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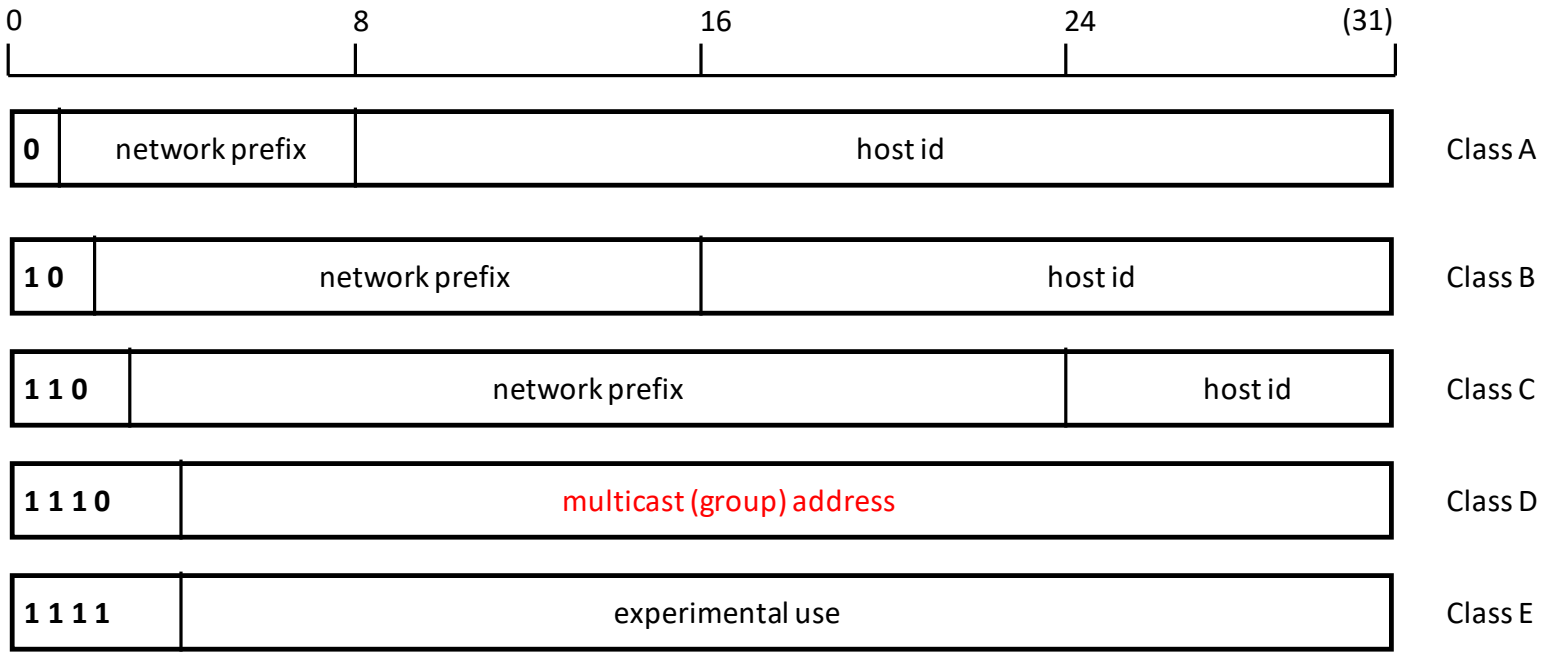
CS2003: Internet and the Web

Communication models: all the casts! (unicast, multicast, broadcast, anycast)

Remember IPv4 classful addressing



Classes A, B and C still in use in some **private** networks, but not used globally.

Class D still in use today, but multicast routing not supported globally.

Class E possibly still in use today, in private networks, for experiments.

