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Distributed Computing Group

AS 2007

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Ad Hoc And Sensor Networks
Exercise 6

Assigned: November 12, 2007
Due: November 19, 2007

1 Mobile IP

We have seen in the lecture that in mobile IP, the client node (CN) sends its packets to the home agent (HA), which forwards the data to the mobile agent (MA). Packets flowing back are sent directly fromt he MA to the CN. As the indirect routing ($CN \rightarrow HA \rightarrow MA$) introduces longer routes, it may be undesirable for many applications.

A proposed solution to the problem works as following: CN asks HA for the current address of the MA, and then uses this address to contact MA directly.

a) What are the problems introduced by this solution?

b) This proposed solution is similar to a location service. Instead of returning a location, the service returns the current network address of a given node. What are the actions performed by the *Lookup*() and *Publish*() methods for the mobile IP? When are they called?

2 Mobility in MANETs

In this exercise, we consider mobile ad hoc networks (MANETs), where many nodes collaborate to build a network. In these networks, it is generally considered that the network nodes themselves are responsible for many tasks, e.g. routing. We have already seen that geographic routing approaches do scale well and can be easily applied to huge networks. However, there is one initial problem: How does the sender node know the position of the destination? This question is especially hard in mobile networks, where nodes change their position over time. In this exercise, we examine *lookup services* for MANETs, which provide *Lookup*() and *Publish*() methods to each network node. *Publish*() is used by a node to announce its current position, and *Lookup*() is used to learn the position of another node.

For this exercise, assume that there is a large set S of stationary nodes in the network that are not mobile. Thus, each mobile node n may choose a node s from S as its home agent, where other nodes can query the current position of n.

a) In mobile IP, each (mobile) node has a *single* dedicated home agent. Show that this single-home approach can introduce a huge communication stretch, e.g. find networks (graphs) where at least one (source-destination) pair has a huge communication stretch.

   Remember: The communication stretch between s and t is defined as the ratio between the experienced number of hops to send the message from s to t, including the lookup cost, and the length (number of hops) of the optimal path between s and t.

b) GLS tackles this problem by storing the position of mobile nodes not only in one home agent, but several home agents. The image below depicts GLS' view of a network: The grid recursively partitions the network into small sub-networks, which are geographically disjoint, see Figure 1. For the nodes 14, 39, 43, and 81 determine the set of the selected location servers. Verify your solution with the slides from the course, but don't cheat ;-)

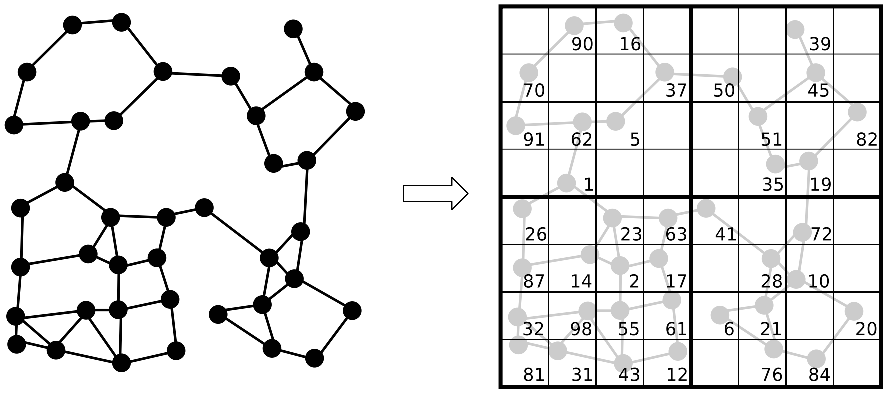

Figure 1: GLS recursively subdivides a network into squares (levels).

c) Determine the lookup path of the following source-destination pairs: $(14 \rightarrow 39)$, $(10 \rightarrow 43)$, $(23 \rightarrow 43)$.

GLS is not particularly good in terms of the update cost generated by a moving node. Whenever a node moves to a different position, it needs to update all of its location servers. One approach is that a location server on level-n does not know the exact position of the node, but only in which of the four level-$(n-1)$ squares the node is located. Then, a node that moves over a level-k boundary only needs to update the location servers of the levels 1 through $k+1$, as the remaining location servers still point to the correct position.

d) Why does the described publish algorithm not reduce the worst case publish cost?

e) How does MLS fix this problem?