University of Moratuwa

Department of Electronic and Telecommunication Engineering

EN2150 - Communication Network Engineering

Design of a Local Area Network

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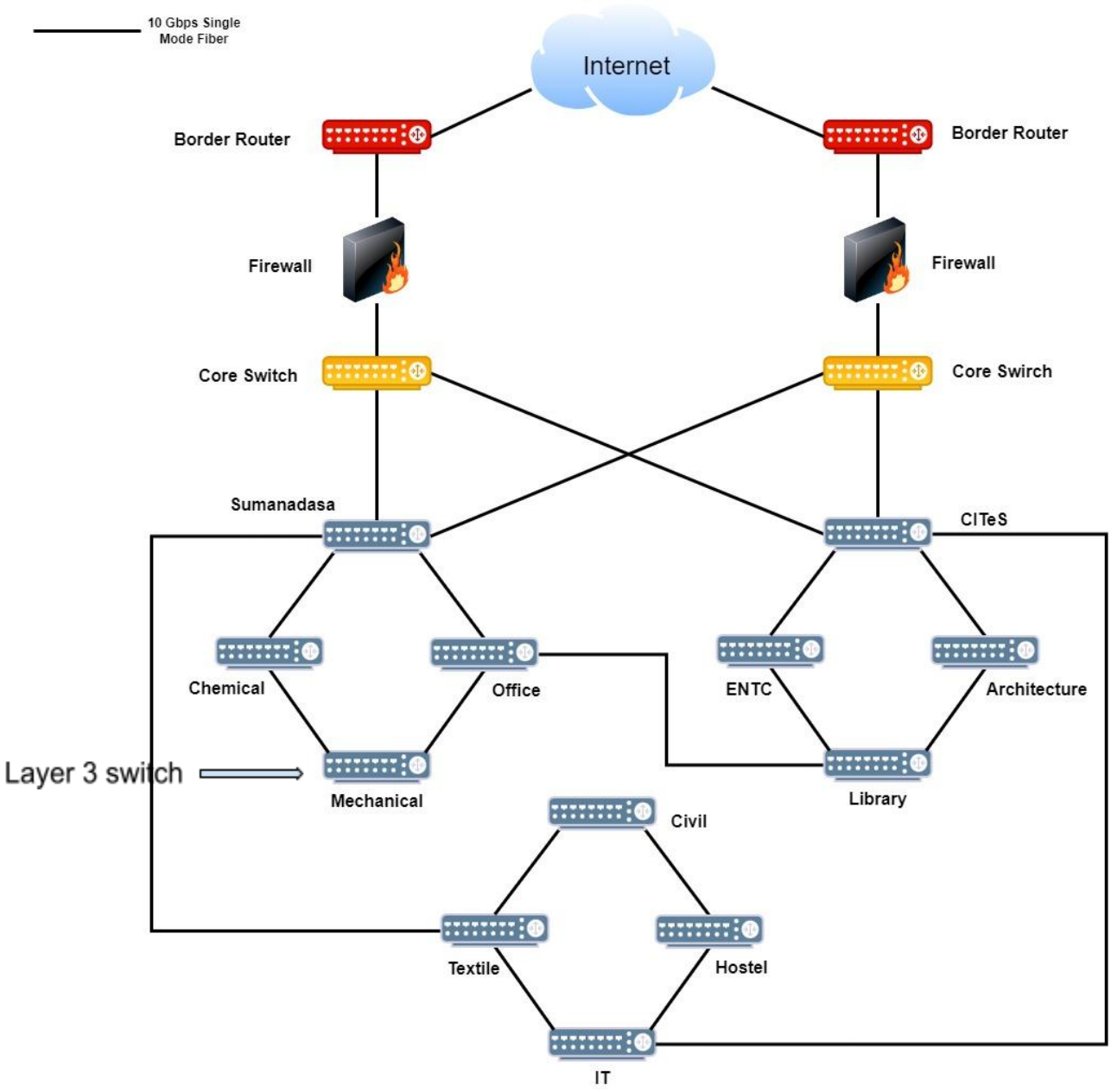
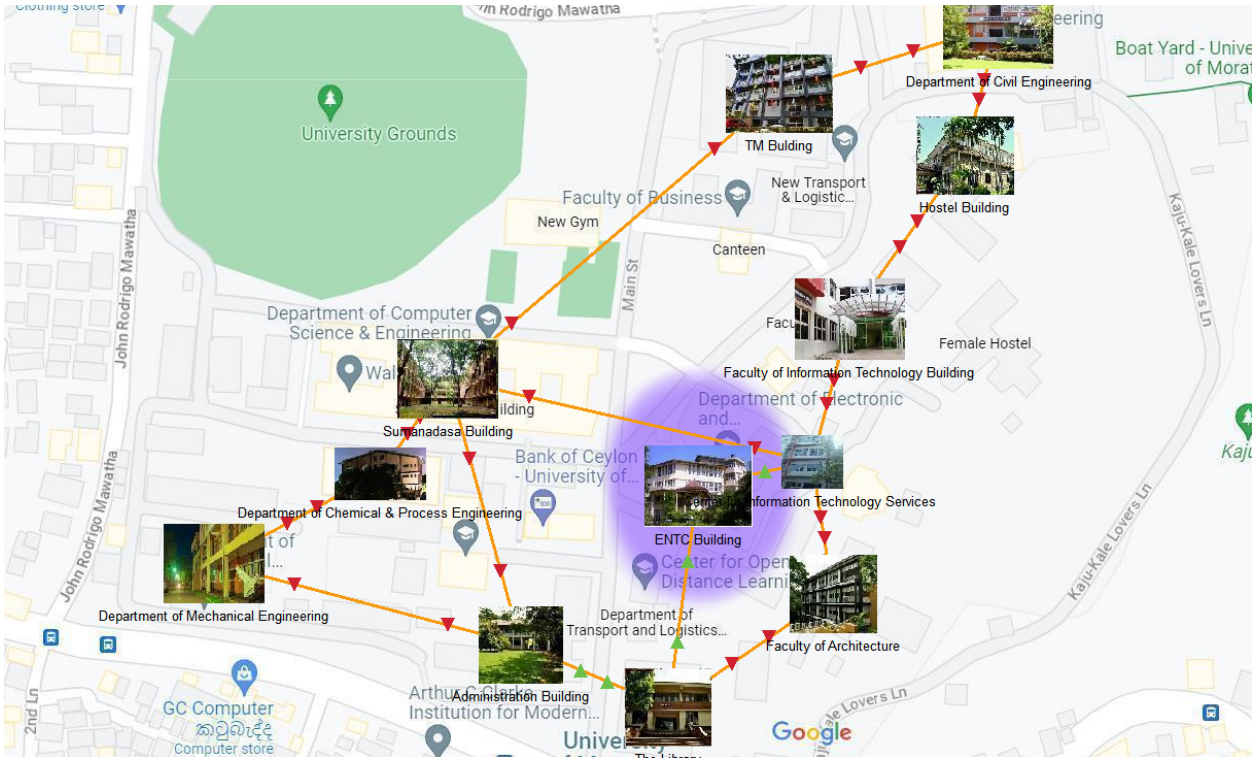
Design of the University Backbone Network

