Web Services for Devices as integration platform for intelligent building services

Short Report

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Zukunft Bau

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Title: Web Services for Devices as integration platform for intelligent building services

Motivation

Smart Home (SH) and Smart Metering (SM) are crucial components for the future of home automation. Many proprietary standards exist nowadays, which show no interoperability to each other. This research project investigated the possibility of the deployment of “Web Services for Devices” (WS4D) and protocol “Devices Profile for Web Services” (DPWS) as overarching and harmonizing solution for building automation.

Aim of the research project

The German federal office for information security (BSI) introduced a protection profile for the gateway of a SM system, which demands high level of security for the transport of metering data. Thus, a smart meter can only communicate with a smart meter gateway (SMG). The data transport takes place in an encrypted way by employing Transport Layer Security (TLS), whereby both communication partners are authorized with certificates. SMG must support three SM protocols such as M-Bus, DLMS/COSEM, and SML (Smart Message Language). The technical challenge is to map the existing proprietary protocols to standard, generic DPWS. For the smart metering profile, SML protocol was selected, as it is a pure application layer protocol and shows a service oriented structure. Thereby, SML messages are mapped to DPWS. Due to the ability of DPWS to create data types of any complexity, SML data types can be mapped to DPWS data types without information loss.

Since DPWS uses Hypertext Transfer Protocol (HTTP) for transport as well as SOAP and Extensible Markup Language Schema (XML-Schema) for data representation, the average packet size amounts to ca. 1 KB. The message size of SML is about 100 byte. In order to make DPWS more attractive for transport media with low bandwidth, a compression of DPWS messages is applied. The use of conventional HTTP compression is not suitable for devices with constrained resources, as it would lead to a significantly higher processor and memory load. A separated HTTP and XML compression is applied instead. HTTP is compressed by mapping it to the Constrained Application Protocol (CoAP). Thereby, HTTP headers, which are required for the transport of DPWS, are mapped to the correspondent CoAP options. This leads to a compression of HTTP part by over 90 %. Efficient XML Interchange (EXI) is used for additional compression of SOAP. EXI deals with a binary representation of XML-Schema. Thereby, an XML document is represented as a sequence of events. The events are encoded with the corresponding number of bits according to the probability of occurrence. Moreover, XML element values are encoded according to their data type. Contrary to the conventional compression, straight access to particular elements is possible without prior decompression. EXI deployment brings SOAP compression rates of over 90 % as well. This induces an overall compression of DPWS messages of about 92 % (see Figure 1). Consequently, the compressed DPWS messages are less than 100 byte (see Figure 2). Thus, DPWS can be applied without restrictions to media with low bandwidths. DPWS fully supports TLS by default and thus complies automatically with the BSI protection profile.

For device discovery in large scale networks such as smart meter networks, optimizations for discovery process were suggested. Thereby, the static parameters are substituted by dynamic parameters. The discovery mechanism can then be adapted to any network size and data rate. Moreover, the suggested approach can smooth the load spikes and reduce the resulting data rate by 50 % (see Figure 3, 4). The dynamic parameters allow to set the data rate to a desired, manufacturer dependent value and thus to increase the safety.

The deployment of DPWS in SH is possible based on SM profile. In contrast to SM, the number of device types in SH is unlimited. For a dynamic and manufacturer independent communication, DPWS offers Plug&Play techniques. Every device can send its own description in form of Web Services Description Language (WSDL) upon request. For the negotiation of dynamic communication parameters, e.g., communication protocol, encryption, signature type etc., WS-Policy is used. WS-Discovery facilitates the automatic device discovery and pairing. By this means, the devices can interact fully automatically without human intervention. In order to present DPWS abilities in practice, a demonstration scenario was implemented (see Figure 5-7).

Conclusion

It was shown that DPWS is excellently suited for smart metering as well as smart home. Therefore, a smart metering profile was developed based on the SML protocol considering BSI protection profile. Applying low footprint compression methods, similar data rates as for special protocols are reached.

Moreover, it was shown that Web services can create added value through the dynamic device discovery for large scaled smart meter and building automation networks. The scalability of the technology can be achieved by corresponding optimizations.

