WEB OF

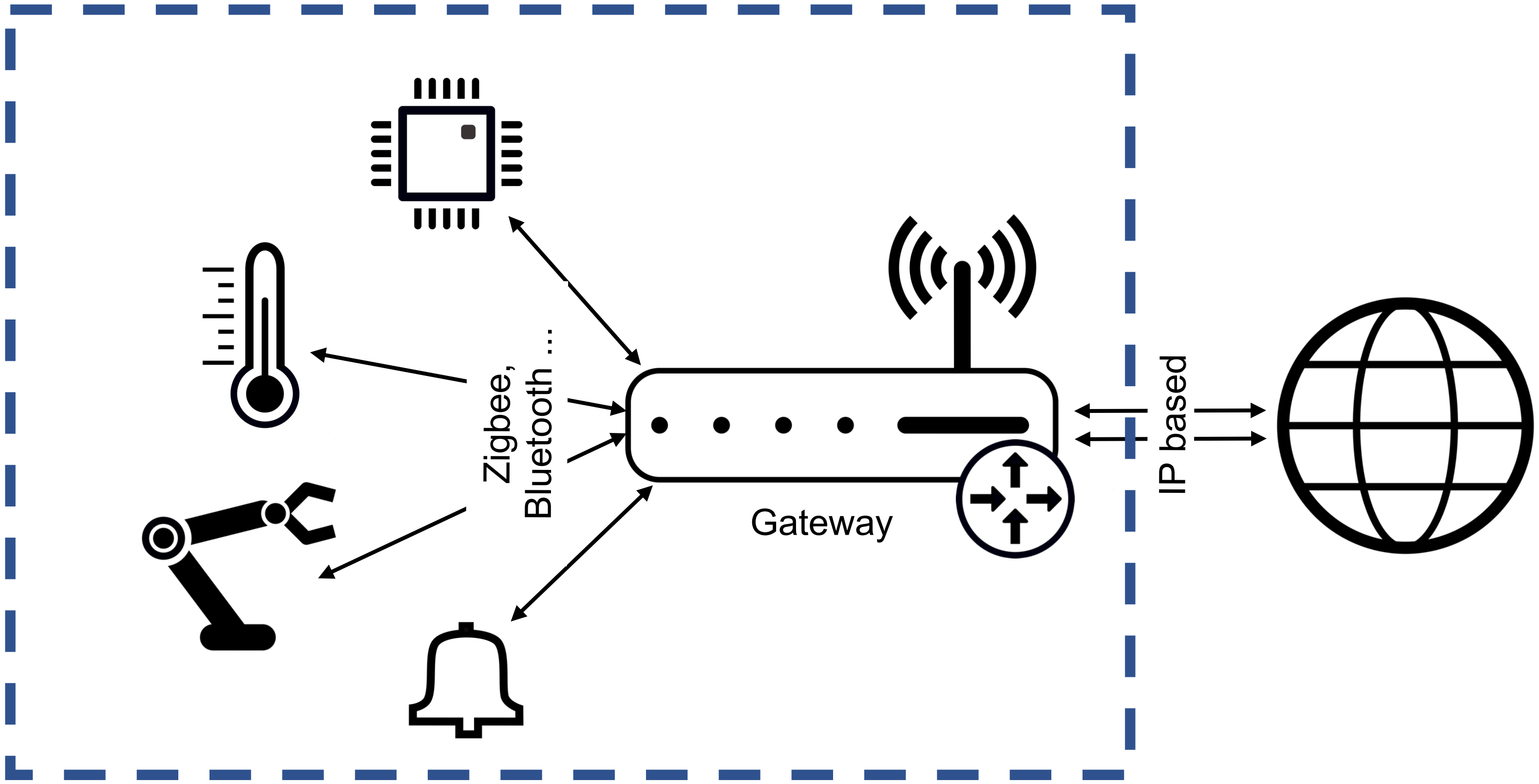
THINGS

# W3C Web of Things Thing Description for API Description of IoT Devices

Ege Korkan - TU Munich | W3C WoT Working Group

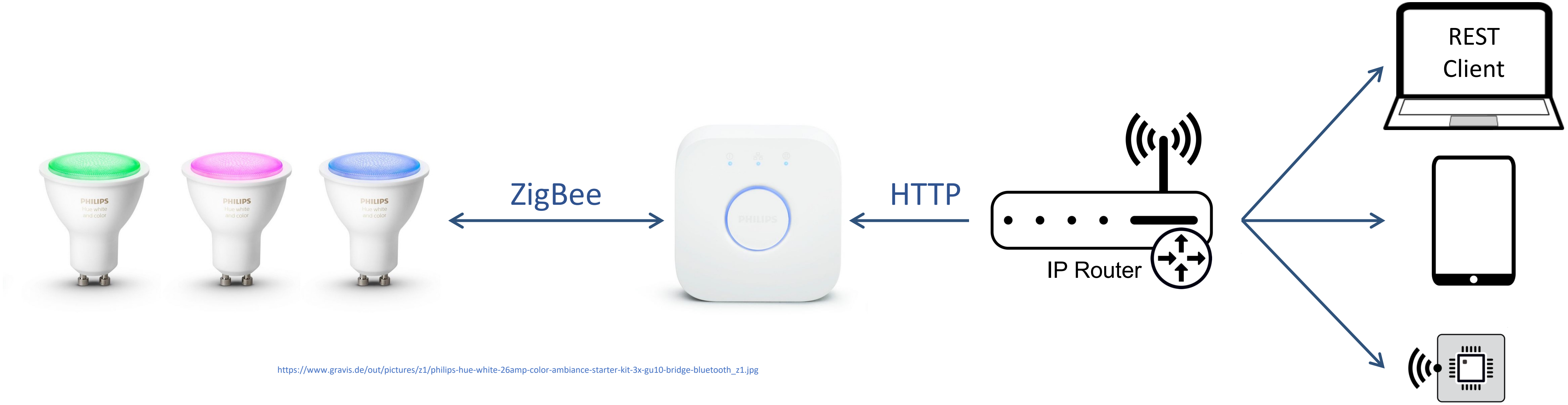
API Specifications Conference 2020 - 09.09.2020

# What is IoT, in this talk?



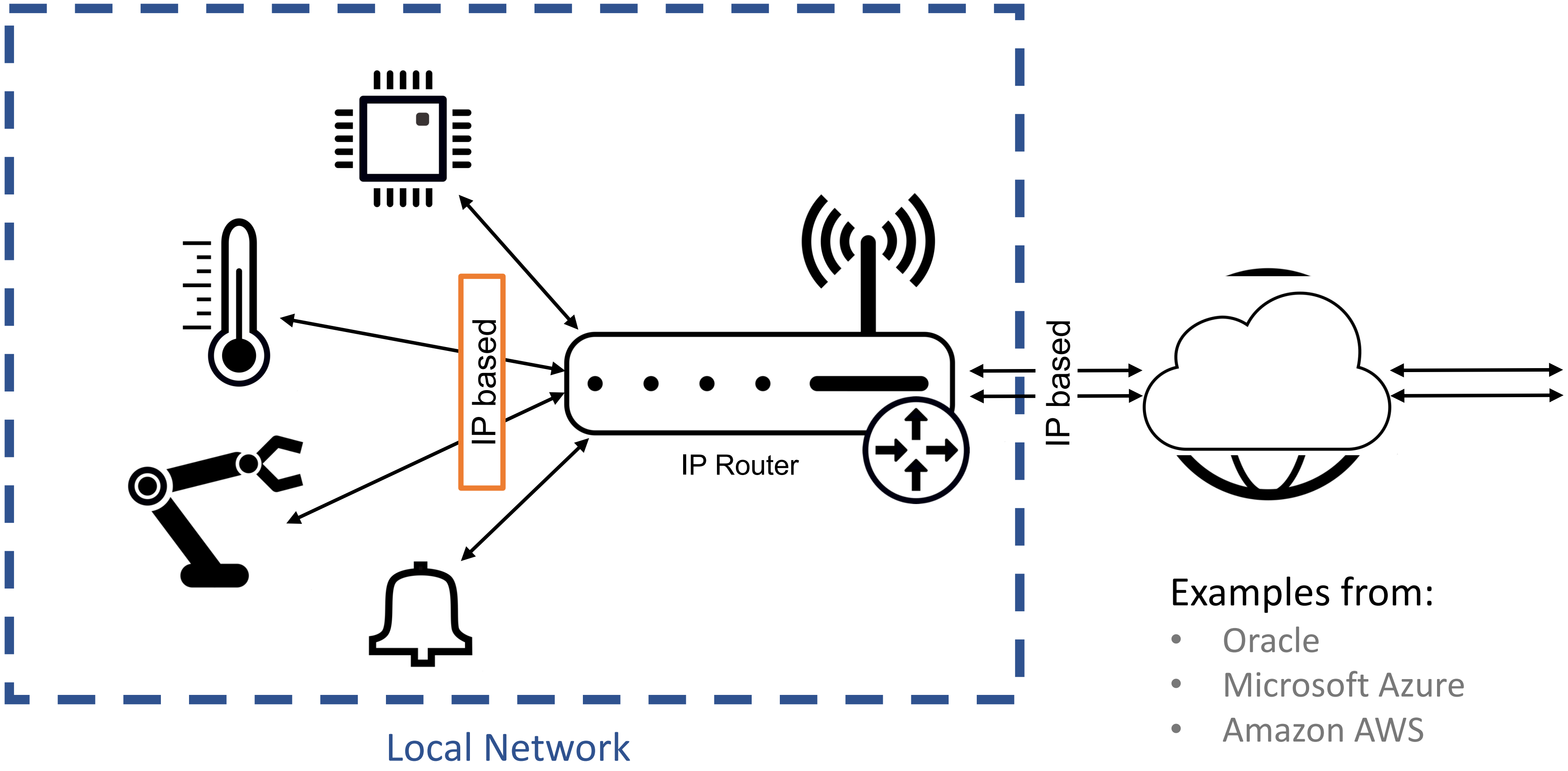
Local Network

# What is IoT, in this talk? An example



https://www.gravis.de/out/pictures/z1/philips-hue-white-26amp-color-ambiance-starter-kit-3x-gu10-bridge-bluetooth_z1.jpg