Overview of the design

Network Diagram



Logical organization of the network



Geographical organization

- The proposed backbone network consists of 12 nodes (excluding the core switches), which are placed in locations that cover all locations in the university where high network usage capabilities are needed. In addition to the present core network nodes, this includes locations such as the library and the hostel.

- The nodes are connected as a ring network with some additional connections at important nodes for redundancy. This is a version of a distributed backbone network. Distributed backbones are more suitable for networks spread out in a large physical area such as a university.

  The primary advantage of a ring-type distributed backbone is the reduced failure impact. There are at least two different paths between any two nodes, and many of them have more than two. Due to this redundancy, even if links fail in two places or a backbone node fails, there is likely to be an alternate path for the traffic, and the service will not be disrupted.

- Since the backbone nodes are routers (layer 3 switches), they will be used to segment the network into subnets connected to each node. This is useful for localizing and troubleshooting issues that arise in a network. It can also be used to avoid broadcast messages being sent to the entire university network, optimizing the use of the available bandwidth.

- A disadvantage of a normal ring network would be that if most of the data is transmitted from the same source, there is still a single point of failure despite the redundant routes provided by the

ring network. This would be the case if all data is routed from the CiTeS node. Therefore, the core switch also has a connection to the Sumanadasa node as a backup if the CiTeS node fails. In addition, there are redundant border routers and core switches to further reduce points of complete failure.

- To have a reliable network connection for general purpose tasks, we determined that at least 1Mbps speed is required for one device. A 10Gbps bandwidth for the backbone network will allow 10000 devices to connect simultaneously with a 1Mbps speed. Since the number of users in the university is less than 10000, and further it is unlikely that all users will connect at the same time, this bandwidth is sufficient for the university backbone network components.

IP Addressing scheme

For each node, the maximum number of users at one time was estimated. For some nodes such as Textile node, this accounted for the users in all the nearby departments covered by the node.

IPv4 addressing

Node	Expected no. of users	Subnet Size	Network Address
CITeS		1024	172.16.180.0/22
Office	250	1024	172.16.176.0/22
Library	1000	4096	172.16.128.0/20
ENTC	500	2048	172.16.168.0/21
Mechanical	500	2048	172.16.160.0/21
Civil	500	2048	172.16.152.0/21
Chemical	900	4096	172.16.112.0/20
Architecture	1100	8192	172.16.64.0/19
Textile	1100	8192	172.16.32.0/19
Sumanadasa	1500	8192	172.16.0.0/19
IT	500	2048	172.16.144.0/21
Hostel	800	4096	172.16.96.0/20
Total		**47104**	**172.16.0.0/12**

A class B private IP address space was used.

- Class B private IP address space : 172.16.0.0 to 172.31.255.255
- We have used the space from 172.16.0.0 to 172.16.183.255

Since this space is large enough, four times the required subnet size is allocated to each node, in order to account for future growth in the number of users.

IPv6 Addressing

A /48 IPv6 network (which is a standard available size) is divided into suitably sized subnets for each backbone node.

Node	**Expected no. of users**	**Subnet Size**	**Network Address IPV6**
CITeS		1024	2400:ee00:0010:b400::/54
Office	250	1024	2400:ee00:0010:b000::/54
Library	1000	4096	2400:ee00:0010:8000::/52
ENTC	500	2048	2400:ee00:0010:a800::/53
Mechanical	500	2048	2400:ee00:0010:a000::/53
Civil	500	2048	2400:ee00:0010:9800::/53
Chemical	900	4096	2400:ee00:0010:7000::/52
Architecture	1100	8192	2400:ee00:0010:4000::/51
Textile	1100	8192	2400:ee00:0010:2000::/51
Sumanadasa	1500	8192	2400:ee00:0010:0000::/51
IT	500	2048	2400:ee00:0010:9000::/53
Hostel	800	4096	2400:ee00:0010:6000::/52
Total		**47104**	**2400:ee00:0010::/48**

Selection of Active Components

The nodes in the backbone network will be Layer 3 switches. These switches will only be directly connected to adjacent backbone nodes and a building main router. Therefore, 24 port switches are sufficient with enough room for future modifications.

Specifications of routers and switches

- At nodes: 24 port, 10 Gbps, Layer 3 switch
- Core switches: 8 port, 10 Gbps, Layer 2 switch
- Border routers: 4 port, 10 Gbps multilayer switch

Selection of Passive Components

The links connecting the backbone nodes will be 10 Gbps single mode fiber cables. Single mode cables allow only one light ray to pass through, and the wavelengths that are used have less attenuation and degradation of the signal. Therefore single mode cables are more suitable for cables that connect over large distances, such as between buildings.

