CMSC417 Spring 2016 Lecture #12 3/21/2016

Agenda!

⇒ grades posted for p2 & midterm
  - midterms handed back Wed

⇒ p3 assigned by tomorrow

⇒ office hours moved a bit this week

⇒ BGP (cont'd)
  - quick review
  - valley-free routing
  - policy examples
  - joining BGP & IGP

⇒ Reliable Transmission
  - sequence #s
  - stop and wait
  - sliding windows

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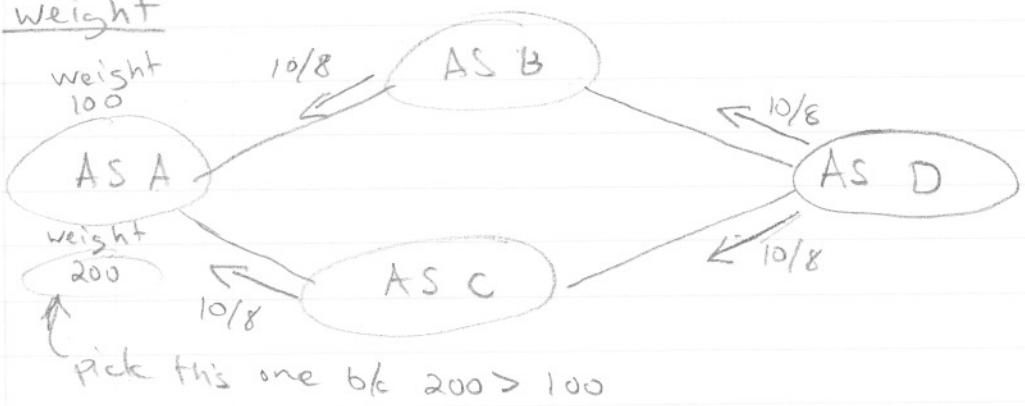
How BGP selects paths

each path has attributes

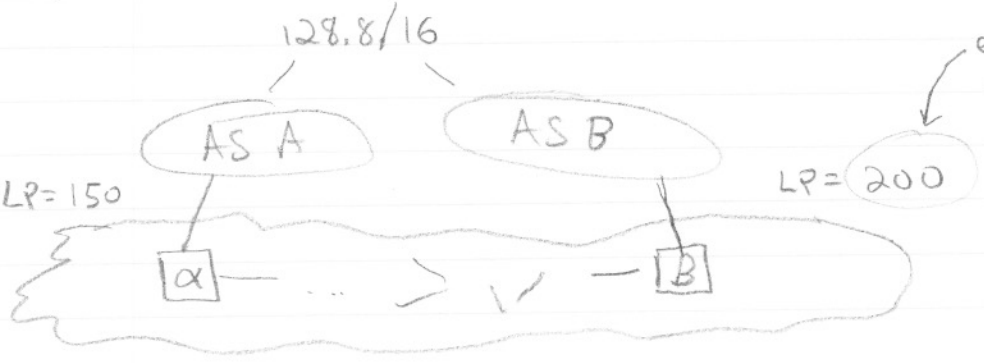
⇒ considered (loosely) in the following order

- weight (local to router, does not propagate)
- local preference / local pref (local to AS, allows you to prefer routes from certain ASes)
- shortest AS path
- route origin (EGP over IGP over incomplete)
- lowest MED (multi-exit discriminator, lets you tell other ASes how you'd prefer they enter you)
- prefer eBGP over iBGP
- lowest IGP metric to BGP nexthop
- address / ID-based tie-breakers

weight



local pref



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Multi-Exit Discriminator (MED)

⇒ let's you tell others to prefer a way to get to you

⇒ e.g., reach me via terrestrial routes instead of a satellite link

shortest AS path

⇒ ASes prepend their AS number to the path when they re-advertise

⇒ ASes can prepend themselves multiple times.
- why would they do this?

route origin

⇒ prefer IGP over EGP over INCOMPLETE

- IGP: generated locally
- EGP: learned from outside
- INCOMPLETE: gotten from some other source

next hop

⇒ needs to be explicity stated b/c the next hop router may not be the BGP speaker

⇒ needs to be reachable using the IGP

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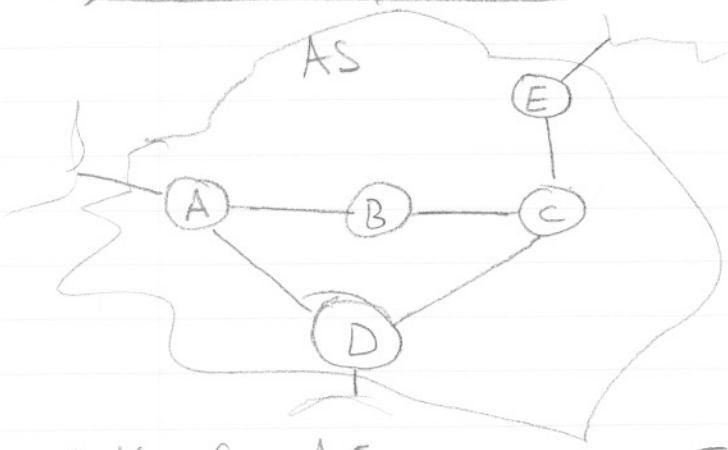
Joining BGP with your IGP



