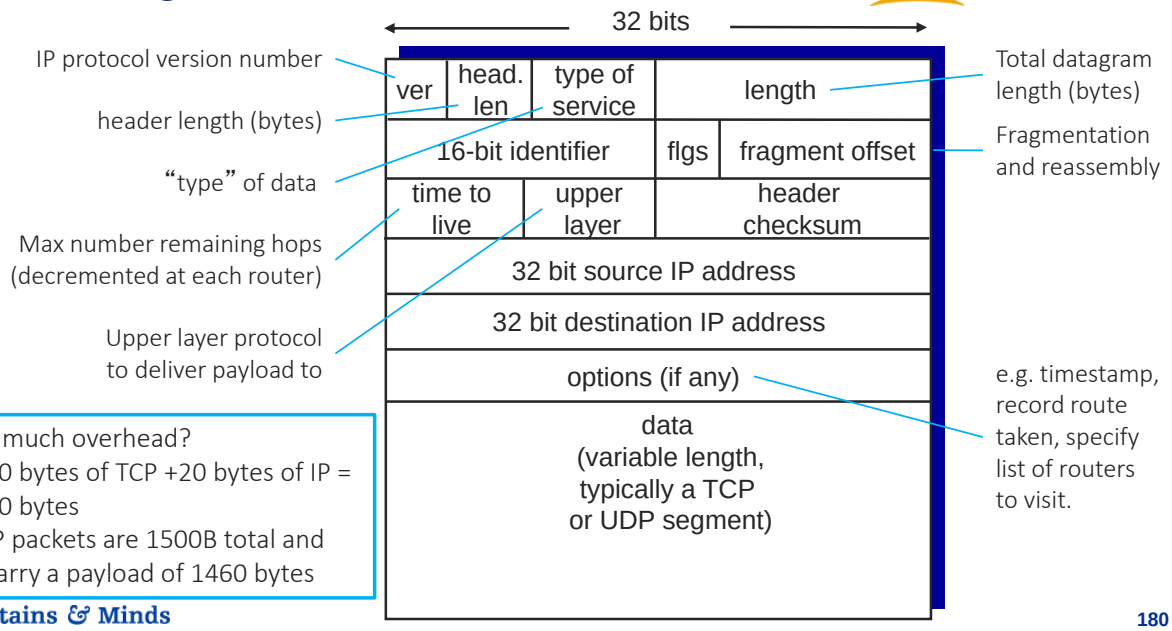
IP Datagram Format



How much overhead?
- 20 bytes of TCP +20 bytes of IP = 40 bytes
- IP packets are 1500B total and carry a payload of 1460 bytes

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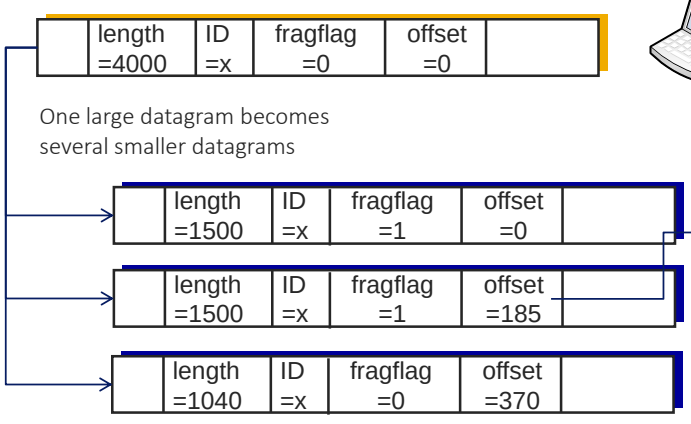
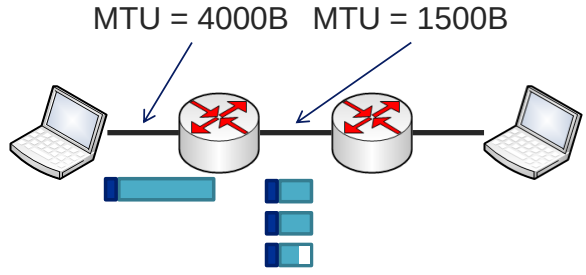
IP Fragmentation

How to deal with different maximum transmission units (MTUs) of different link layer technologies?





Offset in 8B chunks

$185 * 8 = 1480$

Insert this data at byte 1480

Where should the packet be reassembled?
- Next hop?
- Destination?

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IP Addressing

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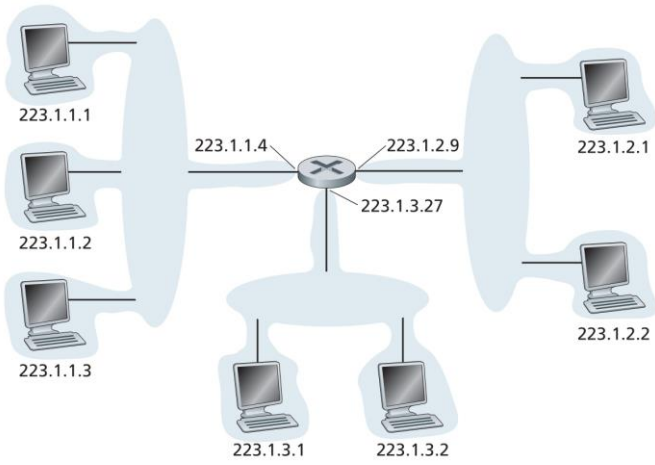
- IP address: 32-bit identifier for host, router interface
- Interface: connection between host/router and physical link
  - Routers typically have multiple interfaces
  - How many interfaces do hosts have? Think of your laptop.
- IP addresses associated with each interface



