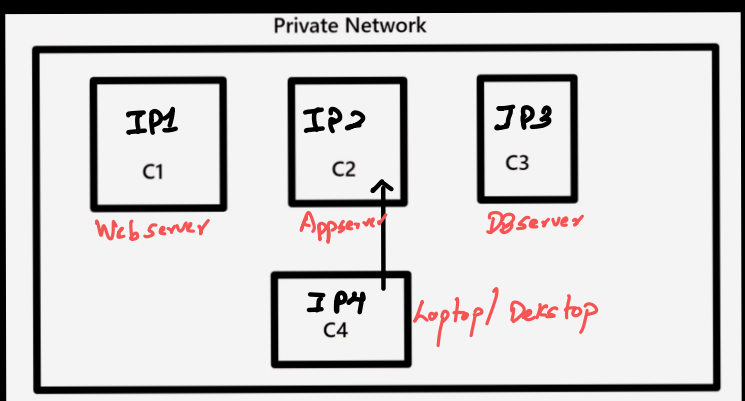
What is a Network?

→ Network is a set of interconnected devices such as computers, printers, and so on.

→ Network can be
- → public (Connecting home network to ISP)
- → private (Home & office)



Any computer works in bits and bytes. Thus in a network of multiple computers, for a computer to uniquely identify another each of them have IP address.

Now, for a user it is hard to remember each of IP address so, we give each IP address a host name. And then we make a table of hosts, link it to network for translation.

Hosts
Webserver → IP1
Appserver → IP2
⋮

Now, imagine a large network, which has hundreds of hosts. Will our host table work for such servers? No. In such large scale maintaining a list of hosts is not efficient, Therefore, we can rather create a seperate host computer that maintains the list- called DNS (Domain Name System).

Now, even in the large network, if I want to add a computer, instead of changing host table in every computer, I can go to DNS and update a new IP address.

Bcd, before anything let's look into the basics of IP addresses.

IP Addressing

There are two kinds:
- IPv4 - 32 bit
- IPv6 — 128 bit.

An IPv4 is a older version of IP addressing that contains 32 bit binary representation of computer. And as more & more computers came in use such representation became small so IPv6 was introduced.

• How are IP addressess allocated?

For any network, the first and foremost thing that happens is the generation of CIDR – Classless Inter Domain Routing. CIDR is nothing complex but a compact representation of the IP address of all the computers in the network or simply a range of IP addresses for a network.

Say for eg: ⓐ CIDR : 192.168.0.0/16

This means for this network, first 16 bits are constant, so IP address can range from

192.168.0.0 → 192.168.255.255

ⓑ CIDR : 192.168.0.0/24

This means first 24 bits are constant so, IP address can range from

192.168.0.0 → 192.168.0.255

∴ For any network we have

① Network prefix : 192.168.1

② Host Identifiers : 0-255

• CIDR : Public & Private Network

When the internet was initially developed, developers were concerned about uniquely identifying the computers, so IP address was developed. But, since Internet is a public network, what happens if a private network connects to the internet. How will ISP make sure the IP address in a Priv. network dont match with another computer in another priv. network ?

∴ A scheme called RFC 1918 was developed i.e, "Request for comments". It gave specific ranges for private networks

i.e,
- 10.0.0/8
- 172.16.0.0/12
- 192.168.0.0/16

} Priv CIDR

These addresses are thus conserved for private networks

· CIDR : Subnets, NICS & Bonding

Now imagine I have a private network 10.0.0.0/16. Say, I want to generate sub-networks depending upon my requirements. This can be done by generating CIDR for each subnets, such that it falls within 10.0.0.0/16

i.e,

Subnet 1 = 10.0.1.0/24

subnet 2 = 10.0.2.0/24

⋮

Subnet 255 = 10.0.255.0/24

This way I can generate 255 subnets each of capacity 255.

· DHCP: Dynamic Host Configuration Protocol

When you generate a network, you need two things

① What IP address will you assign to each server

② What DNS server will be in the network

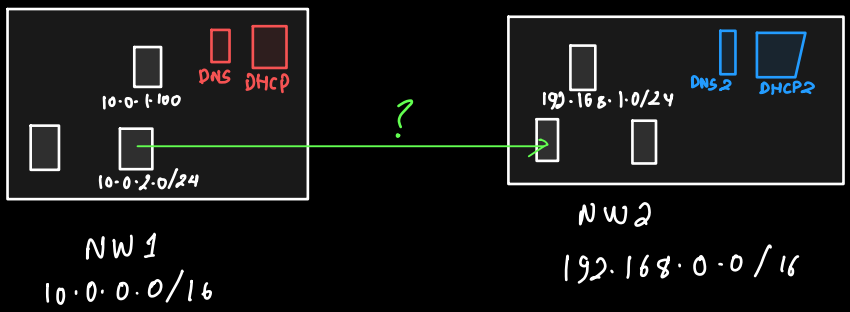
You can do this in two ways ① Manually
② Automated way

Easier way to do is automated using DHCP.

