Overview of IPv4, IPv6, Networking and Designing a Network Based on IPv4 in Shariatpur Polytechnic Institute's Campus

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1. Abstract:

At the present time IPv4 is the most and widely used networking protocol. Now-a-days IPv4 is in a critical situation for huge of demand. That's why the networking world introducesIPv6. This paper tries to present the overview of IPv4, IPv6 and networking concepts. It also presents an entire network design based on IPv4 on Shariatpur Polytechnic Institute Campus.

2. Introduction:

From the beginning of internet, IPV4 has been using as a network layer protocol. But now, the use of IPV4 is so high that is not even imagined when it was designed. At present, internet addresses exhaustion, routing scalability, broken end to end property approach to inconsolable problem which all is dependent on IPv4.

IPV4 address served by IANA (Internet Assigned Number Authority) are about to end. According to a report of 2013, IPv4 address of RIRS (Regional Internet registries) will be fearfully reduced within three years which is a great threat for the internet world. To solve this problem IPv6 is invented.IPv6 is next generation network protocol which address format has 128 bits and it can be fulfilled the demand for many years.

3. Protocol Specification:

3.1 IPv4:

IPv4 has 32 bits. These 32 bits are divided into 4 octets and each octet is separated by dots "."

As example: 192.168.30.1

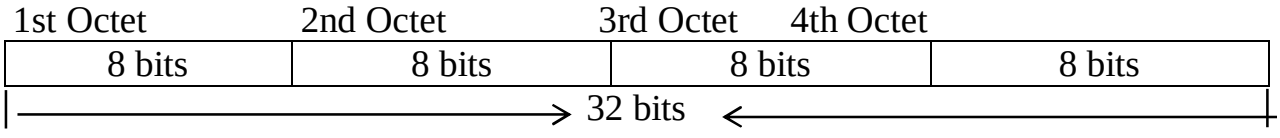


Figure: 32 bits IPv4.

There are five types of IPv4 in accordance with Class.

Class	First Octet Range	Bit Sequence	Default Subnet Mask	Users Level
A	0 to 127	0000 0000 to 0111 1111	255.0.0.0	Public Users
B	128 to 191	1000 0000 to 1011 1111	255.255.0.0	
C	192 to 223	1100 0000 to 1101 1111	255.255.255.0	
D	224 to 239	1110 0000 to 1110 1111	—	Multicast
E	240 to 255	1111 0000 to 1111 1111	—	High Security Purpose

Figure: IPv4 Classification according to class.

For Class A

N	H	H	H

For Class B

N	N	H	H

For Class C

N	N	N	H

Here,
N = Network
H = Host

Figure: Network and host part for Class A, Class B and Class C IPv4 Address.

There are two types of IPv4 in accordance with application.

a. Public
b. Private

Public IP is to purchase from ISP to use. On the other hand, Private IP can be used in local networks without any cost. Free of cost IP are:

For Class A: 10.0.0.0 to 10.255.255.255
For Class B: 172.16.0.0 to 172.31.255.255
For Class C: 192.168.0.0 to 192.168.255.255
*Loopback IP- 127.0.0.1 for checking NIC card.

If we want to use IPv4 as a fixed class, Network and Host part can be determined by default subnet mask. Again, if there is CIDR (Classless Inter Domain Routing) value with an IP then Network and Host part will have to be determined. Then, That IP cannot be considered as a fixed class IP. It is called classless IP.

3.2 IPv6:

IPv6 has 128 bits these 128 bits are divided into 8 segments, each segment is separated by colon ":".

To memories IPv4 address there will be two conditions;

a. We can drop any leading zero in each of the individual block. For example;

00dc:0000:0000:00a0:0629:0000:0000:001a

For this IPv6 we can drop leading zero, such as:

dc:0:0:a0:629:0:0:1a

b. We can remove contiguous zero block by double (::), but if there are two separate zero block that can replace only one contiguous zero block by double (::). For example;

00dc:0000:0000:00a0:0629:0000:0000:001a

We can rearrange the IPv6 as

dc:0:0:a0:629::1a

Or, dc::a0:629:0:0:1a

There are three types of IPv6. Such as:

a. Unicast
b. Anycast
c. Multicast

In IPv6, Prefix is being used to understand network and host. Subnet mask or wild card mask is not used here.

