Implementation OSPFV3 for Internet Protocol Verses 6 (IPv6) based on Juniper Touters use Emulator Virtual Engine – Next Generation (EVE-NG)

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Abstract: Advances in computer network technology and increased use of Internet information have reduced IPv4 offerings. This requires a computer network protocol that can replace the role of IPv4 which is currently limited/loose. Also known as Internet Protocol Verses 6 (IPv6), it aims to improve on IPv4 and does not represent a fundamental change from IPv4. Features that are available in IPv4 are also available in IPv6, but features that do not work in IPv4 are available in IPv4. IPv6 is no longer used. A transition mechanism is required to forward IPv6 packets to an existing IPv4 network and vice versa. One of the available mechanisms is automatic tunnelling (abbreviated as Tunnelling). The EVE-NG simulator is used to implement and study the routing protocol (OSPFv3) on IPv6 networks. To check the results, use the traceroute, ping command. The Juniper platform is implemented in this small virtual network to test the OSPFv3 protocol on an IPv6 network. This research explains how to assign IPv6 addresses on Juniper routers and end devices as well as their configuration. The Internet protocol layer is responsible for receiving and sending data packets within the network. In the virtual environment simulation mode, Juniper packets are analyzed and packet forwarding via IPv6 on OSPFv3 is used to make decisions for protocols in the IPv6 environment that are faster, and more secure.

Keywords: IPv4, IPv6, OSPFv3, Computer Network, Juniper Routers, Eve-NG

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Introduction

The development of science & technology requires support to build student knowledge by using existing facilities such as computers and networks that support institutions in practicum learning. It can be used as a learning tool by adding applications for various devices and network operations, one of which is using the Eve-NG application which can assist students in the learning process of network virtualization in a network laboratory. The use of IPv6 is currently increasing and the number of large companies, educational institutions, and ISPs is decreasing due to the limitations of IPv4. How to prevent changes if you suddenly switch from IPv4 to IPv6, you have three options: 1. Tunnelling and double-stack conversion. In this research, in 1998 OSPF version 2 as RFC 2328 became the most widely used internal gateway protocol (IGP) for intra-domain routing. Additionally it has also been extended in version 3 (RFC 2740) to support OSPF over IPv6 networks. In RFC 2740 it is detailed that OSPFv3 has added support for IPv6 in the Open Shortest Path First (OSPF) routing protocol (Gammel et al., 2022). The IPv6 protocol represents an enhanced version of IPv4 (Yusoff et al., 2020). IPv6 uses a more complex 128-bit addressing scheme than IPv4. IPv4 provides a 32-bit address space with 4.3 billion Internet Protocol addresses. The problem lies in the ability to exchange and use information with utilities for the OSPFv3 routing protocol in an IPv6 environment. Currently, business and enterprise network zones use the OSPFv3 routing protocol. In this paper, an extension of the configuration mechanism has been made to the Eve-NG virtual environment where the aim of using the IPv6 protocol is to create insight and provide next generation network capabilities.

Research Method

Eve-NG (Emulated Virtual Environment - Next Generation)

Juniper router-based Emulated Virtual Environment Next. Generation (EVE-NG) simulator used in training, education, and research, offers free distribution to faculty, alumni staff, and students. Users can create animated visualizations and simulate network phenomena using Eve-NG. Eve-NG is based on network device models and some simple protocols for emulation. Simulation is handled by a variety of network devices such as routers, switches, and wireless access points. The calculator and different terminals are displayed with animation. Easily explained Development creates learning skills. It also provides students and teachers with learning tools in a network environment (Korniyenko & Galata, 2019; Sierszeń et al., 2017).

Internet Protocol Verses 6 (IPv6)

The IPv6 addressing format was developed to complement and be compatible with existing IPv4 network architectures. IPv6 not only solves existing IPv4 problems but also extends and enhances the IPv4 format. IPv6 added a routing format in a simple header format. IPv6 also uses multicast routing to support multiple broadcast patterns for IP addresses with large blocks of addresses (Beverly et al., 2018; Jia et al., 2019; Naagas et al., 2020).

