

W3C Web of Things & AAS

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Agenda

1. Web of Things in a Nutshell
2. Thing Description
3. TD & AAS

W3C Web of Things

W3C Web of Things

- WoT Working Group started 2017
- ~200 Participants (Multiple Companies)
- Normative work on technology building blocks
→ similar to what the WWW is for the Internet
- First released Recommendations in 2020
 - WoT Architecture 1.0
 - WoT Thing Description 1.0
- Releasing soon WoT Discovery, WoT Profile, WoT Architecture 1.1, and WoT Thing Description 1.1 incl. Thing Model
- PlugFest / Testfest every 3-4 month



W3C Web of Things Member Organizations



Invited experts from

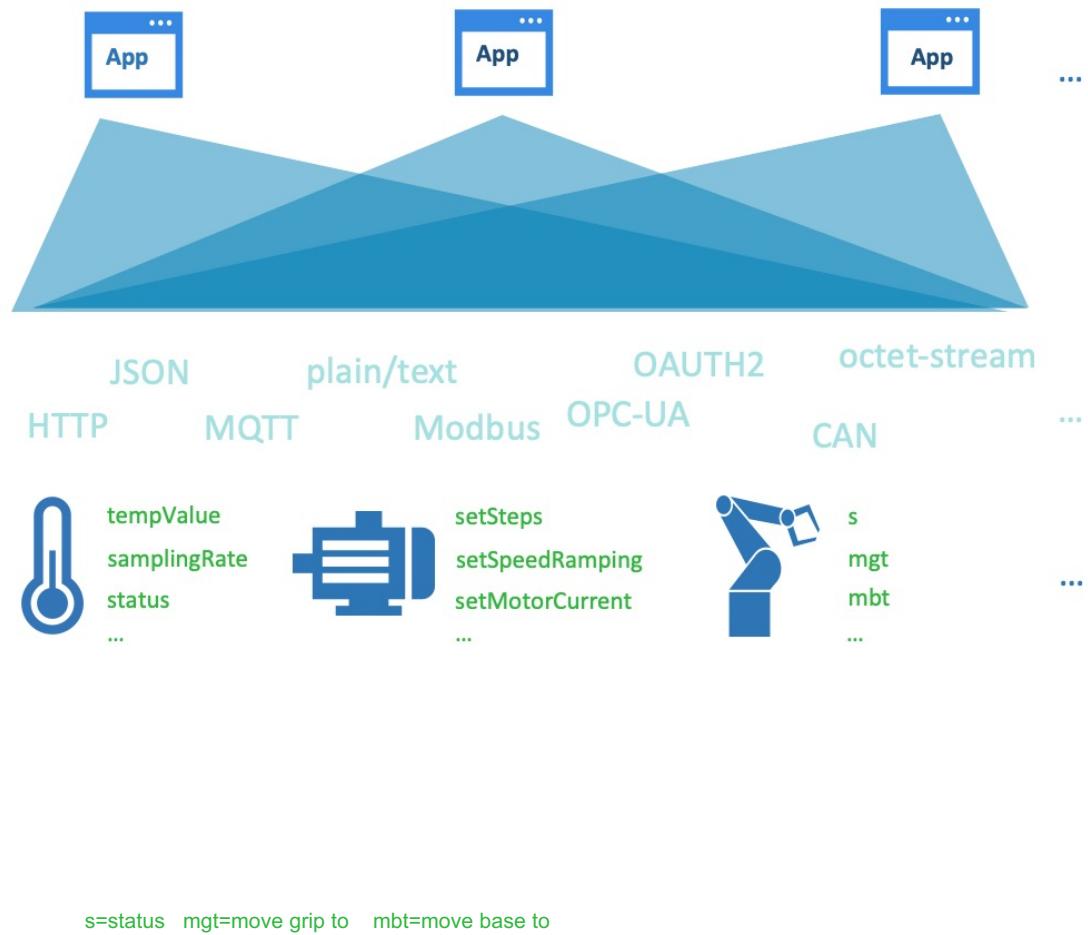


Liaisons

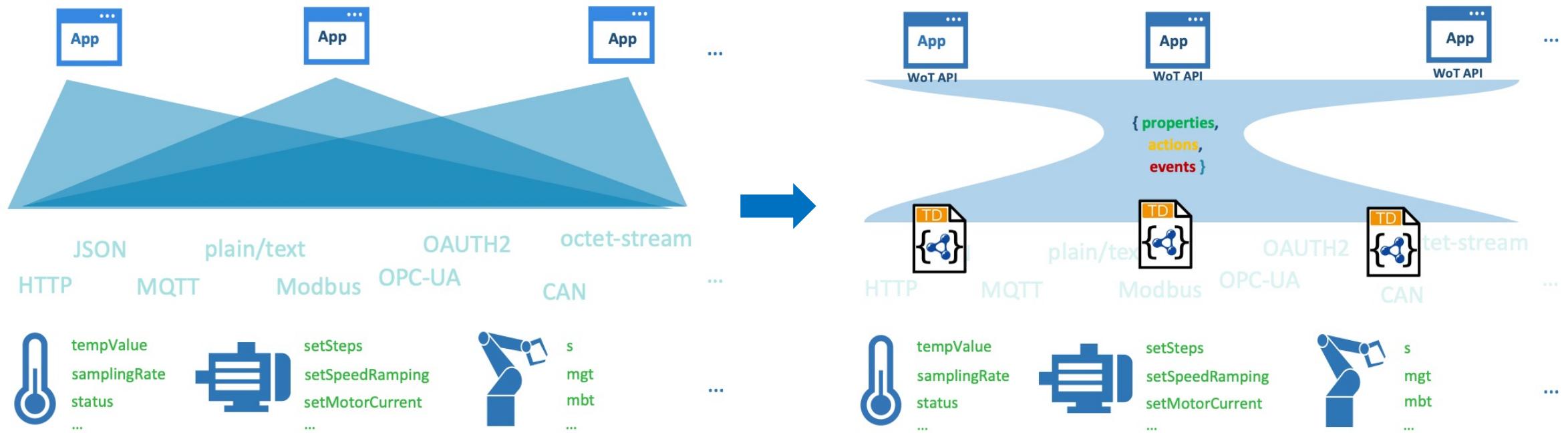


SIEMENS

Web of Things Motivation



Web of Things Motivation



s=status mgt=move grip to mbt=move base to

Details on Thing Description

Websites are intended for *Humans*

Typically, we know **what** we get and **how**!

Context of website

Select something

Enter data in a web form

Get more information

Content / Information

Get more information