1Gbps multi-mode fiber cables will be used as a backup connection. Multi-mode fiber cables and interfaces are cheaper than single mode, and it is sufficient as a backup because the cable lengths are not extremely long.

Bill of Quantities

Active Components

Item Description	**Quantity**
24 port, 10 Gbps Layer 3 switch	12
8 port, 10 Gbps Layer 2 switch	2
4 port, 10 Gbps Layer 3 switch	2
10 Gbps Firewall	2

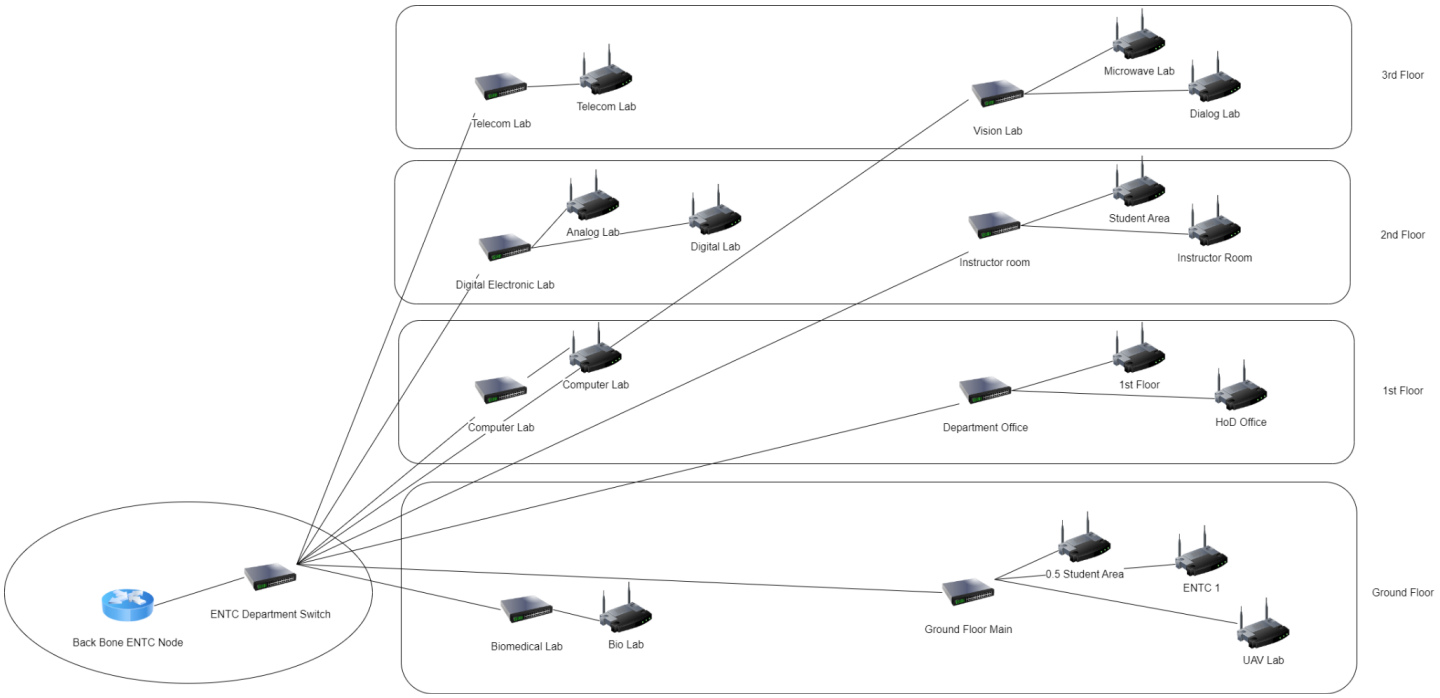
Passive Components

Item Description	**Quantity**
10 Gbps single-mode fiber cables	1600 m

1 Gbps multi-mode fiber cables	1600 m
Fiber connector modules	50 pcs

ENTC Network Design

Network Diagram



The ENTC backbone node connects to the department main switch, which connects to multilayer switches placed in various locations in the department. These switches are in locations where many network devices such as computers, access points and printers are likely to be connected.

