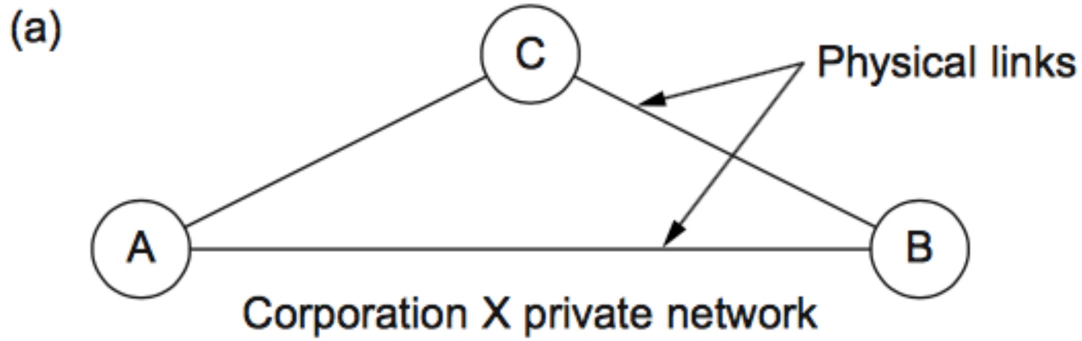
CS640 Mobile IP

Today

- Tunneling and Virtual Networking
- IPv6
- Mobile IP

Tunneling and Virtual Networking

Traditional Connectivity

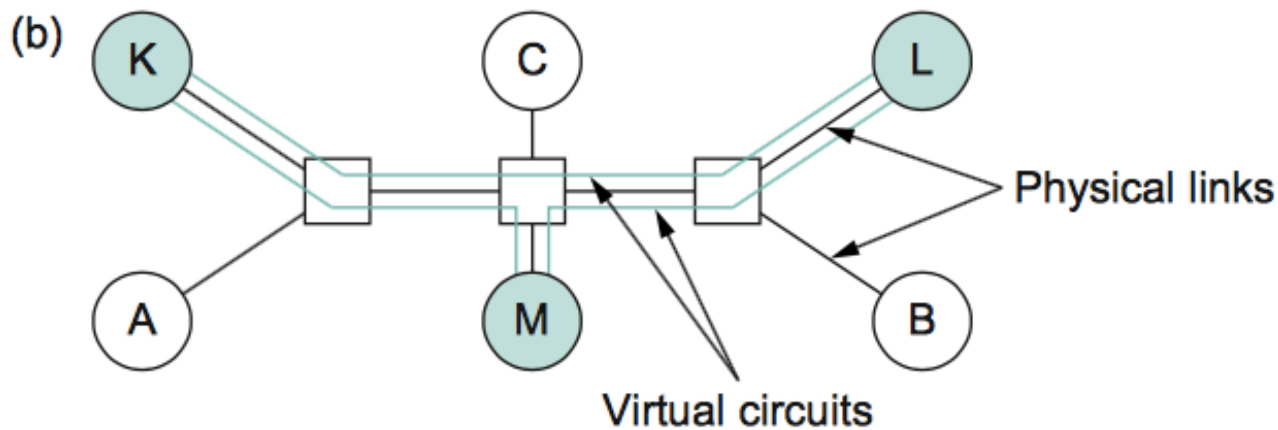


Private Network

- Corporates lease transmission lines/links
- Communication is restricted
  - Often for security reasons
- Is this scalable?

Virtual Private Network (VPN)

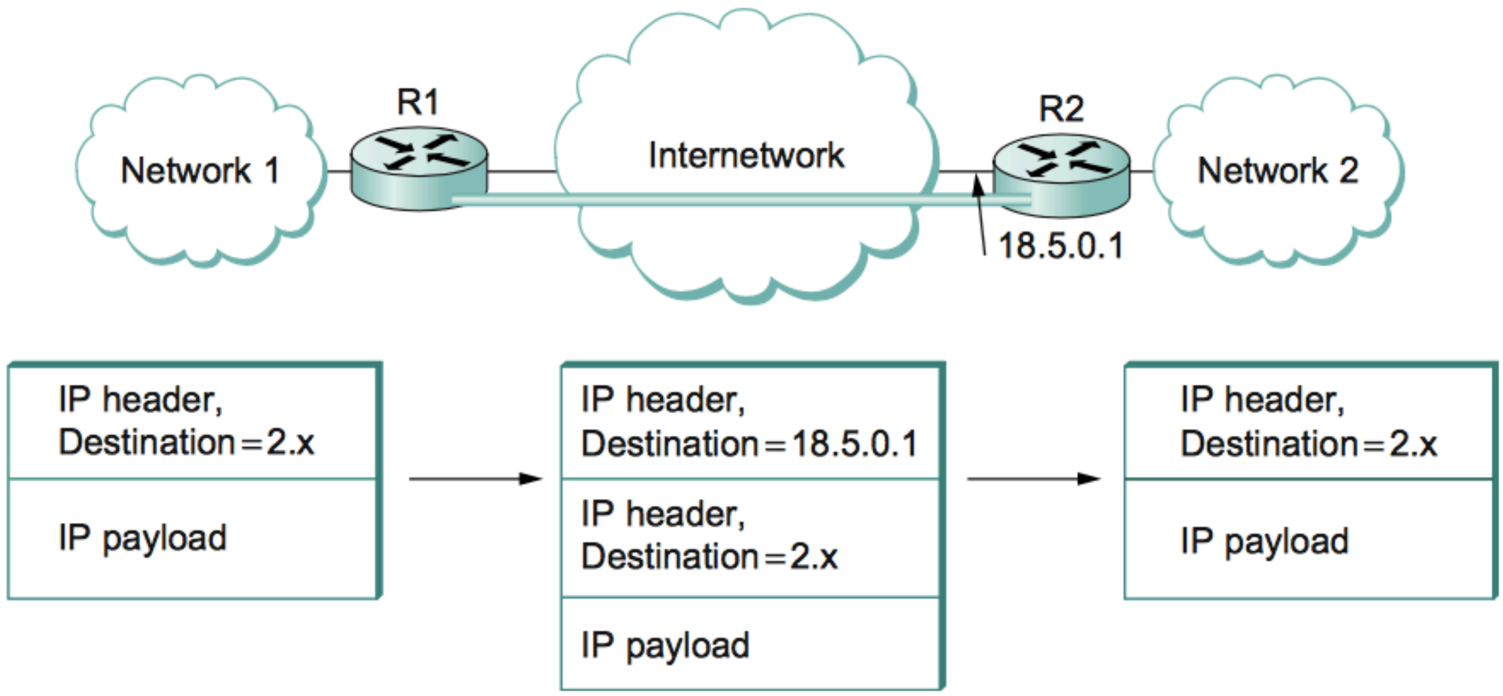
- Idea is simple: replace dedicated medium with shared medium *and* provide a virtually private connection



