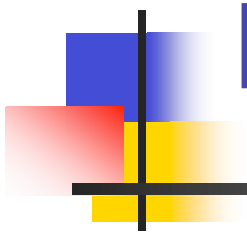
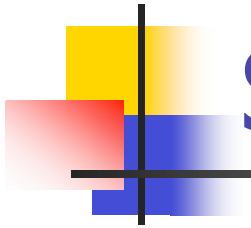


Dynamic Routing

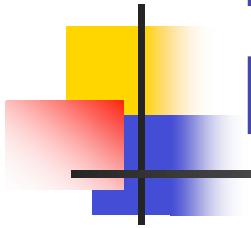
Philip Smith

E2 Workshop, AfNOG2007



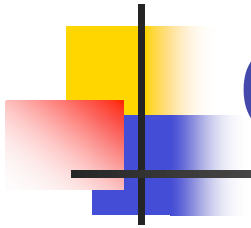
Static and Dynamic Routing

- 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



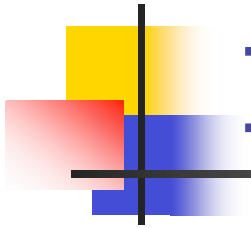
Desirable Characteristics of Dynamic Routing

- 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



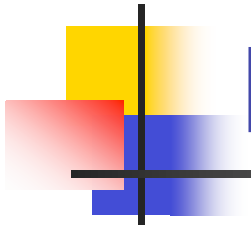
Convergence – why do I care?

- 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



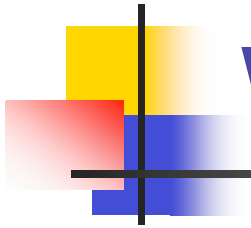
Interior Gateway Protocols

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



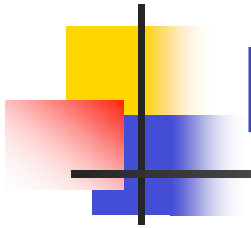
RIP

- 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



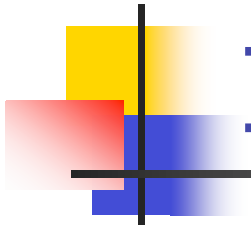
Why not use RIP?

- 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



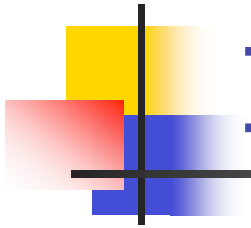
EIGRP

- "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



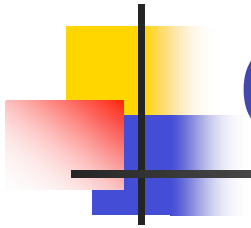
IS-IS

- "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



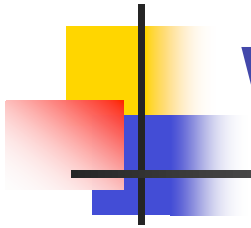
IS-IS (cont)

- 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



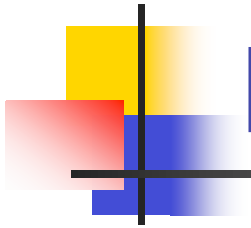
OSPF

- 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 includes extensions 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

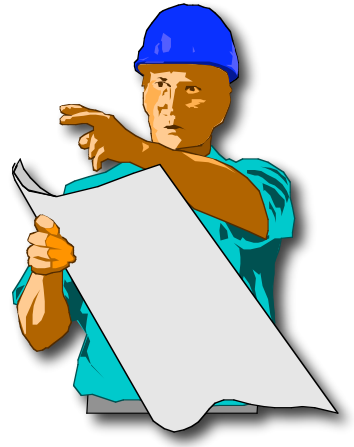


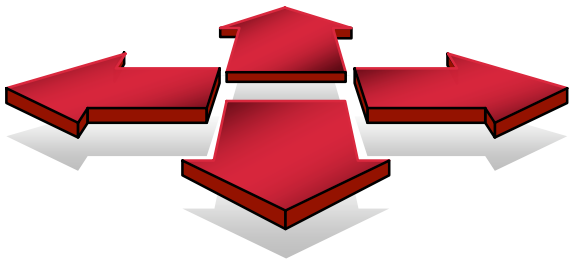
Link State Algorithm

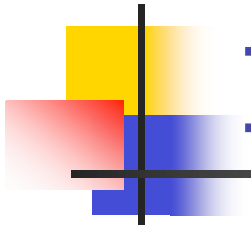
- Each router contains a database containing a map of the whole topology
  - Links
  - Their state (including cost)
- All routers have the same information
- All routers calculate the best path to every destination
- Any link state changes are flooded across the network
  - “Global spread of local knowledge”

