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IPV4 / IPV6
Which Routing Protocol
(Session 13298)

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SHARE in Boston

?????????????????????
Is

Is one protocol better than the others?

Which routing protocol should I use in my network?

Should I switch from the one I’m using?

Do the same selection rules apply to IPv4 and IPv6?

How will my IPv4 and IPv6 routing protocols coexist?

Do You Feel Lucky?

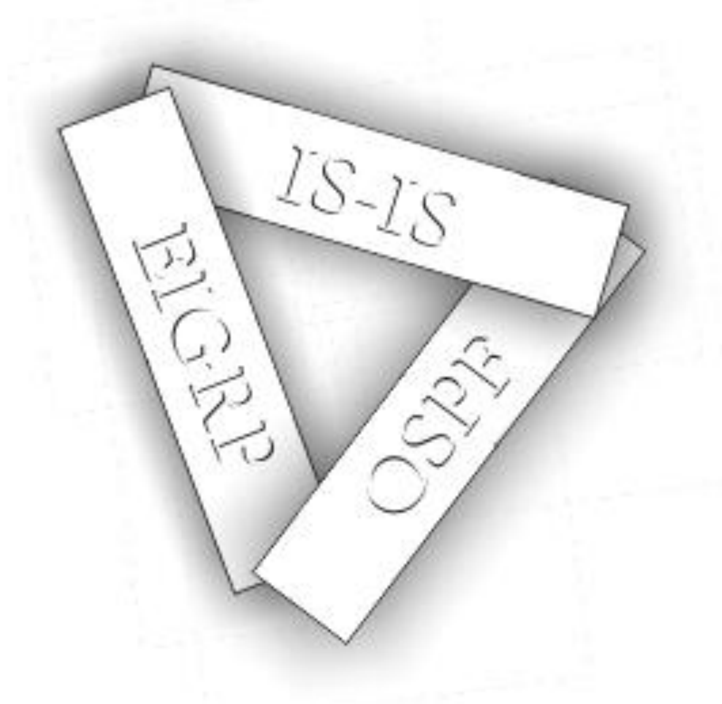
The Questions

- Is one routing protocol better than any other protocol?
- **Define "Better!"**
  - Converges faster?
  - Uses less resources?
  - Easier to troubleshoot?
  - Easier to configure?
  - Scales to a larger number of routers, routes, or neighbors?
  - More flexible?
  - Degrades more gracefully?
  - …

The Questions

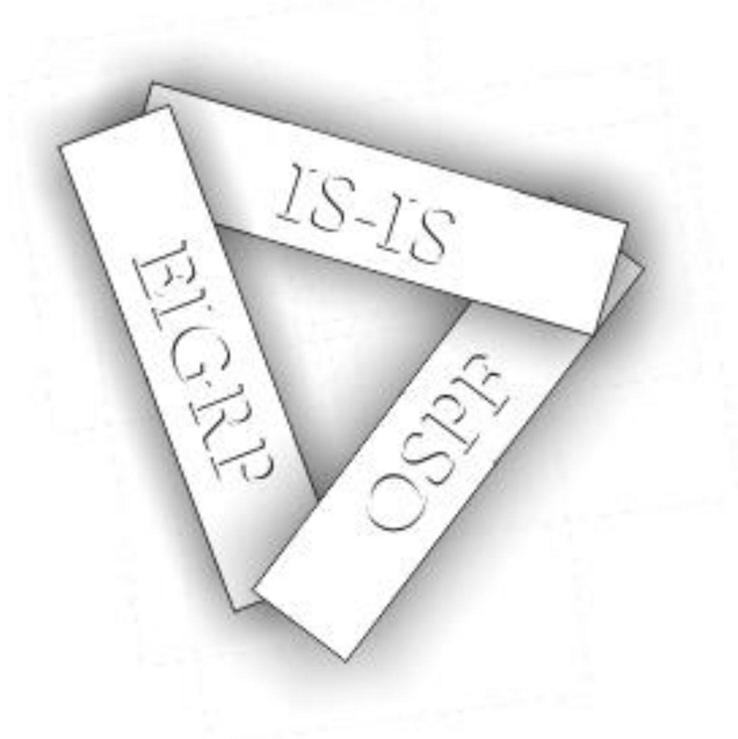
The Answer Is Yes If:

- The network is complex enough to “bring out” a protocol’s specific advantages
- You can define a specific feature (or set of features) that will benefit your network tremendously…



The Questions

- **But, then again, the answer is no! ☺**
- Every protocol has some features and not others, different scaling properties, etc.
- Let's consider some specific topics for each protocol…



Before That…The Twist!

