Static and Dynamic Routing – Exploration & Verification

Submitted by

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PART A – Conceptual Grounding

1. Static Routing – Understanding Control

- Static routing is when a network administrator manually decides how a router should send packets to a particular network. The router does not learn anything by itself and does not communicate with other routers. It simply follows the path that has been configured by the administrator.
- Static routing feels very predictable because the route never changes unless someone manually changes it. Every packet follows the same path every time, which makes the network behavior easy to understand and control.
- However, static routing is also fragile. If a link or router in the path goes down, the router does not automatically detect the problem. It keeps sending packets to the same broken path, and communication fails. To fix the issue, a person has to manually update or remove the route.
- Static routing is useful in small networks where there are only a few routers. It is also commonly used in branch offices that have only one way to connect to the main network. Another use is as a backup route, called a floating static route. Static routing is preferred in networks where security and full control are more important than flexibility.

In simple words, static routing is like written directions on paper. They work well as long as the road is open, but once the road is closed, they are no longer useful.

2.Dynamic Routing – Letting Routers Learn

- Dynamic routing works in a completely different way. Here, routers communicate with each other and share information about the networks they know. Instead of manually setting routes, routers learn paths automatically using routing protocols.
- With dynamic routing, routers can discover new networks on their own, and routing tables update automatically. If a link goes down or a better path becomes available, the router recalculates the route and forwards packets through a new path without any human involvement.
- Dynamic routing protocols exist because manually managing routes is not practical in large networks. Networks change often, and failures can happen at any time. Dynamic routing allows the network to continue working even when something goes wrong.

Dynamic routing helps in:

- Automatically finding routes to new networks
- Supporting large and growing networks
- Recovering from failures without manual work
- Reducing the workload of network administrators

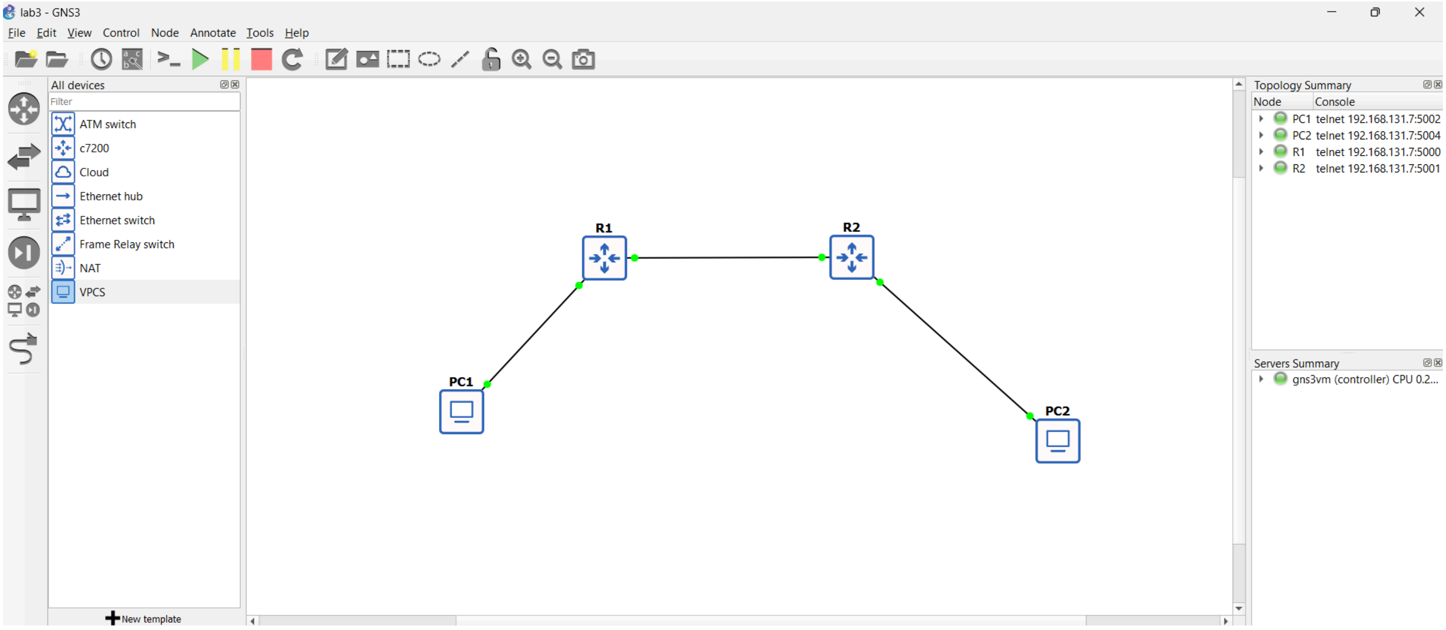
Dynamic routing is like using Google Maps. When there is traffic or a road is blocked, it automatically finds another route to reach the destination.