How do we create a VPN?

- We cannot just connect various sites
  - Traffic between (A, B, C) and (K, L, M) should be private
- Tunneling
  - Virtual point-to-point link between nodes that are separated by arbitrary number of networks
  - Point-to-point link made through a public network
  - Links transport encapsulated datagrams

Example Tunnel

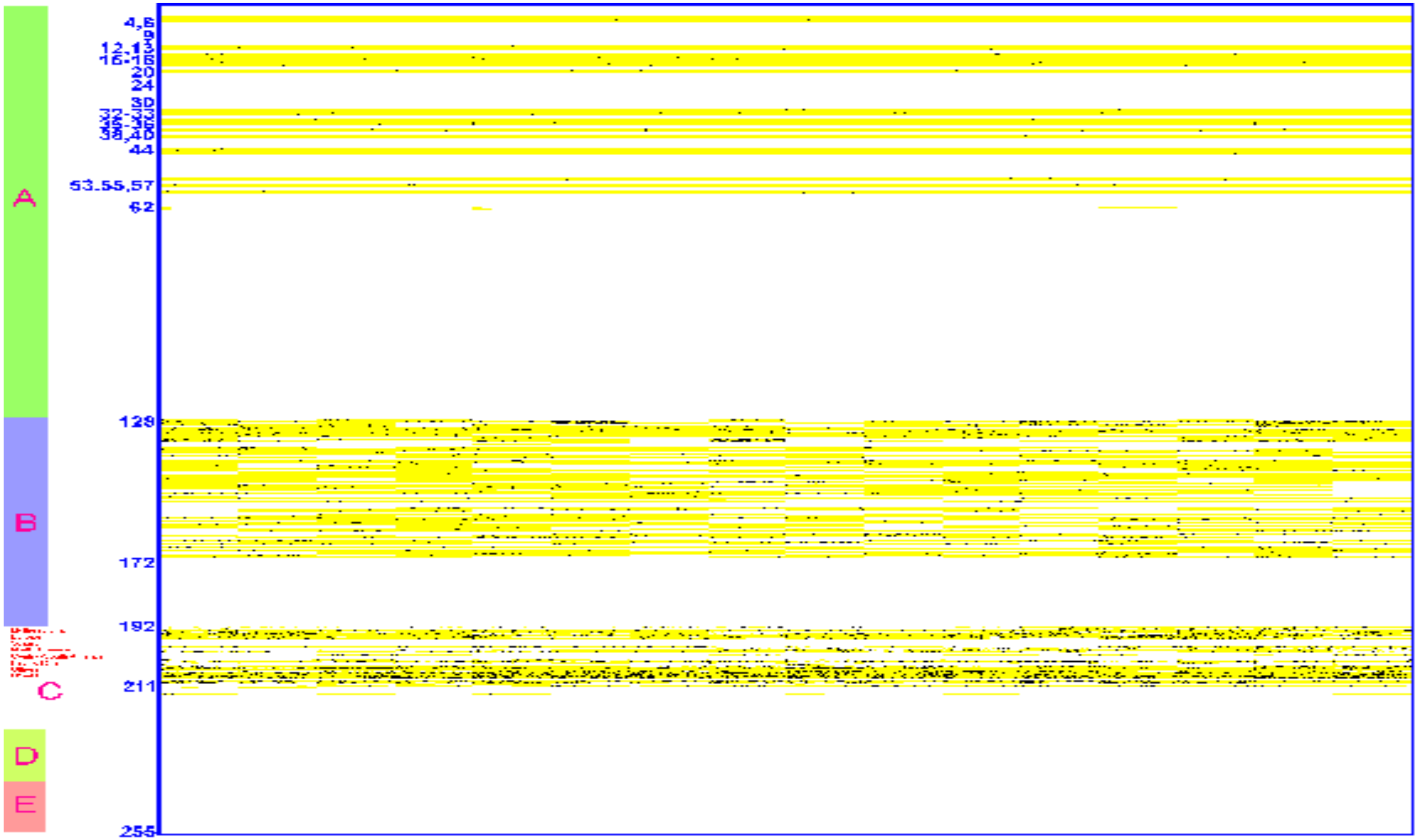


IPv6

Outline

- Background
- Structure
- Deployment

IPv4 Address Allocation - 1998



Source: www.caida.org

Holes in v4 Address Space

- Each pixel represents a /24
- Routing tables were used to generate yellow portions of the table – routable addresses
  - Incomplete view of the entire Internet
- Packet traces were used to generate black portions of the table – source/destination addresses
  - Raises more questions than it answers
- Class A's allocated to companies, etc. used for internal routing only (?)
- Class B & C allocation from lowest to highest
- Reserved address space
- Unallocated space

IPv6 Background

- IP has been patched (subnets, supernets) but there is still the fundamental 32 bit address limitation
- IETF started effort to specify new version of IP in 1991
  - New version would require change of header
  - Include all modifications in one new protocol
  - Solicitation of suggestions from community
  - Result was IPng which became IPv6
  - First version completed in ’94
- Same architectural principles as v4 – only bigger ☺

IPv6 planned support list

- 128-bit address space
  - This is what it's all about…
- Real-time/QoS services
- Security and authentication
- Autoconfiguration
  - Hosts autoconfig with IP address and domain name
  - Idea is to try to make systems more plug-n-play
- Enhanced routing functionality eg. Mobile hosts
- Multicast
- Protocol extensions
- Smooth transition path from IPv4
  - Can't do it all at once!

Address Space and Notation

- Allocation is classless
  - Prefixes specify different uses (unicast, multicast, anycast)
    - Anycast: send packets to nearest member of a group
  - Address space division is based on *leading bits*
  - Prefixes can be used to map v4 to v6 space and vice-versa
  - Lots of flexibility with 128 bits!
    - ~1500 address/sqft of the earths surface
- Standard representation is set of eight 16-bit values separated by colons
  - Eg. 47CD:1234:3200:0000:0000:4325:B792:0428
  - If there are large number of zeros, they can be omitted with series of colons
    - Eg. 47CD:1234:3200::4325:B792:0428
  - Address prefixes (slash notation) are the same as v4
    - Eg. FEDC:BA98:7600::/40 describes a 40 bit prefix

