DEPLOYING A WSN ON AN ACTIVE VOLCANO

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Paper

Werner-Allen, G., Lorincz, K., Ruiz, M., Marcillo, O., Johnson, J., Lees, J., & Welsh, M. (2006). Deploying a wireless sensor network on an active volcano. Internet Computing, IEEE, 10(2), 18-25.

Viewable at `http://bit.ly/wsn-volcano`

1. Discuss objectives of paper
2. Why is a WSN suitable for this task?
3. Potential roadblocks
4. Solutions implemented
5. Results

OBJECTIVES

1. Deploy 16 low-power wireless sensor nodes on an active volcano.
2. Monitor seismic activity through accelerometer data.
3. Discuss the feasibility of this approach in this harsh environment.
4. Examine benefits and detriments.

WHY A WSN?

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- Fast deployment

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- Network Topology
  - Nodes must have large internode distance to capture diverse data
  - Node failure poses serious threat to communication

HARDWARE

Each sensor was equipped with the following:

- 8-dBi 2.4 GHz external omnidirectional antenna
    - 2.4-GHz Chipcon CC2420 IEEE 802.15.4 radio
- Geospace Industrial GS-11 single axis seismometer
- Microphone
- Custom hardware interface board
- Runs TinyOS

OVERCOMING HIGH DATA RATES

Explanation

*IEEE 802.15.4 radios, such as the Chipcon CC2420, have raw data rates of **30 Kbytes per second**. However, overheads caused by packet framing, medium access control (MAC), and multihop routing reduce the achievable data rate to less than **10 Kbytes per second**, even in a single-hop network.*

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Problem

- Nodes can acquire data faster than they can transmit it.
- Long-term local storage infeasible, as flash memory (1 Mbyte) fills up in roughly 20 minutes during normal use cases.

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SOLUTION

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2. Upon triggering, the nodes sends a small message to the base-station laptop.
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    - Note that since most volcanic events last only 60 seconds, we should be able to keep this data stored long enough to retrieve.

RELIABLE DATA TRANSMISSION

Problem

Radio links are lossy and frequently asymmetrical.

SOLUTION

The authors developed a reliable data-collection protocol, which they called **Fetch**.

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Protocol

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4. Because the network is sparse, the laptop uses **flooding** to request data from the network.

TIME SYNCHRONIZATION

Problem

The low-cost crystal oscillators on these nodes have low tolerances. Therefore, the clock rate varies across the network.

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2. Using this receiver, the node would map FTSP global time to GMT.
3. This data was then flooded across the network and each node would update its time when its time was off by more than 10 milliseconds.

NETWORK TOPOLOGY

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- Most nodes had 3 hops to base station. A select few were using 6.

FIGURE 1

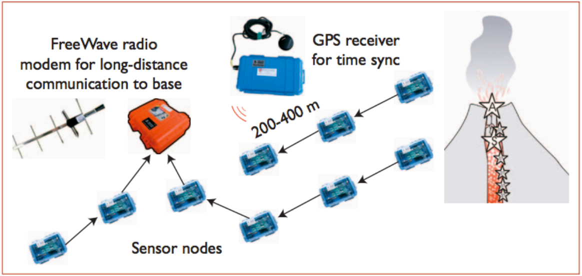
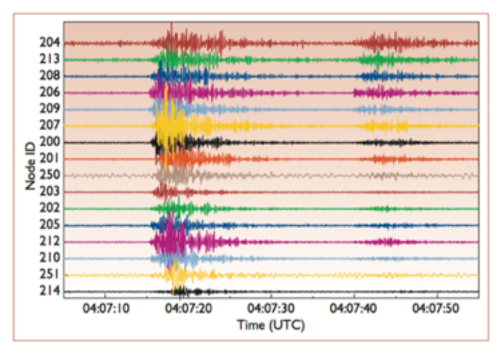


Figure 1. The volcano monitoring sensor-network architecture. The network consists of 16 sensor nodes, each with a microphone and siesmometer, collecting seismic and acoustic data on volcanic activity. Nodes relay data via a multihop network to a gateway node connected to a long-distance FreeWave modem, providing radio connectivity with a laptop at the observatory. A GPS receiver is used along with a multihop time-synchronization protocol to establish a network-wide timebase.

Figure 1: Figure from the paper describing the topology

RESULTS

- General good performance
- 19 day deployment
- Network uptime: 61%
- Most common point of failure was software failure.
- Detected 230 eruptions and 107 Mbytes of data.



QUESTIONS?