DHCP will automatically assign an IP address to a newly joined server in a network based on what is currently available IP address in the network. DHCP is also a server like DNS server. Moreover, say you are in your office, working on your computer and you logged out. Now, when a new computer joins it may get the same IP as you did, because it is a free IP now. ∴ DHCP is a very efficient configuration protocol.

Gateways & Route Tables

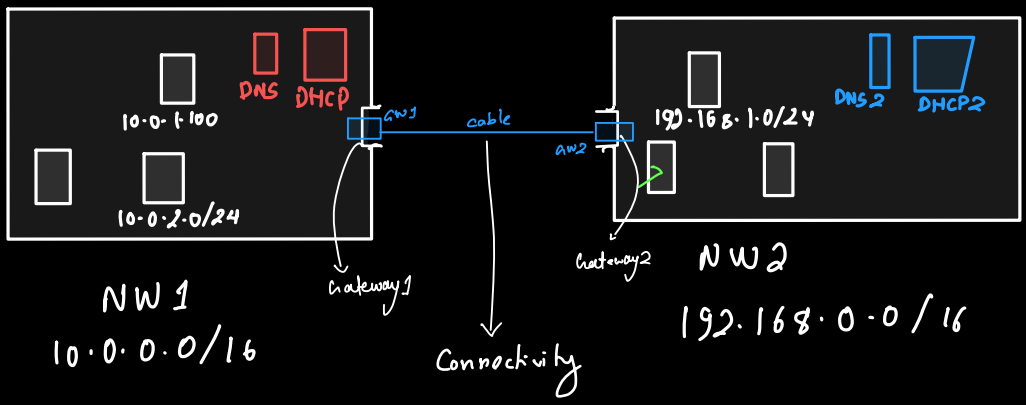
Say you have two networks NW1 and NW2 each of them comprising of many private networks.



Now, say a computer in NW1's 10.0.2.0/24 Priv. nw. wants to connect to a server 192.168.1.24 in NW2. How will it be done? Now, we know in same network, there is connectivity, but in different we need Gateways & Route tables.

∴ In order to generate connectivity among different networks we use Gateways & Routes.

So, Gateways & Routes
— enable inter network communicat^

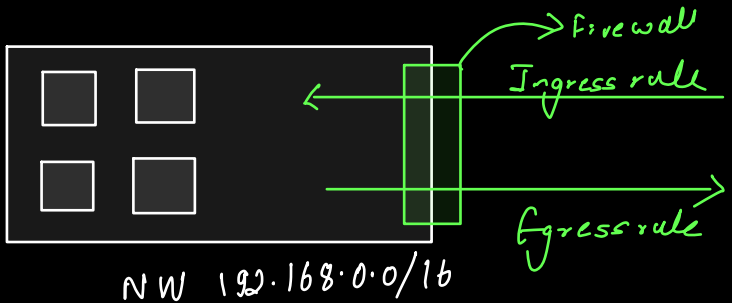


∴ Gateways enable internetwork connectivity.

Note that, one network can have multiple gateways, and can connect to various networks. This means, we can have a very complex set of interconnected network. Then, if say in a interconnected network of NW1, NW2 ... NW1000, NW1 has 75 gateways GW0, GW1 --- GW74, then we need a path finder for it to say connect to a PN65 in NW766. This is kept in track by the route table.

Network Firewall

Firewall is a security mechanism of a network. Security mechanism means what is allowed inside — called ingress rule, and what is allowed outside — called egress rule.



When the configuration of these ingress & egress rules are done, a CIDR → protocol → port formula / system.

Eg:
An ingress rule might look like

198.162.1.0/24 — TCP — 80

CIDR — protocol — port

This means network 198.162.1.0 has transmission control protocol for connection to port 80.

Similarly an egress rule looks like

127 — TCP — 192.168.0.0/16

This means at Port 127, communication / data from the above CIDR is allowed.

