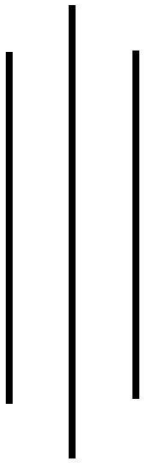

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS



# Computer Networks Project Report

A network topology of UNIVERSITY ( Stanford University )

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**Submitted To:**
Department of Electronics
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# TITLE: REPORT ON MAKING A NETWORK TOPOLOGY OF A UNIVERSITY ( STANFORD UNIVERSITY )

## RELATED INFORMATION:

As part of my project in computer networks, I have decided to create a network topology of Stanford University where I have included the following departments: ( Since, such university is very huge having many departments and sub-departments ,it would be too huge for this mini-project ,thus I went to official website of Standford university and selected a few of those departments & sub-departments for this project and a bit modified as per requirement)

They are:

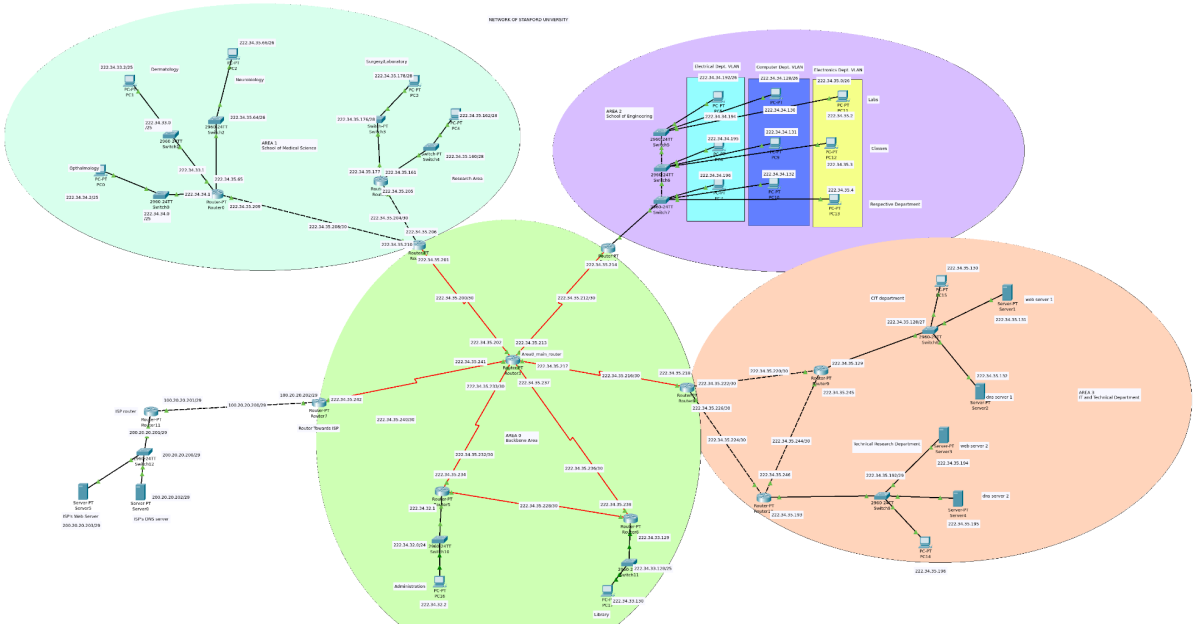
1. School of Medical Science:
    a. Neurobiology
    b. Opthalmology
    c. Dermatology
    d. Practical / Surgery lab
    e. Research Department
2. School of Engineering:
    a. Electrical
    b. Computer
    c. Electronics

- Each have computers in **departments** ( where executives of respective departments reside ) , **labs** and **classes**. Thus making a good reason to do VLAN.

