROOM
172.16.16.0/25
A0608
172.16.17.0/26

# TCP/IP Layer

## Layer 1 - Physical Layer

*Devices and Prices*

1. UTP Cable: **Rp 39.000**/20 meters

*Floor Details*

1. <u>3rd Floor</u>

   On the third floor, there are 17 rooms which consist of 13 classrooms, SADC, Library, *Rektorat* room, and Finance room. In each classroom and in the *Rektorat* room, 1 computer is placed. In practice, 4 computers are placed for SADC, 6 computers are placed for the Library, and 4 computers are placed in the Finance room. However, for simplicity, rooms with more than 1 computer are represented with just 2 computers. Therefore, SADC, Library, and the Finance room all have 2 computers each.

   The type of cable that will be used is the UTP cable. This is because the UTP cable is the most accessible and affordable cable with a considerable durability. It has the ability to block interference without the need of having a physical shield since it has a metal casing. UTP cable is also the most common twisted-pair cable used for communications. Therefore, it is easy to find and also simple to repair. For the third floor, the length of UTP cable needed is  to cover the entire floor.

   *Summary:*

   a) UTP cable: **Rp 390.000** for 200 meters

2. <u>5th Floor</u>

   The fifth floor is made up of 11 rooms in total, 1 auditorium and 10 classrooms. In each room, 1 computer is placed. For similar reasons as explained for the third floor, the type of cable that will be used is UTP cable. However, since this floor has fewer rooms compared to the third floor, only 150 meters of UTP cable is needed.

   *Summary:*

   a) UTP cable: **Rp 312.000** for 150 meters (160 meters)

3. 6th Floor

On the sixth floor, there are 4 rooms which consist of 3 classrooms and 1 Drawing room. In all of these rooms, there is only 1 computer each. For similar reasons as explained for the third floor, the type of cable that will be used is UTP cable. However, since this floor has a small number of classes, only 100 meters of UTP cable is needed.

*Summary:*

a) UTP cable: **Rp 195.000** for 100 meters

*Total Cable Length And Total Price Of The UTP Cable*

Type of cable: UTP Cable Cat6E

Total Cable Length: 450m (estimation)

Total Price: **Rp 877.500**

## Layer 2 - Data Link Layer

*Devices and Prices*

1. 4-Port Switch: **Rp 350.000** for 1 switch

*Floor Details*

1. <u>3rd Floor</u>

   On the third floor, every room only has 1 switch. This is to accommodate the map drawn of the floor where each room only has a maximum of 2 computers which represents multiple computers. Because of this, a single 4-port switch per room is sufficient enough. Since there are 17 rooms on the third floor, there are 17 switches as well.

   *Summary:*

   a) 4-Port Switch: **Rp 5.590.000** for 17 switches

2. <u>5th Floor</u>

   Since there are 11 rooms on the fifth floor, there will also be 11 switches; 1 for each room. Because each room only has 1 computer, a 4-port switch will be used.

   *Summary:*

   a) 4-Port Switch: **Rp 3.850.000** for 11 switches

3. <u>6th Floor</u>

   On the sixth floor, similarly, each room uses only 1 switch that the computers are connected to. Since there are 4 rooms, only 4 switches will be needed.

   *Summary:*

   a) 4-Port Switch: **Rp 1.400.000** for 4 switches

*Total Switch And Total Price Of The Switches*

Total 4-Port Switch: 32

Total Price: **Rp 11.200.000**

## Layer 3 - Network Layer

*Devices and Prices*

1. Router: **Rp 169.999** for 1 router

*Floor Details*

<u>3rd Floor</u>

On the third floor, there are 3 routers provided on the third floor which are divided based on the proximity of each router to the classes which are all connected to 1 main router. This division to 3 different routers is done to decrease delay and waiting times when passing or delivering messages between devices and to increase efficiency. The first router is connected to 5 rooms (B0301, B0302, Library, Finance room, and *Rektorat* room). The second router is connected to 6 rooms (SADC, C0307, C0309, C0310, C0311, C0312). The third router is connected to 6 rooms (C0301, C0302, C0303, C0304, C0305, C0306). All three of these routers are connected to 1 main router for the third floor which will be used to connect to other floors.

