

# **IPv6Next – Enterprise Migration to IPv6**

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## **1. Summary:**

This report presents the design, implementation, and validation of a dualstack IPv4/IPv6 network architecture tailored for a mid-sized enterprise environment. The project aims to facilitate a seamless transition to IPv6 while maintaining full backward compatibility with IPv4 infrastructure. Using Cisco Packet Tracer as a simulation platform, the network topology includes eight routers, ten inter-router links, and eight local area networks (LANs), all configured to support dual-stack addressing. The routing protocol selected for IPv6 is OSPFv3, chosen for its scalability, open-standard compatibility, and fast convergence. The implementation includes core IPv6 services such as Stateless Address Autoconfiguration (SLAAC), stateless DHCPv6, and ICMPv6. Comprehensive testing was conducted to ensure end-to-end connectivity, routing stability, and fault recovery under various failure scenarios. This document provides a detailed addressing plan, protocol comparison, configuration steps, and a migration guide, offering a practical blueprint for future enterprise-grade IPv6 deployments.

## **2. Introduction**

With the depletion of IPv4 addresses and evolving network demands, the transition to IPv6 is imperative. This report presents a simulated enterprise

network deployment utilizing a dual-stack configuration. It covers design rationale, routing protocol evaluation, implementation procedures, testing methodologies, and operational verification.

## 2.1. Why IPV6?

The transition to IPv6 is driven by the limitations of IPv4 and the evolving needs of modern networks. IPv4's 32-bit address space provides approximately 4.3 billion addresses, which is no longer sufficient due to the rapid growth of internet-connected devices, IoT, and cloud infrastructure.

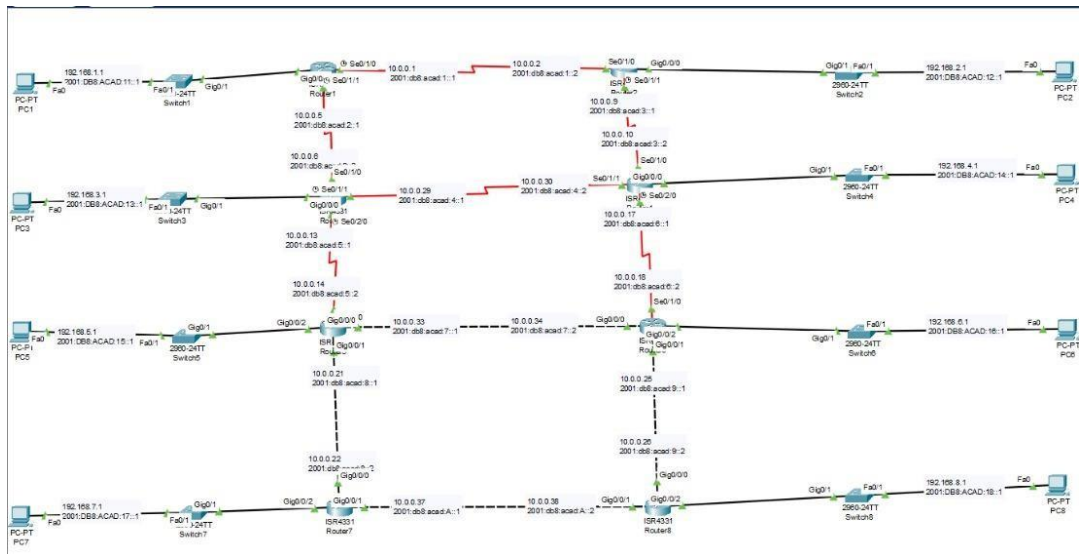
IPv6, with its 128-bit addressing, offers an almost limitless number of unique IP addresses, enabling end-to-end connectivity without the need for NAT (Network Address Translation). In addition to expanded address space, IPv6 introduces advantages such as:

- **Improved routing efficiency** with simplified headers and hierarchical addressing
- **Enhanced security**, with IPsec support built into the protocol
- **Better support for mobile and real-time applications**
- **Simplified network configuration** through stateless address autoconfiguration (SLAAC)

For enterprises, adopting IPv6 is essential to ensure scalability, maintain global reach, and stay aligned with current and future internet standards.

## 3. Network Design

### 3.1. Network Topology:



### 3.2. Router – Router Links

Router number	IPv4	IPv6
R1	192.168.1.0/24	2001\::db8\::acad:11::1
R2	192.168.2.0/24	2001\::db8\::acad:12::1
R3	192.168.3.0/24	2001\::db8\::acad:13::1
R4	192.168.4.0/24	2001\::db8\::acad:14::1
R5	192.168.5.0/24	2001\::db8\::acad:15::1
R6	192.168.6.0/24	2001\::db8\::acad:16::1
R7	192.168.7.0/24	2001\::db8\::acad:17::1
R8	192.168.8.0/24	2001\::db8\::acad:18::1

