2009 High Speed Workshop Problem Statement

WEATHER MODIFICATION

It is the year 2020, and the science of weather modification has advanced to the point that it can be used across the North American continent to control precipitation, cloud cover, and received solar energy. It can be used to remove cloud cover during daytime over solar energy facilities, for example, and to create cloud cover for periods of time to stave off some effects of global warming.

It is based on cloud seeding technology originally developed in 1946. Experiments based on this idea confirmed that cloud seeding had an effect on weather, but data at that time was inconclusive as to the effectiveness of the technology. See http://en.wikipedia.org/wiki/Cloud_seeding

The breakthough in weather modification that occurred in 2015 led to global weather models that incorporated the effects of weather modification techniques, which confirmed that weather modification was possible and practical. By 2020, continental North America deployed a weather modification system comprising:

- A network of sensors on the surface of the continent that sample temperature, pressure, humidity, and wind velocity, and communicate these values with time of day and geographic location to a data center repository
- Airborne sensors installed on commercial aircraft that collect temperature, pressure, humidity, wind velocity, time of day, altitude, and GPS coordinates,
- Cloud cover images from satellites
- A network of weather modification injectors that can inject weather modification chemicals into the atmosphere
- A data repository to hold the real time information, and to collect historical data to enable simulation and analysis
- A petaflop computer that can determine how and when to inject weather modification chemicals to attain specific results.

Here are some design issues for workshop groups:

1. Assume that the earthbound sensors are distributed with a density that averages one sensor per 10 square miles. The area of the United States is about 10 million square miles, so that the US by itself requires a millions of these sensors. The collection rate of the sensor is a sample set per minute. Assume that the sensor net collects the information by a distributed to wireless protocol and moves data to ports where land lines can feed the data to a data center.
Work out the communication details for this network. Given the assumed technology in 2020, how much power would a node in the network need to draw to perform its tasks. How large a solar array would be needed to power the node?

2. For the airborne network, the commercial flights need to hand off data to collection centers as they overfly the centers. Assume that at any time there are 10,000 commercial flights in the air. The data rate for the sensors on the aircraft are one data set per second. Work out the communication details for the airborne communication network.

3. The petaflop computer uses ciurrent and historical data to model where and when to inject chemicals to modify weather. Assume that the petaflop processor must perform its simulations by using repository data that collects samples from all nodes in the system. The transfer rate of data from the repository to support the simulation must be 100 times the real-time data collection rate. Design the data repository to support both random and serial access to the data to meet these requirements. Assume that for each byte of data accessed randomly, there are 100,000 bytes of data accessed sequentially.

4. Blue sky conjectures: Just for fun, estimate what a network would like that could mitigate the effects of hurricanes like Katrina and Ike.