

ONTOLOGY-DRIVEN DEVICE DESCRIPTIONS FOR IOT NETWORK MANAGEMENT

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The background is a solid teal color with a subtle gradient. In the four corners, there are decorative white line-art elements resembling circuit traces or network diagrams, with small circles at the end of the lines.

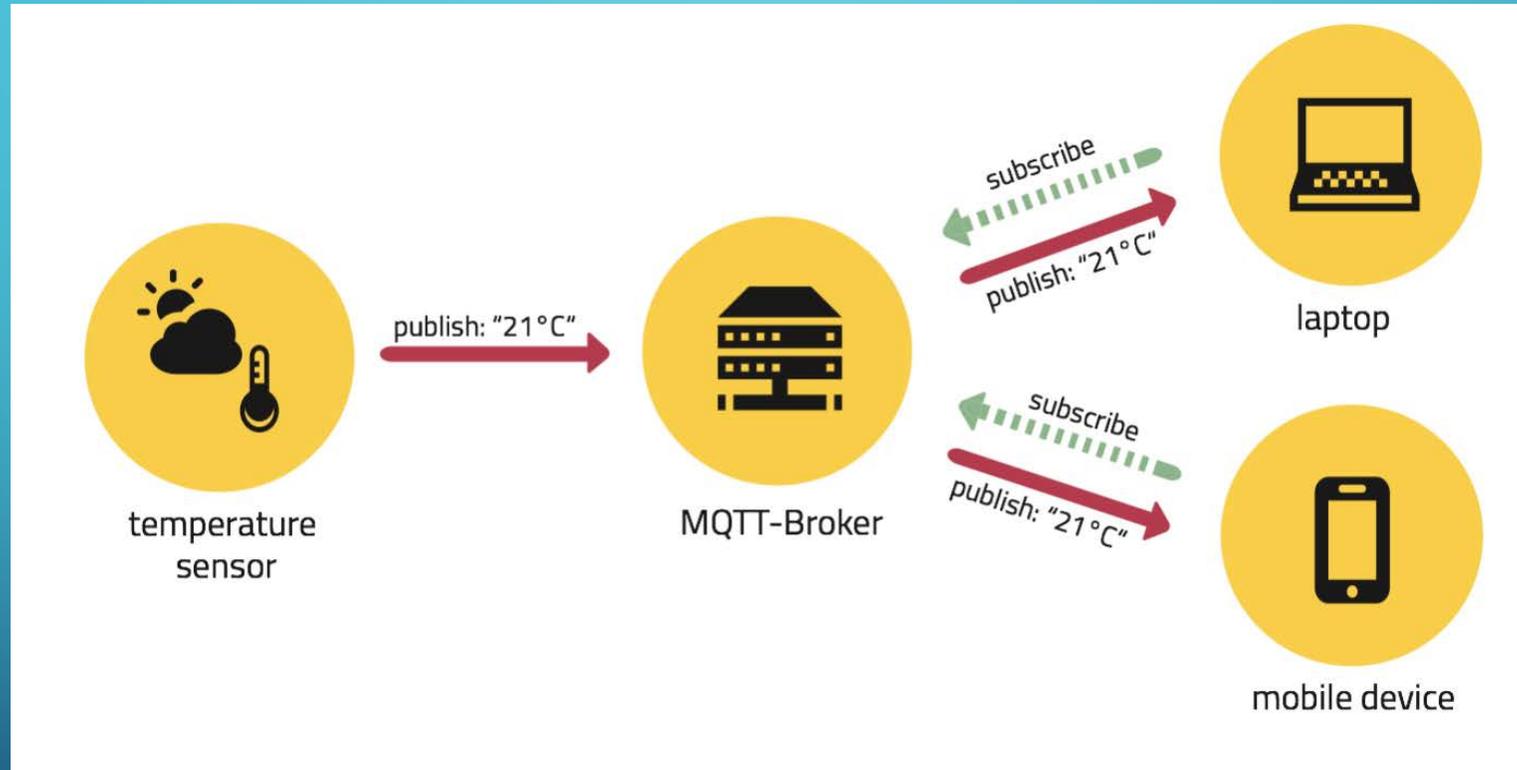
INTRODUCTION

KRISTINA SAHLMANN: ONTOLOGY-DRIVEN DEVICE DESCRIPTIONS FOR IOT NETWORK MANAGEMENT

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)



Source: <https://www.ietf.org/slides/slides-edu-network-configuration-with-netconf-00.pdf>

NETCONF SERVER ON IOT DEVICE?

