University of Moratuwa

Department of Electronic and Telecommunication Engineering

EN2150 - Communication Network Engineering
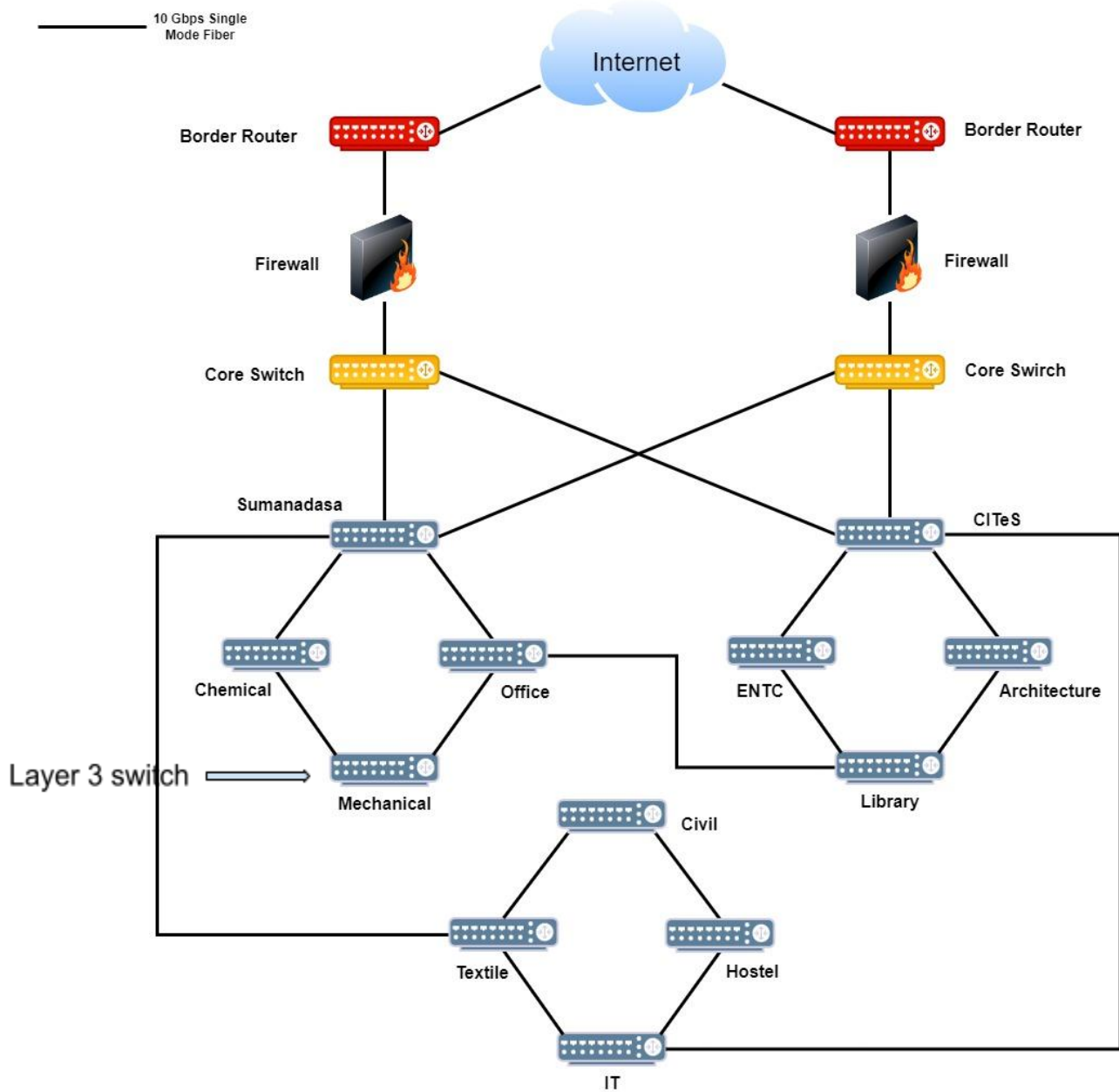
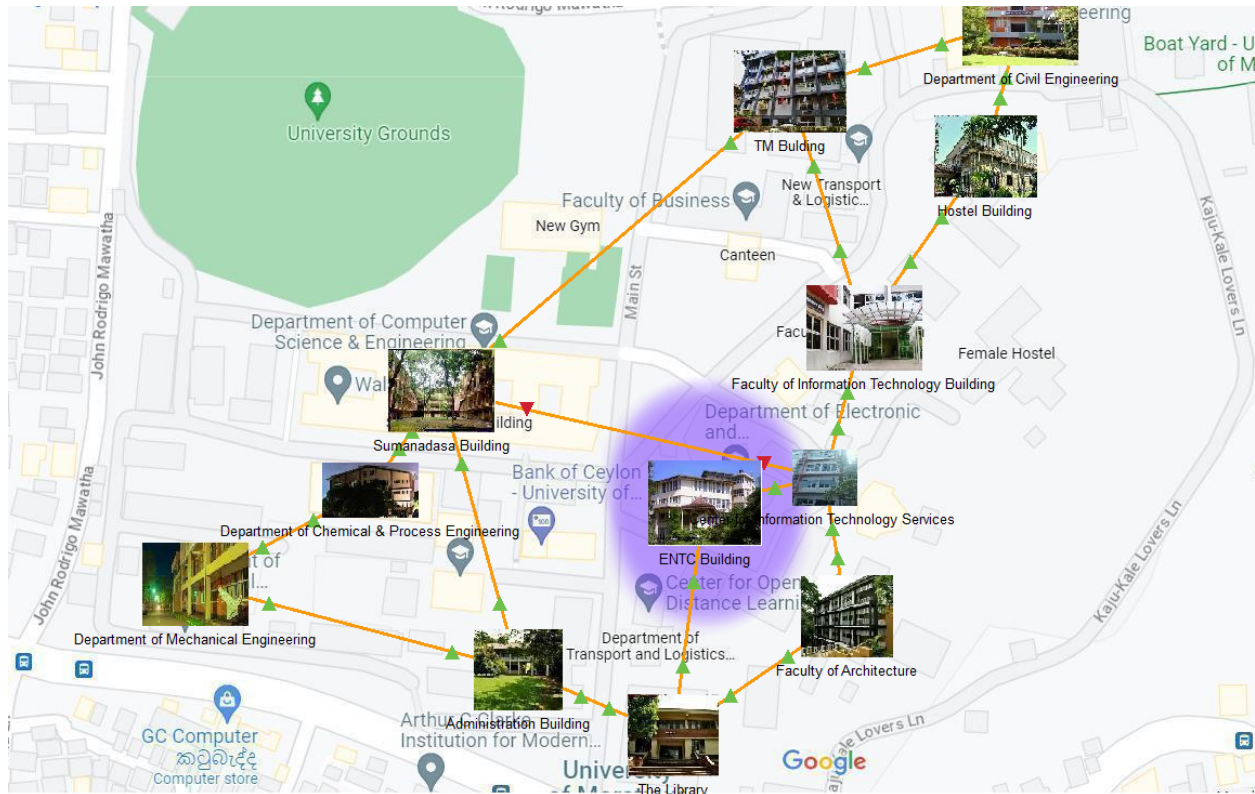## Network Routing Simulation - OSPF