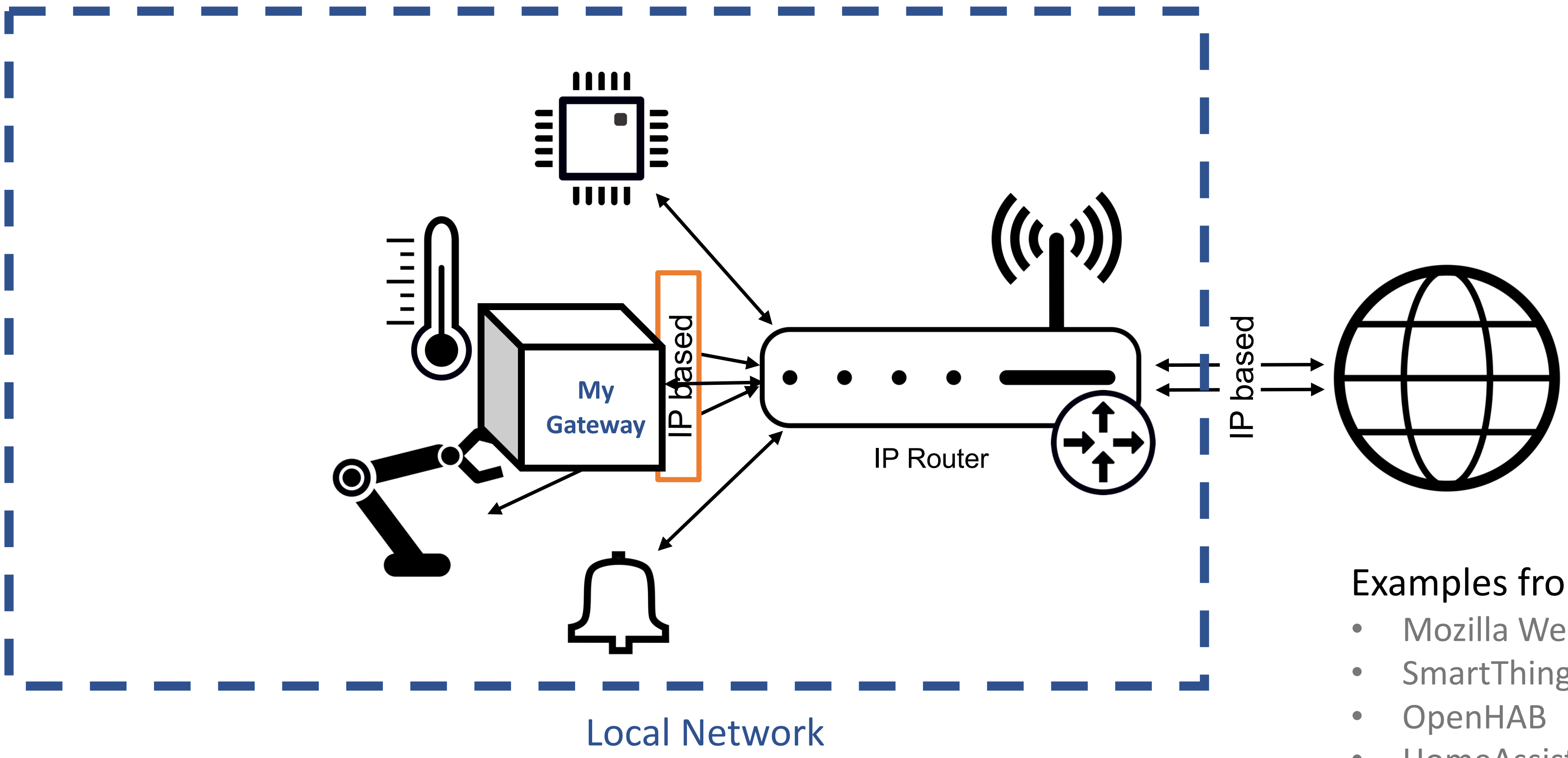
# What is IoT, in this talk?



Examples from:

- Oracle
- Microsoft Azure
- Amazon AWS

# What is IoT, in this talk?



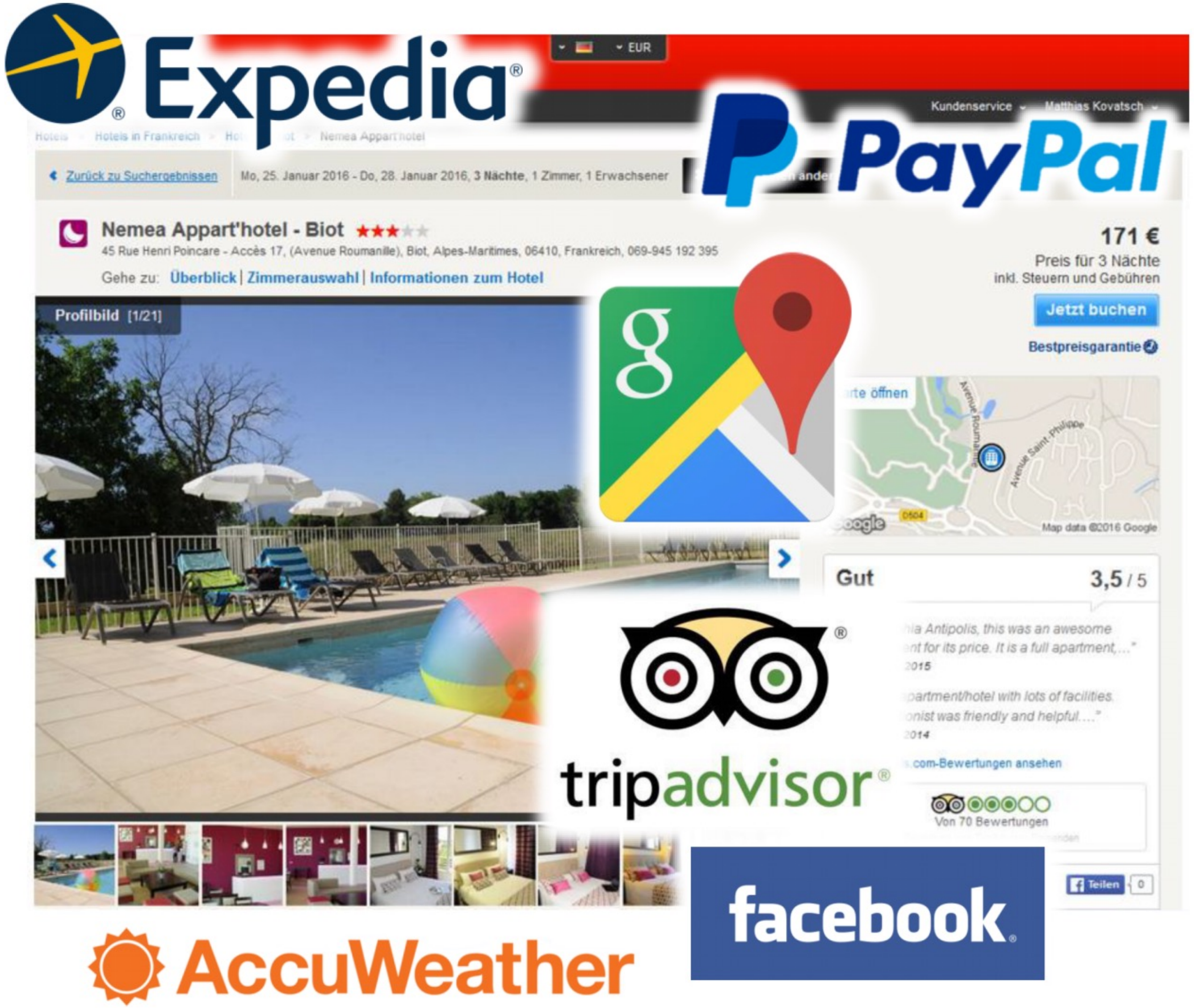
Examples from:

- Mozilla WebThing
- SmartThings
- OpenHAB
- HomeAssistant
- Thingworx

# To summarize

- The communication to the *public* Internet happens always via IP level protocols such as:
  - HTTP
  - MQTT
  - WebSockets, etc.
- The communication in the local network happens via many different non-IP and IP level protocols such as:
  - HTTP, MQTT, CoAP, WebSockets
  - Industrial protocols: OPC-UA, Modbus TCP, BacNet
  - Non-IP protocols: Bluetooth, Zigbee, LoRaWAN
- Additional silos due to different verticals also exist

# Our Goal: Support Mashups 🤩



Nemea Appart'hotel - Biot ★★★

45 Rue Henri Poincare - Accès 17, (Avenue Roumanille), Biot, Alpes-Maritimes, 06410, Frankreich, 069-945 192 395

Mo, 25. Januar 2016 - Do, 28. Januar 2016, 3 Nächte, 1 Zimmer, 1 Erwachsener

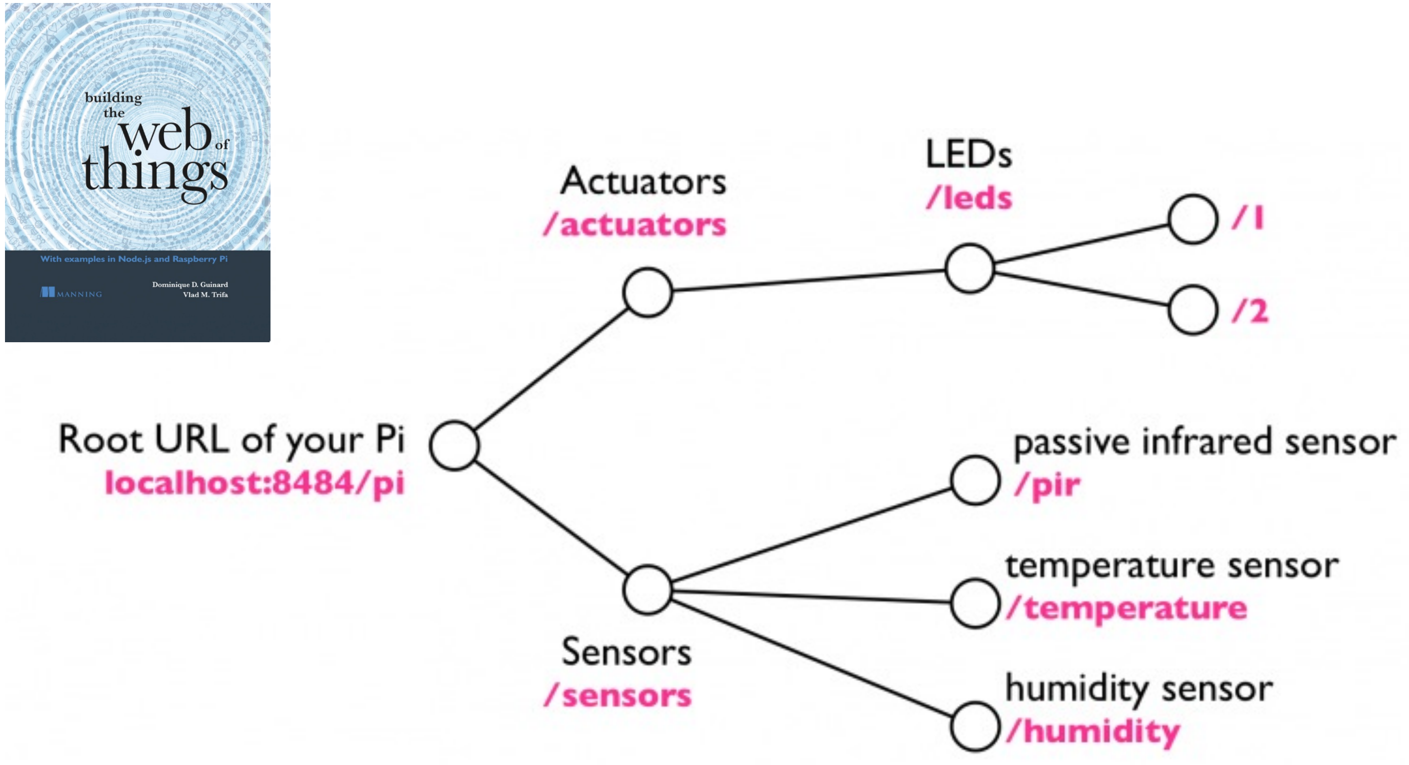
171 €

Preis für 3 Nächte inkl. Steuern und Gebühren

Gut 3,5 / 5

but in the IoT!