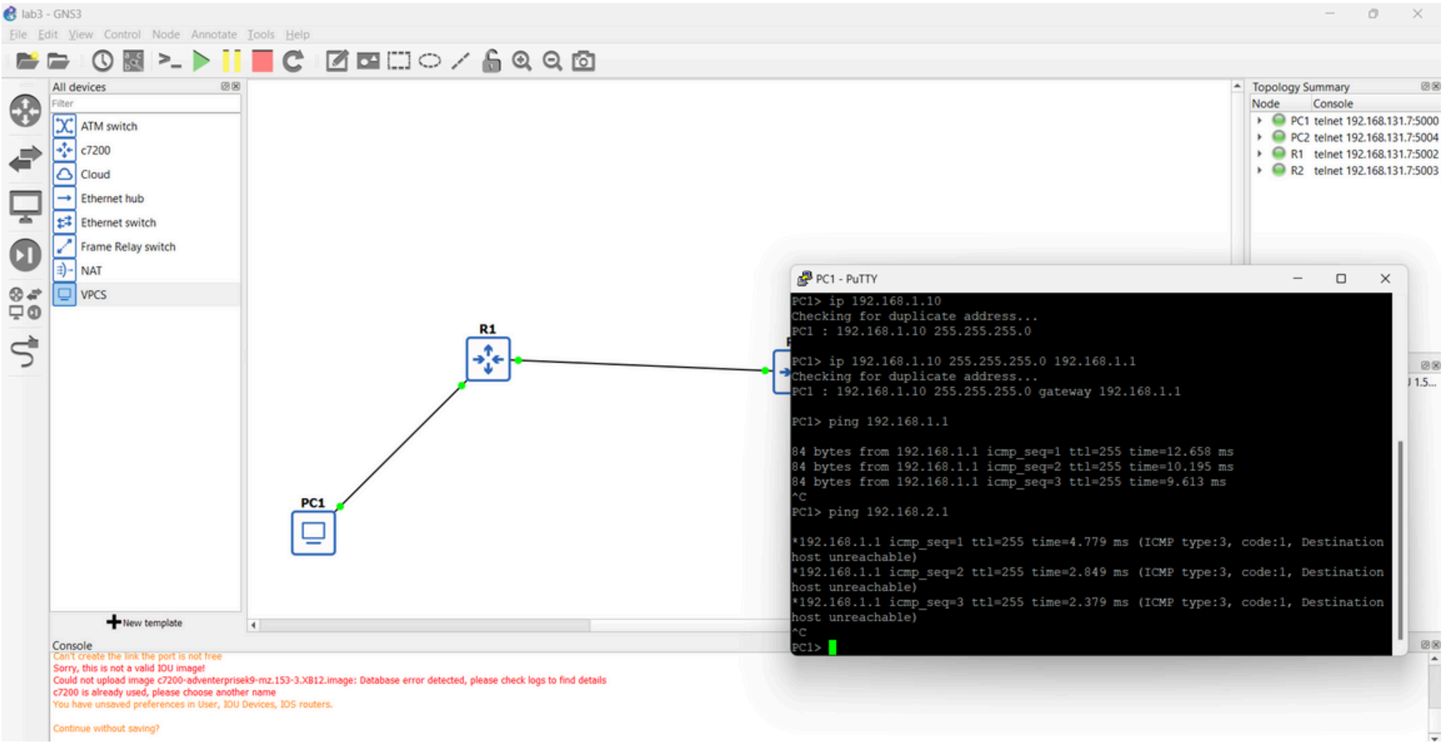
3.Static vs Dynamic – Thought Comparison