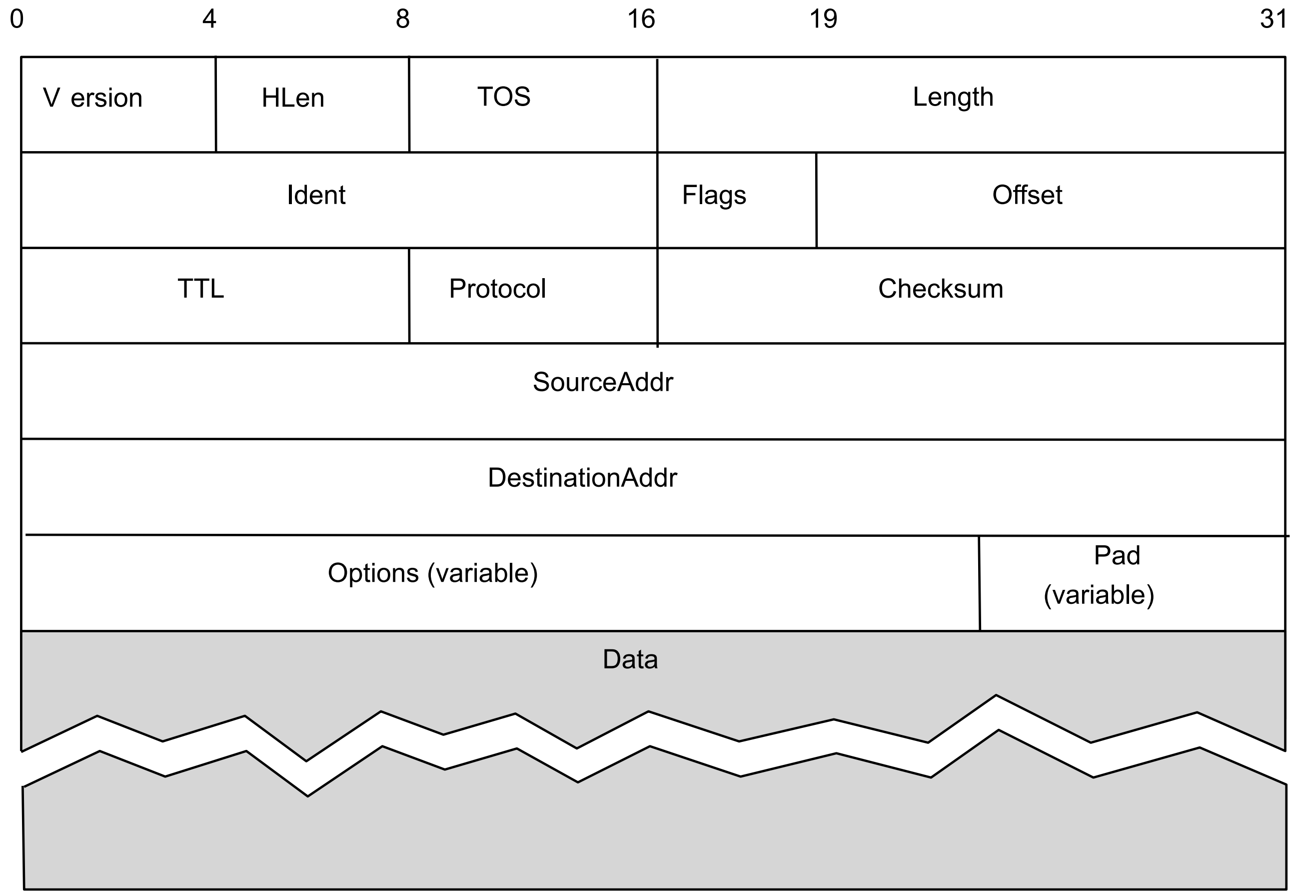
Address Prefix Assignments

0000 0000	**Reserved**
0000 0001	**Unassigned**
0000 001	**Reserved for NSAP (non-IP addresses used by ISO)**
0000 010	**Reserved for IPX (non-IP addresses used by IPX)**
0000 011	**Unassigned**
0000 1	**Unassigned**
0001	**Unassigned**
001	**Unicast Address Space**
010	**Unassigned**
011	**Unassigned**
100	**Unassigned**
101	**Unassigned**
110	**Unassigned**
1110	**Unassigned**
1111 0	**Unassigned**
1111 10	**Unassigned**
1111 110	**Unassigned**
1111 1110 0	**Unassigned**
1111 1110 10	**Link Local Use addresses**
1111 1110 11	**Site Local Use addresses**
1111 1111	**Multicast addresses**

