

Dynamic Routing



Scalable Infrastructure
Workshop, AfNOG2008

Static and Dynamic Routing

- ❑ Static Routing is a simplistic approach
- ❑ Shortcomings
 - Cumbersome to configure
 - Cannot adapt to addition of new links or nodes
 - Cannot adapt to link or node failures
 - Cannot easily handle multiple paths to a destination
 - Does not scale to large networks
- ❑ Solution is to use Dynamic Routing

Desirable Characteristics of Dynamic Routing

- Automatically detect and adapt to topology changes
- Provide optimal routing
- Scalability
- Robustness
- Simplicity
- Rapid convergence
- Some control of routing choices
 - E.g. which links we prefer to use

Convergence – why do I care?

- ❑ Convergence is when all the routers have the same routing information
- ❑ When a network is not converged there is network downtime
 - Packets don't get to where they are supposed to go
 - ❑ Black holes (packets "disappear")
 - ❑ Routing Loops (packets go back and fore between the same devices)
 - Occurs when there is a change in status of router or the links

Interior Gateway Protocols

- Four well known IGPs today
 - RIP
 - EIGRP
 - ISIS
 - OSPF

RIP

- Stands for “Routing Information Protocol”
 - Some call it “Rest In Peace” 😊
- Lots of scaling problems
- RIPv1 is classfull, and officially obsolete
- RIPv2 is classless
 - has improvements over RIPv1
 - is not widely used in the Internet industry
 - Only use is at the internet edge, between dial aggregation devices which can only speak RIPv2 and the next layer of the network

Why not use RIP?

- ❑ RIP is a Distance Vector Algorithm
 - Listen to neighbouring routes
 - Install all routes in routing table
 - ❑ Lowest hop count wins
 - Advertise all routes in table
 - ❑ Very simple, very stupid
- ❑ Only metric is hop count
- ❑ Network is max 16 hops (not large enough)
- ❑ Slow convergence (routing loops)
- ❑ Poor robustness

EIGRP

- ❑ “Enhanced Interior Gateway Routing Protocol”
- ❑ Predecessor was IGRP which was classfull
 - IGRP developed by Cisco in mid 1980s to overcome scalability problems with RIP
- ❑ Cisco proprietary routing protocol
- ❑ Distance Vector Routing Protocol
 - Has very good metric control
- ❑ Widely used in many enterprise networks and in some ISP networks
 - Multi-protocol (supports more than IP)
 - Exhibits good scalability and rapid convergence
 - Supports unequal cost load balancing

IS-IS

- “Intermediate System to Intermediate System”
- Selected in 1987 by ANSI as OSI intradomain routing protocol (CLNP – connectionless network protocol)
 - Based on work by DEC for DECnet/OSI (DECnet Phase V)
- Extensions for IP developed in 1988
 - NSFnet deployed its IGP based on early ISIS-IP draft

IS-IS (cont)

- Adopted as ISO proposed standard in 1989
 - Integrated ISIS supports IP and CLNP
- Debate between benefits of ISIS and OSPF
 - Several ISPs chose ISIS over OSPF due to superior Cisco implementation
- 1994-date: deployed by several larger ISPs
- Developments continuing in IETF in parallel with OSPF

OSPF

- ❑ Open Shortest Path First
 - “Open” means it is public domain
 - Uses “Shortest Path First” algorithm – sometimes called “the Dijkstra algorithm”
- ❑ IETF Working Group formed in 1988 to design an IGP for IP
- ❑ OSPF v1 published in 1989 – RFC1131
- ❑ OSPF v2 published in 1991 – RFC1247
- ❑ Developments continued through the 90s and today
 - OSPFv3 based on OSPFv2 designed to support IPv6

Why use OSPF?

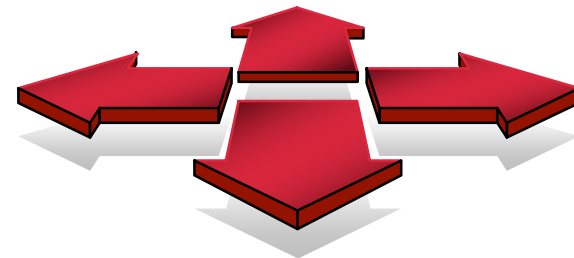
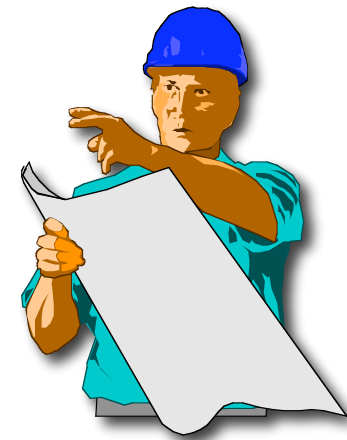
- Dynamic IGP, Link State Protocol
 - IETF standard – RFC2328
 - RFC1812 requires that a router with routing protocols **must** implement OSPF
 - Encourages good network design
 - Areas naturally follow typical ISP network layouts
 - Relatively easy to learn
 - Has fast convergence
 - Scales well