*Summary:*

a) Router: **Rp 679.996** for 4 routers

<u>5th Floor</u>

There are 3 routers on the fifth floor, 2 of which are divided based on the proximity of each router to the classes and 1 main router to connect the 2 routers. Similar to the third floor, the division of 2 routers is done to decrease delay and waiting times when passing or delivering messages between devices and to increase efficiency. The first router is connected to 5 rooms – the Auditorium, ASA0501, ASA0503, B0503, B0504 – and the second router is connected to 6 rooms – ASA0504, ASA0504-05, C0507, C0508, C0509, C0511. These 2 routers are then connected to 1 main router for the fifth floor which will be used to connect to other floors.

*Summary:*

a) Router: **Rp 509.997** for 3 routers

<u>6th Floor</u>

There is only 1 router on the 6th floor because this is a relatively small floor with only 4 classes that are near to each other. Therefore, there will be minimal interference even with just 1 router. Rooms A0601, A0603, Drawing room

(A0605-06), and A0608 are connected to the same router. This router will also be used to connect between floors.

*Summary:*

a) Router: **Rp 169.999** for 1 router

*Total Router And Total Price Of The Routers*

Total Router: 8

Total Price: **Rp 1.359.992**

*IP Addresses*

For the IP address, we chose to use Class B with private addresses. The reason why we chose Class B is because there will be more addresses to host a big amount of devices. Since the number of students as well as the number of devices owned per student can change, we decided that providing extra IP addresses is the safest option. The type of switch may also vary depending on the needs. Moreover, a private address is used because it is likely that sensitive or personal information passed on between devices and PCs in a campus area. Hence, it is safer to provide a private IP address for these hosts.

An approximation of the number of devices used on each floor is made based on the understanding that it is prone to changes depending on each student's needs. The approximation is made by taking the most number of devices required in a certain room as the reference to create a uniform amount of devices required per floor:

1. **Third floor**: 1160 devices
2. **Fifth floor**: 1400 devices
3. **Sixth floor**: 1020 devices

With the approximation, we can now calculate the starting IP address per floor using the FLSM method. Since the fifth floor requires the most hosts for 1400 devices, this will be used as the reference for calculating the starting IP addresses.

2^n - 3 >= 1400

2^11 - 3 >= 1400

**n = 11**

32-11 = 21

*2^n -3 → here we - 3, for the IP addresses of network address (NA), broadcast address (BA), and default gateway.

Therefore, the subnet mask for each floor is **/21** or **255.255.248.0**. Since as /21 subnet mask can host up to 2048 devices, this would make the starting IP addresses for each floor as follows:

1. **Third floor**: 172.16.0.0/21
2. **Fifth floor**: 172.16.8.0/21
3. **Sixth floor**: 172.16.16.0/21

This is because an octet can only host a maximum of 256 devices. In order to fit 2048 devices, we would need to prepare 8 x 256 hosts. Hence, the interval for the IP address per floor is 8 in the third octet.

After obtaining the subnet mask and starting IP address of each floor, we can then proceed with calculating the IP address for each room. This time, we would be using the VLSM method to make sure the number of devices will not exceed the amount of devices in each floor. Therefore, we have to first sort the rooms of each floor with the highest number of devices to the lowest. For VLSM, we use the same formula to do the subnetting of each room:

2^n - 3 >= number of devices

**h = 32 - n**

*2^n -3 → here we - 3, for the ip addresses of network address (NA), broadcast address (BA), and default gateway.

1. **Third floor**

| 3rd Floor (Starting IP: 172.16.0.0/21) | | | | | | |
|---|---|---|---|---|---|---|
| **Room** | **Num. of Devices** | **n value** | **Subnet Mask** | **NA** | **Gateway** | **BA** |
| B0301 | 200 | 8 | /24 | 172.16.0.0 | 172.16.0.1 | 172.16.0.255 |
| Library | 60 | 6 | /26 | 172.16.1.0 | 172.16.1.1 | 172.16.1.63 |
| B0302 | 50 | 6 | /26 | 172.16.1.64 | 172.16.1.65 | 172.16.1.127 |