### 3.3. LAN segments (Router ↔ Switch ↔ PCs)

Links	IPV4
R1 ↔ R2 (S0/0/0 ↔ S0/0/0)	10.0.0.1 / 10.0.0.2
R1 ↔ R3 (S0/0/1 ↔ S0/0/0)	10.0.0.5 / 10.0.0.6
R2 ↔ R4 (S0/1/0 ↔ S0/0/0)	10.0.0.9 / 10.0.0.10
R3 ↔ R4 (S0/1/1 ↔ S0/1/1)	10.0.0.29 / 10.0.0.30
R3 ↔ R5 (S0/2/0 ↔ S0/1/0)	10.0.0.13 / 10.0.0.14
R4 ↔ R6 (S0/1/0 ↔ S0/0/0)	10.0.0.17 / 10.0.0.18
R5 ↔ R6 (G0/0/1 ↔ G0/0/0)	10.0.0.33 / 10.0.0.34
R5 ↔ R7 (G0/0/2 ↔ G0/0/0)	10.0.0.21 / 10.0.0.22
R6 ↔ R8 (S0/1/0 ↔ S0/1/0)	10.0.0.25 / 10.0.0.26
R7 ↔ R8 (S0/1/1 ↔ S0/1/1)	10.0.0.37 / 10.0.0.38

## 4. Routing Protocols

### 4.1. OSPFv3 vs EIGRP Comparison

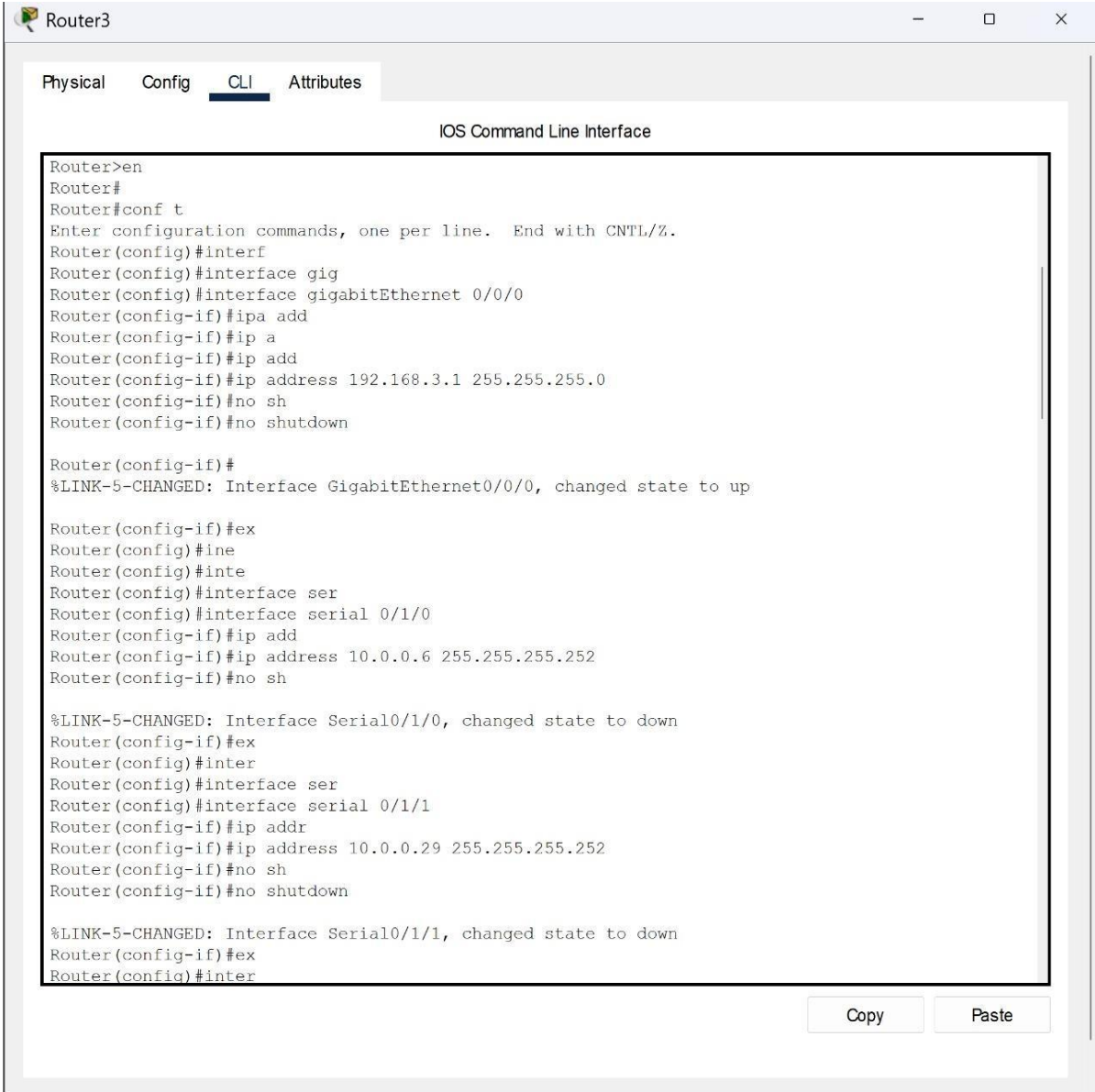
Protocol	Type	Scalability	Convergence	Complexity	Suitability
OSPFv3	Link-State	High	Fast	Moderate	Open Standard
EIGRP	Enhanced Distance Vector	High	Very fast	Moderate	Cisco - Proprietary

### 4.2. Justification for Protocol Choice

Based on the comparison, OSPFv3 was selected due to its open-standard nature, making it more suitable for multi-vendor environments than Cisco proprietary EIGRP. While both offer high scalability and moderate complexity, OSPFv3 provides fast convergence and greater flexibility in enterprise networks. Its compatibility, structure, and long-term support make it a more strategic choice for this dual-stack deployment.

