Lecture 19: Border Gateway Protocol (again)

CSE 123: Computer Networks
Aaron Schulman

Some figures courtesy Mike Freedman
In conventional path vector routing, a node has one ranking function, which reflects its routing policy.
Default decision for route selection
- Highest local pref, shortest AS path, lowest MED, prefer eBGP over iBGP, lowest IGP cost, router id

Many policies built on default decision process, but...
- Possible to create arbitrary policies in principle
  - Any criteria: BGP attributes, source address, prime number of bytes in message, …
  - Can have separate policy for inbound routes, installed routes and outbound routes
- Limited only by power of vendor-specific routing language
Example: Local Pref

Higher Local preference values are more preferred.

CSE 123 – Lecture 19: Border Gateway Protocol (again)
Example: Shortest AS Path

Shorter AS Paths are more preferred

AS701
Verizon

128.2/16 9

AS9
CMU (128.2/16)

AS7018
AT&T

128.2/16 9

AS73
Univ of Wash

128.2/16 9 701

128.2/16 9 7018 1239

AS1239
Sprint

128.2/16 9 7018

128.2/16 9
Mr. BGP says that path 4 1 is better than path 3 2 1.
Instability
- Route flapping hurts (prefix goes up, down, up, down)
  - Lots of recalculation!
- Not guaranteed to converge, NP-hard to tell if it does

Scalability still a problem
- >500,000 network prefixes in default-free table today
- Tension: Want to manage traffic to very specific networks (e.g. “multihomed” content providers) but also want to aggregate information so you don’t need info on all specific prefixes.

Performance
- Non-optimal, doesn’t balance load across paths
AS Business Relationships

- Neighboring ASes have business contracts
  - How much traffic to carry
  - Which destinations to reach
  - How much money to pay

- Common business relationships
  - Customers pay providers (95% billing model)
    - E.g., Princeton is a customer of USLEC
    - E.g., MIT is a customer of Lumen
  - Peers don’t pay peers (exchange equal traffic for free)
    - E.g., Verizon is a peer of AT&T
    - E.g., Harvard is a peer of Harvard Business School

- Routing follows the money (allow inexpensive paths)
The telephone world
- LECs (local exchange carriers) (e.g., PacBell, NYNEx)
- IXCs (inter-exchange carriers) (e.g., Sprint, AT&T)

LECs MUST provide IXCs access to customers
- This is enforced by laws and regulation

When a call goes from one phone company to another:
- Call billed to the caller
- The money is split up among the phone systems – this is called “settlement”
Customer/Provider

- Customer needs to be reachable from everyone
  - Provider tells all neighbors how to reach the customer
- Customer does not want to provide transit service
  - Customer does not let its providers route through it to other providers

Traffic to the customer

Traffic from the customer

CSE 123 – Lecture 19: Border Gateway Protocol (again)
Tier-1 Providers

- Make up the “core” of the Internet
  - Has no upstream provider of its own
  - Typically has a national or international backbone
- Top of the Internet hierarchy of ~10-20 ASes
  - E.g., AT&T, Lumen (CenturyLink), NTT/Verio, Verizon, ChinaNet
  - Full peer-peer connections between tier-1 providers
The Internet Hierarchy

A New Internet Model
- Flatter and much more densely interconnected Internet
- Disintermediation between content and "eyeball" networks
- New commercial models between content, consumer and transit

Pay for BW
Pay for access BW
Settlement free

CSE 123 – Lecture 19: Border Gateway Protocol (again)
Multi-Homing

- Customers may have more than one provider
  - Extra reliability, survive single ISP failure
  - Financial leverage through competition
  - Better performance by selecting better path
  - Gaming the 95th-percentile billing model
BGP Summary

- Interdomain-routing
  - Exchange reachability information (plus hints)
  - BGP is based on path vector routing
  - Local policy to decide which path to follow

- Traffic exchange policies are a big issue ($$$)
  - Complicated by lack of compelling economic model (who creates value?)
  - Can have significant impact on performance
For Next Time

- Read P&D 3.5 (Router Implementation)
- Homework 3 due Wed and Project 3 due