| | | | | | | |
|---|---|---|---|---|---|---|
| C0312 | 50 | 6 | /26 | 172.16.1.128 | 172.16.1.129 | 172.16.1.191 |
| C0311 | 50 | 6 | /26 | 172.16.1.192 | 172.16.1.193 | 172.16.1.255 |
| C0307 | 50 | 6 | /26 | 172.16.2.0 | 172.16.2.1 | 172.16.2.63 |
| C0309 | 50 | 6 | /26 | 172.16.2.64 | 172.16.2.65 | 172.16.2.127 |
| C0310 | 50 | 6 | /26 | 172.16.2.128 | 172.16.2.129 | 172.16.2.191 |
| C0306 | 50 | 6 | /26 | 172.16.2.192 | 172.16.2.193 | 172.16.2.255 |
| C0305 | 50 | 6 | /26 | 172.16.3.0 | 172.16.3.1 | 172.16.3.63 |
| C0301 | 50 | 6 | /26 | 172.16.3.64 | 172.16.3.65 | 172.16.3.127 |
| C0302 | 50 | 6 | /26 | 172.16.3.128 | 172.16.3.129 | 172.16.3.191 |
| C0303 | 50 | 6 | /26 | 172.16.3.192 | 172.16.3.193 | 172.16.3.255 |
| C0304 | 50 | 6 | /26 | 172.16.4.0 | 172.16.4.1 | 172.16.4.63 |
| SADC | 20 | 5 | /27 | 172.16.4.64 | 172.16.4.65 | 172.16.4.95 |
| Finance | 10 | 4 | /28 | 172.16.4.96 | 172.16.4.97 | 172.16.4.111 |
| Rektorat | 2 | 2 | /30 | 172.16.4.112 | 172.16.4.113 | 172.16.4.115 |

2. **Fifth floor**

| 5th Floor (Starting IP: 172.16.8.0/21) | | | | | | |
|---|---|---|---|---|---|---|
| **Room** | **Num. of Devices** | **n value** | **Subnet Mask** | **NA** | **Gateway** | **BA** |
| Auditorium | 500 | 9 | /23 | 172.16.8.0 | 172.16.8.1 | 172.16.9.255 |
| ASA0504-05 | 100 | 7 | /25 | 172.16.10.0 | 172.16.10.1 | 172.16.10.127 |
| ASA0501 | 50 | 6 | /26 | 172.16.10.128 | 172.16.10.129 | 172.16.10.191 |
| ASA0503 | 50 | 6 | /26 | 172.16.10.192 | 172.16.10.193 | 172.16.10.255 |
| ASA0504 | 50 | 6 | /26 | 172.16.11.0 | 172.16.11.1 | 172.16.11.63 |
| B0503 | 50 | 6 | /26 | 172.16.11.64 | 172.16.11.65 | 172.16.11.127 |

| | | | | | | |
|---|---|---|---|---|---|---|
| B0504 | 50 | 6 | /26 | 172.16.11.128 | 172.16.11.129 | 172.16.11.191 |
| C0507 | 50 | 6 | /26 | 172.16.11.192 | 172.16.11.193 | 172.16.11.255 |
| C0508 | 50 | 6 | /26 | 172.16.12.0 | 172.16.12.1 | 172.16.12.63 |
| C0509 | 50 | 6 | /26 | 172.16.12.64 | 172.16.12.65 | 172.16.12.127 |
| C0511 | 50 | 6 | /26 | 172.16.12.128 | 172.16.12.129 | 172.16.12.191 |

3. **Sixth floor**

| 6th Floor (Starting IP Address: 172.16.16.0/21) | | | | | | |
|---|---|---|---|---|---|---|
| **Room** | **Num. of Devices** | **n value** | **Subnet Mask** | **NA** | **Gateway** | **BA** |
| A0605-06 | 100 | 7 | /25 | 172.16.16.0 | 172.16.16.1 | 172.16.16.127 |
| A0601 | 50 | 6 | /26 | 172.16.16.128 | 172.16.16.129 | 172.16.16.191 |
| A0603 | 50 | 6 | /26 | 172.16.16.192 | 172.16.16.193 | 172.16.16.255 |
| A0608 | 50 | 6 | /26 | 172.16.17.0 | 172.16.17.1 | 172.16.17.63 |

4. **Router Address**

| Router Address | | | | |
|---|---|---|---|---|
| **3rd Floor** | **5th Floor** | **6th Floor** | **Between Floors** | **DNS** |
| 172.17.0.0 | 172.20.0.0 | 172.22.0.0 | 172.23.0.0 | 172.16.1.4 |
| 172.18.0.0 | 172.21.0.0 | | 172.24.0.0 | |
| 172.19.0.0 | | | 172.25.0.0 | |

*Static Routing*

With these IP addresses that have been assigned to each floor and each room, we can continue with the static routing. Static routing is done to connect all devices between different floors. To do this, we connected all the 3 main routers on each floor to each other.

