A model based development approach for building automation systems

Björn Butzin, Frank Golatowski
Universität Rostock

Christoph Niedermeier, Norbert Vicari, Egon Wuchner
Siemens AG, Corporate Technology
What is building automation?

Source: http://baas-itea2.org/
Building automation

- Distributed control system for networking devices
- Monitoring and control of appliances

Home automation

- Extension for residential building automation
  - Comfort
    - Housework
    - Multimedia
    - Pet feeding
  - Energy efficiency

SMART HOME
Source: us.123rf.com
Problem: separated sub domains

- Different semantics, protocols, data and security models
- Fields for data usage/analysis are kept small
- High engineering effort to make sub domains interoperable

Source: http://www.swiss-architects.com/projects/projects_detail/2433
Problem: proprietary engineering

- Reinvent the wheel
- Bunch of different tools and technologies
- Cause interoperability issues

Source:
Flow-meter: http://ahnam.net
Valve: http://www.uniklinger.com
Problem: no explicit semantic model

- Ambiguities in the meaning e.g.:
  - What is the temperature of a freezer, heater?
  - What to expect when subscribing to an event?

- Prevents dynamic service (re-)configuration
  - Which function should be used? Run() or Start()?

- Some aspects might be omitted that are valuable to other services

- Experts needed for development

- Additional time to examine which data is needed and what the data reflects
Our goal

- Abstract from communication mechanisms:
  - Technologies
  - Protocols
- Generated code is using standard IT infrastructure
- Faster development

Domain specific language (DSL)

Semantic and syntactic description of entities

- Comprehensive data models
- Domain knowledge

Development tool
device Weatherstation {
    namespace https://example.org/weatherstation

    service temperatureSensor {
        attribute temperature read event;
        attribute unit read;
        attribute alertTemperature read write;
    }

    service humiditySensor {
        attribute humidity read event;
    }
}
The BaaS domain model

- BaaS Service
- BaaS Gateway
- Legacy Device
- BaaS Registry
- Data point (data source/sink)

- BaaS Device
- monitor & control
- register at
- access
- host
- register at
- is a
- consume & provide
Data point repository

- Contains data point descriptions
  - Describing all data points within the building automation domain
  - Relates different data points with each other
- Can be queried for specific data points
- Provided by the BaaS project
- Extended by a domain expert
• Abstract definition:
  • Required data points of a service
  • Provided data points of a service
• Select additional adapters:
  • Communication protocols
  • Security
  • Administration
  • …

Data point repository → SDK → Service refinement → Service repository
BaaS SDK generates:
- Service basic code
- Code for:
  - Communication protocols
  - Interface
  - Security
  - Administration
- Used libraries

The software engineer just needs to provide the business logic
- Use tool of own choice
Store information about each engineered service

- Provided data points
- Required data points
- Used adapters

This information can be used later when planning installations

- Plan multiple instances
- Check if conditions for service operation are given
  - Required data points
  - Used adapters
- Check if information is consumed (provided data points)
Combining a domain specific language and semantic descriptions

- To create building automation services …
  - … abstracted from communication mechanisms
  - … with comprehensive data models
  - … with less domain knowledge
  - … using standard IT infrastructures
  - … in a shorter time
- Enable the use of information in further steps

Future Work

- Methodology and (graphical) tool for engineering building automation installations based on developed services and existing infrastructure
- Tool for commissioning services in the field
• Thank You for your attention

• Our project website: http://baas-itea2.eu/

• Björn Butzin - bjoern.butzin@uni-rostock.de
• Institute of Applied Microelectronics and Computer Engineering, University of Rostock, Faculty of Computer Science and Electrical Engineering
Our Concept

BaaS SDK

- Communication Adaptor Concepts
- System Administration Adaptor
- DSL Editor
- BaaS Service Creator
- Security Adaptor Concepts
- ...

**Software engineer** creates BaaS Service
specifies required & provided data points
specifies adaptor types to be considered

query for specific data points
(required or provided)

store new service descriptions

BaaS Data Point Repository
- Data Point Ontology
  - Provided by BaaS
  - or extended by Domain engineer

BaaS Service Repository
- BaaS Service Description
- BaaS Service Description
  - Adaptor
  - Data Point
  - Data

BaaS Service Core Code (hooks)

generate

BaaS Libraries
- CoAP / DPWS
- BACnet
- Legacy Integration
- OAuth
- ...

**Software engineer** implements BaaS Service
What is a DSL

- A domain specific language is ...
  - ... a formal language having syntax and semantic
  - ... limited to a certain domain
  - ... used to easily describe entities, relations, problems and solutions

- A domain specific language can be ...
  - ... a graphical or textual language
  - ... an extension of an existing language or a stand-alone language