OSPFv3

OSPFv3 is the first open shortest path routing protocol for IPv6. It is similar to OSPFv2 in the concept of link state, intra- and inter-area databases, as well as external AS routes and virtual links (Chen et al., 2021; Fachrurrozi & Pratama, 2021; Nugroho & Adlina, 2020). This study uses the literature search method to obtain and present data contained on Juniper routers on the network. Network topology, IP Address and the OSPFv3 routing technique used is the data collected for this research. The formulation of the problem in this study is how to use IPv4 and IPv6 side by side for data communication, especially in the IT Telkom Jakarta Computer Network LAB in terms of network development and design. About TCP/IP. Simulation with multiple router devices. As shown below (Figure 1). After configuring the simulation, the next step is to configure IPv4, IPv6, and routing attributes using the OSPFv3 protocol. Dual-stack is only used on interfaces (routers). After being implemented in a simulation, the results of this study can be used as a reference for real implementation without modifying existing models locally or on the router side (Aung, 2020; Fachrurrozi & Pratama, 2021; Oliveira, 2020).

Result and Discussion

This research resulted from a learning media. The learning media for computer network courses produced is OSPFv3 IPv6 configuration learning using the Eve-NG application to be applied to students. The results of this study are as follows: Consideration of research results in making a GUI (Graphical User Interface) based computer network simulator, this work uses the Eve-NG simulator which can be downloaded free of charge. This program works on the Ubuntu Linux operating system. What makes Eve-NG different from other simulations is that it is multi-vendor and the configurations made are real configurations that can be implemented directly such as routers and switches. Apart from the Eve-NG software, the software that needs to be prepared is an ISO which can be downloaded from the eve-ng.com website. Juniper ISO is used as the router program. In some cases, at least the Junos 10 series or later must be used to perform the IPv6 configuration function (Alrashide et al., 2022; Putri, 2019).

The specified addresses are IPv4 and IPv6 addresses. The address table for each router is shown in table 1 :

Table 1 Allocation IP Address

Device	Interface	IPv4	IPv6	IPv4 Loopback	IPv6 Loopback	Area OSPF
ITTJ-Router-A	ge-0/0/0	10.20.1.1/24	8008:1::1/64	10.245.81.4/32	feee::10:255:81:4/128	0
ITTJ-Router-B	ge-0/0/0	10.20.2.1/24	8008:2::1/64	10.245.81.1/32	feee::10:255:81:1/128	0
ITTJ-Router-C	ge-0/0/0	10.20.3.1/24	8008:3::1/64	10.245.81.11/32	feee::10:255:81:11/128	1
	ge-0/0/1	10.20.2.2/24	8008:2::2/64			0
	ge-0/0/2	10.20.4.1/24	8008:4::1/64	ge-0/0/2	10.20.4.1/24	8008:4::1 /64
ITTJ-Router-D	ge-0/0/0	10.20.1.2/24	8008:1::2/64	10.245.81.3/32	feee::10:255:81:3/128	0
	ge-0/0/1	10.20.3.2/24	8008:3::2/64			1
	ge-0/0/2	10.20.5.1/24	8008:5::1/64			1
ITTJ-Router-E	ge-0/0/0	10.20.5.2/24	8008:5::2/64	10.245.81.5/32	feee::10:255:81:5/128	1
	ge-0/0/1	10.20.4.2/24	8008:4::2/64			1
	ge-0/0/2	10.20.6.1/24	8008:6::1/64			2
ITTJ-Router-F	ge-0/0/0	10.20.6.2/24	8008:6::2/64	10.245.81.6/32	feee::10:255:81:6/128	2

