ONTIOLOGY-DRIVEN DEVICE DESCRIPTIONS FOR IOT NETWORK MANAGEMENT

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INTRODUCTION
CHALLENGES OF THE INTERNET OF THINGS (IOT)

- Heterogeneity of network devices
- Facilitate automatized network management
  - ability to discover device capabilities
  - notifications about changes
MQTT AS A COMMON IOT PROTOCOL

Source: http://www.hivemq.com
WHAT IS MISSING IN THIS APPROACH?

• MQTT is only a transport protocol
• IoT needs self-descriptive device configurations
• Semantics to avoid vendor lock-in
• Automatized network management

Idea: use standard network management approach for the IoT
NETCONF: NETWORK CONFIGURATION PROTOCOL

• version 1.1 by RFC 6241 in 2011
• mechanisms to install, manipulate, and delete the configuration of network devices
• operations are realized as remote procedure calls (RPCs)

NETCONF SERVER ON IOT DEVICE?


YANG: A DATA MODELING LANGUAGE FOR NETCONF

- RFC 6020 published in 2010
- YANG module defines a hierarchy of data for NETCONF-based operations
  - configurations
  - state data
  - Remote Procedure Calls (RPCs)
  - notifications
- balance between high-level data modeling and low-level encoding
WHAT IS MISSING IN YANG?

• Semantic expression is restricted
• XPath expressions are not that powerful as semantic web technologies
• YANG is a data modeling language

Idea: use an IoT ontology for device descriptions
USED PART OF THE ONEM2M BASE ONTOLOGY
AN ONTOLOGY-BASED NETCONF-MQTT BRIDGE
SYSTEM-ARCHITECTURE
PUBLISH DEVICE DESCRIPTIONS

Device Description: oneM2M Ontology

1. MQTT Publish Description & Subscribe for Control

MQTT Broker

2. MQTT Publish Description

NETCONF-MQTT bridge

3. parse_ontology(Description);
   add_RPC(Description);
   generate_YANG(Description)

4. Get YANG Schema

NETCONF Client Web-Interface

User

Microcontroller
Board with LED and brightness sensor
SYSTEM-ARCHITECTURE
CONTROL THE ACTUATOR
NETCONF-MQTT BRIDGE SOFTWARE ARCHITECTURE
HARDWARE: CC2538 DEVELOPMENT KIT FROM TEXAS INSTRUMENTS

- 32 kiB RAM
- 512 kiB Flash Memory
- Low Power RF ARM Cortex M3-based System 32-bit processor
- IEEE 802.15.4 compliant (6LoWPAN)
ONTOLOGY OPTIMIZATION RESULTS

- oneM2M ontology uses RDF/XML syntax
- we use JSON-LD
- CBOR achieved compressing rate about only 87.45% comparing to the optimized JSON-LD file
CONCLUSION
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• Results
  • Development of the NETCONF-MQTT Bridge
  • Ontology parser and YANG data models generator
  • Using oneM2M ontology on constrained devices
  • Evaluation on ontology file size optimization for constrained devices
THANK YOU!
ANY QUESTIONS?

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