Applied Networks & Security

Routing

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IPv4 unicast routing

- All Internet hosts perform basic routing
  - for local net destinations, forward to local host
  - for non-local nets, forward to default router
- Dedicated routers often used between networks
- Routing tables maintain next hop information
- Forwarding decision based on destination address
  - routers can use other info to influence decision
- Routers forward to next-hop if not locally attached

Basic IPv4 forwarding process

- For an IP datagram received on an interface...
- remove layer 2 information,
- extract destination IP address (D),
- find best match for (D) in routing table,
- extract forwarding address (F) for next hop,
- create layer 2 info on outgoing interface,
- send datagram to (F).

IP routing tables

Since each row in a routing table represents an entry associated with one IP network, the size of the routing table is directly proportional to the number of IP networks known throughout the entire internetwork.

IP routing table illustrated

***diagrams courtesy of http://www.netbook.cs.purdue.edu**

(a)

Destination	Mask	Next Hop
30.0.0.0	255.0.0.0	40.0.0.7
40.0.0.0	255.0.0.0	deliver direct
128.1.0.0	255.255.0.0	deliver direct
192.4.10.0	255.255.255.0	128.1.0.9

(b)

IP routing table illustrated

(a)

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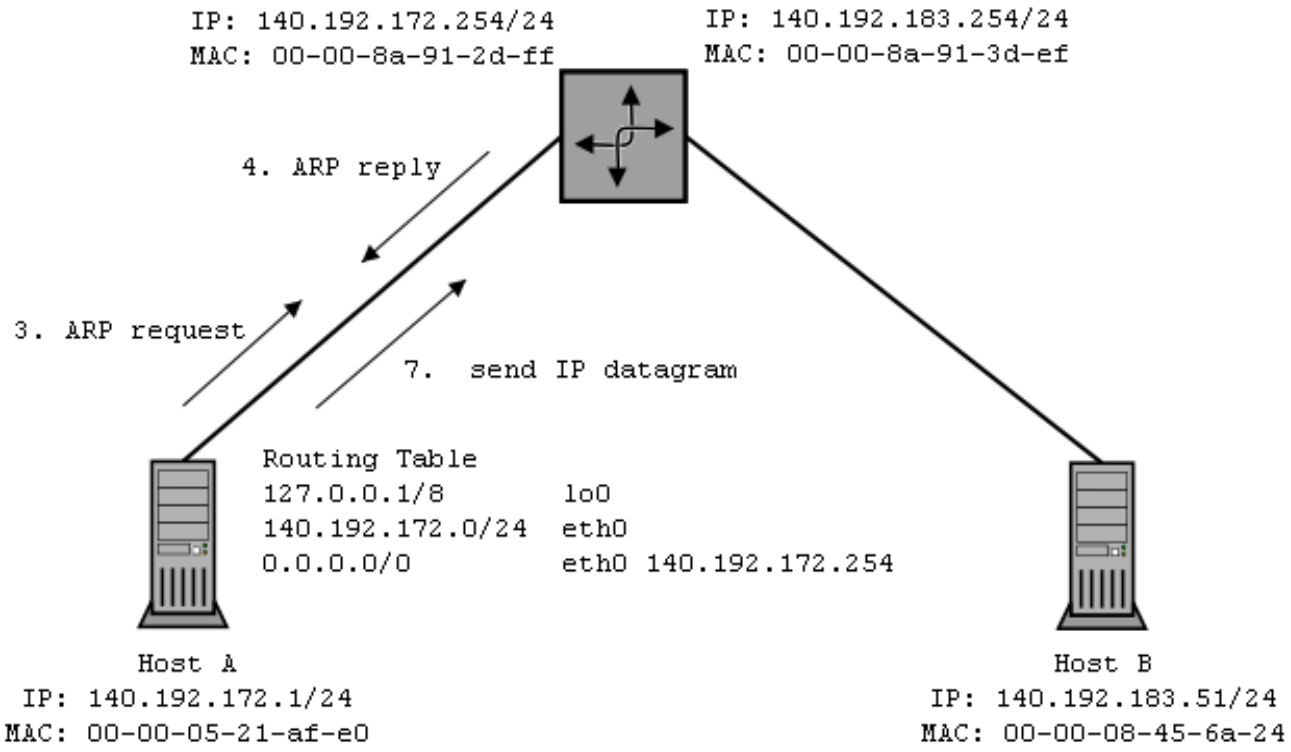
192.4.10.0	255.255.255.0	128.1.0.9

(b)