## 5. Implementation

## 5.1. Interface Configuration



```
Router>en
Router#
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interf
Router(config)#interface gig
Router(config)#interface gigabitEthernet 0/0/0
Router(config-if)#ip a add
Router(config-if)#ip a
Router(config-if)#ip add
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no sh
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up

Router(config-if)#ex
Router(config)#ine
Router(config)#inte
Router(config)#interface ser
Router(config)#interface serial 0/1/0
Router(config-if)#ip add
Router(config-if)#ip address 10.0.0.6 255.255.255.252
Router(config-if)#no sh

%LINK-5-CHANGED: Interface Serial0/1/0, changed state to down
Router(config-if)#ex
Router(config)#inter
Router(config)#interface ser
Router(config)#interface serial 0/1/1
Router(config-if)#ip addr
Router(config-if)#ip address 10.0.0.29 255.255.255.252
Router(config-if)#no sh
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/1/1, changed state to down
Router(config-if)#ex
Router(config)#inter
```

## 5.2. IPv4/IPv6 Dual Stack Setup

A dual-stack configuration was implemented on all routers to support both IPv4 and IPv6 protocols simultaneously. Each router interface was assigned both an IPv4 and an IPv6 address, allowing devices to communicate over either protocol based on availability and compatibility. The `ipv6 unicast-routing` command was used to enable IPv6 routing functionality on each router. This setup ensures



continued support for IPv4 services while enabling IPv6 capabilities, facilitating a smooth transition without disrupting existing operations.

## 5.3. OSPFv3 Configuration



```
Router3
Physical Config CLI Attributes
IOS Command Line Interface
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router ospf
% Incomplete command.
Router(config)#router ospf 1
Router(config-router)#net
Router(config-router)#network 192.168.3.0 0.0.0.255
% Incomplete command.
Router(config-router)#network 192.168.3.0 0.0.0.255 area 0
Router(config-router)#network 10.0.0.4 0.0.0.3 area 0
Router(config-router)#network 10.0.0.12 0.0.0.3 area 0
Router(config-router)#network 10.0.0.28 0.0.0.3 area 0
Router(config-router)#no sh
Router(config-router)#ex
Router(config)#ex
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#wr
Building configuration...
[OK]
Router#conf t
```

