

# ICS 351: Today's plan

- multicasting in general
- IP multicasting
- IGMP
- PIM
- TCP and UDP
- port numbers
- congestion control

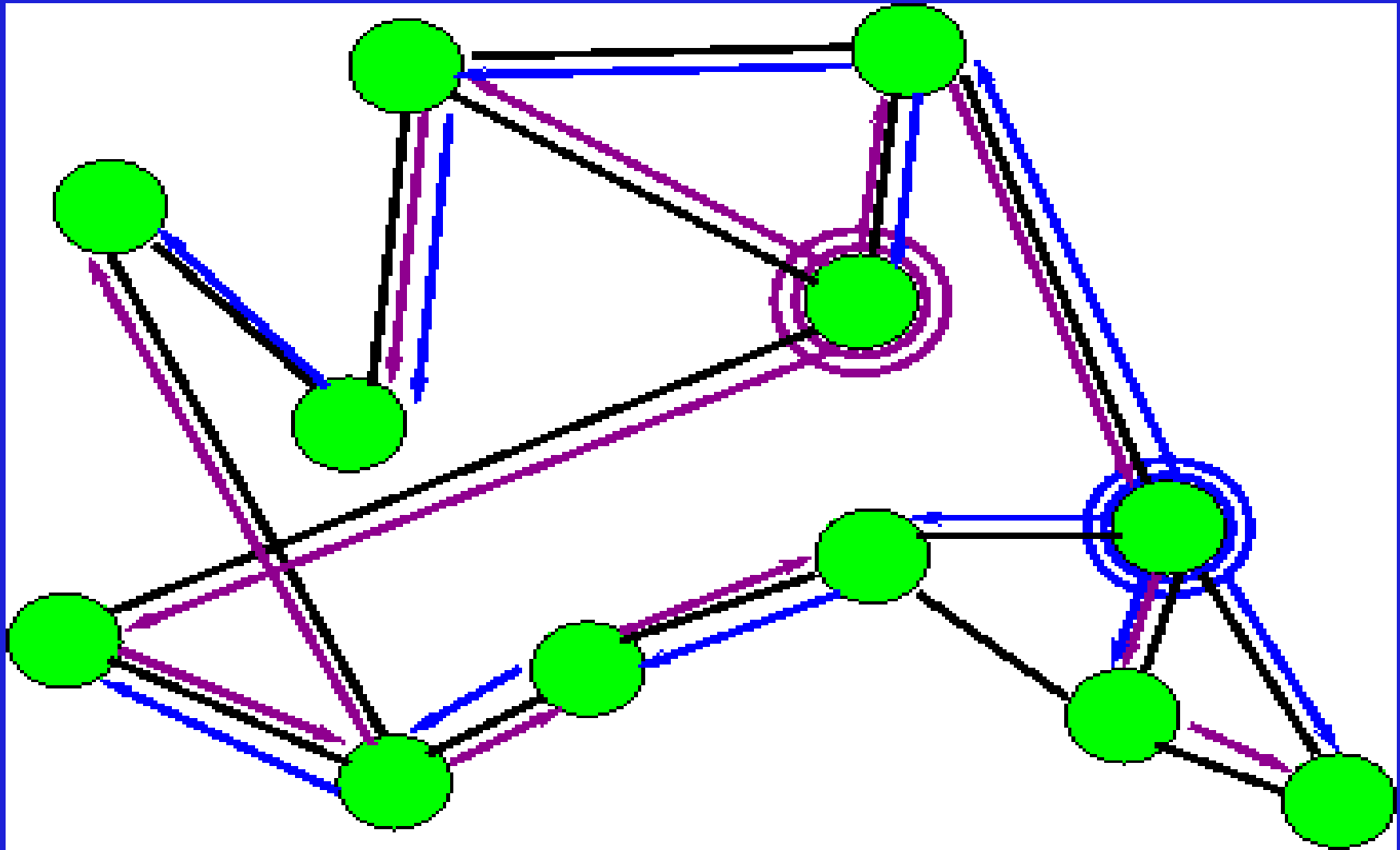
# Multicasting

- if a single sender needs to reach a group of receivers
- or if multiple senders need to reach a group of receivers
- or if multiple computers need to reach each other
- in general, a sender should send each packet (stream) exactly once
- intermediate systems (routers) should duplicate the packet (stream) once for each outgoing link
- overall, this forms a **multicast tree**

# Multicast Trees

- The multicast tree can be built starting from the sender towards the receivers (leaves), along the route that unicast packets would take, or
- the tree can be built by each receiver along the reverse path towards the sender, until a router that already carries the multicast data is found. This is **reverse path forwarding**
- for multicast with multiple senders, the tree can be seen as a **spanning tree** with no real root, and a standard **flooding algorithm** can be used to distribute the data throughout this overlay network
- alternately, the tree can have a designated root, a **rendezvous point** or **RP**

# Multicast Trees



# IP Multicast Addresses

- IP multicast addresses are in class D, beginning with 224 through 239
- 1. the first byte for class A addresses is 0 through 127
- 2. the first byte for class B addresses is 128 through 191
- 3. the first byte for class C addresses is 192 through 223
- 4. the first byte for class D addresses is 224 through 239
- 5. the first byte for class E addresses is 240 through 255
- for example, 224.0.0.9 for RIP packets, 224.0.0.5 for OSPF packets

# IP Multicasting

- IGMP manages group membership in multicast groups within local networks (MLD does the same on IPv6 networks)
- PIM (or MOSPF) are the equivalent of routing protocols for multicast, providing multicast routing when the multicast router is not local

# IGMP

- Internet Group Management Protocol version 3
- used to communicate between a multicast router and local multicast hosts
- the router needs to know which hosts require which multicast stream(s), so as to only forward streams that are needed
- a host requesting a stream from its router results in the router recording this information
- this request expires if not refreshed often enough: **soft state** in the router
- messages sent over IP (protocol number 2) with TTL 1
- IGMP routers send Membership Queries, IGMP hosts send Membership Reports
- RFC 3376

# PIM

- Protocol Independent Multicast is protocol-independent in the sense that it relies on a not-otherwise defined routing protocol to find routes
- PIM dense mode (PIM-DM), RFC 3973
- in dense mode, multicast data is sent to all routers except those that send prune messages
- dense mode is only used within an autonomous system (with MSDP used to allow multicast among autonomous systems)
- PIM sparse mode (PIM-SM), RFC 4601
- in sparse mode, multicast data is broadcast over a tree rooted at a designated router called the **Rendezvous Point (RP)**
- also PIM Source-Specific Multicast (PIM-SSM) and Bidirectional PIM (BIDIR-PIM), a variant of PIM-SM