Demo: Opportunistic Deployment Support for Wireless Sensor Networks

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ABSTRACT

While Wireless Sensor Networks are versatile tools to monitor the environment in scenarios usually not accessible via wired infrastructure, deployments of such networks are challenging even for experts, particularly in remote areas. In this work, we present a smartphone based system that supports such deployments by keeping track of exact sensor locations and providing unique debugging tools, that can work hands- and eyes-free.

Through opportunistic communication, we are able to support collaborative data gathering making the deployment and network maintenance process faster and easier, also for non-experts, even in environments without mobile network coverage. As location and configuration data is immediately available electronically, domain experts, such as geo-engineers, can have their evaluation and assessment systems boot-strapped automatically, leading to faster feedback, already during the initial deployment.

Categories and Subject Descriptors

C.2.1 [**Computer Communication Networks**]: Network Architecture and Design—*Store and forward networks*

General Terms

Design, Performance

Keywords

WSN deployment; deployment support; data input

1. INTRODUCTION

Deploying a Wireless Sensor Network (WSN) is a cumbersome task even as an expert in the area. Outside of testbeds [2], the question if the network was deployed as planned remains open until the end of the deployment, when we compare the obtained measurements with expected theoretical data. In this work, we present a system that assists us during surveying, deployment and maintenance of a WSN, to keep track of each node and the overall state of the network. We provide tools to collaboratively create and explore the network topology, and exchange data gathered across the deployment site opportunistically.

Keeping track of devices, their identifiers, location or their view of the network is a painstaking task if done manually in the field [1]. Our goal during WSN deployment is to be able to respond to unpredicted wireless behavior and other obstacles, to reduce the time needed to set up the system. While passing through the deployment area, we already monitor the WSN traffic of active nodes, and maintain an overview on where nodes are located and how they participate in the network. Also, we can pin point locations where further nodes could improve network performance.

2. ARCHITECTURE OVERVIEW

Our system is based on the Android operating system. We provide the user with a map view, communication tools and a packet logger to display messages sent over the network, and display active links between nodes on the map.

Due to the dynamic nature of a deployment, e.g. covering distances of several hundred meters by foot between nodes, our system utilizes all available radio modules on the device. Accordingly, we opportunistically switch between them to provide the best possible communication channel between participants. As the devices autonomously discover and connect to each other, exchanging and updating gathered network information epidemically, our system does not require a dedicated local server. We employ protobuf encoded messages on top of a reliable stream socket provided by different technologies, cf. Figure 1. With increasing distance, we use:

- **Beam**: Android Beam or Near Field Communication (NFC). Data is exchanged using existing sharing functionalities built into Android.
- **Bluetooth**: Provides short range communication.
- **WiFi**: Provides mid-range communication at higher data rates.
- **XBee**: Allows WSN traffic monitoring and mid-range communication.
- **GSM/3G**: Optionally allows global connectivity, if available in deployment area.

Note, that data transfer using NFC or Android "Beam" requires the devices to be held next to each other. With an XBee radio module attached to a smartphone, it is possible to sniff WSN traffic, but also use the same technology for local communication. To avoid throwing away information

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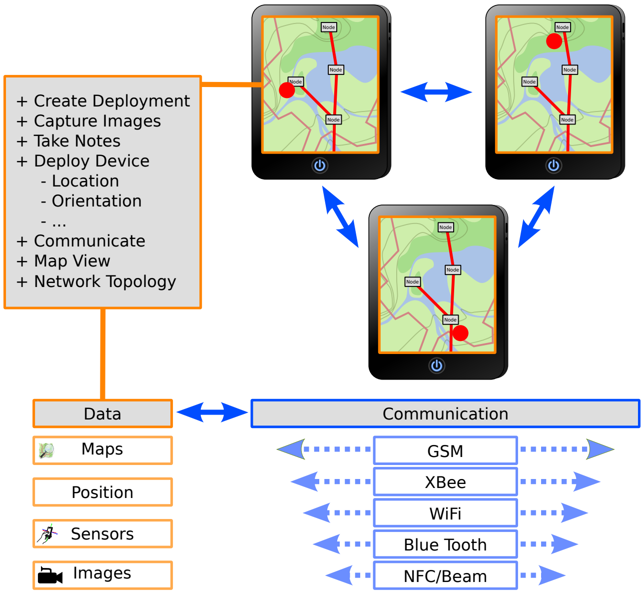

Figure 1: Overview of the system architecture. The communication channels used for collaborative exchange of data generated during deployment, is used according to availability and range of the respective system.

