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http://www.gnu.org/copyleft/fdl.html

Outline

- Why routing protocols are needed?
- Routing in the Internet
- Designing large-scale IP internetworks
- Introduction to routing protocols
- Conclusions

Why are routing protocols needed?

- IP network’s primary function is deliver packets from source to destination
- Routing is needed to know what is the best route from source to destination
- If network topology changes routing function sets up a new route from source to destination

Static vs. dynamic routing

- static routes can be set by network administrators
  - "the hard way"
  - mainly used as a default route
- dynamic routing
  - route discovered and selected by dynamic routing protocol

Address allocations

- Internet Assigned Numbers Authority (IANA) allocates IP addresses and AS-numbers
- ISPs get their IP addresses from upstream provider or from regional registry
  - APNIC (Asian-Pacific Network Information Center)
  - ARIN (American Registry for Internet Numbers)
  - RIPE NCC (RØseaux IP EuropØens)

Routing in The Internet

- Internet is set of autonomous systems (AS)
- autonomous system is collection of routers under same administration
- routing inside of AS is handled by IGP (Interior Gateway Protocol)
- routing between ASes is done by EGP (Exterior Gateway Protocol)

Designing IP internetworks

- network topology
- addressing and route summarization
- route selection
- convergence
- network scalability
- security

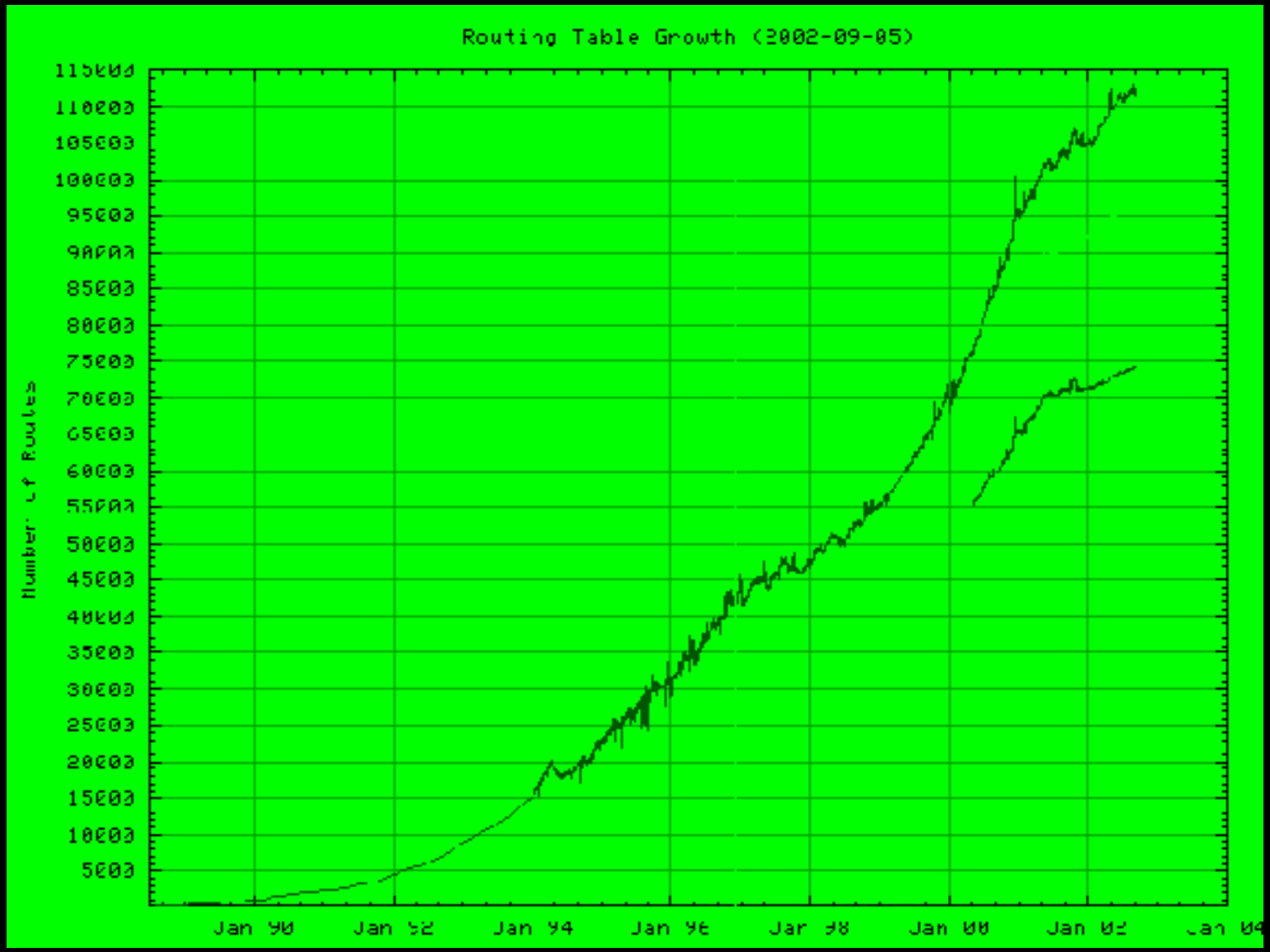
Network Topology

- physical topology
  - set of routers
  - networks which connect them
- logical topology
  - different routing protocols establish logical topology in different way
  - flat topology vs. hierarcical topology