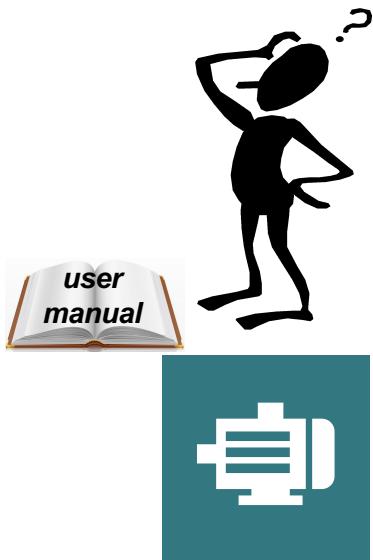
The screenshot shows the homepage of the University of Passau's website. At the top, there is a navigation bar with links for 'Login', 'Hilfe', 'Kontakt', and a language switcher ('Deutsch'). Below the navigation is a search bar labeled 'Universitätsweite Suche' with a magnifying glass icon. The main content area features a banner with the text 'AUSGEZEICHNET STUDIEREN' and a link 'Alle Studiengänge im Überblick →'. To the left of the banner is a sidebar with a navigation menu for 'UNIVERSITÄT PASSAU' including 'Universität im Überblick', 'Leitung und Gremien', 'Fakultäten', 'Einrichtungen', 'Universitätsmedien', and 'Kontakt'. Below this is another section titled 'UNI-PORTAL FÜR' with links for 'Studierende', 'Studieninteressierte', 'Wissenschaftler', 'Nachwuchsförderung', 'Unternehmen', and 'Alumni, Förderer, Freunde'. The main content area also includes sections for 'Bewerbung für einen Masterstudiengang' (with a link to 'Mehr') and three featured articles at the bottom: 'Wettbewerb in digitalen Märkten gestalten', 'Die Universität Passau in 360°', and 'Roboterjournalismus im Fokus'.

