STW250CT-NETWORKED SYSTEM ARCHITECTURE

INTAKE:MAY/2021

Importantnotes

- Please refer to the Assignment PresentationRequirements for advice on how to set out your assignment.These can be found on the*Softwarica's Moodle Course Page*.
- You are expected to use the CUHarvard referencing format on any written work. For support and advice on how this students can contact Centre for Academic Writing (CAW).
- Please notify your registry course support team and module leader for disability support.
- Any student requiring an extension should follow the university process as outlined at here
- The College cannot take responsibility for any coursework lost or corrupted on disks, laptops or personal computer. Students should therefore regularly back-up any work and are advised to save it on external media or system.
- If there are technical or performance issues that prevent students submitting Coursework through the online coursework submission system on the day of a coursework deadline, an appropriate extension to the coursework submission deadline will be agreed. This extension will normally be 24 hours or the next working day if the deadline falls on a Friday or over the weekend period. This will be communicated via email and as a Softwarica's Moodle announcement.
- You **must** complete the **'Assessment Submission and Declaration Form'**.The form is available on *Softwarica's Moodle Course Page*.
- Please make a note of there commended word count.You could lose marks if you write 10%more or less than this.
- You must submit a paper copy and digital copy(on disk or similarly acceptable medium).Media containing viruses, or media that cannot be run directly,will result in a fail grade being awarded for this assessment.
- All electronic media will be checked for plagiarism.

Ashim Pradhan
10176184

Softwarica College in collaboration with
Coventry University
Assessment Submission and Declaration Form
PLEASE COMPLETE SECTIONS IN BLOCK CAPITALS

Group work If group work ALL student names and IDs must be added below- on behalf of all members; Name..... ID..... Name..... ID..... Name..... ID..... Name..... ID..... Name..... ID.....	**Surname:** PRADHAN **First Name:** ASHIM **Word Count:** 2784
Student number (ID): 10176184	**Attempt:** FIRST ☐ RESIT ☐
Assignment Due Date: 02/10/2021	**Module Code:** STW250CT
Programme Title: BSc (Hons) ETHICAL HACKING AND CYBER SECURITY	
Module Title: NETWORKED SYSTEM ARCHITECTURE	

Name of Supervisor or Tutor (if applicable): AMRIT MANANDHAR	**Individual Work:** ☐	**Group Work:** ☐
Assessment Title and Type(ie essay, journal, CD, Dissertation)	Softwarica Pharmacy System	

I have read the Softwarica College rules and regulations on the submission of academic work and in particular the sections concerning misconduct in assessment, including plagiarism, collusion and cheating. I certify that this assignment is the result of my ownS (or group) work and contains no unreferenced material from another source and does not contravene any part of the College's rules and regulations.

I acknowledge that in submitting this work I am declaring that I (or my group) are fit to be assessed and that a deferral may not be requested following hand in.

I confirm that an electronic version of the item to be assessed where appropriate) is available and will be made available to the College by the specified deadline via Moodle.

In respect of group assignments, the submission of this work is made on the basis that all group members are jointly and severally responsible for the work presented for assessment and that by handing in this item for assessment, all group members acknowledge and confirm the statements above and that ALL student names and ID numbers for the group are listed.

Student(s) Signature:	**College Stamp**

Contents

Abstract

This documentation includes the project of Bare Metal company. After reading this one can have a basic idea about network design. And how the plannings are done and what are major things we should be including while doing the design part. And also what protocols must be used for communication and also the process which makes the network very reliable for the client.

Introduction

The documentation is all about the project of a network system for the company named Bare Metal Company. This project is a total worth eighty lakh rupees. Bare Metal company is the single distributor of network devices in Nepal and is located at Pokhara, which was set up in the year 2018. So, to adapt to current trends and technology, the company needs the network infrastructure for its four-storey buildings. And now the company needs the network infrastructure to provide a better service to their customers.

Objective

The main objective of this project is to allow the company to have its own self service-oriented network infrastructure and has the features like scalability. Scalability is the most need for today's network infrastructure as the need for the network is rising day by day. For which company could increase their employee as per their need so, the network should be able to adapt to that huge change. Currently, the network system should work efficiently for the user of a total of over two hundred plus.

