ARQUITETURA DE REDES AVANÇADAS

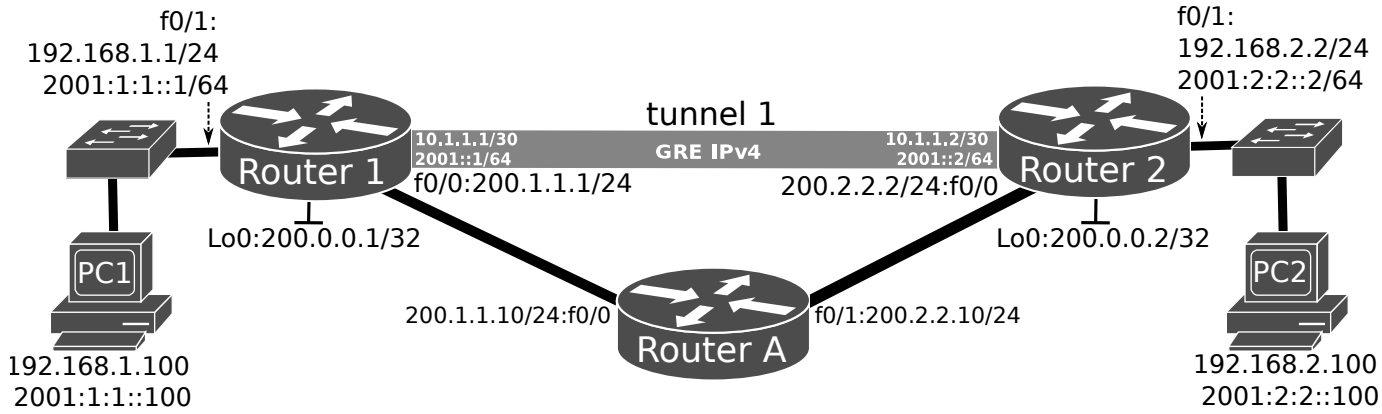
LABORATORY GUIDE

OVERLAY IP NETWORKS

Objectives

- IP Tunneling (Review)
- Overlay Network Deployment
  Tunnel mesh deployment (point-to-point and multi-point)
  Multiple dynamic routing processes
  NHRP study

GRE IPv4 Tunnel / Overlay Network



With Static Routing

1. Configure the IPv4 and IPv6 addresses and activate OSPF for the underlying IPv4 network (including Loopback interfaces' addresses). To activate OSPF (process 1) in Router 1 for the underlying network:

```
#router ospf 1
#network 200.1.1.0 0.0.0.255 area 0
#network 200.0.0.1 0.0.0.0 area 0
```

OR (by interface, independently of IPv4 networks);

```
#interface FastEthernet0/0
#ip ospf 1 area 0
#interface Loopback0
#ip ospf 1 area 0
```

Perform the equivalent configurations on Routers A and 2. Verify the IPv4 routing tables (`show ip route`).

Configure an GRE IPv4 tunnel (with overlay networks 10.1.1.0/30 and 2001::/64). On Router 1:

```
#interface Tunnel1
#ip address 10.1.1.1 255.255.255.252
#ipv6 address 2001::1/64
#tunnel source Loopback0
#tunnel destination 200.0.0.2
#tunnel mode gre ip
```

Configure also the overlay network routing with IPv4 and IPv6 static routes to the remote private networks (PC networks):

```
#ip route 192.168.2.0 255.255.255.0 Tunnel1
#ipv6 route 2001:2:2::/64 Tunnel1
```

Perform the equivalent configuration on Router2.

Verify the IPv4 and IPv6 routing tables. From PC1 ping PC2 (using IPv4 and IPv6 addresses) while capturing packets on links R1-RA and RA-R2. Analyze the dual IP headers (of overlay and underlying networks, respectively.

Note: tunnel end points virtual interfaces (VTI) do not require the same ID number, however, good configuration guidelines strongly recommend it.

With Route Maps

2. Replace the IPv4 and IPv6 static routes by Route Maps. On Router 1:

```
#no ip route 192.168.2.0 255.255.255.0 Tunnel1
#no ipv6 route 2001:2:2::/64 Tunnel 1
!
#ipv6 access-list L101
#sequence 20 permit ipv6 2001:1:1::/64 2001:2:2::/64
#access-list 100 permit ip 192.168.1.0 0.0.0.255 192.168.2.0 0.0.0.255
!
#route-map routeT1 permit 10
#match ip address 100
#set ip next-hop 10.1.1.2
#route-map routeT1 permit 20
#match ipv6 address L101
#set ipv6 next-hop 2001::2
!
#interface FastEthernet0/1
#ip policy route-map routeT1
```

Perform the equivalent configuration on Router2.