Key data

Short title: Intelligente Dienste der Gebäudetechnik

Researcher / Project leader: M.Sc. Vlado Altmann / Prof. Dr. Dirk Timmermann

Total costs: 160484.00 €

Federal subsidy: 112338.80 €

Project duration: 26 Months

Figures

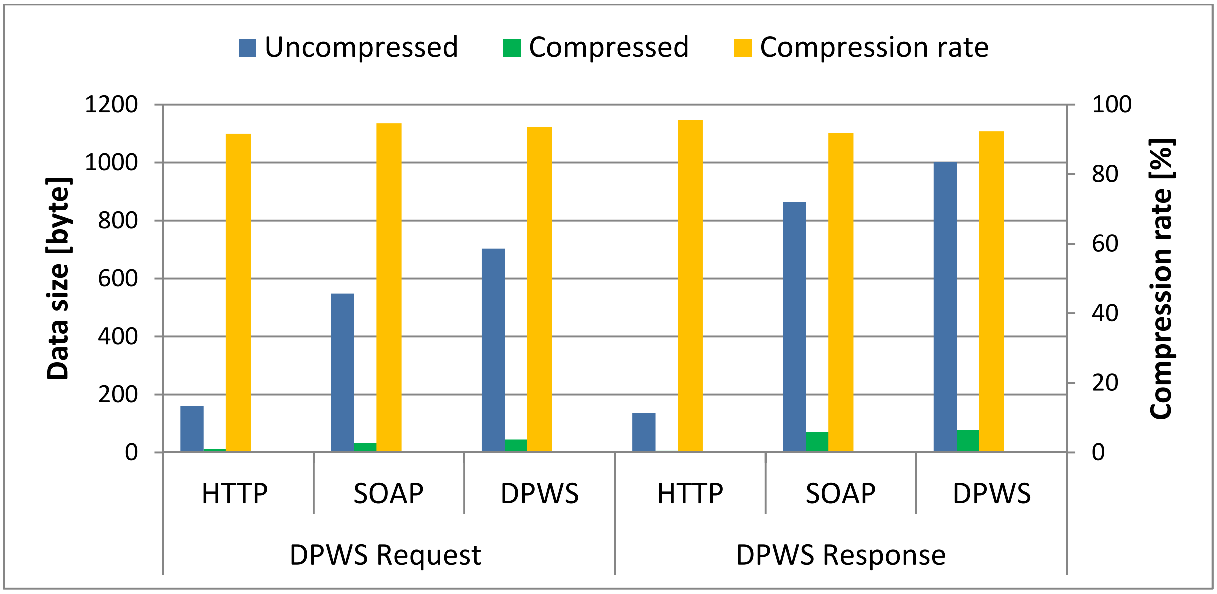

Figure 1: Compression.png
Caption: DPWS compression rates with CoAP and EXI applied

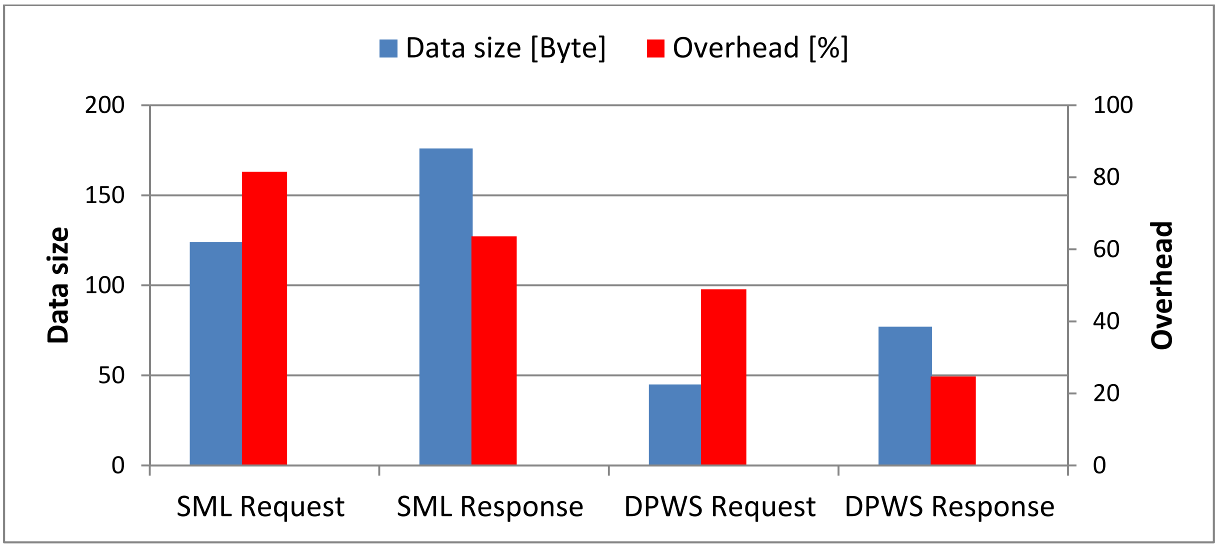

Figure 2: Overheadcomparison.png
Caption: Comparison of communication overhead between SML and DPWS