Multi-layer switches are used to enable subnetting inside the department as well. This will reduce the size of the broadcast domain and make the network more bandwidth efficient.

1Gbps multi-mode fiber cables are used to connect the switches. From the same calculations used for the backbone network, we can assume that this bandwidth is enough for the whole department have at least a 1Mbps connection.

Cat5 Ethernet cables with a 100Mbps speed are used to connect access points and computers to switches. For ease of connecting, switches are connected to patch panels which lead to network ports in nearby rooms.

IP addressing

The complete address space allocated to ENTC is 172.16.168.0/21, which has 2048 addresses. If subnetting is used, each multilayer switch in the department will be assigned a subnet of size 256 (/24 network)

Location	**Network Address**
Ground floor	172.16.168.0/24
Biomedical lab	172.16.169.0/24
Computer lab	172.16.170.0/24
Department office	172.16.171.0/24
Digital lab	172.16.172.0/24
Instructor room	172.16.173.0/24
Telecom lab	172.16.174.0/24
Vision lab	172.16.175.0/24

Bill of Quantities

Active Components

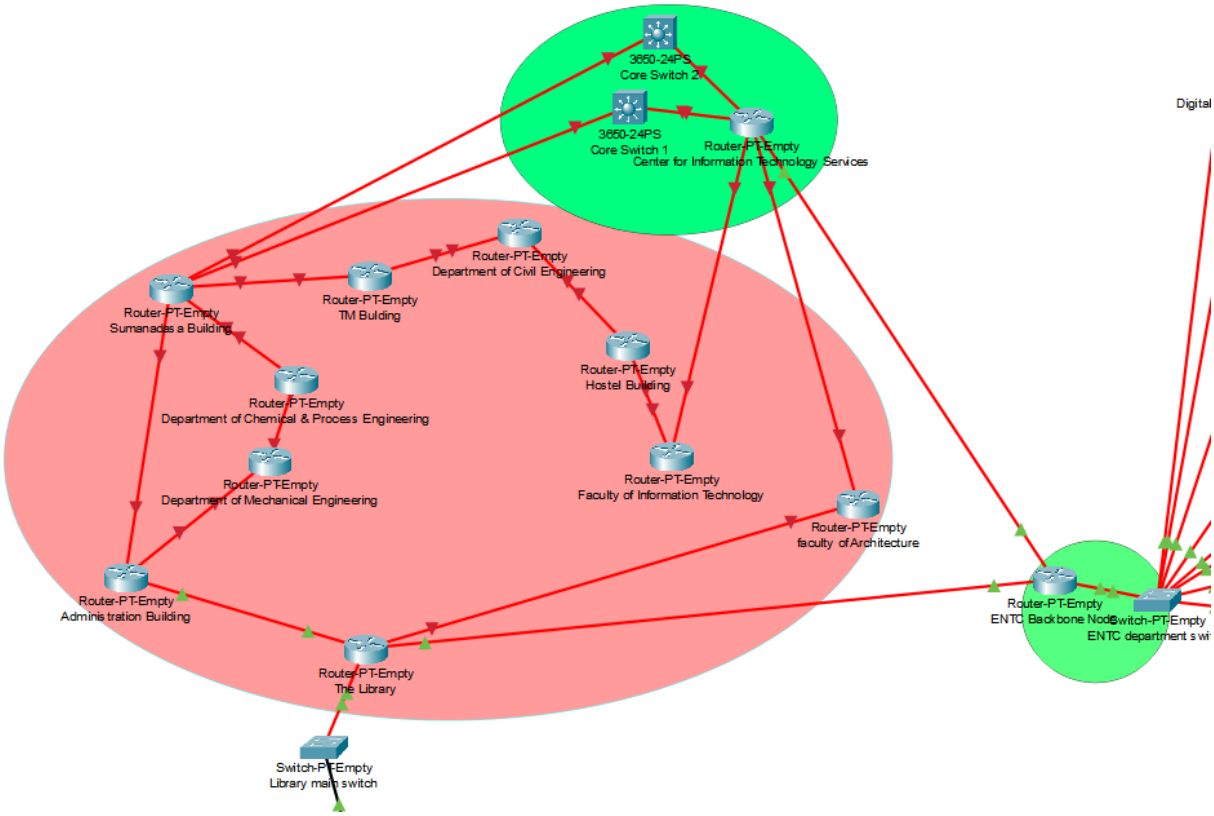
Item Description	Quantity
24 port, 10 Gbps Layer 3 switch	1
24 port, 1 Gbps Layer 2 switch	1
24 port, 1 Gbps Multilayer switch	8
WiFi access points	14

