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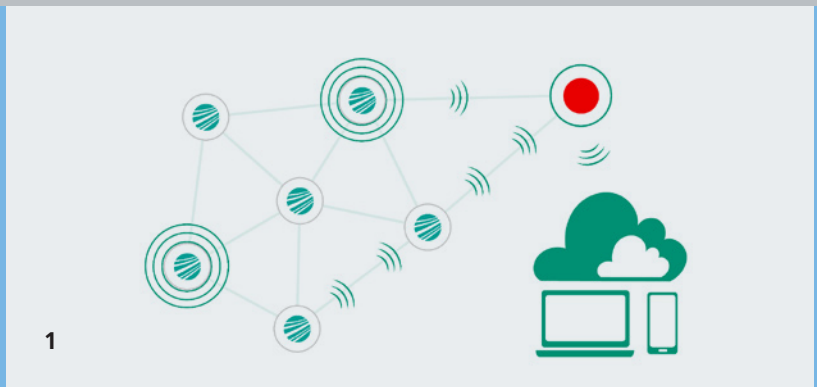

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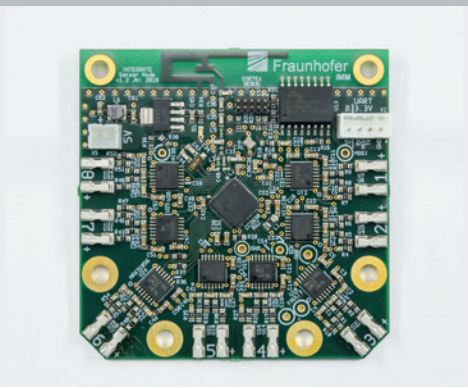

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1 *Sensor node network, LoWPAN*
2 *Single sensor node board*

WIRELESS SENSOR NETWORK FOR DECENTRALIZED DATA ACQUISITION

Fraunhofer Institute for Microengineering and Microsystems IMM

Carl-Zeiss-Strasse 18-20
55129 Mainz | Germany

Contact

Joern Wittek
Phone: +49 6131 990-131
joern.wittek@imm.fraunhofer.de

www.imm.fraunhofer.de

Motivation

The desire for a better understanding of the operational parameters of components - both individually during their development and in the interaction of a larger plant - driven by the digitization of industrial manufacturing processes - poses technical challenges for conventional plant engineering.

The in-situ measurement of different variables plays a central role; the parallel acquisition of a potentially large number of values with simultaneous low effort and flexible scalability is not always economically feasible using conventional technology.

Therefore we have developed a smart platform that enables such data acquisition while taking into account the requirements of "Industrie 4.0" - both on a small laboratory scale and also as a retrofit for existing plants.

Quick facts

Status: Prototype platform;
several prototypes are in use in IMM projects

Purpose: Decentralized acquisition and storage of measurement data, communication via standards-based protocols to ease integration into new and existing control systems.

Features:
- Distributed data acquisition with variable number of nodes per network
- Self-configuring network, based on standard mesh technology
- Miniaturized electronics platform
- Intelligence on each node
- Local data storage
- Streaming and bulk download to external systems
- 8 values per node at 2 Hz

Keywords: wireless, sensor, network, process monitoring, mesh, distributed system, data acquisition

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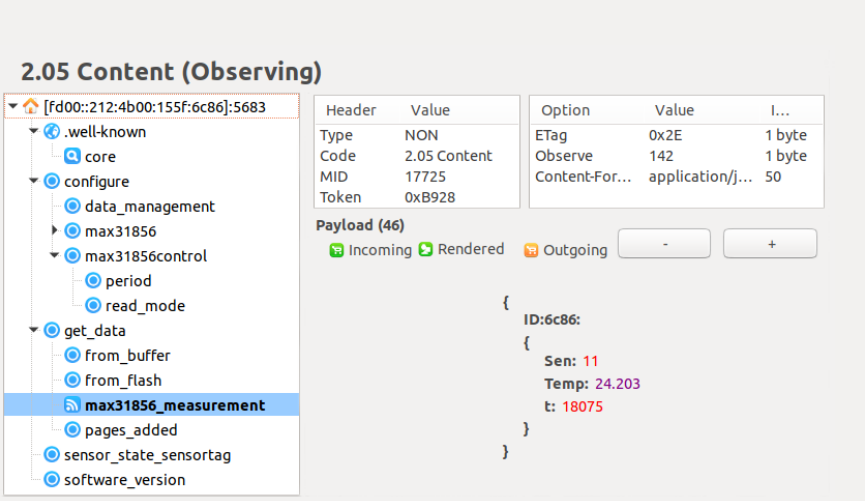

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The developed sensor node hardware as a basic component of the sensor network was miniaturized to a reasonable level. A microcontroller is used as the central element on a cost effective circuit board. This provides an easier integration of the wireless interface into the software development process and potentially low energy consumption.

In this dedicated project eight converter modules are arranged around the microcontroller. In order to enable miniaturization to a large extent, conventional connectors for thermocouples have been replaced by miniature punch-in connectors. The electronics already integrate some functions per thermocouple, which are carried out independently after configuration, for instance a monitoring of the temperature with regard to fixed minima and maxima. Thus the central microcontroller can be released from these monitoring tasks with a positive effect on the energy consumption. The application is not limited to temperature measurement - due to customer-specific design of the circuit board, a large number of physical values can be measured.

The board contains a flash module for local storage of data. Depending on the programming, for example, historical data can be stored. Continuous storage of data is also possible. In case of a significant event all data will be still available, without "live" transmission via the sensor network. The bandwidth of the sensor network can be used efficiently in normal, undisturbed operation.

The memory is sufficiently dimensioned for a rolling recording of all eight values at a rate of 2 Hz over a 36 hour window.

For communication via the wireless interface, an antenna optimized for the 2.4 GHz frequency range is directly integrated on the board.

Currently, the power supply for the prototype is conventionally wired. In the future, it could be possible to design sensor nodes for self-sufficiency through energy harvesting for specific sensor types.

On the software side, the platform relies heavily on open and current standards. The protocol stack used is 6LoWPAN, with the aim of integrating this wireless sensor network into existing networks with minimum expenditure. A border router (6LBR) is required to connect the network to the wired world. Each node simultaneously serves as a relay station for other nodes. Basically, the platform supports end-to-end communication via IPv6 and the CoAP protocol, e.g. directly from a smartphone to each individual node. No protocol gateways are required. Intelligent features such as an application-specific detection of anomalies in the data with subsequent network-wide reaction (e.g. increasing the data rate for subsequent diagnosis of the anomaly) are implemented in each node and do not require a central control unit.

Scope of application

- Tomographic temperature measurement in reactors in the field of chemical process engineering for design optimization
- Retrofitting of systems for the optimization of existing control systems on the basis of additional data
- Continuous data acquisition on mobile platforms within a plant
- Environmental monitoring in large warehouses

Research and development offer

- Energy harvesting for independent power supply
- Installation of sensors other than temperature
- Further miniaturization

3 *Sensor nodes, installed in plant*

4 *Standard interface (CoAP API)*