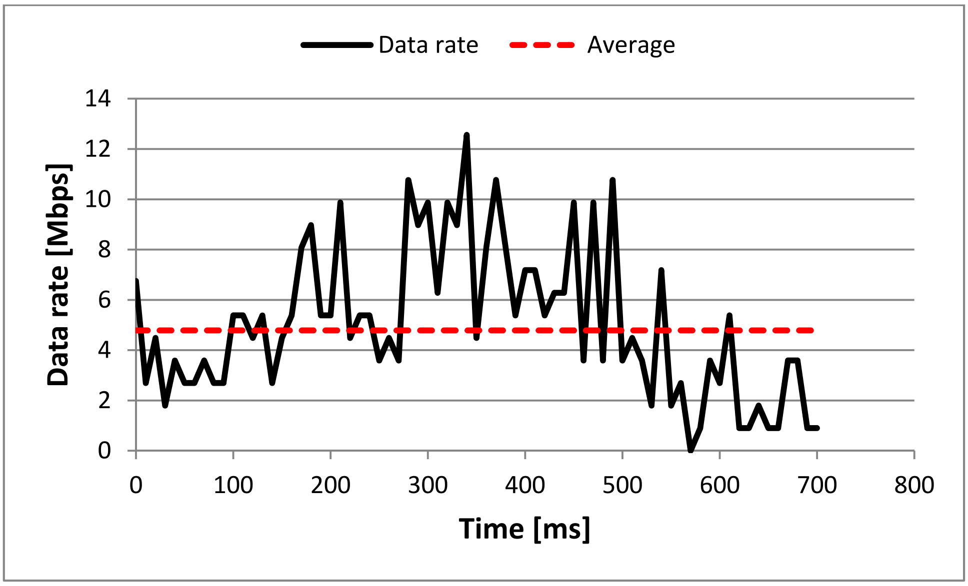

Figure 3: Discoverydatarate.png
Caption: Data rate during the discovery process

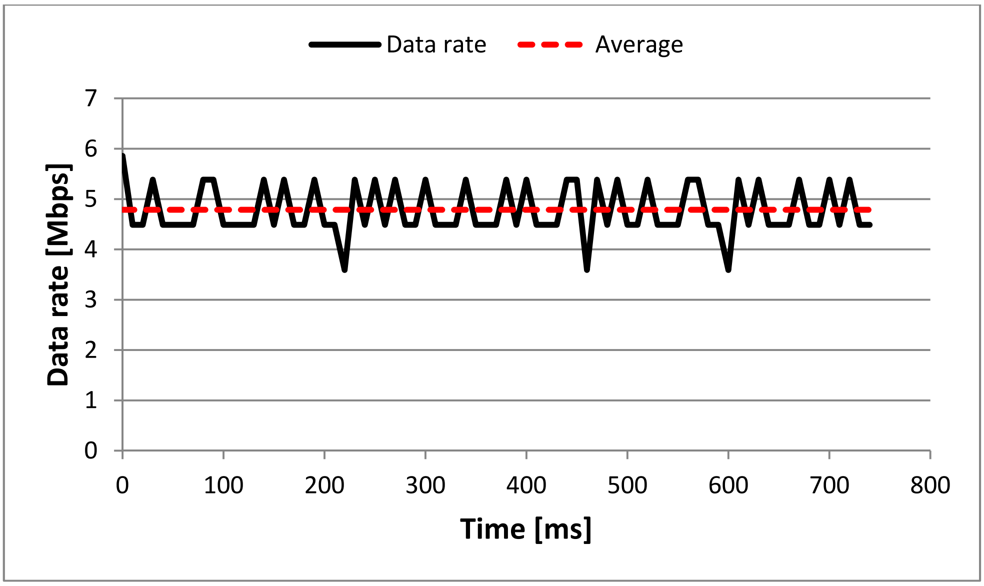

Figure 4: Discoverydatarate_optimized.png
Caption: Data rate during the discovery process with improvements applied

