University of Moratuwa

Department of Electronic and Telecommunication Engineering

EN2150 - Communication Network Engineering

Design of Local Area Network - Group Project

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Table of Contents

Approach to the backbone design 3

Network diagram 5

IP addressing scheme for network. 6

Justification for the selection of active and passive components. 7

In the ENTC building 7

For each floor network closet 7

The selection of active and passive components 7

Features of the routers in backbone network 8

Bill of Quantities 9

Active Elements 9

Passive Elements 9

Simulation Result 10

Pinging from Laptop to Smartphone 10

Pinging from Laptop to Civil Node 11

Traceroute from Laptop to Textile Node 12

Approach to the backbone design

A backbone network is a high-speed network that connects the major components of a computer network. It is responsible for carrying the bulk of the traffic between the different parts of the network. When designing a backbone network, it is essential to consider factors such as cost-effectiveness, scalability, and reliability.

In this report, we present the backbone design approach for the network of University of Moratuwa (UOM). Our network consists of 9 nodes, all of which are routers. Our backbone design consists of a ring topology with alternative links between multiple nodes in case of failure.

- The backbone topology we have chosen is a ring topology, which is a closed-loop network.
    - It is easy to identify and troubleshoot problems.
        - In a ring topology, if there is a problem with one link, the traffic can be rerouted around the failed link. This makes it easy to identify and troubleshoot problems.
    - It is fault tolerant.
        - If one node fails, the rest of the network can still continue to operate. This is because the traffic can be rerouted around the failed node.
    - It is cost-effective.
        - A ring topology requires less cabling than other topologies. This is because each node is only connected to two other nodes. This is particularly beneficial when covering a large area.
- In our backbone design, we have used 10Gbps single-mode fiber channel to travel through the backbone.
    - It has a smaller core diameter.
        - Single-mode fiber cables have a smaller core diameter than multi-mode fiber cables, which means that they can transmit data over longer distances with less attenuation and less dispersion.
    - It provides higher bandwidth and longer distances than multi-mode fiber.
        - This property makes it ideal for long-distance transmissions. This is particularly important in backbone networks, where large amounts of data need to be transmitted over long distances at high speeds.

- Inclusion of a connecting node (Sumanadhasa Node).
    - It acts as a central hub that connects multiple nodes in the network.
        - By including this node in the network, we can provide additional paths for data transmission, which provides redundancy, helps to avoid congestion, and ensures that the network can handle increased traffic.
    - It makes it easier to manage and troubleshoot the network.
        - Rather than having to monitor and troubleshoot each individual node in the network, network administrators can focus on the connecting node and its connections to the rest of the network. This can help to reduce the complexity and cost of managing the network.
- The UoM Node serves as the edge node of the network.
    - It allows devices within our network to communicate with devices outside of our network.
        - By this we are able to provide our network with access to a wider range of resources, such as cloud-based applications and remote servers.