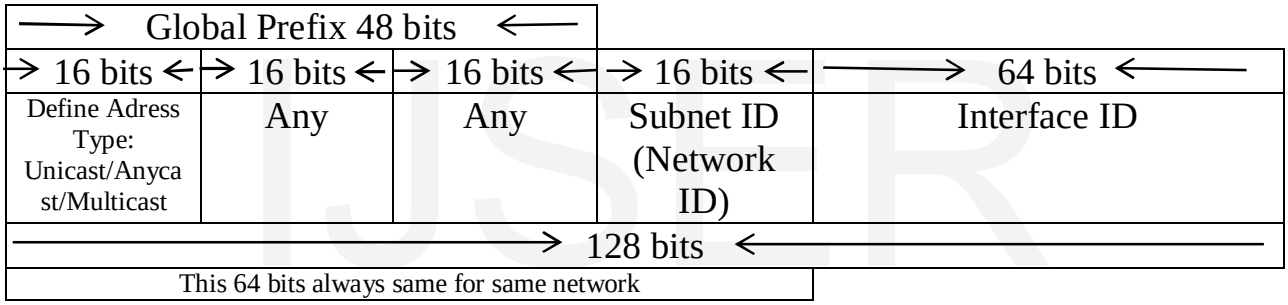


Figure: 128 bits IPv6.

3.2.1 Unicast:

There are three types of unicast IP.

a. Global Unicast: These can used to route globally same as public IP of IPv4.
   2000::/3
   Example: 2000:123:aOc:10::/64
b. Uniq Local Unicast: These IP cannot communicate globally same as private IP of IPv4.

FC.00::/7

   Example: fc00:123:abc:10::1/64
c. Link local Unicast: These are neither public nor private IP. These are used in research work or in other purposes.
   fe80::/10
   Example: fe80:123:abc:10::1/64

3.2.2 Any cast:

Any cast works as redundant system. Let, three hosts/servers are given same IP address. There will be no confliction, but all hosts will not work simultaneously. If one host/server is in trouble or shutdown then another one will work on automatically. Generally, these are used as back up IPs and are globally routed.

3ffe::/64

Example:

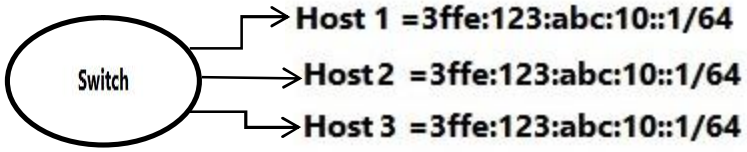


Figure: Use as a web server

In IPv4, this process is not possible where secondary server has to make using by same IP when primary is down then secondary will automatically up. This is a complex process.

3.2.3 Multicast:

In IPv6, Multicast IP is used to maintain protocol between routers to router. For example: RIP, EIGRP, and OSPF. IPs of these protocols communicates among themselves.

ff00:18

Example: ff00: 123: abc: 10: 1/64

*Loopback IP- ::/128 for checking NIC card.

4. The Structure of Computer Networks:

The internal construction of the computer network is very complicated and also differs from computer industries to industries, from the regional area to another regional area and also the private networks make its own private modifications. So, the actual physical construction of the network is not the concern of the designers. Data transfer between two or more devices called networking. For networking we need two active devices and a channel.

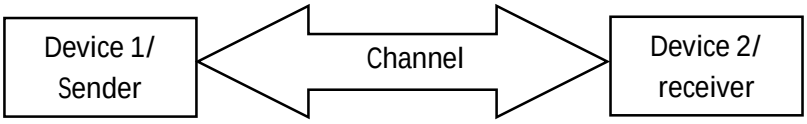


Figure: Basic networking diagram

4.1 Why Networking:

- To save time.
- To save cost.
- For high security.
- To save energy.

