

Implementation of GRE-ipv6ip, DHCPv6, NAT64

IPv4 & IPv6 internet Access for IPv6-Only Host

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1.0 Introduction

IPv4 are depleting and IPv6 is future, but it would be like switch-off one and switch-on other. The internet world has to go through a transition, as IPv4 and IPv6 form their own inlands. In the period of transitions IPv4 and IPv6 have to talk to each other.

Multiple transition techniques are available like Dual-Staking, Tunneling. Which include: GRE (RFC 2473) 6to4 (RFC 3056), 6rd (RFC 5569), ISATAP (RFC 5214), MPLS 6PE, MPLS 6VPE (MPLS 6PE + VPN). Every technique has its own benefits and problems.

This document will demonstrator implementation of a transition technique, which enables IPv6-Only-Host, to communicate to IPv6-Internet as well as to IPv4-Internet. Communication to IPv6 is quite straight forward where for IPv4 it requires special implementation of NAT and DNS. For this experiment project we use GRE Tunnel (with Tunnel Broker) to advertise our IPv6 Prefixes. And use NAT64/DSN64 for dynamically map of IPv4 addresses to IPv6 for IPv6 Host and NAT IPv6 to IPv4 for IPv4 destination as defined in following IETF drafts:

- draft-ietf-behave-dns64-05
- draft-ietf-behave-v6v4-framework-06
- draft-ietf-behave-v6v4-xlate-09
- draft-ietf-behave-v6v4-xlate-stateful-08

NAT64 is also (Sort-off) part of NAT-PT. Conceptual layout of design show in figure 1.0:



Figure 1.1 Conceptual layout of NAT64/DNS64 deployment

- An IPv6 Prefix (Well-Known or Network prefix) is dedicated to map IPv4 prefixes.
 - We use 64:ff9b::/96 as recommended in draft-ietf-behave-dns64-05
- DNS64 convert A record into AAAA using NAT64 prefix, server A and AAAA record to clients
- Router connected to NAT64-Server, advertise NAT64 Prefix to attract traffic toward IPv4 servers.

2.0 Prerequisites

Before going into this you require:

- Account with IPv6 Tunnel Broker
- At least one (1) /48 IPv6 Global Aggregatable Unicast Prefix
- Internet Connectivity with static IP and /30 Live IPv4 prefix
- IPv6 enable Routers
- Linux Server
- Workstation IPv6 enabled OS

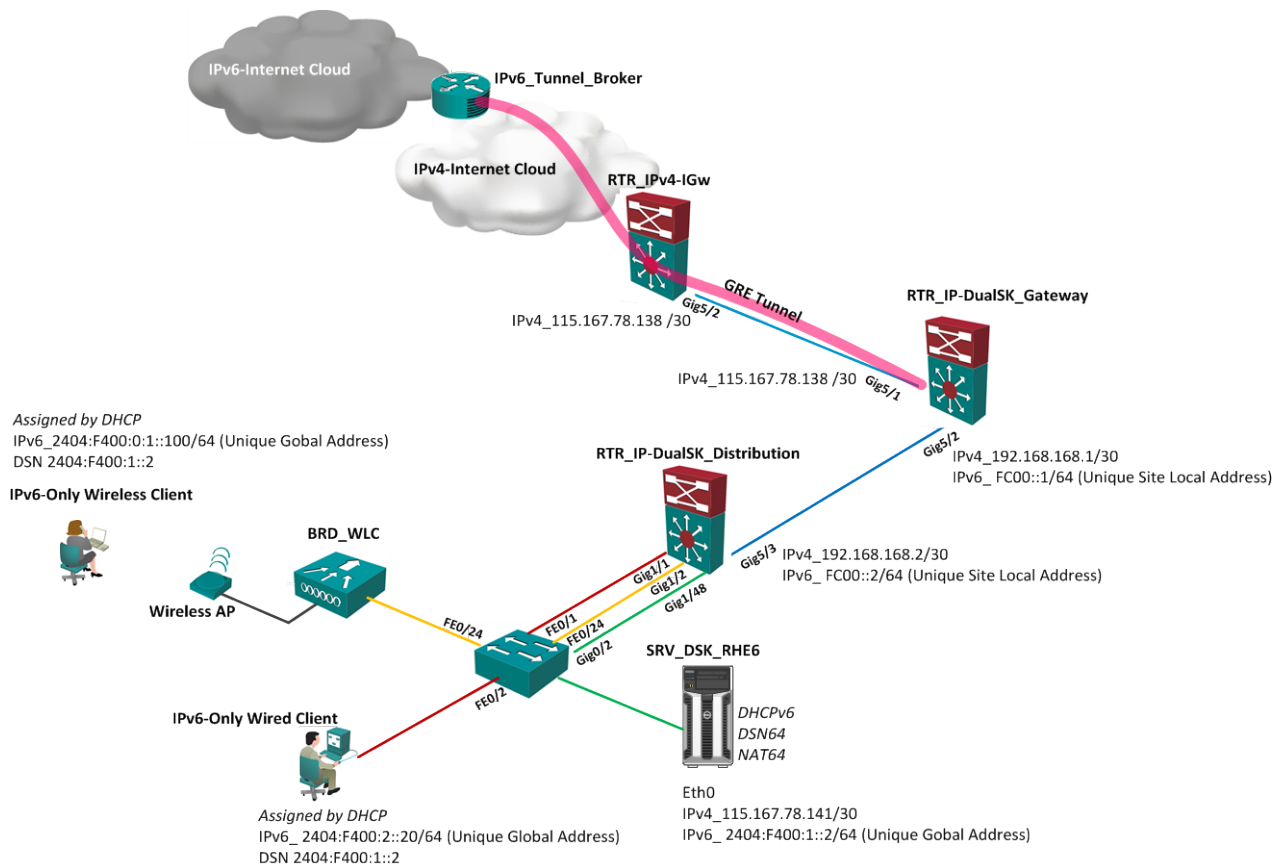
2.1 Component used

We have used following component to build lab:

- Account on “Hurricane Electric Free IPv6 Tunnel Broker”
- Three (3) /48 IPv6 Global Aggregatable Unicast Prefixes
- One (1) /30 IPv4 Prefixes
- Devices
 - Two(2) Cisco Routers
 - One (1) Desktop running Linux
 - Cisco Wireless Controller
 - One (1) Laptop with Win 7
- Ecdysis: open-source implementation of a NAT64 gateway

3.0 Network

This document uses this network setup:



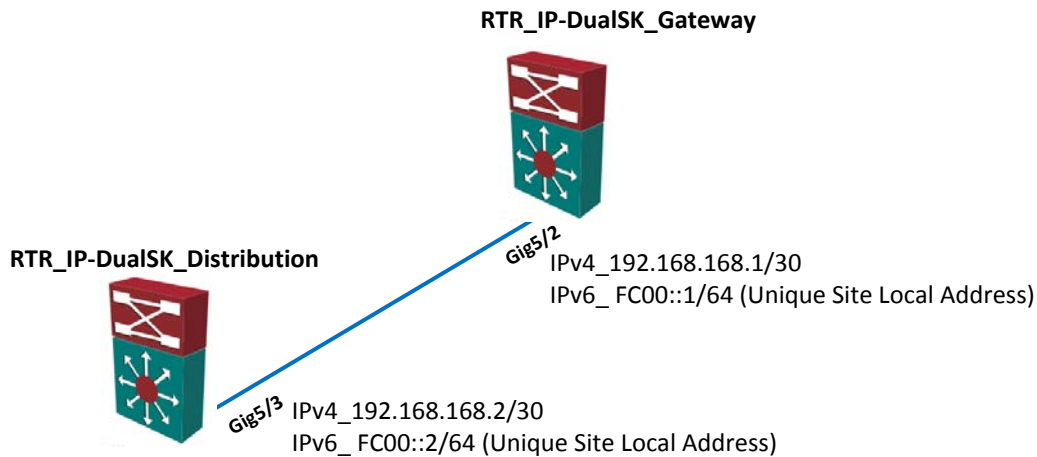
4.0 Configuration

This LAB was conducted in following Steps:

1. Lab Routers inter-connect
 - a. Establishing OSPFv3 and OSPFv2
2. IPv4 Internet Connectivity
3. GRE Tunnel to Tunnel Broker
 - a. BGP (address IPv6- Family)
4. IPv6 LAN and Wireless
 - a. Configure DHCPv6

- b. Configure DNSv6
 - c. Test browsing of IPv6 Sites (e.g www.google.com)
- Install Ecdysis: NAT64 gateway
5. Test IPv4 and IPv6 Internet Browsing

4.1 Lab Routers Inter-Connect



RTR_IP-DualSK_Gateway Configuration

| | |
|--|--|
| ipv6 unicast-routing ! | Enabling IPv6 routing on Router |
| interface Loopback0 ip address 172.16.16.1 255.255.255.255 ipv6 address 2404:F400::1/128 ipv6 enable ipv6 ospf 69 area 0 ! | Creating Dual-Stack loopback Interface, with IPv6 Global Unicast Aggregatable Address |
| interface GigabitEthernet5/2 description *** RTR_IP-DualSK_Distribution: Gi5/3 ***** ip address 192.168.168.1 255.255.255.252 media-type rj45 ipv6 address FC00::1/64 ipv6 enable ipv6 ospf 69 area 0 ! | Creating Dual-Stack Interface, with IPv6 Unique Site local Addresses and IPv4 local IP Class |
| router ospf 143 log-adjacency-changes network 172.16.16.1 0.0.0.0 area 0 network 192.168.168.0 0.0.0.3 area 0 default-information originate ! | OSPF configuration for IPv4 Route Advertisement and declaring Default Router for IPv4 |
| ipv6 router ospf 69 router-id 10.1.1.1 log-adjacency-changes default-information originate ! | OSPFv3 configuration for IPv6 Route Advertisement and declaring Default Router for IPv6 |

| RTR_IP-DualSK_Distribution Configuration | |
|---|--|
| ipv6 unicast-routing ! | Enabling IPv6 routing on Router |
| interface Loopback0 ip address 172.16.16.2 255.255.255.255 ipv6 address 2404:F400::2/128 ipv6 enable ipv6 ospf 69 area 0 ! | Creating Dual-Stack loopback Interface, with IPv6 Global Unicast Aggregatable Address |
| interface GigabitEthernet5/2 description *** RTR_IP-DualSK_Gateway: Gi5/3 ***** ip address 192.168.168.2 255.255.255.252 media-type rj45 ipv6 address FC00::2/64 ipv6 enable ipv6 ospf 69 area 0 ! | Creating Dual-Stack Interface, with IPv6 Unique Site local Addresses and IPv4 local IP Class |
| router ospf 143 log-adjacency-changes network 172.16.16.2 0.0.0.0 area 0 network 192.168.168.0 0.0.0.3 area 0 ! | OSPF configuration for IPv4 Route Advertisement |
| ipv6 router ospf 69 router-id 10.2.2.2 log-adjacency-changes ! | OSPFv3 configuration for IPv6 Route Advertisement |

4.1.1 Verify

Use this section to confirm that your configuration works properly.