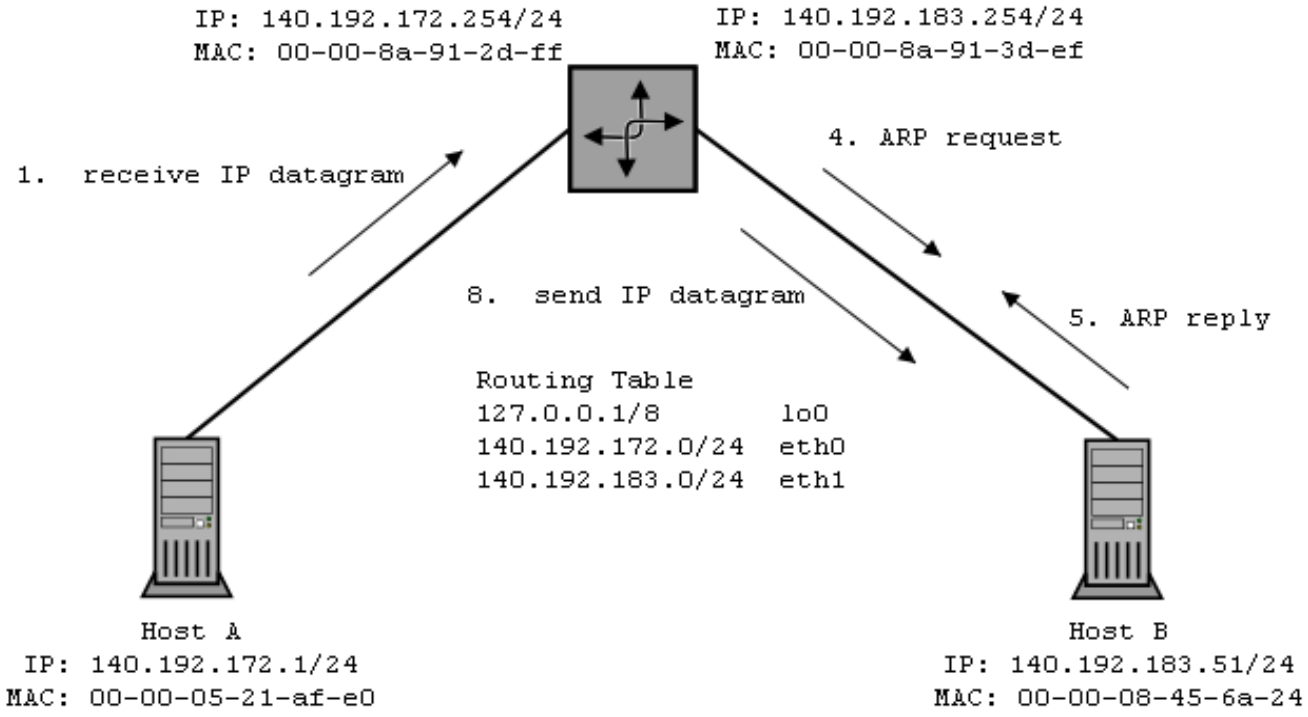
IP routing illustrated



Host A sends an IP datagram to Host B

1. Host A examines destination IP network
2. No match in its routing table, chooses default gateway
3. ARPs for default gateway's MAC address
4. Receives ARP reply from 00-00-8a-91-2d-ff
5. Builds layer 2 frame with destination to 00-00-8a-91-2d-ff
6. Adds IP info with destination IP of 140.192.183.51
7. Sends datagram on local link

IP routing illustrated (continued)



Host A sends an IP datagram to Host B

1. Router receives frame with IP datagram inside
2. Examines layer 3 destination address/network
3. Matches destination network to attached link's network
4. ARPs for destination 140.192.183.51 on local network link
5. Receives ARP reply from 00-00-08-45-6a-24
6. Builds layer 2 frame with destination 00-00-08-45-6a-24
7. Adds IP info with destination IP of 140.192.183.51
8. Sends datagram on local network link

Routing metrics

- Shortest/longest hop path
- Lowest/highest cost path
- Lowest/highest reliable path
- Best/worst latency/delay
- Site specific path policy decision

Some routing terminology

- Autonomous system (AS)
  - Network(s) set administered by a single entity
- Interior gateway protocol (IGP)
  - distributed routing protocol used within an AS
- Exterior gateway protocol (EGP)
  - distributed routing protocol used between ASes

Intradomain routing

- Routing domains under central control and policy
- Static routing
- RIP (v1 and RIPv2) – sipmle distance vector (DV)
- IGRP - early Cisco DV protocol, little used today
- EIGRP - newer Cisco protoco, still deployed
- OSPF - “IETF-approved” link state protocol
- IS-IS – one of the few successful OSI protocols

Interdomain routing

- Routing domains are independently funded
- Routing domains do not trust each other
- Different routing domains have different policies
- Static routing
- EGP – first interdomain routing protocol
- BGP – current path vector routing protocol

Peering

- Networks need to interconnect to each other
  - In order for all customers to interconnect
- Networks tend to have compete against each other
  - How are the interconnection agreements made?
- Peering economics
  - Some networks peer with everyone
  - Some have peer “requirements”
- Paid-peering versus settlement-free peering