Passive Components

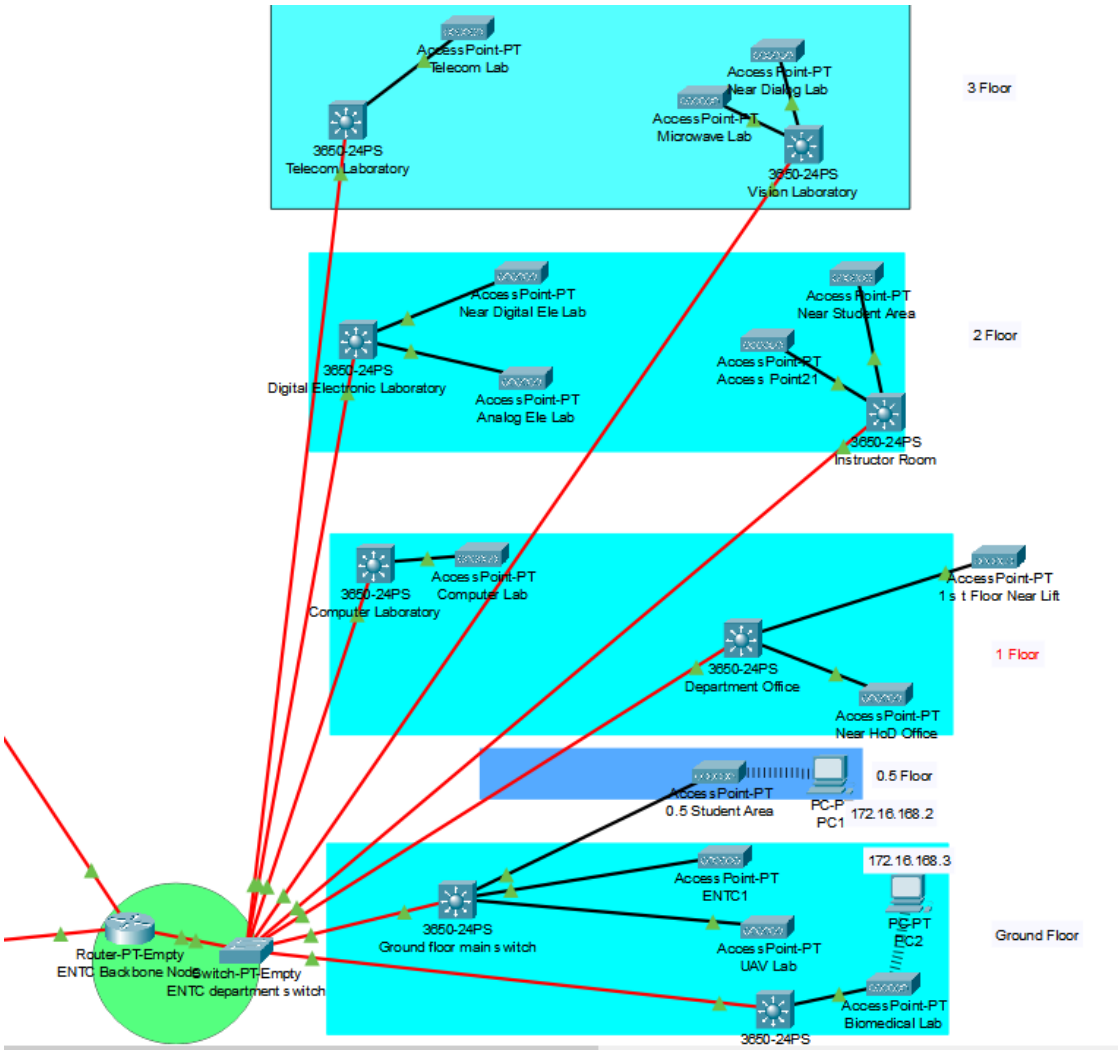
Item Description	Quantity
1 Gbps multi-mode fiber cables	200 m
Fiber connector modules	20 pcs
24 port fibre capable patch panels	10 pcs

