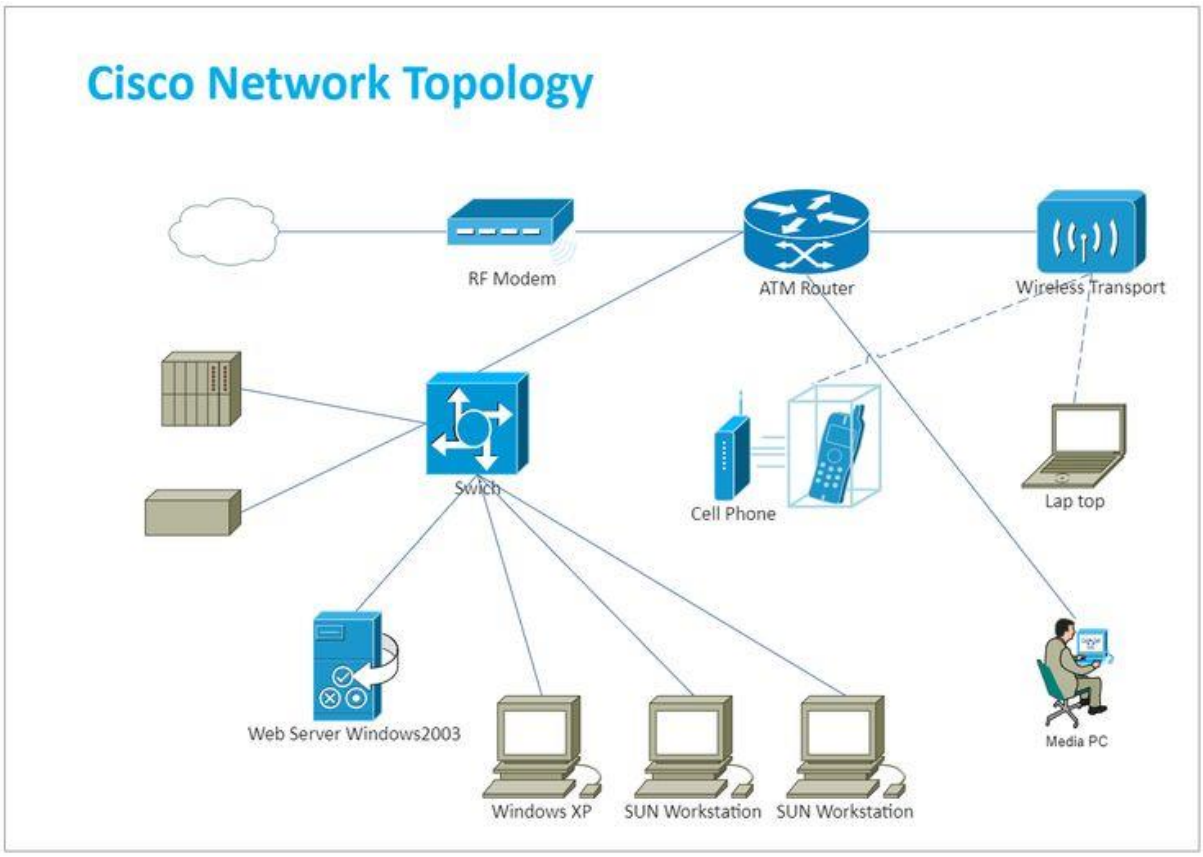
Project Title: NetPath Illuminator – The Network Odyssey



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LEVEL 1: Direct PC to PC Communication

Objective:

To establish a basic network between two PCs and study ARP (Address Resolution Protocol), MAC & IP addressing.

Topology Used:

- PC0 ↔ PC1 (via copper cross cable)

IP Configuration:

- PC0: 10.1.1.1 /8
- PC1: 10.1.1.2 /8

Commands Used:

- ping 10.1.1.2
- arp -a
- arp -d
- ipconfig

Observations:

- Ping successful.
- ARP table shows IP–MAC mapping.
- After arp -d, cache is cleared and repopulated on next ping.