3. IT and Technical Department
    a. CIT
    b. Technical Research Department
4. Administration
5. Library

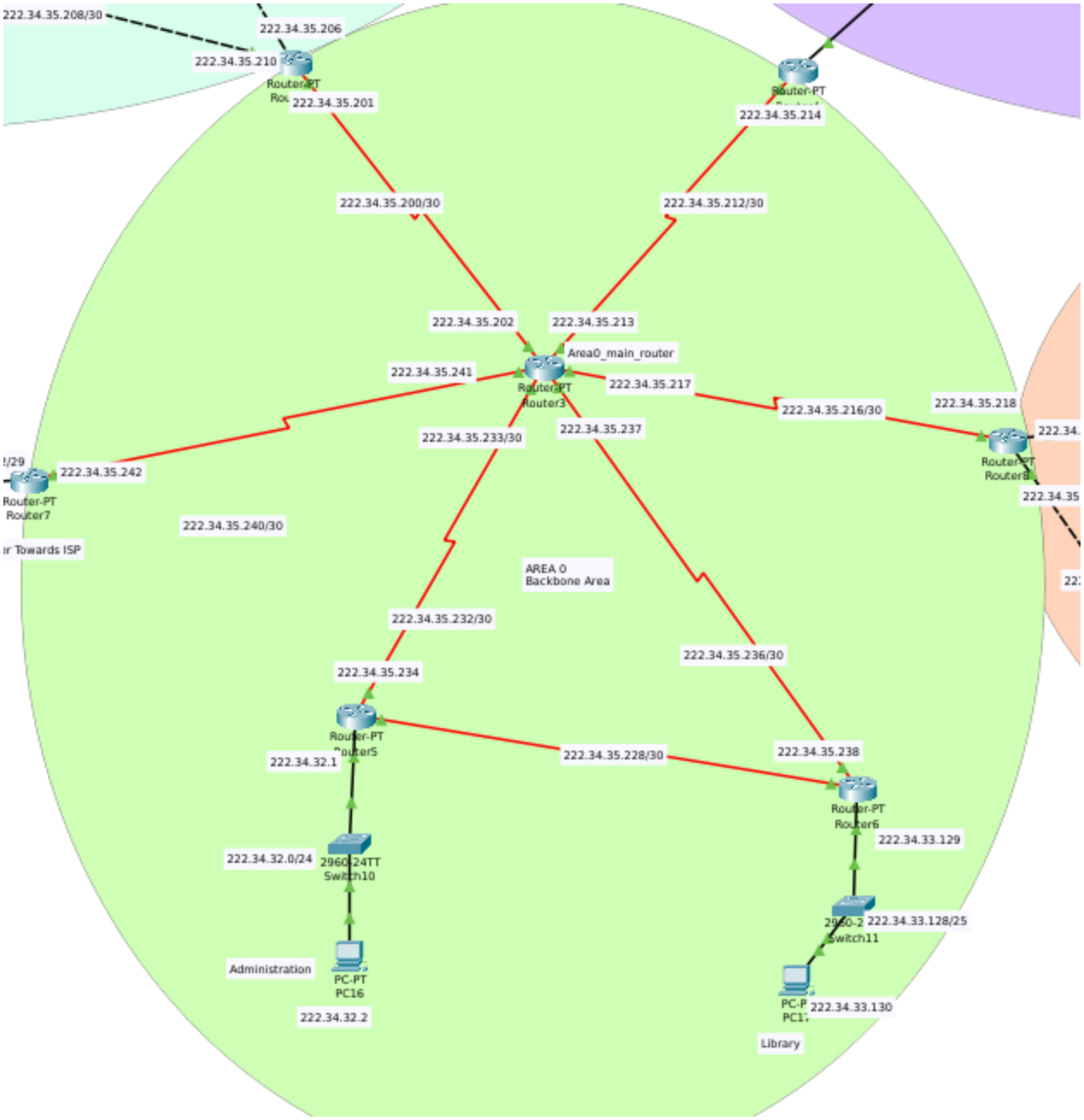
- **I just chose this much for this mini-project, but in actual Stanford University, there are many many more.**

