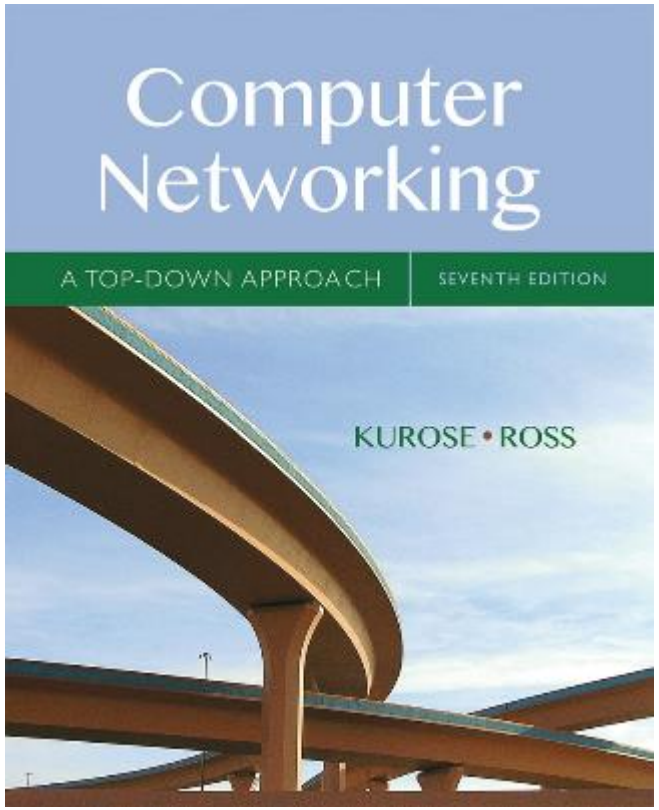
شبکه های کامپیوتری ۲

درس ۷ فصل ۵

BGP Protocol

دانشگاه صنعتی اصفهان
دانشکده مهندسی برق و کامپیوتر

Chapter 5
Network Layer: The Control Plane



Computer Networking: A Top Down Approach

7th edition
Jim Kurose, Keith Ross
Pearson/Addison Wesley
April 2016

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Chapter 5: outline

5.1 introduction

5.2 routing protocols

- link state
- distance vector

5.3 intra-AS routing in the Internet: OSPF

5.4 routing among the ISPs: BGP

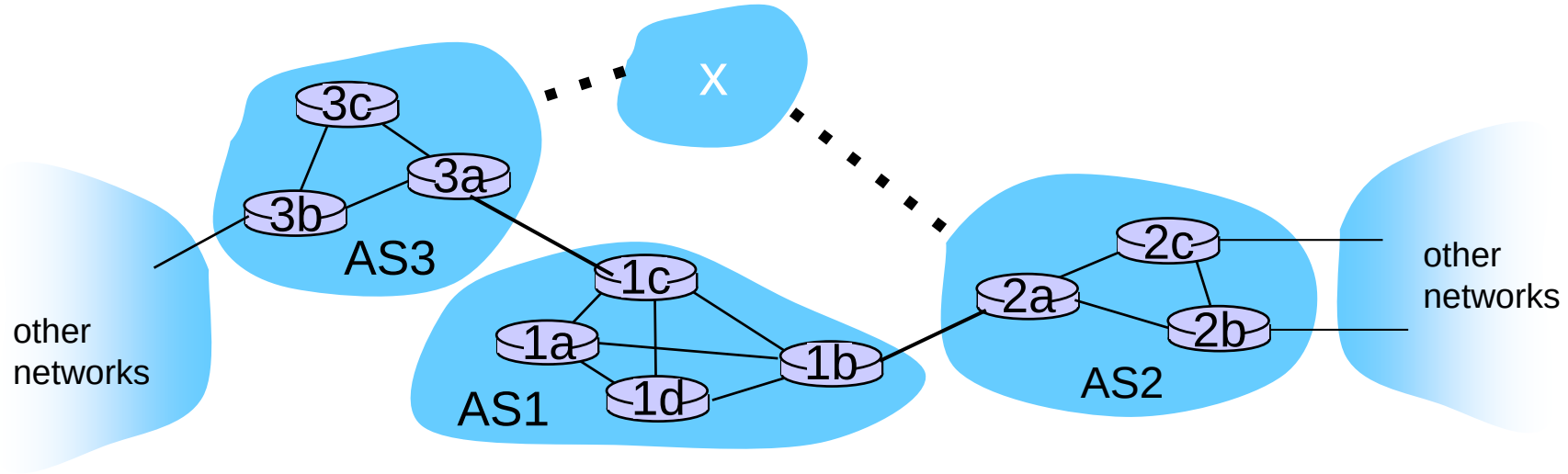
5.5 The SDN control plane

5.6 ICMP: The Internet Control Message Protocol

5.7 Network management and SNMP

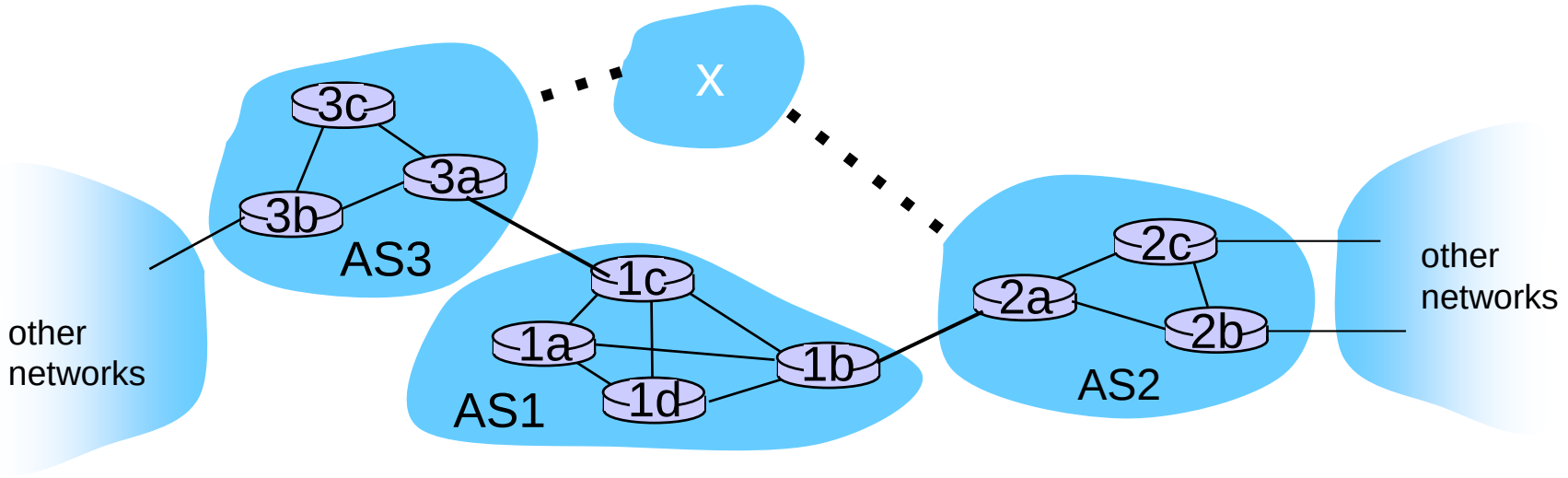
Example: choosing among multiple ASes

- now suppose AS1 learns from inter-AS protocol that subnet *x* is reachable from AS3 *and* from AS2.
- to configure forwarding table, router 1d must determine towards which gateway it should forward packets for dest x
  - this is also job of inter-AS routing protocol!



BGP route selection

- router may learn about more than one route to destination AS, selects route based on:
  1. local preference value attribute: policy decision
  2. shortest AS-PATH
  3. closest NEXT-HOP router: hot potato routing
  4. additional criteria