Flow Diagram:

Source MAC: PC0

Destination MAC: PC1

Source IP: 10.1.1.1

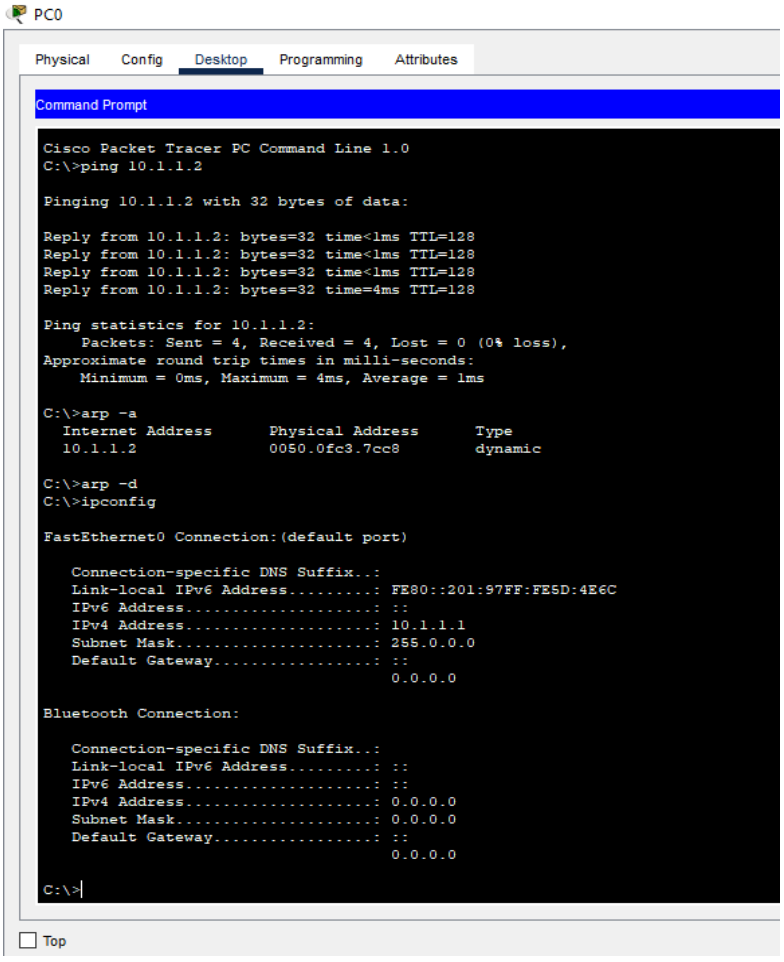
Destination IP: 10.1.1.2

Simulation Panel

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	PC0
	0.002	PC1
	0.002	--
	0.003	PC0
	0.004	PC1
	1.005	--
	1.006	PC0

Commands Captured:



Conclusion:

Learned how ARP resolves IP to MAC. Understood the role of IP and MAC addresses in direct communication.

LEVEL 2: PC to PC via Switch

Objective:

To connect multiple PCs using a switch and understand MAC address learning.

Topology Used:

- PC0, PC1, PC2, PC3 ↔ Switch0

IP Configuration:

- PC0: 10.1.1.1 /8
- PC1: 10.1.1.2 /8
- PC2: 10.1.1.3 /8
- PC3: 10.1.1.4 /8

Commands Used:

- ping 10.1.1.2
- arp -a

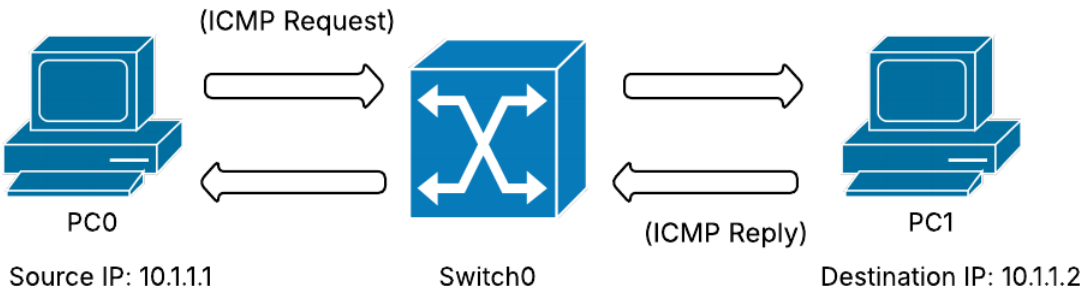
In Switch0

- show mac address-table

Observations:

- Switch learns MAC addresses dynamically.
- Verified MAC entries and port mappings.
- Learned about flooding and forwarding.