# Web of Things to help! - Initial Ideas



Source: Building the Web of Things: book.webofthings.io
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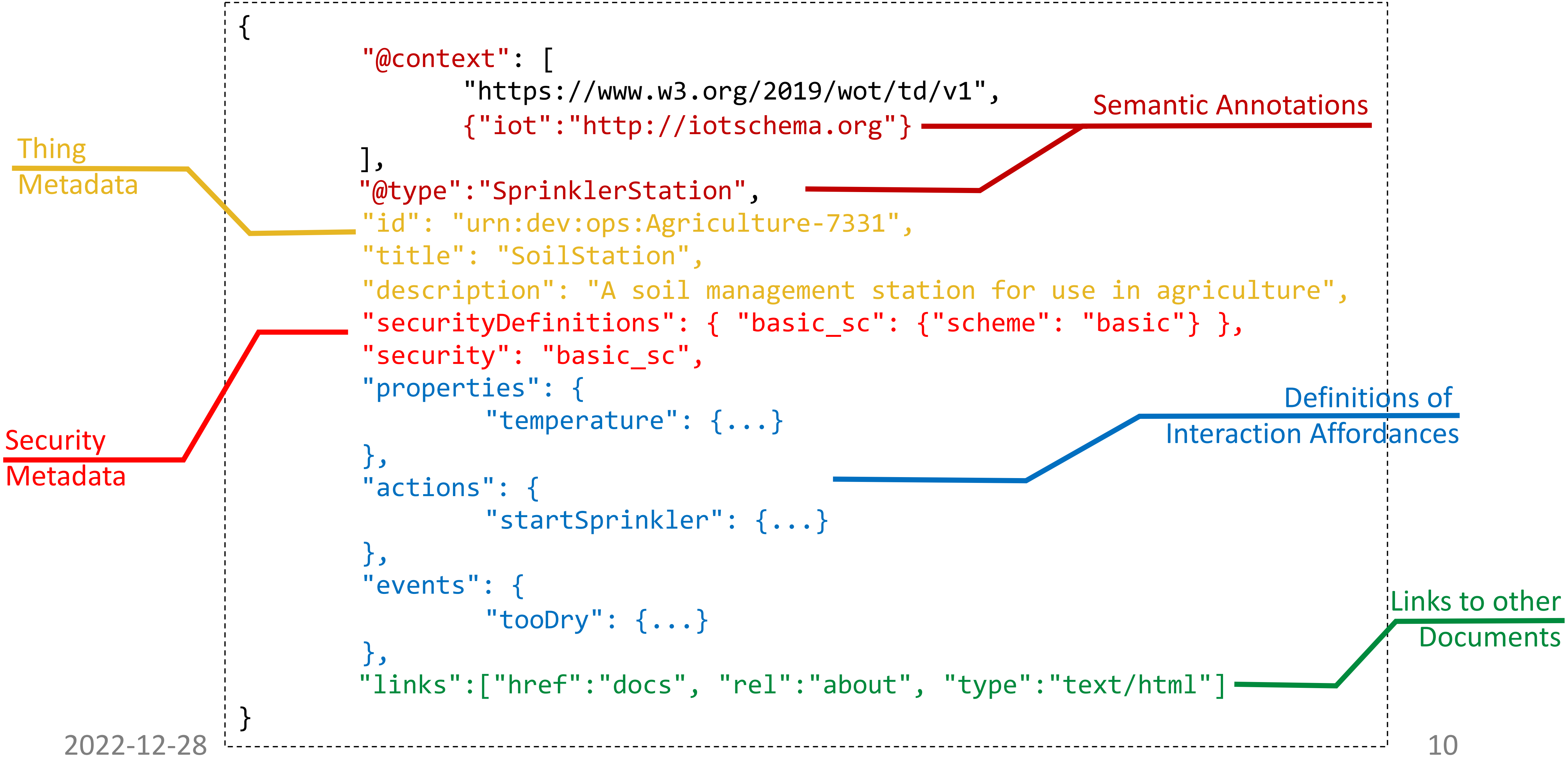
**Was** a proposal on how to build REST APIs for IoT devices

**Is** about describing *any* kind of API for IoT devices

# Standardization via Thing Descriptions! 😌

1. Abstract description of network APIs of IoT devices
   - Property
   - Action
   - Event
2. Semantic annotation of capabilities by other vocabularies over the Web: schema.org, SSN, ...
3. Concrete protocol description of individual devices

# Example TD: Thing Level



```
{
        "@context": [
                "https://www.w3.org/2019/wot/td/v1",
                {"iot":"http://iotschema.org"}
        ],
        "@type":"SprinklerStation",
        "id": "urn:dev:ops:Agriculture-7331",
        "title": "SoilStation",
        "description": "A soil management station for use in agriculture",
        "securityDefinitions": { "basic_sc": {"scheme": "basic"} },
        "security": "basic_sc",
        "properties": {
                "temperature": {...}
        },
        "actions": {
                "startSprinkler": {...}
        },
        "events": {
                "tooDry": {...}
        },
        "links":["href":"docs", "rel":"about", "type":"text/html"]
}
```