4.2 Where Networking:

- For Information Sharing.
- For resource sharing.
- For remote communication.
- In distributed system.

4.3 For a success network system we need:

- Protocols (Set of rules).
- Media/ channel.
- Network interface module.
- Two active entity or device.

Actually there are two kind of networking group. Such as:

- Peer-to-peer communication: Here only two device share information or data each other. As like as Bluetooth.
- Work group communication: There are two or more networking device communicates each other and share information. For the connection establishment we need many kind of connection topologies. The structure of the network is sub-divided into some criteria:
- Topology
- Geographical Area
- Data injection into the network
- Networking systems

4.3.1 Topology:

Topology in the field of computer network shows the common structure in which the computers in the network are really connected. It is not like the geographically connection area but the virtual connection area. The popular topologies are:

- Bus topology
- Ring topology
- Star topology
- Mesh topology

4.3.1.1 Bus Topology:

Bus topology is the basic topology. In this topology computers are connected to a single connecting line serially. The main disadvantage of this type of connection is it is slow, having no security for the data as all the computer in the way can intercept data packet

and it does not serve with alternative route which is required for the computers for real-time access in the network.

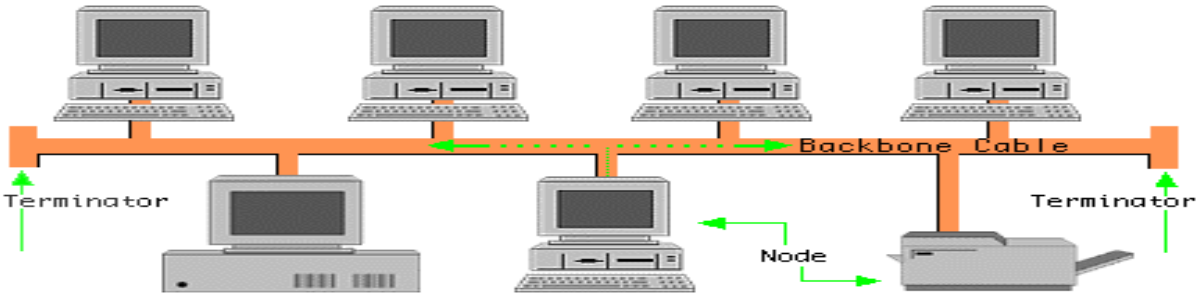


Figure: Bus Topology

4.3.1.2 Ring Topology:

Ring topology is like a cyclic connection. The connecting wire ends with the starting point. It is the improvement of the Bus topology as it provides bi-directional route for communication, choose which is the smallest path for travel to the destination computer. But it has all the other drawback of the Bus topology.

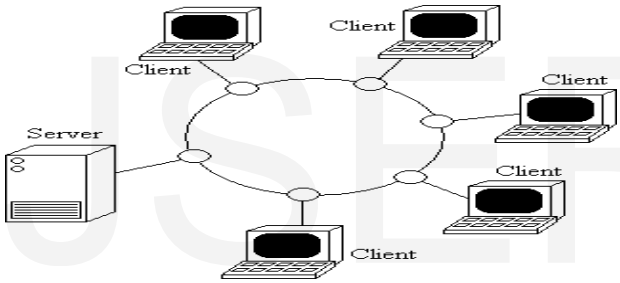


Figure: Ring Topology

4.3.1.3 Mesh Topology:

In the Mesh topology, each pair of computers in the network share a connecting wire. It is fastest connection and reliable as none of other users can access the shared link. But this is costly and complex to maintain as too much wire is used.