Flow Diagram:

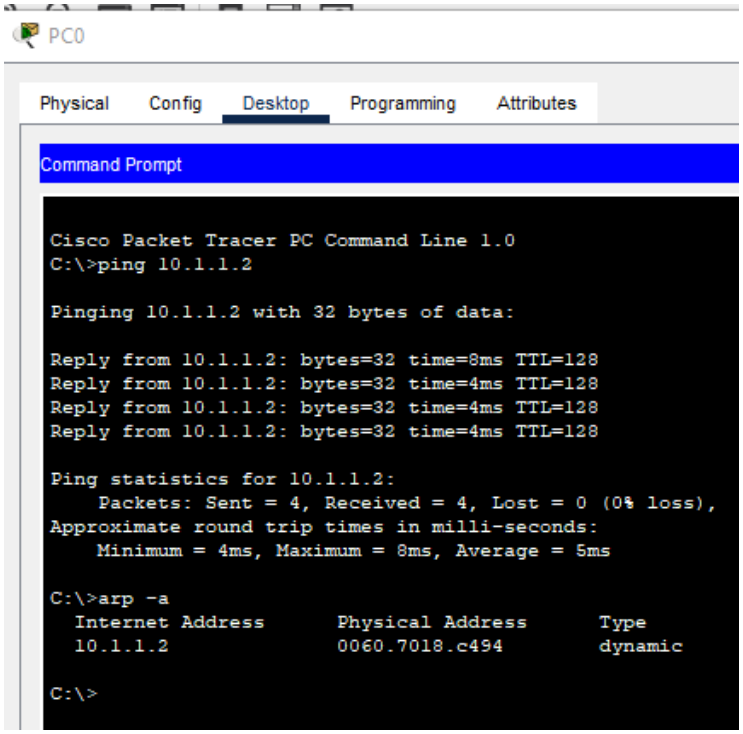


Simulation Panel

Event List

Vis.	Time(sec)	Last Device
	2.012	--
	2.013	PC0
	2.014	Switch0
	2.015	PC1
	2.016	Switch0
	3.019	--
	3.020	PC0
	3.021	Switch0
	3.022	PC1
	3.023	Switch0

Commands Captured:




```
Switch>enable
Switch#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    0030.f224.8ec8    DYNAMIC     Fa0/1
   1    0060.7018.c494    DYNAMIC     Fa0/2
```

Conclusion:

Switching works at Layer 2 using MAC. Learned how switches build MAC address tables.

LEVEL 3: PC to PC (Different Subnets, No Router)

Objective:

To understand failed communication due to subnet mismatch.

Topology Used:

- PC0 ↔ PC1 (via copper cross cable)

IP Configuration:

- PC0: 10.1.1.1 /8
- PC1: 20.1.1.1 /8

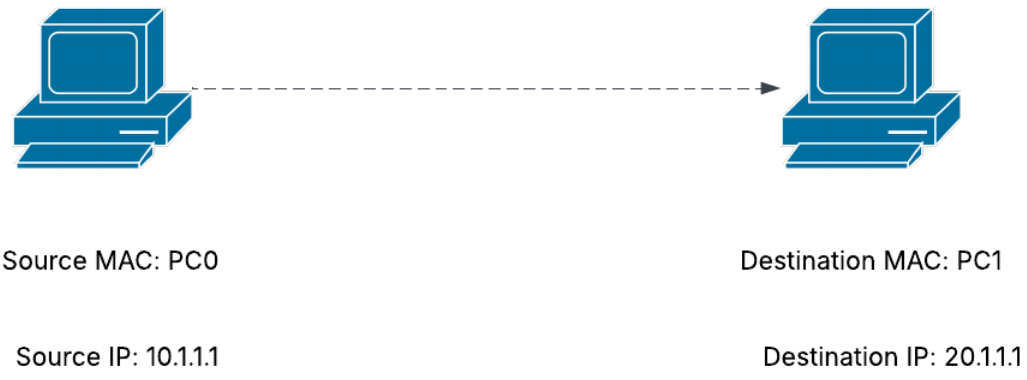
Commands Used:

- ping 20.1.1.1
- arp -a

Observation:

- Ping fails.
- ARP entry not created.
- ARP broadcasts do not cross subnets.

Flow Diagram:



Simulation Panel

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	PC0
	6.004	--
	12.006	--
	18.012	--

Commands Captured:

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 20.1.1.1

Pinging 20.1.1.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 20.1.1.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>arp -a
No ARP Entries Found
C:\>
```

Conclusion:

Router is needed for communication across different subnets.

LEVEL 4: PC to PC via Router

Objective:

Enable inter-subnet communication using a router.

Topology Used:

- PC0↔ Router ↔ PC1

IP Configuration:

- PC0: 10.1.1.10 /8
- Router: Interfaces for both subnets
- PC1: 20.1.1.10 /8

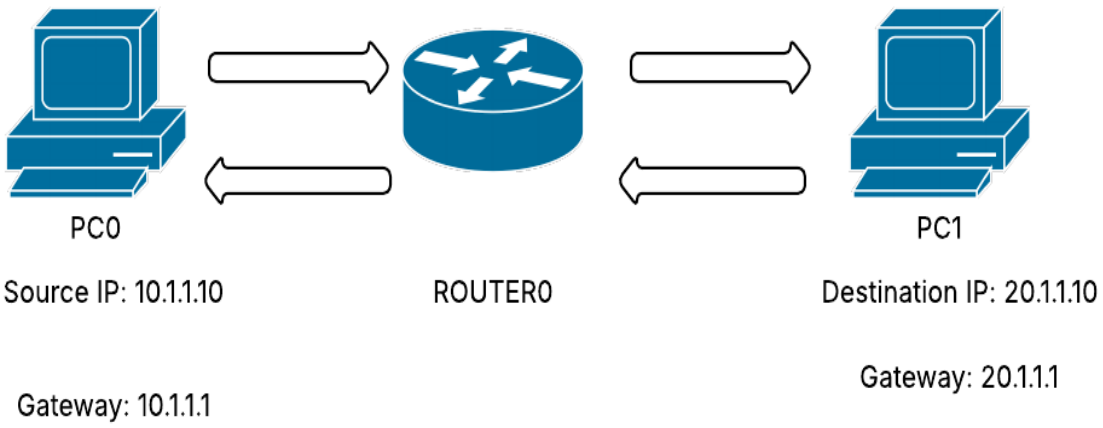
Commands Used:

- ping
- show ip route
- show ip interface brief

Observation:

- Ping successful.
- Routing table shows connected networks.
- Default gateway plays a vital role.

Flow Diagram:



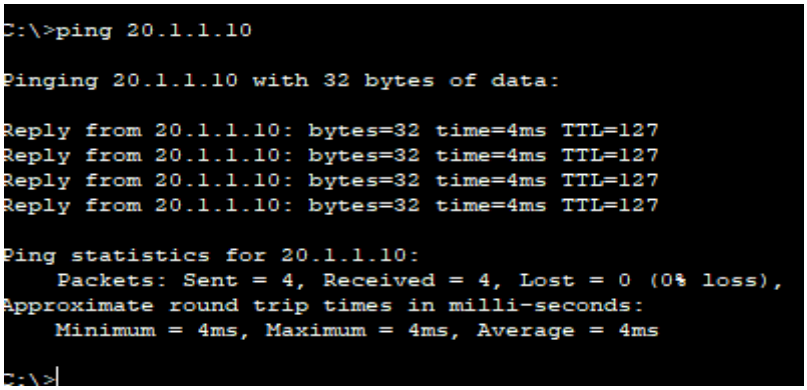
Simulation Panel

Event List

Time(sec)	Last Device	At Device
10.037	--	PC0
10.038	PC0	Router0
10.039	Router0	PC1
10.040	PC1	Router0
10.041	Router0	PC0
11.041	--	PC0
11.042	PC0	Router0
11.043	Router0	PC1
11.044	PC1	Router0

Commands Captured:

- Ping Test: From PC0 to PC1



```
C:\>ping 20.1.1.10

Pinging 20.1.1.10 with 32 bytes of data:

Reply from 20.1.1.10: bytes=32 time=4ms TTL=127
Reply from 20.1.1.10: bytes=32 time=4ms TTL=127
Reply from 20.1.1.10: bytes=32 time=4ms TTL=127
Reply from 20.1.1.10: bytes=32 time=4ms TTL=127

Ping statistics for 20.1.1.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 4ms, Average = 4ms

C:\>
```

- From Router0

```
Router>enable
Router#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0/0   10.1.1.1        YES manual up                    up
GigabitEthernet0/0/1   20.1.1.1        YES manual up                    up
GigabitEthernet0/0/2   unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
Router#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/8 is directly connected, GigabitEthernet0/0/0
L       10.1.1.1/32 is directly connected, GigabitEthernet0/0/0
     20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       20.0.0.0/8 is directly connected, GigabitEthernet0/0/1
L       20.1.1.1/32 is directly connected, GigabitEthernet0/0/1