Semantic Annotations

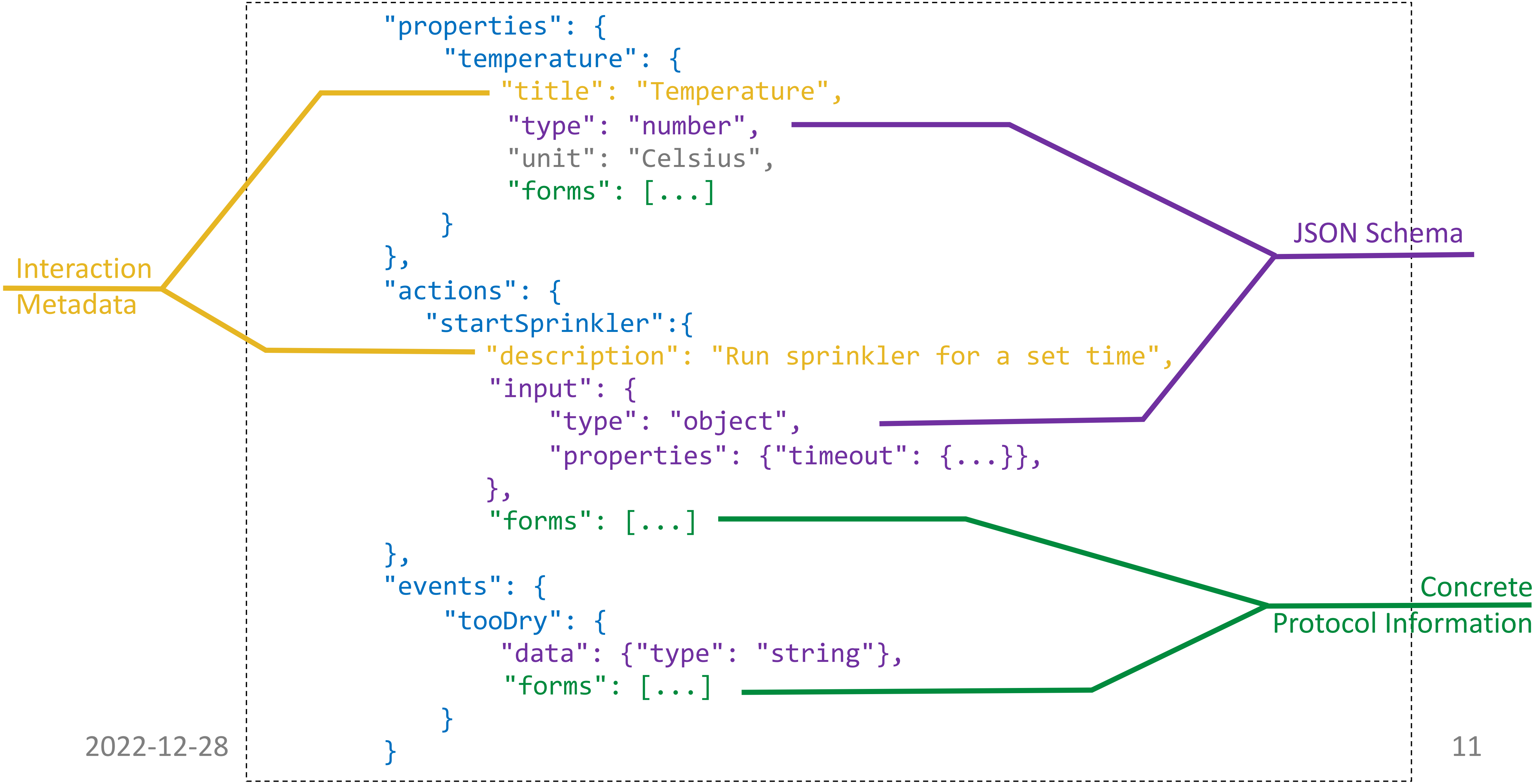
Thing Metadata

Security Metadata

Definitions of Interaction Affordances

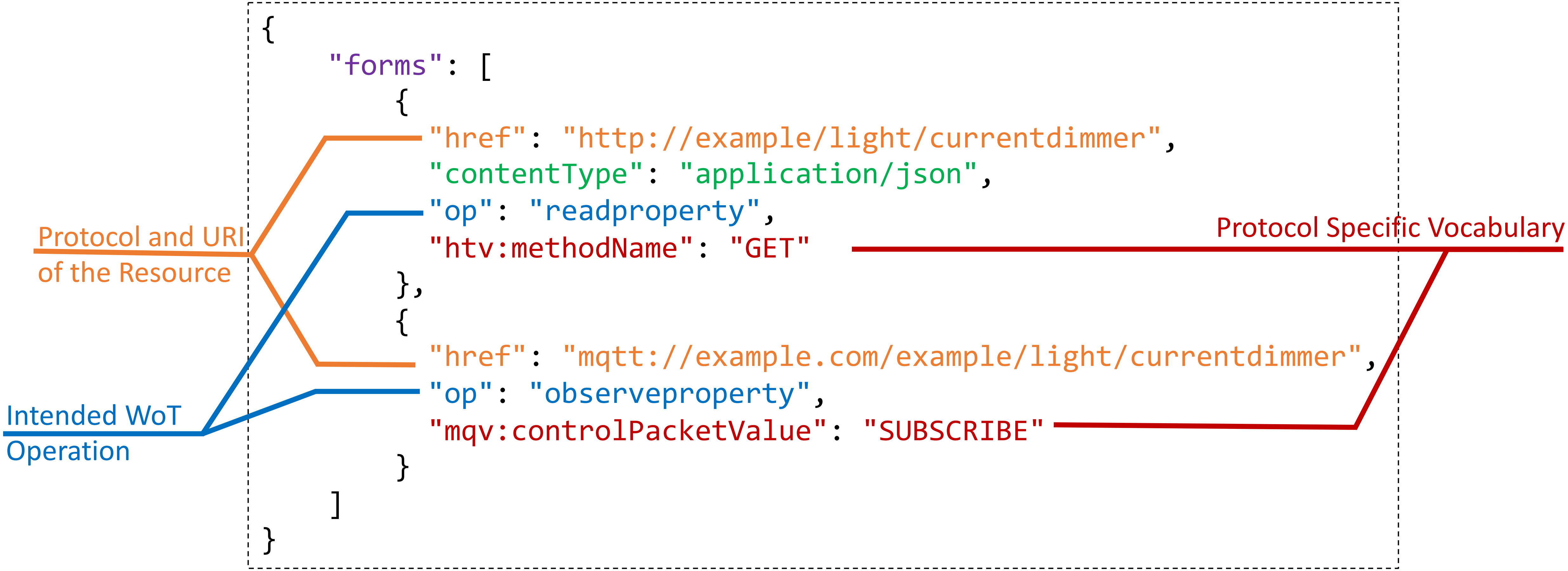
Links to other Documents

# Example TD: Interaction Level



```
"properties": {
    "temperature": {
        "title": "Temperature",
        "type": "number",
        "unit": "Celsius",
        "forms": [...]
    }
},
"actions": {
   "startSprinkler":{
       "description": "Run sprinkler for a set time",
       "input": {
           "type": "object",
           "properties": {"timeout": {...}},
       },
       "forms": [...]
},
"events": {
    "tooDry": {
        "data": {"type": "string"},
        "forms": [...]
    }
}
```

# Example TD: Protocol Bindings



```
{
    "forms": [
        {
          "href": "http://example/light/currentdimmer",
          "contentType": "application/json",
          "op": "readproperty",
          "htv:methodName": "GET"
        },
        {
          "href": "mqtt://example.com/example/light/currentdimmer",
          "op": "observeproperty",
          "mqv:controlPacketValue": "SUBSCRIBE"
        }
    ]
}
```

Protocol and URI of the Resource

Intended WoT Operation

Protocol Specific Vocabulary

# Specification

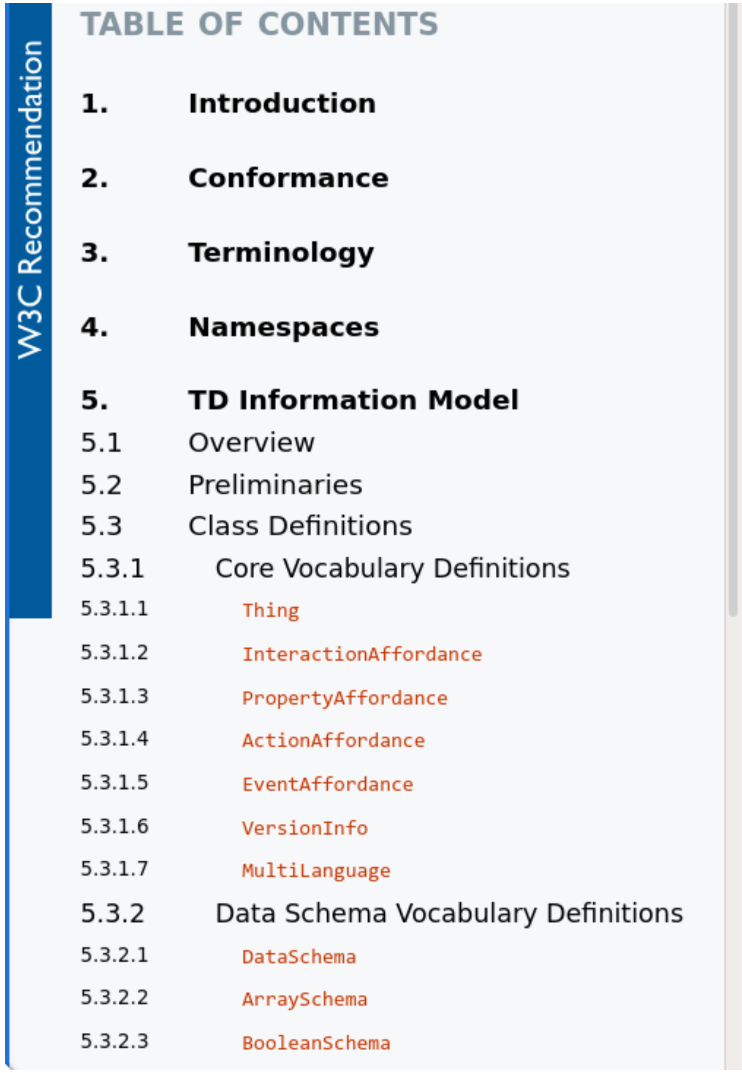
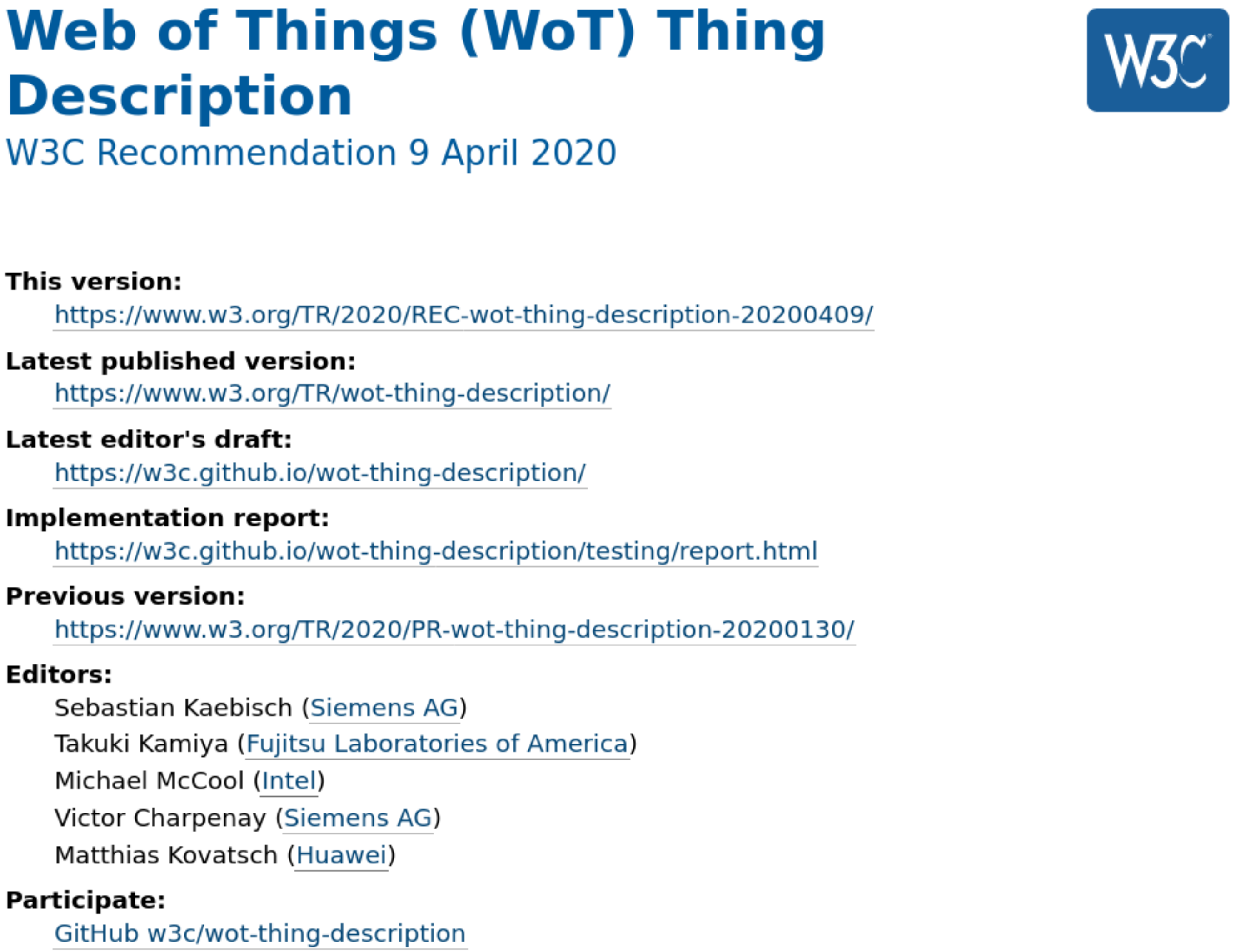