The **show ipv6 ospf database** and **show ip ospf database** command shows the Link State Database (LSDB) of the router for IPv6 and IPv4 respectively:

RTR_IP-DualSK_Distribution# **show ip ospf database**

OSPF Router with ID (172.16.16.2) (Process ID 143)

Router Link States (Area 0)

| Link ID | ADV Router | Age | Seq# | Checksum | Link count |
|-------------|-------------|------|------------|----------|------------|
| 172.16.16.1 | 172.16.16.1 | 1385 | 0x8000017A | 0x0039DB | 2 |
| 172.16.16.2 | 172.16.16.2 | 918 | 0x8000017D | 0x00DB30 | 3 |

Net Link States (Area 0)

| Link ID | ADV Router | Age | Seq# | Checksum |
|---------------|-------------|-----|------------|----------|
| 192.168.168.2 | 172.16.16.2 | 918 | 0x80000178 | 0x0070D4 |

Type-5 AS External Link States

| Link ID | ADV Router | Age | Seq# | Checksum | Tag |
|---------|-------------|------|------------|----------|-----|
| 0.0.0.0 | 172.16.16.1 | 1385 | 0x8000012A | 0x00E249 | 143 |

RTR_IP-DualSK_Distribution# **show ipv6 ospf database**

OSPFv3 Router with ID (10.2.2.2) (Process ID 69)

Router Link States (Area 0)

| ADV Router | Age | Seq# | Fragment ID | Link count | Bits |
|------------|------|------------|-------------|------------|------|
| 10.1.1.1 | 1349 | 0x8000017B | 0 | 1 | E |
| 10.2.2.2 | 516 | 0x80000191 | 0 | 1 | None |

Net Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Rtr count |
|------------|------|------------|---------|-----------|
| 10.2.2.2 | 1299 | 0x80000178 | 55 | 2 |

Link (Type-8) Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Interface |
|------------|------|------------|---------|-----------|
| 10.2.2.2 | 516 | 0x80000135 | 6 | Gi 1/2 |
| 10.2.2.2 | 1299 | 0x80000164 | 52 | Gi 1/48 |
| 10.1.1.1 | 1349 | 0x80000179 | 55 | Gi 5/3 |
| 10.2.2.2 | 1299 | 0x80000179 | 55 | Gi 5/3 |
| 10.2.2.2 | 516 | 0x8000017B | 5 | Gi 1/1 |

Intra Area Prefix Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Ref-lstype | Ref-LSID |
|------------|------|------------|---------|------------|----------|
| 10.1.1.1 | 1349 | 0x8000017A | 0 | 0x2001 | 0 |
| 10.2.2.2 | 516 | 0x80000189 | 0 | 0x2001 | 0 |
| 10.2.2.2 | 1299 | 0x80000178 | 56320 | 0x2002 | 55 |

Type-5 AS External Link States

| ADV Router | Age | Seq# | Prefix |
|------------|------|------------|--------|
| 10.1.1.1 | 1349 | 0x80000178 | ::/0 |

RTR_IP-DualSK_Distribution# **show ip ospf database router**

OSPF Router with ID (172.16.16.2) (Process ID 143)

Router Link States (Area 0)

Routing Bit Set on this LSA in topology Base with MTID 0
 LS age: 1968
 Options: (No TOS-capability, DC)
 LS Type: Router Links
 Link State ID: 172.16.16.1
 Advertising Router: 172.16.16.1
 LS Seq Number: 8000017A
 Checksum: 0x39DB
 Length: 48
 AS Boundary Router
 Number of Links: 2

Link connected to: a Stub Network
 (Link ID) Network/subnet number: 172.16.16.1
 (Link Data) Network Mask: 255.255.255.255

Number of MFID metrics: 0
TOS 0 Metrics: 1

Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.168.2
(Link Data) Router Interface address: 192.168.168.1
Number of MFID metrics: 0
TOS 0 Metrics: 1

LS age: 1502
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 172.16.16.2
Advertising Router: 172.16.16.2
LS Seq Number: 8000017D
Checksum: 0xDB30
Length: 60
Number of Links: 2

Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.168.2
(Link Data) Router Interface address: 192.168.168.2
Number of MFID metrics: 0
TOS 0 Metrics: 1

Link connected to: a Stub Network
(Link ID) Network/subnet number: 172.16.16.2
(Link Data) Network Mask: 255.255.255.255
Number of MFID metrics: 0
TOS 0 Metrics: 1

RTR_IP-DualSK_Distribution# **show ipv6 ospf database router**

OSPFv3 Router with ID (10.2.2.2) (Process ID 69)

Router Link States (Area 0)

Routing Bit Set on this LSA
LS age: 1575
Options: (V6-Bit E-Bit R-bit DC-Bit)
LS Type: Router Links
Link State ID: 0
Advertising Router: 10.1.1.1
LS Seq Number: 8000017B
Checksum: 0xE90C
Length: 40
AS Boundary Router
Number of Links: 1

Link connected to: a Transit Network
Link Metric: 1
Local Interface ID: 55
Neighbor (DR) Interface ID: 55
Neighbor (DR) Router ID: 10.2.2.2

LS age: 742
Options: (V6-Bit E-Bit R-bit DC-Bit)
LS Type: Router Links
Link State ID: 0
Advertising Router: 10.2.2.2
LS Seq Number: 80000191
Checksum: 0xA23C
Length: 40
Number of Links: 1

Link connected to: a Transit Network

```

Link Metric: 1
Local Interface ID: 55
Neighbor (DR) Interface ID: 55
Neighbor (DR) Router ID: 10.2.2.2

```

```
RTR_IP-DualSK_Distribution# sh ipv6 ospf database link
```

```
OSPFv3 Router with ID (10.2.2.2) (Process ID 69)
```

```
Link (Type-8) Link States (Area 0)
```

```

LS age: 499
Options: (V6-Bit E-Bit R-bit DC-Bit)
LS Type: Link-LSA (Interface: GigabitEthernet5/3)
Link State ID: 55 (Interface ID)
Advertising Router: 10.1.1.1
LS Seq Number: 8000017A
Checksum: 0x9AC7
Length: 56
Router Priority: 1
Link Local Address: FE80::C67D:4FFF:FEBD:5A80
Number of Prefixes: 1
Prefix Address: FC00:
Prefix Length: 64, Options: None

```

```

LS age: 479
Options: (V6-Bit E-Bit R-bit DC-Bit)
LS Type: Link-LSA (Interface: GigabitEthernet5/3)
Link State ID: 55 (Interface ID)
Advertising Router: 10.2.2.2
LS Seq Number: 8000017A
Checksum: 0xACA4
Length: 56
Router Priority: 1
Link Local Address: FE80::C67D:4FFF:FEBD:6880
Number of Prefixes: 1
Prefix Address: FC00:
Prefix Length: 64, Options: None

```

```
RTR_IP-DualSK_Distribution# sh 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, + - replicated route

```

```
Gateway of last resort is 192.168.168.1 to network 0.0.0.0
```

```

O*E2 0.0.0.0/0 [110/1] via 192.168.168.1, 6d18h, GigabitEthernet5/3
    172.16.0.0/32 is subnetted, 2 subnets
O    172.16.16.1 [110/2] via 192.168.168.1, 6d18h, GigabitEthernet5/3
C    172.16.16.2 is directly connected, Loopback0
    192.168.168.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.168.0/30 is directly connected, GigabitEthernet5/3
L    192.168.168.2/32 is directly connected, GigabitEthernet5/3

```

```
RTR_IP-DualSK_Distribution# show ipv6 route
```

```

IPv6 Routing Table - default - 13 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OE2 ::/0 [110/1], tag 69
    via FE80::C67D:4FFF:FEBD:5A80, GigabitEthernet5/3
S 64:FF9B::/96 [1/0]

```



```

    via 2404:F400:1::2
O  2404:F400::1/128 [110/1]
    via FE80::C67D:4FFF:FEBD:5A80, Gi gabi tEthernet5/3
LC 2404:F400::2/128 [0/0]
    via Loopback0, receive
C  FC00::/64 [0/0]
    via Gi gabi tEthernet5/3, directly connected
L  FC00::2/128 [0/0]
    via Gi gabi tEthernet5/3, receive
L  FF00::/8 [0/0]
    via Null0, receive

```

Now let's see on RTR_IP-DualSK_Gateway

RTR_IP-DualSK_Gateway# **sh ip ospf database**

OSPF Router with ID (172.16.16.1) (Process ID 143)

Router Link States (Area 0)

| Link ID | ADV Router | Age | Seq# | Checksum | Link count |
|-------------|-------------|-----|------------|----------|------------|
| 172.16.16.1 | 172.16.16.1 | 788 | 0x8000017E | 0x0031DF | 2 |
| 172.16.16.2 | 172.16.16.2 | 255 | 0x80000181 | 0x00D334 | 3 |