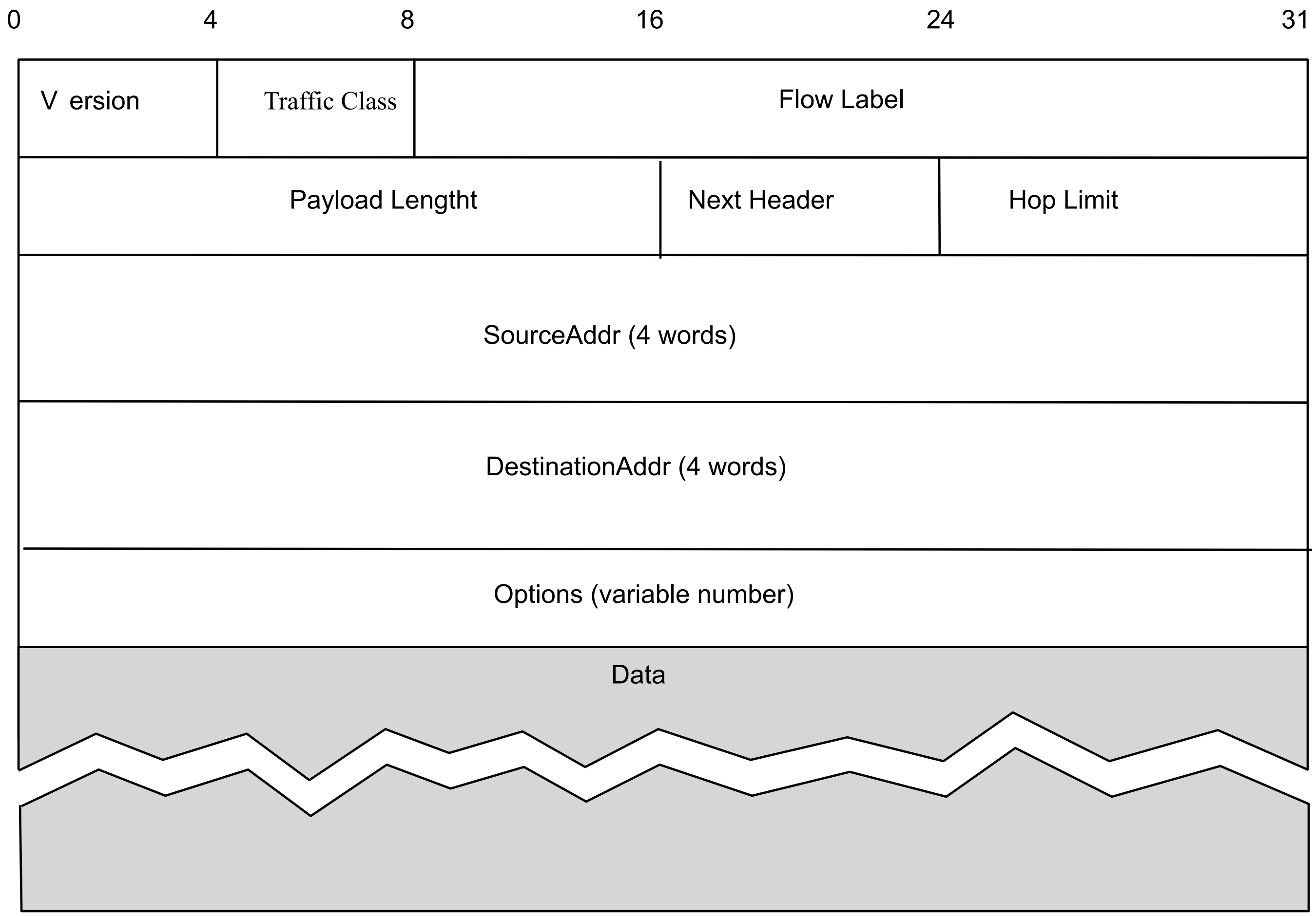
Unicast Assignment in v6

- Unicast address assignment is similar to CIDR
  - Unicast addresses start with 001
  - Host interfaces belong to subnets
  - Addresses are composed of a subnet prefix and a host identifier
  - Subnet prefix structure provides for aggregation into larger networks
- Provider-based plan
  - Idea is that the Internet is global hierarchy of network
  - Three levels of hierarchy – region, provider, subscriber
  - Goal is to provide route aggregation to reduce BGP overhead
    - A provider can advertise a single prefix for all of its subscribers
  - Region = 13 bits, Provider = 24 bits, Subscriber = 16 bits, Host = 80 bits
    - Eg. 001,regionID,providerID,subscriberID,subnetID,intefaceID
- Anycase addresses are treated just like unicast addresses
  - It's up to the routing system to determine which server is "closest"

Recall IPv4 Packet Format Details



IPv6 Packet Format



Packet Format Details

- Simpler format than v4
- Version = 6
- Traffic class same as v4 ToS (eg. low latency or high throughput)
- Treat all packets with the same Flow Label equally
  - Support QoS and fair bandwidth allocation
- Payload length does not include header –limits packets to 64KB
  - There is a "jumbogram option"
- Hop limit is TTL field in v4
- Next header combines Options and Protocol fields in v4
  - If there are no options then NextHeader is the protocol field
- Options are "extension header" that follow IP header
  - *Ordered* list of tuples – 6 common types
    - Quickly enable a router to tell if the options are meant for it
  - Eg. routing, fragmentation, authentication encryption…

Key differences in header

- No checksum
  - Bit level errors are checked for all over the place
- No length variability in header
  - Fixed format speeds processing
- No more fragmentation and reassembly in header
  - Incorrectly sized packets are dropped and message is sent to sender to reduce packet size
  - Hosts should do path MTU discovery
  - But of course we have to be able to segment packets!

Fragmentation Extension

- Similar to v4 fragmentation
  - Implemented as an extension header