Thing's Interface - Situation Today

What kind of data do you serve?

Who are you?

How does the payload structure look like?



Are there some context information
(e.g., kind of actuator/sensor, unit)?

How can I access the data/function?

What kind of functions do you have?

What kind of protocols & serializations do you support?

Are there some security constrains?

Do you have other relations to other Things?

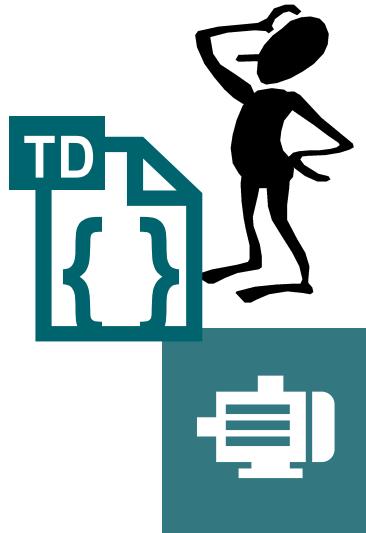
The WoT Thing Description

The “index.html” for Things – A common language based on JSON-LD / RDF

What kind of data do you serve?

Who are you?

How does the payload structure look like?



Are there some context information
(e.g., kind of actuator/sensor, unit)?

How can I access the data/function?

What kind of functions do you have?

What kind of protocols & serializations do you support?

Are there some security constraints?

Do you have other relations to other Things?

The WoT Thing Description

Reuse existing domain knowledge

What kind of data do you serve?

Who are you?

How does the payload structure look like?



Are there some context information
(e.g., kind of actuator/sensor, unit)?

How can I access the data/function?

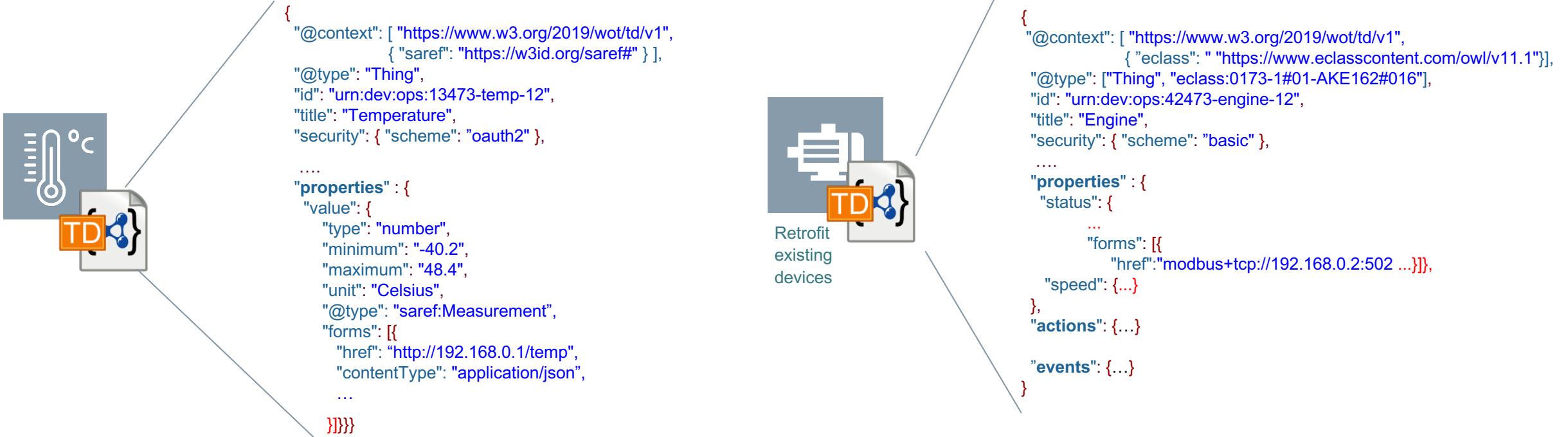
What kind of functions do you have?

What kind of protocols & serializations do you support?