Remember IPv4 classless addressing

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- Special addresses:
  - (also many for IPv6, not shown here)

Address example	Src	Dst	Description
255.255.255.255	No	Yes	Limited broadcast. If the local network supports broadcast then broadcast the datagram. This is never passed on by routers.
138.251.255.255 210.50.160.255	No	Yes	Net directed broadcast. If the target network supports broadcast then broadcast the datagram on it.
127.x.x.x	Yes	Yes	Loopback. Send to yourself.
0.0.42.6	Yes	No	Used by a host which does not know its network prefix.
0.0.0.0	Yes	No	Used by a host that does not know its IP address.

- Classless addressing:
  - remove use of Class A, B and C
  - **address mask** → network prefix
  - IPv4 address plus mask: e.g. 138.251.195.61/24
- More flexibility in address allocation.
- routeing information aggregation:
  - (sub-netting & super-netting)
  - **CIDR: Classless InterDomain**

Today's lecture

Expanding these terms that we have already seen:

1. Unicast
2. Broadcast
3. Multicast communication with UDP
4. Anycast with IP

Unicast communication

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- We have already seen this!
  - It is the default communication model that we have been using and implementing

- One-to-one transmission between sender and receiver
- Single copy of data sent from sender to receiver
  - e.g. at application layer: e-mail sent from one sender to one receiver

Unicast communication

- Is unicast appropriate for all applications?
- What about if you want to send the same data to many receivers?
  - "spam" e-mail!
  - any other applications?

Broadcast communication

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- Some applications are “one-to-all”
  - e.g., terrestrial television
- Is this appropriate for the Internet?
  - can you think of an application that would need to send data to every host on the Internet?
  - do TV stations broadcast to every TV in the world?
  - what about applications that might need to send to every host on a LAN?

IP broadcast

- Take bitwise NOT of subnet mask and OR with IP address
  - Gives broadcast address for a subnetwork
- For example: 138.251.195.61/24

```
/24 → 255.255.255.0

138.251.195.61    1000 1010 1111 1011 1100 0011 0011 1101

255.255.255.0     1111 1111 1111 1111 1111 1111 0000 0000

0.0.0.255         0000 0000 0000 0000 0000 0000 1111 1111

138.251.195.255   1000 1010 1111 1011 1100 0011 1111 1111
```

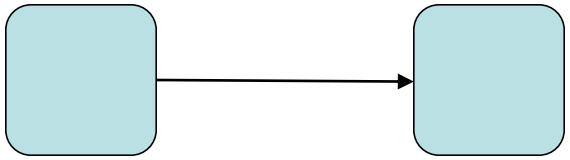
Sending to 138.251.195.255 will broadcast to all hosts in subnet

Unicast, broadcast, ?

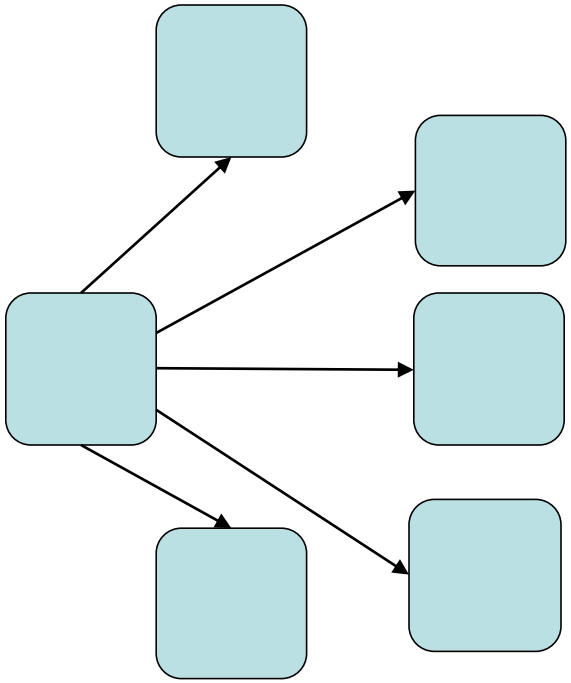
- Some applications are “one-to-one”
- Some applications are “one-to-all”
- Are some applications neither?

- Applications that send same data to more than one receiver
- Applications that send lots of data, and might end up congesting the network if they send to all
- Games, multimedia, …?