Network Design

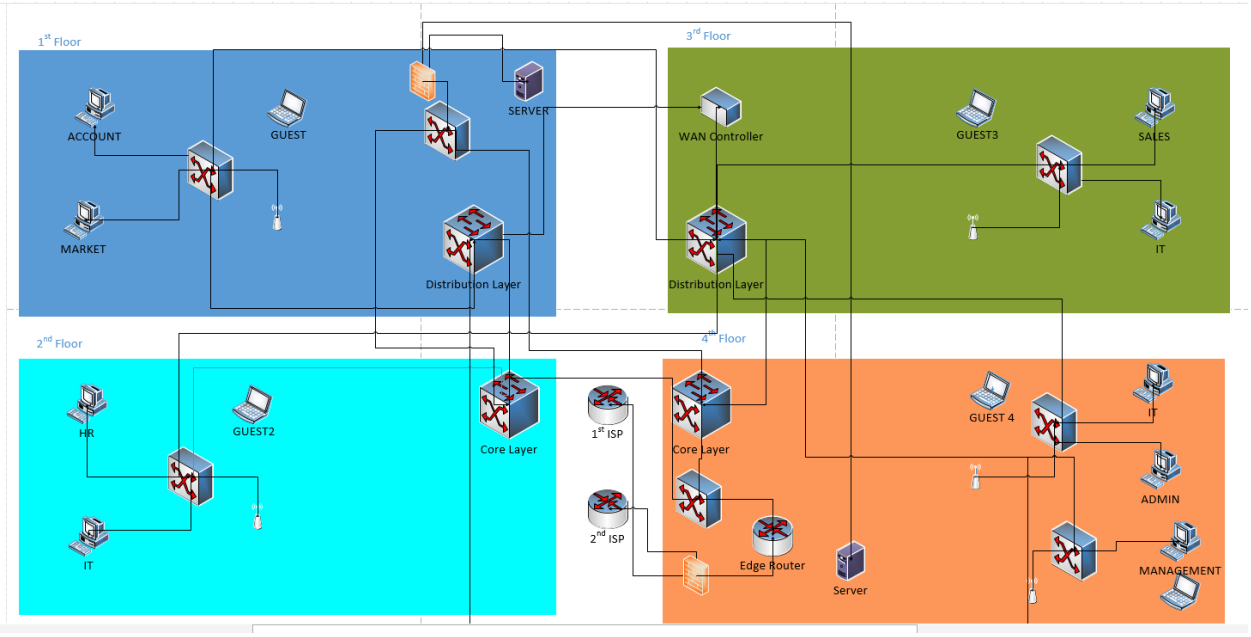
The network design is done to plan and design a communicating network infrastructure for different organizations or companies etc. This includes planning for VLAN allocation, IP planning, network devices and topology diagram etc. There are design models which can be used to design the network. The campus network design model is being used for network designing which is part of the recommended model name Enterprise Network Design model This design can be used for a single building or groups of the building which located over the different location. The design consists of different layers and the layers are as follows : (informatech, 2021)

Core Layer: This layer provides good transportation between the different sites and high performance using different routing protocols. As being the core of the system the design is done nicely so that it can recover quickly and work smoothly.

Distribution Layer: This layer provides the connectivity between the access layer and the core layer. The major function of these layers is to provide a policy-based connection between two layers and control the boundaries.

Access Layer: This layer is the lowest level of the tier network design model. The end-user connects to this layer to access the network resources as well as the internet.

Physical Layout



Prices of network devices

Product Name	Device	Price	Quantity	Total amount
CCR1072-1G-8S+	Router	450000	3	1350000
CRS328-24P-4S+RM	Multilayer Switch	66000	4	264000
Cisco UCS-SD400G0KA2-S	Server	498850	2	997700
WS-C2960PD-8TTL-RF	Switch	57011	7	399077
Cisco 2504 wireless controller	WAN Controller	95375	1	95375
AIR-PWRINJ6=	Access points	20904	5	104520
FR-C6FW	Firewall	831418	2	1662836
Ultra Spec Cables 4330087197 300m	Fibre optic cable	27040	1	27040
FEDUS High Speed 80M	Ethernet	2558	200	511680
			Grand Total =	NRP 5352228