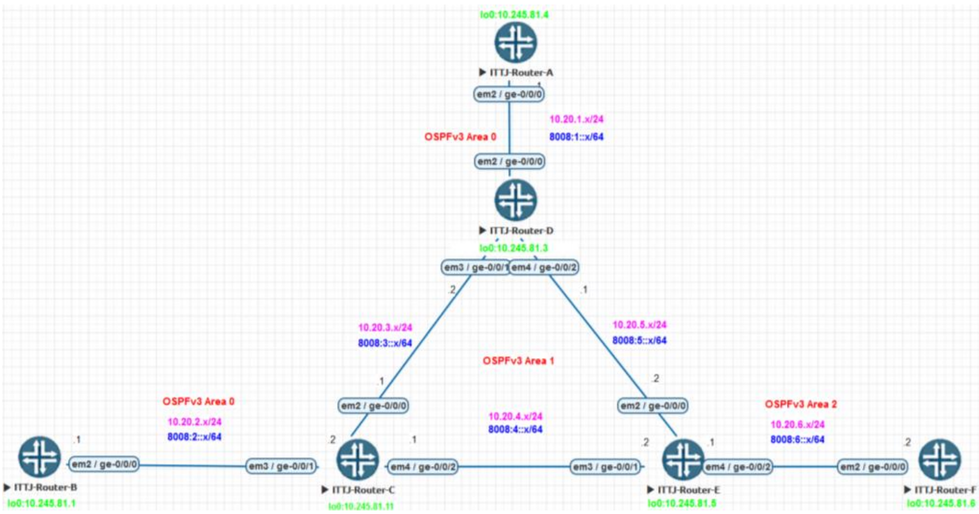


Figure 1 Topology Eve-NG Juniper - Configuration OSPFv3 for IPv6 (Fachrurrozi, 2022)

Figure 1 shows the OSPFv3 topology. Routers A, B, C, and D are connected to the OSPFv3 Backbone Area 0; Routers C, D, and E are connected to each other in Area 1; and Area 2 lies between Router E and Router F. Because Router F is not located directly adjacent to Area 0, there needs to be a virtual link in Area 1 between Router D and Router E. Likewise, because Routers A and B have two separate trunk line sections in zone 0, so a second virtual trunk needs to be configured Part. connecting across Zone 1 between Routers C and D (Giambene & Giambene, 2021).

In Router-A Configuration, add the GE-0/0/0 interface of the OSPFv3 process to Area 0 :

```
[Edit]
Protocol {
ospf3 {
Area 0.0.0.0 {
    Interface ge-0/0/0.0;
    Interface lo0.0 {
    Passive;
    }
```

In Router B Configuration, add interface GE-0/0/0 interface of the OSPFv3 process to Area 0:

```
[Edit]
Protocol {
ospf3 {
Area 0.0.0.0 {
    Interface ge-0/0/0.0;
    Interface lo0.0 {
    Passive;
    }
```

In Router C Configuration, add connected interfaces from the OSPFv3 process to Routers B, D, and E. Then add a complete virtual link to Router D via Area 1 so that Router A can access a separate part of the OSPF Backbone located on Router A:

```
[edit]
protocol {
ospf3 {
area 0.0.0.0 {
    virtual-link neighbor-id 10.245.81.3
    transit-area 0.0.0.1;
    interface ge-0/0/1.0;
    }
area 0.0.0.1 {
    interface ge-0/0/0.0 {
    metric 1;
    }
    interface ge-0/0/2.0 {
    metric 10;
    }
    interface lo0.0 {
    passive;
    }
```

On Router D, the OSPFv3 process configures the interface connected to Router C and Router D to Area 1 and the interface connected to Router A to Area 0. Apart from that, the device must also configure two virtual links via Area, one connected to Router C and the second connection to Router E. On the virtual link will be Router F accessing the OSPF Backbone, and connecting separate parts of Area 0 located on Router A and Router B :

```
[edit]
protocol {
ospf3 {
```

```
area 0.0.0.0 {
    virtual-link neighbor-id 10.245.81.11
    transit-area 0.0.0.1;
    virtual-link neighbor-id 10.245.81.5
    transit-area 0.0.0.1;
    interface ge-0/0/0.0;
    }
area 0.0.0.1 {
    interface ge-0/1/0.0 {
    metric 1;
    }
    interface ge-0/0/2.0 {
    metric 1;
    }
    interface lo0.0 {
    passive;
    }
```

In the Router E configuration, add OSPFv3 processes to the connected interface and then configure it by completing a virtual link to Router D via Area 1 so that Router F can access the OSPF Backbone:

```
[edit]
protocol {
ospf3 {
area 0.0.0.1 {
     interface ge-0/0/1.0 {
     metric 10;
     }
     interface ge-0/0/0.0 {
     metric 1;
     }
     interface lo0.0 {
     passive;
     }
area 0.0.0.0 {
     virtual-link neighbor-id 10.245.81.3
     transit-area 0.0.0.1;
     }
area 0.0.0.2 {
     interface ge-0/0/2.0;
     }
```