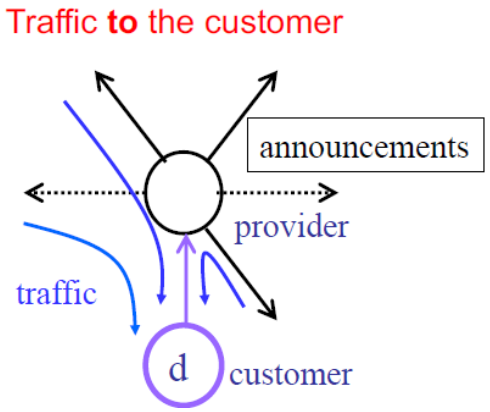


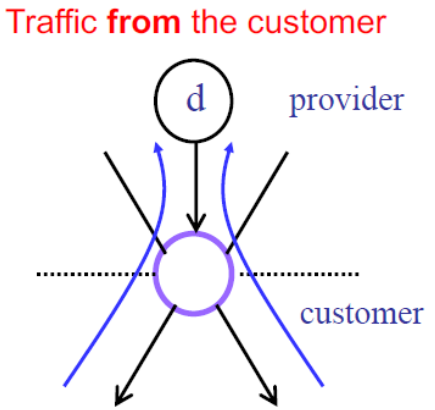
Business Relationships

- Neighboring ASes have business contracts
  - How much traffic to carry
  - Which destinations to reach
  - How much money to pay
- Common business relationships
  - Customer-provider
    - E.g., Princeton is a customer of USLEC
    - E.g., MIT is a customer of Level3
  - Peer-peer
    - E.g., UUNET is a peer of Sprint
    - E.g., Harvard is a peer of Harvard Business School

Customer/Provider

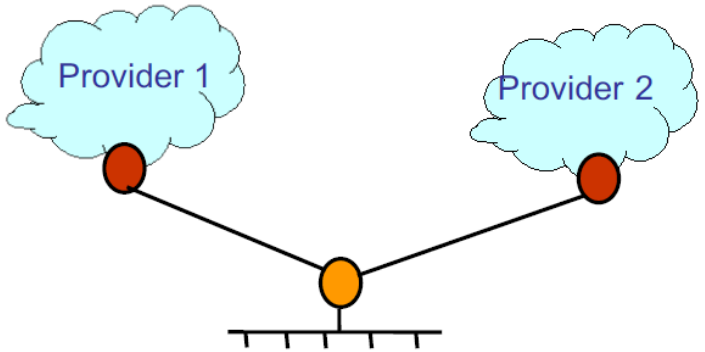
- Customer needs to be reachable from everyone
  - Provider tells all neighbors how to reach the customer
- Customer does not want to provide transit service
  - Customer does not let its providers route through it





Multi-Homing

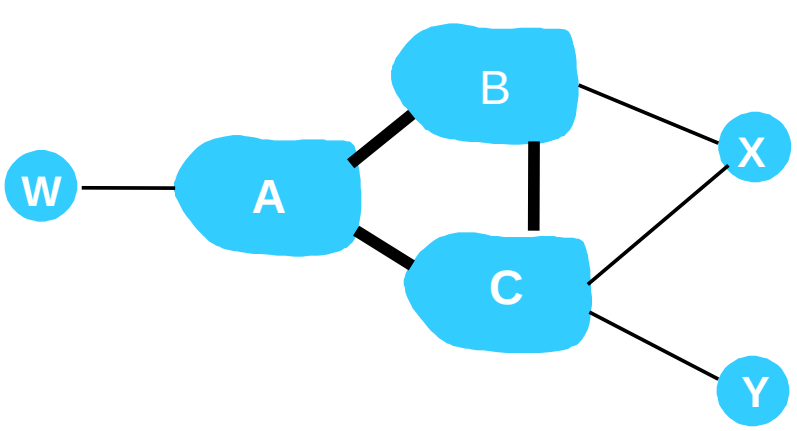
- Customers may have more than one provider
  - Extra reliability, survive single ISP failure
  - Financial leverage through competition
  - Better performance by selecting better path
  - Gaming the 95$_{th}$-percentile billing model

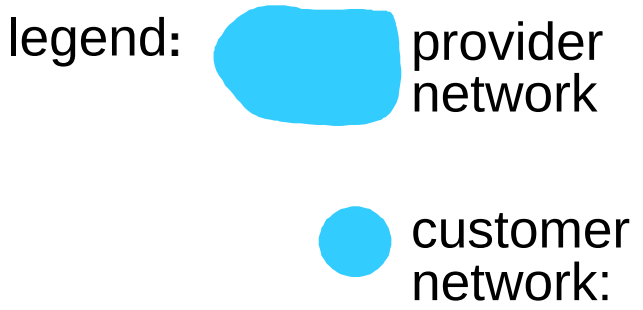


Policy-based routing

- Gateway receiving route advertisement uses *import policy* to accept/decline path (e.g., never route through AS Y).
- AS policy also determines whether to *advertise* path to other neighboring ASes