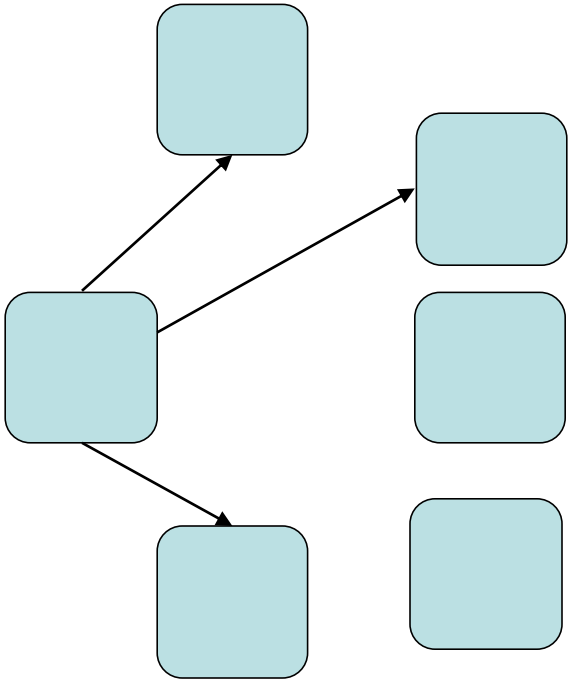
Communication models



Unicast:
one-to-one



Broadcast:
one-to-all



Multicast:
one-to-many

UDP multicast

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- As well as unicast communication …
- … UDP permits **multicast** communication.
- {Many|One}-to-many:
  - destination IP address - multicast **group** address.
  - class D: 224.0.0.0 – 239.255.255.255
  - anyone can send to a **group.**
  - must be a member of the group to receive.
- UDP multicast has same service characteristics as UDP unicast (unreliable datagram service):
  - reliability is a challenge for multicast!

Why UDP multicast?