- Most likely the IPv6 IGP will not be deployed in a brand new network and just by itself
- Most likely the existing IPv4 services are more important at first since they are generating most of the revenue
- **Redefine "Better!"**
  - What is the impact on the convergence of IPv4?
  - How are the resources shared between the two protocols?
  - Are the topologies going to be congruent?
  - …

Which Routing Protocol

- IPv4 and IPv6 IGPs
- Convergence
- Design and Topology Considerations
- Protocol Features
- Summary

IPv4 and IPv6 IGPs

“IPv6 Is an Evolutionary Step
“Not” a Revolutionary Step
and this is very clear in the case of routing
which saw minor changes even though most of the
Routing Protocols were completely rebuilt.”

Anonymous

The Mainframe Supported Routing Protocols

RIP	RIPv2 for IPv4 RIPng for IPv6 Distinct but similar protocols with RIPng taking advantage of IPv6 specificities
OSPF	OSPFv2 for IPv4 OSPFv3 for IPv6 > OMPROUTE Support for OSPFv3 - z/OS V1R6 Distinct but similar protocols with OSPFv3 being a cleaner implementation that takes advantage of IPv6 specificities
Static	Default Gateway / Next Hop Routing

- For all intents and purposes, same IPv4 IGP network design concepts apply to the IPv6 IGP network design
- IPv6 IGPs have additional features that could lead to new designs

The Network Supported Routing Protocols

RIP	RIPv2 for IPv4 RIPng for IPv6 Distinct but similar protocols with RIPng taking advantage of IPv6 specificities
OSPF	OSPFv2 for IPv4 OSPFv3 for IPv6 Distinct but similar protocols with OSPFv3 being a cleaner implementation that takes advantage of IPv6 specificities
IS-IS	Extended to support IPv6 Natural fit to some of the IPv6 foundational concepts Support Single and Multi Topology operation
EIGRP	Extended to support IPv6 Some changes reflecting IPv6 characteristics

- For all intents and purposes, same IPv4 IGP network design concepts apply to the IPv6 IGP network design
- IPv6 IGPs have additional features that could lead to new designs

IPv4 and IPv6 Perspective

- The similarities between the IPv4 and IPv6 IGP lead to similar network design considerations as far as routing is concerned.
- The implementation of the IPv6 IGPs achieves parity with the IPv4 counterparts in most aspects but this is an ongoing development and optimization process.
- Coexistence of IPv4 and IPv6 IGPs is a very important design consideration.

Convergence – How does it work ?

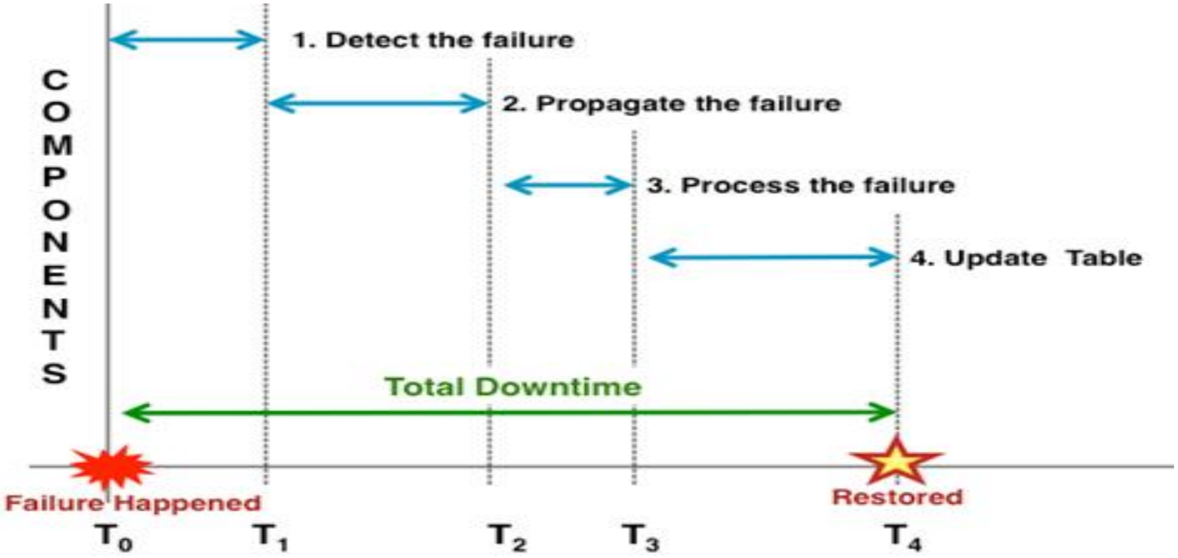
Four steps to convergence:

