Bringing it all together:
A distributed system to monitor snow water equivalence (SWE)

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Motivation
Present Approach 1: Snow Course

Photos: US Forest Service (L) and Canadian National Snow Information System for Water (R)

Present Approach 2: Snow Pillow

Photo: Delaware River Basin Commission
SWE Problem Statement

- How can the temporal and spatial resolution of data regarding snow packs be improved?
- How can this data be provided in a non-destructive manner?

SnowMAN 1.0 concept
Embedded System

Sensor Node Block Diagram

- Snow Height (ultrasound ranger)
- Weight (Load Cell)
- Weight (Pressure Gauge)
- Voltage Regulator
- Battery (external sensors)
- Temperature
- Humidity
- Battery (mote)
- I/O
- A/D
- Microcontroller
- Radio
- Antenna
Integrated System

Network Topology

Station 1

Station 2

Hub Station

Station 3

Data Mule
SnowMAN 1.0 deployment

Lessons Learned

- Test, test, test!
- Battery technology (A-hr is not enough)
- Weight sensor issues
  - Small platform prone to snow-bridging error
  - Sensor failure
Can microwave attenuation be utilized?

Can gamma attenuation be utilized?
Implementing New Sensing Modalities

Adaptive Sampling

- Ultrasound sensor indicates height change?
- Temperature sensors indicate melt conditions?
- Microwave sensors indicate change in attenuation?
- CZT detector captures SWE data.
Conclusion

- A distributed sensing approach would improve the current understanding of SWE
- New sensing modalities need to be developed
- Algorithms are needed to ensure sampling and processing is conducted efficiently

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