ETH zürich





Services for the Internet of Things with CoAP

Matthias Kovatsch

8th International Workshop on Service-Oriented Cyber-Physical Systems in Converging Networked Environments (SOCNE) Barcelona, Spain



The Internet of Things as Seen by Gartner



ETH zürich





From Internet of Things Building Blocks ...











Tiny Resource-constrained IoT Devices







Closing the Gap



Web Technology



Constrained IoT Devices



Constrained Application Protocol (CoAP)



- RESTful protocol designed from scratch
- Transparent mapping to HTTP
- Additional features for M2M scenarios



GET, POST, PUT, DELETE, URIs, and Internet Media Types

Deduplication Optional retransmissions



e.g., Observing Resources

Resource state at origin server





e.g., Group Communication





e.g., Alternative Transports

Short Message Service (SMS)

Addressable through URIs

coap+sms://+123456789/bananas/temp*

Could power up subsystems for IP connectivity after SMS signal



illustration only, +123456789 unfortunately not allowed by URI RFC





Interoperability at the Application Layer



ETH zürich





... to Web of Things Services



Authentication & Authorization





IETF ACE Working Group

DTLS: all-or-nothing



- ACE: fine-grained policies defined by resource server
 - Per resource
 - Per access method (read/write)
- Rely on unconstrained delegates
 - Authorization servers
 - Can be split into resource owner and client domains



IETF ACE Working Group: Gap Analysis





Scaling Up to 200 Billion Connected Devices



Californium Architecture



http://www.eclipse.org/californium/





Scalability: CoAP vs HTTP with Keep-Alive



Matthias Kovatsch, Martin Lanter, Zach Shelby

Californium: Scalable Cloud Services for the Internet of Things with CoAP.

Proceedings of the 4th International Conference on the Internet of Things (IoT 2014). Cambridge, MA, USA, October 2014



Scalability: CoAP vs HTTP without Keep-Alive



Matthias Kovatsch, Martin Lanter, Zach Shelby

Californium: Scalable Cloud Services for the Internet of Things with CoAP.

Proceedings of the 4th International Conference on the Internet of Things (IoT 2014). Cambridge, MA, USA, October 2014



Service Descriptions





Classic Approaches



- Devices Profile for Web Services (DPWS)
 - WS-* specifications
 - Efficient XML Interchange (EXI)



- oneM2M
 - M2M super specification: ARIB, ATIS, CCSA, ETSI, TIA, TTA, TTC

OMA Lightweight M2M



- Device management
 - Bootstrapping
 - Registration
 - Function sets (Objects)
 - Access control
 - Reporting
- M2M communication
 - Object IDs (fixed URIs, e.g., /12/1/3)
 - Interfaces (read, write, execute, batches)
 - Payloads (text/plain, binary, JSON)
- Open registry $\rightarrow p$





RESTful M2M Services

- Design of new Internet Media Types
 - Reuse as far as possible

(http://www.iana.org/assignments/media-types/media-types.xhtml)

- Standardize meaningful, re-usable types (e.g., SenML) (<u>RCF 6838</u>)
- Definition of machine-readable link relations
 - CoRE Link Format attributes
 - Bottom-up semantics for self-configuration



And many more challenges Electromagnetic L rtphones Detection **Application** Interaction **Traffic Cor** runtime models Sportsmen Care Structural Health Lifecycle 0 **Business** management models Water Quality Quality of Shipmen dium



Questions?

Matthias Kovatsch

kovatsch@inf.ethz.ch

<u>https://github.com/mkovatsc/</u> <u>http://people.inf.ethz.ch/mkovatsc/</u>





Resource-constrained Devices and Efficiency

https://github.com/contiki-os/contiki



- Embedded CoAP Web server for Contiki OS
- Thin server architecture
- Small size and intuitive resource handler API
- Application-agnostic device infrastructure



IoT Cloud Services and Scalability

http://www.eclipse.org/californium/



- Java CoAP framework at the Eclipse Foundation
- IETF "running code"
- Unconstrained service backend for myriads of IoT devices
- DTLS 1.2 implementation
- Basis for Actinium (Ac)



The Human in the Loop I

http://www.eclipse.org/californium/



- App-server for Californium
- IoT mashups for automation in the background
- Server-side JavaScript
- CoapRequest object API
- RESTful lifecycle management



The Human in the Loop II

https://addons.mozilla.org/firefox/addon/copper-270430/



- CoAP protocol handler for Mozilla Firefox
- Browsing and bookmarking of CoAP URIs
- Interaction with resource like RESTClient or Poster
- Treat tiny devices like normal RESTful Web services