Network diagram

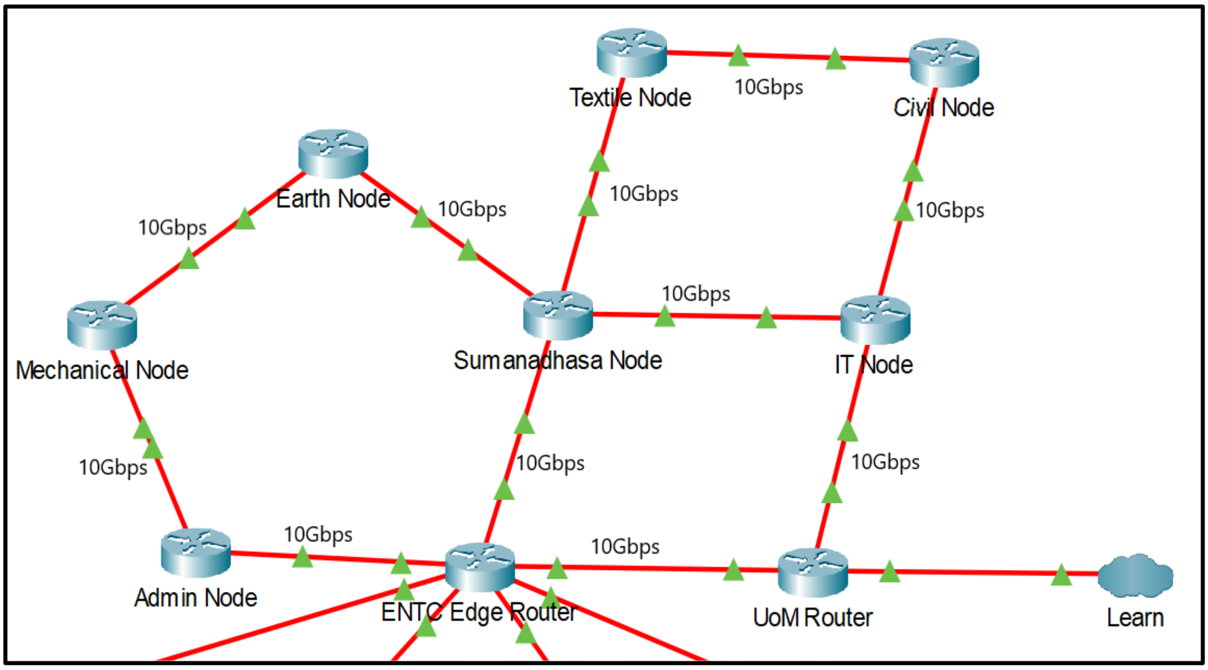


Figure 1: Network diagram indicating all the building nodes and bandwidth in each link.

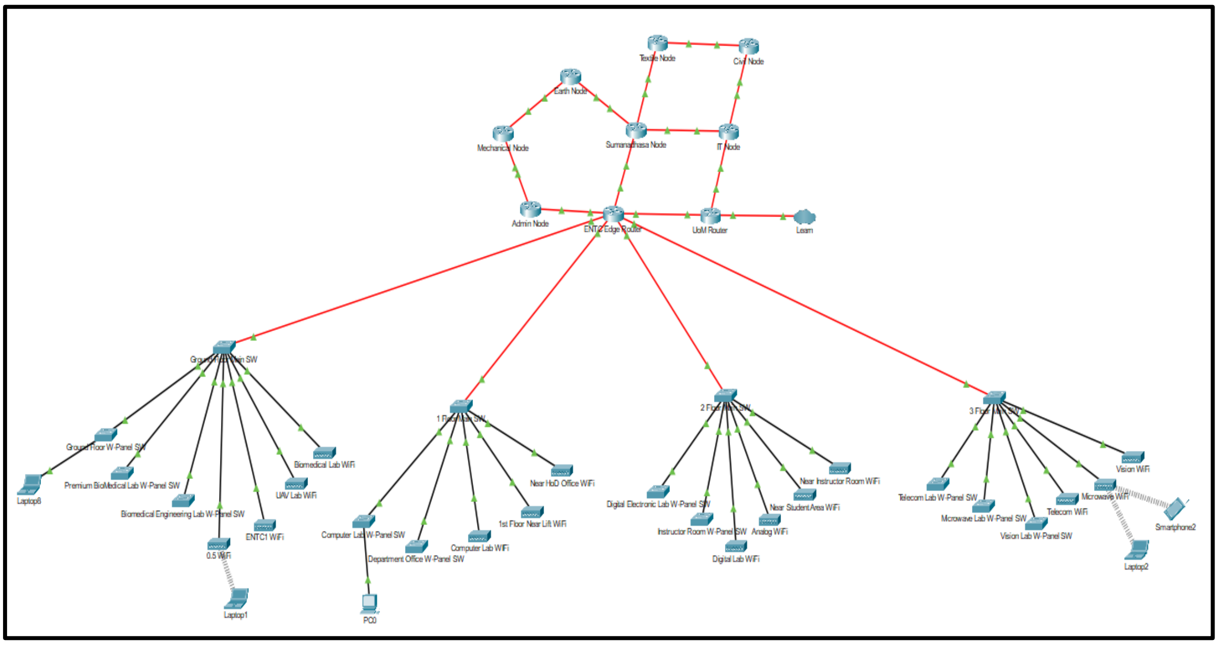


Figure 2: UOM Network

IP addressing scheme for network.