- A. Sehgal, V. Perelman, S. Kuryla, and J. Schönwälder, “**Management of Resource Constrained Devices in the Internet of Things**”, IEEE Communications Magazine, vol. 50, no. 12, pp. 144–149, 2012.
- J. Schönwälder, K. Watsen, M. Ersue, and V. Perelman, “**Network Configuration Protocol Light (NETCONF Light)**”, Working Draft, IETF, Internet-Draft draft-schoenw-netconf-light-01, January 2012.

YANG: A DATA MODELING LANGUAGE FOR NETCONF

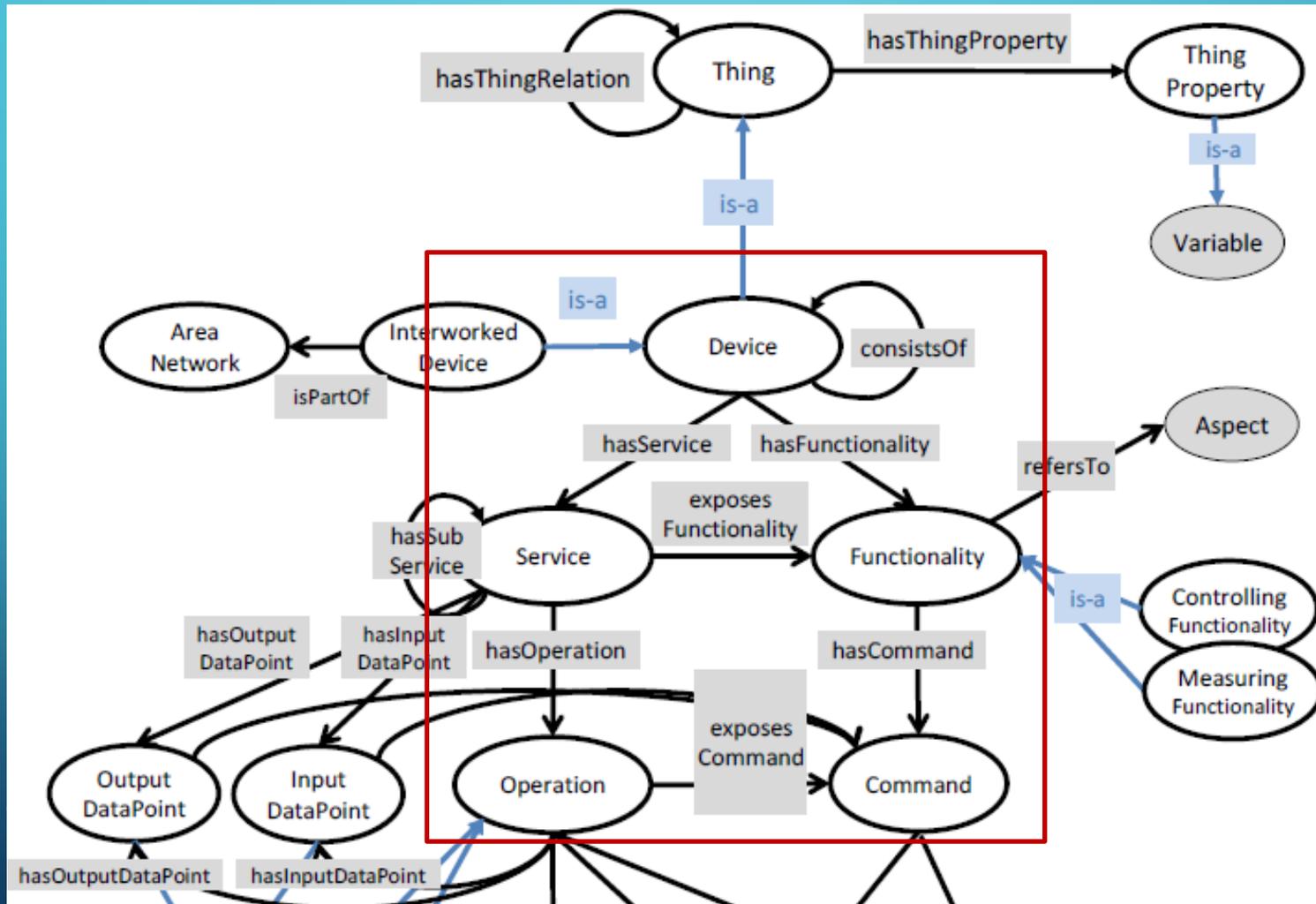
- RFC 6020 published in 2010
- YANG module defines a hierarchy of data for NETCONF-based operations
 - configurations
 - state data
 - Remote Procedure Calls (RPCs)
 - notifications
- balance between high-level data modeling and low-level encoding

WHAT IS MISSING IN YANG?