TABLE OF CONTENTS



## Web of Things (WoT) Thing Description

W3C Recommendation 9 April 2020

**This version:**
https://www.w3.org/TR/2020/REC-wot-thing-description-20200409/

**Latest published version:**
https://www.w3.org/TR/wot-thing-description/

**Latest editor's draft:**
https://w3c.github.io/wot-thing-description/

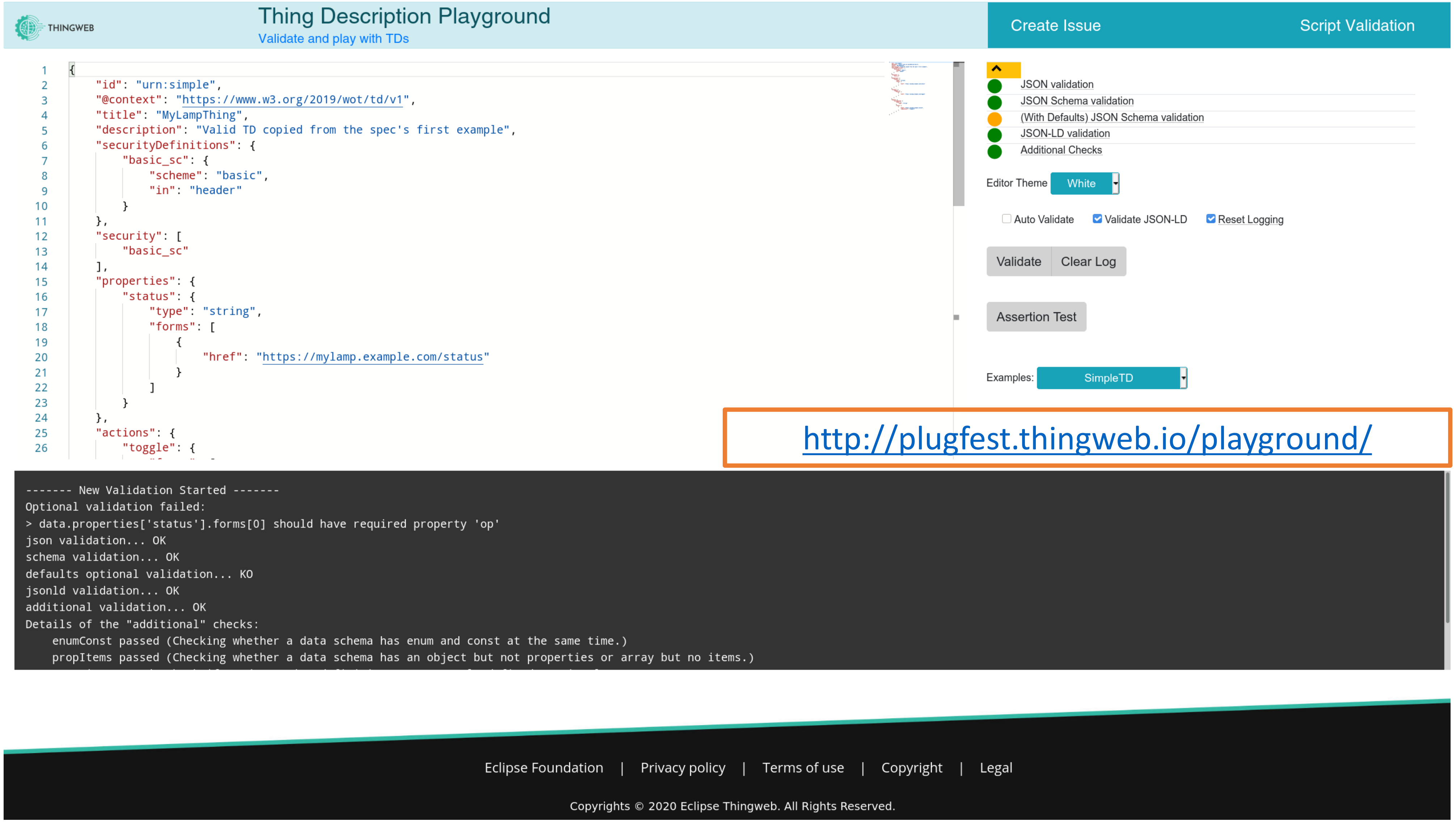
**Implementation report:**
https://w3c.github.io/wot-thing-description/testing/report.html

**Previous version:**
https://www.w3.org/TR/2020/PR-wot-thing-description-20200130/

**Editors:**
Sebastian Kaebisch (Siemens AG)
Takuki Kamiya (Fujitsu Laboratories of America)
Michael McCool (Intel)
Victor Charpenay (Siemens AG)
Matthias Kovatsch (Huawei)

**Participate:**
GitHub w3c/wot-thing-description

# TD Playground



```
{
    "id": "urn:simple",
    "@context": "https://www.w3.org/2019/wot/td/v1",
    "title": "MyLampThing",
    "description": "Valid TD copied from the spec's first example",
    "securityDefinitions": {
        "basic_sc": {
            "scheme": "basic",
            "in": "header"
        }
    },
    "security": [
        "basic_sc"
    ],
    "properties": {
        "status": {
            "type": "string",
            "forms": [
                {
                    "href": "https://mylamp.example.com/status"
                }
            ]
        }
    },
    "actions": {
        "toggle": {
```

● JSON validation

● JSON Schema validation

● (With Defaults) JSON Schema validation

● JSON-LD validation

● Additional Checks

Editor Theme: White

☐ Auto Validate ☑ Validate JSON-LD ☑ Reset Logging

Examples: SimpleTD

http://plugfest.thingweb.io/playground/

```
------- New Validation Started -------
Optional validation failed:
> data.properties['status'].forms[0] should have required property 'op'
json validation... OK
schema validation... OK
defaults optional validation... KO
jsonld validation... OK
additional validation... OK
Details of the "additional" checks:
    enumConst passed (Checking whether a data schema has enum and const at the same time.)
    propItems passed (Checking whether a data schema has an object but not properties or array but no items.)
```

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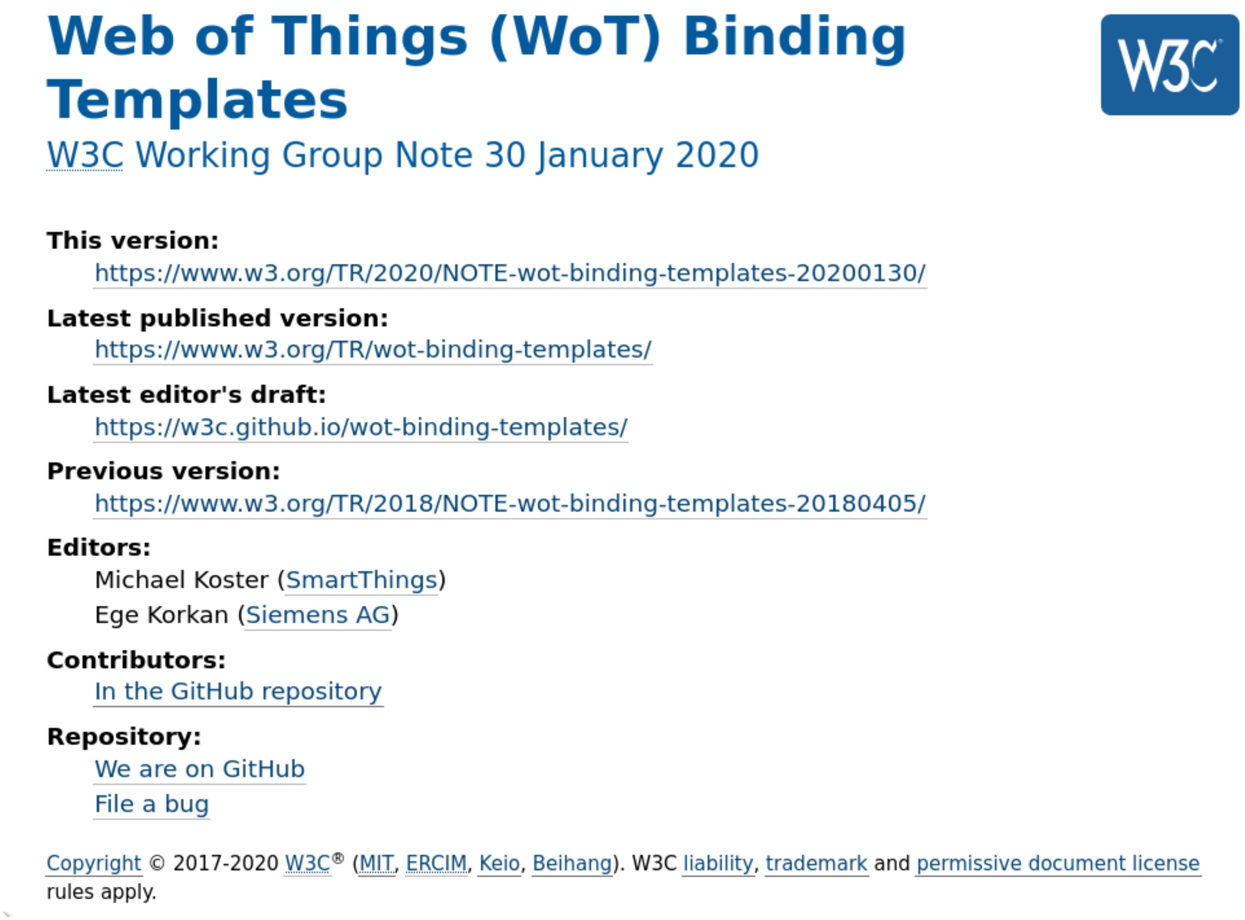
# Related to