# NETWORK TOPOLOGY:

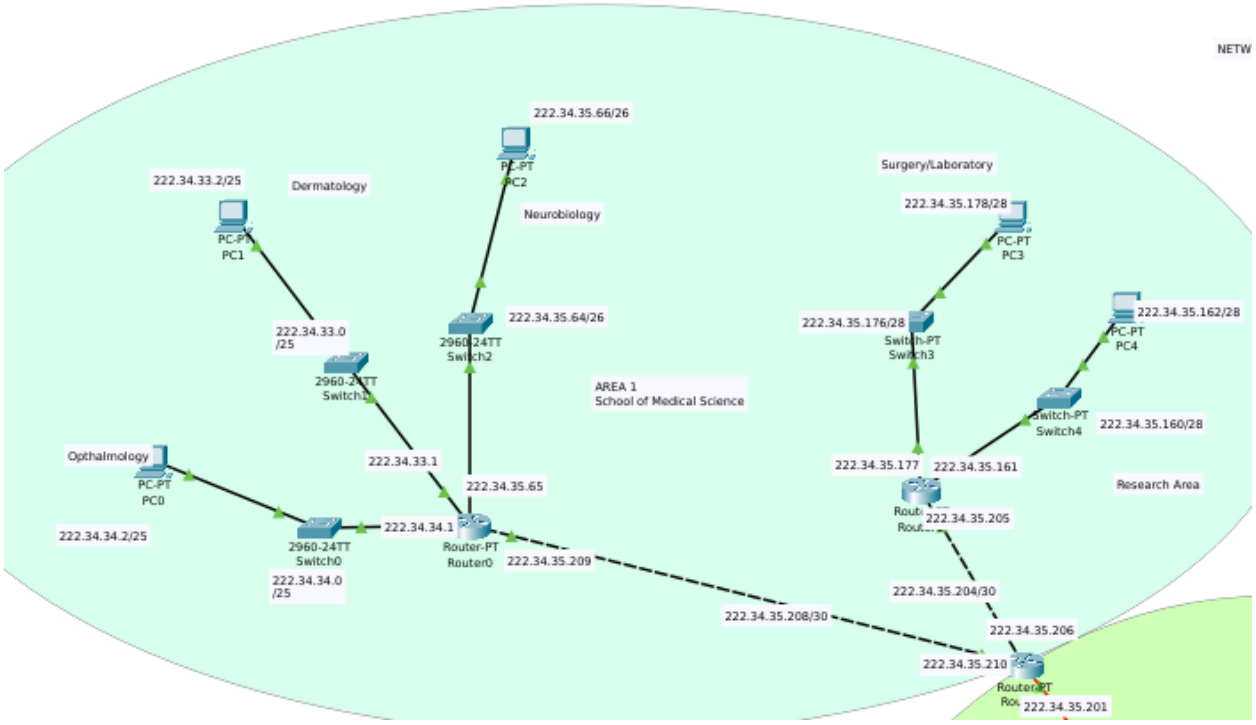


# Detailed view:

## Area 0:


222.34.35.208/30
222.34.35.206
222.34.35.210
222.34.35.201
222.34.35.214
222.34.35.200/30
222.34.35.212/30
222.34.35.202
222.34.35.213
Area0_main_router
Router3
222.34.35.241
222.34.35.217
222.34.35.216/30
222.34.35.218
222.34.35.233/30
222.34.35.237
222.34.35.242
Router7
222.34.35.240/30
AREA 0
Backbone Area
222.34.35.232/30
222.34.35.236/30
222.34.35.234
222.34.32.1
222.34.35.228/30
222.34.35.238
222.34.32.0/24
Switch10
222.34.33.129
Switch11
222.34.33.128/25
Administration
PC16
222.34.32.2
222.34.33.130
Library