Addressing and route summarization

- summarization reduces routing information for each router
- several routes as a single advertisement
- reduces the load on the router
- very important when network size increases

Summarization Example: The Internet



Metric calculation

- trivial if single path to destination
- computed by assigning a characteristics to each physical link (e.g.)
  - link bandwidth
  - link reliability
  - propagation delay
- some protocols use multiple paths with equal cost for load balancing

Convergence

- when the network topology changes (e.g. link down), routers need to
  - detect the change
  - select a new route
  - inform other routers
- route selection is protocol independent

Network scalability

- when network size increases, some resources are critical
  - memory
  - CPU
  - bandwidth

Security

- authentication prevents unauthorized routers or hosts to participate to routing process
- filters
  - routes to be advertised
  - routes not to advertised

Introduction to routing protocols

- two categories in use
  - distance vector protocol (e.g. RIP)
    - broadcasts complete routing table periodically and when network topology changes
  - link-state procol (e.g. OSPF)
    - send table updates only when change occurs

Distance vector protocols

- each router calculates its routing table
- shortest distance to networks or routers are stored in routing table
- routers sends router table every XX seconds to neighbors
- cannot scale
- cannot resolve loops quickly

Link-state protocol

- each router knows network topology
- if topology changes, it is updated by flooding the change to all routers
- each router re-computes routing table in parallel using link-state database

RIP

- RIP = Routing Information Protocol
- distance vector protocol, IGP
- traditional routing protocol
- first version was shipped with BSD distribution as a routed (1982)
- the best route has lowest hop count (simple metric)

RIP

- max. hop count is 15 (16 is unreachable)
- max. hop count is used to prevent routing loops
- regular route table update causes unnecessary resource use
- RIP is not suitable for low bandwidth or large networks

RIPv2

- enhanced version of RIP
- distance vector protocol, IGP
- almost same as RIP
- supports variable-length subnet masks and very simple authentication

IGRP

- IGRP = Interior Gateway Routing Protocol
- proprietary solution by Cisco Systems in the mid-1980’s
- distance vector protocol
- designed to replace RIP

EIGRP

- enhanced IGRP
- advanced distance vector protocol
- like link-state protocols EIGRP sends updates only on changes
- supports variable-length subnet masks
- route summarization at any bit boundary

OSPF

- OSPF = Open Shortest Path First
- developed by IETF
- link-state protocol
- supports variable-length subnet masks
- as IGP, OSPF is used inside a single autonomous system (AS)

OSPF

- administration of large IP network is simplified by dividing network to areas
- mandatory area is the backbone (area 0)
- backbone area is the transit domain between other areas

OSPF

- area border router (ABR) has typically interface to local area and to backbone area
- ABR summarizes information from the local area to the backbone and information is propagated to other areas

OSPF

- when OSPF starts, it elects two special routers
  - designated router (DR)
  - backup designated router (BDR)
- these routers has following responsibilities
  - determine which routers are connected to network
  - synchronize all routers' link state databases

OSPF

- important things when designing OSPF network
  - sutability and redundancy of backbone
  - definition of area boundaries
  - address assigment
  - the number of routers per area
  - selection of designated router

BGP4

- BGP = Border Gateway Protocol
- path vector protocol
- exchanges network reachability information between BGP systems
- network reachability information includes AS-path topology
- classless routing protocol
- supports route aggregation and supernetting

BGP4

- learns multiple paths via internal and external BGP peers
- selects the best path
- loop detection (important)
- policy based on AS path, community or the network
  - rejects/accepts selected routes
- no load balancing

Conclusion about routing techniques

- recommendation is to
  - use OSPF inside AS (not RIP)
  - use BGP4 between autonomous systems
- OSPF and BGP4 are commonly used and it is possible to use them in multivendor environment
- [E]IGRP is proprietary solution, although perhaps technically superior

More Information

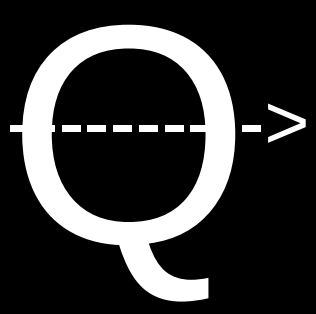
It’s the Internet Age and the problem is now in finding the useful amongst all the information that’s available.

- Now
  - http://www.tldp.org/HOWTO/Net-HOWTO/
  - http://www.bergen.org/ATC/Course/InfoTech/Coolip/
- Tomorrow
  - http://www.ietf.org/html.charters/mobileip-charter.html

Security

Just being connected increases risk --- wireless adds a whole new dimension.

- http://zwitterion.org/link/54559 # Wireless Articles
- http://www.freeswan.org/

- http://www.cert.org/tech_tips/home_networks.html
- http://www.auscert.org.au/render.html?it=1968&cid=1920

Thank-you