The network has a ring topology with 9 nodes, all of which are routers. Each node can assign a number of /24 IPv4 addressed subnets (mask 255.255.255.0) for each interface. 253 devices beside the router can be connected to a subnet. To ensure efficient utilization of IP addresses, each building connected to the network can lease the required number of subnets from the available subnets.

Links between nodes use a /30 subnet (mask 255.255.255.252) for their interfaces, which provides enough IP addresses for the links without wasting any.

In the case of the ENTC building, each floor has been assigned four of such subnets. This allows for a sufficient number of IP addresses for the devices connected to the network on each floor while ensuring efficient IP address utilization.

Specific requirements of the backbone design, including high bandwidth, long-distance transmissions, and the use of a ring topology. By utilizing appropriate subnetting and addressing techniques, the network is able to operate efficiently and effectively, with minimal risk of IP address conflicts or other issues.

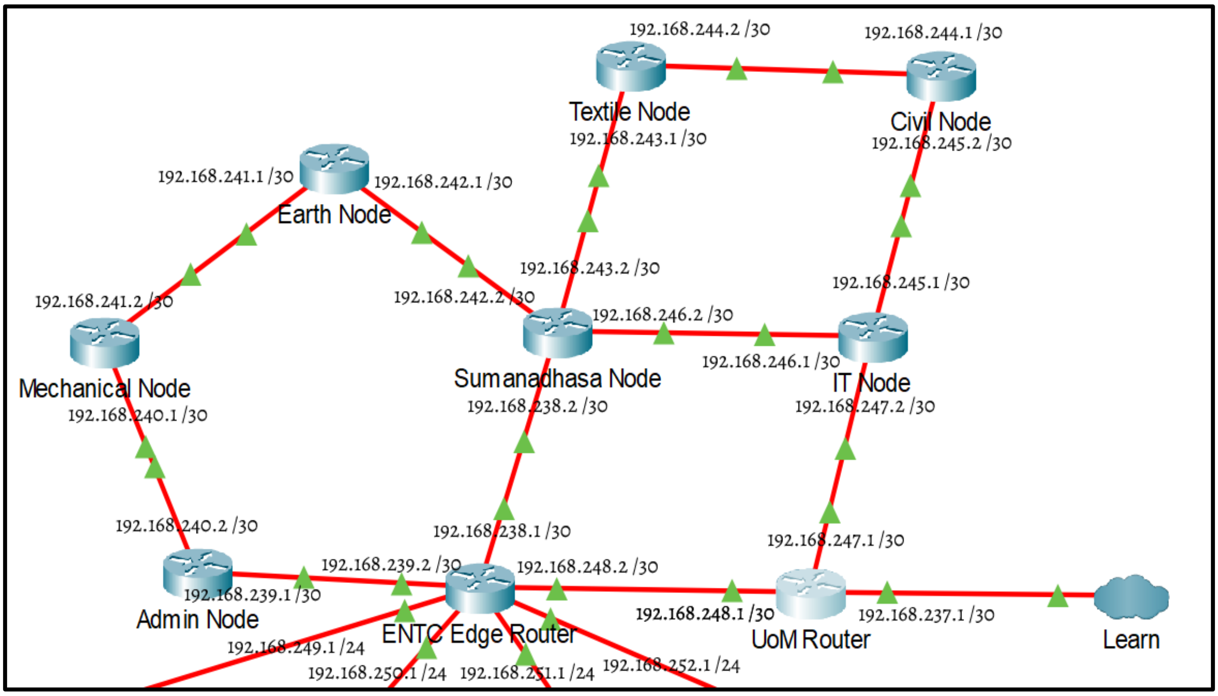


Figure 3: Router interface IP addresses

Justification for the selection of active and passive components.

The network infrastructure has been designed with a hierarchical structure to ensure scalability, manageability, and high availability. The routers and switches used in the network are carefully selected based on the requirements of the network. In each connected building, routers act as the edge node for the internal network.

In the ENTC building

The ENTC edge router is selected as the edge node for the internal network, which is capable of handling high volumes of traffic from every floor. To ensure high availability and fault tolerance, the router is equipped with,

- 7 optical fiber ports
  - 3 of which are connected to the backbone.
  - 4 of which go to each floor.