Group - Panthers

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Designed Network Topology of the University Backbone Network

10 Gbps Single
Mode Fiber

Internet

Border Router

Border Router

Firewall

Firewall

Core Switch

Core Swirch

Sumanadasa

CITeS

Chemical

Office

ENTC

Architecture

Layer 3 switch

Mechanical

Library

Civil

Textile

Hostel

IT

Logical organization of the network

Geographical organization

- The 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.

- The nodes are connected as a ring network with some additional connections at important nodes for redundancy. 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.

- Each department/division connects to the backbone through a separate department switch. Several departments may also connect to the same backbone router.

IP addressing plan based on the network design

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.

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**

Network Design in Packet Tracer with IP addressing

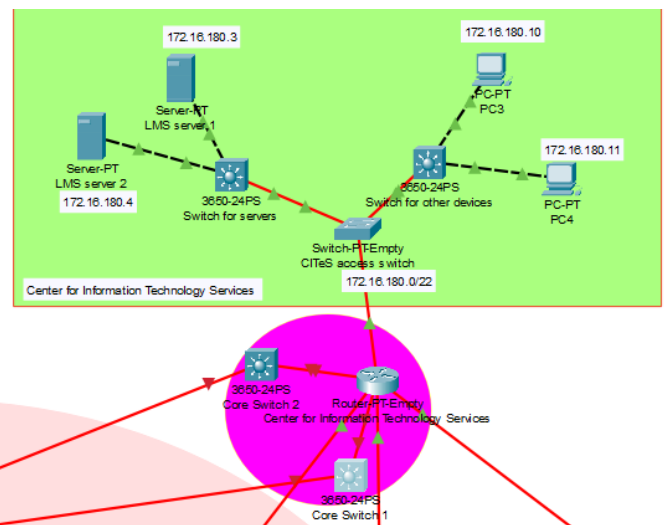*Backbone network and its connections to department switches*

- Connections between two routers in the backbone network use /30 networks such as 192.168.2.0/30, as only 2 IP addresses are needed.
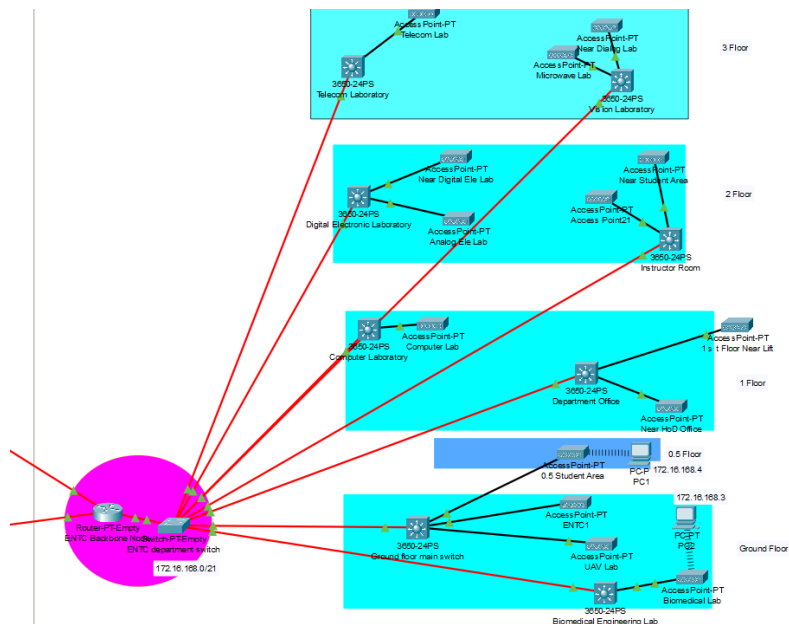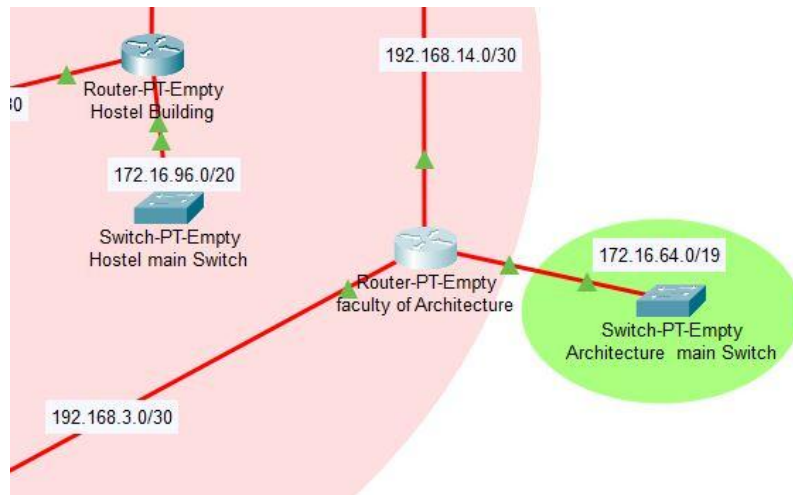
ENTC network connected to backbone
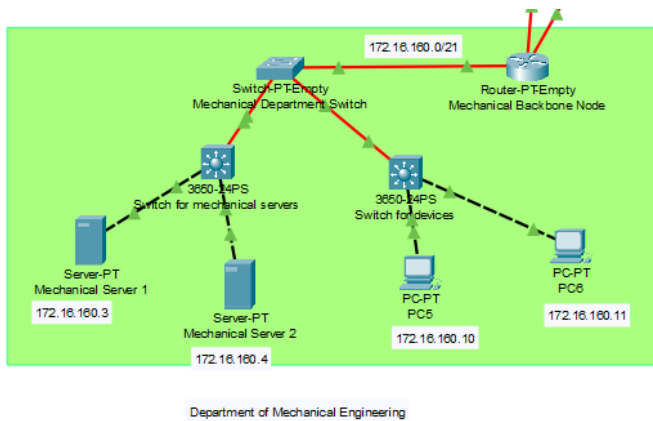
Mechanical Engineering Department