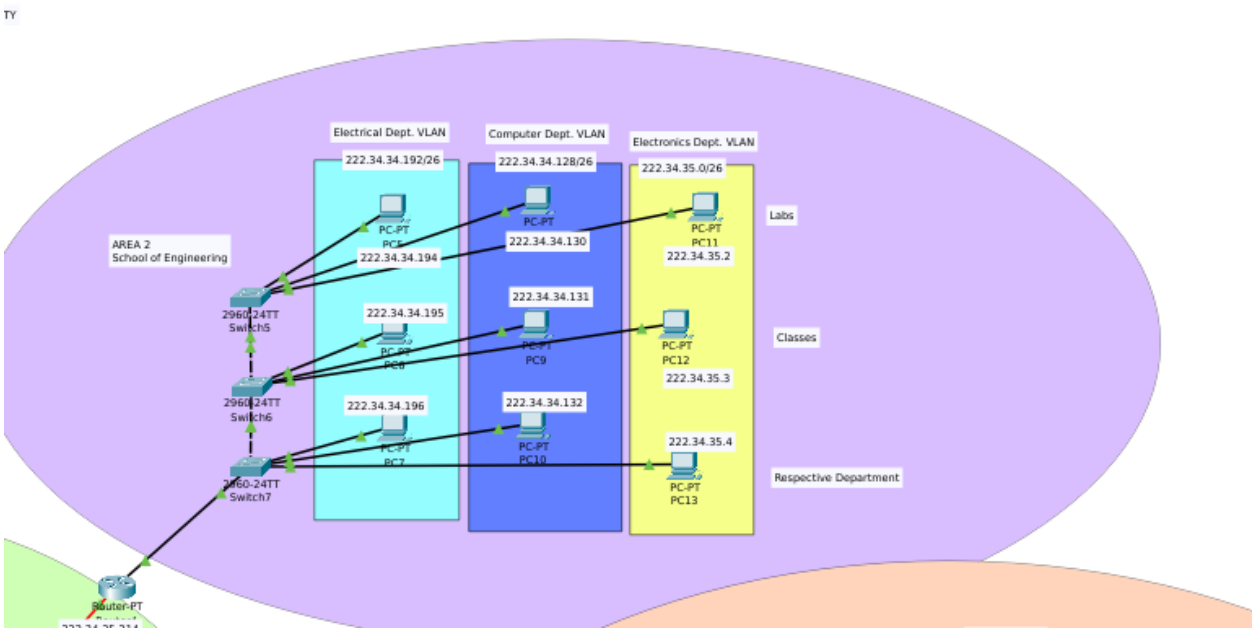
## Area 1:




## Area 2:

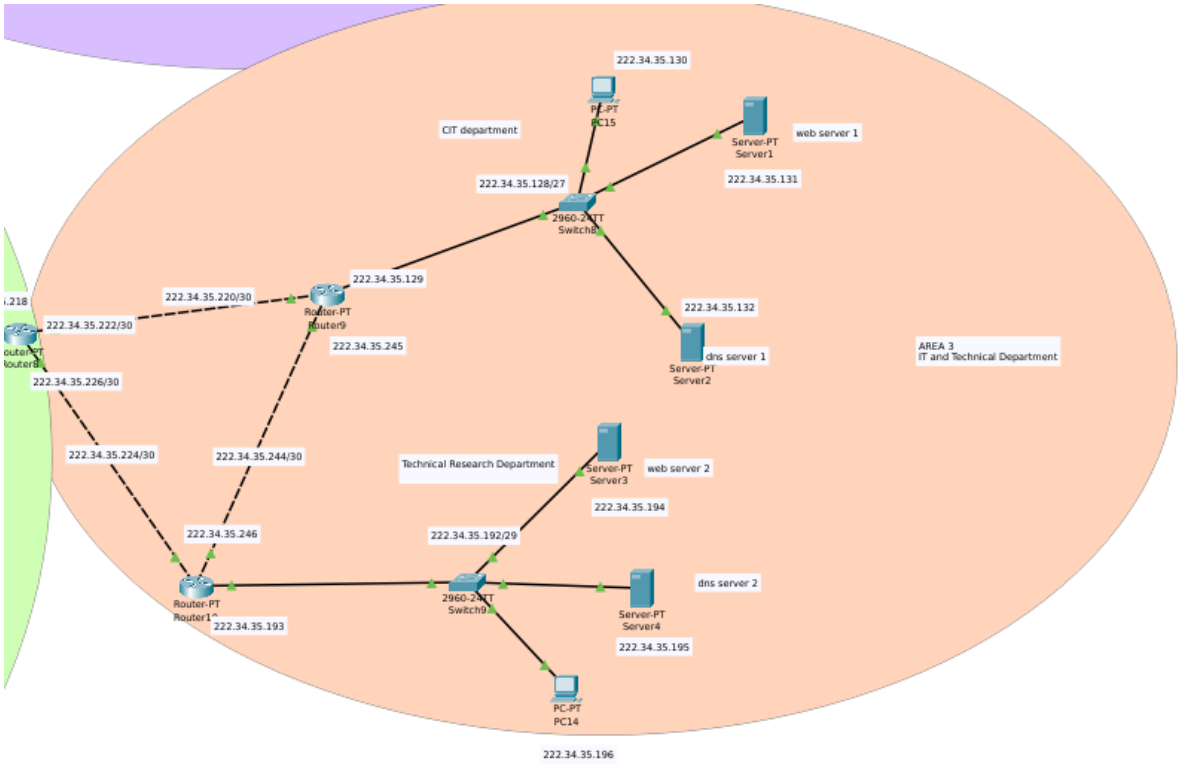
Three VLANs are created:

a. Computer Engineering VLAN
b. Electronics Engineering VLAN
c. Electrical Engineering VLAN