In general when talking about security we talk about:

(1) White list
- → what is allowed
- → everything else is not allowed
- → The above example is white list.
- → better security

(2) Black list
- → explicit defining what is not allowed
- → easy to implement, but not secured

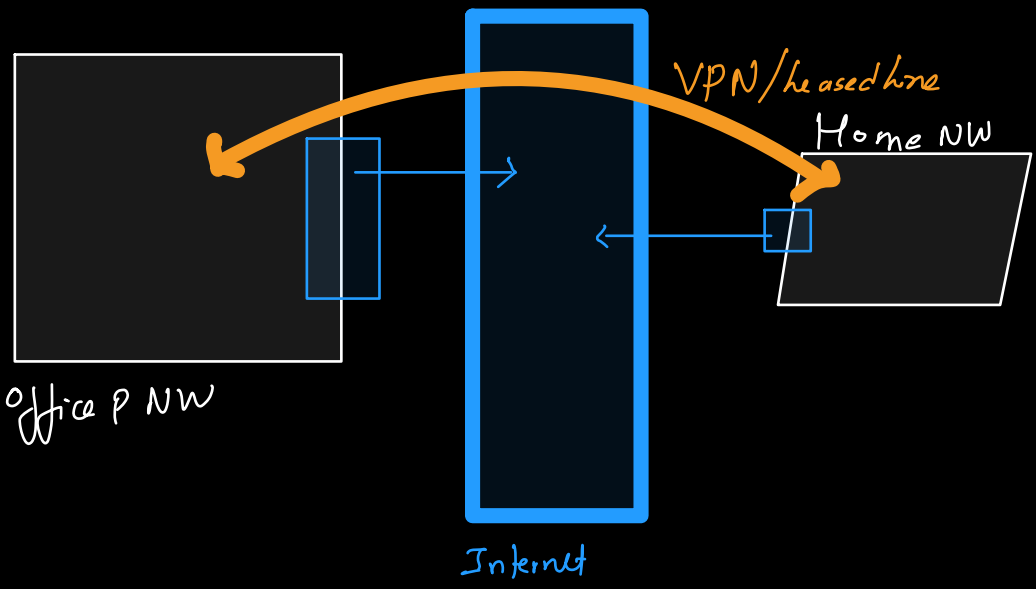
Private Connectivity (VPN)

Say, you are working in your office and you wish to go home. Now, you migrate from a office priv. NW to home priv. NW. Say both networks are connected to the internet using a Router.

What is a router?

→ router is a network device that forwards data packets between computer networks. It performs traffic directing functions on the internet, ensuring that data sent from one network device reaches the correct destination on another network. Routers generally operate at layer 3 of the OSI model.

Now, coming back to our discussion, can you access your office dataserver from your homeserver? No. Just because both networks are connected to the internet does not mean any private IP address is accessible. For such access, we have VPN i.e, virtual private network.


VPN/leased line
Home NW
Office NW
Internet

Inbound vs Outbound traffic

Inbound

Inbound traffic refers to the data that is coming into a network or device from external sources. Eg:

(a) Web Requests: when a user accesses a website hosted on a server, the user request is considered inbound

(b) Emails: receiving emails from external email servers

(c) File downloads: user downloads a file from a server

(d) API requests

Outbound

- Web browsing: When a user visits a web, the data sent by user is outbound
- Sending emails
- File upload
- API responses

What is Ports in Networking?

Whenever any application in one computer sends data to another application of a diff. computer then it sends using IP address & MAC address, but how does our computer know that this data is for a specific application & sent by this specific application?

Imagine your MAC address or IP address as the PIN code for nearest Post office & your house address as a port. Whenever any parcel is sent to you it gets received by the nearest post office and then is identified by your address where to deliver that parcel. Similarly, in a computer the data is first received using their IP or MAC address then it is delivered to the application whose port

number is with the data packets.

> Port is a logical address of a 16-bit unsigned integer that is alloted to every application on the computer that uses the internet to send or recieve data

Ports are assigned by operating system to different applications. Ports help computer to differentiate between incoming and outgoing traffic. It ranges from 0 to $2^{16}-1$

Types of ports

1. Well known Port : 0 - 1023

   Ex: HTTP - 80
   FTP - 21
   DNS - 53
   SSH - 22

② Registered port : 1023 - 49151

· assigned by IANA (Internet Assigned number authority) for any port specific number within this range

③ Dynamic Port : 49152 - 65535

· private port, for connections that are short lived