Inter-domain routing is often asymmetric
BGP Dynamics

- How many updates are flying around the Internet?
- How long does it take routes to change?

The goals of
(1) fast convergence
(2) minimal updates
(3) path redundancy
are at odds.

Pick any two!!

Hourly Average of Per-Second Updated and Withdrawn Prefix Rate

http://bgpupdates.potaroo.net
Hourly Peak of Per-Second Updated and Withdrawn Prefix Rate

Cumulative Distribution of per-Prefix and per-AS Updates
Q: Why All the Updates?

- The Internet is large, so isn’t there always something going on somewhere? (That is, BGP is just doing a good job of keeping things connected!)
- Is BGP exploring many alternate paths during convergence?
- Are IGP instabilities being exported to the interdomain world?
- Have bad tradeoffs been made in router software implementation?
- Are BGP sessions being reset due to congestion?
- Weird policy interactions like MED oscillation?
- Gnomes, sprites, and fairies
- …

A: NO ONE REALLY KNOWS …
BGP does a very good job hiding information!

Routing Change: Path Exploration

- Initial situation
  - Destination 0 is alive
  - All ASes use direct path
- When destination dies
  - All ASes lose direct path
  - All switch to longer paths
  - Eventually withdrawn
- E.g., AS 2
  - (2,0) → (2,1,0)
  - (2,1,0) → (2,3,0)
  - (2,3,0) → (2,1,3,0)
  - (2,1,3,0) → null
IGP Tie Breaking Can Export Internal Instability to the Whole Wide World

MEDs Can Export Internal Instability
Implementation Does Matter!

Thanks to Abha Ahuja and Craig Labovitz for this plot.

Congestion can take down BGP sessions! The SQL Slammer worm
BEWARE of MED OSCILLATION!

Only AS 2000 sends MEDs to AS 4000

Initial Routing

D prefers AS 2000 path due to router ID tie breaking
B changes its route

The AS 4000 ↔ AS 3000 BGP Session is dropped

A changes its route

The MED 1 route from B beats the MED 2 routes that A sees from its clients.....
C & D change routes

The MED 1 route from A knocks both MED 2 routes out of the picture for C & D ...

A changes route again

A now sees the route from D through AS 3000, and it is closer IGP-wise than the route from B...
C & D go back to initial routes

C & D no longer see MED 1 route from A, so they return to the eBGP routes with MED 2...

Back to state zero!

A switches back to egress C, which is closer.