Routing versus Forwarding

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

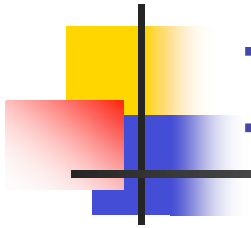






IP Routing – finding the path

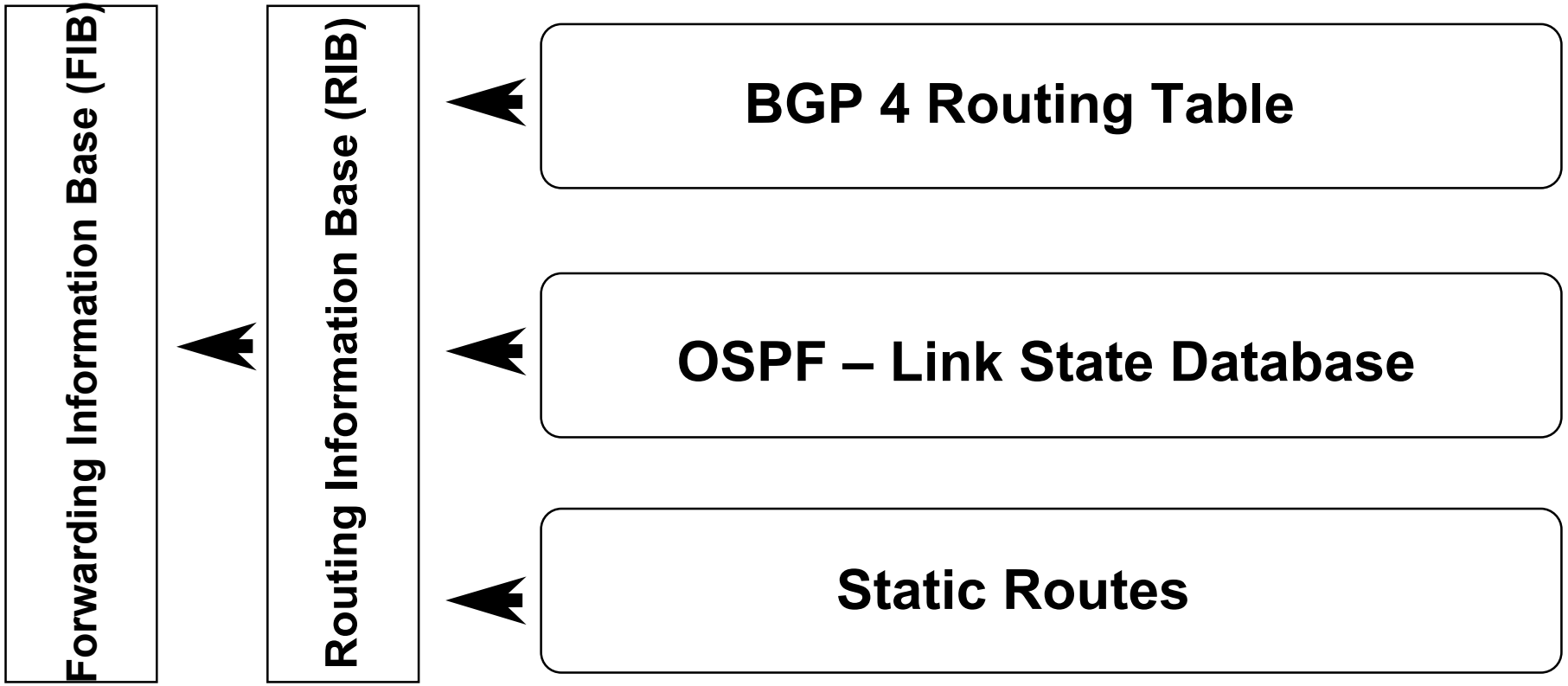
- Path is derived from information received from the routing protocol
- Several alternative paths may exist
  - best next hop stored in forwarding table
- Decisions are updated periodically or as topology changes (event driven)
- Decisions are based on:
  - topology, policies and metrics (hop count,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

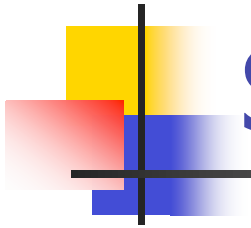


IP Forwarding

- 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)