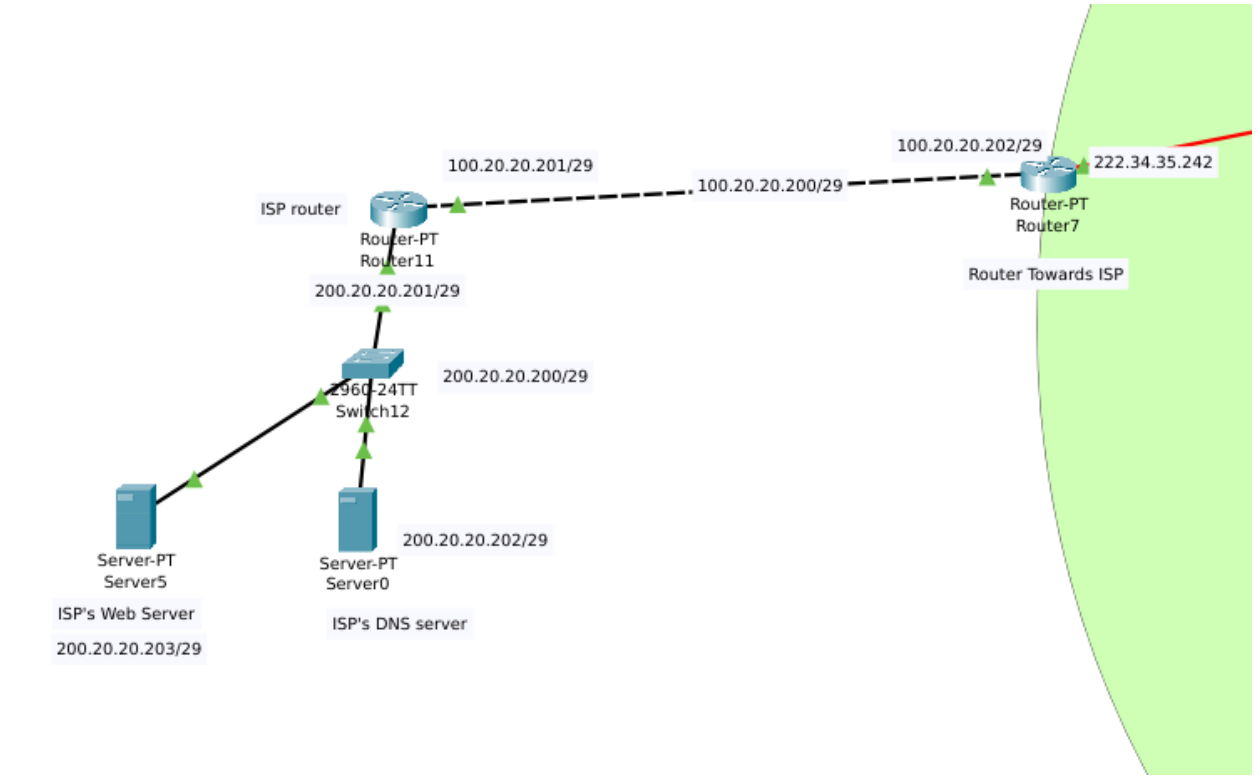

## Area 3:

- Area 3 is IT and Technical Department, **thus it consists of 2 web servers and 2 DNS in two different networks as specified in requirements.**




**Connection to ISP:**

( ISP router is on left side )



# SUBNETTING AND CIDR:

**IP address given to STANFORD UNIVERSITY: 222.34.32.0 / 22**
**[ Note: In my Proposal mistakenly i did put 234.34.32.0/22 as main ip address, but now i changed that to 222.34.32.0 / 22 and subnetted that ip address ]**