    - Placed between v6 header and data (if it is the only extension used)
  - 13 bit offset
  - Last-fragment mark (M)
  - Larger fragment ID field than v4
- Fragmentation is done on end host

0	8	16	29	31
next header	reserved	offset	reserved	M
ID				

Routing Extension

- Without this header, routing is essentially the same as v4
- With this header essentially same as the source routing option in v4
  - Loose or strict
- Header length is in 64-bit words
- Up to 24 addresses can be included
  - Packet will go to nearest of these in "anycast" configuration
- Segments left tracks current target

0	8	16	24 31
Next header	Hd. Ext. Len	0	Segmnts left
1 – 24 addresses			

Transition from v4 to v6

- *Flag day* is not feasible
- Dual stack operation – v6 nodes run in both v4 and v6 modes and use version field to decide which stack to use
  - Nodes can be assigned a *v4 compatible v6 address*
    - Allows a host which supports v6 to talk v6 even if local routers only speak v4
    - Signals the need for tunneling
    - Add 96 0's (zero-extending) to a 32-bit v4 address – eg. ::10.0.0.1
  - Nodes can be assigned a *v4 mapped v6 address*
    - Allows a host which supports both v6 and v4 to communicate with a v4 hosts
    - Add 2 bytes of 1's to v4 address then zero-extend the rest – eg. ::ffff:10.0.0.1
- Tunneling is used to deal with networks where v4 router(s) sit between two v6 routers
  - Simply encapsulate v6 packets and all of their information in v4 packets until you hit the next v6 router

IPv6 Issues

- Address length: usable addresses vs. overhead
- Hop limit: is 65K necessary?
- Is the checksum necessary?
- How do servers handle both types of packets?
- Is security necessary in IP?
  - How is it best implemented?
- DNS can be very important in the transition – how?

Mobile IP

Outline

- Intro to mobile IP
- Operation
- Problems with mobility

We’re not quite done with IP

- You’re probably sick and tired of hearing about all things IP
  - Forwarding, routing, multicast, etc…
- One last topic we must cover because it’s going to be important in the future – mobile networking
  - Examples of mobile networking today?
  - Examples of mobile networking tomorrow?