## Web of Things (WoT) Binding Templates

W3C Working Group Note 30 January 2020

**This version:**
https://www.w3.org/TR/2020/NOTE-wot-binding-templates-20200130/

**Latest published version:**
https://www.w3.org/TR/wot-binding-templates/

**Latest editor's draft:**
https://w3c.github.io/wot-binding-templates/

**Previous version:**
https://www.w3.org/TR/2018/NOTE-wot-binding-templates-20180405/

**Editors:**
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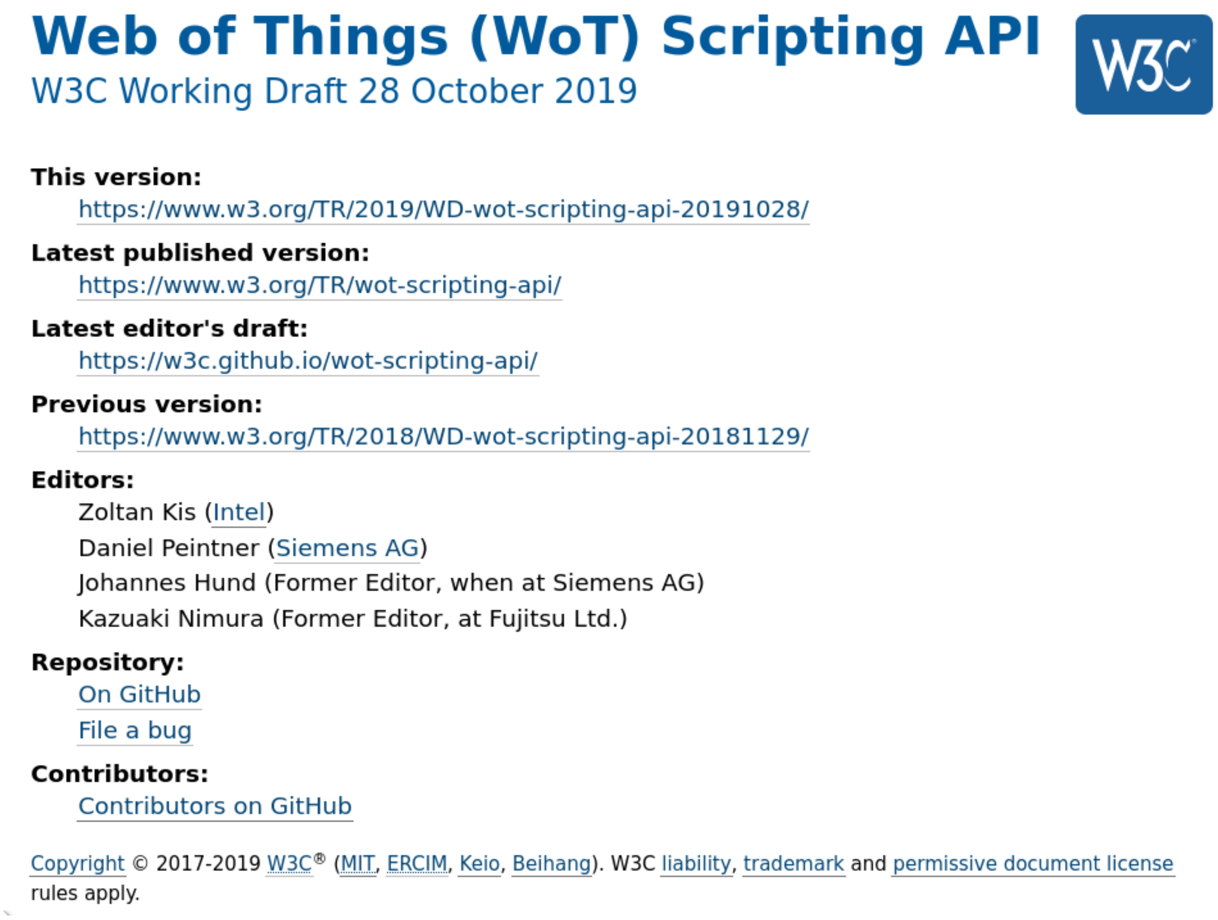
Ege Korkan (Siemens AG)

**Contributors:**
In the GitHub repository

**Repository:**
We are on GitHub
File a bug



## Web of Things (WoT) Scripting API

W3C Working Draft 28 October 2019

**This version:**
https://www.w3.org/TR/2019/WD-wot-scripting-api-20191028/

**Latest published version:**
https://www.w3.org/TR/wot-scripting-api/

**Latest editor's draft:**
https://w3c.github.io/wot-scripting-api/

**Previous version:**
https://www.w3.org/TR/2018/WD-wot-scripting-api-20181129/

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Zoltan Kis (Intel)
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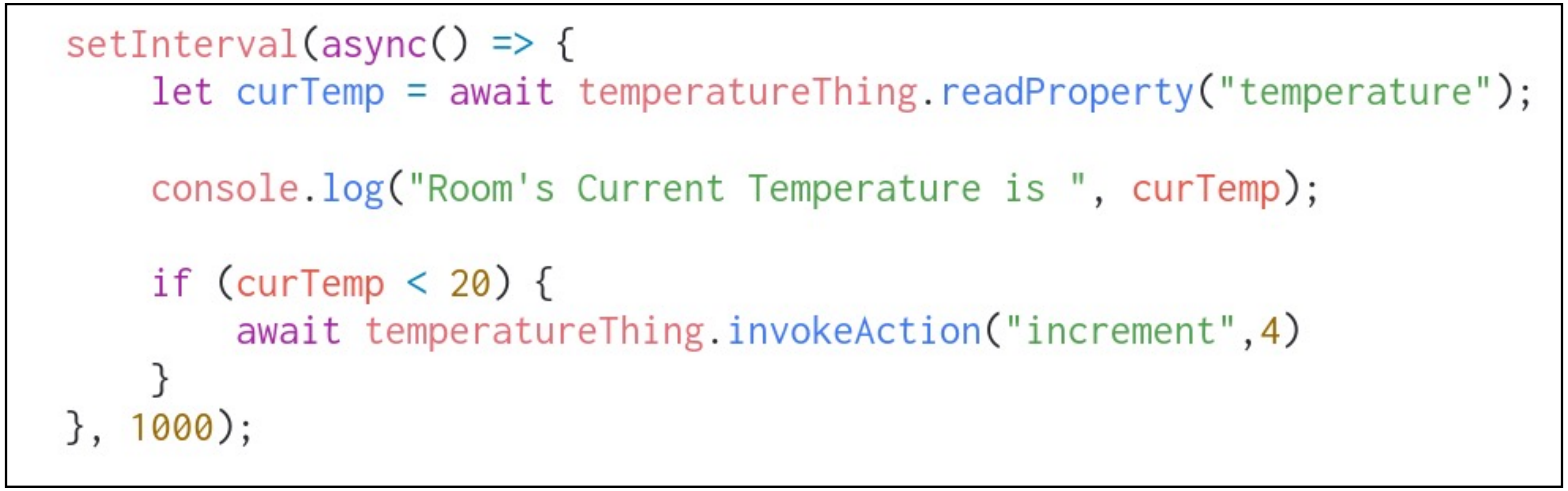
Johannes Hund (Former Editor, when at Siemens AG)
Kazuaki Nimura (Former Editor, at Fujitsu Ltd.)

**Repository:**
On GitHub
File a bug

**Contributors:**
Contributors on GitHub

# What can you do with TDs: Scripting

Interact with Things without thinking about the protocol !



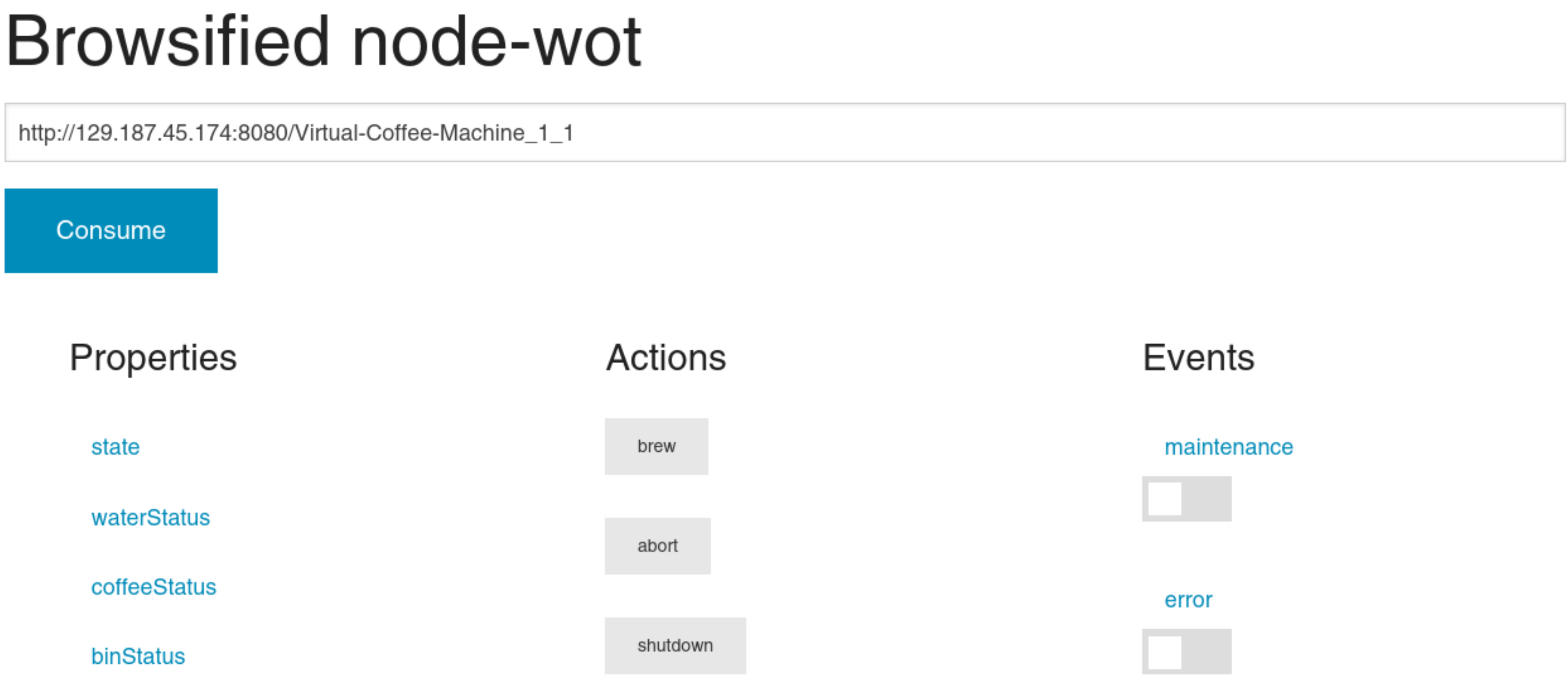
```
setInterval(async() => {
    let curTemp = await temperatureThing.readProperty("temperature");

    console.log("Room's Current Temperature is ", curTemp);

    if (curTemp < 20) {
        await temperatureThing.invokeAction("increment",4)
    }
}, 1000);
```

