Network Layer: Broadcast

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Broadcast routing

- deliver packets from source to all other nodes
- source duplication is inefficient:

  - source duplication: how does source determine recipient addresses?

  - in-network duplication
In-network duplication

• **flooding**: when node receives broadcast packet, sends copy to all neighbors
  – problems: cycles & broadcast storm

• **controlled flooding**: node only broadcasts pkt if it hasn’t broadcast same packet before
  – node keeps track of packet ids already broadcasted
  – or reverse path forwarding (RPF): only forward packet if it arrived on shortest path between node and source

• **spanning tree**:
  – no redundant packets received by any node
Spanning tree

- first construct a spanning tree
- nodes then forward/make copies only along spanning tree

(a) broadcast initiated at A
(b) broadcast initiated at D
Spanning tree: creation

- center node
- each node sends unicast join message to center node
  - message forwarded until it arrives at a node already belonging to spanning tree

(a) stepwise construction of spanning tree (center: E)
(b) constructed spanning tree
Broadcast in the Network

• Special IP addresses are "reserved" for broadcast on a subnet
• 255.255.255.255 ("all ones") is always reserved, and won't (usually) cross a router boundary
  – This is how DHCP worked – host without an address sends to 255.255.255.255
  – Sent to all hosts within that subnet, but not across routers
  – Routers can forward to others, but typically will not
Broadcast in the Network

• Special IP addresses are "reserved" for broadcast on a subnet

• All ones in the host part of the subnet is used to broadcast within that subnet (even if multiple routers in use)
  – So if my subnet is 155.66.74.0/24, 155.66.74.255 address is reserved for broadcast
  – If 155.66.74.0/23, it will be 155.66.75.255
  – If 155.66.0.0/16, it will be 155.66.255.255

• This gets forwarded to all hosts in the subnet
IP Multicast

• Newer (and less widely used) is IP multicast

• Basic idea:
  – A single IP address is assigned to be a multicast address (destination)
  – Multiple hosts can join the multicast group
  – Messages sent to that IP address are forwarded to all members of the group

• Use cases:
  – Broadcast media (particularly IPTV), data feeds (stocks), etc.
IP Multicast

- Hosts that are part of the group receive messages
- Routers in these groups need to be aware, forward the messages along
- Other hosts or routers may not participate
Multicast routing: problem statement

**goal:** find a tree (or trees) connecting routers having local mcast group members

- **tree:** not all paths between routers used
- **shared-tree:** same tree used by all group members
- **source-based:** different tree from each sender to rcvrs

**legend**

- group member
- not group member
- router with a group member
- router without group member

shared tree

source-based trees
Q: how to connect “islands” of multicast routers in a “sea” of unicast routers?

- mcast datagram encapsulated inside “normal” (non-multicast-addressed) datagram
- normal IP datagram sent thru “tunnel” via regular IP unicast to receiving mcast router (recall IPv6 inside IPv4 tunneling)
- receiving mcast router unencapsulates to get mcast datagram