Router#exit
```

Conclusion:

Router connects different subnets using Layer 3 routing.

LEVEL 5: Router + Switch + Multiple PCs

Objective:

Test routing between two networks with switch and router

Topology Used:

- Multiple PCs ↔ Switch ↔ Router ↔ Other Switch ↔ Other PCs.

IP Configuration:

Network 1

- PC0: 192.168.1.10 /24
- PC1: 192.168.1.11 /24
- PC2: 192.168.1.12/24
- Default Gateway: 192.168.1.1

Network 2

- PC0: 192.168.2.10 /24
- PC1: 192.168.2.11 /24
- PC2: 192.168.2.12/24
- Default Gateway: 192.168.2.1

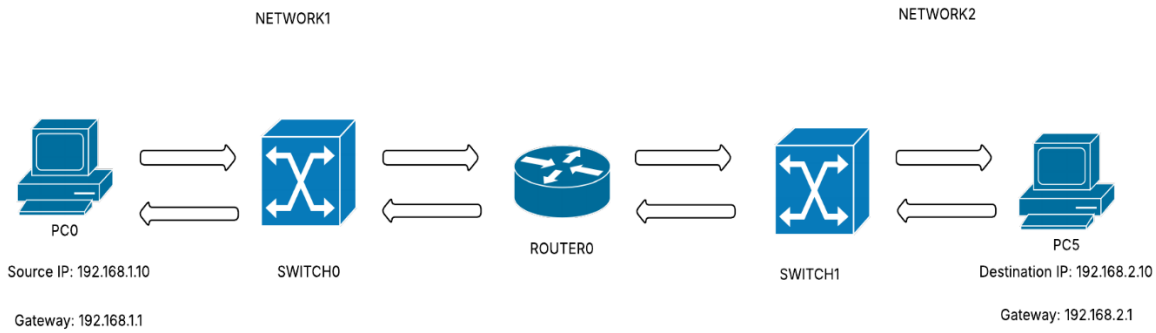
Commands Used:

- ping from PC0 to PC5
- show ip route
- show ip arp
- show mac address-table

Observation:

- Verified inter-network routing.
- Observed ARP table and MAC learning.

Flow Diagram:



Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device
	3.031	PC0	Switch0
	3.032	Switch0	Router0
	3.033	Router0	Switch1
	3.034	Switch1	PC5
	3.035	PC5	Switch1
	3.036	Switch1	Router0
	3.037	Router0	Switch0
	3.038	Switch0	PC0

Commands Captured:

- Ping Test: From PC0 to PC5

```
C:\>ping 192.168.2.10

Pinging 192.168.2.10 with 32 bytes of data:

Reply from 192.168.2.10: bytes=32 time=1ms TTL=127
Reply from 192.168.2.10: bytes=32 time=1ms TTL=127
Reply from 192.168.2.10: bytes=32 time<1ms TTL=127
Reply from 192.168.2.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.2.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

- From Router0

```
Router>enable
Router#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.1.1/32 is directly connected, GigabitEthernet0/0/0
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, GigabitEthernet0/0/1
L       192.168.2.1/32 is directly connected, GigabitEthernet0/0/1

Router#show ip arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.1.1            -   000C.8516.1B01  ARPA   GigabitEthernet0/0/0
Internet  192.168.1.10           0   0040.0BD6.4877  ARPA   GigabitEthernet0/0/0
Internet  192.168.2.1            -   000C.8516.1B02  ARPA   GigabitEthernet0/0/1
Internet  192.168.2.10           0   0001.96E9.D436  ARPA   GigabitEthernet0/0/1
Router#exit
```

- From Switch0

```
Switch>enable
Switch#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    000c.8516.1b01    DYNAMIC     Fa0/24
   1    0040.0bd6.4877    DYNAMIC     Fa0/1
```

Conclusion:

Understood full Layer 2 & Layer 3 behaviour in a mixed network.

Level 6 – Static Routing

Objective:

Enable network communication via manually configured static routes.

Topology Used:

- PC's ↔ Switch0 ↔ Router0↔ Router1 ↔ Router2 ↔ Switch1↔ PC's

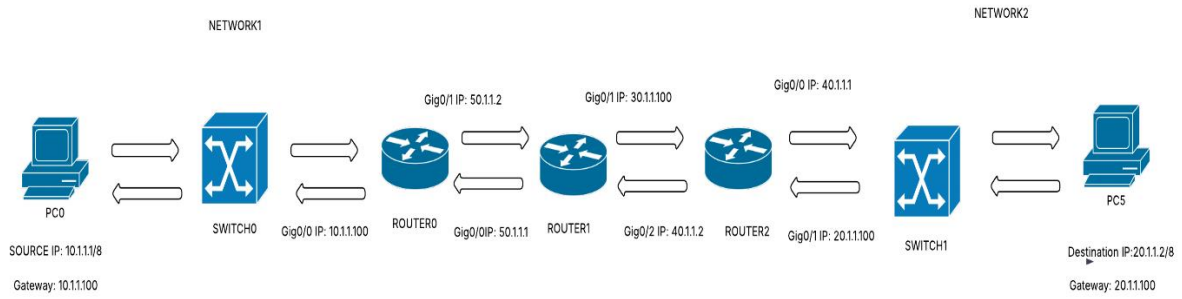
Commands Used:

- ip route <destination> <mask> <next-hop>
- show ip route
- show running-config

Observations:

- Ping successful after static route added.
- Routing table updated manually.