Possible via WoT Scripting API and its implementation node-wot

https://github.com/eclipse/thingweb.node-wot

A tutorial: https://www.youtube.com/watch?v=wDX45dsD4GM

# What can you do with TDs: UI Generation

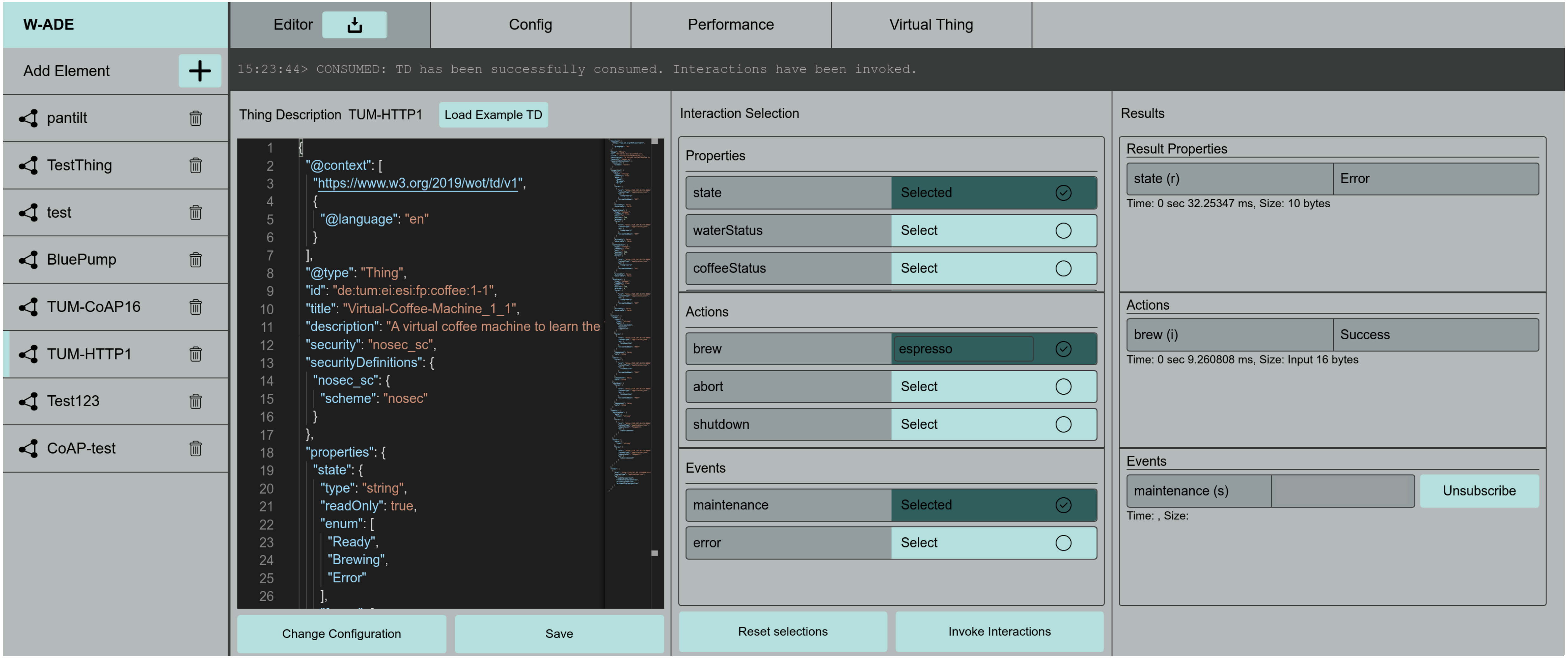


Browsified node-wot

http://129.187.45.174:8080/Virtual-Coffee-Machine_1_1

Simple demo hosted at http://plugfest.thingweb.io/webui/

# What can you do with TDs: UI Generation



```
15:23:44> CONSUMED: TD has been successfully consumed. Interactions have been invoked.
```

Thing Description TUM-HTTP1

```
{
  "@context": [
    "https://www.w3.org/2019/wot/td/v1",
    {
      "@language": "en"
    }
  ],
  "@type": "Thing",
  "id": "de:tum:ei:esi:fp:coffee:1-1",
  "title": "Virtual-Coffee-Machine_1_1",
  "description": "A virtual coffee machine to learn the
  "security": "nosec_sc",
  "securityDefinitions": {
    "nosec_sc": {
      "scheme": "nosec"
    }
  },
  "properties": {
    "state": {
      "type": "string",
      "readOnly": true,
      "enum": [
        "Ready",
        "Brewing",
        "Error"
      ],
```

Interaction Selection

Properties

| | |
|---|---|
| state | Selected ✓ |
| waterStatus | Select ○ |
| coffeeStatus | Select ○ |

Actions

| | |
|---|---|
| brew | espresso ✓ |
| abort | Select ○ |
| shutdown | Select ○ |

Events

| | |
|---|---|
| maintenance | Selected ✓ |
| error | Select ○ |

Results

Result Properties

| | |
|---|---|
| state (r) | Error |

Time: 0 sec 32.25347 ms, Size: 10 bytes

Actions

| | |
|---|---|
| brew (i) | Success |

Time: 0 sec 9.260808 ms, Size: Input 16 bytes

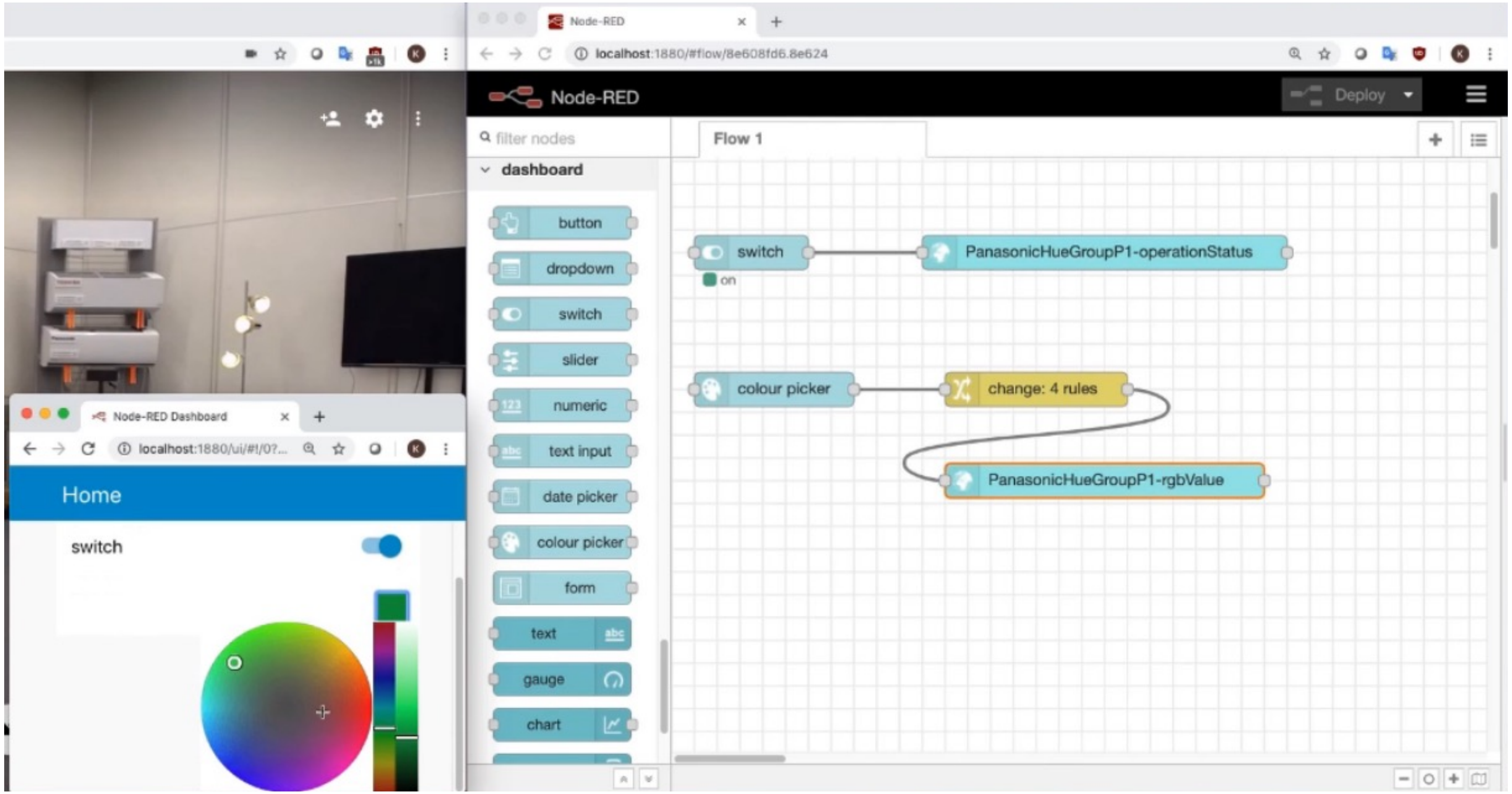
Events

| | |
|---|---|
| maintenance (s) | |

Time: , Size:

Available at https://github.com/tum-esi/wade

# What can you do with TDs: Orchestration



Node-RED Node generator:

- Flow based programming and orchestration tool

- Generate nodes from OpenAPI or TD documents

- Officially supported by OpenJS Foundation

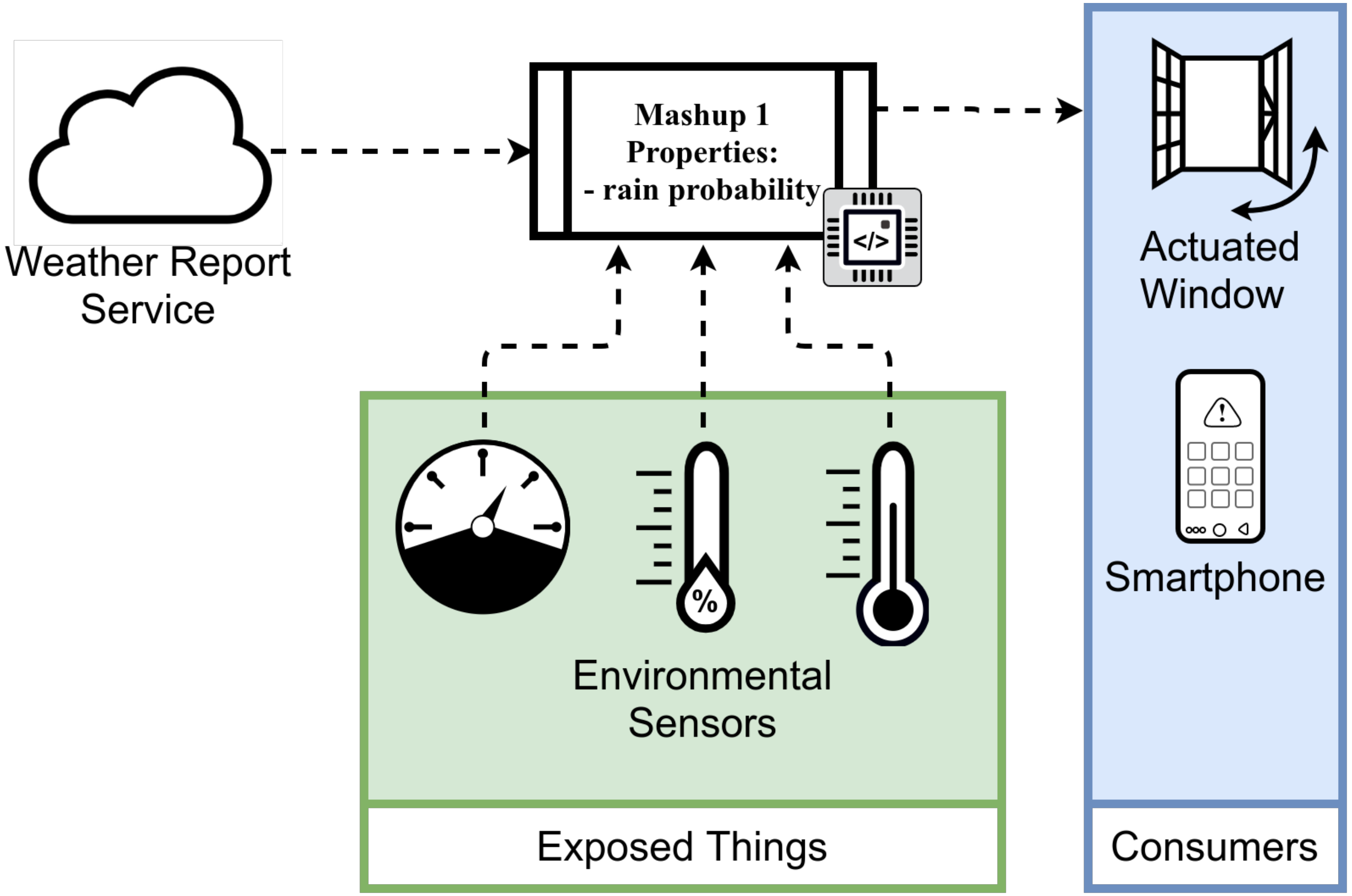
Full video at: https://w3c.github.io/wot-marketing/developers/wot_nodegen.mp4

# What can you do with TDs 👀

MASHUPS!