This allows for redundancy and provides alternative paths in the event of link failures.

For each floor network closet

Layer 2 switches are used, connected to the edge router via multimode fiber cable. This is to reduce the cost of using single mode fiber, since the distance of connection is minimal. The main switch for each floor is equipped with several Ethernet ports, which are used to connect other lower switches and access points on the floor. Wall-panel switches used have 24 Ethernet ports in each.

The main floor switches are connected to Wi-Fi access points and lab wall panel switches. The Wi-Fi access points use both 2.4GHz and 5GHz channels, providing high-speed connectivity to wireless devices. The wall-panel switches are connected via Ethernet cables to provide wired connectivity to devices in the lab.

The selection of active and passive components

The selection is based on the specific requirements of the network.

- The use of multimode fiber cable for internal connections
  - It helps to reduce the cost of the network, while still providing adequate bandwidth for the distances involved.
- The use of layer 2 switches for each floor network closet
  - It helps to reduce network complexity, while still providing adequate connectivity to devices on each floor.
- The ENTC edge router is equipped with multiple fiber ports.
  - It has the ability to handle high volumes of traffic, ensuring that the network is capable of handling the required traffic load.

Features of the routers in backbone network

The routers in a backbone network are an essential component that plays a vital role in ensuring network performance, scalability, reliability, security, and protocol support. Here are the key features and specifications that the backbone routers we used have:

- High Performance:
  - The backbone routers we used are able to handle a high volume of traffic, up to 168 Gbps. This is essential to ensure that the network can handle the increased traffic and provide seamless connectivity.

- Protocol Support:
  - Backbone routers support various routing protocols such as OSPF, BGP, RIP, IS-IS to ensure the smooth functioning of the network. These protocols help in establishing network paths and choosing the best path to transmit data packets.

- Reliability:
  - The backbone routers are equipped with hot-swappable components and redundant power supplies. This ensures that the network is up and running, even if any component fails.

- Security:
  - The backbone routers are equipped with a firewall and intrusion detection system to protect the network from cyber threats. This ensures that the network remains secure and prevents any unauthorized access.

- Scalability:
  - The backbone routers are scalable to meet the needs of the network. This ensures that the network can handle increased traffic and provides a high level of redundancy, which is critical for ensuring continuous network connectivity.

Bill of Quantities

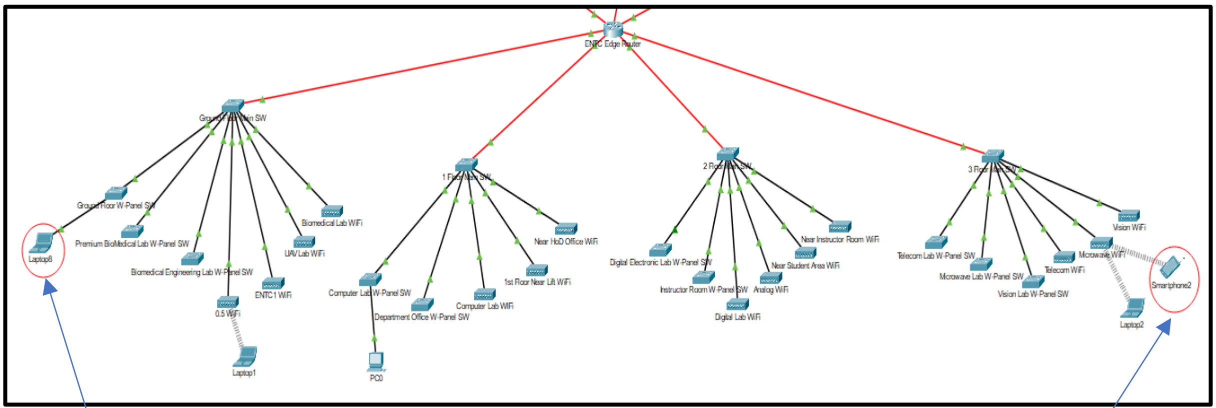
	Item	Quantity	Market Price	Total Price
Active Elements	Fiber Cable	1389m	$0.50	$694.50
	Copper through Cable	462m	$0.30	$147.60
	Copper wall mount	48	$16.00	$768.00
	Power distribution device	12	$7.00	$84.00
	Copper patch panel	10	$3.38	$33.80
	Rack	12	$35.00	$420.00
			Total	$2147.90

