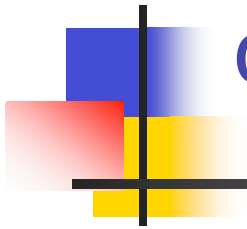


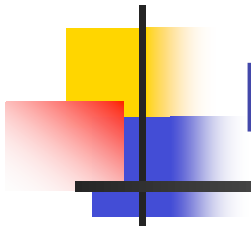
# IPv6 Routing Protocols: What has changed?

Philip Smith

MENOG 2

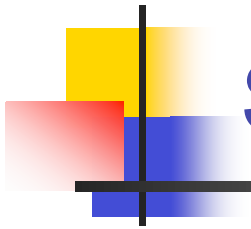
19-21 November 2007

Doha, Qatar



# Routing Protocols

- Static Routing
  - Specific & Defaults
- Dynamic Routing
  - RIP
  - EIGRP
  - OSPF
  - ISIS
  - BGP



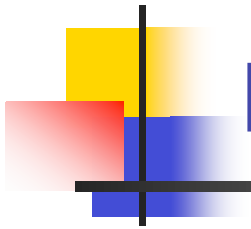
# Static & Default Routing

- Static Routing is unchanged from IPv4
  - Still specify source network and destination address
  - Still specify static routing protocol distance

```
ipv6 route <source> <destination> <distance>
```

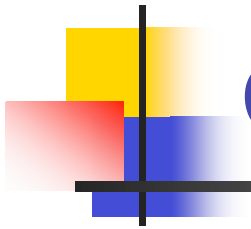
- Default Routing is unchanged from IPv4

```
ipv6 route ::/0 <destination> <distance>
```



# Dynamic Routing Protocols in IPv6

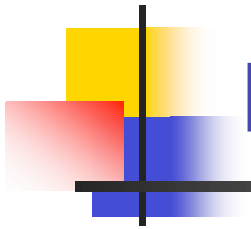
- Dynamic Routing in IPv6 is unchanged from IPv4:
  - IPv6 has 2 types of routing protocols: IGP and EGP
  - IPv6 still uses the longest-prefix match routing algorithm
- IGP
  - RIPng (RFC 2080)
  - Cisco EIGRP for IPv6
  - OSPFv3 (RFC 2740)
  - Integrated IS-ISv6 (draft-ietf-isis-ipv6-06)
- EGP
  - MP-BGP4 (RFC 4760 and RFC 2545)



# Configuring Routing Protocols

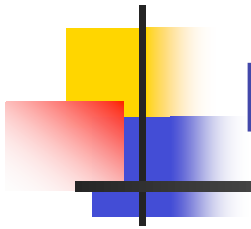
- Dynamic routing protocols require router-id
  - Router-id is a 32 bit integer
  - IOS auto-generates these from loopback interface address if configured, else highest IPv4 address on the router
  - **Most ISPs will deploy IPv6 dual stack** – so router-id will be automatically created
- Early adopters choosing to deploy IPv6 in the total absence of any IPv4 addressing need to be aware:
  - Router-id needs to be manually configured:

```
ipv6 router ospf 100
 router-id 10.1.1.4
```



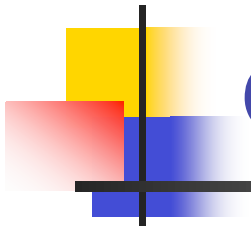
# RIPng

- For the ISP industry, simply don't go here
- ISPs do not use RIP in any form unless there is absolutely no alternative
  - And there usually is
- RIPng was used in the early days of the IPv6 test network
  - Sensible routing protocols such as OSPF and BGP rapidly replaced RIPng when they became available



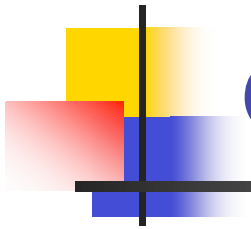
# EIGRP for IPv6

- Cisco EIGRP has had IPv6 protocol support added
  - Just another protocol module (IP, IPX, AppleTalk) with three new TLVs:
    - IPv6_REQUEST_TYPE (0X0401)
    - IPv6_METRIC_TYPE (0X0402)
    - IPv6_EXTERIOR_TYPE (0X0403)
  - Router-ID is still 32-bit, protocol is still 88
- Uses similar CLI to existing IPv4 protocol support
- Easy deployment path for existing IPv4 EIGRP users



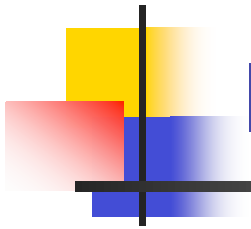
# OSPFv3 overview

- OSPF for IPv6
- Based on OSPFv2, with enhancements
- Distributes IPv6 prefixes
- Runs directly over IPv6
- Ships-in-the-night with OSPFv2
  - **NO** interaction with OSPFv2