BGP: achieving policy via advertisements

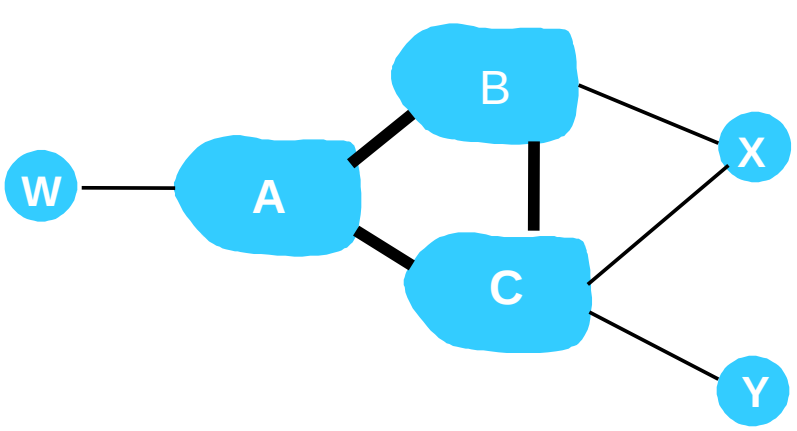


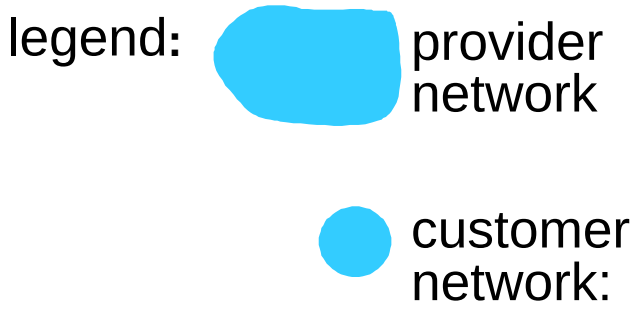


Suppose an ISP only wants to route traffic to/from its customer networks (does not want to carry transit traffic between other ISPs)

- A advertises path Aw to B and to C
- B *chooses not to advertise* BAw to C:
  - B gets no "revenue" for routing CBAw, since none of C, A, w are B's customers
  - C does not learn about CBAw path
- C will route CAw (not using B) to get to w

BGP: achieving policy via advertisements

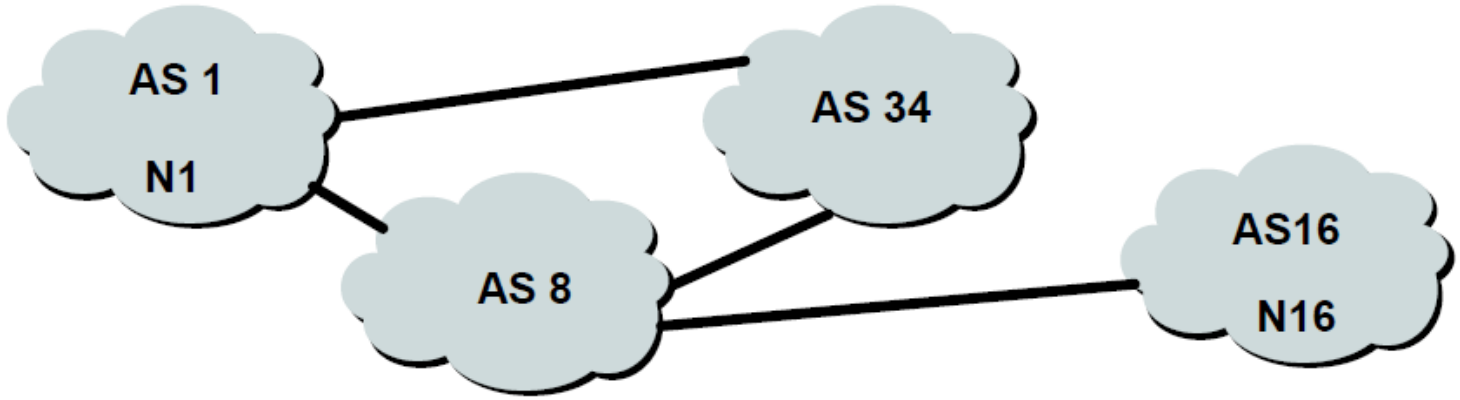




Suppose an ISP only wants to route traffic to/from its customer networks (does not want to carry transit traffic between other ISPs)

- A,B,C are *provider networks*
- X,W,Y are customer (of provider networks)
- X is *dual-homed:* attached to two networks
- *policy to enforce:* X does not want to route from B to C via X
  - .. so X will not advertise to B a route to C

Policies

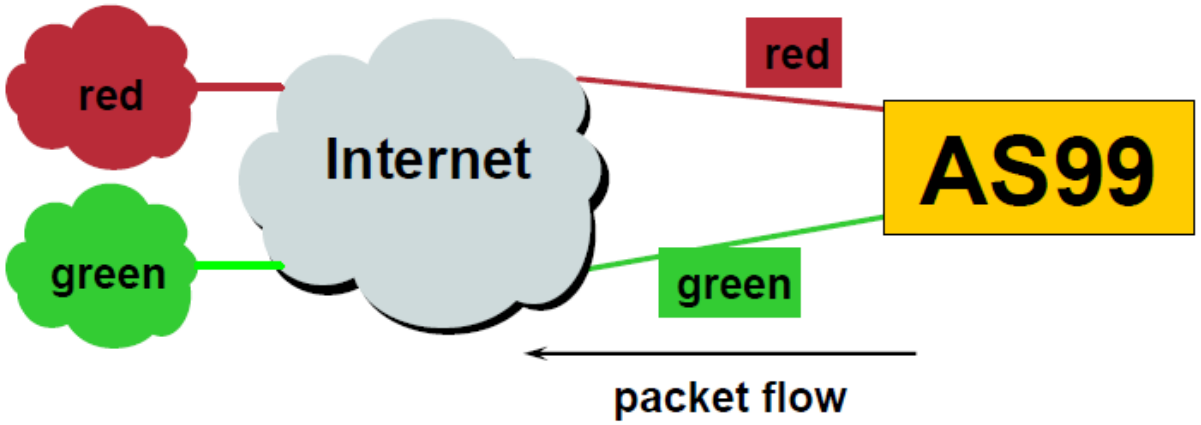


As multiple paths between sites are implemented it is easy to see how policies can become quite complex.