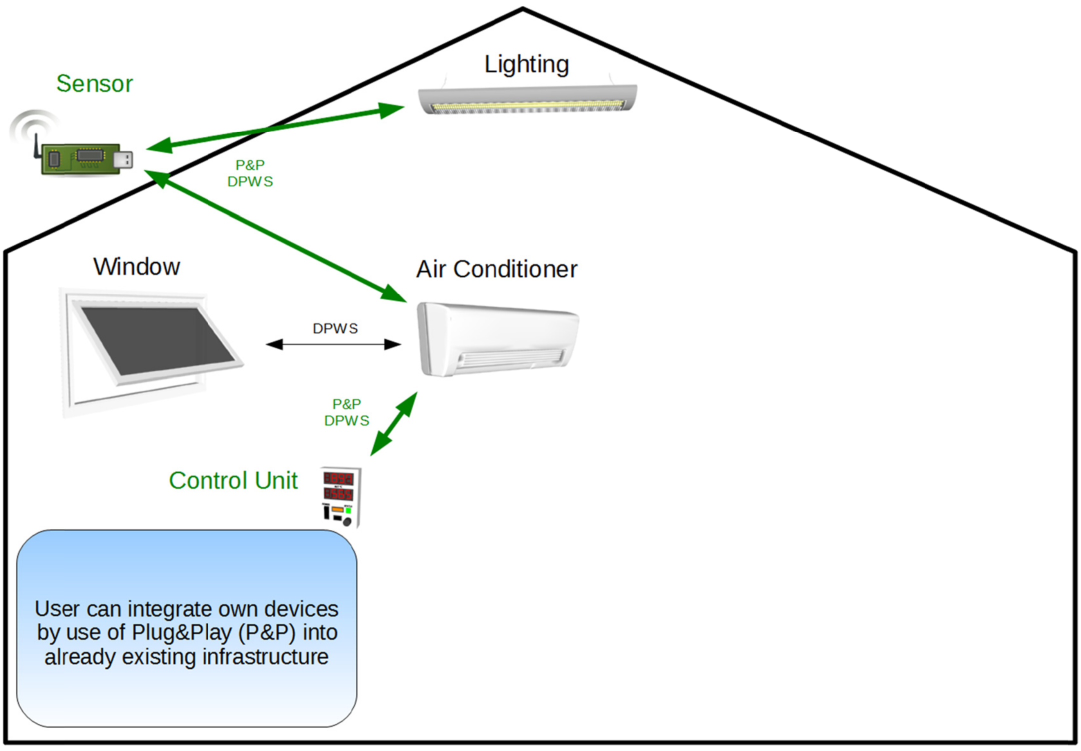

Figure 5: Szenario_Figure_1.png
Caption: Demonstration scenario - dynamic integration of new devices