1. Bandwith for access layer cable.

Given,

Transfer Size = 60MB

Transfer Time=3sec

Converting MB to bytes

As we know 1MB = 1000000 bytes

60MB = 60 * 1000000 bytes

= 60000000 bytes

Converting bytes to bits

As we know 1 bytes = 8bits

60000000 bytes= 60000000 * 8 bits

= 480000000 bits

Now,

Bandwidth = Transfer Size/Transfer Time

= 480000000/3 bits/sec

= 160000000 bits/sec

Finally converting bits/s to Mb/s

As we know 1 bits = 1/1000000 Mb

160000000 bits/sec = 1/1000000 * 160000000 Mbps

= 160 Mbps

Therefore the required bandwith for the access layer is 160 Mbps.

2. Bandwith for trunk link between Access and Distribution layer.

8 departments i.e IT, Marketing, Admin, Sales, Account, HR and two additional departments are guests and management that are can be allocated as 8 VLANs in the network.

Given,

No. of department = 8

From above, we know bandwith of access layer = 160 Mbps

So now as all these 8 departments travel through the trunk link.

Now,

Bandwith of trunk link = no.departments * bandwith of access layer

= 8 * 160 Mbps

= 1280 Mbps

Therefore the required bandwith between access and distribution trunk link is 1280 Mbps.

3. Bandwith between Distribution and Core layer

Given,

Transfer Size = 600MB

Transfer Time=3sec

Converting MB to bytes

As we know 1MB = 1000000 bytes

600MB = 600 * 1000000 bytes

= 600000000 bytes

Converting bytes to bits

As we know 1 bytes = 8bits

600000000 bytes= 600000000 * 8 bits

= 4800000000 bits

Now,

Bandwidth = Transfer Size/Transfer Time

= 4800000000/3 bits/sec

= 1600000000 bits/sec

Finally converting bits/s to Mb/s

As we know 1 bits = 1/1000000 Mb

1600000000 bits/sec = 1/1000000 * 1600000000 Mbps

= 1600 Mbps

Therefore the required bandwith between the Distribution and core layer is 1600. And same applies to the link between the core layer and server farm.

4. Redundancy in network

Sometimes there might be a failure in some of the network devices which could disrupt the network service for which a backup is needed. So redundancy is the process in which identical switches or routers are installed in the same layer so that it does not disrupt services with a failure in one device. For example, if there is a failure in the core multilayer switch or router which might cause the network services to go down in the case of the single device but if there is another core device there then it can carry on the services by diverting the signals from the failed devices. But the condition in this process is that the device must be identical to it and must have the same connection as much as is possible in the network. The major advantage of redundancy is that it provides stability to the network and improves the performance of the system. In this project, the redundancy is maintained in all the three-layer of the system i.e the three tiers of the network. Its only done on the major layer of the system so, that there is no complexity in the network, is easy to configure and also decrease the cost of the network devices.

5. Bandwith from the two ISPs

From Primary ISP

Given,

Data size to be transferred = 3KB

= 3 * 1024 bytes (converting KB to bytes)

= 3072 bytes

= 3072 * 8 bits (converting bytes to bits)

= 24576 bits

Latency = 2.5ms

= 2.5/1000 s (converting ms to s)

=0.0025 s

Distance = 210 km

= 210 * 1000 m (converting km to m)

= 210000 m

Speed of a light = $2 * 10^8$ m/s

= 200000000m/s

Now, as we know

Latency = Transmission delay + Propagation delay

Where,

Transmission delay = Data size/ Bandwith

= 24576 / Bandwith

Propagation delay = Distance/ Speed of light

= 210000/200000000

= 21/20000

= 0.00105

Now putting transmission delay and propagation delay,

0.0025= 24576/Bandwith + 0.00105

24576/Bandwith = 0.0025 – 0.00105

Bandwith = 24576/0.00145

= 16948965.52 bits/s

= 16948965.52/1024bits/s

= 16551.73/1024 kb/s

= 16.16 Mbps

Therefore bandwith from the primary ISP is 16.16 Mbps.