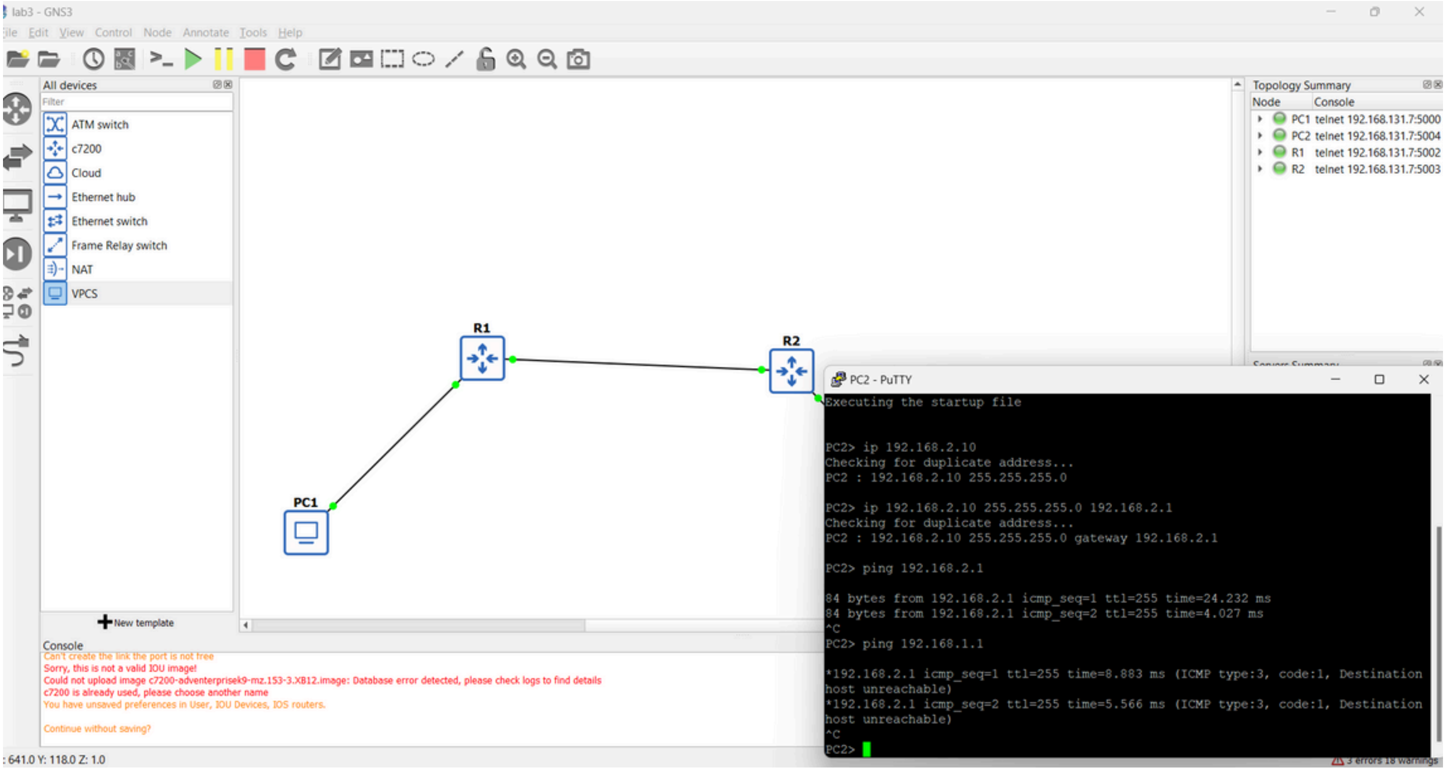
- Dynamic routing scales better because it can handle large networks easily. Static routing does not scale well because every route must be configured manually.
- Static routing fails faster because it cannot adapt to network changes. Dynamic routing can recover automatically when a failure occurs.
- Static routing requires more human effort, while dynamic routing reduces manual work by allowing routers to learn routes on their own.

