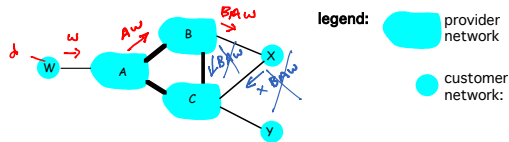


BGP routing policy



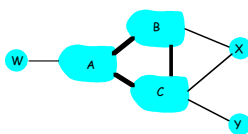
legend: provider network
 customer network:

- A,B,C are **provider networks**
- X,W,Y are customers (of provider networks)
- X is **dual-homed**: attached to two networks
 - X does not want to route from C via X to B
 - .. so X will not advertise to C a route to B
- Gateway router imposes **export policy** on what route to advertise to other AS's

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BGP routing policy (2)



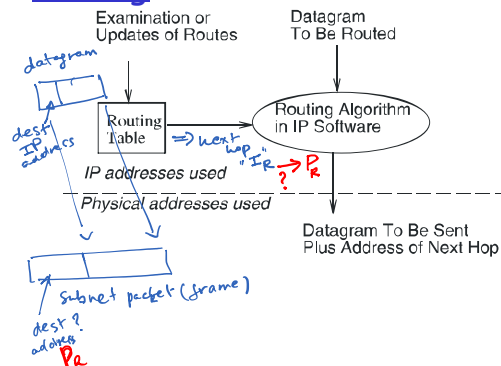
legend: provider network
 customer network:

- A advertises to B the path AW
- B advertises to X the path BAW
- Should B advertise to C the path BAW?
 - No way! B gets no "revenue" for routing CBAW since neither W nor C are B's customers
 - B wants to force C to route to W via A
 - B wants to route **only** to/from its customers!

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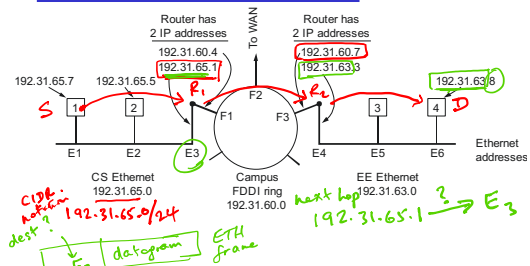
Routing



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Address Translation



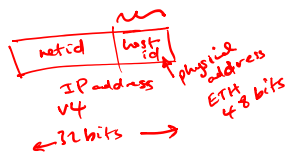
- Map IP (high-level) addresses into physical (low-level) addresses
 - destination host
 - next hop router

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Address Translation (cont'd)

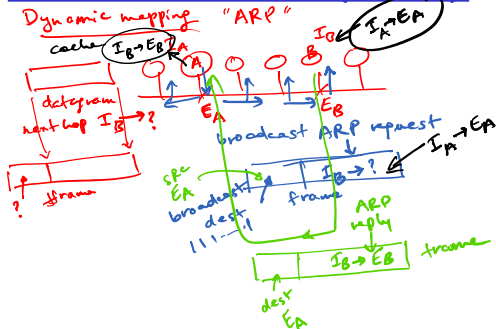
Direct mapping



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Address Translation (cont'd)



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Address Translation (cont'd)

□ Techniques

- m encode physical address in host part of IP address
- m table-based

□ ARP (Address Resolution Protocol)

- m table of IP to physical address bindings
- m broadcast request if IP address not in table
- m target machine responds with its physical address
- m table entries are discarded if not refreshed

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ARP

- ARP messages are encapsulated in physical frames
 - HardwareType: type of physical network (e.g., Ethernet)
 - ProtocolType: type of higher layer protocol (e.g., IP)
 - HLEN & PLEN: length of physical and protocol addresses
 - Operation: request or response
 - Source/Target Physical/Protocol addresses

| | |
|--------------------|---------------------|
| HardwareType=1 | ProtocolType=0x0800 |
| HLEN=48 | PLEN=32 |
| Operation | |
| SourceHardwareAddr | |
| SourceHardwareAddr | SourceProtocolAddr |
| SourceProtocolAddr | TargetHardwareAddr |
| TargetHardwareAddr | |
| TargetProtocolAddr | |

□ Notes

- table entries timeout in about 10-20 minutes
- update table with source when you are the target
- refresh entry if already have an entry for source
- do not refresh table entries upon reference

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IPv6

- **Initial motivation:** 32-bit address space completely allocated
- 128-bit IPv6 address length gives us more than 10^{28} times as many IPv4 addresses
- Additional motivation:
 - header format helps speed processing/forwarding
 - header changes to facilitate QoS
- **IPv6 datagram format:**
 - fixed-length 40 byte header
 - no fragmentation allowed

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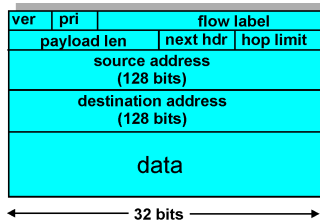
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IPv6 Header (Cont)

Priority: identify priority among datagrams in flow

Flow Label: identify datagrams in same "flow"
(concept of "flow" not well defined)

Next header: identify upper layer protocol for data



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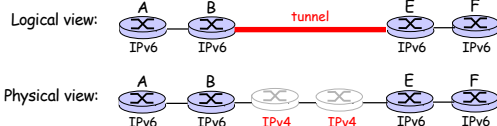
Transition From IPv4 To IPv6

- Not all routers can be upgraded simultaneously
 - no "flag day"
 - How will the network operate with mixed IPv4 and IPv6 routers?
- *Tunneling:* IPv6 carried as payload in IPv4 datagram among IPv4 routers

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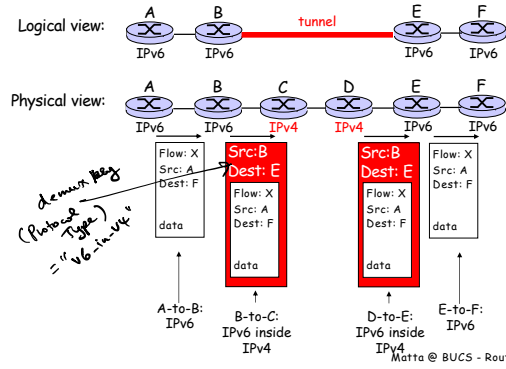
Tunneling



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Tunneling



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