- Detect the failure
- Propagate the Failure
- Calculate new routes around the topology change
- Add changed routing information to the routing table

- All four steps are similar for any routing protocol.
  - Note: Step 1 is for tuning your speed of convergence by how fast you detect network reachable issues.

- **But, it's important to keep the others in mind, since they often impact convergence more than the routing protocol does**

Steps to convergence:



Downtime Analysis

Total Downtime will be determined the following components;

Detect the failure (Loss of signal, keep alive, and etc.)

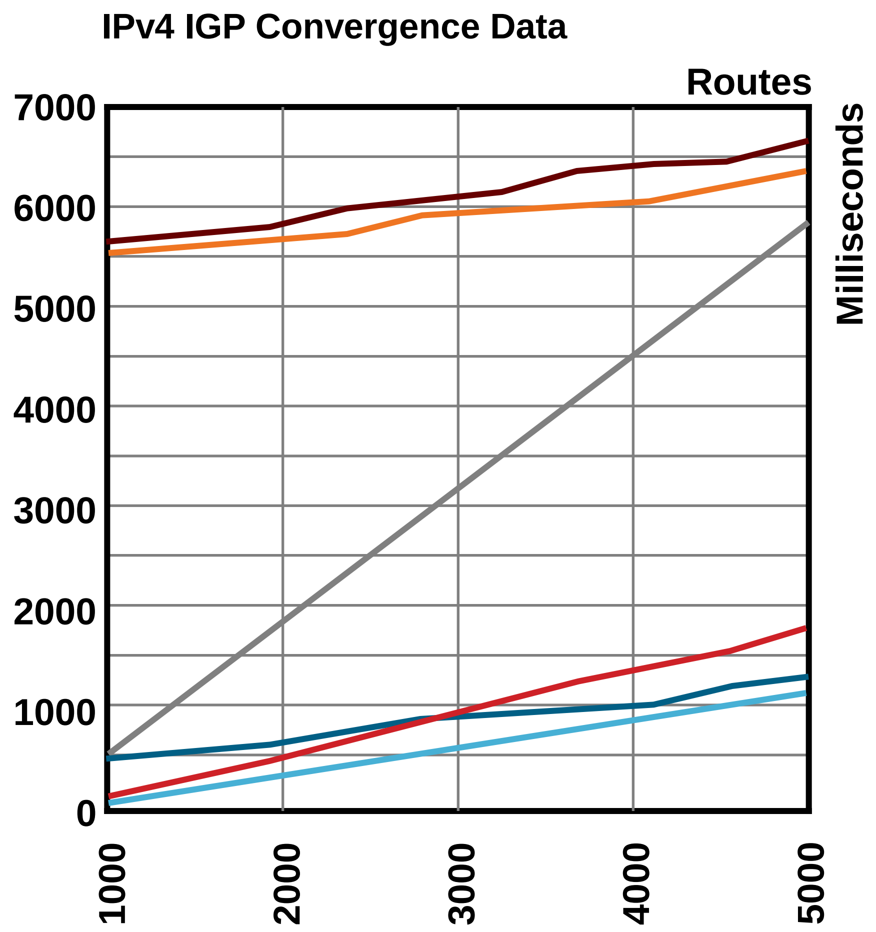
Propagate the failure (Routing protocol, CAPWAP, STP, and etc.)

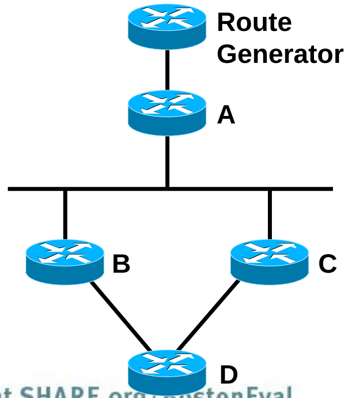
Process the failure (Calculate SPF, Node switch-over, and etc.)