## 6. Migration Strategy

### 6.1. Migration Steps

1. Configure IPv4/IPv6 interfaces
2. Enable IPv6 routing
3. Configure OSPFv3

#### 4. Enable DHCPv6 and SLAAC

### **6.2. Device Configuration Changes**

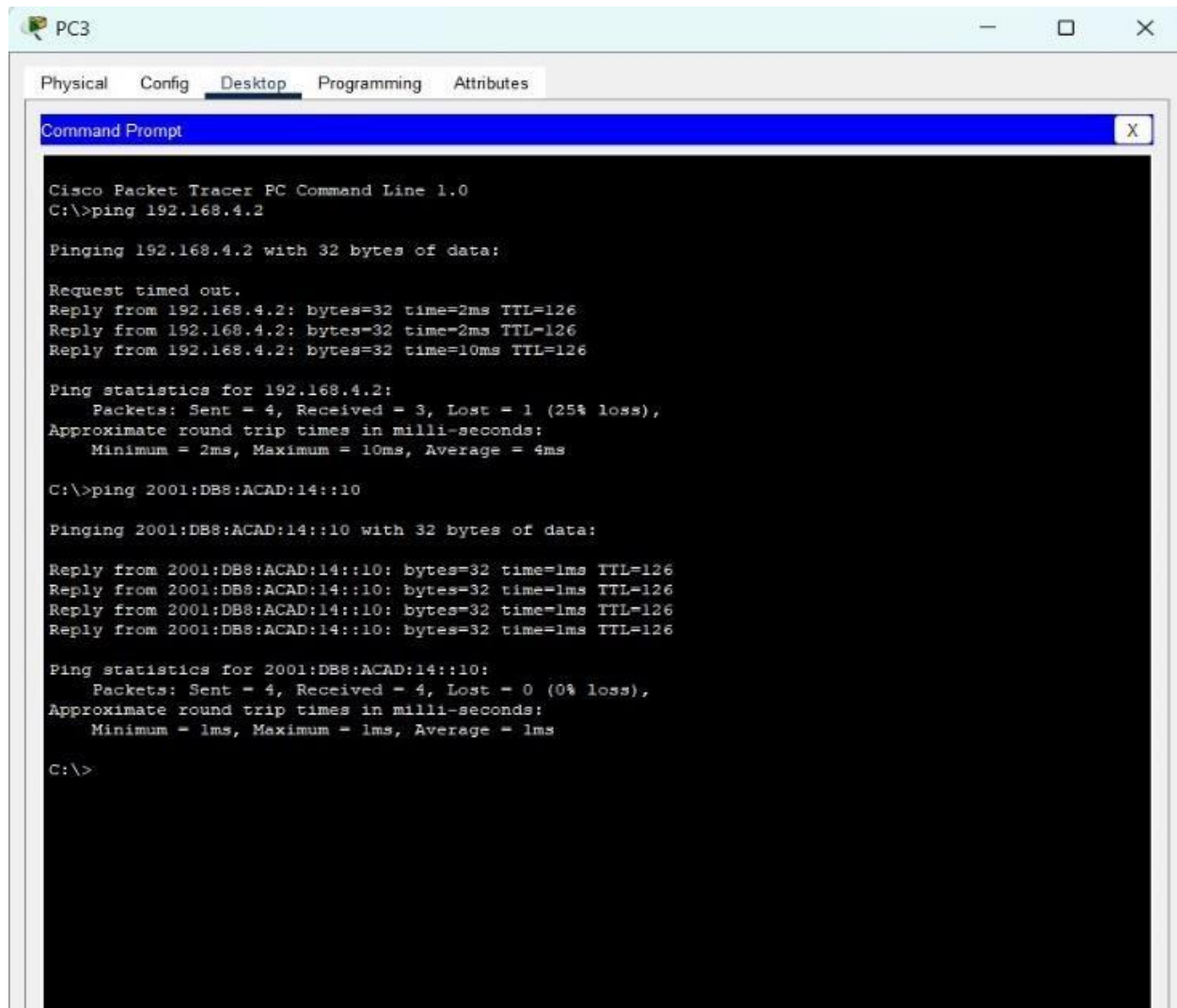
- Routers: Interface configs, routing protocols
- PCs: IPv6 auto config, IPv4 DHCP
- Switches: VLAN setup

### **6.3. Rollback Plan**

- Static IPv6 fallback if OSPFv3 fails
- IPv4 routing retained throughout

## **7. Testing**

### **7.1. ICMP Testing**



The screenshot shows a Cisco Packet Tracer PC Command Prompt window for PC3. The window has tabs for Physical, Config, Desktop, Programming, and Attributes, with Desktop selected. The Command Prompt displays the following text:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.4.2

Pinging 192.168.4.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.4.2: bytes=32 time=2ms TTL=126
Reply from 192.168.4.2: bytes=32 time=2ms TTL=126
Reply from 192.168.4.2: bytes=32 time=10ms TTL=126

Ping statistics for 192.168.4.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 10ms, Average = 4ms

C:\>ping 2001:DB8:ACAD:14::10

Pinging 2001:DB8:ACAD:14::10 with 32 bytes of data:

Reply from 2001:DB8:ACAD:14::10: bytes=32 time=1ms TTL=126
Reply from 2001:DB8:ACAD:14::10: bytes=32 time=1ms TTL=126
Reply from 2001:DB8:ACAD:14::10: bytes=32 time=1ms TTL=126
Reply from 2001:DB8:ACAD:14::10: bytes=32 time=1ms TTL=126

Ping statistics for 2001:DB8:ACAD:14::10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\>
```

The above screenshot show successful ICMPv6 ping tests between various network devices. These tests verify that IPv6 addressing and routing are correctly configured, and that ICMPv6 messages are properly exchanged, confirming reliable end-to-end IPv6 connectivity.

## 7.2. SLAAC

```
C:\>
C:\>IPCONFIG /ALL

FastEthernet0 Connection: (default port)