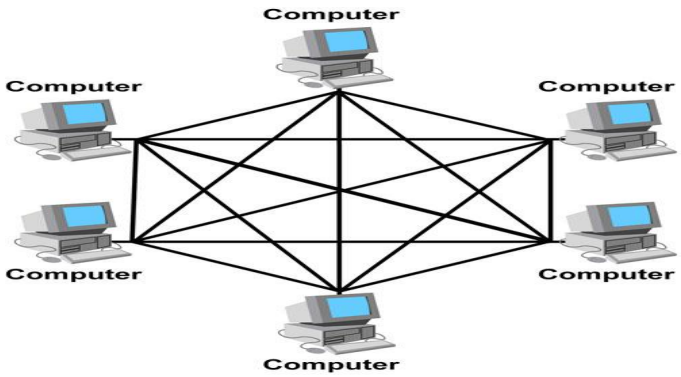


Figure: Mesh Topology

4.3.1.4 Star Topology:

The Star topology is just an advancement of the Mesh topology. Here rather than connecting each pair of computer with a single wire, each computer is connected to a central switching devise. This reduces the wire required for the star connection. This Star topology is popular and used in almost everywhere. But this topology has a great drawback; if the switching device is compromised the entire data link is compromised.

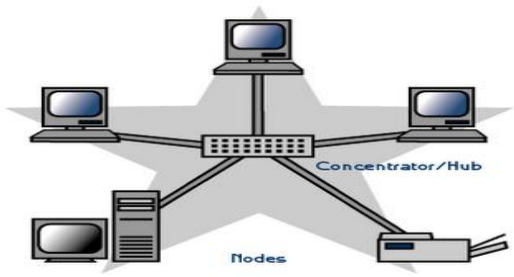


Figure: Star Topology

4.3.2 Geographical Area:

This section actually defines the geographical area which is covered by the network. The regional division is not the concern but the geographical area which is covered by the network sub-section is includes in the calculation. For the geographical area network, there are three divisions of network. Those are:

- LAN (Local Area Network)
- WAN (Wide Area Network)
- MAN (Metropolitan Area Network)

4.3.2.1 LAN (Local Area Network):

Local area network covers small geographical area. Individual companies use their own private networks internally in their domain which basically a LAN network. LAN network provides the service of sharing valuable resources, central database, authentication of the private network of the company etc.

4.3.2.2 WAN (Wide Area Network):

WAN covers larger geographical area than LAN. Basically, WAN is the summation of some LANs. It represents a regional area for the computer network. It provides the routing service for that region.

4.3.2.3 MAN (Metropolitan Area Network):

MAN covers a metropolitan city. It can be consist of several LANs or several WANs depending on the size of the city.

4.3.3 Data Injection in the Network:

This sub-section runs in the computers not in the network. It is the computational system for the user to network data processing or vice-versa for the transmission of the information. The widely used computational system for the data communication is TCP/IP protocol model. It is a layered model and it has five layers from user level to the suitable format of the information for transmission from the sender computer to the receiver computer. Each layer add header of that layer for the suitable information to use throughout the process of the communicating between senders to receivers. Those layers are (top to bottom view):

- Application layer
- Transport layer
- Network layer
- Data link layer
- Physical layer