Link State Algorithm

- Each router contains a database containing a map of the whole topology
 - Links
 - Their state (including cost)
- All routers have the same information
- All routers calculate the best path to every destination
- Any link state changes are flooded across the network
 - “Global spread of local knowledge”

Routing versus Forwarding

- Routing = building maps and giving directions
- Forwarding = moving packets between interfaces according to the “directions”



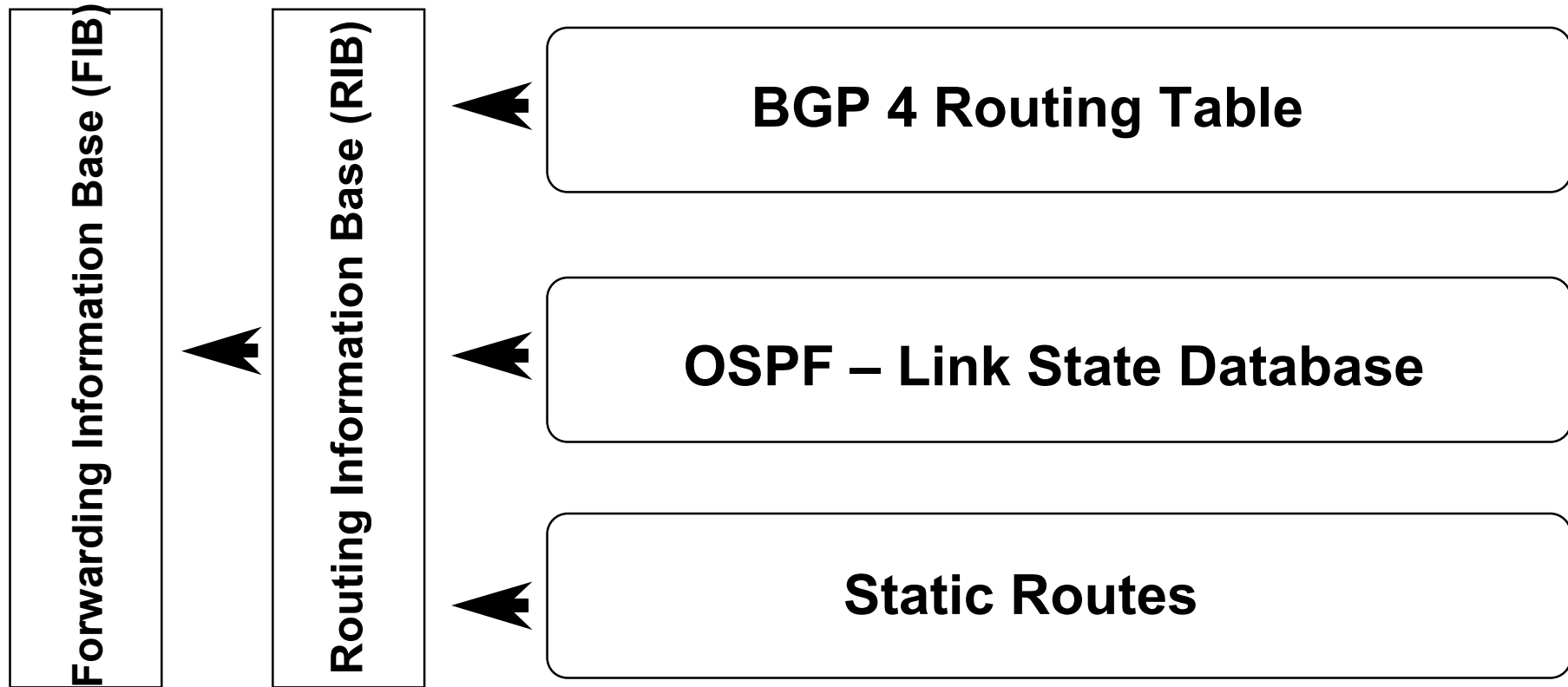
IP Routing – finding the path

- Path is derived from information received from the routing protocol
- Several alternative paths may exist
 - best next hop stored in **forwarding** table
- Decisions are updated periodically or as topology changes (event driven)
- Decisions are based on:
 - topology, policies and metrics (hop count, filtering, delay, bandwidth, etc.)

IP Forwarding

- ❑ Router makes decision on which interface a packet is sent to
- ❑ Forwarding table populated by routing process
- ❑ Forwarding decisions:
 - Destination address
 - class of service (fair queuing, precedence, others)
 - local requirements (packet filtering)

Routing Tables Feed the Forwarding Table



Summary

□ Now know:

- Difference between static routes, RIP and OSPF
- Difference between Routing and Forwarding
- A Dynamic Routing Protocol should be used in any ISP network
- Static routes don't scale
- RIP doesn't scale (and is obsolete)