Cluster 3 – Networked software systems

PermaSense: Second Generation, Second Investigation

Igor Talzi, Christian Tschudin / University of Basel, Computer Science Dept
Andreas Hasler, Stephan Gruber / University of Zürich, Dept of Geography

Introduction

Currently, there is a lack of stand-alone geo-monitoring systems for harsh environments that are

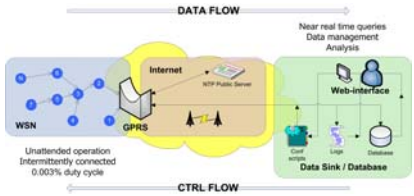
- easy to configure, deploy and manage,
- while at the same time adhering to science grade quality requirements.

In a joint computer and geo-science project we have built and deployed a wireless sensor network for measuring permafrost related parameters.

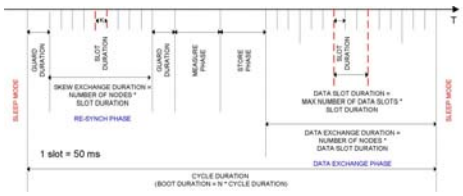
PermaSense at a Glance

Adapting sensor data collection to an Intermittently Connected Network (ICN):

- long sleep cycles: power-aware hardware and protocol design.
- extended network partitions (e.g. due to snow cover).
- reliable data delivery.



- Own Time-Division-style Medium Access (TDMA) with integrated node re-synchronization.
- Multi-hop routing based on a simple spanning tree.
- Robust data collection, in-network data replication.

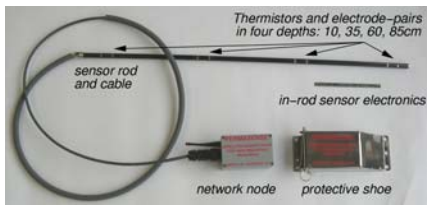


1-st Generation, year 2006

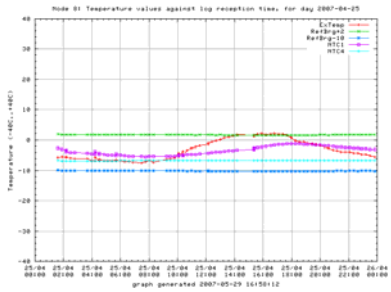
One sensor field (10 sensor nodes) was installed in the Swiss Alps on Jungfraujoch at 3'500 m above sea level, in August 2006. Each node measures in near real-time:

- 4 temperatures
- 4 conductivities

These values are indicative for rock moisture content and its phase state in the near surface layer.



Measurements, as well as special events (clock skew, sensor replacement, etc) are numbered, recorded in the flash memory and queued for transmission towards the GPRS node where they are cached.



The data-sink software (Java and CGI-scripts)

- receives and stores data packets,
- assigns calibrated time stamps to the measurements,
- visualizes data in a various ways,
- allows to manage the collected data and the network.

2-nd Generation, year 2007

The upgrade of the system with 15 nodes will be deployed in summer 2007 on the Jungfrau east ridge and Sphinx. Moreover, we will build a second generation of sensors and deploy two additional sites for summer 2007 that can also measure:

- crack dilatation.
- moisture/ice content.
- water pressure.

The second generation will imply:

- a fully customized extension board and a TinyNode wireless module.
- all form-factors remain the same.
- integration with Deployment Support Network (DSN) infrastructure.

EMSR - New Initiative

In March, 2007 we have started an additional joint project including:

- Comp Science Dept, UniBas
- Dept of Geography, UniZür
- TIK group @ ETHZ

Major goals of the EMSR project are:

- specifying, production and testing the Sensor Interface Board (SIB) platform which will include many new features and will be specifically designed for low-power operation.
- providing testing support for PermaSense infrastructure.
- support and documentation for other projects.

Publications

1) "PermaSense: Investigating Permafrost with a WSN in the Swiss Alps". 4th Workshop on Embedded Networked Sensors (EmNets 2007), Cork, 25-26 June 07.

2) "Permafrost in steep bedrock slopes and its temperature-related destabilization following climate change". Journal of Geophysical Research, 112, 2007.

3) "Power-Aware Synchronization in Intermittently Connected Wireless Sensor Networks" (to be published).

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Umwelt BAFU
Office fédéral de l'environnement OFEV
Ufficio federale dell'ambiente UFAM
Uffizi federal d'ambient UFAM

FNSNF
Fonds national suisse
Schweizerischer Nationalfonds
Fondo nazionale svizzero
Swiss National Science Foundation

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

UNI BASEL

iat/MICS-Neuchatel'07