From Secondary ISP

Given,

Data size to be transferred = 3KB

= 24576 bits

Latency = 3ms

= 3/1000 s (converting ms to s)

=0.003s

Distance = 210 km

= 210000 m

Speed of a light = $2 * 10^8$ m/s

= 200000000m/s

Now, as we know

Latency = Transmission delay + Propagation delay

Where,

Transmission delay = Data size/ Bandwith

= 24576 / Bandwith

Propagation delay = Distance/ Speed of light

= 210000/200000000

= 21/20000

= 0.00105

Now putting transmission delay and propagation delay,

0.0025= 24576/Bandwith + 0.00105

24576/Bandwith = 0.003 – 0.00105

Bandwith = 24576/0.00195

= 12603076.92 kb/s

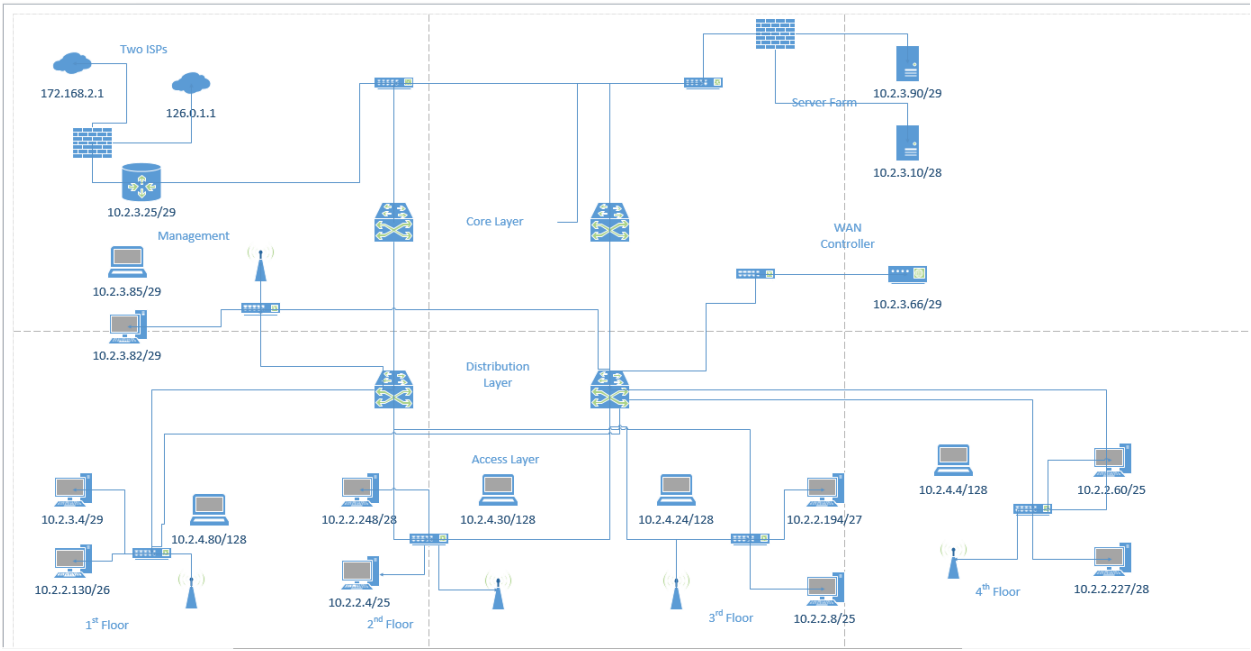
= 12603076.92 /1024bits/s

= 12307.69/1024 kb/s

= 12.01 Mbps

Therefore bandwith from the secondary ISP is 12.01 Mbps.

Logical Layout



Assigning IP Address

Assigning IP addresses is the main part of the logical layout as it is the process of identifying the devices on the network. While providing the IP address to the devices the subnetting of the IP address is done. Subnetting is the process in which the larger IP address is divided into a smaller subnetwork. The main reason to do subnetting is to minimize the traffic in the network by splitting them. In this project, there are 6 main departments and two additional which should be provided with proper IP addresses.