In Configuration Router F, add to the OSPF process to interface the ge-0/0/0 this example:

```
[edit]
Protocol {
ospf3 {
area 0.0.0.2 {
     interface ge-0/0/0.0;
     interface lo0.0 {
     passive;
     }
```

Verification

To verify that OSPFv3 for IPv6 is working correctly, use the following command (taken from ITTJ-Router-A):

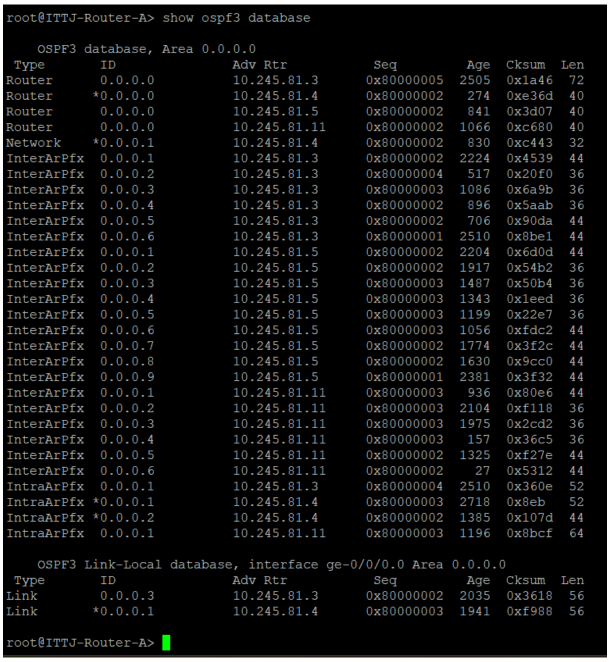
```
root@ITTJ-Router-A> show ospf3 interface
Interface           State   Area            DR ID           BDR ID          Nbrs
ge-0/0/0.0          DR      0.0.0.0         10.245.81.4     10.245.81.3        1
lo0.0               DRother 0.0.0.0         0.0.0.0         0.0.0.0            0

root@ITTJ-Router-A> show ospf3 neighbor
ID               Interface              State     Pri   Dead
10.245.81.3      ge-0/0/0.0             Full      128     36
  Neighbor-address fe80::205:86ff:fe71:9b00
```

Figure 2 Verify OSPFv3 Interface & OSPFv3 Neighbor Topology Eve-NG Juniper - Configuration OSPFv3 for IPv6

```
root@ITTJ-Router-A> show ospf3 route
Prefix                                           Path  Route      NH   Metric
                                                 Type  Type       Type
10.245.81.3                                      Intra Area BR    IP   1
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
10.245.81.4;0.0.0.1                              Intra Transit    IP   1
  NH-interface ge-0/0/0.0
10.245.81.5                                      Intra Area BR    IP   12
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
10.245.81.11                                     Intra Area BR    IP   2
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:1::/64                                      Intra Network    IP   1
  NH-interface ge-0/0/0.0
8008:1::2/128                                    Intra Network    IP   1
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:2::/64                                      Intra Network    IP   3
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:2::2/128                                    Intra Network    IP   2
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:3::/64                                      Inter Network    IP   2
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:4::/64                                      Inter Network    IP   12
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:5::/64                                      Inter Network    IP   11
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:6::/64                                      Inter Network    IP   13
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
8008:6::1/128                                    Inter Network    IP   12
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
feee::10:255:81:3/128                            Inter Network    IP   1
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
feee::10:255:81:4/128                            Intra Network    IP   0
  NH-interface lo0.0
feee::10:255:81:5/128                            Inter Network    IP   12
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
feee::10:255:81:6/128                            Inter Network    IP   13
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
feee::10:255:81:11/128                           Inter Network    IP   2
  NH-interface ge-0/0/0.0, NH-addr fe80::205:86ff:fe71:9b00
```

