

**CNT5106C Computer Networks, Fall 2009**

**Instructor: Prof. Ahmed Helmy**

**Homework #5**

**On Multicast at the Network Layer (IP Multicast and Membership)**

**[Date Assigned: Dec 6<sup>th</sup>, 2009. Due Date: Dec 15<sup>th</sup>, to the TA]**

Total points: 124 points, including 24 extra points

**Q1.** (12 points) In IP multicast, separate mechanisms are used for member management on LANs (consider only IGMP as introduced in class) by the last-hop router and multicast routing in networks. What are the benefits of such separation? What are potential problems of such separation? (list 2 each)

**Q2.** (10 points) In several multicast routing protocols we use RPF check (reversed-path forwarding check). What is the purpose of such check? How does it work? What are the underlying assumptions this check relies on?

**Q3.** (10 points) What are the differences between the targeted environments (potential number of group members etc.) for PIM-DM and PIM-SM? How does this lead to different protocol design?

**Q4.** (18 points) IGMP provides membership information to the first hop router regarding the existence of receivers on a directly connected LAN.

(a) Why are group-specific query messages introduced in IGMPv2? Argue showing what a router does when it receives a 'leave' message from a host.

(b) The multicast host model does not define any interaction between the sources and IGMP. Do you see any problems with that? Explain. [Hint: Think of a case where there are no members for a group.]

(c) A researcher suggested to have the source multicast a query to the group in order to find out whether there are members in the group or not. Receivers would respond to this query by sending response to the source.

(I) Do you think that helps to solve the problem in (b) above? How?

(II) What is a main problem associated with this approach (i.e., the multicast query/response)? Suggest two alternative modifications to alleviate this problem. [Hint: You may use timers at the receivers, but how? You may also suggest simple modifications to IGMP.]

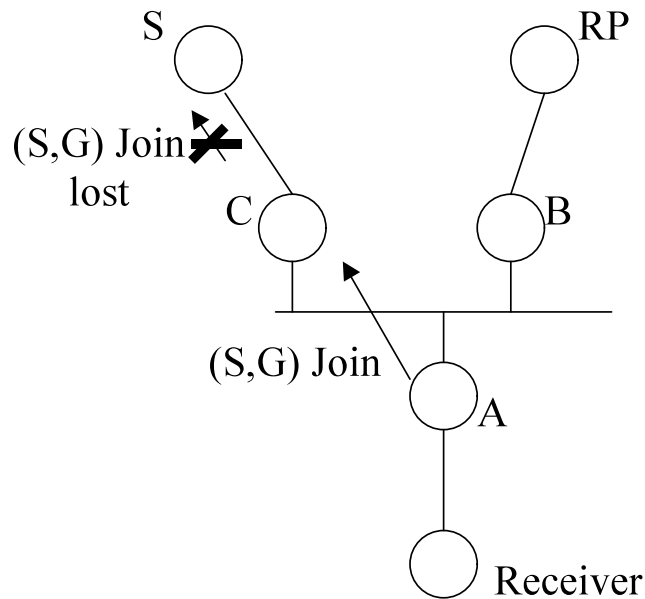
(d) Suggest a simple modification to IGMP (as an alternative to the approach in (c)) to solve the problem in (b).

**Q5.** (12 points: extra) SPT bit in PIM-SM:

- What is the main use of the SPT (Shortest Path Tree) bit in PIM-SM? [Clarify using two simple scenarios]
- Someone suggested to remove this bit to reduce the state required in the routers and reduce the complexity of the protocol. What could be the effect on PIM-SM operation? [Mention a scenario to illustrate]

**Q6.** (18 points) Assert mechanism in PIM-SM:

Based on understanding of the previous question, try to point out the problem with the following scenario:



Node *A* has an interface on a LAN leading to two routers *B* and *C*. Router *B* is the next-hop router on the shortest path to the rendezvous point (*RP*) and router *C* is the next-hop router on the shortest path to the source *S*. One version of the PIM-SM specification states that:

“Upon switching to the shortest path tree (SPT), the router with two different next-hop routers towards the *RP* and the source sets the SPT bit to ‘0’. Upon receiving the first packet from the interface leading to the source, the SPT bit is set to ‘1’ and a prune is sent towards the *RP*”.

- If *A* decides to switch to the shortest path for (S,G), but the (S,G) join from router *C* towards *S* is lost in the above scenario (see figure above), what would happen? [mention which messages will be sent by *A* and what would happen to the packets being forwarded to *A*]
- Someone suggested to change the wording in the specification to add: “only if the ‘interfaces’ (not next-hop routers) towards the *RP* and the source are different, does the router send a prune towards the *RP* when it receives the first packet on

the interface leading to the source”. Do you think that is a good or bad idea (i.e., will it solve the previous problem or not, and will it introduce any other problems)?

[Mention a complete scenario saying what would happen in this case. Would *A* be getting duplicates from the LAN from both *B* and *C*. Hint: you need to understand the Assert mechanism.]

(c) From your understanding in (b) above, comment on the need for distinction between an inactive created state (one that was created with a Join message but not yet used to forward data packets), and an active state (one that has already been used to forward packets). Which of these states should be used in the Assert mechanism, and why?

**Q7.** (16 points) RP Bootstrap mechanism

(a) Someone suggested to use application-level mechanisms to distribute information about the RP in PIM-SM. An application wishing to join or send to a group would listen to an RP announcement group (a multicast group used to disseminate RP to group mapping) to get the RP address for the group. Do you see any problem with the above scenario?

(b) Hashing for Group-to-RP mapping:

Someone suggested a hash algorithm that takes as input the number of the RPs in the RP-list and the group address to get the RP for the group. For example, a list has 3 RPs, RP1, RP2 and RP3, the hash algorithm takes a group address *G* and applies  $f(G,3)=2$  (for example) so it chooses RP2 to be the RP for the group. Do you think that is a good approach to the RP mapping? Why?

**Q8.** (18 points) Soft state vs. hard state

PIM-SM uses a concept called ‘soft-state’ in its messaging protocol. This concept simply indicates that a join message (for example) is sent periodically by the downstream routers to the upstream router to refresh the join state. An alternative would be to use ‘hard-state’ messaging, in which an ack is sent for each message, such that a join and a join-ack (2 messages) only need to be sent between an upstream and a downstream router on a link.

(a) Which protocol incurs less overhead on the network?

(b) Why are soft-state mechanisms sometimes preferred over hard-state mechanisms?

(c) Soft-state protocols incur more overhead on the network, especially when the number of states in the router (source-group pair state, for example) increases, as a state refresh needs to be sent upstream for every state at fixed periods. Obviously,

this approach does not scale. Suggest an approach to alleviate this problem and discuss its advantages and disadvantages. [Hint: You may use timers].

**Q9.** (10 points) What is the timer-suppression mechanism, and why is it used? Mention at least two mechanisms for multicast routing (either in IGMP or multicast routing protocols) that use such a scheme.