Here the given IP address is 10.2.2.0/23 which needs to be divided into the smaller network so that one can assign it to the different departments in the network. The private IP for the departments in the network system. This is done as follows:

Departments	Network	Usable host ID	Broadcast ID
IT	10.2.2.0/25	10.2.2.1 -10.2.2.126	10.2.2.127
Marketing	10.2.2.128/26	10.2.2.129-10.2.2.190	10.2.2.191
Sales	10.2.2.192/27	10.2.2.193-10.2.2.222	10.2.2.223
Admin	10.2.2.224/28	10.2.2.225-10.2.2.238	10.2.2.239
HR	10.2.2.240/28	10.2.2.241-10.2.2.254	10.2.2.255
Account	10.2.3.0/29	10.2.3.1-10.2.3.6	10.2.3.7
Management	10.2.3.80/29	10.2.3.81-10.2.3.86	10.2.3.87
Guest	10.2.4.0/25	10.2.4.1-10.2.4.126	10.2.4.127

And the proper public planning for the ISPs and the interface of edge routers is done as follows :

Devices	Network	IP address
Primary ISP	126.0.1.0	126.0.1.1
Secondary ISP	172.168.2.0	172.168.2.1
Router – Primary ISP	-	126.0.1.2
Router – Secondary ISP	-	172.168.2.2

VLAN Allocation

VLAN	Departments	Network
40	IT	10.2.2.0/25
20	Marketing	10.2.2.128/26
50	Sales	10.2.2.192/27
60	Admin	10.2.2.224/28
30	HR	10.2.2.240/28
10	Account	10.2.3.0/29
22	Management	10.2.3.80/29
11	Guest	10.2.4.0/25

Protocol

The protocol is the rules, regulations and guidelines that are needed to be followed. These sets of a rule meant for the step and processes which are followed during communication between the two devices. The same steps or processes can be done using different protocols in the network. Some of the famously named protocols are TCP/IP, ARP, FTP etc. The protocol is used mainly for the reliability of the network. Here are some of the protocols which is been used in the network infrastructure.

Interior Gateway Protocol

The protocol is used to exchange the IP route update protocol between the routers dynamically inside the system. This protocol is used by Ip to exchange their IP route information to the neighbour routers. This protocol ensures that every router routing table is updated with the available routing information. This protocol manages the routing table in such as way that the connection between the nodes or between the nodes to the internet is done through the optimal path. (Techopedia, 2021)

IN this project RIP version 2 protocol is being used.

Rip Version 2

Routing information protocol also known as RIP is the protocol that uses the hop counts as routing measures so that it can provide the best path between the source and destination for the connection to be established. RIP version 2 is preferred over 1 due it major features i.e it is a classless protocol and sends subnet mask to the routing update. Its measure i.e hop count is the count of the router between the source and destination and updates the routing table looking at the lowest hop count in the network. And maximum allowed hop count in the RIP is 15 and when there is a 16 hop count then it is considered as not reachable. (GeeksForGeeks, 2021)

Some of the features of RIP protocol are as follows:

1. While updating routing information it is always broadcasted so that all the routers connected to that network can receive the information/
2. This protocol can be said a dynamic protocol because updates of the network are done timely.
3. The whole routing tables are updated at once.

4. And the routing information shared by the neighbour routers are trusted and the routers work according to provided information.

Exterior Gateway Protocol

The protocol is used to share routing information between the internet gateway either of the same network or a different network. This protocol helps to establish a neighbour in the network, checks the status of the neighbour whether it is active or not and after checking the status it informs all the neighbours who are reachable in the network. And also it shares the messages which help the neighbour to establish/ establish the connection, as well as informs about the availability of the neighbour. (TechTarget, 1999-2021)

The BGP protocol is used in this project as an Exterior Gateway protocol.

BGP

BGP stands for Border Gateway protocol which is the standardized EGP that is used to share the reachability of the router and routing information of the autonomous system on the internet. This is the protocol that is used as a routing protocol on the internet. This is the protocol that has allowed us to do day to day functions on the internet. We google on the internet or we use Facebook and also send mail through the internet this all is possible due to this protocol which helps the internet to function. (imperva, 2021)

Some of the features of this protocol are as follows:

1. This protocol is mainly used on the internet, it uses the TCP port 179 to establish the connections between the different neighbours.
2. There are two types of BGP: the first one is the external BGP which is used for a neighbour in a different domain. The second one is internal which is used for a neighbour in the same domain.
3. BGP implements CIDR in the network system.