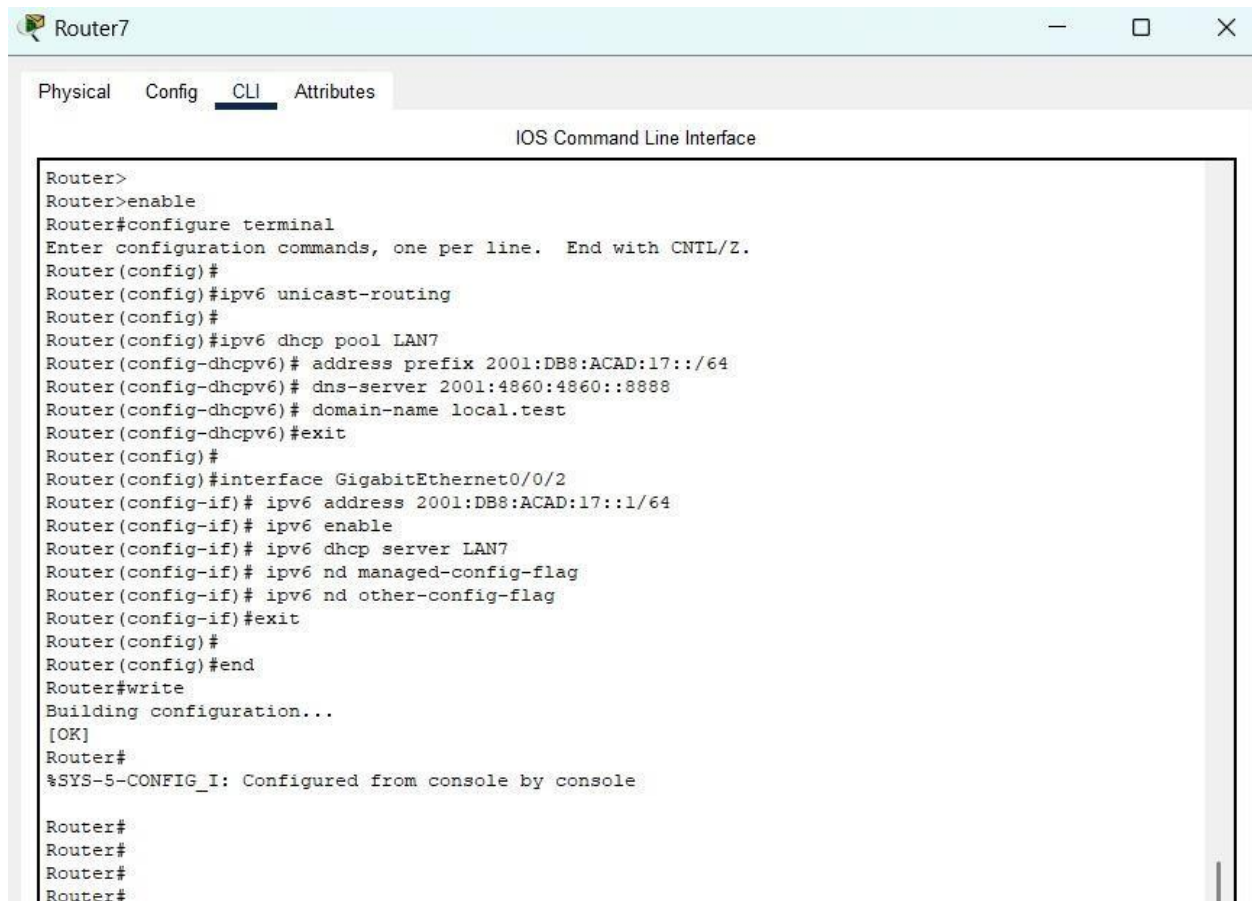
    Connection-specific DNS Suffix...:
    Physical Address.....: 000C.CF29.99AE
    Link-local IPv6 Address.....: FE80::20C:CFFF:FE29:99AE
    IPv6 Address.....: 2001:DB8:ACAD:11::10
    IPv4 Address.....: 192.168.1.2
    Subnet Mask.....: 255.255.255.0
    Default Gateway.....: 2001:DB8:ACAD:11::1
                        192.168.1.1
    DHCP Servers.....: 0.0.0.0
    DHCPv6 IAID.....:
    DHCPv6 Client DUID.....: 00-01-00-01-34-AA-1B-0C-00-0C-CF-29-99-AE
    DNS Servers.....: ::
                        0.0.0.0

Bluetooth Connection:

    Connection-specific DNS Suffix...:
    Physical Address.....: 0040.0B9A.EA89
    Link-local IPv6 Address.....: ::
    IPv6 Address.....: ::
    IPv4 Address.....: 0.0.0.0
    Subnet Mask.....: 0.0.0.0
    Default Gateway.....: ::
                        0.0.0.0
    DHCP Servers.....: 0.0.0.0
    DHCPv6 IAID.....:
    DHCPv6 Client DUID.....: 00-01-00-01-34-AA-1B-0C-00-0C-CF-29-99-AE
    DNS Servers.....: ::
                        0.0.0.0
```

The PC received a global IPv6 address (2001:DB8:ACAD:11::10) via SLAAC, confirming successful IPv6 autoconfiguration from the router's advertisement.

## 7.3. DHCPv3 Testing

The screenshot shows a window titled "Router7" with a light blue header bar. Below the header is a tabbed interface with four tabs: "Physical", "Config", "CLI", and "Attributes". The "CLI" tab is selected and highlighted. The main area of the window is titled "IOS Command Line Interface" and contains a text-based representation of a command-line session. The session starts with "Router>" and proceeds through several commands: "enable", "configure terminal", "ipv6 unicast-routing", "dhcp pool LAN7", "address prefix 2001:DB8:ACAD:17::/64", "dns-server 2001:4860:4860::8888", "domain-name local.test", "exit", "interface GigabitEthernet0/0/2", "ipv6 address 2001:DB8:ACAD:17::1/64", "ipv6 enable", "ipv6 dhcp server LAN7", "ipv6 nd managed-config-flag", "ipv6 nd other-config-flag", "exit", "end", "write", and "exit". The output shows the configuration being written and a system message "%SYS-5-CONFIG\_I: Configured from console by console". The session ends with "Router#" and four blank lines.