Are there some security constrains?

Do you have other relations to other Things?

Describe any Thing's Interface with a TD



WoT Binding Templates – Uniform Documentation of IoT Protocols

HTTP

```
"properties": {  
  ...  
  "forms": [  
    {  
      "op": "readproperty",  
      "href": "https://myled.example.com:8080/livingroom/lamp/status",  
      "contentType": "application/json",  
      "htv:methodName": "GET"  
    }  
  ...  
}
```

MQTT

```
"events": {  
  ...  
  "forms": [  
    {  
      "op": "subscribeevent",  
      "href": "mqtt://mybroker.example.com:1883/livingroom/lamp/criticalCond",  
      "contentType": "application/json",  
      "mqv:controlPacketValue": "SUBSCRIBE"  
    }  
  ...  
}
```

MQTT Broker
address

CoAP

```
"actions": {  
  ...  
  "forms": [  
    {  
      "op": "invokeaction",  
      "href": "coaps://myled.example.com:5684/lr/l/fi",  
      "contentType": "application/ocf+cbor",  
      "cov:methodName": "POST",  
      "cov:options": [ {  
        "cov:optionNumber": 2053,  
        "cov:optionValue": "1.1.0"  
      } ]  
    }  
  ...  
}
```

MQTT Topic

CoAP header
settings

WoT Binding Templates – Uniform Documentation of IoT Protocols (cont.)

Modbus

```
"properties": {  
  ...  
  "forms": [  
    {  
      "op": "readproperty",  
      "href": "modbus+tcp://127.0.0.1:60000/1/",  
      "contentType": "application/octet-stream;byteSeq=BIG_ENDIAN;length=4",  
      "modbus:function": 3,  
      "modbus:offset": 1,  
      "modbus:length": 2,  
      "modbus:pollingTime": 500  
    }  
  ]  
}
```

OPC UA

```
"properties": {  
  ...  
  "forms": [  
    {  
      "op": "readproperty",  
      "href": "opc.tcp://localhost:26543/ns=3;s=\\"Case_Lamp_Variable\\\"",  
      "contentType": "application/x.opcua-binary",  
      "opc:method": "READ"  
    }  
  ]  
}
```

M-Bus

```
"properties": {  
  ...  
  "forms": [  
    {  
      "op": "readproperty",  
      "href": "mbus+tcp://127.0.0.1:8182",  
      "contentType": "application/octet-stream",  
      "mbus:unitID": 3,  
      "mbus:offset": 1,  
      "mbus:timeout": 2000  
    } ]  
}
```

Alternative
addressing possible
(e.g via browse path)

...

Specific Bindings Documents

HTTP Binding Template

W3C Editor's Draft 23 September 2021



▼ More details about this document

This version:

<https://w3c.github.io/wot-binding-templates/http>

Latest published version:

<https://www.w3.org/TR/wot-http-template/>

Latest editor's draft:

<https://w3c.github.io/wot-binding-templates/http>

Editors:

Michael Koster ([SmartThings](#))

Ege Korkan ([Siemens AG](#))

Other documentation

[In the GitHub repository](#)

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MQTT Binding Template

W3C Editor's Draft 23 September 2021



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<https://w3c.github.io/wot-binding-templates/coap>

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CoAP Binding Template

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MODBUS binding template

W3C Editor's Draft 23 September 2021



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Latest editor's draft:

<https://w3c.github.io/wot-binding-templates/modbus>

Editor:

Cristiano Aguzzi ([Invited Expert](#))

Other documentation

[MODBUS ontology](#)

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OPCUA binding

W3C Editor's Draft 15 October 2021



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<https://w3c.github.io/wot-binding-templates/opcua>

Latest published version:

<https://www.w3.org/TR/opcua/>

Latest editor's draft:

<https://w3c.github.io/wot-binding-templates/opcua>

Editor:

Etienne Rossignon ([Sterfive](#))

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Simple IoT Orchestration

The Things*



Script your application

Embed things from different domains by their TDs

Concentrate on the actual application logic (e.g., blend out protocol-specific characteristics of Modbus, CoAP, etc.)