Verify the IPv4 and IPv6 routing tables (note the absence of routes to the remote private networks). From PC1 ping PC2 (using IPv4 and IPv6 addresses) while capturing packets on links R1-RA and RA-R2.

Analyze the route-map statistics (`show route-map routeT1`).

With Dynamic Routing

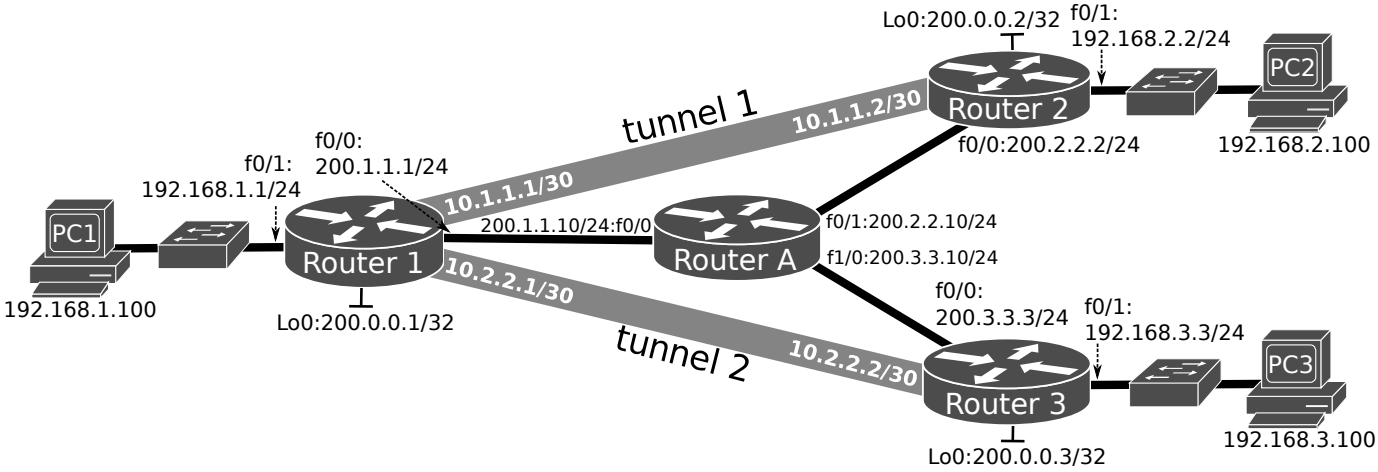
3. Replace the IPv4 and IPv6 Route Maps with Dynamic Routing by activating a second OSPF and OSPFv3 process (process 2) within the overlay network (tunnel network and private networks), on Router 1:

```
#interface FastEthernet0/1
#no ip policy route-map routeT1
!
#interface Tunnel1
#ip ospf 2 area 0
#ipv6 ospf 2 area 0
#interface FastEthernet0/1
#ip ospf 2 area 0
#ipv6 ospf 2 area 0
```

Perform the equivalent configuration on Router2.

Verify the IPv4 and IPv6 routing tables. Analyze the exchanged OSPF and OSPFv3 packets exchanged over the overlay network with dual IP headers (networks 10.1.1.0/30 and fe80::/10). From PC1 ping PC2 (using IPv4 and IPv6 addresses) while capturing packets on links (R1-RA and RA-R2).

Overlay Network with Partial Mesh GRE IPv4 Tunnels



4. Add an new private network (PC3 network) with address 192.168.3.0/24 and Router3 as gateway, and configure an additional tunnel (Tunnel2) between Router1 and Router3 (network 10.2.2.0/30) to create a partial mesh of IPv4 tunnels to extend the overlay network.