1. **Third Floor**

| Destination | Next Hop |
|---|---|

| | |
|---|---|
| Fifth floor | 172.23.0.1 |
| Sixth floor | 172.24.0.2 |

2. **Fifth floor**

| Destination | Next Hop |
|---|---|
| Third floor | 172.23.0.2 |
| Sixth floor | 172.25.0.2 |

3. **Sixth floor**

| Destination | Next Hop |
|---|---|
| Third floor | 172.24.0.1 |
| Fifth floor | 172.25.0.1 |

## Layer 4 - Transport Layer

In layer 4, we have the transport layer, this layer is responsible for establishing communication between application processes that are being executed on separate hosts. Although the application processes themselves are not connected physically, they would still need to transmit messages to each other, like when we call someone via our whatsapp to their whatsapp, and this is possible through the logical connection provided by the transport layer.

There are many protocols available for the fourth layer, but the most used protocols are TCP and UDP. Each application can communicate via TCP or UDP protocols, both providing different ways said applications communicate with each other with different pros and cons. There are several services provided by the transport layer as well, to mention it briefly there are services such as:

1. Error control
2. Sequence control
3. Loss Control
4. Duplication control
5. Flow control
6. Multiplexing
7. Etc

For the protocols themselves, TCP and UDP provide different ways for applications to communicate. TCP is a connection based protocol, it can sequence data and retransmit data if packets fall to arrive, guaranteeing data delivery. It is slower than UDP but it ensures a complete data delivery. TCP uses a 3-way handshake before the communication process starts so that both ends can initiate, negotiate, and separate TCP socket connections. TCP is suitable for transferring data such as text messages, files, basically data that needs to be fully delivered.

On the other hand, UDP is a connectionless based protocol, it does not establish connection when sending data, it just sends data without confirming receipt or checking for errors or packet losses and UDP cannot retransmit lost data, so full delivery is not guaranteed. UDP prioritizes fast data delivery over complete data delivery. UDP is suitable for video calling or online gaming

TCP and UDP provide a connection from the network layer to the application layer (HTTP, FTP, POP, etc). Thus, the transport layer needs to track activities and ensure that the received data is directed to the correct application layer protocol. TCP and UDP manage these multiple processes by using port numbers contained in the header field.

The port number selected to support the session will determine the link between the application and transport layer protocols. There are 65,535 port numbers available, and are divided into three ranges:

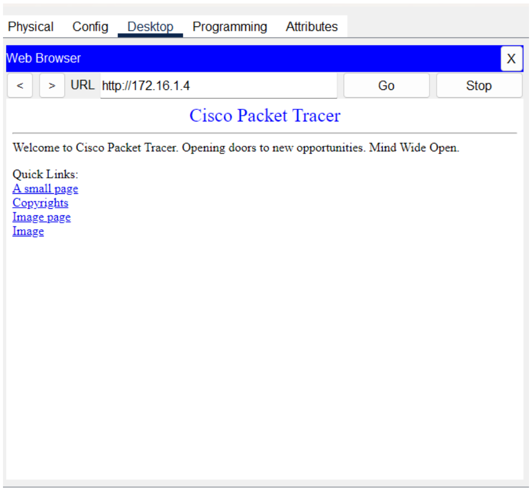
- *Well-known* ports (0 - 1023), these port numbers are reserved and mostly used by HTTP, SMTP, POP, FTP, DNS, etc.
- *Registered ports* (1024-49151), these are assigned to user applications, like programs that we install that require network connectivity like online games.
- *Dynamic or private ports* (49152 - 65535) These are assigned dynamically to client applications when the client initiates a connection, this is used when applications are not assigned ports from the *registered ports*.