+ Update the Routing/Forwarding Tables, re-establish new sessions = Total Downtime (End-to-End Convergence)

Convergence Summary

- IS-IS with default timers
- OSPF with default timers
- EIGRP without feasible successors
- OSPF with tuned timers
- IS-IS with tuned timers
- EIGRP with feasible successors





Design and Topology Considerations

Topology Summary

- Rules of Thumb
  - EIGRP performs better in large scale hub and spoke environments
  - Link state protocols (OSPF, ISIS) perform better in full mesh environments, **if tuned correctly**
  - EIGRP tends to perform better in more strongly hierarchical network models, link state protocols in flatter networks

  - Note: With IPv6 a great deal of emphasis is placed on hierarchical addressing schemes. EIGRP thus becomes very well suited to support such designs

The Coexistence Twist

OSPFv2-v3 RIP2-RIPNG EIGRP –EIGRP v6	Single Process/Topo ISIS
• Clear separation of the two control planes • Non-congruent topologies are very common if not desired in deployments	• Requires less resources • Might provide a more deterministic co-existence of IPv4 and IPv6

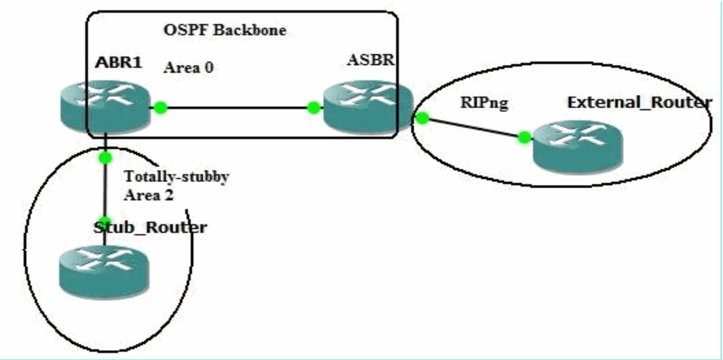
* Today most IPv6 IGPs are distinct from their IPv4 counterparts and will run as ships in the night. The only exception is ISIS.

Protocol Management

	Debugs	Event Log	Neighbor Logging	SNMP
OSPF	Neighbor and Protocol Events	Yes, but Not Easy to Read	Yes	Rfc1253
IS-IS	Neighbor and Protocol Events	No	No	No
EIGRP	Neighbor and Protocol Events	Yes, Moderately Difficult to Read	Yes	Yes

IPv6 Routing Protocol Configuration Examples from a Network Routers Perspective

OSPFv3 IPv6



STUB ROUTER

```
ipv6 unicast-routing
ipv6 cef
! interface serial 0/0
   no ip address
   ipv6 enable
   ipv6 address 2001:ABAB::/64 eui-64
   ipv6 ospf 1 area 2
! ipv6 router ospf 1
  router-id 3.3.3.3
  area 2 stub
!
```

External Router

```
ipv6 unicast-routing
ipv6 cef
!
interface Loopback0
 no ip address
 ipv6 address 2004:ABAB::/64 eui-64
 ipv6 enable
 ipv6 rip EXT enable
!
interface Serial0/0
 no ip address
 ipv6 address 2003::1:2/124
 ipv6 enable
 ipv6 rip EXT enable
!
ipv6 router rip EXT
```

ASBR Router

```
ipv6 unicast-routing
ipv6 cef
!
interface FastEthernet0/0
 no ip address
 ipv6 address 2003::2/124
 ipv6 enable
 ipv6 ospf 1 area 0
!
interface Serial0/0
 no ip address
 ipv6 address 2003::1:1/124
 ipv6 enable
 ipv6 rip EXT enable
!
ipv6 router ospf 1
 router-id 2.2.2.2
 default-metric 25
 redistribute rip EXT metric-type 1 include-connected
!
ipv6 router rip EXT
 redistribute ospf 1 match internal external 1 external 2
include-connected
!
```