	Item	Quantity	Market Price	Total Price
Passive Elements	Cisco ASR9000V Router	9	$617.93	$5561.37
	Cisco Catalyst Switch 2960-48TC	4	$725.00	$2900.00
	Catalyst 2960 Switch	10	$523.00	$5230.00
	AIR-OEAP602I-T-K9 Access Point	14	$230.00	$3220.00
			Total	$16911.37

For ENTC network only: - $13451.33

Simulation Result

Pinging from Laptop to Smartphone



Laptop

Figure 4: ENTC Backbone

Smartphone

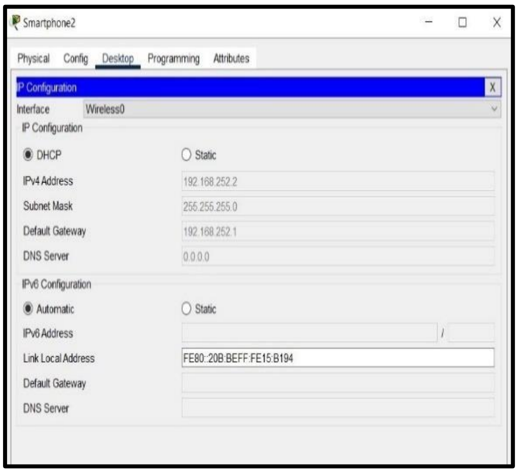


Figure 3: Ip configuration of Smartphone (192.168.252.2)

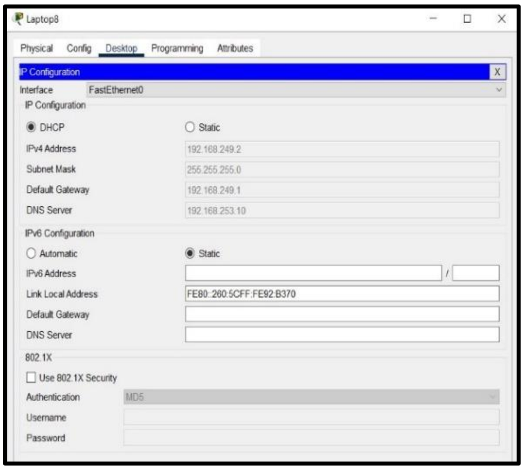
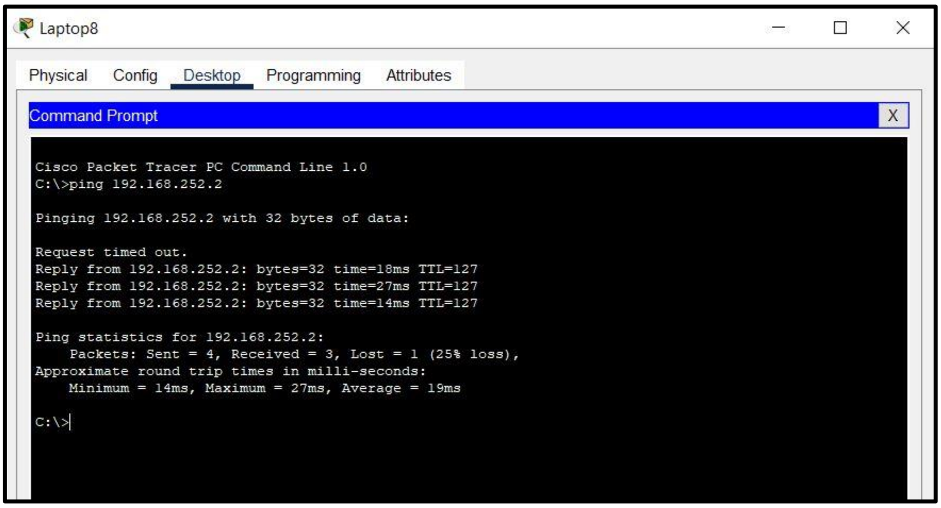