```
Router>
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#ipv6 unicast-routing
Router(config)#
Router(config)#ipv6 dhcp pool LAN7
Router(config-dhcpv6)# address prefix 2001:DB8:ACAD:17::/64
Router(config-dhcpv6)# dns-server 2001:4860:4860::8888
Router(config-dhcpv6)# domain-name local.test
Router(config-dhcpv6)#exit
Router(config)#
Router(config)#interface GigabitEthernet0/0/2
Router(config-if)# ipv6 address 2001:DB8:ACAD:17::1/64
Router(config-if)# ipv6 enable
Router(config-if)# ipv6 dhcp server LAN7
Router(config-if)# ipv6 nd managed-config-flag
Router(config-if)# ipv6 nd other-config-flag
Router(config-if)#exit
Router(config)#
Router(config)#end
Router#write
Building configuration...
[OK]
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
Router#
Router#
Router#
```

This screenshot displays the configuration of DHCPv6 on the router using the CLI. The router is set to provide IPv6 addresses with the prefix 2001:DB8:ACAD:17::/64 via a DHCPv6 pool named LAN7. It also advertises DNS and domain settings, and enables RA flags to inform hosts to use DHCPv6 for both addressing and other configurations.

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

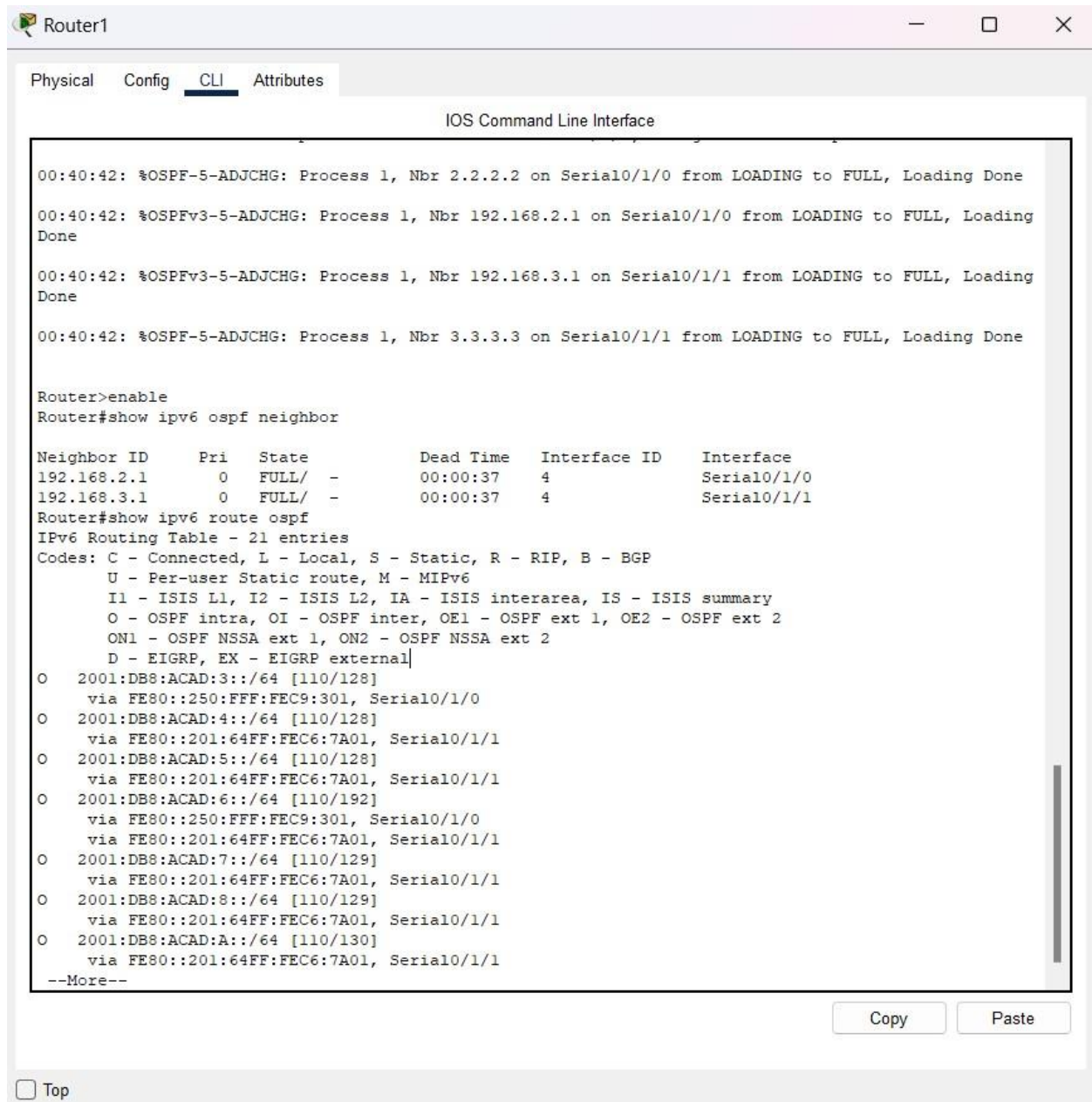
    Connection-specific DNS Suffix...: local.test
    Physical Address.....: 000C.8575.E67E
    Link-local IPv6 Address.....: FE80::20C:85FF:FE75:E67E
    IPv6 Address.....: 2001:DB8:ACAD:13:FF4A:AA5F:62F7:3831
    IPv4 Address.....: 192.168.3.2
    Subnet Mask.....: 255.255.255.0
    Default Gateway.....: FE80::201:64FF:FEC6:7A01
                           192.168.3.1
    DHCP Servers.....: 0.0.0.0
    DHCPv6 IAID.....: 2107409215
    DHCPv6 Client DUID.....: 00-01-00-01-DB-94-BC-2B-00-0C-85-75-E6-7E
    DNS Servers.....: 2001:4860:4860::8888
                           0.0.0.0

Bluetooth Connection:

    Connection-specific DNS Suffix...: local.test
    Physical Address.....: 000B.BE53.ED2B
    Link-local IPv6 Address.....: ::
    IPv6 Address.....: ::
    IPv4 Address.....: 0.0.0.0
    Subnet Mask.....: 0.0.0.0
    Default Gateway.....: ::
                           0.0.0.0
    DHCP Servers.....: 0.0.0.0
    DHCPv6 IAID.....: 2107409215
    DHCPv6 Client DUID.....: 00-01-00-01-DB-94-BC-2B-00-0C-85-75-E6-7E
    DNS Servers.....: ::
                           0.0.0.0
```