Check the results



(Video)

Further WoT Information + Tools

<https://www.w3.org/WoT>

 **Web of Things**

Standards · Participate · Membership 

Working Group Interest Group Community Group Activities · Developers More ·

W3C Web of Things

The Web of Things (WoT) seeks to counter the fragmentation of the IoT by using and extending existing, standardized Web technologies. By providing standardized metadata and other re-usable technological building blocks, W3C WoT enables easy integration across IoT platforms and application domains.

Get more background about the Web of Things in the [Documentation](#) area and check out upcoming [Events](#).

Working Group Normative work on deliverables under W3C Patent Policy.

Interest Group Practical evaluation, exploration, and outreach by W3C Members.

Community Group Users, stakeholders, and open discussion for everyone.

Activities Organizational information and coordination.

Developers Implementations, online Things, and tools.

Documentation Learn more through our presentations and whitepaper.

WoT Videos » 

Tweets by @W3C_WoT 

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 **Web of Things**

Standards · Participate · Membership 

Working Group Interest Group Community Group Activities · Developers More ·

Developer Tools

Thing Description (TD) Tooling

- [Thing Description Playground](#) (TD validation)
- [Eclipse Edi\(TD\)](#) (Editor for easy creation of Thing Description instances and Thing Models)
 - Try it live [here](#)
- [WoTify](#) (a collection of devices that have been WoT-enabled)
- [Shadow Thing](#) (creates and deploys a thing based on its TD)
- [Web of Things Test Bench](#) (tests a WoT Thing by executing interactions automatically, based on its TD)
- [TD code](#) (TD validation and code snippets for Visual Studio Code)
 - See a short presentation about TD Code used together with the [WoT Application Manager \(WAM\)](#): [slides](#) or [video](#)
- [Java API for Thing Descriptions of WoT \(JDTs\)](#) (creates Java Thing Description ORM from a TD in JSON-LD or RDF triples)

WoT Implementations

- [Eclipse Thingweb node-wot](#) (W3C Web of Things implementation in Node.js with support for multiple bindings.)
 - [Browsified node-wot \(Web UI\)](#)
 - See [hands-on tutorials](#) and [videos](#) for node-wot
- [WoT FXUI](#) (UI for desktop, mobile, browser)
 - See [running Web-UI instance](#)
- [Node generator](#) (Generate a WoT Consumer Node for [Node-RED](#) from TD)
 - See a short introduction [slides](#) or [video](#) for Node Generator
- [WoT API Development Environment \(WADE\)](#) (Desktop application based on node-wot, Vue.js and Electron)
- [LinkSmart Thing Directory](#) (Directory of Thing Description, compliant with the W3C WoT Discovery spec)
- [SANE WoT Servient \(Java\)](#)
- [WoTPy](#) (Experimental implementation in Python)
- [sayWoT!](#) (for web and cloud developers)

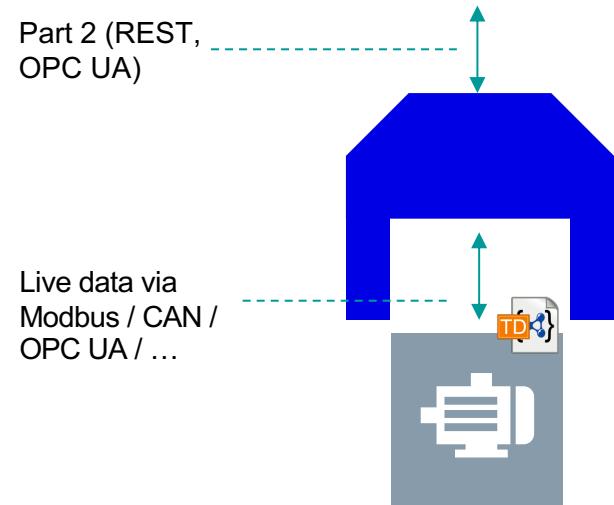
WoT application development tools

- [WoT Application Manager \(WAM\)](#) CLI tool to set up node-wot application projects. See the presentation and video for further information: [slides](#) or [video](#)

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TD and AAS (Joint activity with OVGU / Prof. Diedrich)