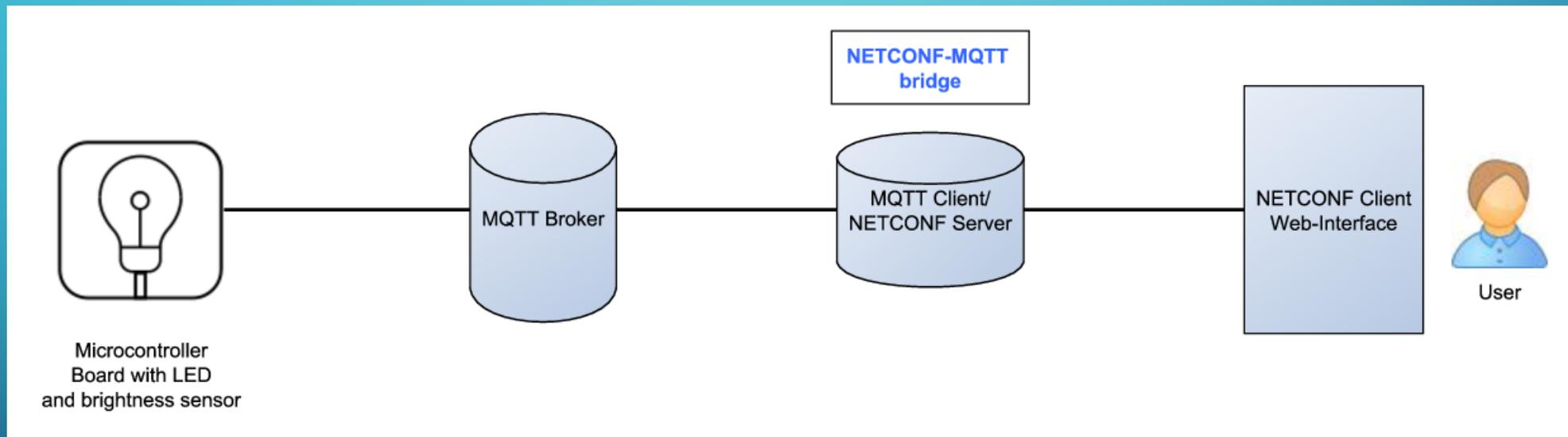
- Semantic expression is restricted
- XPath expressions are not that powerful as semantic web technologies
- YANG is a data modeling language