Policies

- Used to control traffic flow in and out of an ISP network
- ISP makes decisions on what routing information to accept and discard from its neighbours
  - Individual routes
  - Routes originated by specific ASes
  - Routes traversing specific ASes
  - Routes belonging to other groupings
    - Groupings which you define as you see fit

Policies

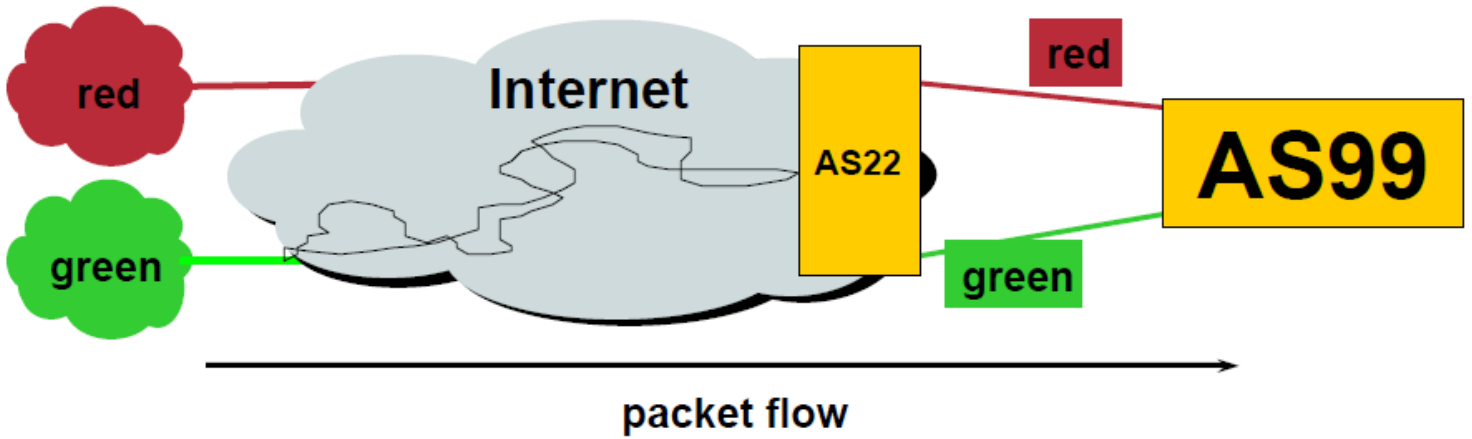


- AS99 uses red link for traffic to the red AS and the green link for remaining traffic
- To implement this policy, AS99 has to:

  Accept routes originating from the red AS on the red link

  Accept all other routes on the green link

Policies



- AS99 would like packets coming from the green AS to use the green link.
- But unless AS22 cooperates in pushing traffic from the green AS down the green link, there is very little that AS99 can do to achieve this aim

Export Policies

- Provider to Customer
  - All routes so as to provide transit service
- Customer to Provider
  - Only customer routes
  - Why?
  - Only transit for those that pay
- Peer to Peer
  - Only customer routes

Import Policies

- Same routes heard from providers, customers, and peers, whom to choose?
  - customer > peer > provider
  - Why?
    - Choose the most economic routes!
    - Customer route: charge $$ J
    - Peer route: free
    - Provider route: pay $$ L

BGP route selection

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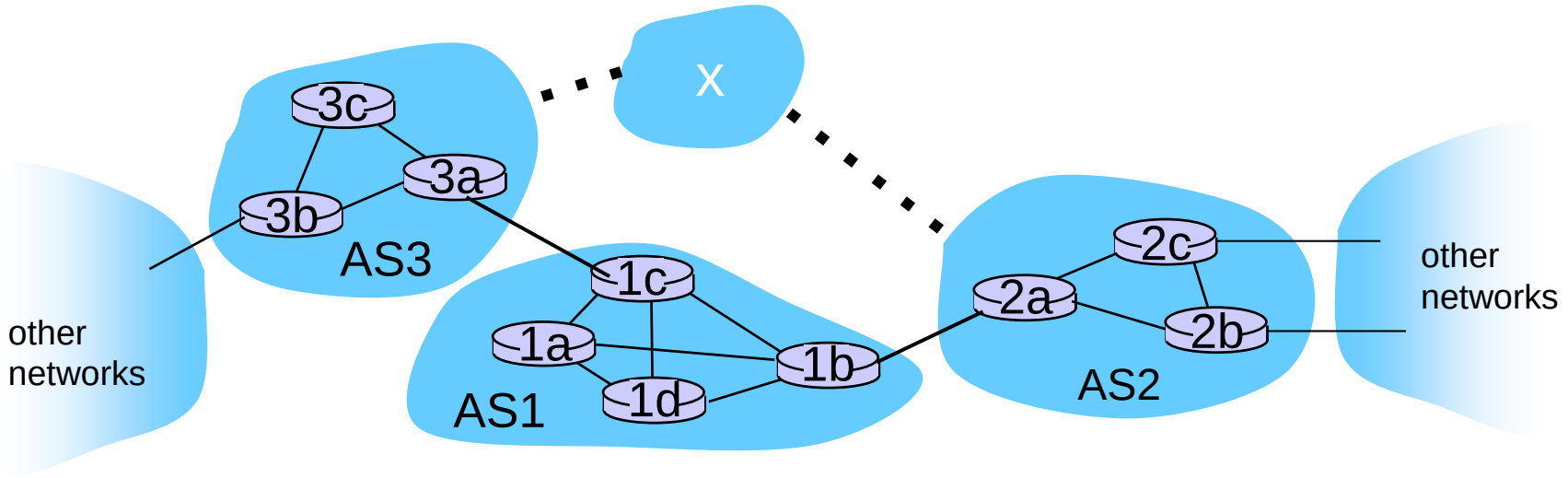