Flow Diagram:



Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.001	PC0	Switch0	ICMP
	0.002	Switch0	Router0	ICMP
	0.003	Router0	Router1	ICMP
	0.004	Router1	Router2	ICMP
	0.005	Router2	Switch2	ICMP
	0.006	Switch2	PC5	ICMP
	0.007	PC5	Switch2	ICMP
	0.008	Switch2	Router2	ICMP
	0.009	Router2	Router1	ICMP
	0.010	Router1	Router0	ICMP
	0.011	Router0	Switch0	ICMP
	0.012	Switch0	PC0	ICMP

Commands Captured:

- Ping Test: From PC0 to PC5

```
C:\>ping 20.1.1.2

Pinging 20.1.1.2 with 32 bytes of data:

Reply from 20.1.1.2: bytes=32 time=12ms TTL=125
Reply from 20.1.1.2: bytes=32 time=12ms TTL=125
Reply from 20.1.1.2: bytes=32 time=12ms TTL=125
Reply from 20.1.1.2: bytes=32 time=12ms TTL=125

Ping statistics for 20.1.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 12ms, Maximum = 12ms, Average = 12ms
```

- From Router0

Router0

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#interface GigabitEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#
Router(config)#ip route 20.0.0.0 255.0.0.0 50.1.1.1
Router(config)#exit
Router#exit
```

```
Router>enable
Router#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/8 is directly connected, GigabitEthernet0/0
L       10.1.1.100/32 is directly connected, GigabitEthernet0/0
S    20.0.0.0/8 [1/0] via 50.1.1.1
S    30.0.0.0/8 [1/0] via 50.1.1.1
S    40.0.0.0/8 [1/0] via 50.1.1.1
     50.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       50.0.0.0/8 is directly connected, GigabitEthernet0/1
L       50.1.1.2/32 is directly connected, GigabitEthernet0/1
```

- From Switch0

```
Switch>enable
Switch#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    0001.c7a4.788e    DYNAMIC     Fa0/1
   1    00e0.b0d8.bb01    DYNAMIC     Fa0/3
Switch#
```

- From Switch1

```
Switch>enable
Switch#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    000a.f354.a311    DYNAMIC     Fa0/2
   1    0090.2b0c.8802    DYNAMIC     Fa0/3
Switch#
```

Conclusion:

Static routing is manual but effective for small networks.

Level 7 – Dynamic Routing using OSPF

Objective:

Enable automatic route discovery using OSPF.

Topology Used:

- PC's ↔ Switch0 ↔ Router0↔ Router1 ↔ Router2 ↔ Switch1↔ PC's.

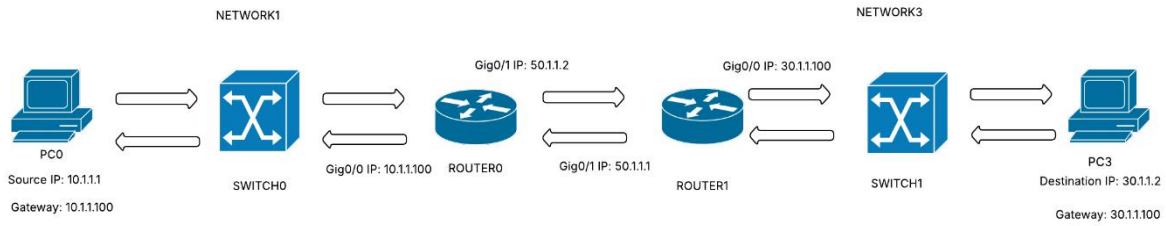
Commands Used:

- router ospf 1
- network <ip> <wildcard> area 0
- show ip route

Observations:

- OSPF dynamically builds routing table.
- Routers exchange routing info.

Flow Diagram:



Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch0	ICMP
	0.002	Switch0	Router0	ICMP
	0.003	Router0	Router1	ICMP
	0.004	Router1	Switch1	ICMP
	0.005	Switch1	PC3	ICMP
	0.006	PC3	Switch1	ICMP
	0.007	Switch1	Router1	ICMP
	0.008	Router1	Router0	ICMP
	0.009	Router0	Switch0	ICMP
	0.010	Switch0	PC0	ICMP
	0.085	--	Switch0	STP

Commands Used:

- Ping Test: From PC0 to PC3