Idea: use an IoT ontology for device descriptions

USED PART OF THE ONEM2M BASE ONTOLOGY

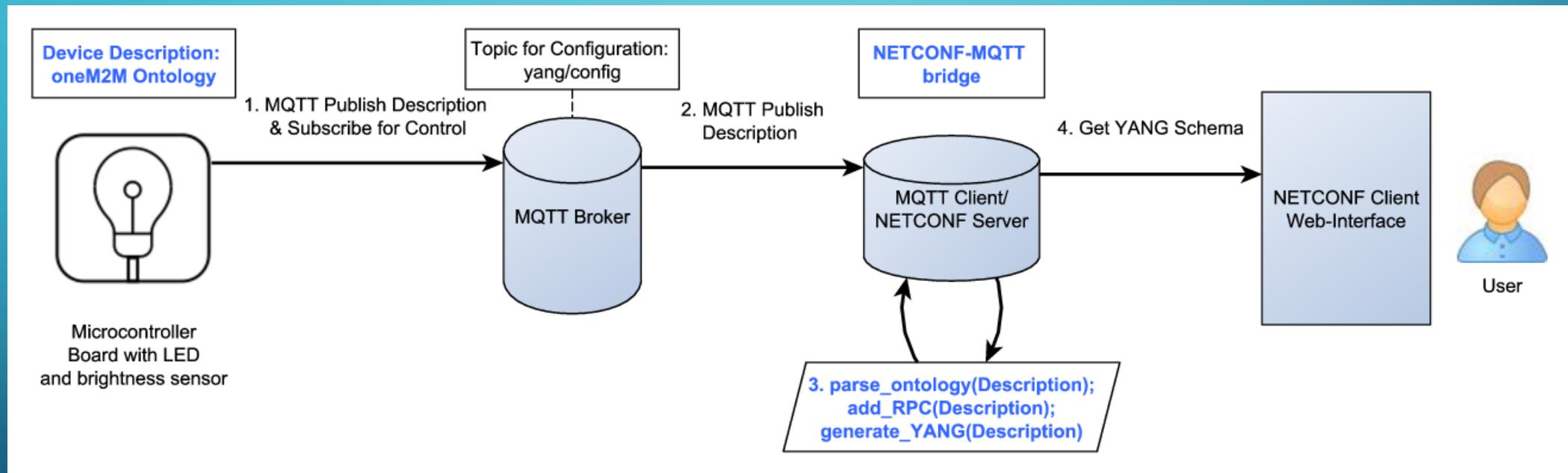


AN ONTOLOGY-BASED NETCONF-MQTT BRIDGE



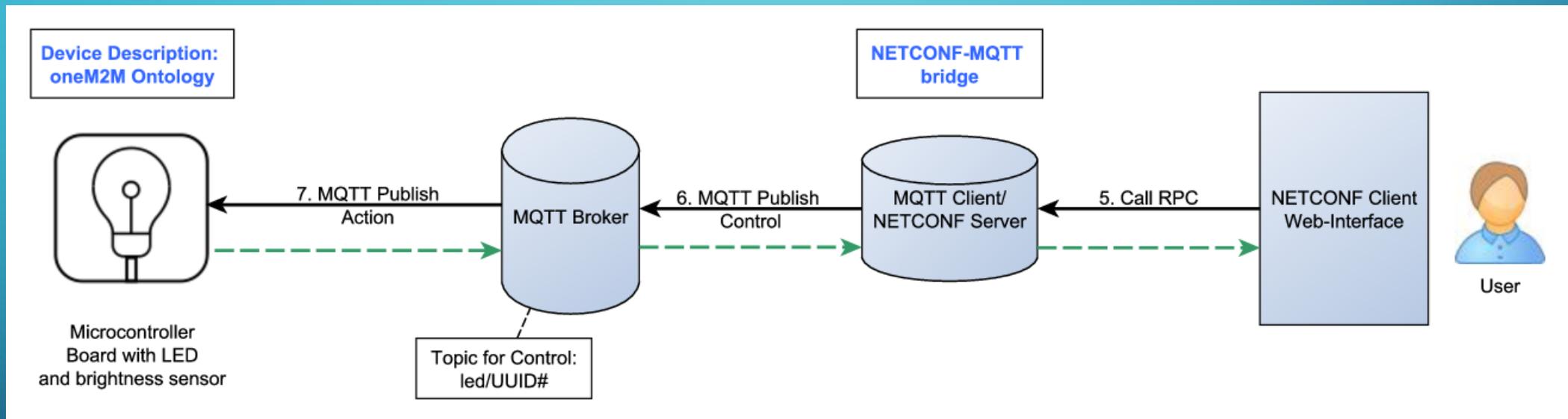
SYSTEM-ARCHITECTURE

PUBLISH DEVICE DESCRIPTIONS