Local Preferences

- **Local to an AS – non-transitive**

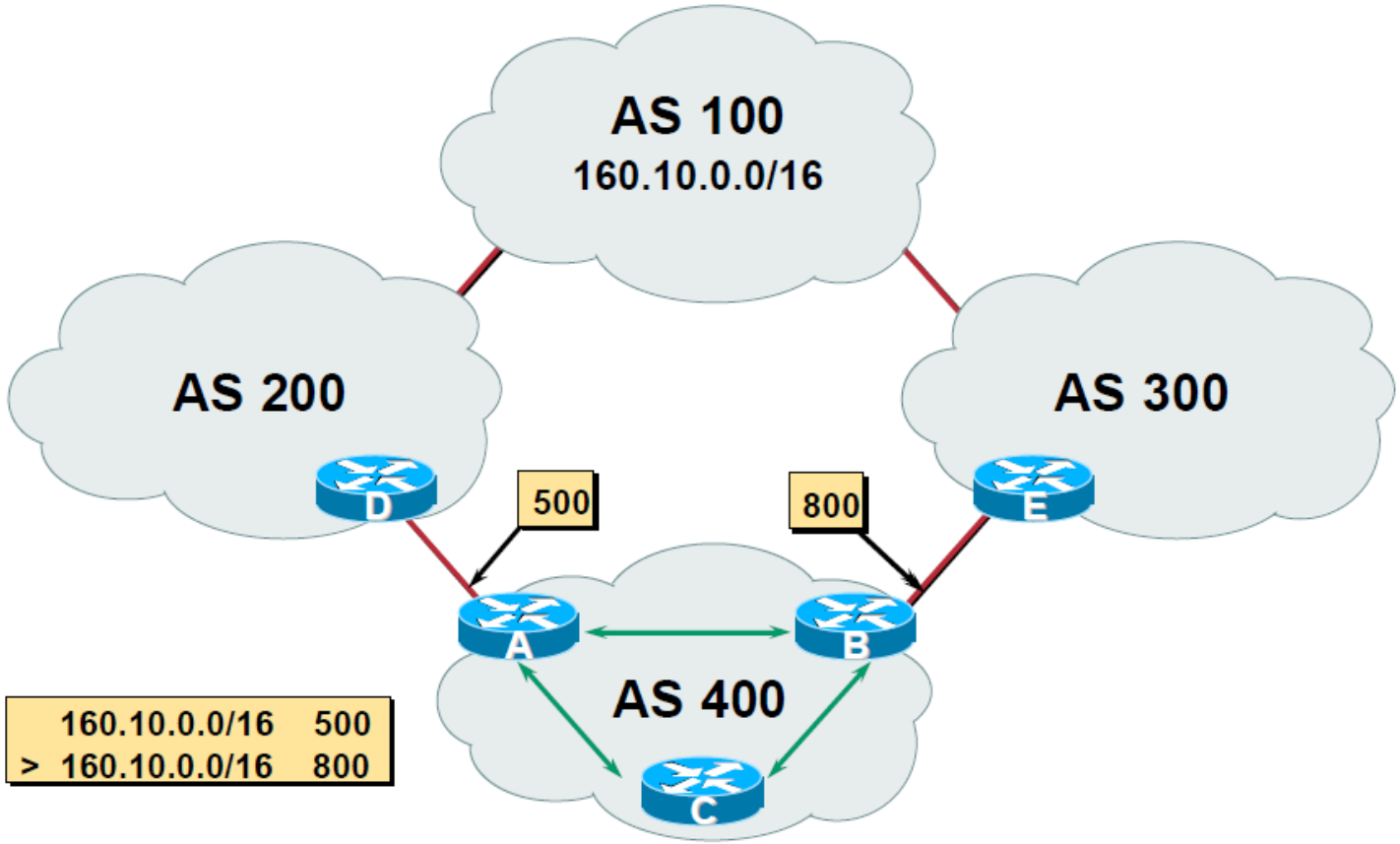
  Default local preference is 100 (IOS)

- **Used to influence BGP path selection**

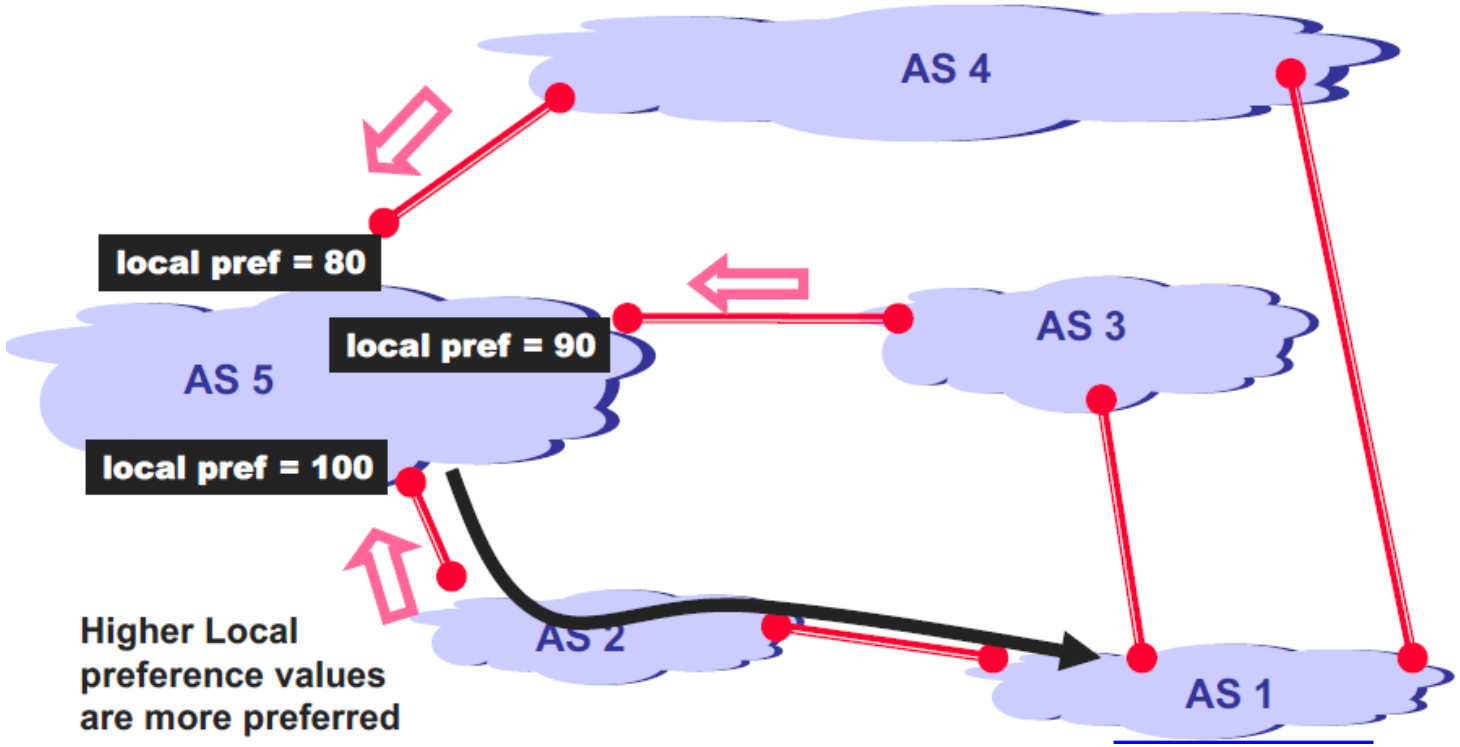
  determines best path for *outbound* traffic