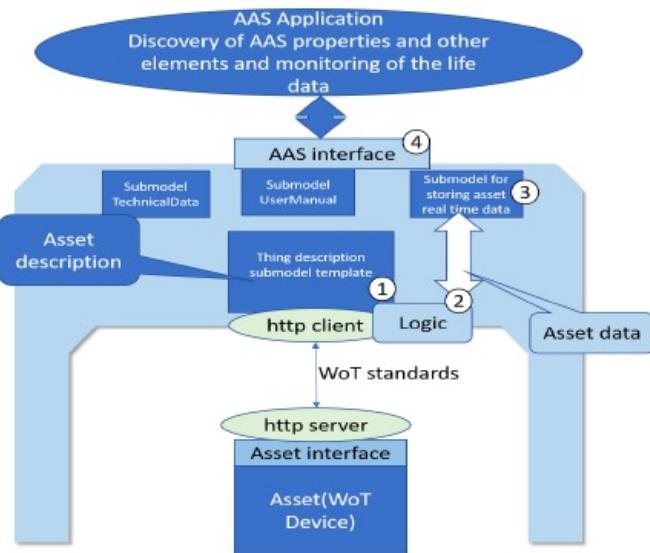
Motivation



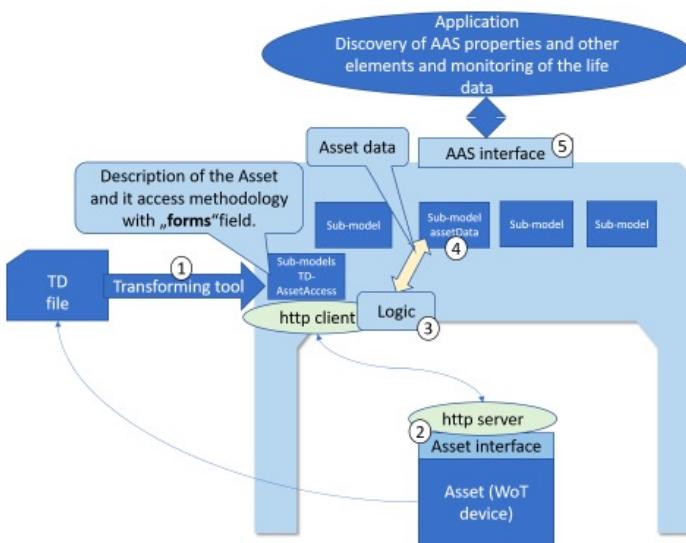
- **Question:** How can the live data of the assets be embedded in the AAS and made accessible via the Part 2 interface?
- **Idea:** Use TD as a common asset interface description and provide live data as sub-modul elements.

How to Integrate TD in AAS (Three Options)

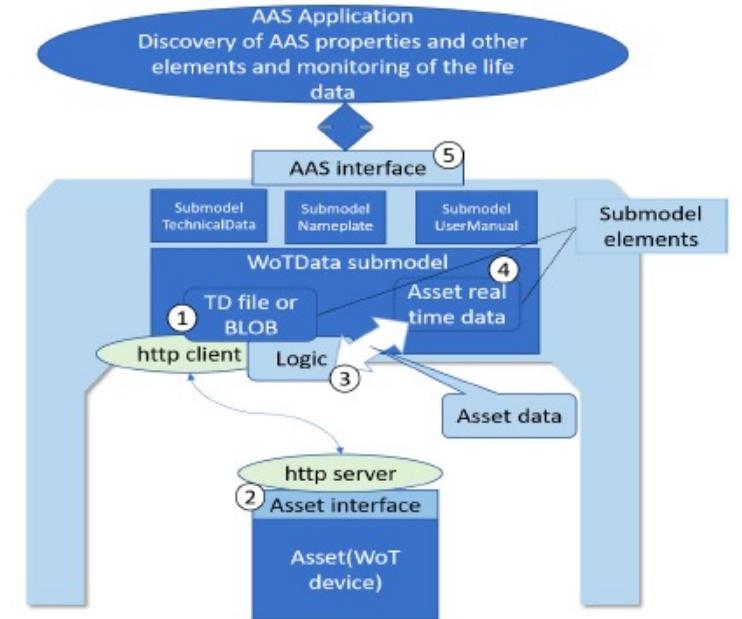
1) Define TD as sub-model template



2) Transform existing TD to a sub-model



3) TD is embedded as blob value or is linked as an external location



Sources: MA thesis Oladipupo Kazeem Olamidekan (OVGU)