Figure 3 Verify OSPFv3 Route



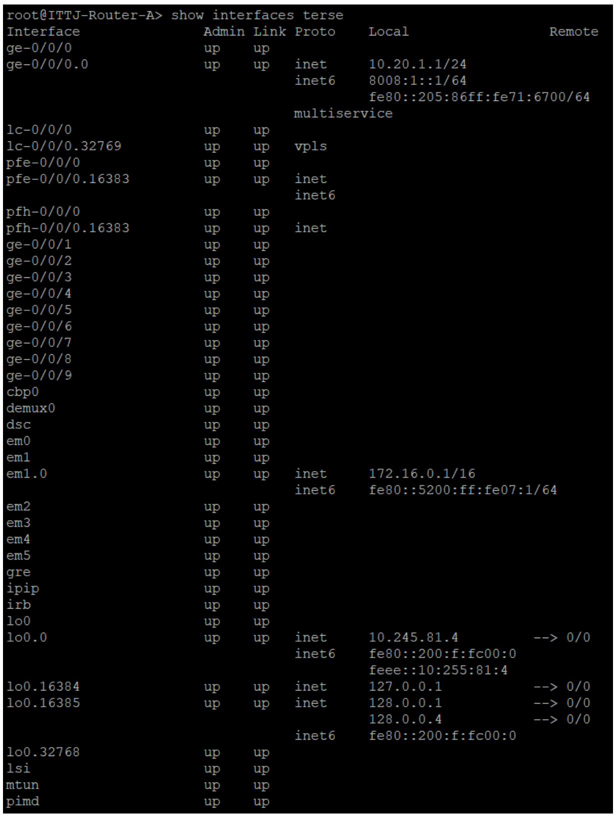
```
root@ITTJ-Router-A> show ospf3 database

    OSPF3 database, Area 0.0.0.0
 Type       ID              Adv Rtr           Seq         Age  Cksum  Len
Router       0.0.0.0         10.245.81.3      0x80000005  2505  0x1a46  72
Router      *0.0.0.0         10.245.81.4      0x80000002   274  0xe36d  40
Router       0.0.0.0         10.245.81.5      0x80000002   841  0x3d07  40
Router       0.0.0.0         10.245.81.11     0x80000002  1066  0xc680  40
Network     *0.0.0.1         10.245.81.4      0x80000002   830  0xc443  32
InterArPfx   0.0.0.1         10.245.81.3      0x80000002  2224  0x4539  44
InterArPfx   0.0.0.2         10.245.81.3      0x80000004   517  0x20f0  36
InterArPfx   0.0.0.3         10.245.81.3      0x80000003  1086  0x6a9b  36
InterArPfx   0.0.0.4         10.245.81.3      0x80000002   896  0x5aab  36
InterArPfx   0.0.0.5         10.245.81.3      0x80000002   706  0x90da  44
InterArPfx   0.0.0.6         10.245.81.3      0x80000001  2510  0x8be1  44
InterArPfx   0.0.0.1         10.245.81.5      0x80000002  2204  0x6d0d  44
InterArPfx   0.0.0.2         10.245.81.5      0x80000002  1917  0x54b2  36
InterArPfx   0.0.0.3         10.245.81.5      0x80000003  1487  0x50b4  36
InterArPfx   0.0.0.4         10.245.81.5      0x80000003  1343  0x1eed  36
InterArPfx   0.0.0.5         10.245.81.5      0x80000003  1199  0x22e7  36
InterArPfx   0.0.0.6         10.245.81.5      0x80000003  1056  0xfdc2  44
InterArPfx   0.0.0.7         10.245.81.5      0x80000002  1774  0x3f2c  44
InterArPfx   0.0.0.8         10.245.81.5      0x80000002  1630  0x9cc0  44
InterArPfx   0.0.0.9         10.245.81.5      0x80000001  2381  0x3f32  44
InterArPfx   0.0.0.1         10.245.81.11     0x80000003   936  0x80e6  44
InterArPfx   0.0.0.2         10.245.81.11     0x80000003  2104  0xf118  36
InterArPfx   0.0.0.3         10.245.81.11     0x80000003  1975  0x2cd2  36
InterArPfx   0.0.0.4         10.245.81.11     0x80000003   157  0x36c5  36
InterArPfx   0.0.0.5         10.245.81.11     0x80000002  1325  0xf27e  44
InterArPfx   0.0.0.6         10.245.81.11     0x80000002    27  0x5312  44
IntraArPfx   0.0.0.1         10.245.81.3      0x80000004  2510  0x360e  52
IntraArPfx  *0.0.0.1         10.245.81.4      0x80000003  2718  0x8eb   52
IntraArPfx  *0.0.0.2         10.245.81.4      0x80000002  1385  0x107d  44
IntraArPfx   0.0.0.1         10.245.81.11     0x80000003  1196  0x8bcf  64

    OSPF3 Link-Local database, interface ge-0/0/0.0 Area 0.0.0.0
 Type       ID              Adv Rtr           Seq         Age  Cksum  Len
Link         0.0.0.3         10.245.81.3      0x80000002  2035  0x3618  56
Link        *0.0.0.1         10.245.81.4      0x80000003  1941  0xf988  56

root@ITTJ-Router-A>
```

