Elementary Sockets

Lecture 4 (A)

Addressing Techniques

- **Unicast**
  - Packets are sent to and received by a single address
- **Multicast**
  - Identifies a dynamic group which can be joined and left: transmissions are received by all group members, subject to routing policies
- **Broadcast**
  - Identifies a static group representing all IP addresses in a subnet: transmissions to the address are received by all group members, subject to addressing limits and routing policies

Motivation

- Normally, there is only one peer that we want to send a UDP datagram to.

- What if we want to send the same data to more than one peer?
  - Using **unicasting**, we must do multiple sends
  - Using **multicasting**, we send only one copy of each datagram, the network (routers) are responsible to distribute them to the intended receipients

Advantages of Multicasting

- When clients need to look for services, instead of sending out unicast requests by cycling through a range of addresses where the service might be, the client can send out a single multicast request.
  - Instances of the service are listening for such multicasts, and each instance responds by sending its unicast address back to the client: this completes the service-location process

- There is a substantial saving in network bandwidth and therefore in network usage costs as well as saving in time to propogate the datagrams when using multicasting, especially with audio and video streaming applications

Why not broadcasting?

- Routers never forward limited broadcast datagrams but may forward directed-broadcast datagrams to other networks, where they may be received by the router into those networks.
  - RFC 2644 states: "While directed broadcasts have uses, their use on the Internet backbone appears to be comprised entirely of malicious attacks on other networks.“
- Using broadcasting, there is the unwanted load incurred by hosts which are not listening.
  - The broadcast datagram is still received by the network interface and propagated upwards through the various layers of the protocol stack

Multicast Addresses

- A logical IP address that defines a *multicast group,* which in turn is a set of zero or more hosts which have joined the group
- Transmissions sent to a multicast address are delivered to all current members of the group.
- A host must join a multicast group to **receive** multicasts, but it is not necessary to join a group to **send** multicasts to it.
- Special API operations are provided for joining and leaving multicast groups.

IPv4 Multicast Addresses

- Start with **1110** in the most significant four bits
  - 224.0.0.0 – 239.255.255.255

- Addresses in the range **224.0.0.0** to **224.0.0.255** are reserved for low-level multicasting support operations.

Multicast Scopes

- Refer to the the distance it will propagate before being discarded

Multicast Scopes

- **Node-local**
  - not propagated beyond the local node
- **Link-local**
  - not propagated beyond a router
- **Site-local**
  - not propagated beyond the site, as defined by the site's network administrators
- **Organization-local**
  - not propagated beyond the organization, as defined by the organization's network administrators

Multicast Scopes

- **Region-local**
  - not propagated beyond the region, however defined
- **Continent-local**
  - not propagated beyond the continent, however defined
- **Global**
  - propagated everywhere

Two Forms of Scoping

- TTL-based (dynamic) scoping
- Address-based (administrative) scoping

TTL-based scoping

- Available only in IPv4
- TTL (time to live) is used to control the ‘scope’ of the multicast, i.e. how ‘far’ the multicast datagram can propagate.
- Default TTL is 1 which is of **link-local** scope

TTL-based scoping

TTL	Scope
0	Node-local
1	Link-local
< 32	Site-local
< 64	Region-local
< 128	Continent-local
< 255	Global

Address-based Scoping

- Multicast addresses are divided into administrative scopes.

- These have two purposes:
  - they specify how far a multicast datagram will travel, and,
  - they specify the range within which the address is expected to be unique.

Address-based Scoping

- In , IPv4, the address range **239.0.0.0** to **239.255.255.255** is defined as the administratively scoped multicast address space

IPv4 Prefix	IPv4 TTL	Scope
-	0	Node-local
224.0.0.0	1	Link-local
239.255.0.0/16	< 32	Site-local
239.192.0.0/14		Organization-local
224.0.1.0 – 238.255.255.255	<255	Global

Multicast Operations

- In addition to the usual sending and receiving operations, multicast introduces the operations of **joining** and **leaving** a multicast group.

- These operations have several effects:

a) They form or break an association between the socket's bind-address and the multicast address.

b) They condition the host to receive or ignore messages addressed to the group.

c) They condition the nearest router to receive or ignore messages addresses to the multicast group, subject to multicasting being supported in that router.

d) The router in turn propagates this conditioning to adjacent routers, and so on recursively, subject to multicasting being supported in those routers.

Applications of Multicasting

a) Software distribution
b) Time services
c) Naming services like
d) Stock-market tickers, race results, and the like
e) Database replication
f) Video and audio streaming: video conferencing, movie shows, etc
g) Multi-player gaming
h) Distributed resource allocation
i) Service discovery.

Multicast Group Membership

- In most multicast applications, the **client** is a member of a multicast group.
- The **server** most probably is not, unless it wants to listen to its own output for some reason.
- However when multicast is used for service discovery, generally both client and server join the multicast group

Sample Program

- **MulticastSocketServer.java**
- **MulticastSocketClient.java**