- **Path with highest local preference wins**

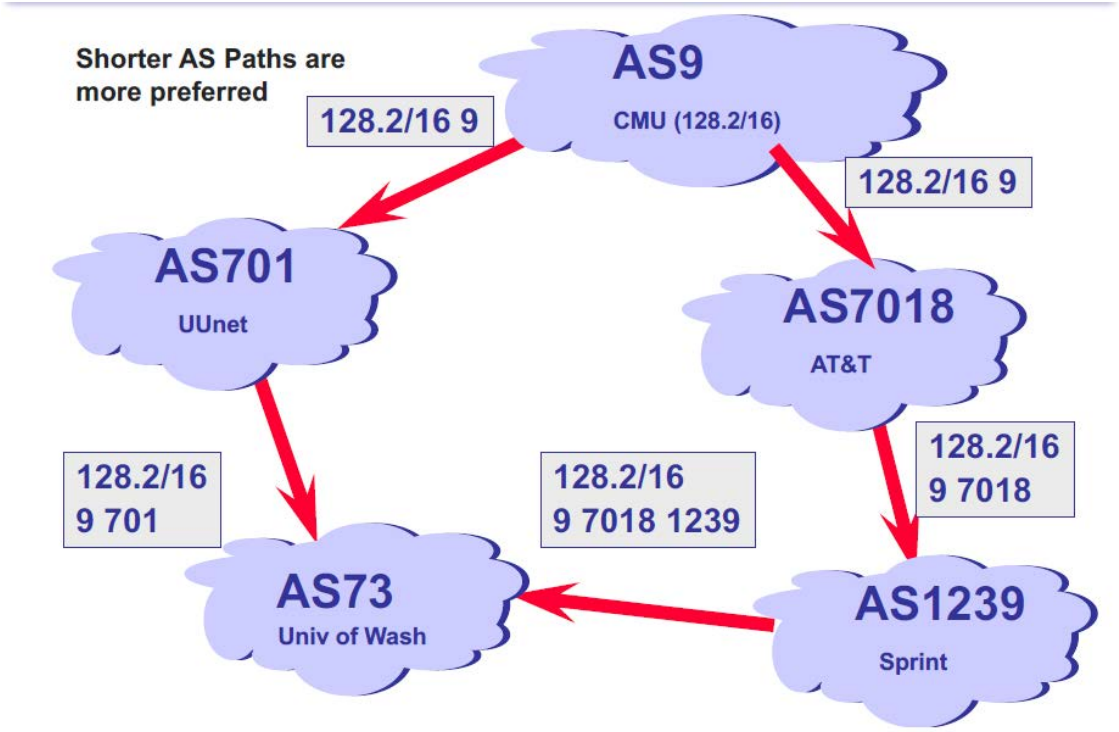
Local Preferences



Local preferences



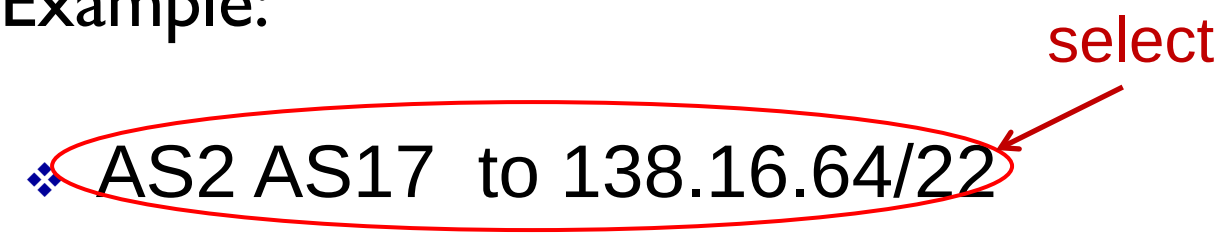
Shorter AS path selection