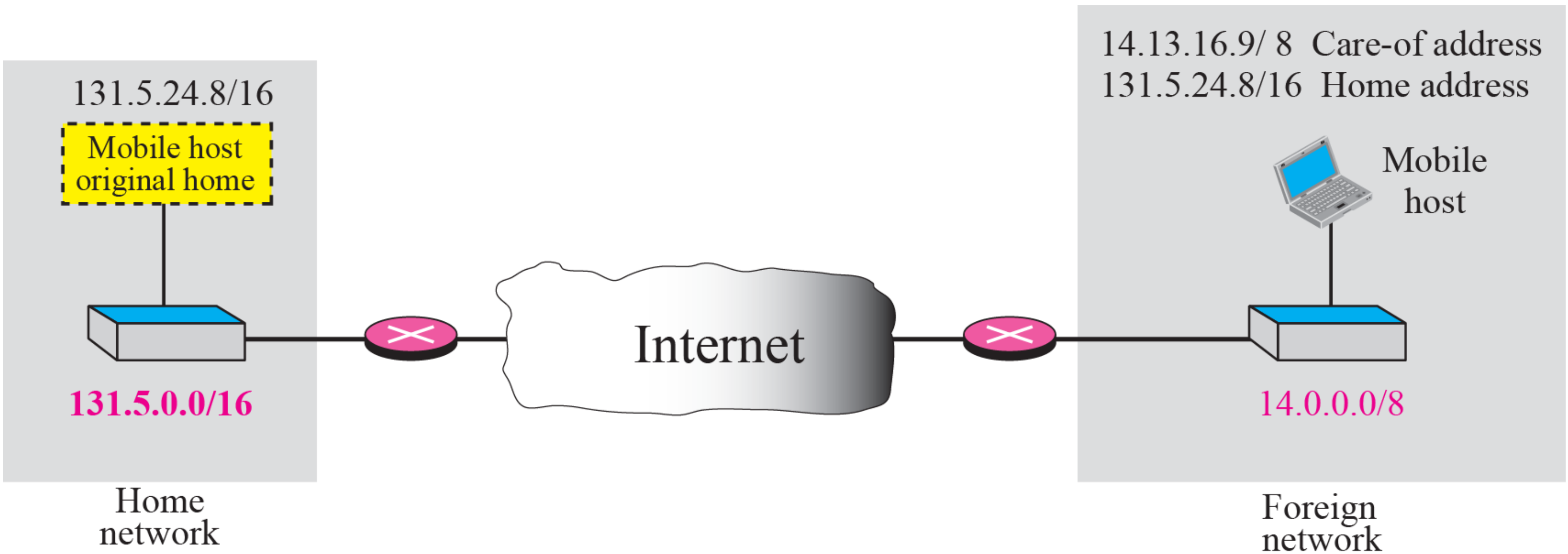
Mobility and Standard IP Routing

- IP assumes end hosts are in fixed physical locations
  - What happens if we move a host between networks?
- IP addresses enable IP routing algorithms to get packets to the correct network
  - Each IP address has network part and host part
    - This keeps host specific information out of routers
  - DHCP is used to get packets to end hosts in networks
    - This still assumes a fixed end host
- What if a user wants to roam between networks?
  - Mobile users don't want to know that they are moving between networks
  - Why can't mobile users change IP when running an application?

Mobile IP

- Mobile IP was developed as a means for transparently dealing with problems of mobile users
  - Enables hosts to stay connected to the Internet regardless of their location
  - Enables hosts to be tracked without needing to change their IP address
  - Requires no changes to software of non-mobile hosts/routers
  - Requires addition of some infrastructure
  - Has no geographical limitations
  - Requires no modifications to IP addresses or IP address format
- IETF standardization process is still underway

Figure 10.1 *Home address and care-of ddress*



Note

Mobile IP has two addresses for a mobile host: one home address and one care-of address.

The home address is permanent; the care-of address changes as the mobile host moves from one network to another.