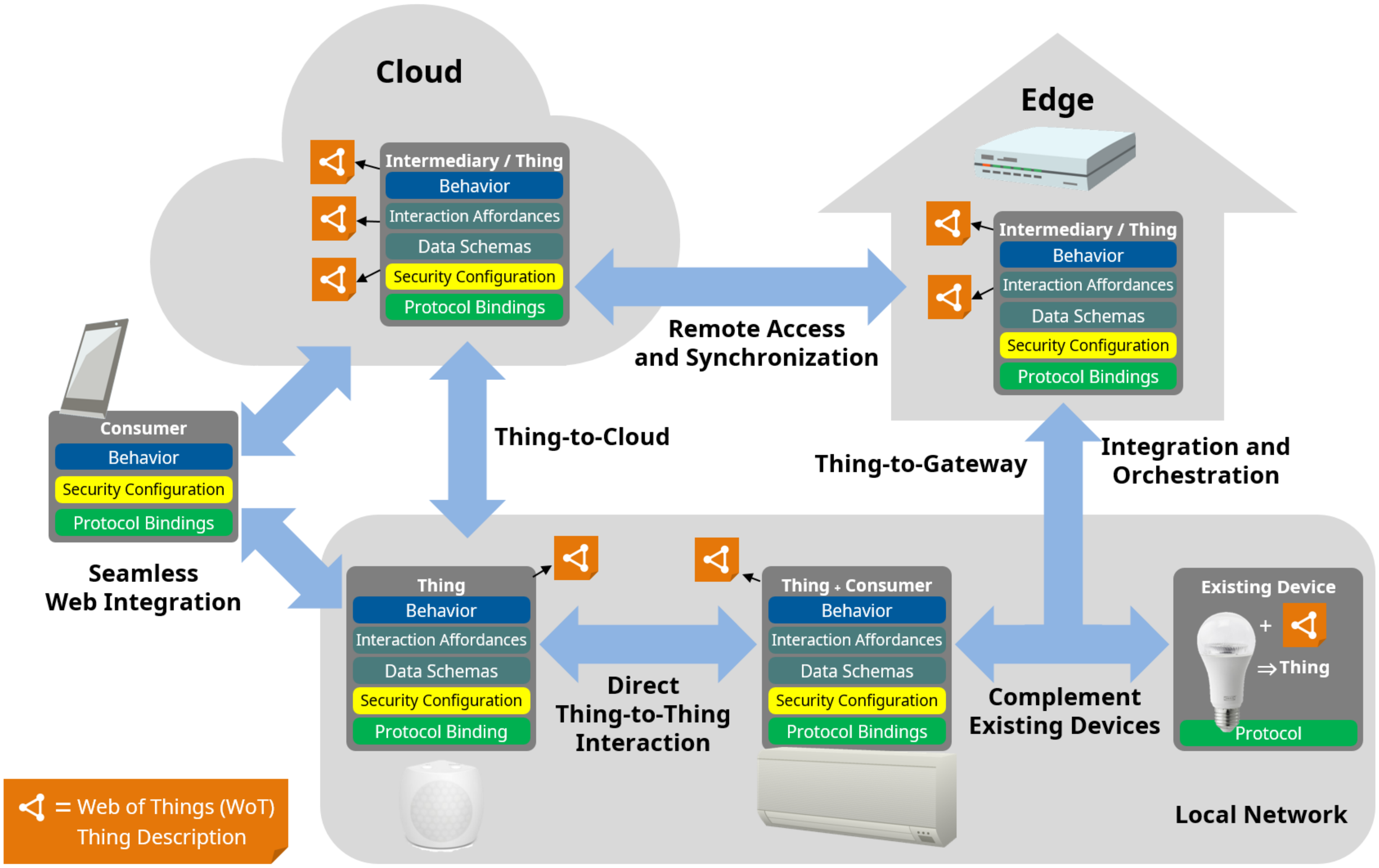
# Mashups in WoT

Bringing devices together (from different manufacturers) to perform bigger tasks



# Mashups in WoT

WEB OF THINGS



Cloud

Intermediary / Thing
Behavior
Interaction Affordances
Data Schemas
Security Configuration
Protocol Bindings

Edge

Intermediary / Thing
Behavior
Interaction Affordances
Data Schemas
Security Configuration
Protocol Bindings

Remote Access and Synchronization

Consumer
Behavior
Security Configuration
Protocol Bindings

Seamless Web Integration

Thing-to-Cloud

Thing-to-Gateway

Integration and Orchestration

Thing
Behavior
Interaction Affordances
Data Schemas
Security Configuration
Protocol Binding

Direct Thing-to-Thing Interaction

Thing + Consumer
Behavior
Interaction Affordances
Data Schemas
Security Configuration
Protocol Bindings

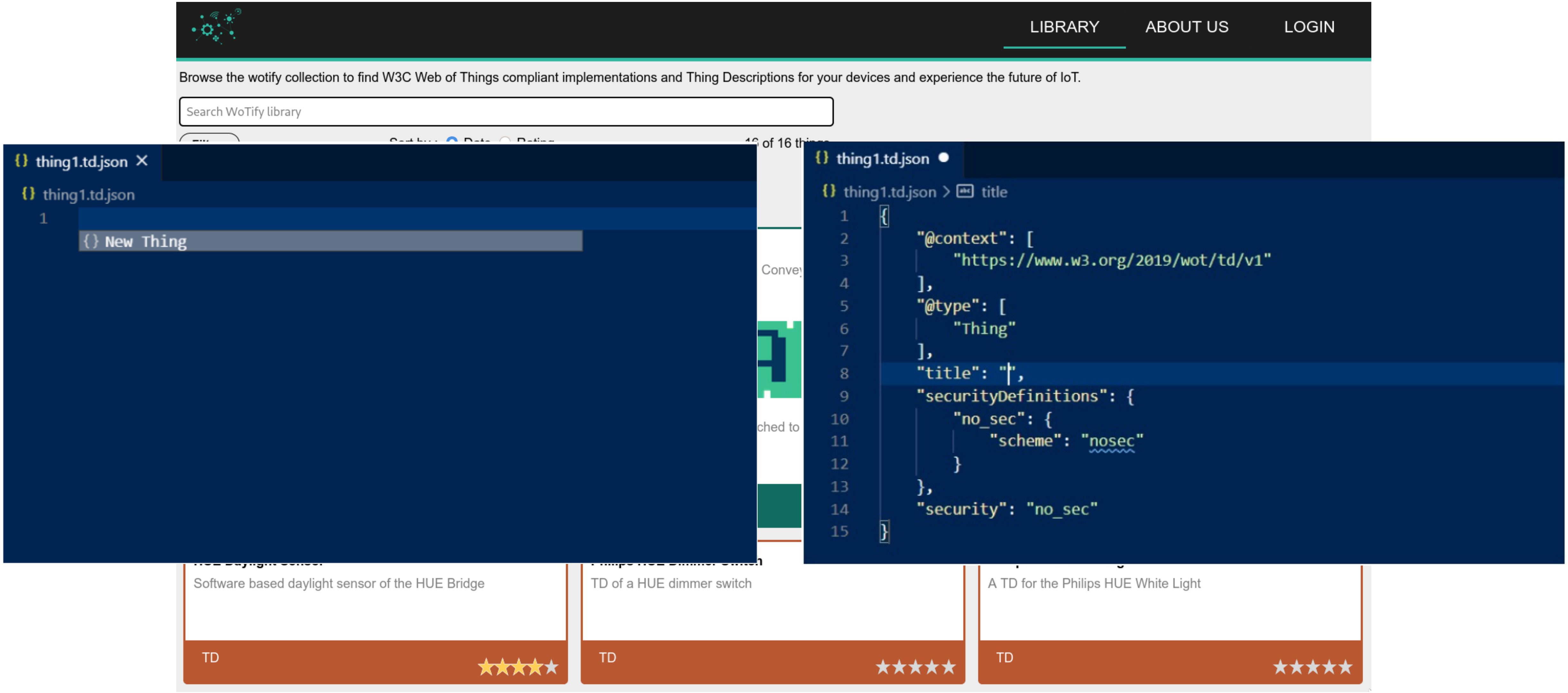
Complement Existing Devices

Existing Device
+ ⇒ Thing
Protocol

Local Network

= Web of Things (WoT) Thing Description

# More for WoT Developers!



Browse the wotify collection to find W3C Web of Things compliant implementations and Thing Descriptions for your devices and experience the future of IoT.

16 of 16 things

```json
{
    "@context": [
        "https://www.w3.org/2019/wot/td/v1"
    ],
    "@type": [
        "Thing"
    ],
    "title": "",
    "securityDefinitions": {
        "no_sec": {
            "scheme": "nosec"
        }
    },
    "security": "no_sec"
}
```

Software based daylight sensor of the HUE Bridge

TD of a HUE dimmer switch

A TD for the Philips HUE White Light

# Going further with the WoT Standardization

- Discovery
  - Registration, Management, Notification and Search API for TD databases
  - Network level service discovery
- TD new features
  - Templating mechanisms
  - Better OAuth2 support
  - Support more complex eventing mechanisms
- Scripting API
  - Stable core API
  - Work on higher level APIs

# How to join

- Weekly calls on Wednesdays for the entire Working Group and guests
- Each Task Force has their own calls, weekly or bi-weekly

W3C TPAC 2020 is on October! https://www.w3.org/2020/10/TPAC/

# Summary

- Goal: Overcome domain silos, increase interoperability between IoT stakeholders, and enable cross domain IoT applications
  - Similar to what the Web is for the Internet!
- About 200 members
- Normative work on technology building blocks (Thing Description, Architecture, Binding Templates, Scripting API, Security, Discovery)
- PlugFests/ Hackathons every 3-4 months
- New charter has just started, come join us!

# Contact

W3C Web of Things Working Group:

- Main Page: https://www.w3.org/WoT/
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  - Sebastian Käbisch (sebastian.kaebisch@siemens.com)

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