Demonstration Abstract: Globally interconnected WSAN testbeds

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***Demonstration Abstract* — This demonstration presents the ongoing development of a framework for a global wireless sensor / actuator network (GWSAN). This GWSAN is formed through the interconnection of about 10 WSAN testbeds currently mainly located in Asia and Europe. GWSANs are one of the enabler for the Internet of Things and thus the Web of Things. Similar to the beginning of the Internet in the late 70s this GWSAN is a research network. Topics of the joint research and development activities include management, maintenance and interoperability. Therefore algorithms and autonomous / automatic configuration mechanisms are implemented and tested as well as remote software updates in distributed WSANs. Furthermore, graphical interfaces for the management and the interaction with GWSAN are part of the development.**

Communication networks, computer architecture, interconnection networks, wireless Sensor Networks, middleware technologies, interconnected testbeds

I. INTRODUCTION

Technical aspects of wireless sensor networks are being researched since about 15 years. Stable and long-term testbeds for application development are still missing, as well as a standardized way to access the devices from backend systems. Several (industrial) standards like IEEE 802.15.4 [1], ZigBee [2], or ZWave [3] have been developed or are currently under development (e.g., DASH7 [4]). However, the rich quantity of non-interoperable proprietary and standard protocols hinders WSAN acceptance by potential users. Therefore, a standardized access to the variety of devices must be established. The presented project will provide a lightweight framework to develop and test globally-distributed WSAN applications. The key facilities of this framework are: announcement- and search-triggered node and service discovery, service value eventing and, of course, request-triggered service execution. Besides sensor- / actuator-related services, a broad set of management services, like enabling / disabling of devices and services, radio neighborhood information and application download, is provided by the testbed nodes.

II. FOKUS SENSOR SOLUTION

Two individual WSAN testbeds integrated in the GWSAN are built up using the hardware devices described next.

A. FOKUS Sensor Board

FOKUS has developed a sensor board with an MC9S12NE64 microcontroller (including Ethernet support) and a CC1100 transceiver. The CC1100 transceiver allows operations in the 868 MHz or 915 MHz band. The sensor board is equipped with several sensors such as temperature, IR and brightness as well as actuators like a beeper and LC display. Further interfaces like CAN are also available. The sensor nodes can communicate simultaneously via a wireless link and the Ethernet and thus act as routers between the WSAN world and the local IP infrastructure.

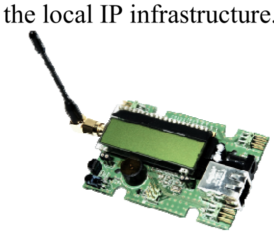

Figure 1. FOKUS Sensor Board

B. FOKUS Multitechnology/Multiprotocol Gateway

ASUS WL-500gP WLAN / Ethernet routers are used to interconnect the individual WSAN testbeds via the Internet using Ethernet or GSM / UMTS access. The original operating system of the routers has been replaced by OpenWrt [5] (based on Linux) allowing the installation and development of additional modules and packages required for the communication of different sensor boards with the router. The routers are able to perform mesh networking based on OLSR [6] with multicast extensions. USB devices like IEEE 802.15.4 dongles, GPRS or, as already mentioned, GSM / UMTS modules can also be connected.

III. FOKUS GWSAN

The individual WSAN testbeds are based on different communication technologies. Several protocols like IPv6 with its pendant for WSANs, 6LoWPAN [7], are used via transceivers in the 2.4 GHz (IEEE 802.15.4/ZigBee) or the 868 MHz ISM bands. The integration of other technologies like RFID or the upcoming devices of digitalSTROM [8] are also envisaged. Parts of the GWSAN are interconnected with other testbeds through the IP infrastructure to study distributed application development as well as data and knowledge sharing among devices connected through long distance links. IPv4 and IPv6 are used for the interconnection.

A. *Major Local WSAN Testbed*

The major local WSAN testbed is build up with about 30 868 MHz FOKUS nodes described in section II.A. Most of them are connected to the local IP backbone through 5 FOKUS nodes acting as routers. One of the routers exclusively connects its clients to a gateway as described in section II.B. A peer gateway acts as the interface to the local IP backbone allowing to test remote interconnection of WSAN testbeds.

B. *Interconnected Testbed*

Currently, two network types are integrated in the GWSAN. On the one hand, local and remote WSANs already based on the lightweight framework are connected to the backbone via IPv4, and on the other hand, 6LoWPAN networks are connected via IPv6. For both types, servers gathering all sensor data are set up in Germany (FOKUS [9]) and South Korea (NIA [10]). Interested users can connect through a Java based GUI [11] to access the local elements of the IPv6 WSAN.

IV. LIGHTWEIGHT SENSOR FRAMEWORK

The Lightweight Sensor Framework development is part of an UPnP-inspired Open Source project [12] provided by Fraunhofer FOKUS for zero-configuration sensor networks. UPnP is a recognized standard for automatic networking of, e.g., multimedia devices or for home automation. While the full XML parsing for UPnP is not feasible for resource-constrained embedded devices, the LSF protocol and its data coding are optimized for the connection of sensors and actuators in various physical networks maintaining UPnP characteristics like transparency and auto-configurability and simple one-to-one mapping between LSF and UPnP protocol and data elements.

V. USER INTERFACE

The graphical user interface allows the configuration and management of all GWSAN devices. The topology of individual WSAN testbeds can be displayed as well as the latest sensor readings and management data gathered by each node. It is also possible to display the sensor data on a mobile device (iPod/iPhone) using Web Service communication and a small gateway for remote access to the GWSAN infrastructure from end devices. A mapping of GWSAN nodes to Web Services is one of the key enabler for a global Web of Things.

VI. DEMONSTRATION

The demonstration comprises the described hardware of section II-A and II-B. The GUI (Figure 2) will be part of the demonstration as well as the interaction of the mobile IPod GUI with individual WSAN nodes. Based on the hard- and software, the following functionalities will be shown: self-configuration of the entire network, node and service discovery of the nodes through a mobile GUI, automatic integration of new or temporarily lost nodes, integration of a (GPRS / UMTS) gateway, control of events and the interaction with the globally distributed nodes.

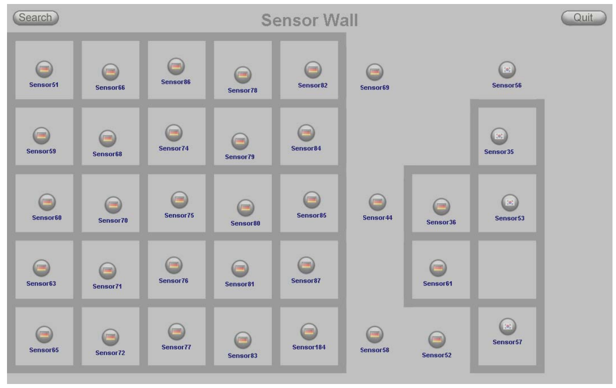

Figure 2. Graphical User Interface

CONCLUSION

In this demonstration an approach for a global interconnected wireless sensor / actuator network through a Lightweight Sensor Framework is presented. First experiences were made and a GUI is available to manage the GWSAN nodes and to present the GWSAN and its nodes including their interconnections and actual sensor readings. Future work will include software distribution mechanisms, deployment tools, further mobile user interfaces and development of globally distributed applications.

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