Select best BGP route to prefix

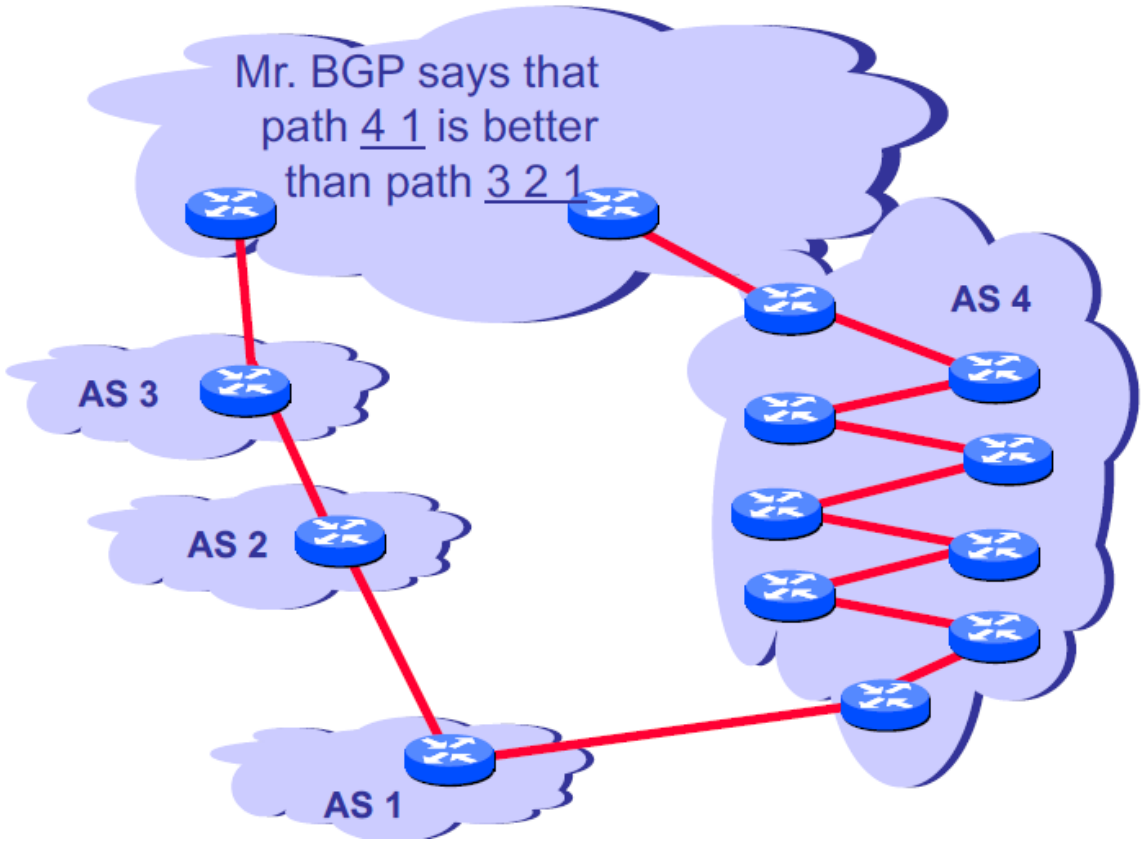
- Router selects route based on shortest AS-PATH

- Example:

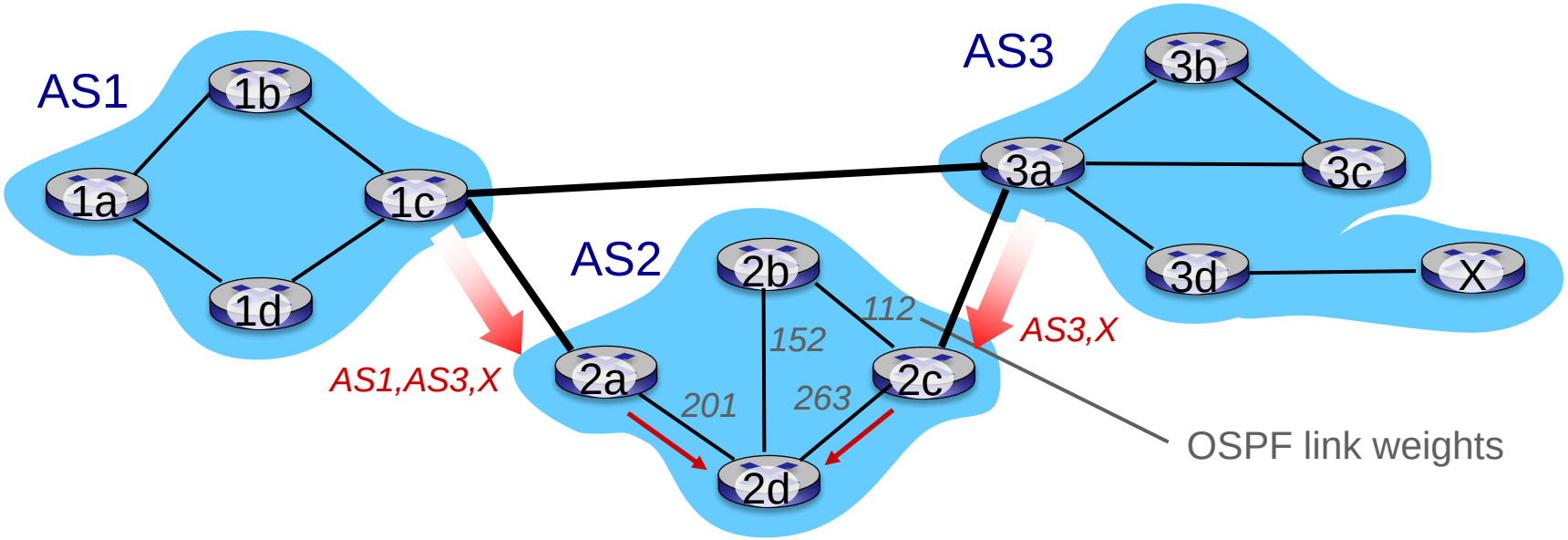


- What if there is a tie?