Packet Tracer Simulation

Backbone network

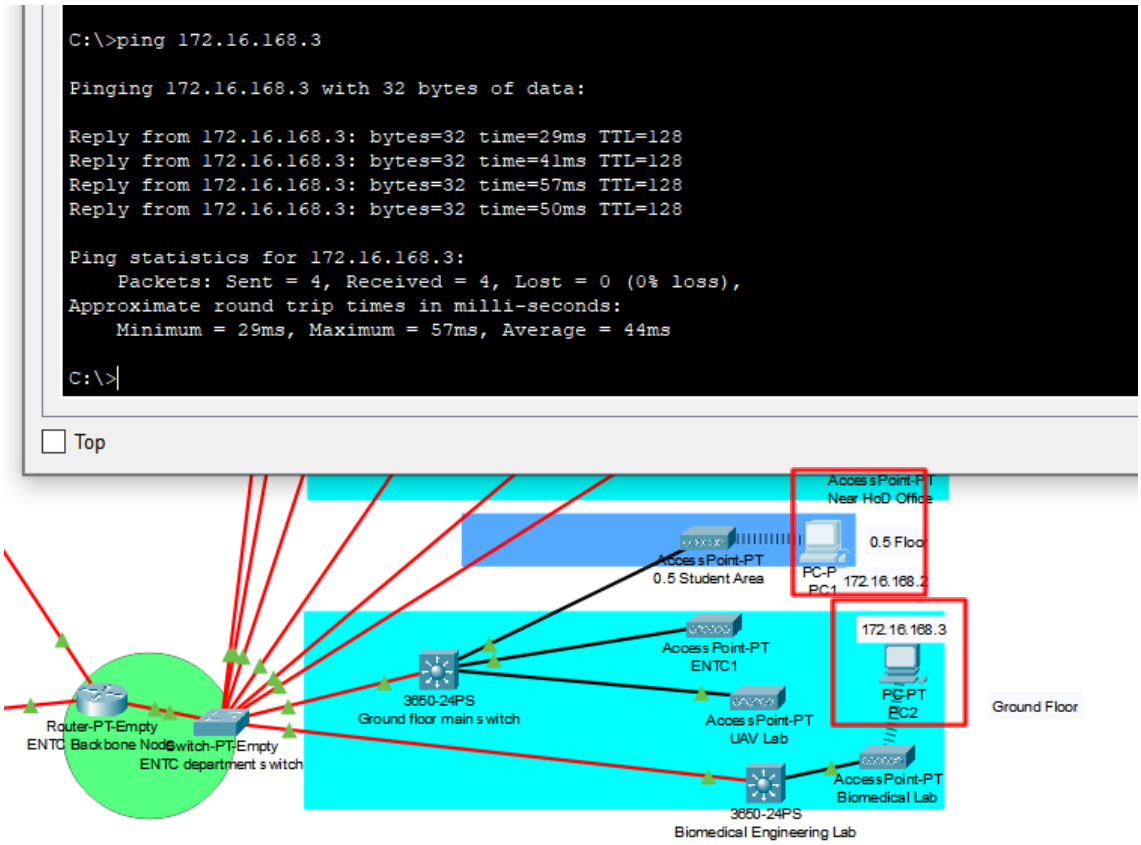


ENTC Network



Simulation Results

Ping within the ENTC subnetwork



Ping between two buildings (Library and ENTC)