```
C:\>ping 30.1.1.2

Pinging 30.1.1.2 with 32 bytes of data:

Reply from 30.1.1.2: bytes=32 time<1ms TTL=126
Reply from 30.1.1.2: bytes=32 time=1ms TTL=126
Reply from 30.1.1.2: bytes=32 time=29ms TTL=126
Reply from 30.1.1.2: bytes=32 time=23ms TTL=126

Ping statistics for 30.1.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 29ms, Average = 13ms

C:\>
```

- From Router0

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#router ospf 1
Router(config-router)#network 10.1.1.100 0.0.0.255 area 0
Router(config-router)#network 50.1.1.2 0.0.0.255 area 0
Router(config-router)#exit
Router(config)#exit
Router#
Router#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/8 is directly connected, GigabitEthernet0/0
L       10.1.1.100/32 is directly connected, GigabitEthernet0/0
O    20.0.0.0/8 [110/3] via 50.1.1.1, 00:03:45, GigabitEthernet0/1
O    30.0.0.0/8 [110/2] via 50.1.1.1, 00:03:45, GigabitEthernet0/1
O    40.0.0.0/8 [110/2] via 50.1.1.1, 00:03:45, GigabitEthernet0/1
     50.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       50.0.0.0/8 is directly connected, GigabitEthernet0/1
L       50.1.1.2/32 is directly connected, GigabitEthernet0/1

Router#exit
```

Conclusion:

Dynamic routing like OSPF is scalable and efficient.

Level 8 – OSPF with Primary and Backup Path

Objective:

Observe dynamic path switching using OSPF upon link failure.

Topology Used:

- Routers with primary and secondary paths to server

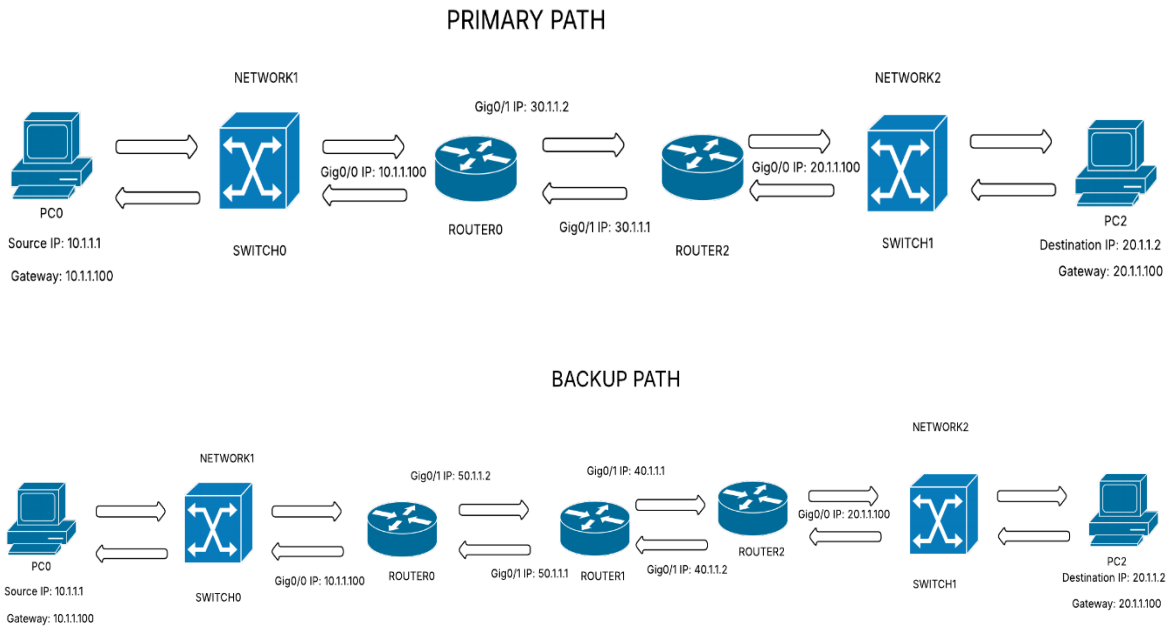
Commands Used:

- show ip route
- tracert <PC2 ip_address>
- interface Fa0/1 → shutdown
- show ip ospf neighbor
- show ip ospf interface brief

Observations:

- Before shutdown: packets use primary path
- After shutdown: OSPF reroutes traffic via backup
- Convergence delay observed.