Overall, static routing is simple and easy to control but very rigid. Dynamic routing is more complex but intelligent and flexible, making it suitable for modern networks.

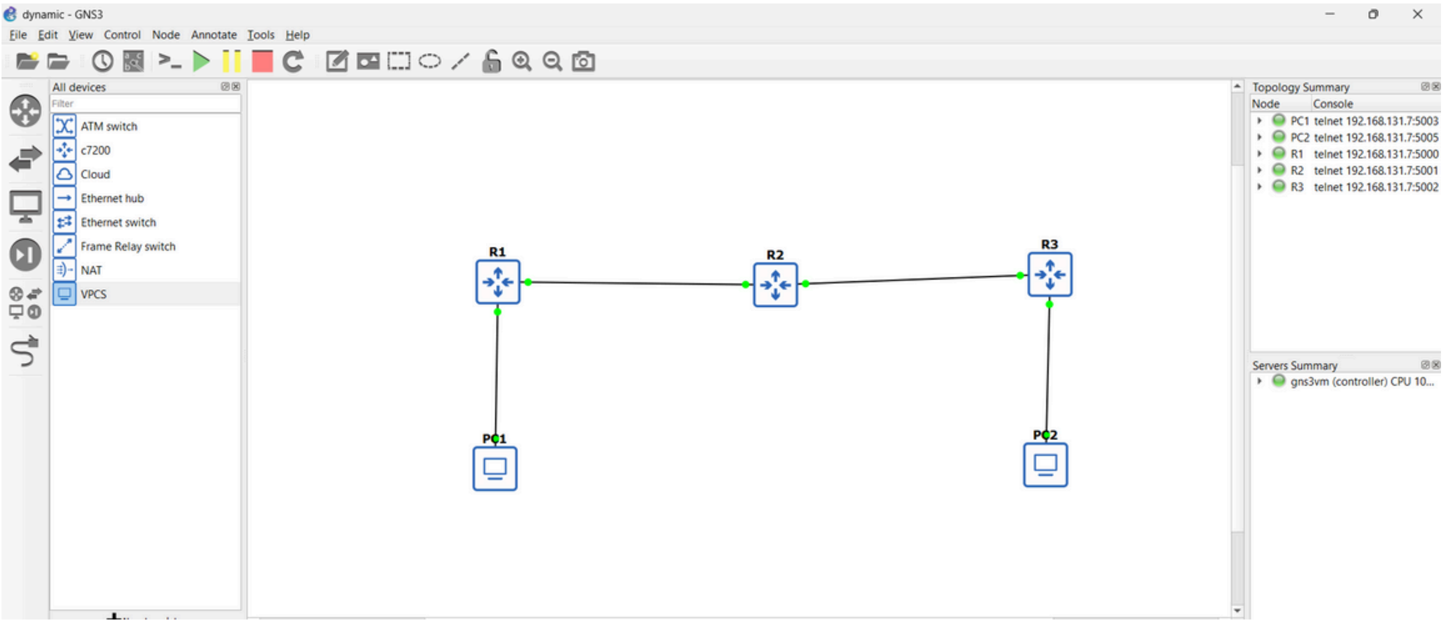
PART B - Static Routing Lab

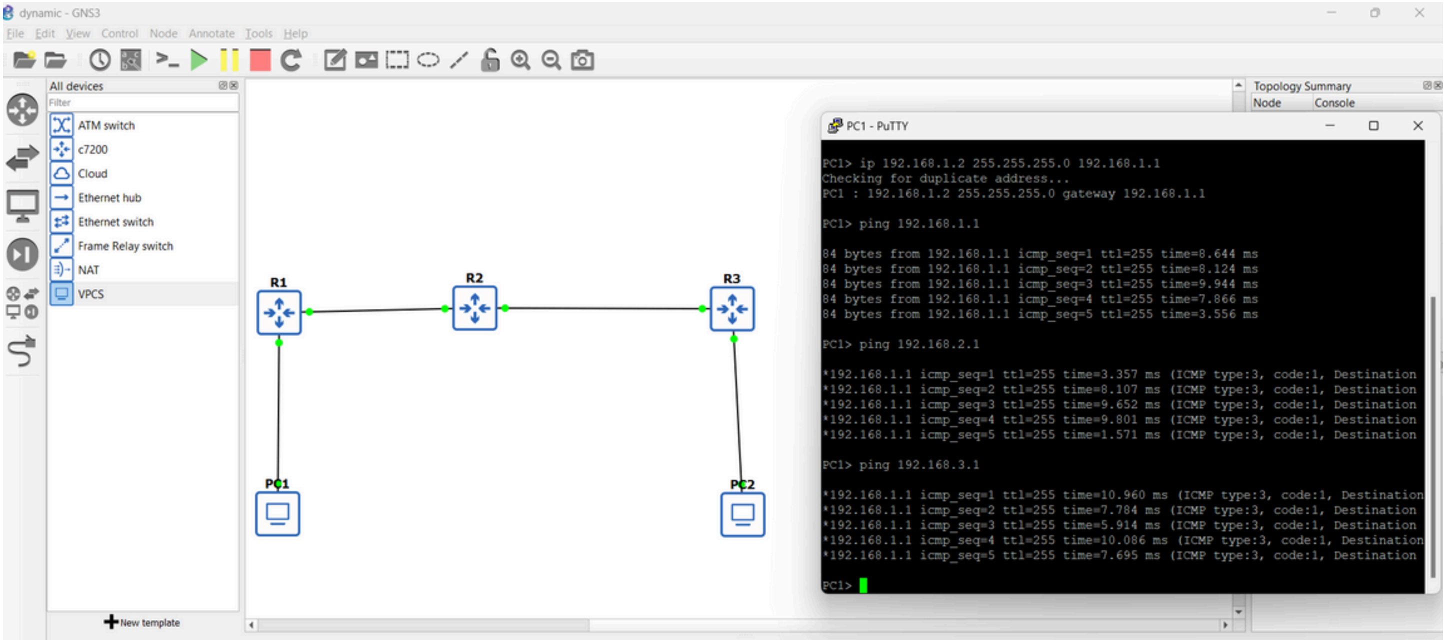


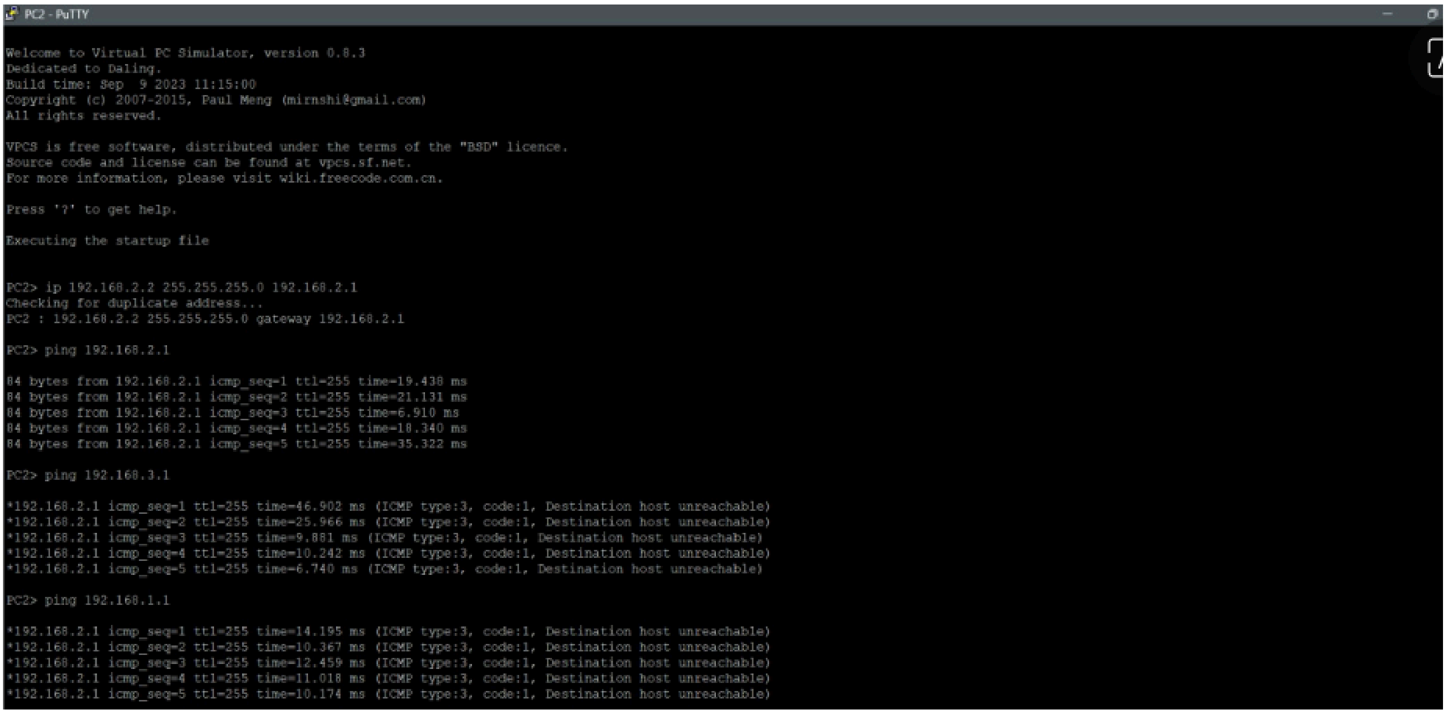




PART C – Dynamic Routing Lab




dynamic - GNS3
File Edit View Control Node Annotate Tools Help
All devices
ATM switch
c7200
Cloud
Ethernet hub
Ethernet switch
Frame Relay switch
NAT
VPCS
New template
R1
R2
R3
PC1
PC2
Topology Summary
Node
Console
PC1 - PuTTY
PC1> ip 192.168.1.2 255.255.255.0 192.168.1.1
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.0 gateway 192.168.1.1
PC1> ping 192.168.1.1
84 bytes from 192.168.1.1 icmp_seq=1 ttl=255 time=8.644 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=255 time=8.124 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=255 time=9.944 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=255 time=7.866 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=255 time=3.556 ms
PC1> ping 192.168.2.1
*192.168.1.1 icmp_seq=1 ttl=255 time=3.357 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=2 ttl=255 time=8.107 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=3 ttl=255 time=9.652 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=4 ttl=255 time=9.801 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=5 ttl=255 time=1.571 ms (ICMP type:3, code:1, Destination
PC1> ping 192.168.3.1
*192.168.1.1 icmp_seq=1 ttl=255 time=10.960 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=2 ttl=255 time=7.784 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=3 ttl=255 time=5.914 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=4 ttl=255 time=10.086 ms (ICMP type:3, code:1, Destination
*192.168.1.1 icmp_seq=5 ttl=255 time=7.695 ms (ICMP type:3, code:1, Destination
PC1>