**No. of AREA = 4**

| Subnet Name | Needed Size | Allocated Size | Address | Mask | Dec Mask | Broadcast |
|---|---|---|---|---|---|---|
| Administration | 254 | 254 | 222.34.32.0 | /24 | 255.255.255.0 | 222.34.32.255 |
| Dermatology | 126 | 126 | 222.34.33.0 | /25 | 255.255.255.128 | 222.34.33.127 |
| Library | 126 | 126 | 222.34.33.128 | /25 | 255.255.255.128 | 222.34.33.255 |
| Opthalmology | 126 | 126 | 222.34.34.0 | /25 | 255.255.255.128 | 222.34.34.127 |
| Computer(VLAN) | 62 | 62 | 222.34.34.128 | /26 | 255.255.255.192 | 222.34.34.191 |
| Electrical(VLAN) | 62 | 62 | 222.34.34.192 | /26 | 255.255.255.192 | 222.34.34.255 |
| Electronics(VLAN) | 62 | 62 | 222.34.35.0 | /26 | 255.255.255.192 | 222.34.35.63 |
| Neurobiology | 62 | 62 | 222.34.35.64 | /26 | 255.255.255.192 | 222.34.35.127 |
| CIT Department | 30 | 30 | 222.34.35.128 | /27 | 255.255.255.224 | 222.34.35.159 |
| Research Area | 14 | 14 | 222.34.35.160 | /28 | 255.255.255.240 | 222.34.35.175 |
| Surgery/Laboratory | 14 | 14 | 222.34.35.176 | /28 | 255.255.255.240 | 222.34.35.191 |
| Technical Research Department | 6 | 6 | 222.34.35.192 | /29 | 255.255.255.248 | 222.34.35.199 |
| ABR01-Area0 main router | 2 | 2 | 222.34.35.200 | /30 | 255.255.255.252 | 222.34.35.203 |
| ABR01-Medical Labs | 2 | 2 | 222.34.35.204 | /30 | 255.255.255.252 | 222.34.35.207 |
| ABR01-Medical schools | 2 | 2 | 222.34.35.208 | /30 | 255.255.255.252 | 222.34.35.211 |
| ABR02-Area0 main router | 2 | 2 | 222.34.35.212 | /30 | 255.255.255.252 | 222.34.35.215 |
| ABR03-Area0 main router | 2 | 2 | 222.34.35.216 | /30 | 255.255.255.252 | 222.34.35.219 |
| ABR03-CIT | 2 | 2 | 222.34.35.220 | /30 | 255.255.255.252 | 222.34.35.223 |
| ABR03-Technical Research Dept | 2 | 2 | 222.34.35.224 | /30 | 255.255.255.252 | 222.34.35.227 |
| Administration-Library | 2 | 2 | 222.34.35.228 | /30 | 255.255.255.252 | 222.34.35.231 |
| Area0 main router-Administration | 2 | 2 | 222.34.35.232 | /30 | 255.255.255.252 | 222.34.35.235 |
| Area0 main router-Library | 2 | 2 | 222.34.35.236 | /30 | 255.255.255.252 | 222.34.35.239 |
| Area0 main router-Router towards ISP | 2 | 2 | 222.34.35.240 | /30 | 255.255.255.252 | 222.34.35.243 |
| CIT-Technical Research | 2 | 2 | 222.34.35.244 | /30 | 255.255.255.252 | 222.34.35.247 |
| | | | | | | |
| | | | | | | |
| OTHER IP Assumed: | | | | | | |
| ISP Router - Router_towards_ISP | 2 | 2 | 100.20.20.200 | /29 | 255.255.255.248 | |
| ISP Router Network | 6 | 6 | 200.20.20.200 | /29 | 255.255.255.248 | |

**Note: ABR01- means Area Border Router between area 0 and area 1**

# Work Done:

1. **Each and Every requirement as mentioned in lab proposal as well as final report is carried out successfully.**

# Observations:

1. Allocation of IP addresses to different Subnets,Router configurations, interface IPs of router,Dynamic Routing with OSPF etc. Is done and observed carefully for errors.
2. 4 areas are made for OSPF and Inter-area routing is done internally.OSPF is used for internal routing.All Internet traffic is forwarded towards upstream service provider. Similarly, network packets are forwarded towards my network
   from ISP without dynamic routing.