HSRP Protocol

Hot Standby Router Protocol is the cisco related protocol, this protocol is designed to control network traffic and non-disruptive services to the users. For example, if there are two identical routers or multilayer switches are used to provide redundancy. Then in this case HSRP is used to configure one of the routers as standby and a single router as active at a given time. The routers in the same HSRP group share mac address as well as an IP address. SO normally the active routers forward the traffic but if it fails to forward due to any dysfunctionality then the standby router takes over. (Technosolutions, 2021)

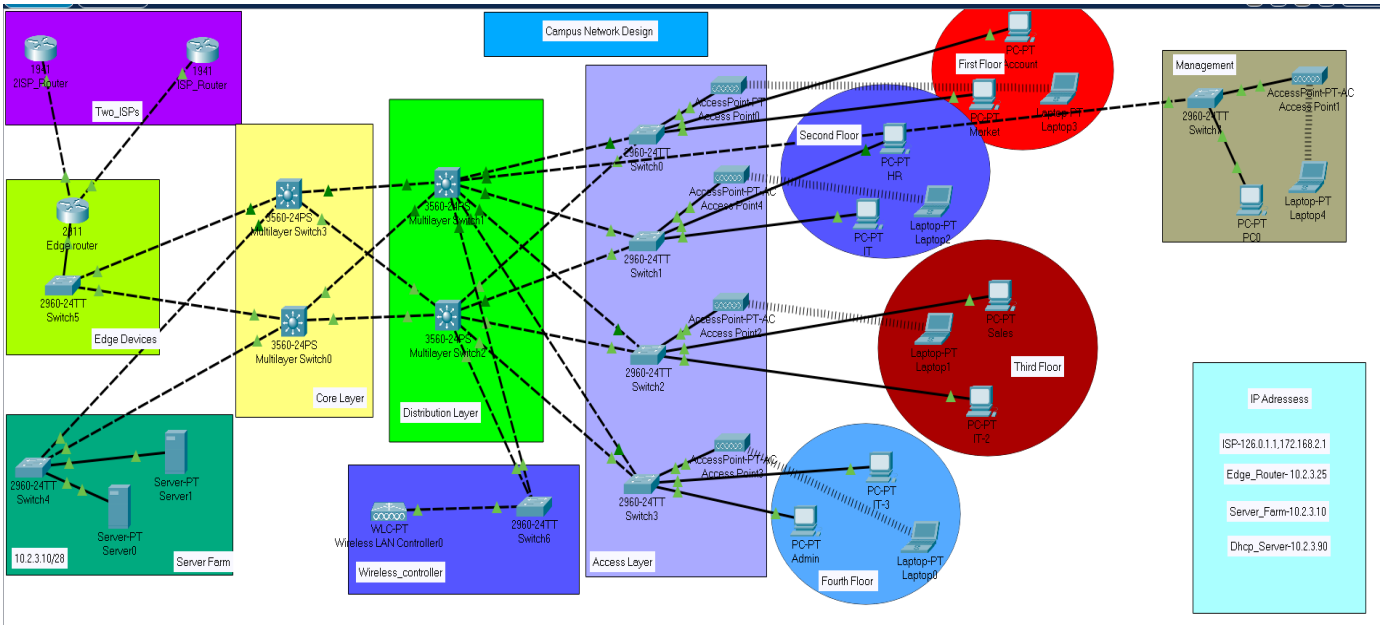
DHCP Protocol

This protocol is used in the network system to configure the IP addresses to the devices. This allows the devices to access the network services such as DNS, FTP etc and allows them to use any protocol which is based on TCP and UDP. This protocol is usually used by the network system to give their client an automatic IP address when they are connected. In this project, there are both DHCP servers as well as a wan controller which assigns the IP addresses to the devices so that they can communicate with each other. (IP, 2021)

Some of the advantages of this protocol are as follows:

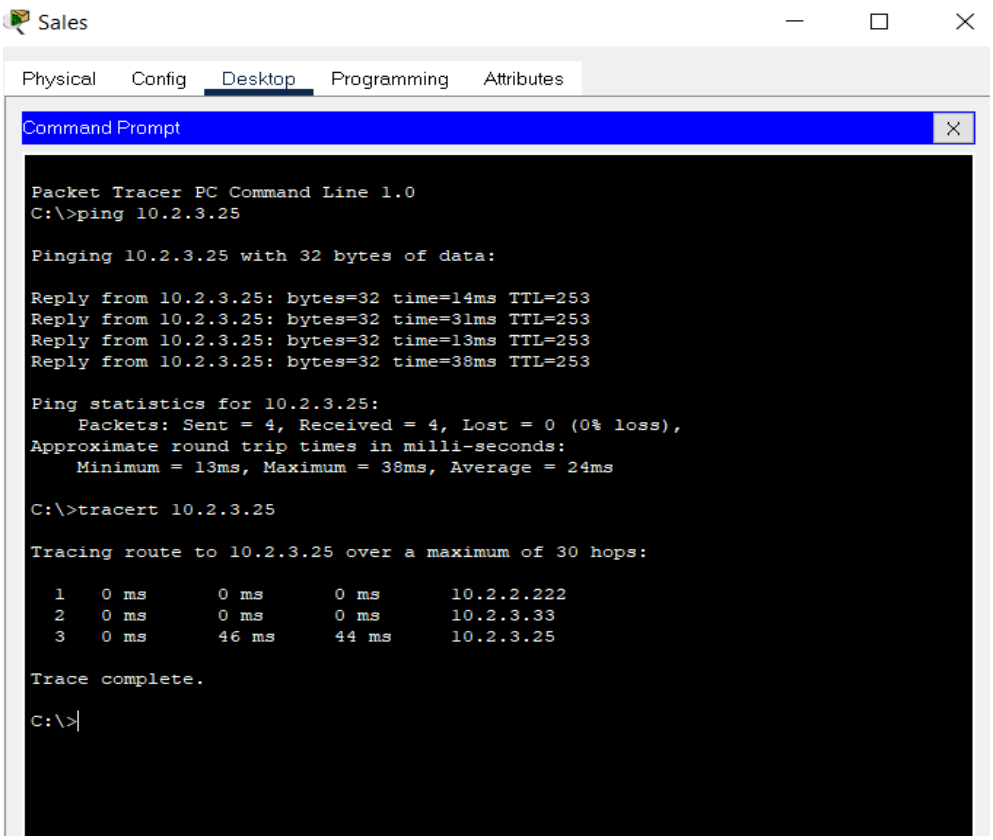
1. It makes the IP address configuration very reliable.
2. It avoids the configuration errors which can happen when assigning the devices IP addresses manually.

Snapshot of Cisco Packer tracer



Some of the devices pinging each other

Edge router being pinged by pc



Server pinged by PC

```
C:\>ping 10.2.3.10

Pinging 10.2.3.10 with 32 bytes of data:

Reply from 10.2.3.10: bytes=32 time<1ms TTL=254
Reply from 10.2.3.10: bytes=32 time=22ms TTL=254
Reply from 10.2.3.10: bytes=32 time<1ms TTL=254
Reply from 10.2.3.10: bytes=32 time=10ms TTL=254

Ping statistics for 10.2.3.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 22ms, Average = 8ms

C:\>tracert 10.2.3.10

Tracing route to 10.2.3.10 over a maximum of 30 hops:

  1    4294967295 ms0 ms       0 ms       10.2.3.1
  2    52 ms      27 ms      41 ms      10.2.3.10

Trace complete.

C:\>
```

ISP router pinged by pc

```
Command Prompt

Packet Tracer PC Command Line 1.0
C:\>ping 126.0.1.1

Pinging 126.0.1.1 with 32 bytes of data:

Reply from 126.0.1.1: bytes=32 time<1ms TTL=252
Reply from 126.0.1.1: bytes=32 time=12ms TTL=252
Reply from 126.0.1.1: bytes=32 time=10ms TTL=252
Reply from 126.0.1.1: bytes=32 time=19ms TTL=252

Ping statistics for 126.0.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 19ms, Average = 10ms

C:\>tracert 126.0.1.1

Tracing route to 126.0.1.1 over a maximum of 30 hops:

  1    1 ms       0 ms       0 ms       10.2.3.81
  2    0 ms       0 ms       3 ms       10.2.3.35
  3    21 ms      12 ms      21 ms      10.2.3.25
  4    17 ms      22 ms      55 ms      126.0.1.1

Trace complete.

C:\>
```

