

15-440: Distributed Systems

Problem Solving Assignment 2

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Due date: Oct 13, 2011

1. The Internet is far too large for any router to hold routing information for all destinations. How does the Internet routing schemes deal with this issue? Specifically, your answer should describe how Internet routing handles the following issues:
 - o Information storage at routers: How do the routing protocols store the information to route packets to all the computers connected to the Internet? What information is stored? Is this information sufficient to route any packet to any computer on the Internet?
 - o Packet forwarding: How does the router use the stored routing information for forwarding each packet? What are the challenges while forwarding? What is the fault-tolerance mechanism employed by routing?
 - o Scalability: Explain the scalability challenge for routing over the Internet?
2. Assume that you are building a distributed system that tracks the animals in a forest, and relays the data about the animal movement to several zoology researchers around the world.

Several wireless routers are deployed across the forest. Wireless routers are connected to a central server using a high-bandwidth dedicated wireless network. Assume that the wireless connectivity from the routers to the server is reliable and the bandwidth is sufficient for all communications.

Each animal is fitted with a wireless *sensor collar* that has a small computer, wireless radio and a GPS unit. Each sensor collar has a unique ID. The collar should record the animal location every 5 minutes, and transmit all the locations of the animal to the central server using wireless connectivity. The data for storing sensor information has the format $\langle time, collarID, location \rangle$. Assume that the collar is weather-proofed (e.g., it works even if the animal is within water), and has enough storage to store all the data generated. However, the collar has intermittent connectivity; it can connect to wireless routers only when it is near one, and there are many regions in the forest where there is no connectivity.

Zoology researchers across the world subscribe to the stream of data from a set of animals (with unique collar ID) from the central server. This data stream

contains the time and location of the animal. Based on this requirement, design a multi-tiered *Message-Queuing (MQ)* system that allows zoology researchers to obtain real-time data of animal movements. Be sure to specify where the queues are placed, how the entities communicate, and how to ensure reliable delivery.

3. How would you design a naming system for the distributed system of sensor nodes explained in Question 2? Assume that each collarID is unique, and a client can communicate with a collarID if it sends a message to the nearest wireless router (assume that each router has a static IP address). The naming system should support resolving the name defined by collarID to the IP address of the nearest router. Identify how the above naming system is different than the traditional naming systems that you have studied in the class? Describe the design of your naming system, and the challenges in designing it.