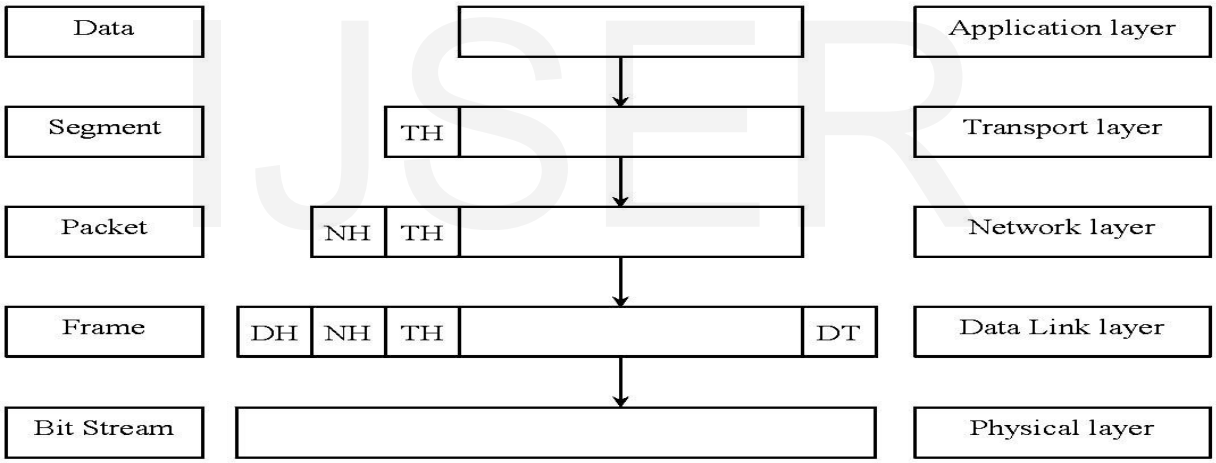


Figure: TCP/IP Model Layered Architecture.

4.3.3.1 Application Layer:

The application layer is the user level layer. In this stage the computer take input of the information which user wants to transfer from his/her computer to the receiver computer. Ports are the software interface of the application layer to communication with the lower layer.

4.3.3.2 Transport Layer:

This is the second layer of the TCP/IP protocol model. The input of this layer is the output of previous layer (Application layer). The main task of the transport layer is to keep track

which data packet is for which process of the receiver computer. It add transport layer header with the information and then it is called the segment.

4.3.3.3 Network Layer:

Each layer of the TCP/IP model is essential but the network layer is most important layer. Because this layer is for routing within the network. If this layer failed to work properly the information sending via the network will not reach to the desire receiver, so the whole process of the sharing information will be a failure. The input of this layer is segment (the output of transport layer). This layer insert network layer header. After inserting the network layer header the segment is converted into packet and send to the layer below it, which is data link layer. The network can be IPv4 or IPv6 version. According to the/ network version the header varies. This layer adds sender address and receiver address within the information.

4.3.3.4 Data link layer:

The data link layer provides flow control, error control and framing service. This layer insert data link layer header and the packet is now converted into frame, which is now ready to inject to the network. The data link layer injects the information frame into the physical layer.

4.3.3.5 Physical layer:

The physical layer transports the data packet to the receiver computer via the physical connections of computer in the network. Depending on medium of the physical layer, the network can be two types –

- Wire-connected network
- Wireless network

5.1 Network Drawback:

Computer network is the modern technique of transferring information. There are still some drawbacks exist. Those drawbacks are:

- Routing problem
- Security over the network

Modern researchers are trying to overcome those drawbacks to make the system more reliable and more efficient. Our targeted topic is network security. To obtain this goal we implemented cryptology over the information. Then injected the information packet to the network.

5.2Network Security:

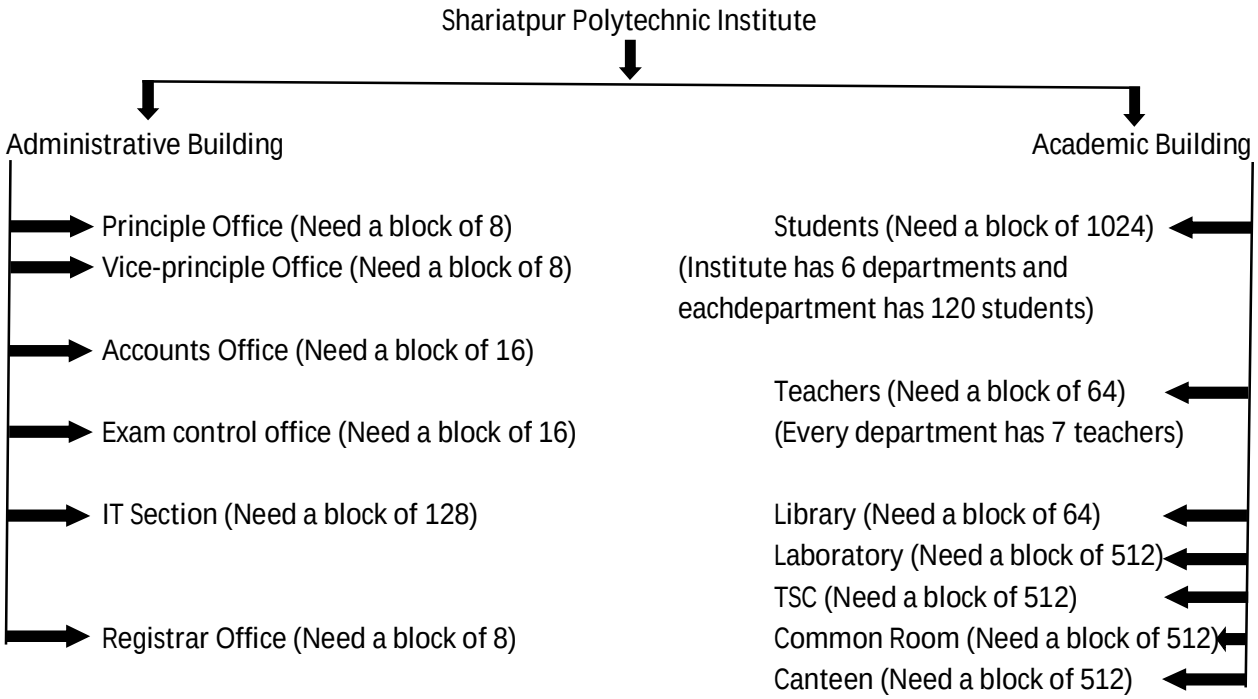
Network security is normally defined as the methods and principles adopted by the network administrator to prevent unauthorized intermediate users to get access, misuse or modification computer network and network-accessible resources. Network security involves the authorization of users to get access in a network, which is monitored by the network administrator. Networks can be private, such as within a company, and others which might be open for public access. In the private network, network security provides authentication service for the verification of exact user to get permitted in the network. And in the public network, network security provides authentication and data confidentiality services. The network security can be improved in two sections. One is improving the authentication system and prevents the unwanted users and data packets in the network. For this department, firewall is applied in the routers. Firewall discards all unwanted data packets that are selected by the network administrator. And for the authentication service password based permission scheme can be applied. Another section of network security is to change the original data for transmission in a way which is only known to the receiver end only. In this way, if the unwanted intermediate users anyhow get access to the network and intercept the data packet he will get garbage information and will not understand the original information. Appling cryptography in the information in sender end serves this service.

6. The Design of the Network (IPv4 Based) on Shariatpur Polytechnic Institute's Campus:

At first we have to follow some steps to complete the networking process. Such as:

- Figure out the network and host requirement.
- Satisfy the network and host requirement.
  - # Figure out network bits
  - # Figure out host bits
- Determined the subnet mask.
- Figure out the block size.
  - # Find out Net IP
  - # Find out Broadcast IP
- Calculate total available host IP

We have two buildings in our institute campus. One is Administrative building and the other is Academic building. The chart given below describes each and every department of the Institute with the block size.



We need:-
1024 Hosts Block= 1
512 Hosts Block = 4
128 Hosts Block = 2
64 Hosts Block = 2
16Hosts Block = 2
8Hosts Block = 2

We determined 192.168.0.0/22 as the pure network.Then we find 64 blocks and each block have 1024 IP.

NET ID: 192.168.0.0
Broadcast ID: 192.168.3.255➔0th
Subnet Mask: 255.255.252.0

here we have 64 blocks and every block consists 1024 hosts

NET ID: 192.168.252.0
Broadcast ID: 192.168.255.255➔63th
Subnet Mask: 255.255.252.0