Net Link States (Area 0)

| Link ID | ADV Router | Age | Seq# | Checksum |
|---------------|-------------|-----|------------|----------|
| 192.168.168.2 | 172.16.16.2 | 255 | 0x8000017C | 0x0068D8 |

Type-5 AS External Link States

| Link ID | ADV Router | Age | Seq# | Checksum | Tag |
|---------|-------------|-----|------------|----------|-----|
| 0.0.0.0 | 172.16.16.1 | 788 | 0x8000012E | 0x00DA4D | 143 |

RTR_IP-DualSK_Gateway# **sh ipv6 ospf database**

OSPFv3 Router with ID (10.1.1.1) (Process ID 69)

Router Link States (Area 0)

| ADV Router | Age | Seq# | Fragment ID | Link count | Bits |
|------------|------|------------|-------------|------------|------|
| 10.1.1.1 | 484 | 0x8000017F | 0 | 1 | E |
| 10.2.2.2 | 1889 | 0x80000194 | 0 | 1 | None |

Net Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Rtr count |
|------------|-----|------------|---------|-----------|
| 10.2.2.2 | 598 | 0x8000017C | 55 | 2 |

Link (Type-8) Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Interface |
|------------|-----|------------|---------|-----------|
| 10.1.1.1 | 484 | 0x8000017D | 55 | Gi 5/2 |
| 10.2.2.2 | 598 | 0x8000017D | 55 | Gi 5/2 |

Intra Area Prefix Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Ref-lstyp | Ref-LSID |
|------------|------|------------|---------|-----------|----------|
| 10.1.1.1 | 484 | 0x8000017E | 0 | 0x2001 | 0 |
| 10.2.2.2 | 1889 | 0x8000018C | 0 | 0x2001 | 0 |
| 10.2.2.2 | 598 | 0x8000017C | 56320 | 0x2002 | 55 |

Type-5 AS External Link States

| ADV Router | Age | Seq# | Prefix |
|------------|-----|------------|--------|
| 10.1.1.1 | 484 | 0x8000017C | ::/0 |

RTR_IP-DualSK_Gateway# **show ip ospf database router**

OSPF Router with ID (172.16.16.1) (Process ID 143)

Router Link States (Area 0)

LS age: 1368
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 172.16.16.1
Advertising Router: 172.16.16.1
LS Seq Number: 8000017E
Checksum: 0x31DF
Length: 48
AS Boundary Router
Number of Links: 2

Link connected to: a Stub Network
(Link ID) Network/subnet number: 172.16.16.1
(Link Data) Network Mask: 255.255.255.255
Number of MTID metrics: 0
TOS 0 Metrics: 1

Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.168.2
(Link Data) Router Interface address: 192.168.168.1
Number of MTID metrics: 0
TOS 0 Metrics: 1

LS age: 835
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 172.16.16.2
Advertising Router: 172.16.16.2
LS Seq Number: 80000181
Checksum: 0xD334
Length: 60
Number of Links: 2

Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.168.2
(Link Data) Router Interface address: 192.168.168.2
Number of MTID metrics: 0
TOS 0 Metrics: 1

Link connected to: a Stub Network
(Link ID) Network/subnet number: 172.16.16.2
(Link Data) Network Mask: 255.255.255.255
Number of MTID metrics: 0
TOS 0 Metrics: 1

RTR_IP-DualSK_Gateway# **show ipv6 ospf database router**

OSPFv3 Router with ID (10.1.1.1) (Process ID 69)

Router Link States (Area 0)

LS age: 970
Options: (V6-Bit, E-Bit, R-bit, DC-Bit)
LS Type: Router Links
Link State ID: 0
Advertising Router: 10.1.1.1
LS Seq Number: 8000017F
Checksum: 0xE110
Length: 40
AS Boundary Router
Number of Links: 1

```

Link connected to: a Transit Network
Link Metric: 1
Local Interface ID: 55
Neighbor (DR) Interface ID: 55
Neighbor (DR) Router ID: 10.2.2.2

```

```

LS age: 339
Options: (V6-Bit, E-Bit, R-bit, DC-Bit)
LS Type: Router Links
Link State ID: 0
Advertising Router: 10.2.2.2
LS Seq Number: 80000195
Checksum: 0x9A40
Length: 40
Number of Links: 1

```

```

Link connected to: a Transit Network
Link Metric: 1
Local Interface ID: 55
Neighbor (DR) Interface ID: 55
Neighbor (DR) Router ID: 10.2.2.2

```

RTR_IP-DualSK_Gateway# **show ipv6 ospf database link**

OSPFv3 Router with ID (10.1.1.1) (Process ID 69)

Link (Type-8) Link States (Area 0)

```

LS age: 1016
Options: (V6-Bit, E-Bit, R-bit, DC-Bit)
LS Type: Link-LSA (Interface: GigabitEthernet5/2)
Link State ID: 55 (Interface ID)
Advertising Router: 10.1.1.1
LS Seq Number: 8000017D
Checksum: 0x94CA
Length: 56
Router Priority: 1
Link Local Address: FE80::C67D:4FFF:FEBD:5A80
Number of Prefixes: 1
Prefix Address: FC00::
Prefix Length: 64, Options: None

```

```

LS age: 1130
Options: (V6-Bit, E-Bit, R-bit, DC-Bit)
LS Type: Link-LSA (Interface: GigabitEthernet5/2)
Link State ID: 55 (Interface ID)
Advertising Router: 10.2.2.2
LS Seq Number: 8000017D
Checksum: 0xA6A7
Length: 56
Router Priority: 1
Link Local Address: FE80::C67D:4FFF:FEBD:6880
Number of Prefixes: 1
Prefix Address: FC00::
Prefix Length: 64, Options: None

```

RTR_IP-DualSK_Gateway# **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, + - replicated route

```

Gateway of last resort is 115.167.78.137 to network 0.0.0.0

```
S* 0.0.0.0/0 [1/0] via 115.167.78.137
   115.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C   115.167.78.136/30 is directly connected, GigabitEthernet5/1
L   115.167.78.138/32 is directly connected, GigabitEthernet5/1
   172.16.0.0/32 is subnetted, 2 subnets
C   172.16.16.1 is directly connected, Loopback0
O   172.16.16.2 [110/2] via 192.168.168.2, 1w1d, GigabitEthernet5/2
   192.168.168.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.168.0/30 is directly connected, GigabitEthernet5/2
L   192.168.168.1/32 is directly connected, GigabitEthernet5/2
```

RTR_IP-DualSK_Gateway# show ipv6 route

IPv6 Routing Table - default - 4780 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

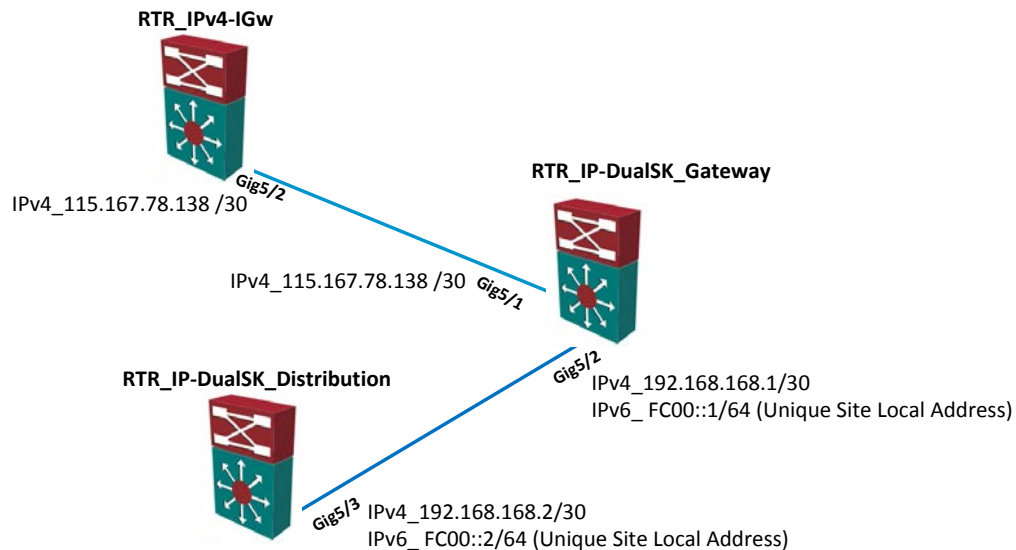
IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2

```
LC 2404:F400::1/128 [0/0]
   via Loopback0, receive
O   2404:F400::2/128 [110/1]
   via FE80::C67D:4FFF:FEBD:6880, GigabitEthernet5/2
L   FF00::/8 [0/0]
   via Null0, receive
```

4.2 IPv4 Internet Connectivity



RTR_IP-DualSK_Gateway Configuration

| | |
|---|---|
| interface GigabitEthernet5/1 | Configure IPv4 Address from IPv4 Internet Gateway |
| ip address 115.167.78.138 255.255.255.252 | |
| end | |
| ip route 0.0.0.0 0.0.0.0 115.167.78.137 | Point Default-Gateway route to ISP Router |

4.2.1 Verify

Verify connectivity by checking reachability to any internet Destination