This screenshot shows the output of the `ipconfig /all` command on a PC, verifying that DHCPv6 is functioning correctly. The PC received an IPv6 address, DNS server, and domain name from the router's DHCPv6 pool. This confirms that the PC is successfully communicating with the DHCPv6 server and obtaining configuration dynamically.

## 7.4. OSPFv3 Neighbor and Route Verification



The screenshot shows a Cisco Router CLI window titled "Router1". The "CLI" tab is selected. The window displays the following output:

```
00:40:42: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on Serial0/1/0 from LOADING to FULL, Loading Done
00:40:42: %OSPFv3-5-ADJCHG: Process 1, Nbr 192.168.2.1 on Serial0/1/0 from LOADING to FULL, Loading Done
00:40:42: %OSPFv3-5-ADJCHG: Process 1, Nbr 192.168.3.1 on Serial0/1/1 from LOADING to FULL, Loading Done
00:40:42: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on Serial0/1/1 from LOADING to FULL, Loading Done

Router>enable
Router#show ipv6 ospf neighbor

Neighbor ID      Pri   State           Dead Time   Interface ID  Interface
192.168.2.1      0     FULL/-         00:00:37    4             Serial0/1/0
192.168.3.1      0     FULL/-         00:00:37    4             Serial0/1/1

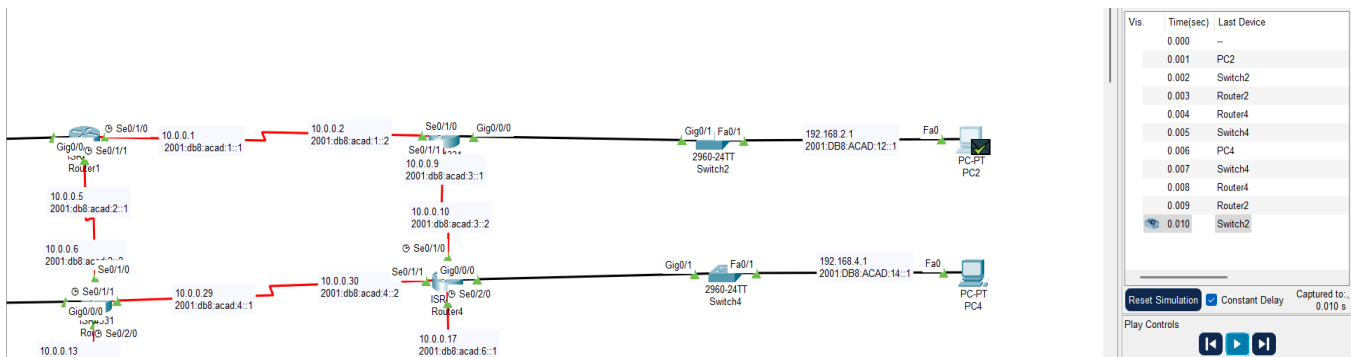
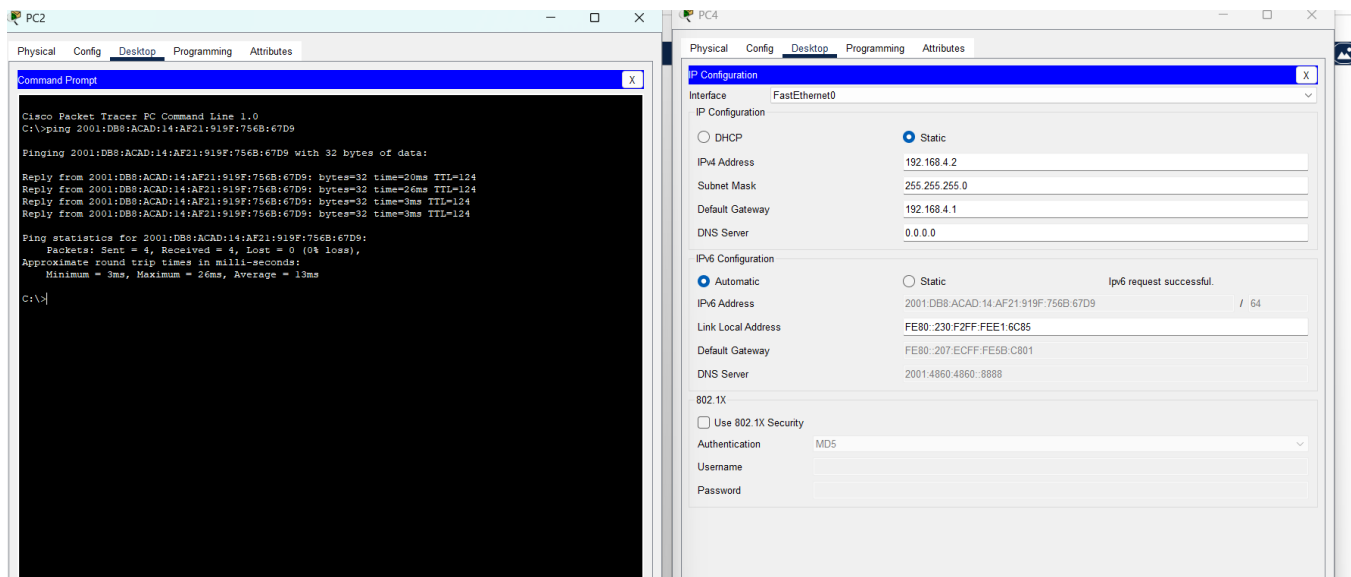
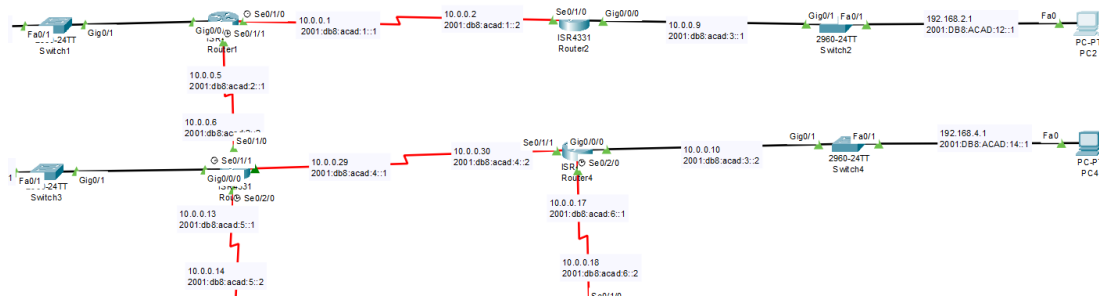
Router#show ipv6 route ospf
IPv6 Routing Table - 21 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
O 2001:DB8:ACAD:3::/64 [110/128]
   via FE80::250:FFF:FEC9:301, Serial0/1/0
O 2001:DB8:ACAD:4::/64 [110/128]
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
O 2001:DB8:ACAD:5::/64 [110/128]
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
O 2001:DB8:ACAD:6::/64 [110/192]
   via FE80::250:FFF:FEC9:301, Serial0/1/0