Figure 10.2 *Home agent and foreign agent*

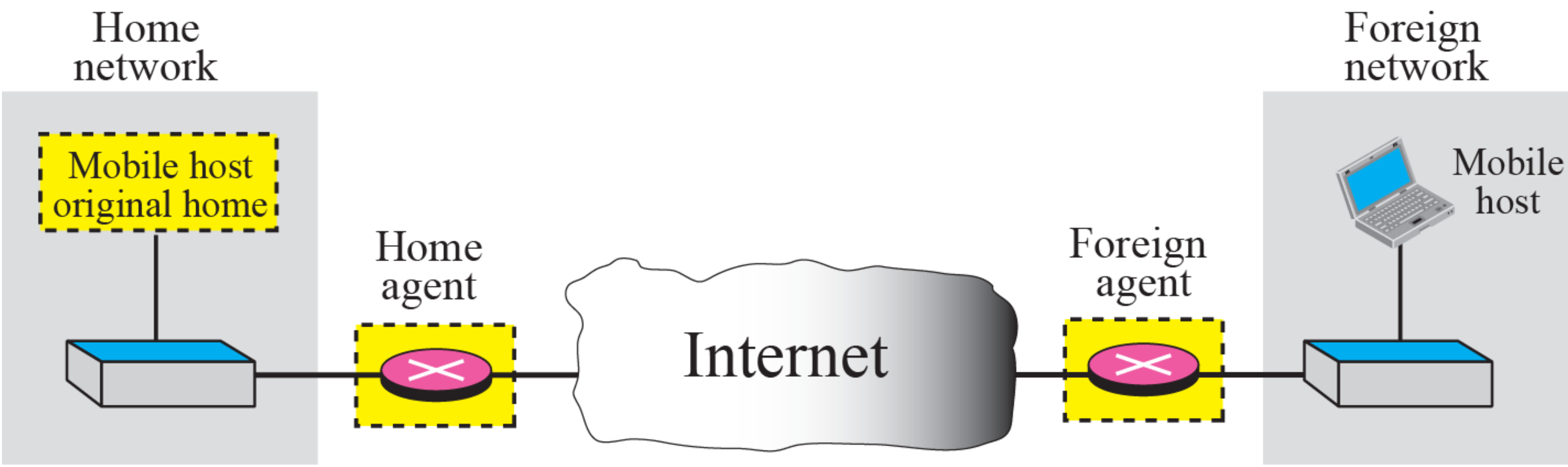
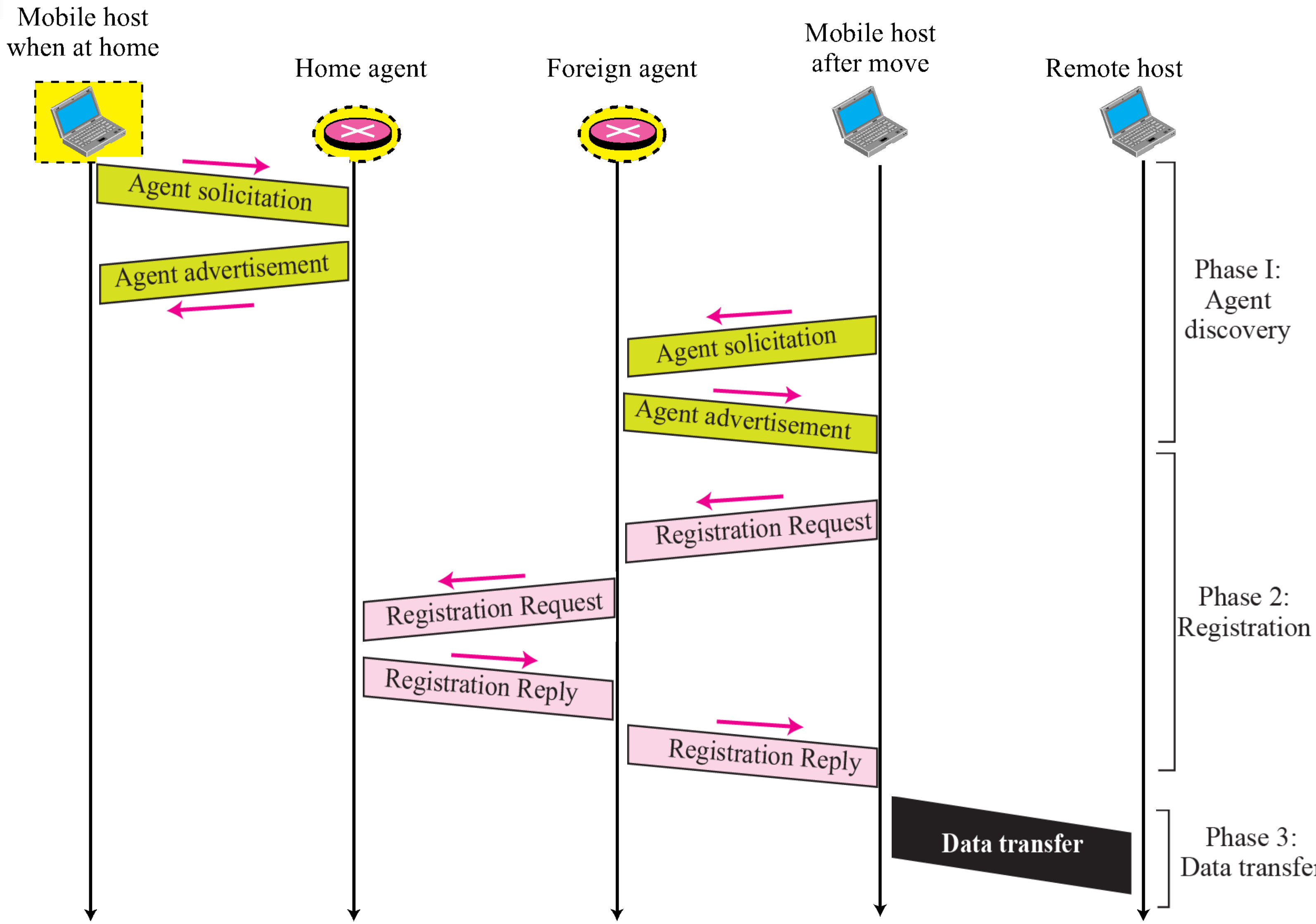


Figure 10.3 *Remote host and mobile host configuration*



Mobile IP Support Services

- Agent Discovery
  - HA's and FA's broadcast their presence on each network to which they are attached
    - Beacon messages via ICMP Router Discovery Protocol (IRDP)
  - MN's listen for advertisement and then initiate registration
- Registration
  - When MN is away, it registers its COA with its HA
    - Typically through the FA with strongest signal
  - Registration control messages are sent via UDP to well known port
- Encapsulation – just like standard IP only with COA
- Decapsulation – again, just like standard IP

