Demo Abstract: Operating a Sensor Network at 3500 m Above Sea Level

Jan Beutel, Stephan Gruber†, Andreas Hasler†, Roman Lim, Andreas Meier, Christian Plessl*, Igor Talzi‡, Lothar Thiele, Christian Tschudin‡, Matthias Woehrle, Mustafa Yuecel

Computer Engineering and Networks Lab, ETH Zurich, Zurich, Switzerland

†Physical Geography Division, Department of Geography, University of Zurich, Switzerland

*Paderborn Center for Parallel Computing, University of Paderborn, Germany

‡Computer Science Department, University of Basel, Switzerland

beutel@tik.ee.ethz.ch

ABSTRACT

Sensor networks deployed in remote locations require easy to use but also extremely expressive tools for reliable operation. The PermaSense project has developed a platform based on a number of proven COTS components and integrated with the GSN based data backend. All tools are accessible from a single location in a web browser. This demo will present the monitoring and control tools in live operation with deployments on real field sites in the Swiss Alps.

1. INTRODUCTION

The PermaSense project strives for collecting geophysical data in the high-altitude environment of the Swiss Alps with a wireless sensor network (WSN). A key issue is unattended, long-term operation. This requirement is not only manifested in a reliable and tailored system architecture [3], but also in a data management, system control and monitoring services running on backend servers. In this demo, we present the set of tools necessary for reliable and successful long-term operation of a remote sensor network. The demonstration encompasses a live demonstration of wireless sensor networks on our field sites in the Swiss Alps and showcase the sensor nodes and base station technology used.

Applications like environmental monitoring heavily rely on the retrieval of high-quality observations from experimental research in field campaigns. Apart from pure accuracy requirements, quality is manifested in data yield and many well-known sensor network deployments have shown inferior performance especially w.r.t. this requirement. In most cases the dominant problem has been the lacking performance of the wireless networking system, e.g. [5]. However, the reliable data delivery from the sensor nodes to the base station is only a part of the larger puzzle involved [4]. In reality a complicated and multi-tier architecture is put in place (c.f. Fig. 1). Failure of any tier leads to performance degradation in the system context and hence tools for reliable monitoring of all tiers are essential.

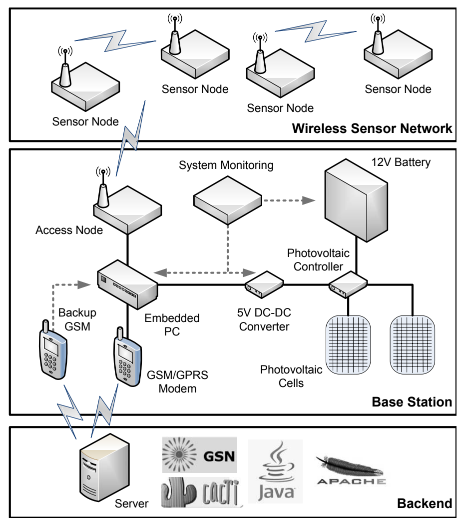

Figure 1: The tiered system architecture from the generation to the final backend tools.

2. END-TO-END SYSTEM MONITORING

In order to monitor and control each tier of a sensor network deployment, the PermaSense project has devised a database-based backend solution with a webfrontend. This does not only encompass handling of the data derived from the sensor network, but also monitoring of system components, e.g. the base station, long-haul data links and backend servers. In contrast to full custom backend system solutions developed from scratch [2] we propose to reuse existing, proven tools wherever possible. This buy-versus-make argument is further supported by the large number of exisiting solutions facilitating 24/7 operation of IT equipment. Custom developments should only be made when there is no other possibility at hand.

- The PermaSense backend architecture is built around the Global Sensor Network (GSN) [1]. GSN has basic capabilities to connect to streaming data sources (virtual sensors), process data, interface to a database and an integrated web server.
- Cacti/rrdtool and Zabbix are used for monitoring/trending of the live network and system status data as well as alerting on error conditions.
- Real-time information from the national weather service and public webcams provide additional information on the environmental conditions.

We have further developed a custom data export utility that allows to easily export data sets to other tools, visualizes live sensor network topology and plotting. Both the PermaSense sensor nodes and base station create duplicates of all data packets sent or received on non-volatile flash memory as an additional failsafe mechanism. A tool to retrieve lost sensor data from these backup log files is also provided. All these tools are integrated into a custom dashboard for convenient access from a single location.

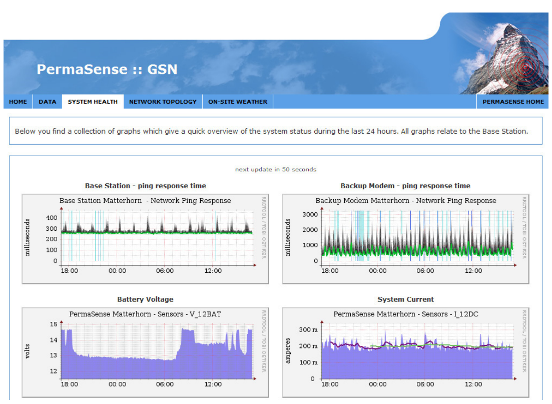

Figure 2: The web dashboard displaying base station status using Cacti/rrdtool.

Furthermore, access and visibility across all system layers and extensive testing are most essential for such mission critical infrastructure. ASCII log files facilitate debugging and direct shell access to systems is much

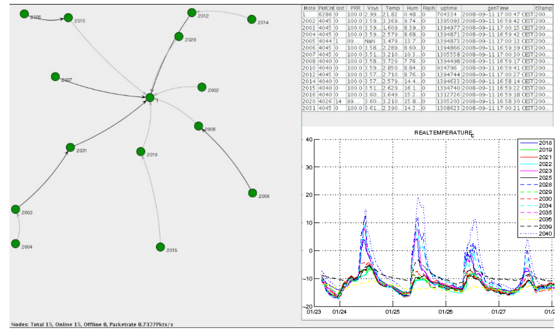

Figure 3: Sensor network topology and status is automatically updated in a web based tool.

easier than deciphering binary packets upon arrival using custom built tools. Since mid 2008, we are operating 2 field sites in the Swiss Alps with only minimal downtimes. Using our set of tools we were able to discover and act timely to prevent several critical system failures.

3. ACKNOWLEDGMENTS

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