For binusmaya specific activities like NIM authentication, etc, we can register a port number into the registered ports. We will use the well known port ranges for basic activities like HTTPS protocols, FTP, SMTP, etc. Finally we can use the Dynamic port range for the rest.

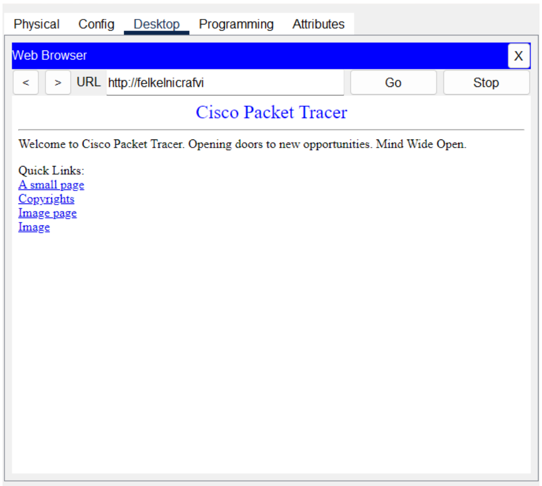
After deciding which port number to use from the three ranges, we now have two identifiers, the IP Address, and the port number. We can combine the two to make a socket address. The Socket address will contain both the IP Address and the Socket number. The Client's socket address defines the client process uniquely whereas the server socket address defines the server process uniquely.

## Layer 5 - Application Layer

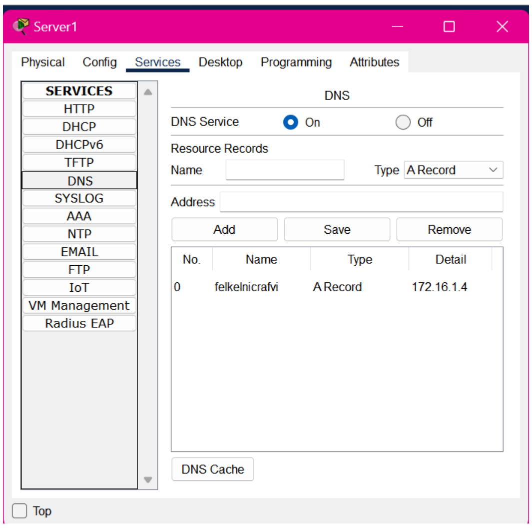
*Domain Name System (DNS)*




1st Image




2nd Image



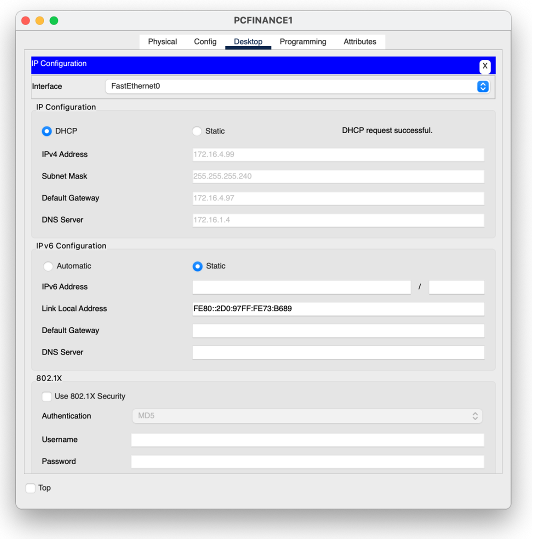

3rd Image

Domain Name System (DNS) translates domain names to readable IP addresses for the computer. The presence of DNS servers eliminates the need for humans to memorize IP addresses such as 192.168.16.11, instead they can just type in their destination domain such as google.com.

We have established a DNS server for our AOL on the third floor, linked to the library room's switch. Despite its physical location on the third floor, it is accessible by all floors – third, fifth, and sixth. The reason for this is because one server can accommodate all the request needs of the client.

In the image above, we can see that the domain http://felkelnicrafvi is translated into http://172.16.1.4 – this can be seen from the 2nd image, the website accessed is the same as the one in the 1st image.