TD as AAS sub-model (WIP) I / II

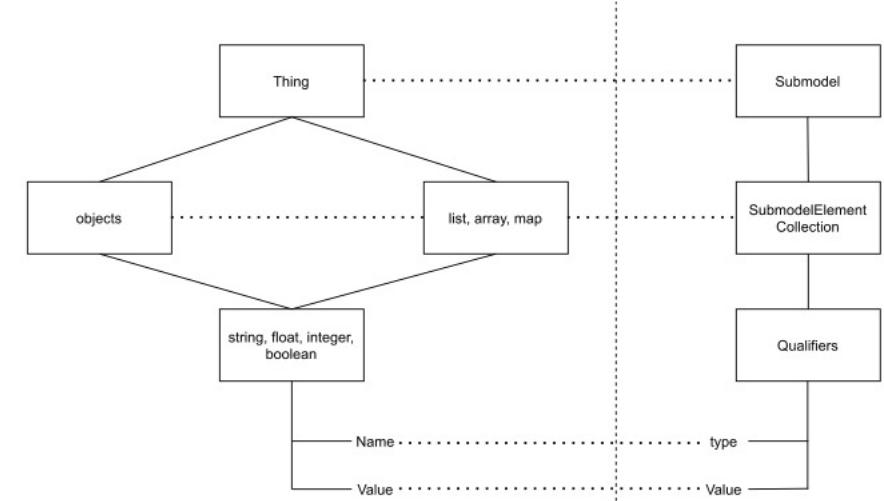
```
SM <T> "assetInterfaceDescription" [IRI, https://localhost.com/sm/Smart-Coffee-Machine/Thing]
Prop "@context" = https://www.w3.org/2019/wot/td/v1
Prop "@type" = Thing
Prop "id" = urn:uuid:55f01138-5c96-4b3d-a5d0-81319a2db677
Prop "title" = Smart-Coffee-Machine
SMC "titles" (3 elements)
Prop "description" = A smart coffee machine with a range of capabilities.
SMC "descriptions" (0 elements)
Prop "created" = 05/03/2021 05:50
Prop "modified" = 05/13/2021 17:00
Prop "support" = git://github.com/eclipse/thingweb.node-wot.git
Prop "base" = http://plugfest.thingweb.io:8083/smart-coffee-machine/
SMC "version" (1 elements)
SMC "properties" (6 elements)
SMC "actions" (2 elements)
SMC "events" (1 elements)
SMC "links" (0 elements)
SMC "forms" (3 elements)
Prop "security" = nosec_sc
SMC "securityDefinitions" (1 elements)
```

```
SMC "properties" (1 elements)
  SMC "dht11" (5 elements)
    Prop "observable" = False 1
    SMC "properties" (2 elements)
      SMC "temperature" (7 elements)
      SMC "humidity" (7 elements)
    Prop "type" = object 3
    Prop "readOnly" = True 2
  SMC "forms" (1 elements)
    SMC "Form" (4 elements)
      Prop "op" = readproperty
      Prop "href" = http://localhost:8000/properties/dht11
      Prop "contentType" = application/json
      Prop "httpmethodName" = GET 5
```