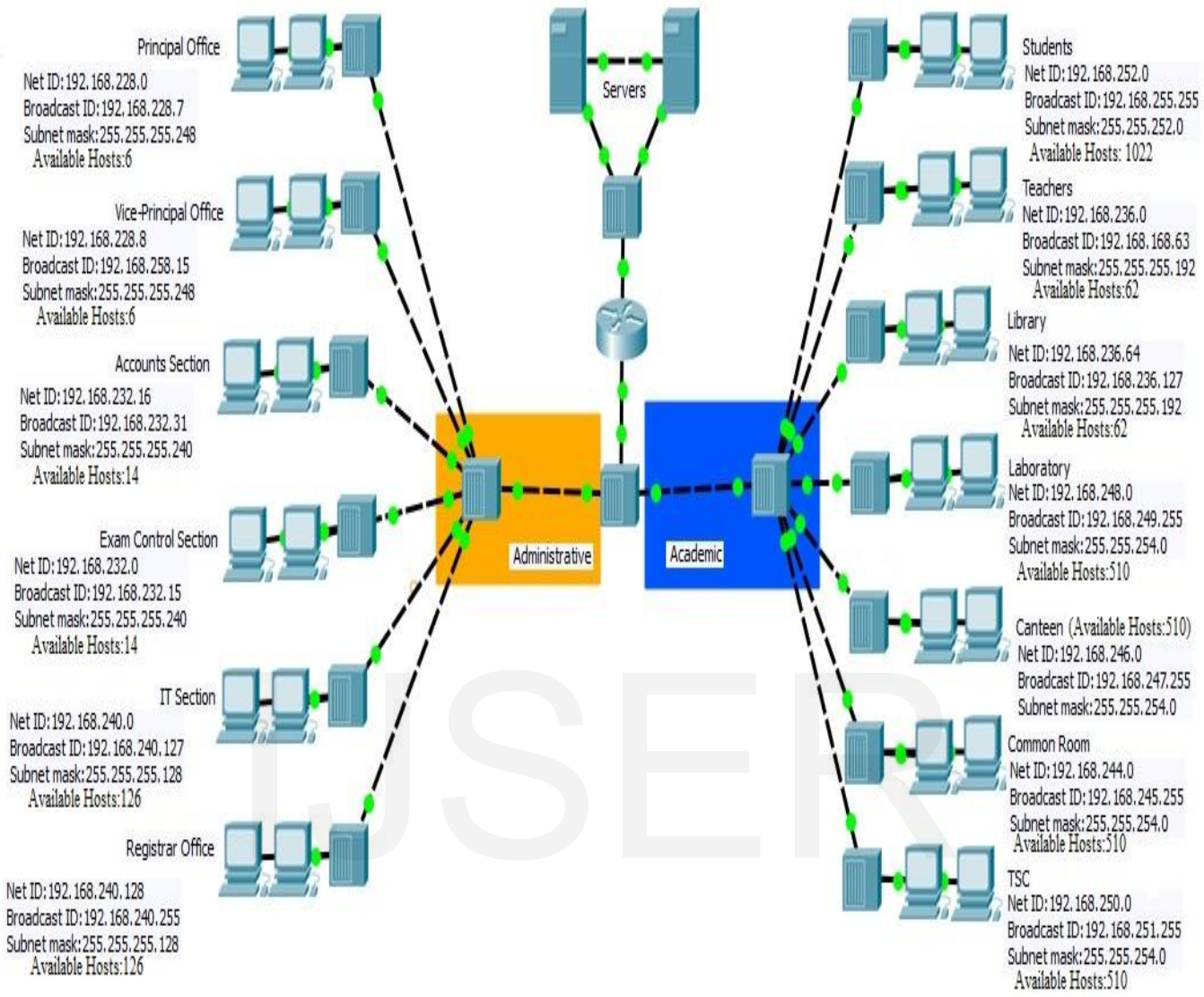


Figure: Architecture of network.