223.1.1.1 = 11011111 00000001 00000001 00000001

223 1 1 1

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Subnets

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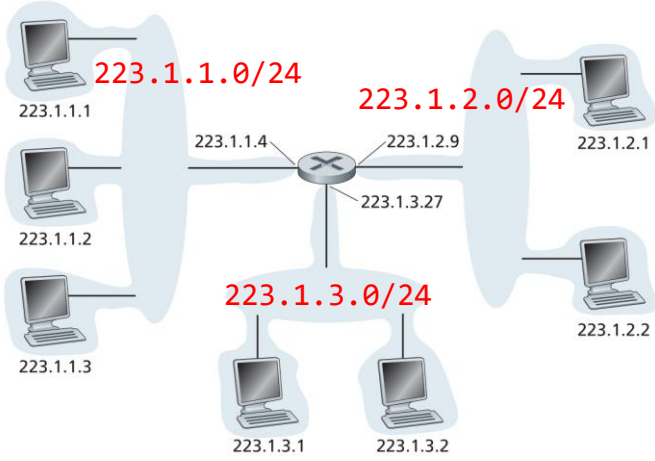
- IP address:
  - subnet part - high order bits
  - host part - low order bits
- What's a subnet ?
  - Device interfaces with same subnet part of IP address
  - Can physically reach each other without intervening router



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How are IP addresses assigned?

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200.23.16.0/23

Subnet part → Host part

11001000 00010111 00010000 00000000

Classful addressing

- Network classes
  - A: 8-bit network portion
  - B: 16-bit network portion
  - C: 24-bit network portion
- What class address should an organization with 500 hosts get?

CIDR

- CIDR: Classless Inter Domain Routing
  - Subnet portion of address of arbitrary length
  - Address format: a.b.c.d/x, where x is # bits in subnet portion of address

How could we double the number of hosts in a /24 subnet?

Subnets

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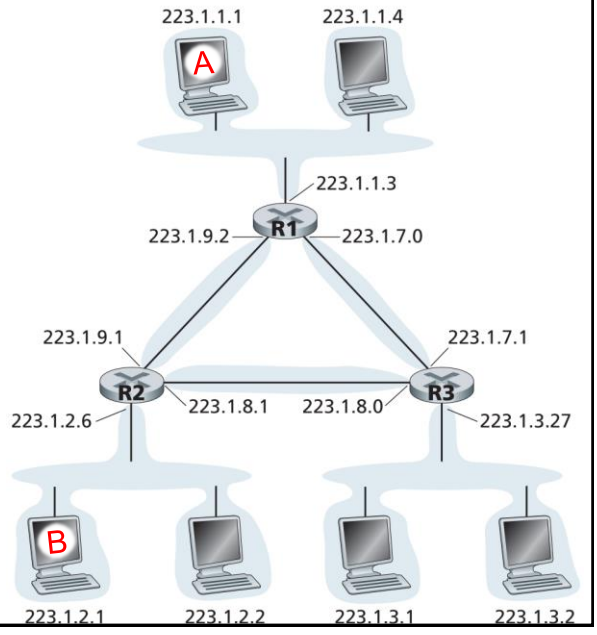
How many subnets are in this network?

Method:

- To determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- Each isolated network is called a subnet

What is a routing path from A to B?



IP addresses: How to get one?

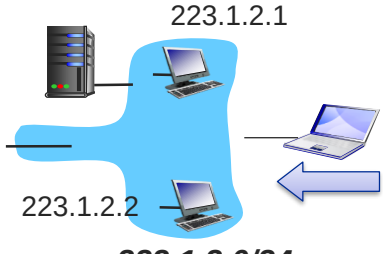
- ISP?: Internet Corporation for Assigned Names and Numbers (ICANN)
- Clients?: Get a portion of ISP's address space
- Users?: Static configuration, or DHCP

ISP's block	11001000 00010111 00010000	00000000	200.23.16.0/20
Organization 0	11001000 00010111 00010000	00000000	200.23.16.0/23
Organization 1	11001000 00010111 00010010	00000000	200.23.18.0/23
Organization 2	11001000 00010111 00010100	00000000	200.23.20.0/23
...	.....	....	....
Organization 7	11001000 00010111 00011110	00000000	200.23.30.0/23

Would it make sense to specify a subnet as 200.23.19.0/23?

Dynamic Host Config. Prot. (DHCP)

- Static configuration:
  - Windows: control-panel → network → configuration → tcp/ip → properties
  - UNIX: /etc/rc.config
- What about mobile users?
- What about /24 network with 500 users?
- DHCP dynamically configures host network settings:
  - Host IP
  - Address of first hop router
  - Name of DNS server
  - Network mask (for broadcast)




```
IP Address:          192.168.1.15
Netmask:             255.255.255.0
Binary IP Address:   11000000.10101000.00000001.00000000
Inverted Net Mask:   00000000.00000000.00000000.11111111
Binary Broadcast IP: 11000000.10101000.00000001.11111111
Broadcast address:   192.168.1.255
```

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	Addresses	Hosts	Netmask	Amount of a Class C
/30	4	2	255.255.255.252	1/64
/29	8	6	255.255.255.248	1/32
/28	16	14	255.255.255.240	1/16
/27	32	30	255.255.255.224	1/8
/26	64	62	255.255.255.192	1/4
/25	128	126	255.255.255.128	1/2
/24	256	254	255.255.255.0	1
/23	512	510	255.255.254.0	2
/22	1024	1022	255.255.252.0	4
/21	2048	2046	255.255.248.0	8
/20	4096	4094	255.255.240.0	16
/19	8192	8190	255.255.224.0	32
/18	16384	16382	255.255.192.0	64
/17	32768	32766	255.255.128.0	128
/16	65536	65534	255.255.0.0	256

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