PC2 - PuTTY
Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep 9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.
VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.
Press '?' to get help.
Executing the startup file
PC2> ip 192.168.2.2 255.255.255.0 192.168.2.1
Checking for duplicate address...
PC2 : 192.168.2.2 255.255.255.0 gateway 192.168.2.1
PC2> ping 192.168.2.1
84 bytes from 192.168.2.1 icmp_seq=1 ttl=255 time=19.438 ms
84 bytes from 192.168.2.1 icmp_seq=2 ttl=255 time=21.131 ms
84 bytes from 192.168.2.1 icmp_seq=3 ttl=255 time=6.910 ms
84 bytes from 192.168.2.1 icmp_seq=4 ttl=255 time=18.340 ms
84 bytes from 192.168.2.1 icmp_seq=5 ttl=255 time=35.322 ms
PC2> ping 192.168.3.1
*192.168.2.1 icmp_seq=1 ttl=255 time=46.902 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=2 ttl=255 time=25.966 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=3 ttl=255 time=9.881 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=4 ttl=255 time=10.242 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=5 ttl=255 time=6.740 ms (ICMP type:3, code:1, Destination host unreachable)
PC2> ping 192.168.1.1
*192.168.2.1 icmp_seq=1 ttl=255 time=14.195 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=2 ttl=255 time=10.367 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=3 ttl=255 time=12.459 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=4 ttl=255 time=11.018 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.2.1 icmp_seq=5 ttl=255 time=10.174 ms (ICMP type:3, code:1, Destination host unreachable)

```
R1(config-if)#no shutdown
R1(config-if)#
*Dec 22 09:25:01.039: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Dec 22 09:25:02.039: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed sta
R1(config-if)#exit
R1(config)#exit
R1#
*Dec 22 09:46:41.403: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/28 is directly connected, FastEthernet0/1
L        10.0.0.1/32 is directly connected, FastEthernet0/1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, FastEthernet0/0
L        192.168.1.1/32 is directly connected, FastEthernet0/0
R1#
```

```
R2(config-if)#exit
R2(config)#exit
R2#
*Dec 22 09:45:06.375: %SYS-5-CONFIG_I: Configured from console by console
R2#show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/28 is directly connected, FastEthernet0/1
L        10.0.0.2/32 is directly connected, FastEthernet0/1
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, FastEthernet0/0
L        192.168.2.1/32 is directly connected, FastEthernet0/0
R2#
```

```
R3#show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/28 is directly connected, FastEthernet0/1
L        10.0.0.3/32 is directly connected, FastEthernet0/1
      192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.3.0/24 is directly connected, FastEthernet0/0
L        192.168.3.1/32 is directly connected, FastEthernet0/0
R3#
```

PART D – Static vs Dynamic Routing in Practice

- During the static routing experiment, the routing tables contained only manually configured routes. Each router knew about remote networks only because a human explicitly told it where to send packets. The routing table remained fixed and did not change unless the static route was added or removed manually. This made the routing table simple and easy to understand, but also very rigid.
- In contrast, during the dynamic routing experiment, the routing tables were populated automatically. Routes appeared and disappeared on their own as routers exchanged information. The routing tables showed routes learned through the routing protocol, and routers were able to discover networks without manual configuration. This made the routing table more detailed and constantly updated.
- When a link failed in the static routing setup, nothing changed in the routing table. The router continued to forward traffic toward the failed link, causing communication to break completely. Connectivity was restored only after manual intervention. However, in the dynamic routing setup, when a link was shut down, routers automatically detected the failure. The affected routes were removed from the routing tables, and traffic was either rerouted or stopped until the link came back up. Once the link was restored, routes reappeared automatically without human involvement.
- Dynamic routing felt more “alive” because the routers actively responded to network changes. They adapted to failures and recoveries on their own, making the network feel intelligent and self-adjusting. Static routing, while predictable, felt passive and dependent entirely on human control.
- A real-world scenario where static routing is better is a small branch office with a single internet connection. In such a case, the network rarely changes, and static routes provide simplicity, stability, and better security.
- A real-world scenario where dynamic routing is unavoidable is a large enterprise or service provider network. These networks have many routers and frequent changes, and manual routing would be impossible to maintain. Dynamic routing is essential to ensure scalability, automatic recovery, and reliable communication.