# OSPFv3 main differences

- Runs on a link instead of per IP subnet
- Support of multiple instances per link
- Explicit handling of unknown LSA
- Authentication has been removed
- Packet format has been changed
- Two new LSAs have been introduced

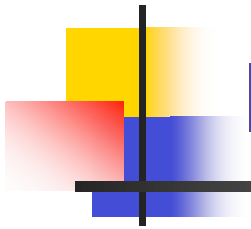


# IS-IS Standards History

- ISO 10589 specifies OSI IS-IS routing protocol for CLNS traffic
  - Tag/Length/Value (TLV) options to enhance the protocol
  - A Link State protocol with a 2 level hierarchical architecture.
- RFC 1195 added IP support
  - I/IS-IS runs on top of the Data Link Layer
  - Requires CLNP to be configured
- Internet Draft defines how to add IPv6 address family support to IS-IS

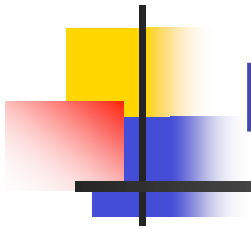
  www.ietf.org/internet-drafts/draft-ietf-isis-ipv6-06.txt
- Internet Draft introduces Multi-Topology concept for IS-IS

  www.ietf.org/internet-drafts/draft-ietf-isis-wg-multi-topology-11.txt



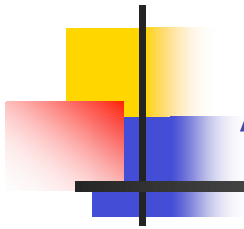
# IS-IS for IPv6

- 2 Tag/Length/Values added to introduce IPv6 routing
- IPv6 Reachability TLV (0xEC)
  - External bit
  - Equivalent to IP Internal/External Reachability TLV's
- IPv6 Interface Address TLV (0xE8)
  - For Hello PDUs, must contain the Link-Local address
  - For LSP, must only contain the non-Link Local address
- IPv6 NLPID (0x8E) is advertised by IPv6 enabled routers



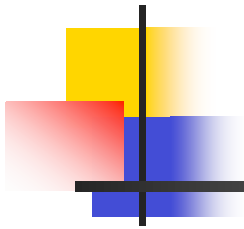
# Multi-Topology IS-IS extensions

- IS-IS for IPv6 assumes that the IPv6 topology is the same as the IPv4 topology
  - Single SPF running, multiple address families
  - Some networks may be like this, but many others are not
- Multi-Topology IS-IS solves this problem
  - New TLV attributes introduced
  - New Multi-Topology ID #2 for IPv6 Routing Topology
  - Two topologies now maintained:
    - ISO/IPv4 Routing Topology (MT ID #0)
    - IPv6 Routing Topology (MT ID #2)



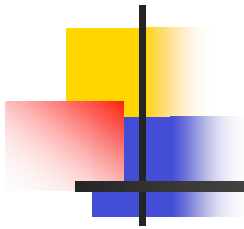
# Adding IPv6 to BGP…

- RFC4760
  - Defines Multi-protocol Extensions for BGP4
  - Enables BGP to carry routing information of protocols other than IPv4
    - e.g. MPLS, IPv6, Multicast etc
  - Exchange of multiprotocol NLRI must be negotiated at session startup
- RFC2545
  - Use of BGP Multiprotocol Extensions for IPv6 Inter-Domain Routing



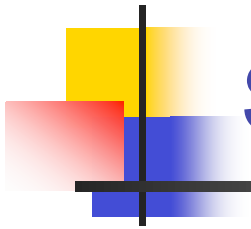
# RFC4760

- New optional and non-transitive BGP attributes:
  - MP_REACH_ NLRI (Attribute code: 14)
    - Carry the set of reachable destinations together with the next-hop information to be used for forwarding to these destinations (RFC4760)
  - MP_UNREACH_NLRI (Attribute code: 15)
    - Carry the set of unreachable destinations
- Attribute contains one or more Triples:
  - AFI Address Family Information
  - Next-Hop Information (must be of the same address family)
  - NLRI Network Layer Reachability Information



# RFC2545

- IPv6 specific extensions
  - Scoped addresses: Next-hop contains a global IPv6 address and/or potentially a link-local address
  - NEXT_HOP and NLRI are expressed as IPv6 addresses and prefix
  - Address Family Information (AFI) = 2 (IPv6)
    - Sub-AFI = 1 (NLRI is used for unicast)
    - Sub-AFI = 2 (NLRI is used for multicast RPF check)
    - Sub-AFI = 3 (NLRI is used for both unicast and multicast RPF check)
    - Sub-AFI = 4 (label)



# Summary

- Routing Protocols in IPv6 behave as they do in IPv4
  - “96 more bits, no magic”
- Configuration concepts are very similar
- CLI is generally very similar
- Most organisations will deploy IPv6 dual stack with IPv4
  - Simple case of adding IPv6 functionality to existing network