Figure 10.7 *Data transfer*

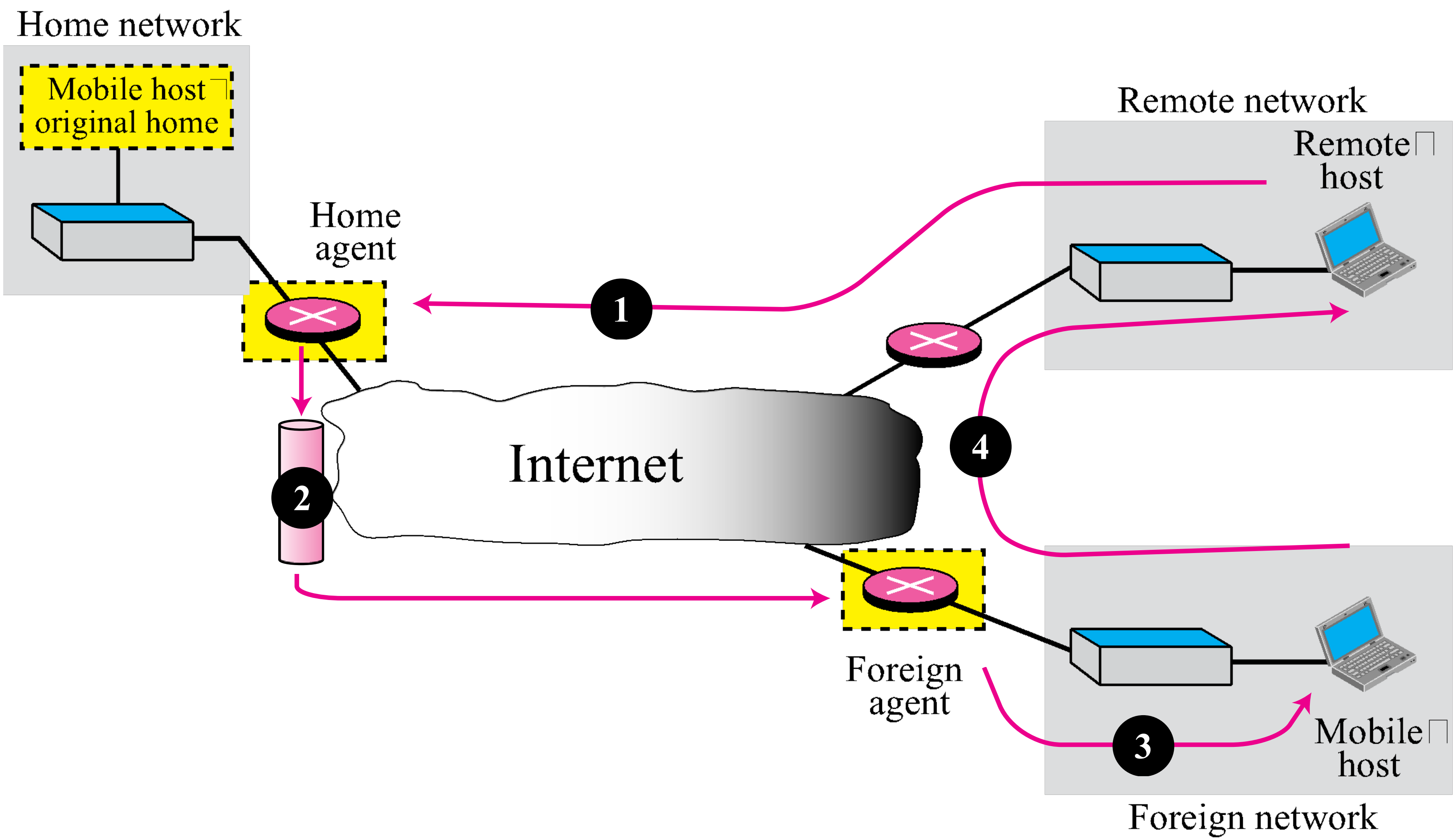


Figure 10.8 *Double crossing*

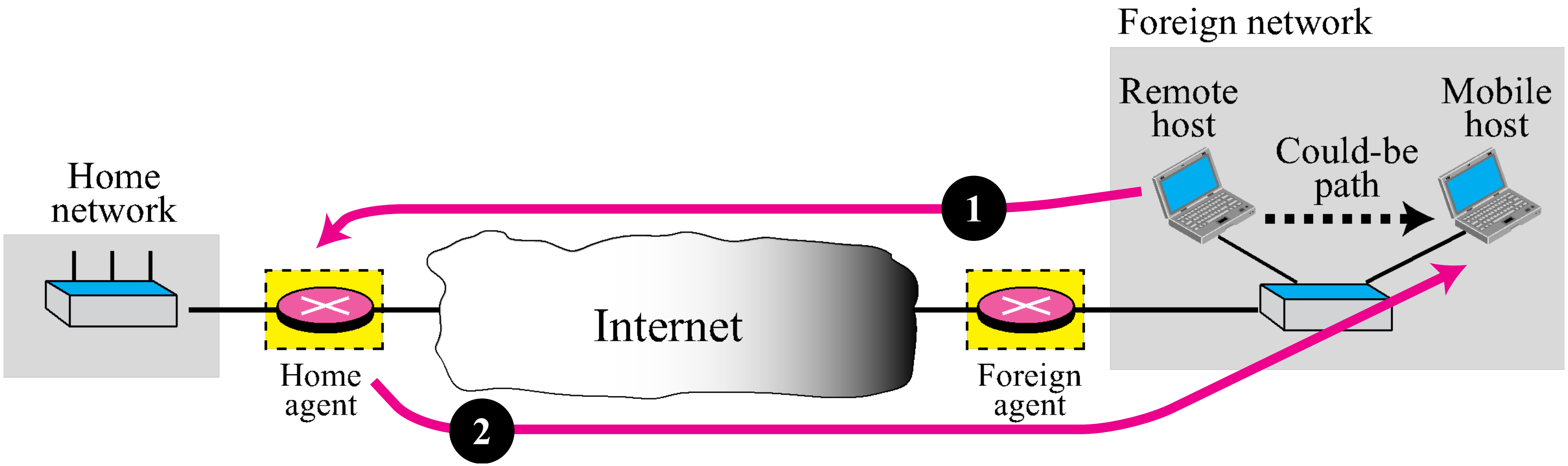


Figure 10.9 *Triangle routing*