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Homework #1.D

Response to:
Mainwaring, Polastre, Szewczyk, Culler, and Anderson, “Wireless Sensor Networks for Habitat Monitoring”, WSNA 2002.
http://www.cs.berkeley.edu/~culler/papers/wsna02.pdf

In this paper, the authors discuss the application of a wireless sensor network for habitat monitoring. This application set is unique in its lack of human interference. Many other applications have the potential for human interaction; especially with maintenance, whereas human interaction could devistate a population in some habitats. To support this sparsity of humans, a tiered network with WAN connectivity was proposed so data could be uploaded to a more central database, removing the need for humans to be on-site. The deployed motes also needed to survive a full 12-months with many probes in a day, and the weather that the full year brought. The architecture for the system was presented in an application agnostic way, with the intent that it could be applied to a variety of similar situations.

The network deployed was designed to monitor Leach's Storm Petrels, a small cold-weather bird found on Great Duck Island (GDI), off the Northern U.S. Atlantic Coast. Previous studies found that the presence of field researchers could cause dramatic effects in the wildlife. To mitigate these risks, a human-less method of data collection was necessary: a wireless sensor network was thus designed to meet these needs. Since GDI is a small island, data-backhaul was a concern: no researchers would be on the island, except for installation and removal of sensors, so a WAN-connected sensor networked was needed.

A tiered network was devised to meet the data-path needs. At the lowest level, Mica motes with a custom weather-sensing board and 512KB of nonvolative memory was used. The weather board contained a photoresistor, thermometer, barometric pressure sensor, barometric pressure temperature sensor, humidity sensor, thermopile, and thermistor. The data gathered from these would be sent over a single-channel 916 MHz RF Monolithic radio to a local gateway, which served a specific breeding ground area. The gateways then fed the area data through a transit network to a single basestation on the island. The transit network allowed gateways to be well spread out though the island, and be able to get their data to the basestation. The basestation had a direct WAN connection, and could upload data to a variety of online storage locations, and also maintain a copy for itself. The basestation would be placed near a ranger station on the island with accessible solar-power, as there is increased power draw for the WAN connectivity. At researchers' home base, an internet-accessible PostgreSQL relational database was deployed as a repository for data. The database was synced with the basestation every 15 minutes. On top of the database, there were a variety of possible interfaces, which were left up to those interested in the data.

The validity of the sensor data was validated against previous years' biologist-collected data, including an assertion of the relationship between above-ground temperature/humidity and the in-burrow temperature/humidity. Conditions were expected to fluctuate above-ground, yet stay relatively constant in the burrows; this was observed, validating with expectations. The sensor network was deployed in July, 2002, and was active until at least September; the paper does not mention results through the winter. There were many recorded instances of loss of WAN connectivity. Connectivity was restored when possible, after which data was sync to the online database, indicating no loss in data, as each tier kept personal records until they could be verifiably transmitted. These results indicate that logging and data-integrity methods were effective.

This application expelified the ability for a wireless sensor network to be designed, deployed, and left alone for an extended period of time. In contrast to many sensor networks, there was a large variety of readings that are desired for habitat monitoring, increasing the sensor-load on the battery, as well as the frequent sample-rate. This case represents a solid application of a wireless sensor network that is robust, has longevity, and is capable, despite occuring at a time when sensor motes were still in relative infancy. These days, the power requirements by the system could easily be met, allowing for multi-year potential.

One technical question I have relates to the RF radios used. Specifically, I'm wondering how they compare to the 802.15.4 Xbee radios we're using in class; how do their power requirements, range, and data-durability differ? I was also informed of the petrel birds that were monitored. One glaring issue with the paper is the lack of conclusive results on the longevity of the network. A few months of data doesn't meet the 9-12month roadmap initally layed out. Specifically, after 7 months, what happened? Did the motes chip creep, explode, forget how to radio? The first few moments of a project are rarely conclusive on the durability of technology.