

IP ROUTING

Internet Solution

- ▣ Autonomous System (AS)
 - Unit of abstraction in interdomain routing
 - A network with common administrative control
 - Presents a consistent external view of a fully connected network
 - Represented by a 16-bit number
 - ▣ Example: UUnet (701), Sprint (1239), Rutgers (46)
- ▣ Use an external gateway protocol between AS
 - Internet's is currently the Border Gateway Protocol, version 4 (BGP-4)
- ▣ Run local routing protocol within an AS, EGPs between the AS

BGP: Path Vector

- ▣ Link State
 - Too much state
 - Currently 11,000 ASs and > 100,000 networks
 - Relies on global metric & policy
- ▣ Distance vector?
 - May not converge; loops
 - Solution: path vector
 - Reachability protocol, no metrics
- ▣ Route advertisements carry list of ASs
 - E.g. router R can reach 128.95/16 through path: AS73, AS703, AS1

Summary

Link State

- ▣ Topology information is flooded within the routing domain
- ▣ Best end-to-end paths are computed locally at each router.
- ▣ **Best end-to-end paths determine next-hops.**
- ▣ Based on minimizing some notion of distance
- ▣ **Works only if policy is shared and uniform**
- ▣ Examples: OSPF, IS-IS

Vectoring

- ▣ Each router knows little about network topology
- ▣ Only best next-hops are chosen by each router for each destination network.
- ▣ **Best end-to-end paths result from composition of all next-hop choices**
- ▣ Does not require any notion of distance
- ▣ **Does not require uniform policies at all routers**
- ▣ Examples: RIP, BGP

Peering and Transit

- ▣ Peering
 - Two ISPs provide connectivity to each others customers (traditionally for free)
 - Non-transitive relationship
- ▣ Transit
 - One ISP provides connectivity to every place it knows about (usually for money)

Peering

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Transit

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Exchanges and Point of Presence

- Exchange idea:
 - Amortize cost of links between ISPs
- ISP's buy link to 1 location
 - Exchange data/routing at that location
- 1 Big link at exchange point cheaper than N smaller links

Peering and Transit

- ▣ Peering and Transit are points on a continuum
 - ▣ Some places sell “partial transit”
 - ▣ Other places sell “usage-based” peering

Issues are:

- Which routes do you give away and which do you sell?
- To whom? Under what conditions?

Interconnect Economics

From: Market Structure in the Network Age

by Hal Varian

<http://www.sims.berkeley.edu/~hal/Papers/doc/doc.html>