Figure 6: Ip configuration of Laptop (192.168.249.2)




```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.252.2

Pinging 192.168.252.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.252.2: bytes=32 time=18ms TTL=127
Reply from 192.168.252.2: bytes=32 time=27ms TTL=127
Reply from 192.168.252.2: bytes=32 time=14ms TTL=127

Ping statistics for 192.168.252.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 14ms, Maximum = 27ms, Average = 19ms

C:\>
```

Figure 7: Pinging form Laptop to Smartphone

Pinging from Laptop to Civil Node

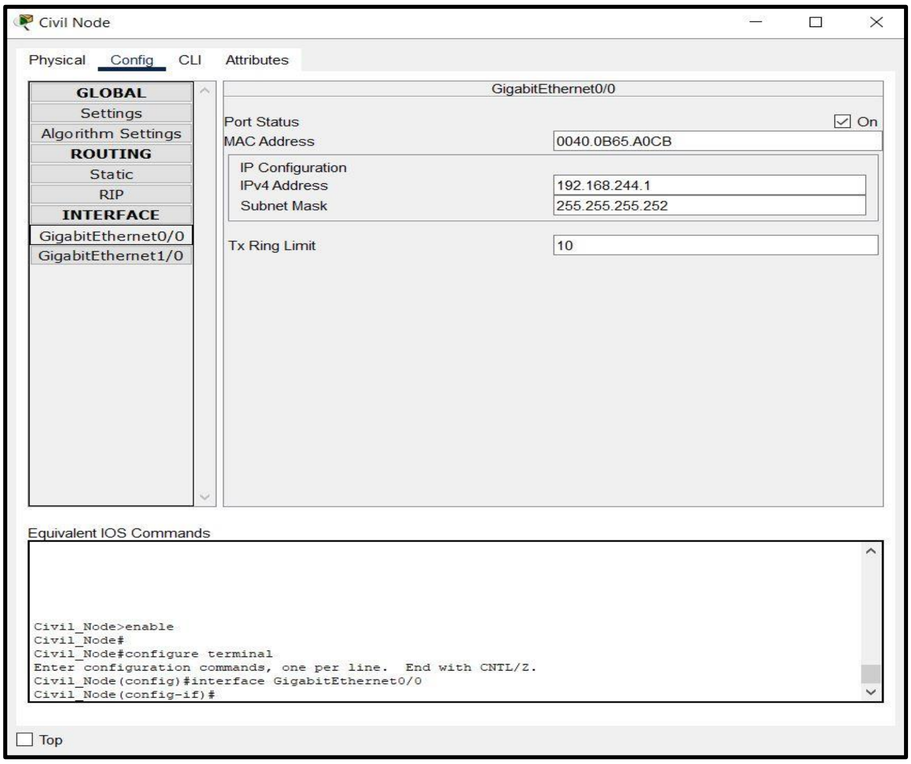


Figure 8: IP configuration of Civil Node (192.168.244.1)

