Demo Abstract: Sensor Network Maintenance Toolkit

ABSTRACT

The test and deployment and especially the validation of real-world sensor networks embedded into a physical environment are complex tasks that require appropriate tools. The sensor network maintenance toolkit introduced in this contribution enables long-term supervision and maintenance of target sensor networks in their actual application setting using a deployment-support network. The toolkit is composed of different services for remote programming, event detection, logging, analysis and reporting.

1. INTRODUCTION

The long-term supervision and maintenance of sensor networks is a complex problem that requires access to all nodes in a target deployment as well as to equip the nodes themselves with application functionality. In real-life scenarios, both these requirements are hard to re- alize. Often nodes are to be deployed in a remote loca- tion, resources are limited and nodes operate on an ex- tremely low duty-cycle to minimize cost, power-consumption and as a result maximize the longevity of the application. The deployment-support network [1] has been proposed as a novel tool for the development, test, deployment, and val- idation of wireless sensor networks. This approach uses a self-organizing backbone network with deployment-support services and so allows direct access to already deployed tar- get nodes in their native environment in a minimal invasive way. The sensor network maintenance toolkit introduces sophisticated services for both maintenance and long-term supervision and monitoring of sensor network applications deployed under real-life conditions.

2. DEPLOYMENT-SUPPORTNETWORKS

Classic approaches to develop and deploy wireless sensor networks use serial or ethernet cables for program download, control and monitoring [3]. Although successful in lab setups, this approach is limited due to scalability issues and completely infeasible for deployment in the field. Distributing firmware updates within a sensor network [2] requires nodes to be equipped with buffering and self-reprogramming support and often exhibit an excessive burden on the network itself, with heavy traffic compared to the average network operation and long latencies due to low power duty-cycling.

The deployment-support network (DSN) (see Figure 1) is a new methodology for the development, test, deployment, and validation of wireless sensor networks. A DSN is a robust, wireless cable replacement offering reliable and transparent connections to arbitrary sensor network target devices. DSN nodes are battery powered nodes that are temporarily attached to some or all target nodes in a sensor network deployment under test. A target adapter on the DSN node is responsible for target control, (re-) program- ming and logging while a small monitor running on the tar- get sensor node is responsible to output events and status information to the DSN node where it is logged and timestamped. Examples of such logged context are packet arrivals, sensor values as references for calibration, interrupts on the target node or error codes for debugging. Compared to traditional serial-cable approaches, this approach results in enhanced scalability and flexibility with respect to node location, density, and mobility. This makes the coordinated deployment and monitoring of sensor networks possible.

The current reference implementation of a deployment-support network is called JAWS and runs on 30 BTnode rev3 devices in a permanent installation at ETH Zurich.

3. SENSOR NETWORK MAINTENANCE TOOLKIT

In order to employ deployment-support network for the development and deployment of a sensor network application, the sensor network maintenance toolkit has been devised as a set of sophisticate services that can be easily adapted and customized according to the maintenance and monitoring requirements.

3.1 RemoteProgramming

The remote programming service allows to disseminate version controlled firmware images along the DSN backbone automatically and reprogram targets on demand. Different types of target architectures are supported by adapting the target adapter on the JAWS application to the target CPU.

3.2 GenericDSNAccess

The DSN interface specification allows generic access us- ing standardized commands and message formats to the resources of a deployment-support network using either a serial port or the Bluetooth radio on the DSN nodes (BTnode rev3 devices). This can then be used to log the communication flow to a file or display and control the status of the experiment on a graphical user interface. Here, both a setup with a JAWS server and GUI Java applet as well as a Java standalone GUI on a Bluetooth equipped PDA