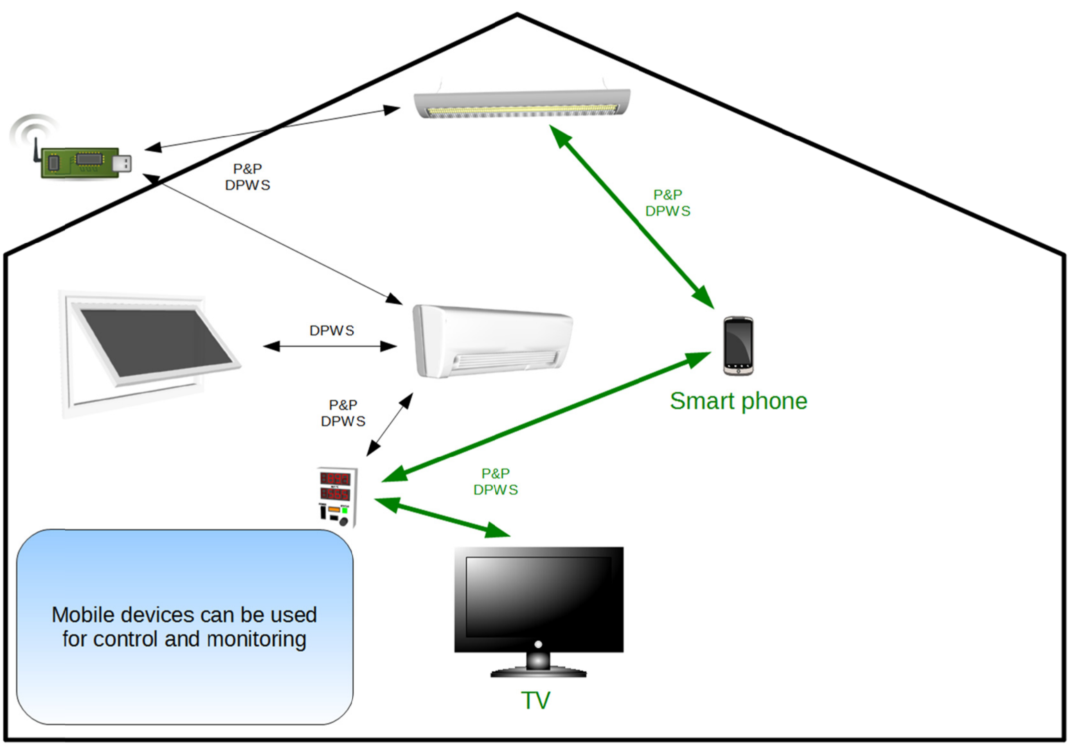

Figure 6: Szenario_Figure_2.png
Caption: Demonstration scenario – use of mobile devices for smart home control (P&P – Plug&Play)

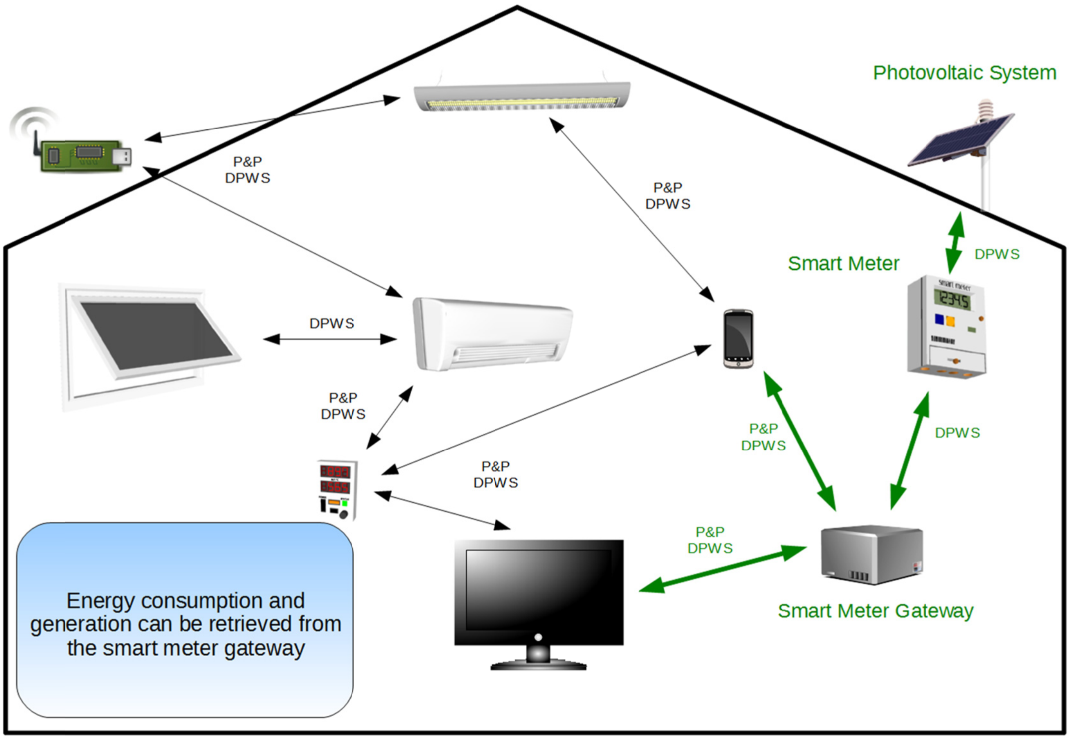

Figure 7: Szenario_Figure_3.png
Caption: Demonstration scenario – retrieval of metering data through smart meter gateway (P&P – Plug&Play)