Update the overlay network OSPF routing process to include the new overlay link (Tunnel2), on Router1:

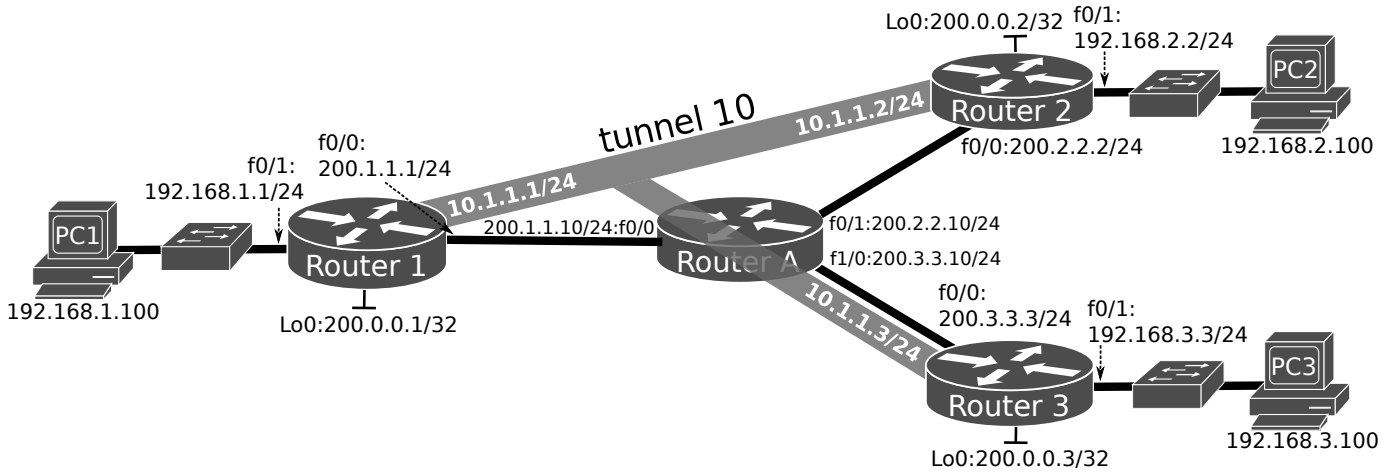
```
#interface Tunnel2
#ip ospf 2 area 0
```

On Router3:

```
#interface Tunnel2
#ip ospf 2 area 0
#interface FastEthernet0/1
#ip ospf 2 area 0
```

Verify the IPv4 routing tables. From PC3 ping PC2 (using IPv4 addresses) while capturing packets on links R1-RA and RA-R2. Analyze the captured packets and explain the duplicated packets. Explain the main disadvantage of having a tunnel partial mesh overlay network.

IPv4-IPv4 Multipoint Tunnel with NHRP and Static Routing



5. Shutdown Tunnel1 and Tunnel2 where configured:

```
#interface Tunnel1
#shutdown
#interface Tunnel2
#shutdown
```

Configure an IPv4-IPV4 Multipoint GRE Tunnel (Tunnel10) with NHRP (network-id 1 and key 1) in a Hub-Spokes architecture where Router1 assumes the hub role. On Router1 (Hub):

```
#interface Tunnel10
#ip address 10.1.1.1 255.255.255.0
#ip nhrp network-id 1
#tunnel source Loopback0
#tunnel mode gre multipoint
#tunnel key 1
```

On Router2 and Router3 (Spokes):

```
#interface Tunnel10
#ip address 10.1.1.2 255.255.255.0      !Router2
       (#ip address 10.1.1.3 255.255.255.0     !Router3)
#ip nhrp network-id 1
#ip nhrp nhs 10.1.1.1
#ip nhrp map 10.1.1.1 200.0.0.1
#tunnel source Loopback0
#tunnel mode gre multipoint
#tunnel key 1
```

Configure static routing:

```
!Router1
#ip route 192.168.2.0 255.255.255.0 10.1.1.2
#ip route 192.168.3.0 255.255.255.0 10.1.1.3
```

Perform the equivalent configuration on Router2 and Router3.

Verify IPv4-IPv4 NHRP mappings with: #`show ip nhrp`

Verify the IPv4 routing tables. From PC3 ping PC2 (using IPv4 addresses) while capturing packets on links R1-RA and RA-R2. Analyze the NHRP packets and explain the absence of duplicated ICMP packets after a few tries. Explain the main advantage of having a multipoint tunnel with NHRP overlay network. Re-verify IPv4-IPv4 NHRP mappings.