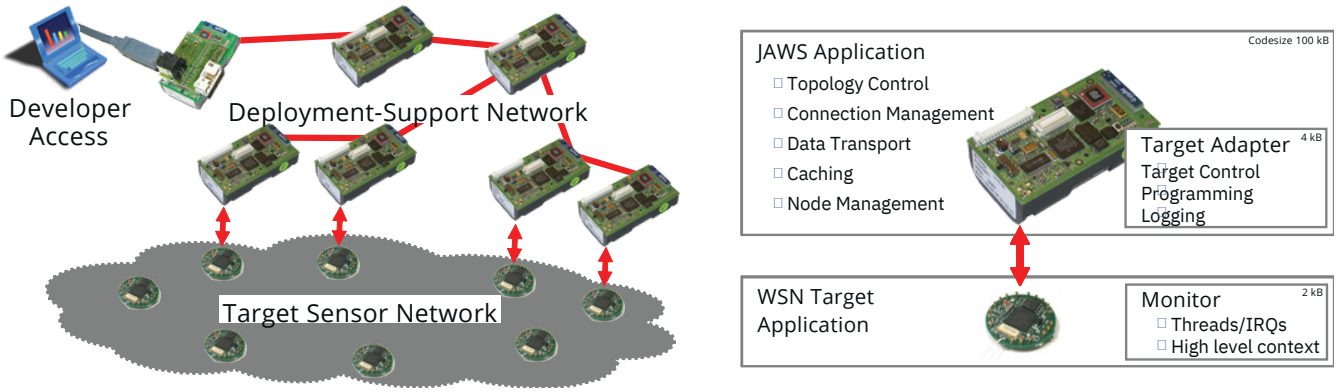

Figure 1: A deployment-support network is temporarilily attached to a experimental target network and facilitates long-term surveillance and maintenance using the SNM toolkit. A developer can access the DSN resources at any point using the Bluetooth backbone network.

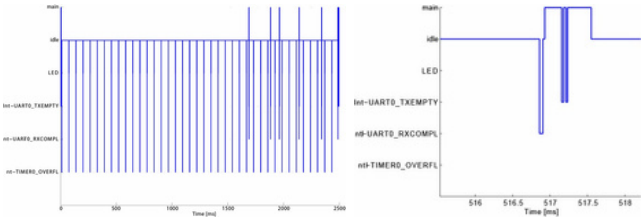

Figure 2: The BTnut OS tracer allows to track critical real-time issues on a target device with minimal influence on the actual timing behavior.

allow flexible access to the resources of the DSN both in a centralized fashion optimized for logging (server) and in a mobile maintenance scenario.

3.3 RemoteLoggingandEventDetection

The target adapter on the DSN nodes is equipped with a remote logging facility that can store and time-stamp events generated by the target devices. These logs can be retrieved from all DSN nodes to a central location on demand for subsequent analysis. Furthermore, filters can be set on a per-node basis to send notifications of certain events, e.g.

warnings, errors, etc. running on the generic DSN access. Time-synchronization between all DSN nodes allows for easy correlation of the distributed event streams gathered by the deployment-support network.

A simple BTnut OS tracer event facility can be installed on the target devices application for tracing low-level events at fine granularity and without unduly disturbance to the target systems timing behavior (see Figure 2).

3.4 Long Term Logging and Data Analysis

Using the generic DSN access infrastructure, data from long-term experiments can be logged into both files and a mySQL database. The sensor network monitoring toolkit allows to create simple, yet powerful queries based on the DSN interface specification that can be executed repeatedly at the server where the resulting data is stored and converted into webpages and graphs using cacti and rrdtool, an online data

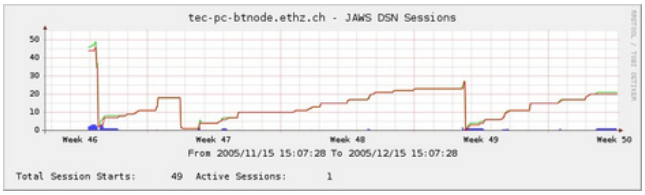

Figure 3: Long-term logging and online analysis of the DSN functions using cacti and rrdtool.

analysis and plotting toolset (see Figure 3).

Acknowledgments

We would like to acknowledge the tireless implementation and debugging work performed by Philipp Blum, Daniel Hobi, Lukas Winterhalter, Mustafa Yü ¨cel and Sven Zim- mermann.

The work presented here was supported by the National Competence Center in Research on Mobile Information and Communication Systems (NCCR-MICS), a center supported by the Swiss, Matthias Ringwald National Science Foundation under grant number 5005-67322.

4. REFERENCES

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