```
RTR_IP-DualSK_Gateway# ping 128. 223. 51. 103
```

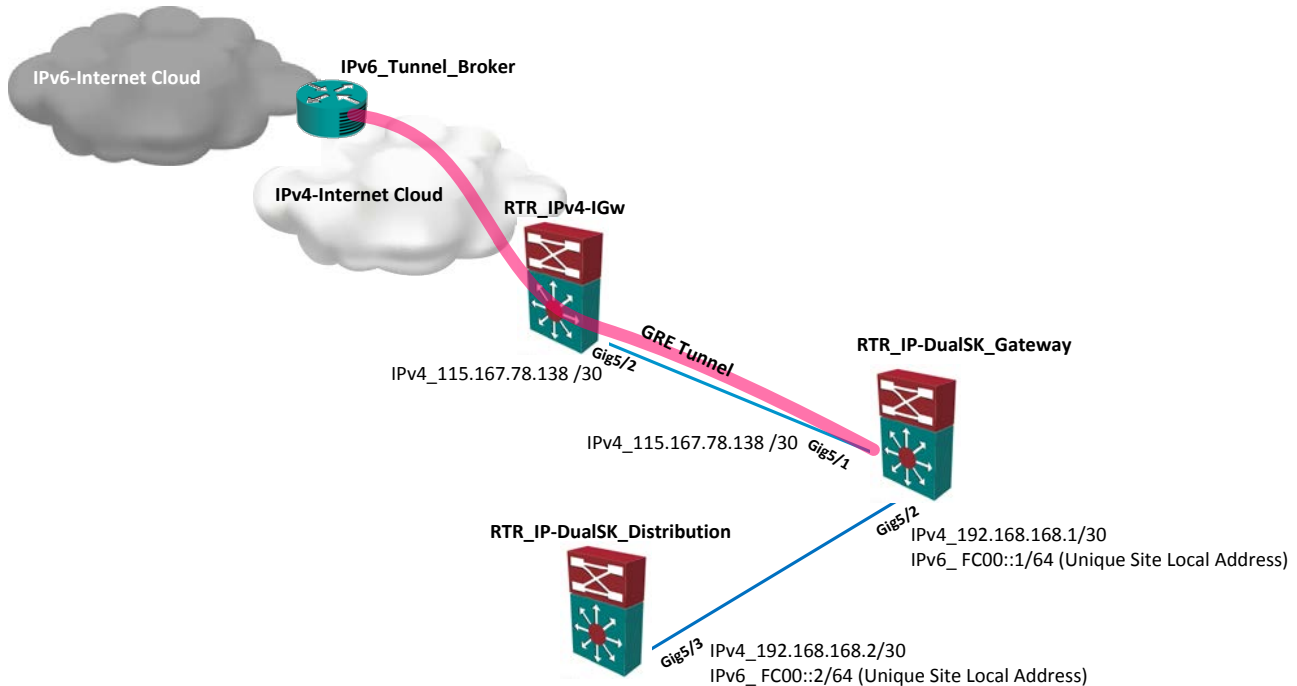
Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 128.223.51.103, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 392/396/404 ms

4.3 GRE Tunnel to Tunnel Broker



RTR_IP-DualSK_Gateway Tunnel Configuration

```
interface Tunnel624
description Hurricane Electric IPv6 Tunnel Broker
no ip address
ip tcp adjust-mss 1460
ipv6 address 2001:470:14:ED::2/64
ipv6 enable
tunnel source 115.167.78.138
tunnel destination 216.66.84.50
tunnel mode ipv6ip
end
```

Configure GRE Tunnel to IPv6-Tunnel Broker, with IPv4 Source and Destination, and IPv6 address for Tunnel interface. Set the Tunnel Mode ipv6ip

```
ip route ::/0 Tunne624
```

Point Default-Gateway route for IPv6 networks towards Tunnel

4.3.1 Verify

```
RTR_IP-DualSK_Gateway#ping 2001: 470: 14: ED: : 1
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:470:14:ED::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 164/164/168 ms

4.4 Multiprotocol BGP Configuration

RTR_IP-DualSK_Gateway BGP Configuration

| | |
|--|--|
| <pre> ipv6 route 2400:F400::/32 Null0 ipv6 route 2404:F400::/48 Null0 ipv6 route 2404:F400:1::/48 Null0 ipv6 route 2404:F400:2::/48 Null0 </pre> | <p>Configure GRE Tunnel to IPv6-Tunnel Broker, with IPv4 Source and Destination , and IPv6 address for Tunnel interface.</p> <p>Set the Tunnel Mode ipv6ip</p> |
| <pre> ipv6 prefix-list IPv6 seq 1 permit 2400:F400::/32 ipv6 prefix-list IPv6 seq 2 permit 2400:F400::/48 ipv6 prefix-list IPv6 seq 3 permit 2400:F400:2::/48 ipv6 prefix-list IPv6 seq 4 permit 2400:F400:1::/48 </pre> | <p>Point Default-Gateway route for IPv6 networks towards Tunnel</p> |
| <pre> route-map IPv6-OUT permit 10 match ipv6 address prefix-list IPv6 </pre> | |
| <pre> router bgp 38547 no synchronization bgp log-neighbor-changes neighbor 2001:470:14:ED::1 remote-as 6939 neighbor 2001:470:14:ED::1 route-map IPv6-OUT out no auto-summary ! address-family ipv6 no synchronization network 2400:F400::/32 network 2404:F400::/48 network 2404:F400:1::/48 network 2404:F400:2::/48 neighbor 2001:470:14:ED::1 activate exit-address-family </pre> | |

4.4.1 Verify

show bgp ipv6 unicast summary

This command provides output similar to the show ip bgp summary command, except it is IPv6-specific

```

RTR_IP-DualSK_Gateway#show ip bgp ipv6 unicast summary
BGP router identifier 172.16.16.1, local AS number 38547
BGP table version is 140385, main routing table version 140385
4771 network entries using 691795 bytes of memory
4771 path entries using 362596 bytes of memory
3524/3523 BGP path/bestpath attribute entries using 267824 bytes of memory
3423 BGP AS-PATH entries using 84156 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1406371 total bytes of memory
BGP activity 37975/33204 prefixes, 48534/43763 paths, scan interval 60 secs

Neighbor      V    AS MsgRcvd MsgSent   TblVer  InQ  OutQ  Up/Down  State/PfxRcd
2001:470:14:ED::1
                4  6939   4107    104   140385    0    0 01:31:58    4767

```

show ipv6 route

This command displays the the IPv6 routing table.

```
RTR_IP-DualSK_Gateway#show ipv6 route
IPv6 Routing Table - default - 4783 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
        B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
        IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
        O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
        ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
S   ::/0 [1/0]
    via Tunnel624, directly connected
B   2001::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:900::/40 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:905::/48 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:C000::/35 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:E000::/35 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:208::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:218::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:218:400::/40 [20/0]
```

Output truncated.....

show ipv6 route bgp

When you specify a protocol, only routes for that particular routing protocol are shown. This sample output is from the show ipv6 route command when entered with the BGP keyword:

```
RTR_IP-DualSK_Gateway#show ipv6 route bgp
IPv6 Routing Table - default - 4783 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
        B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
        IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
        O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
        ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
B   2001::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200::/32 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:900::/40 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:905::/48 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:C000::/35 [20/0]
    via FE80::D842:5432, Tunnel 624
B   2001:200:E000::/35 [20/0]
    via FE80::D842:5432, Tunnel 624
```

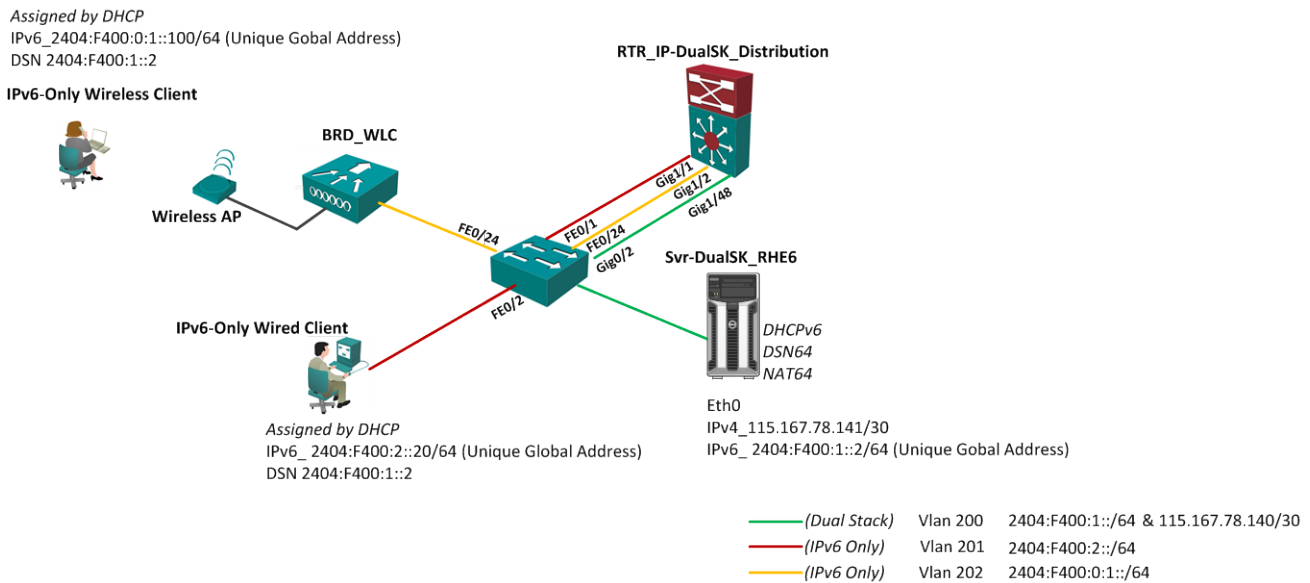
```

B 2001:208::/32 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:218::/32 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:218:400::/40 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:218:6002::/48 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:220::/35 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:240::/32 [20/0]
  via FE80::D842:5432, Tunnel 624
B 2001:250::/32 [20/0]
  via FE80::D842:5432, Tunnel 624
    
```

Output truncated.....