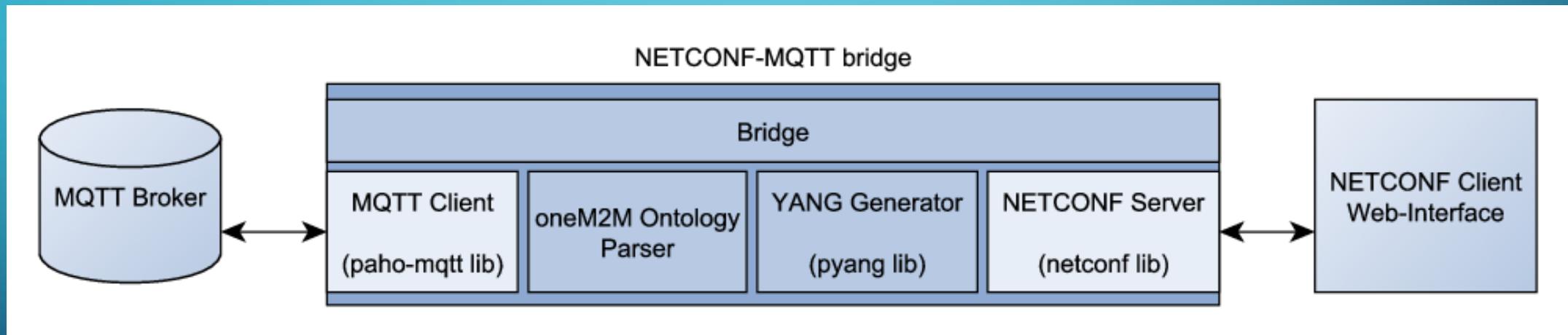


SYSTEM-ARCHITECTURE

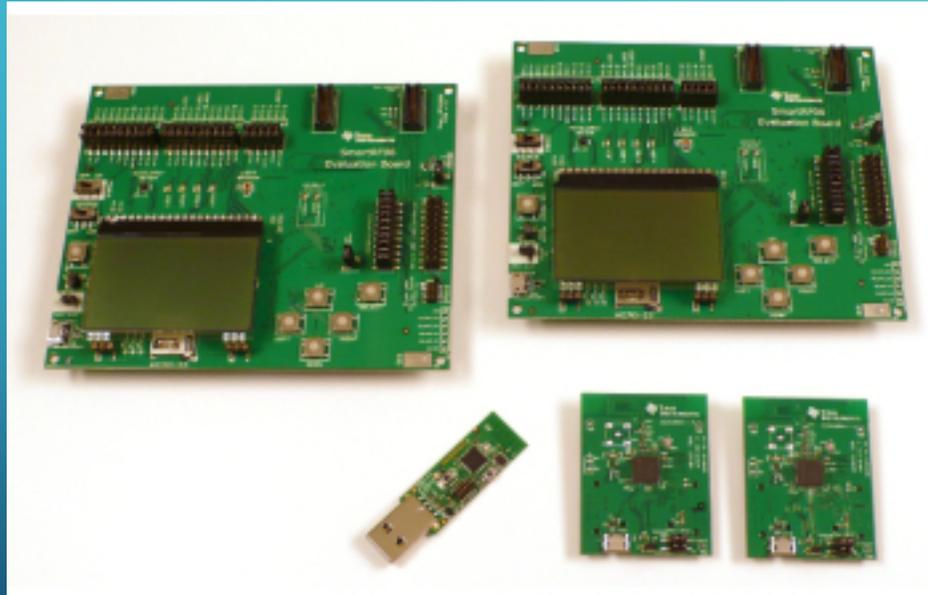
CONTROL THE ACTUATOR



NETCONF-MQTT BRIDGE SOFTWARE ARCHITECTURE



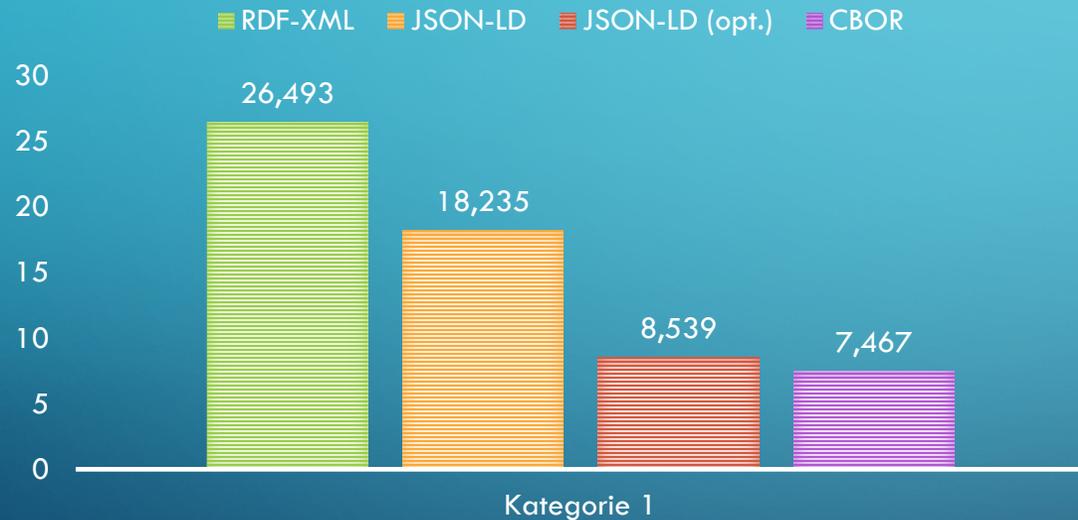
HARDWARE: CC2538 DEVELOPMENT KIT FROM TEXAS INSTRUMENTS