   For example: below is output showing OSPF exists in ‘Avisek1’ router [ i.e. router of medical schools ) [ i.e. In area 1 ]

```
avisek1>show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 222.34.35.210 to network 0.0.0.0

O IA 222.34.32.0/24 [110/130] via 222.34.35.210, 03:02:37, FastEthernet7/0
     222.34.33.0/25 is subnetted, 2 subnets
C       222.34.33.0 is directly connected, FastEthernet0/0
O IA    222.34.33.128 [110/130] via 222.34.35.210, 03:02:37, FastEthernet7/0
     222.34.34.0/24 is variably subnetted, 3 subnets, 2 masks
C       222.34.34.0/25 is directly connected, FastEthernet6/0
O IA    222.34.34.128/26 [110/130] via 222.34.35.210, 03:02:37, FastEthernet7/0
O IA    222.34.34.192/26 [110/130] via 222.34.35.210, 03:02:37, FastEthernet7/0
     222.34.35.0/24 is variably subnetted, 18 subnets, 5 masks
O IA    222.34.35.0/26 [110/130] via 222.34.35.210, 03:02:37, FastEthernet7/0
C       222.34.35.64/26 is directly connected, FastEthernet1/0
O IA    222.34.35.128/27 [110/131] via 222.34.35.210, 03:02:37, FastEthernet7/0
```

3. Each device can ping any other device as there is usage of inter area OSPF,Default gateway, etc.
   - Say I ping from a PC at Neurobiology department (PC2) [ Area 1 ]

a. To its gateway: ( Area 1 )

```
C:\>ping 222.34.35.65

Pinging 222.34.35.65 with 32 bytes of data:

Reply from 222.34.35.65: bytes=32 time<1ms TTL=255
Reply from 222.34.35.65: bytes=32 time<1ms TTL=255
Reply from 222.34.35.65: bytes=32 time<1ms TTL=255
Reply from 222.34.35.65: bytes=32 time<1ms TTL=255

Ping statistics for 222.34.35.65:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

b. To PC of Dermatology department( Area 1 )

```
C:\>ping 222.34.33.2

Pinging 222.34.33.2 with 32 bytes of data:

Request timed out.
Reply from 222.34.33.2: bytes=32 time<1ms TTL=127
Reply from 222.34.33.2: bytes=32 time=1ms TTL=127
Reply from 222.34.33.2: bytes=32 time<1ms TTL=127

Ping statistics for 222.34.33.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

c. To PC of Administration ( Area 0 )

```
C:\>ping 222.34.32.2

Pinging 222.34.32.2 with 32 bytes of data:

Reply from 222.34.32.2: bytes=32 time=3ms TTL=124
Reply from 222.34.32.2: bytes=32 time=27ms TTL=124
Reply from 222.34.32.2: bytes=32 time=10ms TTL=124
Reply from 222.34.32.2: bytes=32 time=42ms TTL=124

Ping statistics for 222.34.32.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 42ms, Average = 20ms
```

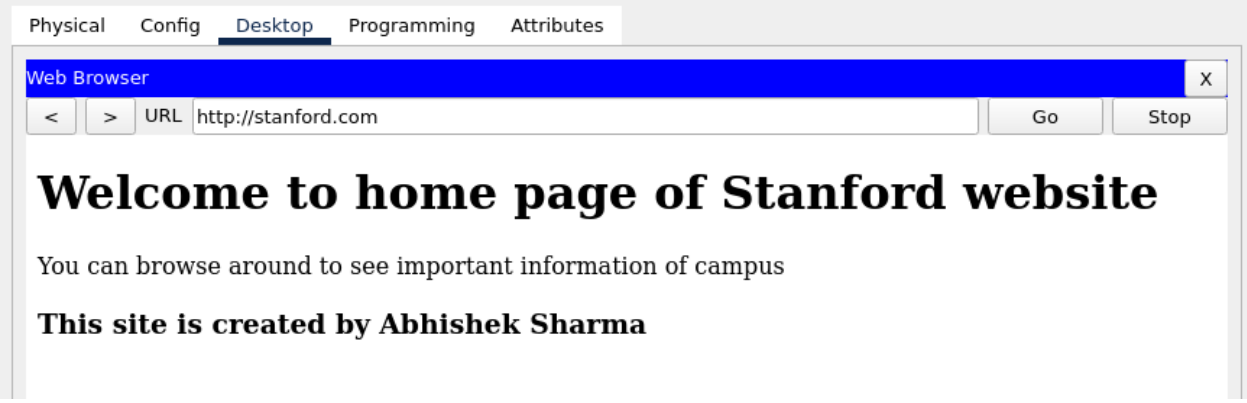
d. To Web Server 1 ( Area 3 )

```
C:\>ping 222.34.35.131

Pinging 222.34.35.131 with 32 bytes of data:

Reply from 222.34.35.131: bytes=32 time=28ms TTL=123
Reply from 222.34.35.131: bytes=32 time=10ms TTL=123
Reply from 222.34.35.131: bytes=32 time=12ms TTL=123
Reply from 222.34.35.131: bytes=32 time=2ms TTL=123

Ping statistics for 222.34.35.131:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 28ms, Average = 13ms
```