4.5 IPv6 LAN and Wireless

We have Setup three LAN segments as shown in the Figure below:



Switch is configured with Vlan 200,201 and 203 to create isolated Layer 2_domains. Configure three interface of the of the Router with following Prefixes:

| Interface | Address Prefixes | Purpose |
|----------------------|---|-------------------------|
| Gigabitethernet 1/48 | IPv6 2404:F400:1::/64 IPv4 115.167.78.140/30 | For Datacenter Services |
| Gigabitethernet 1/1 | 2404:F400:2::/64 | Wired Lan Segment |
| Gigabitethernet 1/2 | 2404:F400:0:1::/64 | Wireless LAN |

Configure RTR_IP-DualSk_Distribution's Interface for Srv_DualSK-RHE6

RTR_IP-DualSK_Distribution Interface Configuration (Datacenter Services)

| | |
|---|---|
| interface GigabitEthernet1/48 description **IPv6-SW-1 (Gig0/2):(Ipv6-DCN) ** ip address 115.167.78.141 255.255.255.252 ipv6 address 2404:F400:1::1/96 ipv6 enable ipv6 ospf 69 area 0 | Configure the Interface as Dual Stack and Advertising the IPv6 Prefix in OSPFv3 |
| router ospf 143 network 115.167.78.140 0.0.0.3 area 0 | Advertising IPv4 Network in by adding Network Command in OSPFv2 configuration |

Srv-DualSK_RHE6 Eth0 Interface Configuration

```
[root@Srv_DualSK_RHE6 network-scripts]# vi /etc/sysconfig/network-scripts/ifcfg-eth0
```

```
DEVICE="eth0"
NM_CONTROLLED="yes"
ONBOOT=yes
TYPE=Ethernet
IPV4_FAILURE_FATAL=yes
IPV6INIT=yes
IPV6_AUTOCONF=no
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=yes
NAME="System eth0"
UUID=5fb06bd0-0bb0-7ffb-45f1-d6edd65f3e03
IPV6ADDR=2404:f400:1::2/64
BOOTPROTO=none
IPADDR=115.167.78.142
PREFIX=30
GATEWAY=115.167.78.141
DEFROUTE=yes
HWADDR=00:25:64:98:52:35
```

4.5.1 Verify

```
ifconfig eth0
```

Verify the configuration of interface Ethernet Configuration

```
[root@Srv_Dual SK_RHE6 network-scripts]# ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:25:64:98:52:35
          inet addr:115.167.78.142  Bcast:115.167.78.143  Mask:255.255.255.252
          inet6 addr: 2404:f400:1::2/96 Scope:Global
          inet6 addr: fe80::225:64ff:fe98:5235/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:814000 errors:0 dropped:0 overruns:0 frame:0
          TX packets:225261 errors:1 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:157892611 (150.5 MiB)  TX bytes:108331575 (103.3 MiB)
          Interrupt:16
```

route -n -A inet6

ViewIPv6 Routing Table of the Linux Server

```
[root@Srv_Dual SK_RHE6]# route -n -A inet6
Kernel IPv6 routing table
```

| Destination | Next Hop | Flags | Metric | Ref | Use | Iface |
|------------------------------|----------------|-------|--------|-------|-----|-------|
| 2404:f400:1::/96 | :: | U | 256 | 1 | 0 | eth0 |
| fe80::/64 | :: | U | 256 | 0 | 0 | eth0 |
| ::/0 | 2404:f400:1::1 | UG | 1 | 86085 | 0 | eth0 |
| ::/0 | :: | U | 1024 | 0 | 0 | eth0 |
| ::1/128 | :: | U | 0 | 1219 | 1 | lo |
| 2404:f400:1::/128 | :: | U | 0 | 0 | 1 | lo |
| 2404:f400:1::2/128 | :: | U | 0 | 8611 | 1 | lo |
| fe80::/128 | :: | U | 0 | 0 | 1 | lo |
| fe80::225:64ff:fe98:5235/128 | :: | U | 0 | 3151 | 1 | lo |
| ff02::5/128 | ff02::5 | UC | 0 | 66262 | 0 | eth0 |
| ff00::/8 | :: | U | 256 | 0 | 0 | eth0 |

route -n

ViewIPv4 Routing Table of the Linux Server

```
[root@Srv_Dual SK_RHE6]# route -n
Kernel IP routing table
```

| Destination | Gateway | Genmask | Flags | Metric | Ref | Use | Iface |
|----------------|----------------|-----------------|-------|--------|-----|-----|-------|
| 115.167.78.140 | 0.0.0.0 | 255.255.255.252 | U | 1 | 0 | 0 | eth0 |
| 0.0.0.0 | 115.167.78.141 | 0.0.0.0 | UG | 0 | 0 | 0 | eth0 |

Verify reachability to IPv6 Gateway:

```
[root@Srv_Dual SK_RHE6 ~]# ping6 2404:f400:1::1
PING 2404:f400:1::1(2404:f400:1::1) 56 data bytes
64 bytes from 2404:f400:1::1: icmp_seq=1 ttl=64 time=0.568 ms
64 bytes from 2404:f400:1::1: icmp_seq=2 ttl=64 time=0.460 ms
64 bytes from 2404:f400:1::1: icmp_seq=3 ttl=64 time=0.495 ms
^C
--- 2404:f400:1::1 ping statistics ---
```

```
3 packets transmitted, 3 received, 0% packet loss, time 2396ms
rtt min/avg/max/mdev = 0.460/0.507/0.568/0.051 ms
```

Verify reachability to IPv4 Gateway:

```
[root@Srv_DualSK_RHE6 ~]# ping 115.167.78.141
PING 115.167.78.141 (115.167.78.141) 56(84) bytes of data.
64 bytes from 115.167.78.141: icmp_seq=1 ttl=255 time=0.650 ms
64 bytes from 115.167.78.141: icmp_seq=2 ttl=255 time=0.678 ms
64 bytes from 115.167.78.141: icmp_seq=3 ttl=255 time=0.540 ms
^C
--- 115.167.78.141 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2812ms
rtt min/avg/max/mdev = 0.540/0.622/0.678/0.066 ms
```

4.6 Configure DHCPv6

DHCPv6 Configuration for Dual-Stack Server

```
[root@Srv_DualSK_RHE6 network-scripts]# vi /etc/dhcp/dhcpd.conf
```

```
default-lease-time 1800;
```

```
subnet6 2404:F400:0001::/64 {
}
```

```
subnet6 2404:F400:0002::/64 {
    range6 2404:F400:0002::10 2404:F400:0002::20;
    #Using DNS caching Server of Tunnel Broker
    option dhcp6.name-servers 2001:470:20::2;
}
```

```
subnet6 2404:F400:0000:1::/64 {
    range6 2404:F400:0000:1::10 2404:F400:0000:1::100;
    #Using DNS caching Server of Tunnel Broker
    option dhcp6.name-servers 2001:470:20::2;
}
```

```
:wq!
```

```
[root@Srv_DualSK_RHE6 network-scripts]# service dhcpd6 restart
```

```
Shutting down dhcpd (DHCPv6): [ OK ]
```

```
Starting dhcpd (DHCPv6): [ OK ]
```

Configure Dual-Stack Distribution's Interface for Wired LAN and Wireless LAN:

RTR_IP-DualSK_Distribution Interface Configuration (Datacenter Services)

```
interface GigabitEthernet1/1
description ** IPv6-SW-1 (FE0/2):(IPv6-LAN) **
no ip address
ipv6 address 2404:F400:2::1/64
ipv6 enable
ipv6 nd managed-config-flag
ipv6 dhcp relay destination 2404:F400:1::2
ipv6 ospf 69 area 0
end
```

Configure the Interface as IPv6-Only and Advertising the IPv6 Prefix in OSPFv3
Setting to intimate the Host, to send DHCP request, in Router Advertisement (RA)
And also Acting as DHCP relay

```
interface GigabitEthernet1/2
description ** IPv6-SW-1 (FE0/24):(IPv6-Wifi) **
no ip address
ipv6 address 2404:F400:0:1::1/64
```

Configure the Interface as IPv6-Only and Advertising the IPv6 Prefix in OSPFv3
Setting to intimate the Host, to send DHCP request, in Router Advertisement (RA)

```
ipv6 enable
ipv6 nd managed-config-flag
ipv6 dhcp relay destination 2404:F400:1::2
ipv6 ospf 69 area 0
end
```

And also Acting as DHCP relay

Now Connect your WIN7 Laptop to Switch, configured as Access port for Vlan 201

4.6.1 Verify

ipconfig /all

View the IP address setting of windows workstation

```
C:\Users\Latherio>ipconfig /all
Ethernet adapter Gigabit-Interface:
```

```
Connection-specific DNS Suffix . :
Description . . . . . : Realtek PCIe GBE Family Controller
Physical Address. . . . . : 90-E6-BA-AA-54-A1
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IPv6 Address. . . . . : 2404:f400:2::20(Preferred)
Lease Obtained. . . . . : Friday, March 25, 2011 1:12:39 PM
Lease Expires . . . . . : Friday, March 25, 2011 1:42:39 PM
IPv6 Address. . . . . : 2404:f400:2:0:a5ed:e0c3:af07:6434(Preferred)
Temporary IPv6 Address. . . . . : 2404:f400:2:0:5c59:e189:c1ec:b2c7(Preferred)
Link-local IPv6 Address . . . . . : fe80::a5ed:e0c3:af07:6434%11(Preferred)
Default Gateway . . . . . : fe80::c67d:4fff:febd:6880%11
DHCPv6 IAID . . . . . : 244377274
DHCPv6 Client DUID. . . . . : 00-01-00-01-14-80-77-6E-90-E6-BA-AA-54-A1

DNS Servers . . . . . : 2001:470:20::2
NetBIOS over Tcpi. . . . . : Enabled
```

nslookup, ping

DNS Query of IPv6 Enable Domain**C:\Users\Latherio>nslookup**

Default Server: ordns.he.net

Address: 2001:470:20::2

> www.google.com

Server: [2001:470:20::2]

Address: 2001:470:20::2

Non-authoritative answer:

Name: www.l.google.com

Addresses: 2a00:1450:8007::6a

74.125.39.105

74.125.39.103

74.125.39.147

74.125.39.104

74.125.39.99

74.125.39.106

Aliases: www.google.com**DNS Query of non-IPv6 Enable Domain****C:\Users\Latherio>nslookup**

Default Server: ordns.he.net

Address: 2001:470:20::2

> www.yahoo.com

Server: ordns.he.net

Address: 2001:470:20::2

Non-authoritative answer:

Name: any-fp.wa1.b.yahoo.com

Addresses: 67.195.160.76

69.147.125.65

Aliases: www.yahoo.com

fp.wg1.b.yahoo.com

note: you can no IPv6 in reply**C:\Users\Latherio>tracert 2a00:1450:8007::6a**

Tracing route to 2a00:1450:8007::6a over a maximum of 30 hops

```

 1 <1 ms <1 ms <1 ms 2404:f400:2::1
 2 <1 ms <1 ms <1 ms fc00::1
 3 161 ms 161 ms 162 ms witrubepk-1.tunnel.tserv17.lon1.ipv6.he.net [2001:470:14:ed::1]
 4 161 ms 166 ms 161 ms gige-g4-18.core1.lon1.he.net [2001:470:0:a3::1]
 5 161 ms 198 ms 161 ms 2001:7f8:4::3b41:1
 6 162 ms 281 ms 164 ms 2001:4860::1:0:6
 7 171 ms 170 ms 170 ms 2001:4860::1:0:8
 8 204 ms 175 ms 175 ms 2001:4860::1:0:10
 9 175 ms 175 ms 175 ms 2001:4860::2:0:48c
10 188 ms 181 ms 179 ms 2001:4860:0:1::c9
11 175 ms 175 ms 175 ms 2a00:1450:8007::6a

```

Trace complete.

C:\Users\Latherio>ping 2a00:1450:8007::6a

Pinging 2a00:1450:8007::6a with 32 bytes of data:

Reply from 2a00:1450:8007::6a: time=175ms

Reply from 2a00:1450:8007::6a: time=175ms

Reply from 2a00:1450:8007::6a: time=175ms

Reply from 2a00:1450:8007::6a: time=175ms

Ping statistics for 2a00:1450:8007::6a:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 175ms, Maximum = 175ms, Average = 175ms

4.7 Build NAT64/DNS64

NAT64 implementation requires two components, DNS64 (for DNS synthesis) and IP-Translator which translator synthesized-IPv6 addresses to IP4 and put them on NAT.

Few implementations of NAT64 are available, like:

- **Open Source** :Ecdysis

- **Microsoft** : Forefront UAG DirectAccess
- **Cisco** : CGv6
- **Ericsson** : Field Trails

We have deployed Open Source : Ecdysis NAT64 Gateway. Ecdysis consist of two (2) separate package one is DNS package (bind and unbound) and second is NAT64 package.

We use Bind-implementation of DNS64, and install both NAT64 and DNS64 on same machine. Following are packages for Linux Redhat 6 Enterprise

Bind: Pre-patched full source: ecdysis-bind-9.7.2-P2D20101117.tar.gz

NAT64 - IP Translator: Source: ecdysis-nf-nat64-20101117.tar.gz

4.7.1 DNS64 Configuration

DNS64 Configuration for Srv_DualSK_RHE6

```
[root@Srv_DualSK_RHE6 esdsysis-bind-9.7.2-PSD20101117]# ./configure
[root@Srv_DualSK_RHE6 esdsysis-bind-9.7.2-PSD20101117]# make
[root@Srv_DualSK_RHE6 esdsysis-bind-9.7.2-PSD20101117]# make install
[root@Srv_DualSK_RHE6 esdsysis-bind-9.7.2-PSD20101117]# vi named.conf
```

```
//add dns option "dns64-prefix"
//The prefix must be a /96 or shorter.
dns64-prefix 64:ff9b::/96;
```

```
[root@Srv_DualSK_RHE6]# named -c named.conf
```

4.7.1.1 Verify

```
[root@Srv_DualSK_RHE6 ~]# dig @localhost www.yahoo.com aaaa

; <<>> DiG 9.7.2-P2 <<>> @localhost www.yahoo.com aaaa
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 31041
;; flags: qr rd ra; QUERY: 1, ANSWER: 4, AUTHORITY: 2, ADDITIONAL: 0

;; QUESTION SECTION:
www.yahoo.com.                IN      AAAA

;; ANSWER SECTION:
www.yahoo.com.                287     IN      CNAME   fp.wg1.b.yahoo.com.
fp.wg1.b.yahoo.com.          3587    IN      CNAME   eu-fp.wa1.b.yahoo.com.
eu-fp.wa1.b.yahoo.com.       48      IN      AAAA    64:ff9b::57f8:7a7a
eu-fp.wa1.b.yahoo.com.       48      IN      AAAA    64:ff9b::57f8:70b5

;; AUTHORITY SECTION:
wa1.b.yahoo.com.              288     IN      NS       yf2.yahoo.com.
wa1.b.yahoo.com.              288     IN      NS       yf1.yahoo.com.

;; Query time: 0 msec
;; SERVER: 127.0.0.1#53(127.0.0.1)
;; WHEN: Fri Mar 25 16:53:00 2011
;; MSG SIZE rcvd: 170
```

Now Again "dhcpd6.conf" replace

“option dhcp6.name-servers 2001:470:20::2;” → option dhcp6.name-servers 2404:F400:1::2;
And reconnect your laptop, perform uslookup and see the difference

DNS Query of IPv6 Enable Domain

C:\Users\Latherio>nslookup

Default Server: UnKnown

Address: 2404:f400:1::2

> www.google.com

Server: UnKnown

Address: 2404:f400:1::2

Non-authoritative answer:

Name: www.l.google.com

Addresses: 64:ff9b::d155:e768

209.85.231.104

Aliases: www.google.com

DNS Query of non-IPv6 Enable Domain

C:\Users\Latherio>nslookup

Server: UnKnown

Address: 2404:f400:1::2

Non-authoritative answer:

Name: eu-fp.wa1.b.yahoo.com

Addresses: 64:ff9b::57f8:7a7a

64:ff9b::57f8:70b5

87.248.122.122

87.248.112.181

Aliases: www.yahoo.com

fp.wg1.b.yahoo.com

note: you can see IPv6-synthesized answer in DNS reply(with NAT64 prefix)

4.7.2 NAT64 Configuration

NAT64 Configuration for Srv_DualSK_RHE6

```
[root@Srv_DualSK_RHE6 ecdysis-nf-nat64-20101117]# make
[root@Srv_DualSK_RHE6 ecdysis-nf-nat64-20101117]# make install
[root@Srv_DualSK_RHE6 ecdysis-nf-nat64-20101117]# vi ./nat64-config.sh
```

```
//IPv4_ADDR should your server IPv4 Address
```

```
//PREFIX_ADDR should be dns64-Prefix
```

```
IPV4_ADDR="115.167.78.142"
```

```
PREFIX_ADDR="64:ff9b::"
```

```
PREFIX_LEN="96";
```

```
[root@Srv_DualSK_RHE6]# ./nat64-config.sh
```

Route DNS64 Prefix towards Srv-DualSK_RHE6on Dual-Stack Distribution

```
Dual-Stack Distribution(config)#ipv6 route 64:FF9B::/96 2404:F400:1::2
```

4.7.2.1 Verify

C:\Users\Latherio>tracert ipv6.google.com

Tracing route to ipv6.l.google.com [2404:6800:8008::68]

over a maximum of 30 hops:

```
 0  2 ms  1 ms  1 ms  2404:f400:0:1::1
 1  3 ms  3 ms  9 ms  fc00::1
 2 241 ms 239 ms 312 ms tunnel237.tserv17.lon1.ipv6.he.net [2001:470:14:ed::1]
 3 245 ms 208 ms 207 ms gige-g4-18.core1.lon1.he.net [2001:470:0:a3::1]
 4 245 ms 221 ms 299 ms 2001:7f8:4::3b41:1
 5 238 ms 312 ms 208 ms 2001:4860::1:0:6
 6 251 ms 417 ms 312 ms 2001:4860::1:0:755
 7 355 ms 312 ms 312 ms 2001:4860::1:0:3f7
```

```
9 355 ms 311 ms 415 ms 2001:4860::1:0:24db
10 358 ms 415 ms 417 ms 2001:4860::8:0:252c
11 357 ms 439 ms 394 ms 2001:4860::1:0:610
12 544 ms 521 ms 590 ms 2001:4860::1:0:75
13 553 ms 627 ms 627 ms 2001:4860::1:0:1c5
14 666 ms 627 ms 623 ms 2001:4860::4:0:f70
15 665 ms 614 ms 675 ms 2001:4860:0:1::f1
16 715 ms 731 ms 521 ms 2404:6800:8008::68
```

Trace complete.