- 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

FILE SIZE IN BYTES



- 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

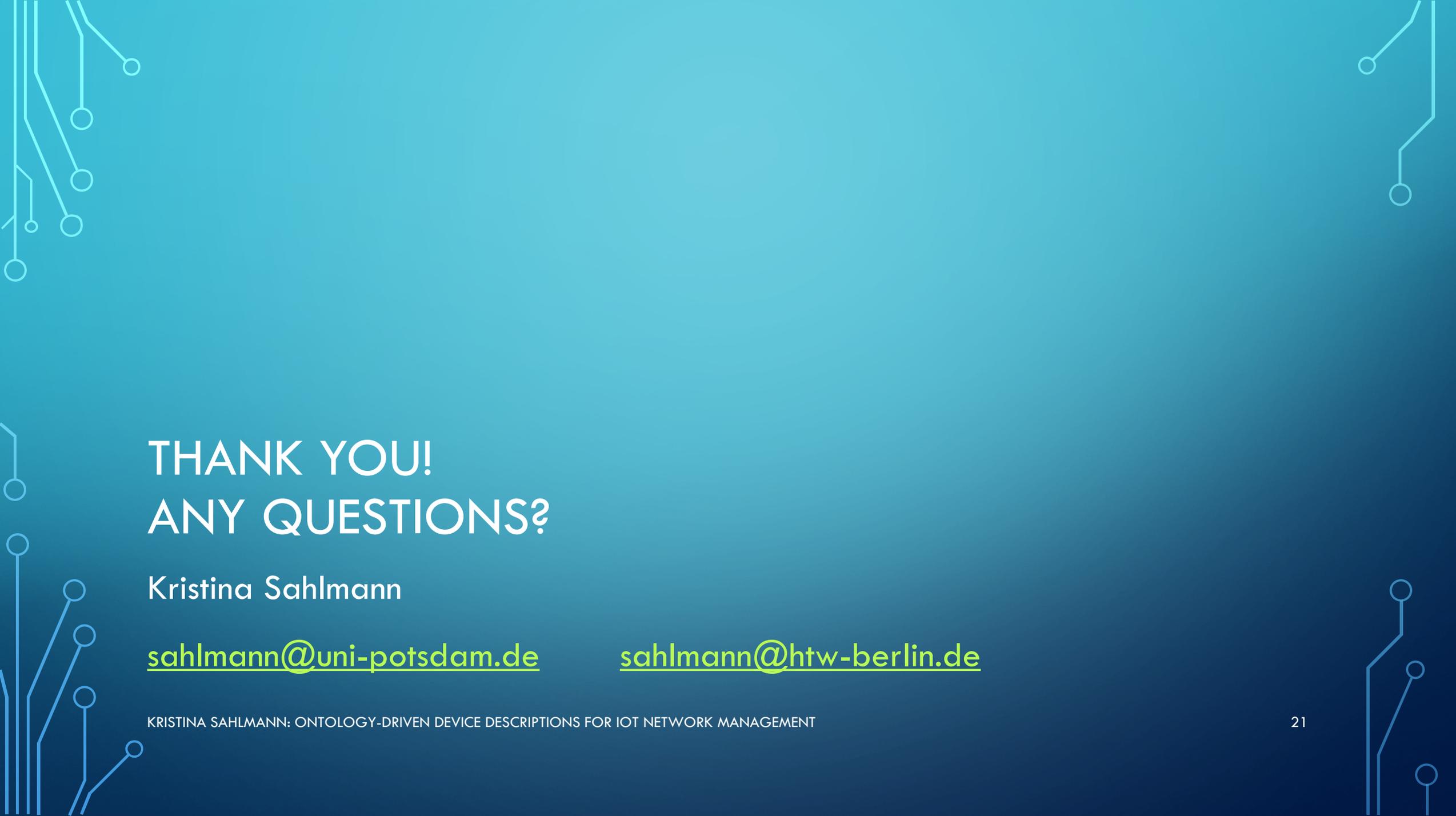
The slide features a blue gradient background with white decorative circuit-like lines in the corners. These lines consist of straight segments connected by small circles, resembling a network or data flow diagram.

CONCLUSION

KRISTINA SAHLMANN: ONTOLOGY-DRIVEN DEVICE DESCRIPTIONS FOR IOT NETWORK MANAGEMENT

CONCLUSION

- 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

The slide features a blue gradient background with white circuit-like lines in the corners. The main text is centered in white.

THANK YOU!
ANY QUESTIONS?

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