ABR1 Router

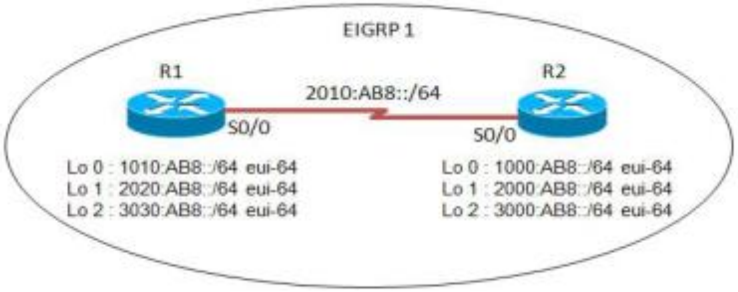
```
ipv6 unicast-routing
ipv6 cef
!
interface FastEthernet0/0
 no ip address
 speed auto
 ipv6 address 2003::1/124
 ipv6 enable
 ipv6 ospf 1 area 0
!
interface Serial0/0
 no ip address
 ipv6 address 2002:ABAB::/64 eui-64
 ipv6 enable
 ipv6 ospf 1 area 2
!
ipv6 router ospf 1
 router-id 1.1.1.1
 area 2 stub no-summary
!
```

EIGRP IPv6

```
hostname R1
!
ipv6 unicast-routing
!
interface Loopback0
 no ip address
 ipv6 address 1010:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Loopback1
 no ip address
 ipv6 address 2020:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Loopback2
 no ip address
 ipv6 address 3030:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Serial0/0
 no ip address
 ipv6 address FE80::1 link-local
 ipv6 address 2010:AB8::1/64
 ipv6 enable
 ipv6 eigrp 1
 clock rate 2000000
!
ipv6 router eigrp 1
 router-id 2.2.2.2
 no shutdown
!
end
```

Network Diagram

This example uses this network setup:



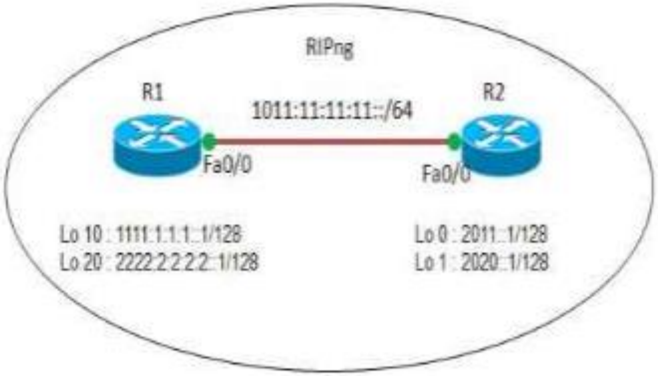

```
hostname R2
!
ipv6 unicast-routing
!
interface Loopback0
 no ip address
 ipv6 address 1000:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Loopback1
 no ip address
 ipv6 address 2000:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Loopback2
 no ip address
 ipv6 address 3000:AB8::/64 eui-64
 ipv6 enable
 ipv6 eigrp 1
!
interface Serial0/0
 no ip address
 ipv6 address FE80::2 link-local
 ipv6 address 2010:AB8::2/64
 ipv6 enable
 ipv6 eigrp 1
 clock rate 2000000
!
ipv6 router eigrp 1
 router-id 1.1.1.1
 no shutdown
!
end
```

IPv6 EIGRP and IPV4 EIGRP are very similar in concept except for the following differences:
IPv6 is configured on interface basis and networks are advertised based on interface command.
When configured on interface, IPv6 EIGRP is initially placed in “shutdown” state.
As with OSPFv3, IPv6 EIGRP require a router-id in IPv4 format.
Passive interfaces can only be configured in the routing process mode.
Need for extra memory resources and supported in IOS 12.4(6)T and later.

RIPNG IPv6

hostname R1
!
ip cef
!
ipv6 unicast-routing
-- enables forwarding of IPv6 packets
!
interface Loopback10
no ip address
ipv6 address 1111:1:1:1::1/128
ipv6 rip RIPng1 enable
-- enables IPv6 RIP routing process (in our case RIPng1) on the interface lo 10.
!
interface Loopback20
no ip address
ipv6 address 2222:2:2:2:2::1/128
ipv6 rip RIPng1 enable
!
interface FastEthernet0/0
no ip address
duplex auto
speed auto
ipv6 address 1011:11:11:11::1/64
ipv6 rip RIPng1 enable
!
ipv6 router rip RIPng1
-- Configures the IPv6 RIP routing process on the router
!
!
end

Topology Diagram



hostname R2
!
ip cef
!
ipv6 unicast-routing
!
interface Loopback0
no ip address
ipv6 address 2011::1/128
ipv6 rip RIPng1 enable
!
interface Loopback1
no ip address
ipv6 address 2020::1/128
ipv6 rip RIPng1 enable
!
interface FastEthernet0/0
no ip address
duplex auto
speed auto
ipv6 address 1011:11:11:11::2/64
ipv6 rip RIPng1 enable
!
ipv6 router rip RIPng1
!
end