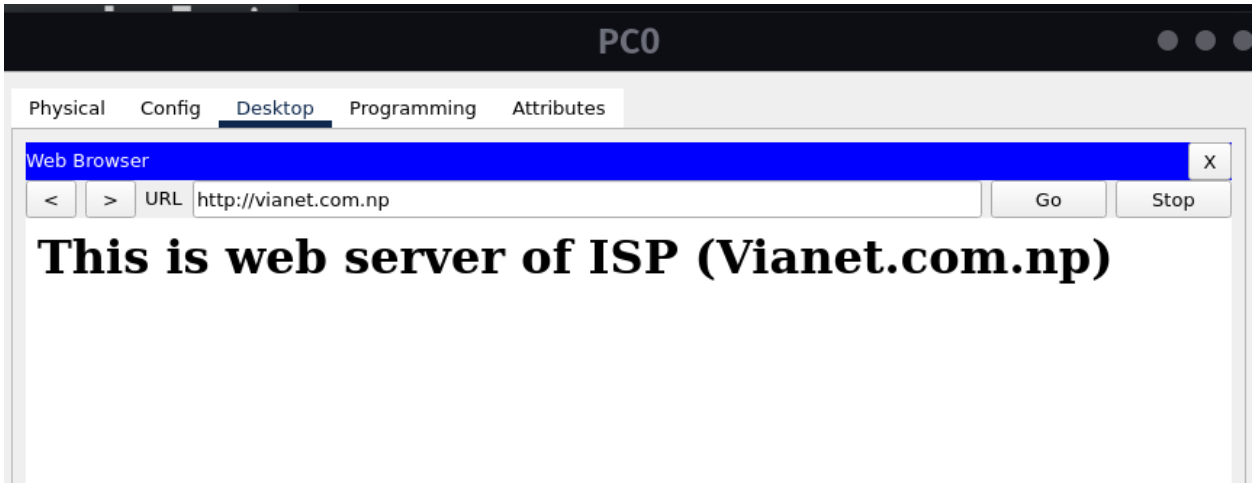
e. To PC of Computer Vlan ( computer Labs ) [ Area 2 ]

```
C:\>ping 222.34.34.130

Pinging 222.34.34.130 with 32 bytes of data:

Reply from 222.34.34.130: bytes=32 time=34ms TTL=124
Reply from 222.34.34.130: bytes=32 time=2ms TTL=124
Reply from 222.34.34.130: bytes=32 time=19ms TTL=124

Ping statistics for 222.34.34.130:
    Packets: Sent = 3, Received = 3, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 34ms, Average = 18ms
```

4. The VLAN configuration is successfully made as shown in above pic of AREA 2. Also , Inter VLAN Routing with Router-on-a-stick is done.
5. I didn't use DHCP server, so I manually put all the IP addresses,subnet masks, dns server address, default gateway,etc.
6. Each device can access to Stanford's site: "www.stanford.com" or "stanford.com" and Admin site ( needs login) "admin.stanford.com" . One web server hosts 'stanford.com' and other hosts 'admin.stanford.com'. Use of Two DNS server is done in two different networks.




7. The DNS server of upstream is pointed if there is no match of those above sites, i.e. for any external URIs.
   I.e. Any other domain name will be forwarded to DNS of ISP; here for example: “vianet.com.np” can be accessed from ISP’s web server




8. There exists multiple path in at least two networks ( one redundant path is  in area 3, other in area 0 )

## Conclusion:

Thus, this project successfully demonstrates the network topology of a university ( Stanford University ) with all the requirements/guidelines being followed.This project thus helped us to realize a university level network infrastructure/architecture.