C:\Users\Latherio>tracert www.yahoo.com

Tracing route to eu-fp.wa1.b.yahoo.com [64:ff9b::57f8:7a7a]
over a maximum of 30 hops:

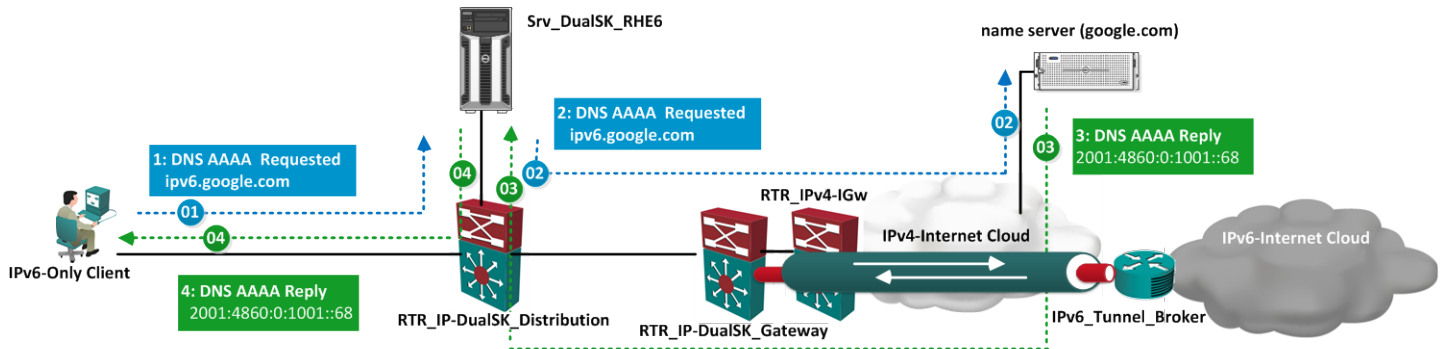
```
1 7 ms 1 ms 1 ms 2404:f400:0:1::1
2 3 ms 1 ms 1 ms 2404:f400:1::2
3 59 ms 1 ms 4 ms 115-167-78-141.wi-tribe.net.pk [64:ff9b::73a7:4e8d]
4 9 ms 8 ms 3 ms 64:ff9b::c0a8:a801
5 7 ms 5 ms 11 ms 115-167-78-137.wi-tribe.net.pk [64:ff9b::73a7:4e89]
6 8 ms 4 ms 3 ms se6-5-0.rwp44d1.pie.net.pk [64:ff9b::ca7d:9565]
7 7 ms 5 ms 6 ms rwp44.pie.net.pk [64:ff9b::dd78:fd01]
8 436 ms 32 ms 61 ms static-khi275-P01-pie.net.pk [64:ff9b::dd78:fe0e]
9 24 ms 23 ms 30 ms static-khidr-ni02-sw.pie.net.pk [64:ff9b::ca7d:8083]
10 170 ms 209 ms 212 ms 64:ff9b::d5f2:7301
11 150 ms 208 ms 317 ms ae-2-3.bar1.Marseille1.Level3.net [64:ff9b::445:8ff9]
12 212 ms 208 ms 209 ms ae-7-7.ebr1.Paris1.Level3.net [64:ff9b::445:8fee]
13 251 ms 208 ms 208 ms 64:ff9b::445:8f76
14 250 ms 206 ms 208 ms ae-5-5.car1.Geneva1.Level3.net [64:ff9b::445:8951]
15 358 ms 205 ms 215 ms YAHOO-INC.car1.Geneva1.Level3.net [64:ff9b::d5f2:49a6]
16 218 ms 208 ms 228 ms gi-1-1.bas-a2.ch1.yahoo.com [64:ff9b::57f8:7f0b]
17 273 ms 206 ms 205 ms ir1.fp.vip.ch1.yahoo.com [64:ff9b::57f8:7a7a]
```

Trace complete.

4.7.3 Traffic Flows

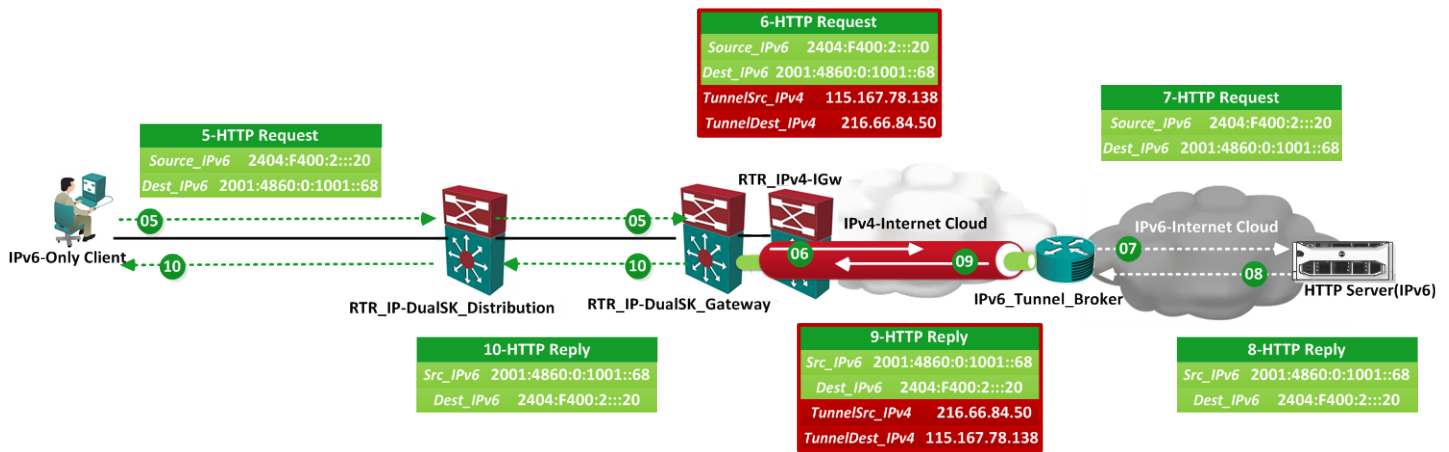
4.7.3.1 Browsing IPv6 Web Site

4.7.3.1.1 DNS Query IPv6 Enable Domain



1. IPv6-only Host request for AAAA record of ip6.google.com from primary configured DNS
2. Caching DNS(DNS64:Srv_DualSK_RHE6), reached the Google.com name Server, request AAAA record.
3. If the Authoritative have AAAA Record against the domain it will be return, which is true in this case. So, Google.com nameserver reply with IPv6 address for requested domain.
4. DNS(DNS64:Srv_DualSK_RHE6) pass-over the answer of google.com nameserver to the IPv6 Client in reply to his request.

4.7.3.1.2 Routing to IPv6 Site



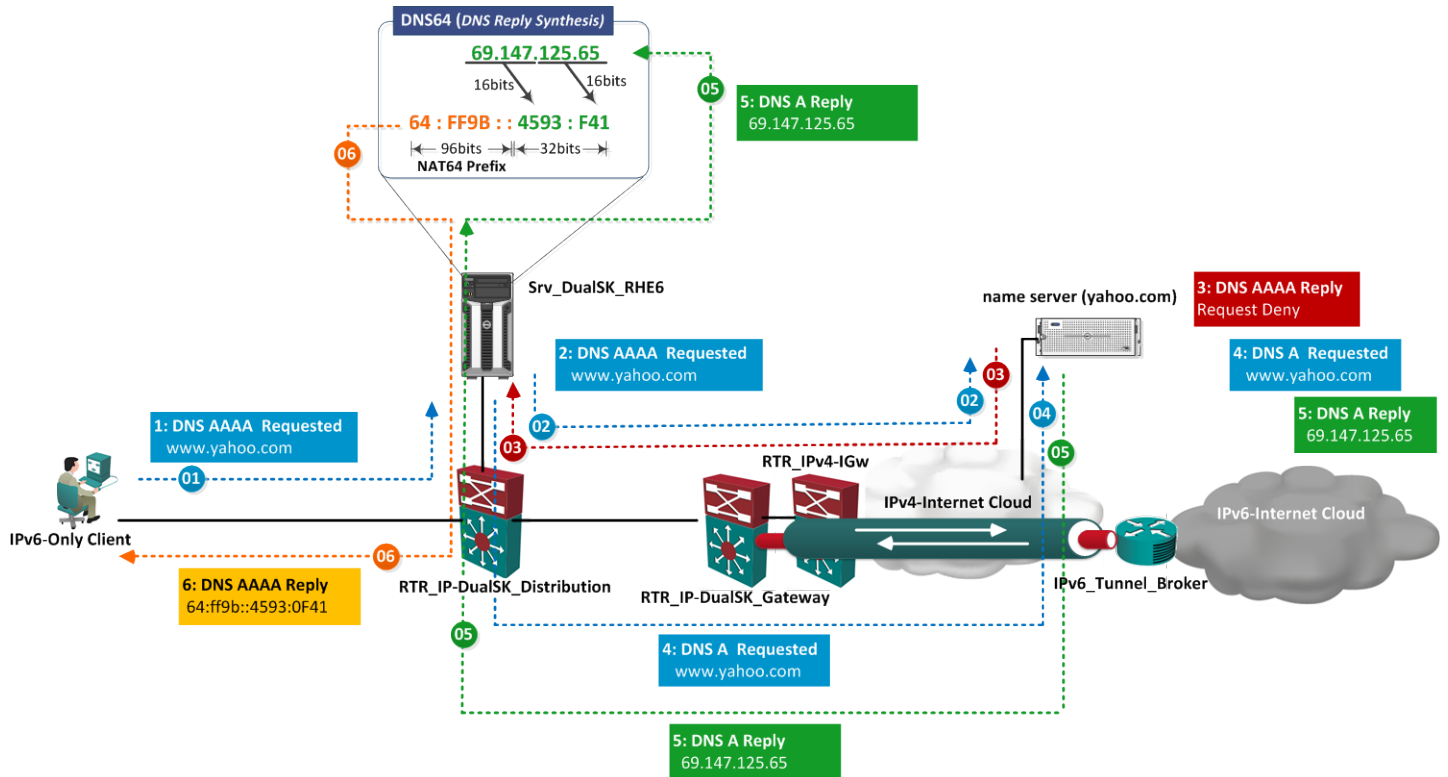
5. Client initial a HTTP request for the IPv6 , received by DNS in above process, packet with IPv6-Source and IPv6-Destination will take IPv6-Default-route to reach RTR_IP-DualSK_Gateway.
6. RTR_IP-DualSK_Gateway have IPv6-Default route pointed to GRE-Tunnel [**ip route ::/0 Tunn624**]; so it will encapsulate the IPv6 Packet to IPv4 Packet with its IPv4 as source and IPv6_Tunnel_Broker's IPv4 as destination, and forward it to RTR_IPv4-IGw. So, encapsulated packet reach IPv4 interface of IPv6_Tunnel_Broker Router via normal IPv4 internet routing.
7. IPv6_Tunnel_Broker will decapsulate the packet received for its interface IPv4 address, to extract IPv6 Packet, and route it to IPv6 internet. So, that it reach the IPv6 destination.
8. IPv6 destination prepares the reply for the IPv6 client, and hand-over to IPv6 routing. As IPv6_Tunnel_Broker is transit for Client's IPv6 prefix, reply for HTTP server reach the IPv6_Tunnel_Broker Router's IPv6 interface.
9. As IPv6_Tunnel_Broker Router have GRE-Tunnel as BGP next-hop for Client prefix , so it will encapsulate the IPv6 Packet to IPv4 Packet with its IPv4 as source and RTR_IP-DualSK_Gateway IPv4 as destination, and forward it to IPv4 internet cloud

for further routing . So, encapsulated packet reach IPv4 interface of RTR_IP-DualSK_Gateway Router via normal IPv4 internet routing.

