COMP 431
Internet Services & Protocols

Routing on the Internet

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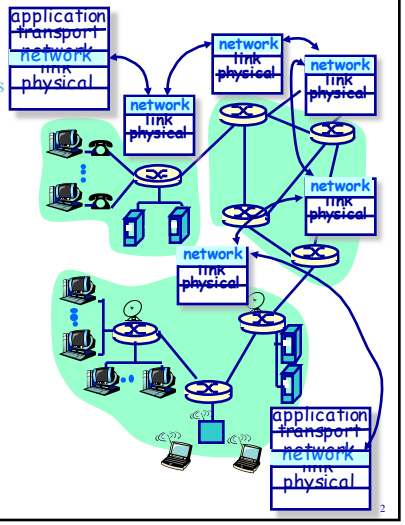
April 9, 2020

The Network Layer: Routing & Addressing

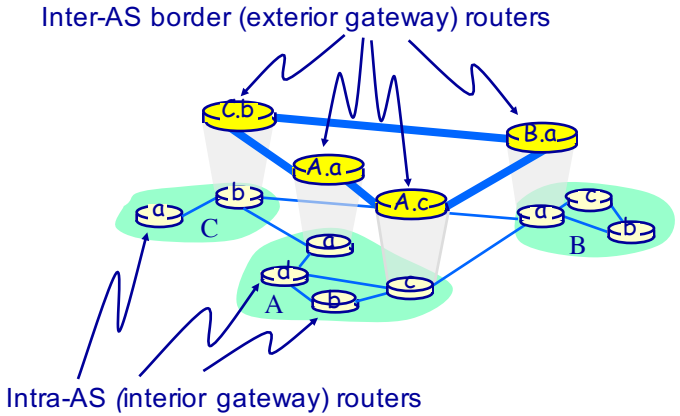
Outline

- Network layer services
- Routing algorithms
  - » Least cost path computation algorithms
- Hierarchical routing
  - » Connecting networks of networks
- IP Internet Protocol
  - » Addressing
  - » IPv6
- Routing on the Internet
  - » Intra-domain routing
  - » Inter-domain routing
- Router architecture



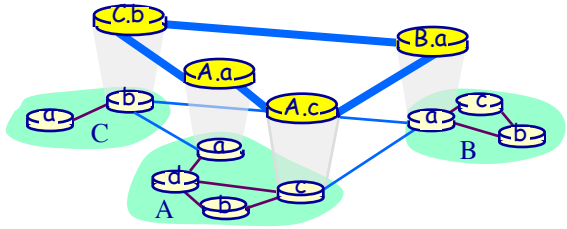
Routing on the Internet

The Internet AS hierarchy



The Internet AS Hierarchy

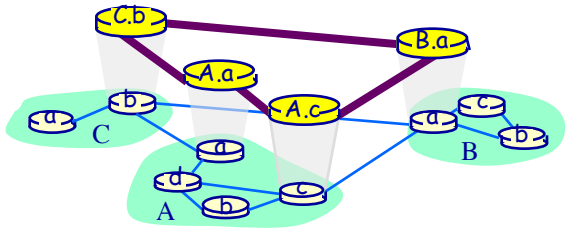
Intra-AS routing



- Also known as "Interior Gateway Protocols" (IGPs)
- Most common IGPs:
  - » RIP: Routing Information Protocol (Distance-vector like routing)
  - » OSPF: Open Shortest Path First (Link-state routing)
  - » IGRP: Interior Gateway Routing Protocol (Cisco proprietary)

The Internet AS Hierarchy

Inter-AS Routing



- Border Gateway Protocol (BGP) is the *defacto* standard
- *Path Vector* protocol:
  - » Similar to Distance Vector protocol
  - » Each Border Gateway advertises to adjacent nodes (peers) the *entire AS path* (*i.e.*, sequence of AS numbers) to a destination
  - » *e.g.*, Gateway X may send its path to destination *Z*:

    $path\ (X,Z) = X, Y_1, Y_2, Y_3, \ldots, Z$
- BGP messages are exchanged using TCP

Internet Inter-AS Routing

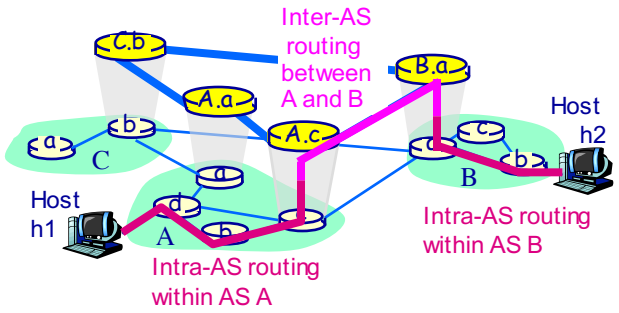
BGP

- Suppose gateway *X* sends a path to peer gateway *W*
- *W* may or may not select the path advertised by *X*
  - » Cost, policy (*"don't route via competitor X's network"*), or loop prevention reasons
- If *W* selects the path advertised by *X* to *Z*, then:

  $path\ (W,Z) = W + path\ (X,Z)$
- Note that *X* can control its incoming traffic by controlling its route advertisements to adjacent border gateways:
  - » If *X* does not want to route traffic to *Z*, then *X* will not advertise any routes to *Z*

Putting It All Together

Intra-AS & Inter-AS Routing



The Internet AS Hierarchy

Why different intra- and inter-AS routing?

- Policy:
  - » Inter-AS: administration wants control over how its traffic routed and who routes through its network
  - » Intra-AS: single administration, 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