Figure 4 Verify OSPFv3 Database



```
root@ITTJ-Router-A> show interfaces terse
Interface               Admin Link Proto    Local                 Remote
ge-0/0/0                up    up
ge-0/0/0.0              up    up   inet     10.20.1.1/24
                                   inet6    8008:1::1/64
                                            fe80::205:86ff:fe71:6700/64
                                   multiservice
lc-0/0/0                up    up
lc-0/0/0.32769          up    up   vpls
pfe-0/0/0               up    up
pfe-0/0/0.16383         up    up   inet
                                   inet6
pfh-0/0/0               up    up
pfh-0/0/0.16383         up    up   inet
ge-0/0/1                up    up
ge-0/0/2                up    up
ge-0/0/3                up    up
ge-0/0/4                up    up
ge-0/0/5                up    up
ge-0/0/6                up    up
ge-0/0/7                up    up
ge-0/0/8                up    up
ge-0/0/9                up    up
cbp0                    up    up
demux0                  up    up
dsc                     up    up
em0                     up    up
em1                     up    up
em1.0                   up    up   inet     172.16.0.1/16
                                   inet6    fe80::5200:ff:fe07:1/64
em2                     up    up
em3                     up    up
em4                     up    up
em5                     up    up
gre                     up    up
ipip                    up    up
irb                     up    up
lo0                     up    up
lo0.0                   up    up   inet     10.245.81.4           --> 0/0
                                   inet6    fe80::200:f:fc00:0
                                            feee::10:255:81:4
lo0.16384               up    up   inet     127.0.0.1             --> 0/0
lo0.16385               up    up   inet     128.0.0.1             --> 0/0
                                            128.0.0.4             --> 0/0
                                   inet6    fe80::200:f:fc00:0
lo0.32768               up    up
lsi                     up    up
mtun                    up    up
pimd                    up    up
```

Figure 5 Verify Interface Terse

Conclusions

In the validation analysis, this teaching material was obtained by evaluating several lecturers from the Faculty of Engineering, Telkom University Campus Jakarta, especially in the field of Computer Networks. The validation evaluated was in the form of learning the OSPFv3 IPv6 configuration using the Eve-NG application. It can be said that the Lecturer's assessment is very good and appropriate.This article explains that the Eve-NG simulator can be a network planning tool for selecting and designing various optimal network and routing topologies. In networks, routing is used to track paths. Additionally, the implementation uses the Eve-NG emulator to implement the routing protocol. It is deployed The use of OSPFv3 routing protocol in IPv6 networks because of its usefulness and necessity, even though there are many types of routing techniques. OSPFv3 is used for businesses small and large businesses as well as other commercial organizations for IPv6 network environments. The time zone (seconds) at each station is mainly used by packets to move from one station to another, checking the destination address to plot these resulting time zones to tell the data packets to transmit How fast is over an OSPFv3 network in an IPv6 environment with and without persistent latency. It is used in security functions, unlimited hops, low cost, and authentication. OSPFv3 uses the concept of key zones to facilitate the management, routing, and control of packet traffic.

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