IPv4-IPv4 Multipoint Tunnel with NHRP and Dynamic Routing

6. Remove all static routing configurations. As configured on experiments 1 and 3, the underlying network already has an OSPF routing process (process 1) and the private networks interfaces already have an OSPF process active (process 2). Additional commands on Router1 (Hub):

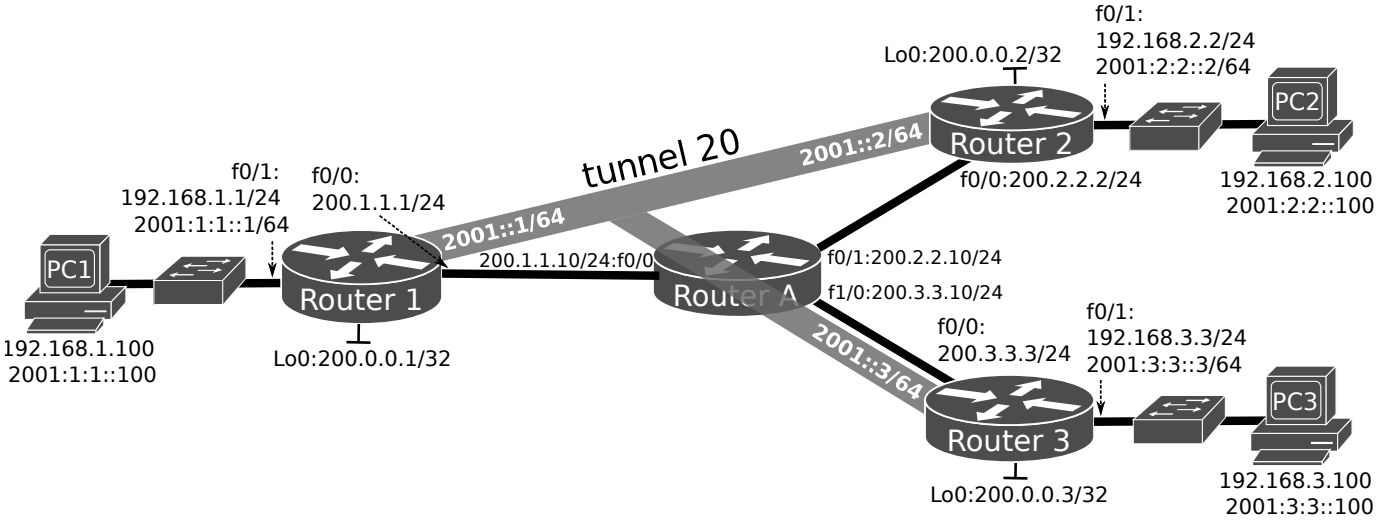
```
#interface Tunnel10
#ip ospf 2 area 0
#ip nhrp map multicast dynamic
#ip ospf network broadcast
#ip ospf priority 2
```

Additional commands on Router2 and Router3 (Spokes):

```
#interface Tunnel10
#ip ospf 2 area 0
#ip nhrp map multicast 200.0.0.1
#ip ospf network broadcast
#ip ospf priority 0
```

Verify the IPv4 routing tables and IPv4-IPv4 NHRP mappings. Re-test the overall connectivity between the private networks. Analyze the NHRP packets. Re-verify IPv4-IPv4 NHRP mappings.

IPv6-IPv4 Multipoint Tunnel with NHRP and Dynamic Routing



As configured on experiments 1 and 3, the underlying network already has an OSPFv3 routing process (process 1) and the private networks interfaces already have an OSPF process active (process 2). Configure a new IPv6-IPV4 Multipoint GRE Tunnel (Tunnel20) with NHRP (network-id 2 and key 2) in a Hub-Spokes architecture where Router1 assumes the hub role. On Router1 (Hub):

```
#interface Tunnel20
#ipv6 address 2001::1/64
#ipv6 nhrp network-id 2
#ipv6 nhrp map multicast dynamic
#tunnel source Loopback0
#tunnel mode gre multipoint
#tunnel key 2
#ipv6 ospf 2 area 0
#ipv6 ospf network broadcast
#ipv6 ospf priority 2
```

On Router2 and Router3 (Spokes):

```
#interface Tunnel20
#ipv6 address 2001::2/64   ! Router 2
       (#ipv6 address 2001::3/64  ! Router 3)
#ipv6 nhrp nhs 2001::1
#ipv6 nhrp map 2001::1/64 200.0.0.1
#ipv6 nhrp map multicast 200.0.0.1
#ipv6 nhrp network-id 2
#tunnel source Loopback0
#tunnel mode gre multipoint
#tunnel key 2
#ipv6 ospf network broadcast
#ipv6 ospf priority 0
#ipv6 ospf 2 area 0
```

Verify IPv6-IPv4 NHRP mappings with:

```
#show ipv6 nhrp
```

Verify the IPv6 routing tables. Re-test the overall connectivity between the private networks. Analyze the NHRP packets. Re-verify IPv6-IPv4 NHRP mappings.