CITeS network and servers

Configuring OSPF in Routers

- Eg.: OSPF configuration for the Architecture


```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 1
Router(config-router)#router-id 8.8.8.8
Router(config-router)#network 192.168.3.0 0.0.0.3 area 0
Router(config-router)#network 192.168.14.0 0.0.0.3 area 0
00:02:55: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet6/0
Router(config-router)#network 172.16.64.0 0.0.31.255 area 0
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

● Routing table for the ENTC backbone node after configuring all routers

ENTC Backbone Node   — □ ✕

Physical   Config   CLI   Attributes

IOS Command Line Interface

```
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks
O       172.16.0.0/19 [110/4] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
O       172.16.32.0/19 [110/4] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
O       172.16.64.0/19 [110/3] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
O       172.16.96.0/20 [110/4] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
O       172.16.112.0/20 [110/5] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
O       172.16.128.0/20 [110/2] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
O       172.16.144.0/21 [110/3] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
O       172.16.152.0/21 [110/5] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
O       172.16.160.0/21 [110/4] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
C       172.16.168.0/21 is directly connected, GigabitEthernet7/0
O       172.16.176.0/21 [110/3] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
O       172.16.180.0/22 [110/2] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.1.0/30 is subnetted, 1 subnets
C       192.168.1.0 is directly connected, GigabitEthernet8/0
     192.168.2.0/30 is subnetted, 1 subnets
C       192.168.2.0 is directly connected, GigabitEthernet9/0
     192.168.3.0/30 is subnetted, 1 subnets
O       192.168.3.0 [110/2] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.4.0/30 is subnetted, 1 subnets
O       192.168.4.0 [110/2] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.5.0/30 is subnetted, 1 subnets
O       192.168.5.0 [110/3] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.6.0/30 is subnetted, 1 subnets
O       192.168.6.0 [110/4] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.7.0/30 is subnetted, 1 subnets
O       192.168.7.0 [110/4] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.8.0/30 is subnetted, 1 subnets
O       192.168.8.0 [110/3] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
     192.168.9.0/30 is subnetted, 1 subnets
O       192.168.9.0 [110/4] via 192.168.1.2, 00:24:36, GigabitEthernet8/0
                    [110/4] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.10.0/30 is subnetted, 1 subnets
O       192.168.10.0 [110/4] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.11.0/30 is subnetted, 1 subnets
O       192.168.11.0 [110/4] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.12.0/30 is subnetted, 1 subnets
O       192.168.12.0 [110/3] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.13.0/30 is subnetted, 1 subnets
O       192.168.13.0 [110/3] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.14.0/30 is subnetted, 1 subnets
O       192.168.14.0 [110/2] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
     192.168.15.0/30 is subnetted, 1 subnets
O       192.168.15.0 [110/2] via 192.168.2.2, 00:24:36, GigabitEthernet9/0
```

Simulations

The traceroute command was run for each scenario to show the routing path taken by the network session.
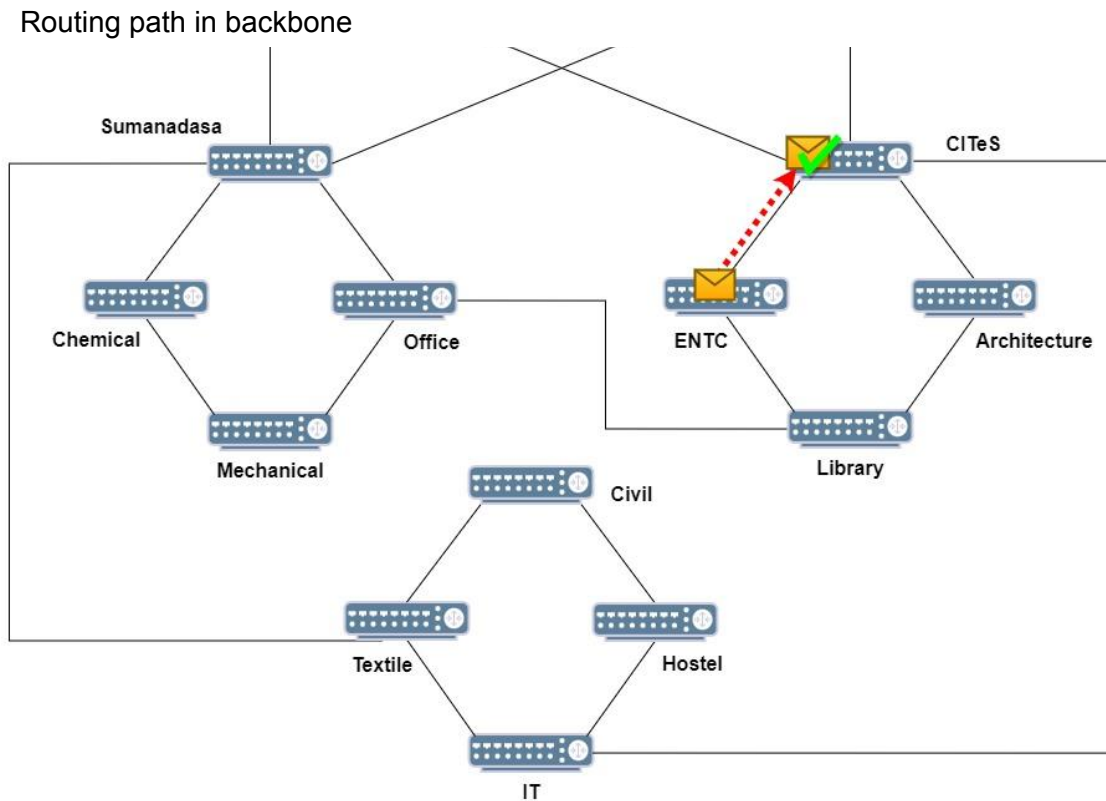
a) An ENTC student accessing LMS servers located at CITeS

```
C:\>tracert 172.16.180.4

Tracing route to 172.16.180.4 over a maximum of 30 hops:

  1    28 ms      22 ms      10 ms      172.16.168.1
  2    24 ms      8 ms       5 ms       192.168.2.2
  3    25 ms      7 ms       25 ms      172.16.180.4

Trace complete.
```

Routing path in backbone

b) The above session with the link between ENTC and CITeS nodes disabled
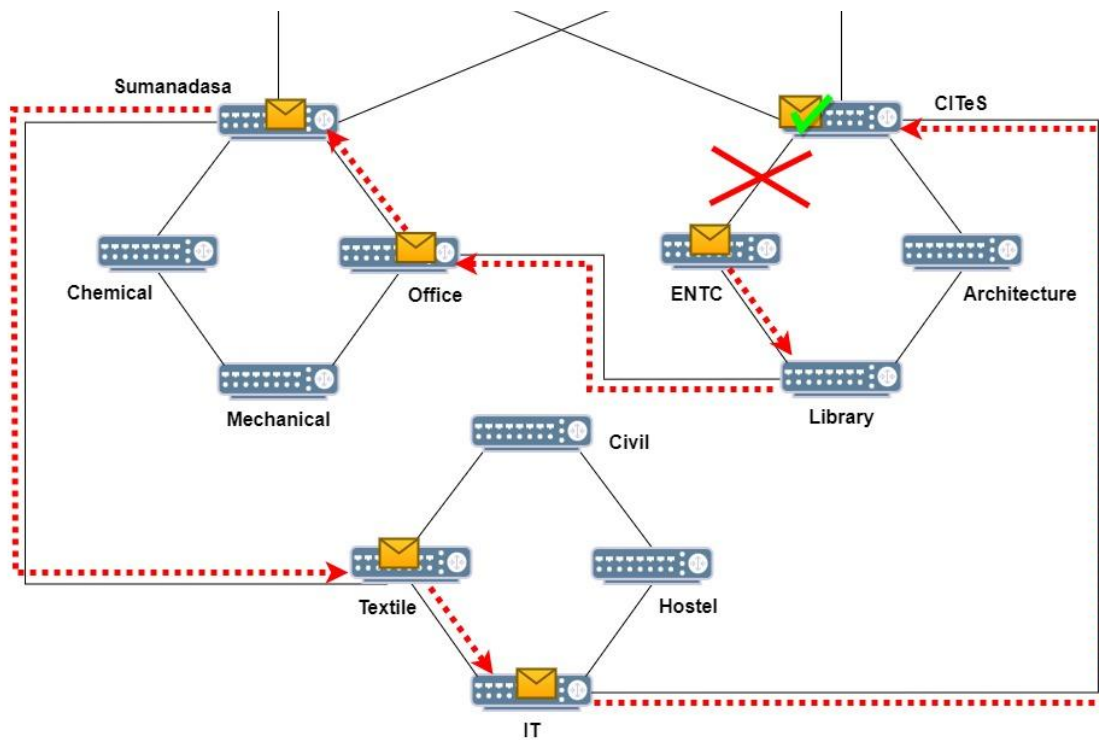
```
C:\>tracert 172.16.180.4

Tracing route to 172.16.180.4 over a maximum of 30 hops:

  1    22 ms      4 ms       33 ms      172.16.168.1
  2    11 ms      20 ms      27 ms      192.168.1.2
  3    19 ms      29 ms      11 ms      192.168.4.1
  4    23 ms      8 ms       8 ms       192.168.8.2
  5    12 ms      22 ms      19 ms      192.168.9.1
  6    30 ms      17 ms      33 ms      192.168.13.1
  7    34 ms      8 ms       24 ms      192.168.15.2
  8    20 ms      18 ms      28 ms      172.16.180.4