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
O 2001:DB8:ACAD:7::/64 [110/129]
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
O 2001:DB8:ACAD:8::/64 [110/129]
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
O 2001:DB8:ACAD:A::/64 [110/130]
   via FE80::201:64FF:FEC6:7A01, Serial0/1/1
--More--
```

At the bottom of the window, there are "Copy" and "Paste" buttons, and a "Top" button with a checkbox.

OSPFv3 neighbors are fully established, and multiple IPv6 routes are learned via OSPF, confirming proper OSPFv3 operation on the router.



## 7.5. Simulate link failures to test OSPFv3 Recovery





## 8. Results and Discussion

- The **dual-stack design** successfully maintained uninterrupted IPv4 and IPv6 connectivity throughout the migration process.
- **OSPFv3** demonstrated quick and stable reconvergence after link failures, ensuring minimal downtime in the IPv6 routing domain.
- Both **SLAAC** and **DHCPv6** configurations were validated and worked as expected, providing efficient IPv6 address assignment to hosts.
- The migration strategy allowed seamless integration of IPv6 routing alongside the existing IPv4 infrastructure without service disruption.
- Overall, the network showed strong resilience and flexibility, confirming the effectiveness of the chosen protocols and configurations.

## 9. Conclusion

The dual-stack network successfully demonstrated seamless IPv6 readiness while maintaining legacy IPv4 support. OSPFv3 provided reliable and efficient routing across all devices, and the combination of SLAAC and DHCPv6 ensured robust and automated IPv6 address assignment. This project establishes a strong foundation for a future migration towards IPv6-exclusive environments, highlighting the network's scalability and resilience.