MULTICAST AND IGMPv3

Internet Protocols

CSC / ECE 573

Fall, 2005

N. C. State University

Announcements

I. HW5 will be online today – CIDR, subnets, routing
   - due in one week

II. Correction to calendar!

Today's Lecture

I. Multicasting Overview

II. IGMPv3

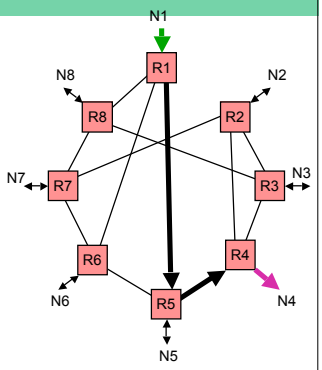
III. Multicast Datagram Forwarding

MULTICASTING OVERVIEW

Unicast

- Simplest case: single source, single destination
- Router just looks up destination address, decides how to forward

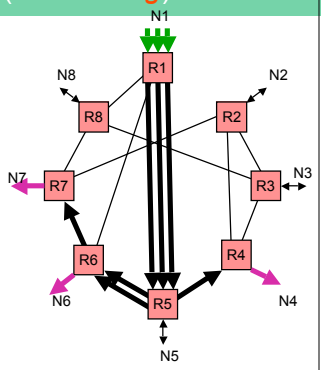
D'gram Copy	Source	Desti-nation
1	N1	N4



Multicast (No *Sharing*)

- One source, $m<n$ destinations
- Source sends m datagram copies, each with one destination

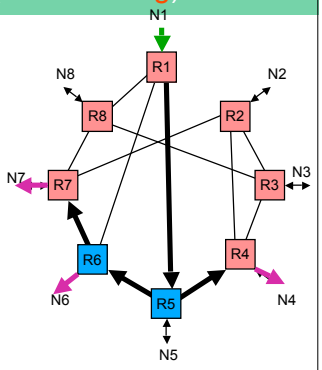
D'gram Copy	Source	Desti-nation
1	N1	N4
2	N1	N6
3	N1	N7



Multicast (With Sharing)

- One source, *m*<*n* destinations
- Source sends 1 datagram copy, with a multicast destination address

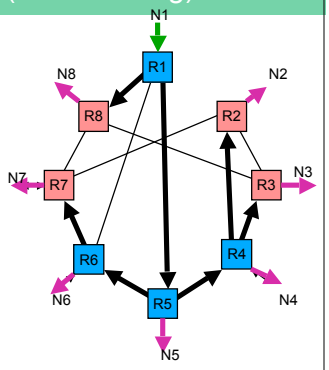
D'gram Copy	Source	Desti-nation
1	N1	M23



Broadcast (With Sharing)

- One source, *n* destinations
- Source sends 1 datagram copy, with a broadcast destination address

D'gram Copy	Source	Desti-nation
1	N1	All



Example Multicast Applications

- Streaming video on-demand
- Radio stations
- Stock quotes
- Multi-user games
- File sharing (e.g. P2P)
- Service location
- …

Possible Approaches to Multicasting

- Source simply unicasts data to each of the receivers
  - advantages?
- Source broadcasts to everyone, receivers accept content if they are interested in it
  - advantages?
- Source unicasts data, and the network replicates and forwards it to the multicast group
  - advantages?

Some Challenges

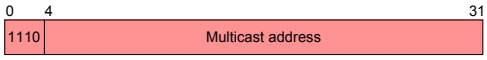
- Non-trivial modifications to routing protocols (and routers)
- Potential for abuse (spammers!)
- Dynamic multicast group membership
- Multicast address allocation and discovery
- Heterogeneity in receiver and network bandwidths
- Simultaneous, reliable transmission (flow and congestion control)

Receiver-Oriented Multicast

- Hosts decide whether they wish to join (become a *member* of) the multicast *group*
  - may join and leave dynamically
  - i.e., *subscribe* to the service
- Groups may be static or dynamic
  - how find out what multicast groups exist?
  - how find out what multicast address is being used?
- Source does not need to know who the members are, but routers do

IPv4 Multicast Addresses

- Class D addresses (224.0.0.0 to 239.255.255.255)
- A part of this range is reserved for control messages, e.g.,
  - 224.0.0.1 = "All systems on this subnet"
  - 224.0.0.2 = "All routers on this subnet"
  - 224.2.0.0/16 = SAP / SDP messages