⇒ assume A, D, E are BGP speakers

BGP table for AS

prefix	BGP NH
18.0/16	E
12.0/12	A
128.8/15	D
128.69/16	A

IGP table at B

dst	NH
A	A
C	C
D	C
E	C

⇒ join IGP & BGP to find paths

18.0/16 → C
12.0/12 → A
128.8/15 → C
128.69/16 → A

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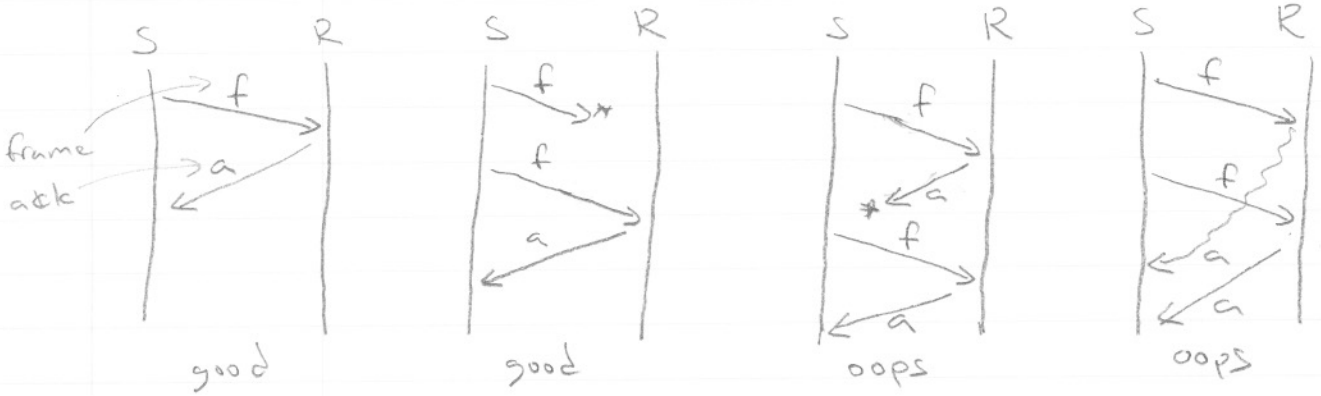
Reliable Transmission

Two approaches
- ⇒ ARQ (Automatic Repeat reQuest)
- ⇒ FEC (Forward Error Correction)

We'll focus on ARQ

Stop & Wait

- ⇒ send a message
- ⇒ wait for an acknowledgement (ack)
- ⇒ resend after a timeout



- ⇒ problem: you can't tell what frame/message an ack was talking about
  - you also might accidentally resend on a lost ack

- ⇒ soln: sequence #s
  - label frames/messages w/ sequence #s
  - increment by 1 on each
  - acks say what seq # they're from
  - rolling over seq #s? how many do you need?

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Stop & Wait)
⇒ only one message/frame in flight at a time
⇒ pipe is not full

e.g., 1.5 Mbps link at 50 ms latency RTT

⇒ assuming 1500 byte frames

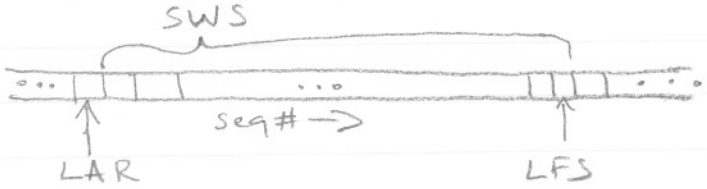
$$\frac{1500 \text{ bytes}}{50 \text{ ms}} \cdot \frac{1000 \text{ ms}}{\text{s}} \cdot \frac{\text{kilobit}}{128 \text{ bytes}} = \sim 235 \text{ Kbps}$$

much less than 1.5 Mbps

bandwidth-delay product matters
latency × BW

sliding windows)
⇒ have a large space of seq #s for frames
⇒ each frame gets the next seq #
⇒ 3 variables at sender
SWS = sender window size in seq #s
LAR = last ack received (a seq #)
LFS = last frame sent (a seq #)

invariant LFS − LAR ≤ SWS



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Sliding Window Sizes

⇒ big
- allows for handling high latency and/or high bw situations

⇒ small
- gentler on the network
- gentler on recievers, esp. resource constrained devices
- if latency is low (or bw is low) it doesn't hurt you

⇒ no universal SWS
- to "fill the pipe" you need

$$SWS \cdot message\_len \geq \underbrace{bandwidth \cdot RTT}_{\text{called bandwidth-delay product}}$$

TCP manages the SWS to meet these needs and a few other things.