Trace complete.
```
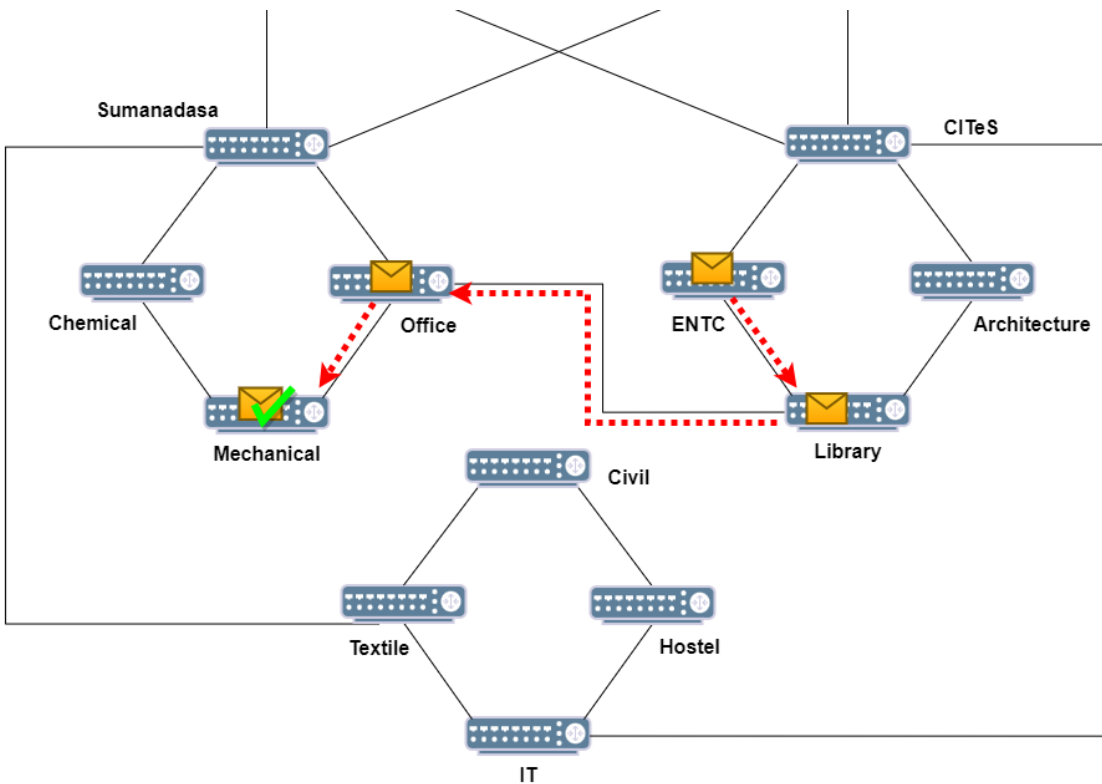
Routing path in backbone

c) An ENTC student accessing a server maintained at Mechanical Department

```
C:\>tracert 172.16.160.4

Tracing route to 172.16.160.4 over a maximum of 30 hops:

  1    19 ms      23 ms      11 ms      172.16.168.1
  2    10 ms      14 ms      20 ms      192.168.1.2
  3    16 ms      7 ms       12 ms      192.168.4.1
  4    9 ms       16 ms      6 ms       192.168.5.1
  5    *          22 ms      10 ms      172.16.160.4

Trace complete.
```

d) The above session with the link between Mechanical and Admin nodes disabled

```
C:\>tracert 172.16.160.4

Tracing route to 172.16.160.4 over a maximum of 30 hops:

  1    6 ms      9 ms      5 ms      172.16.168.1
  2    7 ms     12 ms     14 ms      192.168.1.2
  3   18 ms     17 ms     39 ms      192.168.4.1
  4   57 ms     32 ms     45 ms      192.168.8.2
  5   19 ms     10 ms     43 ms      192.168.7.2
  6    5 ms     16 ms     15 ms      192.168.6.1
  7   47 ms     52 ms     59 ms      172.16.160.4

Trace complete.
```