ISIS IPv6

```
interface Loopback0
 description LOOP0
 ip address 198.108.10.37 255.255.255.255
 ipv6 address 2607:F018:0:20::1E/128
 ipv6 enable
ipv6 router isis 1000
 isis network point-to-point
!
interface Vlan2279
 description abcde
 ip address 198.108.11.81 255.255.255.254
 ipv6 address 2607:F018:0:FFD4::3/127
 ipv6 enable
 ipv6 router isis 1000
 isis network point-to-point
!
interface Vlan2280
 description fghij
 ip address 198.108.11.83 255.255.255.254
 ipv6 address 2607:F018:0:FFD5::3/127
 ipv6 enable
 ipv6 router isis 1000
 isis network point-to-point
!
router isis 1000
 net 49.0001.1981.0801.0037.00
 passive-interface default
 no passive-interface Vlan2279
 no passive-interface Vlan2280
 !
 address-family ipv6
  multi-topology
  redistribute static
 exit-address-family
!
ip forward-protocol nd
!
end
```

BGP IPv6

```
interface Loopback0
description O-LOOP
 ip address 192.12.80.2 255.255.255.255
 no ip redirects
 ip flow ingress
 ipv6 address 2607:F018:FFFF::2/128
!
interface TenGigabitEthernet1/1
 description L3
 ip address 192.12.80.13 255.255.255.254
 ip flow ingress
 ip pim sparse-mode
 ipv6 address 2607:F018:FFFF:D::2/126
!
router bgp 36375
 neighbor 2607:F018:FFFF::1 remote-as 36375
 neighbor 2607:F018:FFFF::3 remote-as 36375
 !
 address-family ipv6
  neighbor 2607:F018:FFFF::1 activate
  neighbor 2607:F018:FFFF::3 activate
  network 2607:F018::/32
 exit-address-family
!
end
```

Dual Stack

ISIS v6

```
interface Vlan2378
description To-Cool –for-school
ip address 198.108.11.185 255.255.255.0
ip pim sparse-mode
ipv6 address 2607:F018:0:FF91::3/127
ipv6 enable
ipv6 router isis 1000
isis network point-to-point
!
interface Vlan2379
description To-Cool1
ip address 198.108.12.187 255.255.255.0
ip pim sparse-mode
ipv6 address 2607:F018:0:FFAD::3/127
ipv6 enable
ipv6 router isis 1000
isis network point-to-point
!
router isis 1000
net 49.0001.1981.0801.0043.00
log-adjacency-changes
passive-interface default
no passive-interface Vlan2378
no passive-interface Vlan2379
!
address-family ipv6
multi-topology
redistribute static
exit-address-family
!
ip forward-protocol nd
```

OSPF v2

```
interface Vlan2378
description To-Cool –for-school
ip address 198.108.11.185 255.255.255.0
ip pim sparse-mode
ipv6 address 2607:F018:0:FF91::3/127
ipv6 enable
ipv6 router isis 1000
isis network point-to-point
!
interface Vlan2379
description To-Cool1
ip address 198.108.12.187 255.255.255.0
ip pim sparse-mode
ipv6 address 2607:F018:0:FFAD::3/127
ipv6 enable
ipv6 router isis 1000
isis network point-to-point
!
router ospf 211
log-adjacency-changes detail
area 0.0.0.3 nssa no-summary
passive-interface default
no passive-interface Vlan2378
no passive-interface Vlan2379
network 198.108.0.0 255.255.0.0 area 0.0.0.3
!
```

Summary

Is one protocol better than the others?

Which routing protocol should I use in my network?

Should I switch from the one I’m using?

Do the same selection rules apply to IPv4 and IPv6?

How will my IPv4 and IPv6 routing protocols coexist?

Did we answer this question???

Summary

- There is no “right” answer!
- Consider:
  - Your business requirements
  - Your network design
  - The coexistence between IPv4 and IPv6
  - Intangibles
- The three advanced IGP’s are generally pretty close in capabilities, development, and other factors

Expertise (Intangible)

- What is your team comfortable with?
- What “escalation resources” and other support avenues are available?
- But remember, this isn’t a popularity contest—you don’t buy your car based on the number of a given model sold, do you?
- An alternate way to look at it: what protocol would you like to learn? ☺

Q and A

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