Flow Diagram:



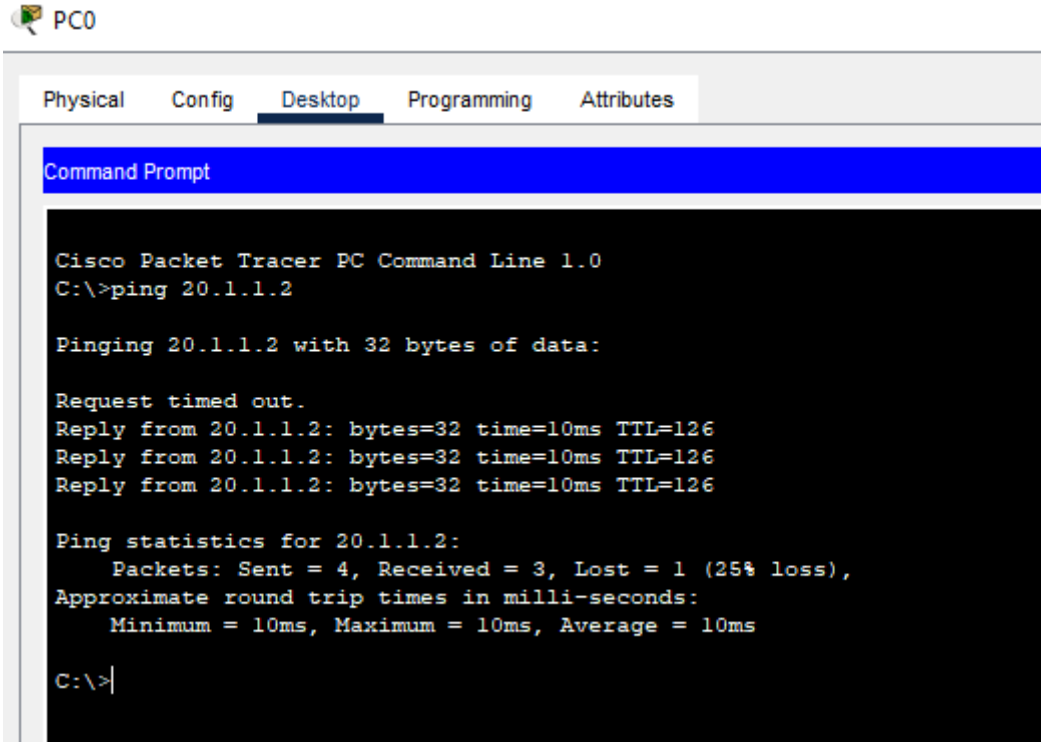
Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device
	8.029	PC0	Switch0
	8.030	Switch0	Router0
	8.031	Router0	Router2
	8.032	Router2	Switch1
	8.033	Switch1	PC2
	8.034	PC2	Switch1
	8.035	Switch1	Router2
	8.036	Router2	Router0
	8.037	Router0	Switch0
	8.038	Switch0	PC0

Commands Captured:

- From PC0 to PC2



```
C:\>tracert 20.1.1.2

Tracing route to 20.1.1.2 over a maximum of 30 hops:

  1    0 ms      0 ms      0 ms      10.1.1.100
  2    13 ms     4 ms      0 ms      30.1.1.2
  3    12 ms     12 ms     32 ms     20.1.1.2

Trace complete.
```

- From Router1:

```
Router>enable
Router#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

O    10.0.0.0/8 [110/102] via 40.1.1.1, 00:03:03, GigabitEthernet0/1
O    20.0.0.0/8 [110/2] via 40.1.1.1, 00:03:03, GigabitEthernet0/1
O    30.0.0.0/8 [110/101] via 40.1.1.1, 00:03:03, GigabitEthernet0/1
     40.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       40.0.0.0/8 is directly connected, GigabitEthernet0/1
L       40.1.1.2/32 is directly connected, GigabitEthernet0/1

Router#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
40.1.1.1          1   FULL/BDR        00:00:30    40.1.1.1        GigabitEthernet0/1
Router#show ip ospf interface brief
Interface     PID   Area                    IP Address/Mask          Cost  State  Nbrs F/C
Gig0/1          1   0                       40.1.1.2/255.0.0.0   1       DR  0/0
```

Conclusion:

OSPF dynamically adjusts to topology changes, ensuring fault tolerance.

.pkt Files

1. LEVEL1 - Direct PC to PC Communication
2. LEVEL 2: PC to PC via Switch
3. LEVEL 3: PC to PC (Different Subnets, No Router)
4. LEVEL 4: PC to PC via Router
5. LEVEL 5: Router + Switch + Multiple PCs
6. LEVEL 6 – Static Routing
7. LEVEL 7 – Dynamic Routing using OSPF
8. LEVEL 8 – OSPF with Primary and Backup Path