Shorter AS path vs shorter route

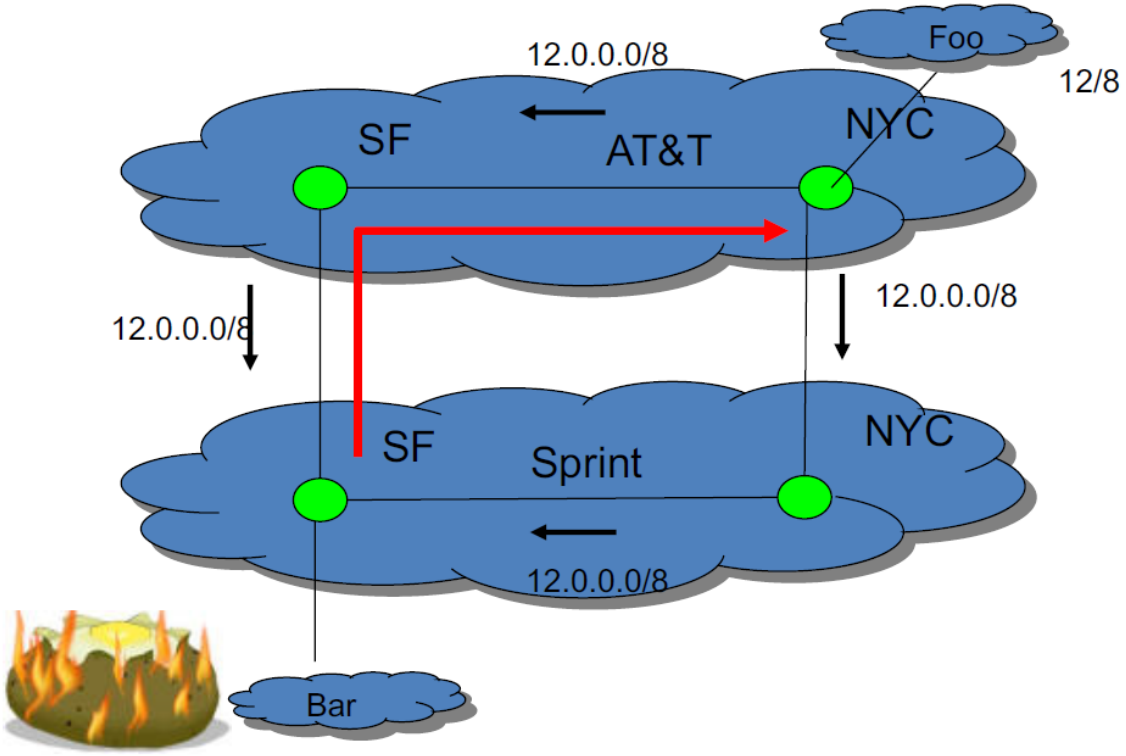


Hot Potato Routing

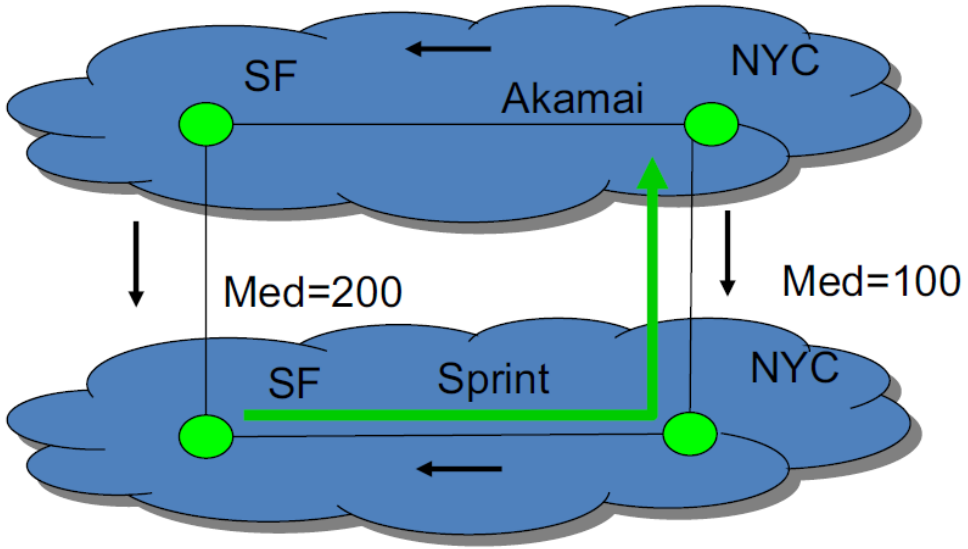


- 2d learns (via iBGP) it can route to X via 2a or 2c
- *hot potato routing:* choose local gateway that has least intra-domain cost (e.g., 2d chooses 2a, even though more AS hops to *X*): don't worry about inter-domain cost!

Hot potato routing

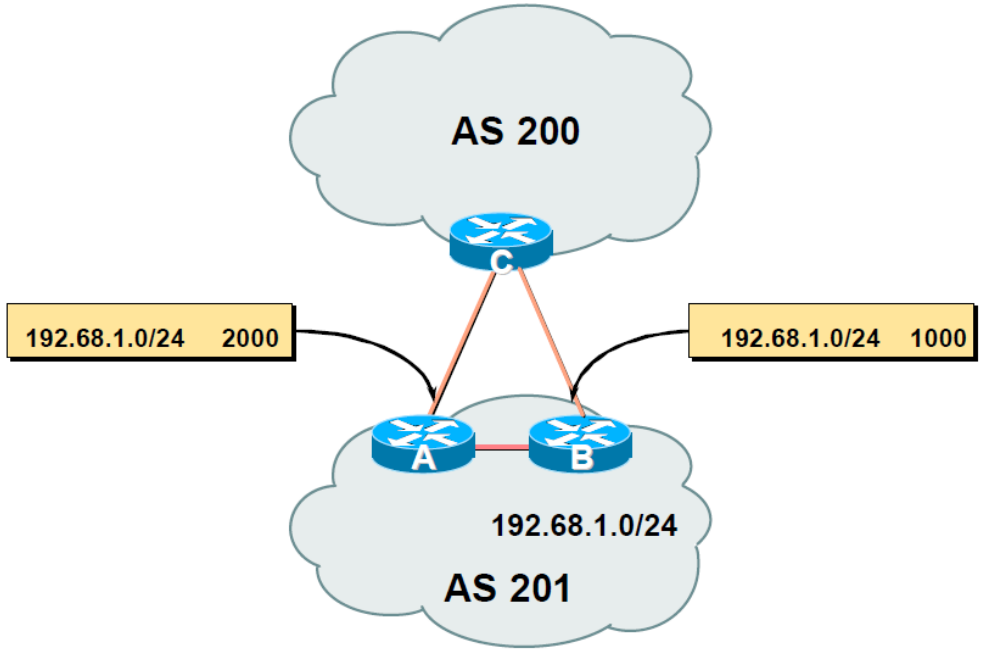


Cold potato routing



MED: Multi Exit Discriminator

MED: Multi-Exit discriminator



MED

- **Inter-AS – non-transitive**
- **Used to convey the relative preference of entry points**

  determines best path for *inbound* traffic
- **Comparable if paths are from same AS**
- **IGP metric can be conveyed as MED**

  set metric-type internal in route-map

Why different Intra-, Inter-AS routing ?

policy:

- inter-AS: admin wants control over how its traffic routed, who routes through its net.
- intra-AS: single admin, so no policy decisions needed

scale:

- hierarchical routing saves table size, reduced update traffic

performance:

- intra-AS: can focus on performance
- inter-AS: policy may dominate over performance

Routing Protocols

- IGP:
  - Intra-AS routing protocols
    - OSPF
      - Dijkstra
- EGP:
  - Inter-AS routing protocol
    - BGP-4
      - eBGP
      - iBGP