*Dynamic Host Configuration Protocol (DHCP)*

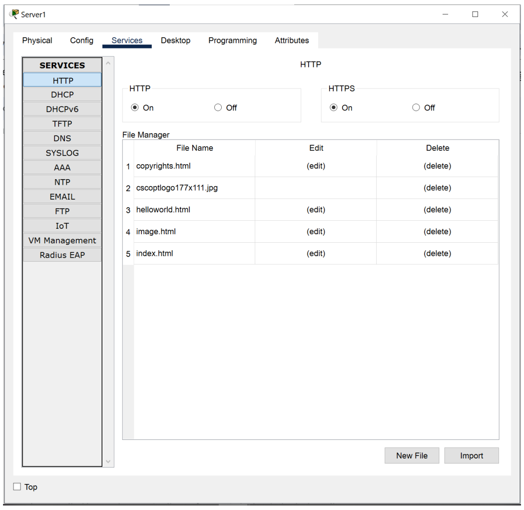
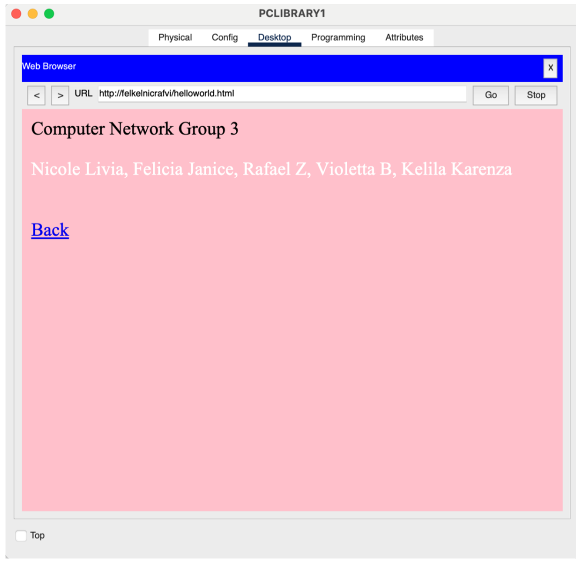



1st Image

Dynamic Host Configuration Protocol (DHCP) is a network protocol that automatically assigns IP addresses and other network settings to devices on a network. By using DHCP, it takes the hassle out of manually assigning IP addresses for every device on a network.

In our Cisco Packet Tracer, we can see a successful DHCP implementation in the image above, where the PC in the Finance room has been assigned the correct IP address. While the image above provides a visual example, it's important to note that DHCP has been successfully implemented throughout the entire topology, not just for the PC in the Finance room.

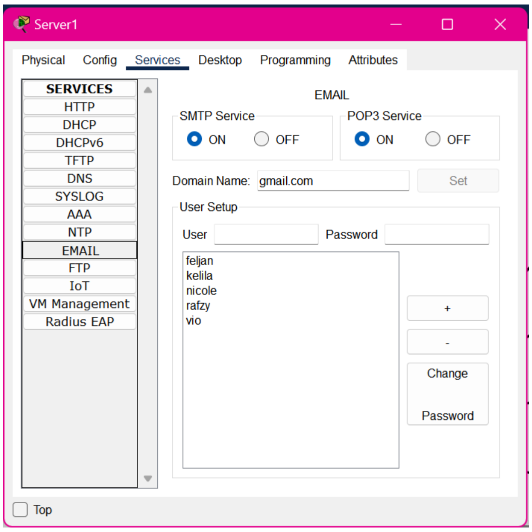
*Hypertext Transfer Protocol (HTTP)*

| | |
|---|---|
|  |  |
| 1st Image | 2nd Image |

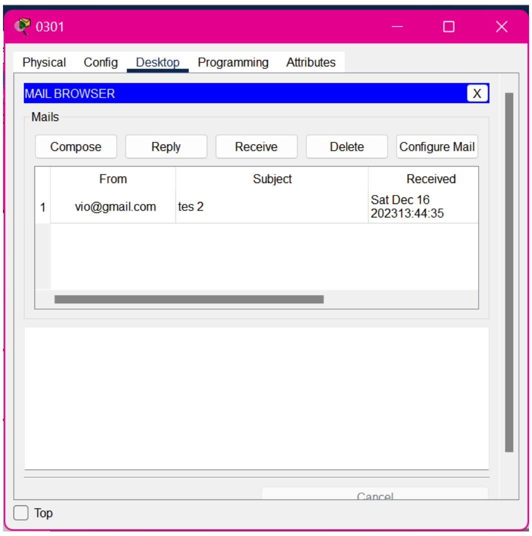
Hypertext Transfer Protocol (HTTP) is an application protocol that loads web pages using hypertext links. Essentially, HTTP is a protocol that transfers data between devices that are connected to the internet. HTTP is divided into HTTP and HTTPS, which is basically HTTP with encryption and verification. In short, HTTPS is more secure compared to the original HTTP since it uses TLS (Transfer Layer Security) to encrypt normal HTTP.