Different departments pinging each other

```
C:\>ping 10.2.2.194

Pinging 10.2.2.194 with 32 bytes of data:

Reply from 10.2.2.194: bytes=32 time=14ms TTL=127
Reply from 10.2.2.194: bytes=32 time=10ms TTL=127
Reply from 10.2.2.194: bytes=32 time=4ms TTL=127
Reply from 10.2.2.194: bytes=32 time=46ms TTL=127

Ping statistics for 10.2.2.194:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 46ms, Average = 18ms

C:\>tracert 10.2.2.194

Tracing route to 10.2.2.194 over a maximum of 30 hops:

  1    0 ms      0 ms      13 ms     10.2.2.1
  2    14 ms     70 ms     1 ms      10.2.2.194

Trace complete.

C:\>
```

```
C:\>ping 10.2.2.3

Pinging 10.2.2.3 with 32 bytes of data:

Reply from 10.2.2.3: bytes=32 time<1ms TTL=127
Reply from 10.2.2.3: bytes=32 time<1ms TTL=127
Reply from 10.2.2.3: bytes=32 time<1ms TTL=127
Reply from 10.2.2.3: bytes=32 time=22ms TTL=127

Ping statistics for 10.2.2.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 22ms, Average = 5ms

C:\>tracert 10.2.2.3

Tracing route to 10.2.2.3 over a maximum of 30 hops:

  1    35 ms     0 ms      0 ms      10.2.2.254
  2    41 ms     0 ms      0 ms      10.2.2.3

Trace complete.

C:\>
```

```
C:\>ping 10.2.2.226

Pinging 10.2.2.226 with 32 bytes of data:

Reply from 10.2.2.226: bytes=32 time<1ms TTL=127
Reply from 10.2.2.226: bytes=32 time=34ms TTL=127
Reply from 10.2.2.226: bytes=32 time<1ms TTL=127
Reply from 10.2.2.226: bytes=32 time<1ms TTL=127

Ping statistics for 10.2.2.226:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 34ms, Average = 8ms

C:\>tracert 10.2.2.226

Tracing route to 10.2.2.226 over a maximum of 30 hops:

  1    0 ms      0 ms      11 ms     10.2.3.81
  2    0 ms      10 ms     0 ms      10.2.2.226

Trace complete.
```

Conclusion

Therefore the major thing one should be thinking about before designing a network system is that how could the network work in various conditions. Whether the traffic in the network is handled efficiently or not. To make the communication secure whether the proper protocols are allocated or not. And also there is no kind of disturbance during the communication between the devices and the users are able to access the network resources efficiently. Hence the performance, security and redundancy are the major things needed in the network.

References

GeeksForGeeks, 2021. *geeksforgeeks.org.* [Online]
Available at: https://www.geeksforgeeks.org/routing-information-protocol-rip/
[Accessed september 2021].

imperva, 2021. *imperva.com.* [Online]
Available at: https://www.imperva.com/blog/bgp-routing-explained/
[Accessed September 2021].

informatech, 2021. *networkcomputing.com.* [Online]
Available at: https://www.networkcomputing.com/data-centers/campus-network-design-models
[Accessed September 2021].

IP, E., 2021. *efficientip.com.* [Online]
Available at: https://www.efficientip.com/what-is-dhcp-and-why-is-it-important/
[Accessed September 2021].

Technosolutions, A., 2021. *networkinterview.com.* [Online]
Available at: https://networkinterview.com/what-is-hot-standby-router-protocol-hsrp/
[Accessed September 2021].

Techopedia, 2021. *techopedia.com.* [Online]
Available at: https://www.techopedia.com/definition/25074/interior-gateway-routing-protocol-igrp
[Accessed September 2021].

TechTarget, 1999-2021. *whatis.techtarget.com.* [Online]
Available at: https://whatis.techtarget.com/definition/Exterior-Gateway-Protocol-EGP
[Accessed September 2021].