PermaSense III & Observability by Design

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PermaSense III – Objectives

- Establishing a *highly reliable and dependable wireless infrastructure* for sensor and actuator networks in *extreme environmental conditions*
  - Terrain movement, evolution of slope stability
  - Long periods of unsupervised operation
  - Limited power sources
  - Maximizing data yield

- Combining *sensor and actuator functionality*

- Paving the road for *future applications in early warning*
PermaSense III – New Horizons

- Multitude of (new) sensors
  - Precision movement detection
  - Resistivity tomography
  - Micro-seismic events
  - High resolution imaging

- Large variety of time scales
  - Real-time actuation and sensing for fast processes
  - Long term for slow processes

- Remote locations
  - No possibility of physical repair/update
  - No infrastructure
  - Sensor node in a pocket
PermaSense III – Acoustic Emission Sensing

- Pilot campaign 04/2010
  - Standard lab equipment with long coaxial cables on Jungfraujoch research station
  - Collaboration with D. Amitrano (U Grenoble)
  - Assessment of small-scale variability -> detailed model

Sensors: Piezo microphone ~150 kHz
Initial Acoustic Emission Data from Jungfraujoch
Observation – Known Scaling Behavior

![Graph showing scaling behavior](image.png)
PermaSense III – Challenges

- Understanding the relevant processes of rock fracturing by ice formation
- Modeling and model validation by measured data
- Identification of suitable measurement techniques
- (Low-power) sensors for distributed acoustic emission measurements
  - High sampling rates (raw data vs. preprocessing)
  - Low-power wireless sensors (batteries or energy scavenging?)
Observability by Design – Objectives

- Sensor networks are fragile
  - Harsh environment, scare resources

- Our goal: To make sensor networks observable
  - Minimal or no interference
  - Systematic and methodology-based
  - Facilitate deployment
  - Improve reliability
A Tool Framework for Observability?

- Energy/resource budget
- Protocols include extra bits of state info in protocols
- Observable state
- Back annotation
- Trace analysis
- Generator
- Executable code
- Observable requirements

Application
Observability – Performance Analysis

Sensor Network

Feedback

SN Data

System/Error Model

System Status

Packet Analysis

Filtered, annotated data

Analysis

User domain Research
Observability – Ongoing/Future Work

- **Tools**
  - Generating event based code from threads
  - Automated communication protocol parameter exploration
  - FlockLab testbed (Multi context tracing)

- **Mechanisms and Concepts**
  - Resource usage vs. observability tradeoff
  - In-system intelligence (online health monitoring)
  - Conformance (model based) testing of trace data
  - Time triggered system architectures