We turned on access to both HTTP and HTTPS in Server1 in the library room, since it increases the amount of web pages accessible by the computer. An example of a normal HTTP website can be seen on the 2nd image, http://felkelnicrafvi/helloworld.html which is accessible through the Cisco Packet Tracer. In the 2nd image you can see the HTML page with its CSS – the pink background color and different text styling – which indicates that it's an actual web structure and that the http is working.

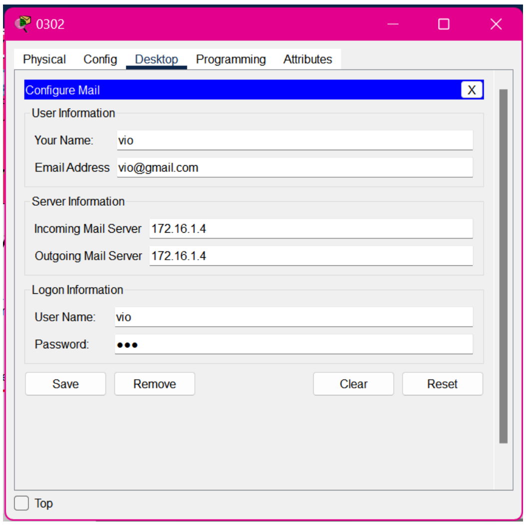
*Simple Mail Transfer Protocol (SMTP)*



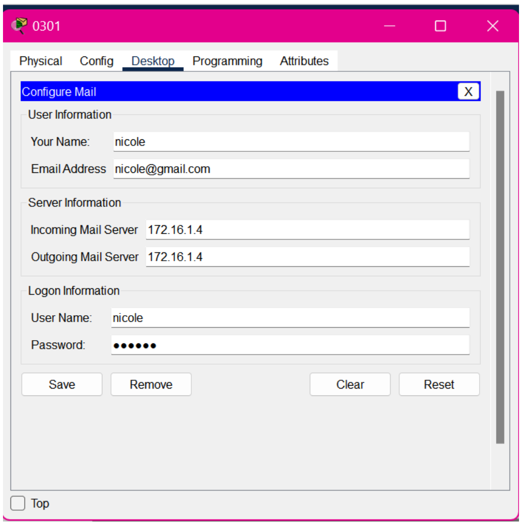

1st Image




2nd Image




3rd Image




4th Image

Simple Mail Transfer Protocol (SMTP) can be defined as a transport protocol used by mail servers to send, receive, and relay outgoing emails between senders and receivers. SMTP is built on top of TCP to ensure reliable delivery of mail packets.

When a user sends an email, the server will get information such as the sender's and receiver's email addresses, as well as the content of the email. After receiving the sender's and receiver's email addresses, the MTA (Mail Transfer Agent) checks whether both email addresses belong to the same domain. If the email addresses are in the same domain, the email will be sent right away. However, if they are not in the same domain, the server will use DNS to identify the recipient's domain and send the email to the correct server.

We placed the SMTP server on the third floor linked to the library and configured it for five users. To test the SMTP functionality, we attempted to send an email with the subject "tes" from one PC to another, using different user accounts. We configured email on two PCs in the library, one PC in C0301, one PC in C0302, and one PC in C0303. The results indicate that the email was successfully sent and received between different PCs located in separate rooms. The first picture shows how we configure SMTP on our server. In the second picture, we successfully sent an email from PC 0302, with the user "vio," to PC 0301, with the user "nicole." In the third and fourth pictures, we can see the sender and receiver's information.

## Attachments - Presentation Video, Cisco Packet Tracer File, Powerpoint, Report Document

https://binusianorg.sharepoint.com/sites/CompNet-CPEN6247001-LB02-GROUP03/Shared%20Documents/GROUP03/Final?csf=1&web=1&e=GXHfib