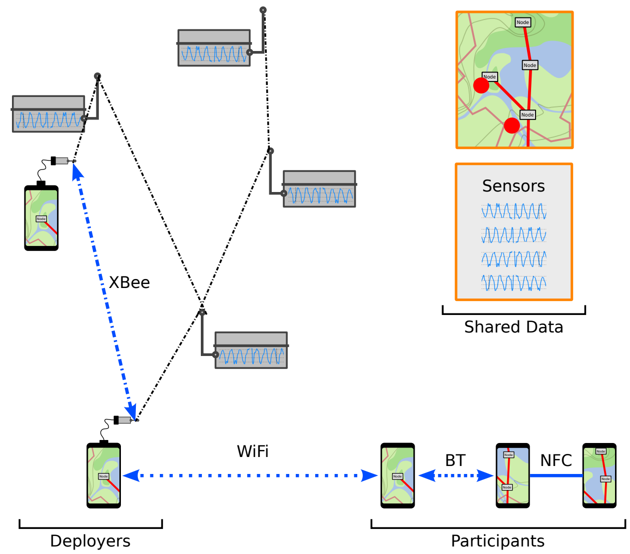

Figure 2: Overview of the demo setup. In the first phase nodes are deployed simultaneously, and a map of the network is created. During this step participants can follow the process on their devices. Data collected from the network is shared to further participants using supported channels.

prematurely, we keep a history of all received records. We resolve conflicts by displaying the newest version.

2.1 Surveying

During the initial survey of the deployment site, we record georeferenced data to add further information as overlays to a base map. We can capture images associated with location and direction at the point where they were taken. Also we can include barometric pressure readings to create a height map of local landmarks to provide further orientation.

2.2 Deploying Nodes

To identify wireless sensor nodes in the field we mark them with pre-coded QR codes or NFC tags. They store configuration data, such as channel and group ID of the sensor network. The QR scanning process itself allows us to automatically record the orientation and GPS position of a sensor node, while also bootstrapping the WSN traffic monitoring. We can estimate the node's relative height above ground from the barometric pressure difference between ground and sensor level, with a resolution of typically 0.3 m. Additionally, we can record text and images associated with a node on the map.

2.3 Maintenance

When the team later tries to find the nodes again to carry out maintenance tasks, such as replacing depleted batteries, we can accurately guide them to the respective locations. Considering the network was deployed with our system and the location of each node recorded with additional information about orientation landmarks, or pictures where the node is located, a user can easily find the device. We designed the interface in such a way, that hands-free and eyes-free operation, e.g. via audio feedback, is possible, enabling the maintenance crew to focus on the task at hand in possibly hazardous environments.

3. DEMO SETUP

To demonstrate our system, we bring several preconfigured devices and sensor nodes. Additionally it is possible for participants to use their own smartphones during the demo. The application will be available through the Android Play Store and distributed on site.

We plan to collaboratively deploy the WSN in a predefined area. As depicted in Figure 2, the data gathered throughout the demo will be distributed among participants. Users will be able to see where a node is placed and track the progress of the network set-up, i.e. where nodes start communicating. While the network is running, devices with an attached XBee dongle are able to display the network links, and provide insight into the communication performance.

4. CONCLUSIONS

Our system provides collaborative communication on the deployment site, employing network technologies provided by current smartphones running the Android operating system. With our system we move away from "trial and error" approaches and provide a more efficient, collaborative method to incrementally deploy a WSN. We provide elaborate data to non-expert end users, that allows them to deploy a network and assess its current state.

5. REFERENCES

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