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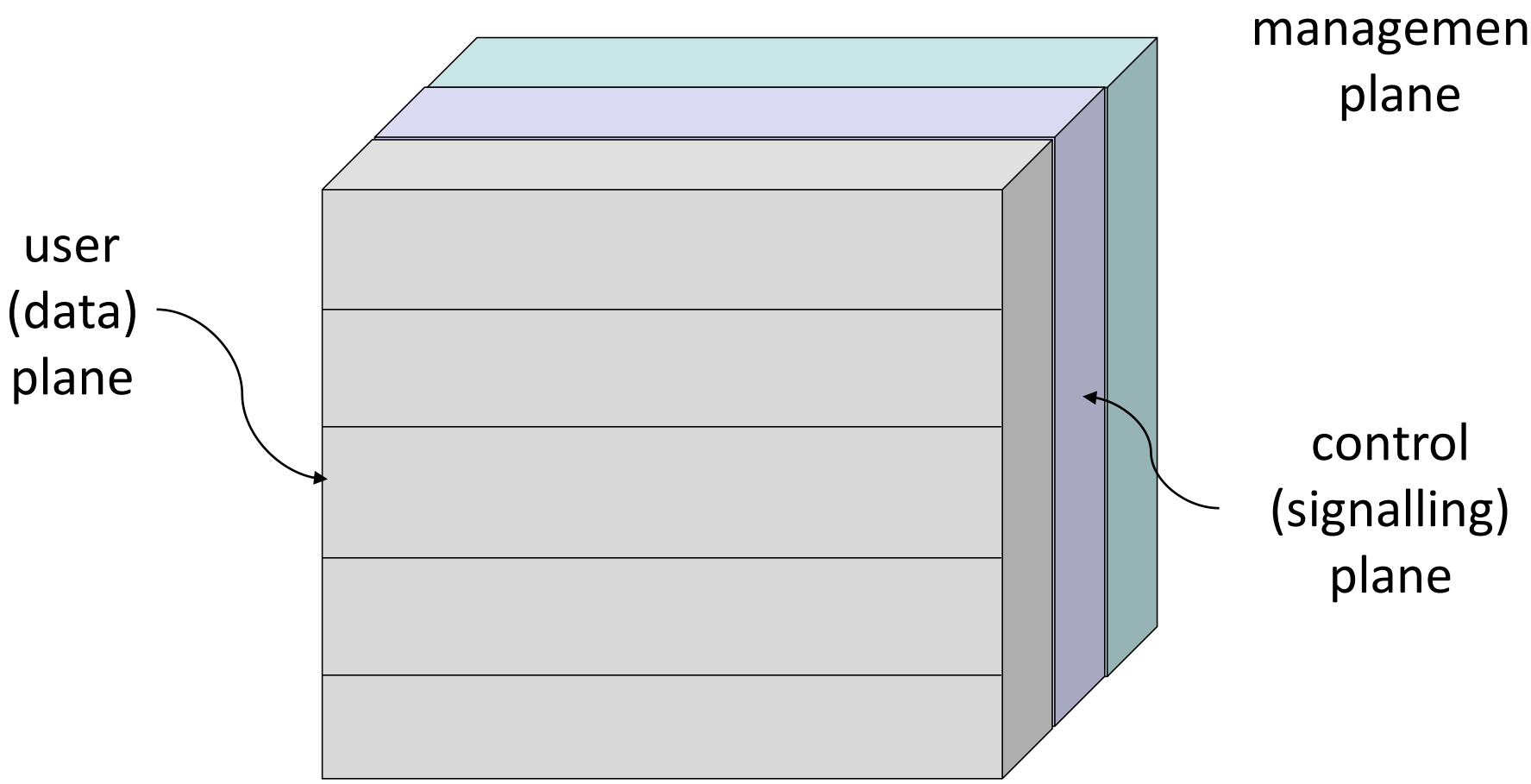
- Why don't we use TCP for multicast?
  - Remember back to flow control and congestion control discussion
  - Flow control: receiver-driven
    - Which receiver should sender listen to?
  - Congestion control: sender-driven
    - Which receiver path should be used to determine congestion response?
- Reliable multicast is tricky!
  - both signalling and management

User / Control / Management planes (1)



User / Control / Management planes (2)

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- User (data) plane:
  - Application data: (human) user of the application.
- Control (signalling) plane:
  - Data and interaction needed for the operation and control of the protocol or application.
- Management plane:
  - configuration information and policy information (for many things that the application does).

Broadcast vs multicast

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Broadcast

- One-to-all
- Packets go to every node on subnet/network (can be Layer 2 or Layer 3)
- Send to broadcast address (e.g. 255.255.255.255)
- Lots of data sent to devices that don't care about it!

Multicast

- One-to-many
- Needs router support and signalling/management
- Can go beyond local network (if other networks and policies support it)
- Send to multicast group address (chosen for particular group, e.g. 224.1.2.3)
- Data only sent to those that subscribe to a group

Discovery protocols

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- Multicast is popular for LAN **discovery protocols**.
  - Devices and services "advertise" their **presence**.
- Examples:
  - mDNS (multicast DNS, RFC6762) – DNS queries for local devices sent to 224.0.0.251
  - NetBIOS (Windows) (also Server Message Block, SMB)
  - DLNA (e.g. TVs, media-players https://www.dlna.org)
- UPnP (Universal Plug and Play)
- ZeroConf (http://www.zeroconf.org):
  - Bonjour in macOS and iOS.

Anycast

- A related and increasingly important concept is IP **anycast**
- Content is often replicated throughout the Internet
  - e.g. CDNs (content distribution network)
  - Netflix etc may replicate videos across regions
- How to find the closest server?
- Anycast: network-layer discovery
  - All replicated servers have same IP address
  - BGP (see later in module) used to point user to "closest" server

Summary

- Unicast
- Broadcast
- Multicast
- (Anycast)
- Further reading: Peterson & Davie Ch 4.3 (but no need to dig into multicast routing at this stage) Kurose & Ross Ch 5.4.4 for anycast