- RTR_IP-DualSK_Gateway will dencapsulate the packet received for its interface IPv4 address, to extract IPv6 Packet, and route in to IPv6 intranet. So, that it reach the IPv6 destination (the IPv6-Only Client).

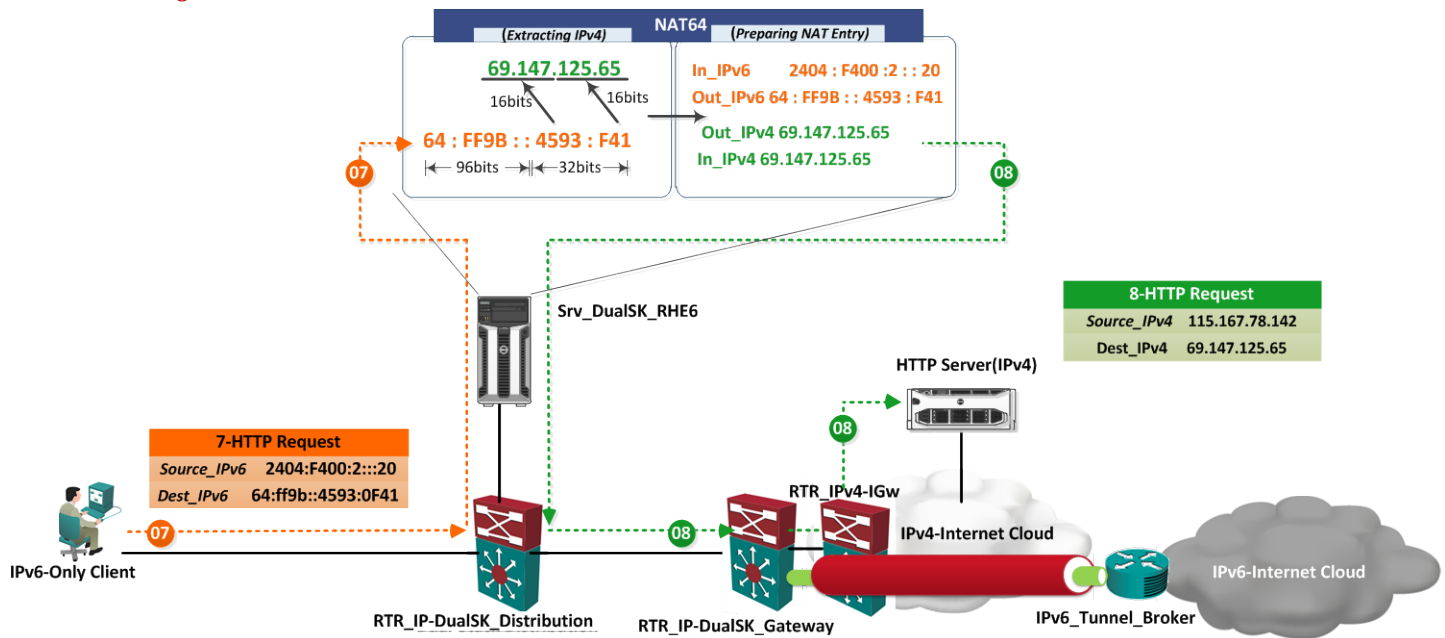
4.7.3.2 Browsing IPv4 Web Site

4.7.3.2.1 DNS Query non-IPv6 Domain

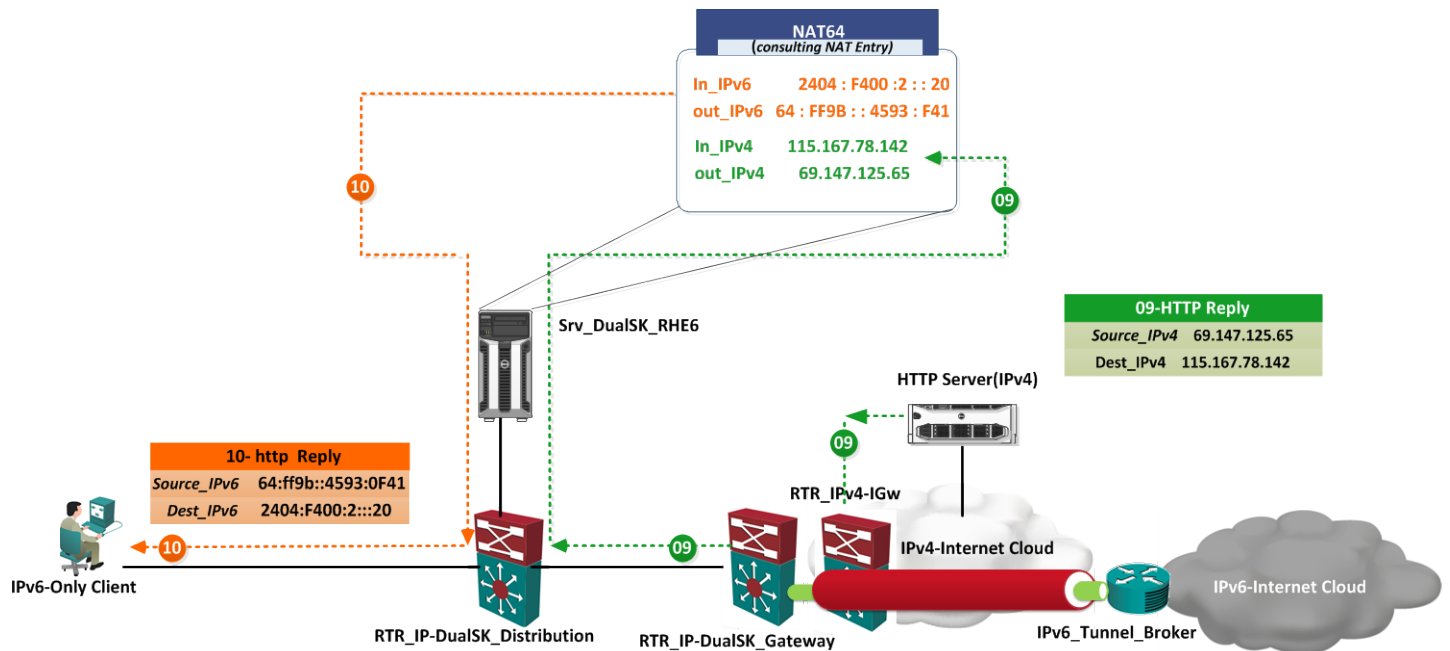


- IPv6-only Host request for AAAA record of www.yahoo.com from his primary configured local DNS Server.
- Local DNS Server (DNS64:Srv_DualSK_RHE6), reached (via recursive query process) the yahoo.com name Server and request AAAA record.
- If the Authoritative have AAAA Record against the domain it will be return, which is true in this false. So, yahoo.com nameserver reply no answer to the query.
- Local DNS Server (DNS64:Srv_DualSK_RHE6), will not pass-over the answer to client, instead it query for A record.
- Authoritative have A Record against the domain. So, yahoo.com nameserver reply with IPv4 address for requested domain.
 - Now DNS64 process triggered and it will synthesized a AAAA out of A reply from Authoritative nameserver, by appended NAT64 Prefix/96 (96 bits) to IPv4 (32 bits), build-up 128bits IPv6 Address
- Then Local DNS Server (DNS64:Srv_DualSK_RHE6) pass-over the synthesized-AAAA answer for yahoo.com to the IPv6 Client in reply to his request.

4.7.3.2.2 Routing to IPv4 Site



7. After getting IP resolved by DNS server, it's time to generate HTTP Request with IPv6 Source and IPv6 Destination. Destination is NAT64 (64:ff9b::/96)Prefix, it not meant be routed to Default gateway by RTR_IP_DualSK_Distribution instead it has a Static route for the NAT64 Prefix [ip6v route 64:FF9B::/96 2404:F400:1::2] point toward IPv6 Address of NAT64 Server. So RTR_IP_DualSK_Distribution route the packet to Srv_DualSK_RHE6.
 - a. NAT64 process running on Srv_DualSK_RHE6, accepted the packet, extract last-32bits, calculate IPv4 Address and forward the With its own IPv4 address , and create a NAT table entry of IPv6 Source, IPv4 Destination and TCP port.
8. Now Packet with IPv4-Source (Address of Srv_DualSK_RHE6) and IPv4-Destination (Address of www.yahoo.com), will reach to RTR_IP_DualSK_Gateway by following IPv4-Default-Route, which handed over to RTR_IPv4_IGw for further routing within IPv4-Could, So the IPv4 HTTP Server get the Packet with normal IPv4 inter-domain routing.



9. HTTP Server will prepare a reply distinct for NAT64 IPv4 address with Source of its IPv4 address. Normal IPv4 Routing mechanism will route the IPv4 packet to NAT64 server.
10. NAT64 process consult NAT entry and prepare repair IPv6 header for HTTP reply for IPv4 Server and Route it on IPv6 intranet to each IPv6-Only Client.