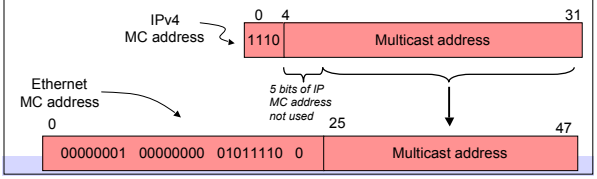


IPv4 Multicast Addresses (cont'd)

- Multicast addresses may only be used as destination addresses
- No ICMP error messages can be generated for multicast datagrams

Ethernet Multicast Addresses

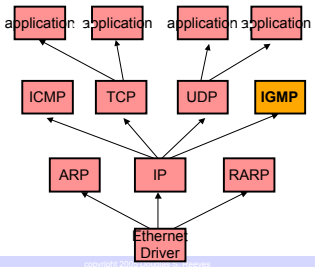
- Ethernet multicast addresses have a 01 (hex) in the most significant 8 bits of the address
- Mapping is not unique
  - more than one IPv4 multicast address may map to the same Ethernet multicast address
  - means receivers have to check whether they are supposed to get this datagram



DYNAMIC GROUP MEMBERSHIP WITH IGMPv3

IGMPv3 (RFC 3376)

- Purpose: notify routers which hosts (on a directly-attached LAN) are interested in receiving data sent to a specific multicast address

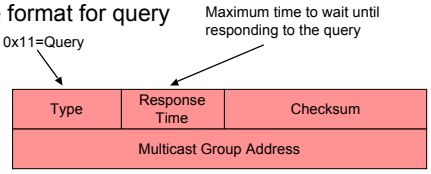


IGMPv3 Phases

- Phase 1 (Host join)
  - send IGMP Request to an IPv4 multicast address, received (and noted) by directly attached routers
  - these routers can notify other routers in the network (not part of IGMP)
- Phase 2 (maintenance)
  - router periodically multicasts IGMP Query to all hosts on the local network to determine whether any hosts are still members of any MC groups
  - if no host replies, router notifies other routers (not part of IGMP)

IGMPv3 Messages: Query

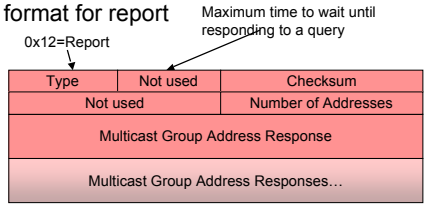
- Message format for query



- Routers multicast IGMP query to all hosts (224.0.0.1) once every 125 seconds
  - general (any group)
  - group-specific

IGMPv3 Messages: Report

- Message format for report



- Hosts listen for responses from other hosts in the same group before responding
  - to suppress duplicate response traffic

IGMPv3 Messages (cont'd)

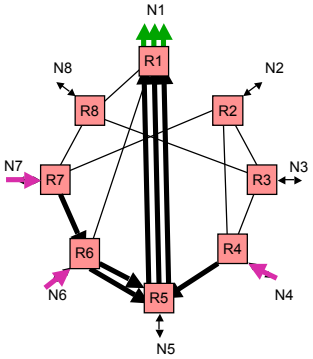
- A host leaving a multicast group sends an explicit Leave message if it previously responded to a IGMP query for that group

MULTICAST DATAGRAM FORWARDING

Multicasting Over the Internet

- Source must establish multicast distribution tree connecting it to destinations in the MC group
- Many ways for doing this, none widely adopted
- A basic idea: reverse path forwarding (RPF)
  - from each destination, follow (in reverse) the forwarding path from that destination to the source
  - merge paths when possible

Example of RPF



Multicast Forwarding

- A host must send the datagram to a multicast router
  - multicast routers recognize multicast addresses and forward datagram out multiple interfaces
  - do not send a copy along a path if that path does not lead to a member of the group

Summary

- Multicasting is intended to be more efficient than multiple unicasts
  - requires support from the network for replicating and forwarding datagrams
- IGMP informs routers of what multicast addresses the hosts on a LAN are subscribed to
- Multicast adds substantial complexity and is not widely used in the Internet despite 15 years of effort, many standards
  - why not?

Next Lecture

- Dynamic Host Configuration Protocol (DHCP)