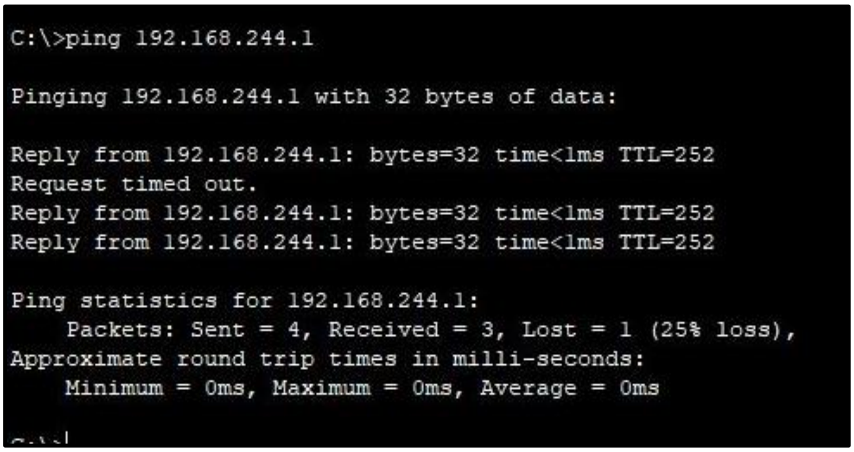


Figure 9: Pinging from Laptop to Civil Node

Traceroute from Laptop to Textile Node

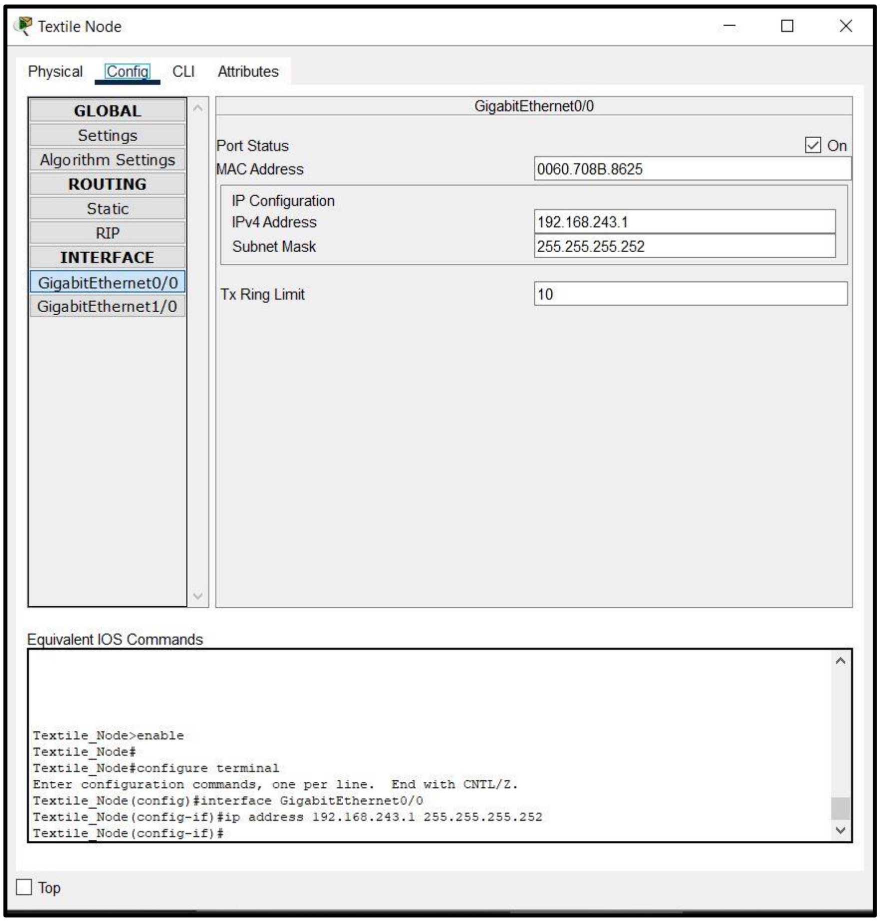


Figure 10: IP configuration of Textile Node

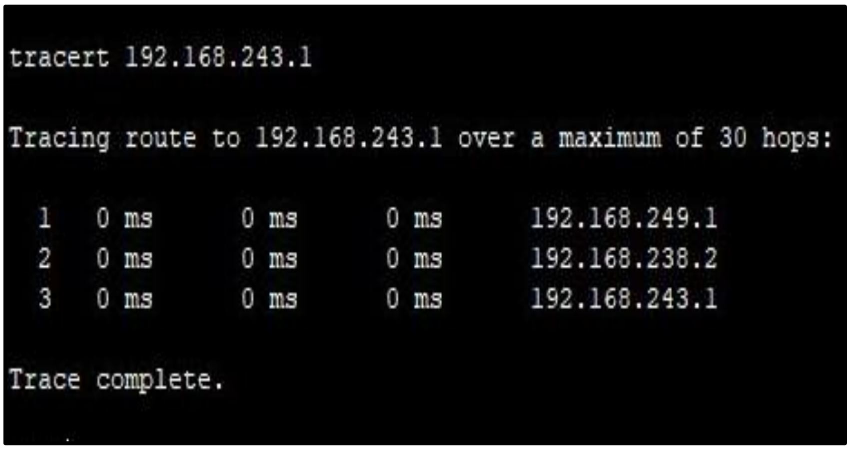


Figure 11: Traceroute from Laptop to Textile Node