6.1 Subnetting for every branch:

Principle Office (Need a block of 8):

NET ID: 192.168.228.0

Broadcast ID: 192.168.228.7➔57th0

Subnet Mask: 255.255.255.248

Vice-principle Office (Need a block of 8):

NET ID: 192.168.228.8

Broadcast ID: 192.168.228.15➔57th1

Subnet Mask: 255.255.255.248

Accounts Office (Need a block of 16):

NET ID: 192.168.232.16
Broadcast ID: 192.168.232.31 ➔58th1
Subnet Mask: 255.255.255.240

Exam control office (Need a block of 16) :

NET ID: 192.168.232.0
Broadcast ID: 192.168.232.15 ➔58th0
Subnet Mask: 255.255.255.240

IT Section (Need a block of 128):

NET ID: 192.168.240.0
Broadcast ID: 192.168.240.127 ➔60th0
Subnet Mask: 255.255.255.128

Registrar Office (Need a block of 8):

NET ID: 192.168.240.128
Broadcast ID: 192.168.240.255 ➔60th1
Subnet Mask: 255.255.255.128

Students (Need a block of 1024):

NET ID: 192.168.252.0
Broadcast ID: 192.168.255.255 ➔63th
Subnet Mask: 255.255.252.0

Teachers (Need a block of 64):

NET ID: 192.168.236.0
Broadcast ID: 192.168.236.63 ➔59th0
Subnet Mask: 255.255.252.192

Library (Need a block of 64):

NET ID: 192.168.236.64
Broadcast ID: 192.168.236.127 ➔59th1
Subnet Mask: 255.255.255.192

Laboratory (Need a block of 512):

NET ID: 192.168.248.0
Broadcast ID: 192.168.249.255 ➔62th0
Subnet Mask: 255.255.254.0

TSC (Need a block of 512):

NET ID: 192.168.250.0
Broadcast ID: 192.168.251.255 ➔62th1
Subnet Mask: 255.255.254.0

Common Room (Need a block of 512):

NET ID: 192.168.244.0
Broadcast ID: 192.168.245.255 ➔61th0
Subnet Mask: 255.255.254.0

Canteen (Need a block of 512):

NET ID: 192.168.246.0
Broadcast ID: 192.168.247.255 ➔61th1
Subnet Mask: 255.255.254.0

6.2 Reserve Blocks:

- NET ID: 192.168.241.0
  Broadcast ID: 192.168.241.127 ➔60th2
  Subnet Mask: 255.255.255.128

All Block have 128 hosts

NET ID: 192.168.241.0
Broadcast ID: 192.168.241.127 ➔60th7
Subnet Mask: 255.255.255.128

- NET ID: 192.168.236.128
  Broadcast ID: 192.168.236.191 ➔59th2
  Subnet Mask: 255.255.255.192

All Block have 64 hosts

NET ID: 192.168.239.192
Broadcast ID: 192.168.239.255 ➔59th15
Subnet Mask: 255.255.255.128

- NET ID: 192.168.232.32
  Broadcast ID: 192.168.232.47 ➔58th2
  Subnet Mask: 255.255.255.240

  ⇕ All Block have 16 hosts

  NET ID: 192.168.233.240
  Broadcast ID: 192.168.233.255 ➔58th31
  Subnet Mask: 255.255.255.240
- NET ID: 192.168.228.16
  Broadcast ID: 192.168.228.23 ➔57th2
  Subnet Mask: 255.255.255.128

  ⇕ All Block have 8 hosts

  NET ID: 192.168.231.248
  Broadcast ID: 192.168.231.255 ➔57th127
  Subnet Mask: 255.255.255.248
- NET ID: 192.168.0.0
  Broadcast ID: 192.168.3.255 ➔0th
  Subnet Mask: 255.255.252.0

  ⇕ All Block have 1024 hosts

  NET ID: 192.168.224.0
  Broadcast ID: 192.168.227.255 ➔56th
  Subnet Mask: 255.255.252.0

We have to avoide every NET ID and Broadcast ID for using as host.

7. Conclusion:

Technical education is the main part of our developing nation. So it might be mandatory to know about IP addressing and their application. This paper helps the people who want to enter this virtual word. If any person helped by this work then it will be our pleasure.

8. Future Work:

Now IPv4 is in a critical stage thats why we try to develope a network based on IPv6 and describe the IPv6 in details.

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