“1:1” mapping. Follows same structure as in the TD

TD as AAS sub-model (WIP) II / II

```
AAS "DeltaRobot" [IRI, www.example.com/ids/aas/6022_7111_0112_9524]
  SM "ThingDescription" [IRI, www.example.com/ids/sm/6122_7111_0112_0664]
    SMC "@context" (0 elements) @{@context=https://www.w3.org/2019/wot/td/v1}
    SMC "security" (0 elements) @{security1=nosec_sc}
    SMC "securityDefinitions" (1 elements)
      SMC "nosec_sc" (0 elements) @{scheme=nosec}
    SMC "properties" (8 elements)
      SMC "Axis1ActualPosition" (1 elements) @{type=integer} @{readOnly=False} @{observable=False}
      SMC "Axis2ActualPosition" (1 elements) @{type=integer} @{readOnly=False} @{observable=False}
      SMC "Axis3ActualPosition" (1 elements) @{type=integer} @{readOnly=False} @{observable=False}
      SMC "sMessage_in_purpose" (1 elements) @{type:string} @{readOnly=False} @{writeOnly=False} @{observable=True}
      SMC "sMessage_in_data_SR" (1 elements) @{type:string} @{readOnly=False} @{writeOnly=False} @{observable=True}
      SMC "sMessage_in_data_SP" (1 elements) @{type:string} @{readOnly=False} @{writeOnly=False} @{observable=True}
      SMC "sMessage_out_purpose" (1 elements) @{type:string} @{readOnly=False} @{writeOnly=False} @{observable=False}
      SMC "sMessage_out_data" (1 elements) @{type:string} @{readOnly=False} @{observable=False}
```



Transformation reuse existing model concepts from AAS

Toolings

TD to AAS Transformer



INSTITUT FÜR
AUTOMATISIERUNGSTECHNIK

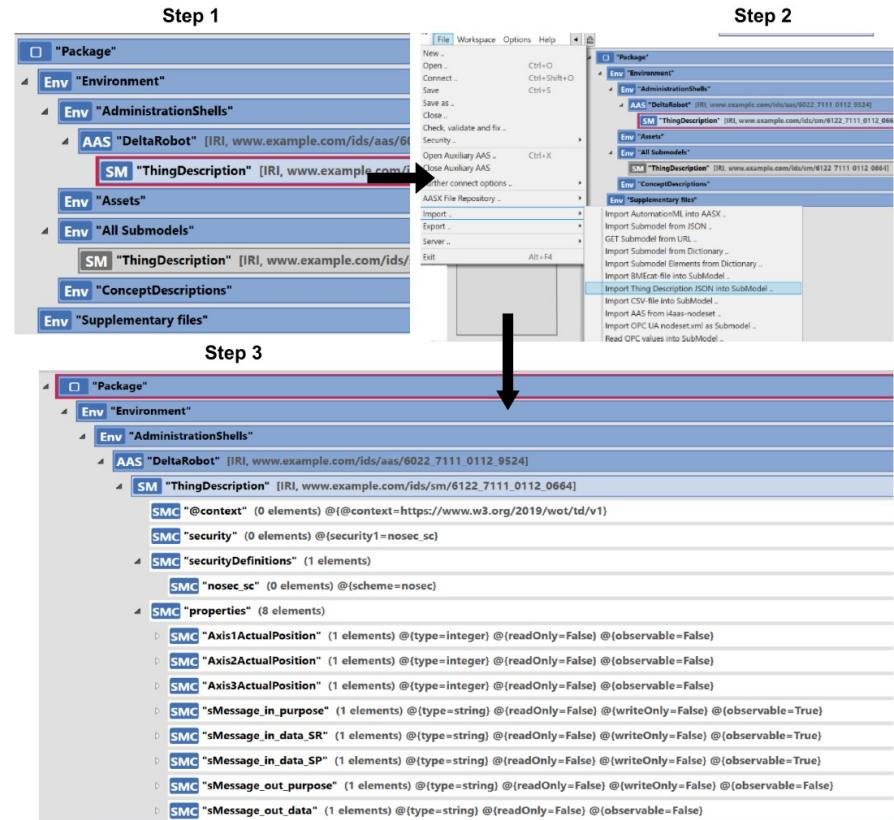
INTEGRATION of AAS & WoT

This is a platform that is used to convert valid thing description into asset administration shell submodels. Please validate your thing description [here](#) before converting it to asset administration shell submodel. If the thing description loaded is not a valid one, the conversion will be rejected.

UPLOAD .json TD UPLOAD FROM URL PASTE PLAIN TEXT

<https://wotaas.pythonanywhere.com/>

AASX Explorer with TD Importer / Exporter



<https://github.com/admin-shell-io/aasx-package-explorer/actions/runs/1578418012>

Related Work

<http://dx.doi.org/10.25673/39570>

Integration of Asset Administration Shell and Web of Things

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Abstract:

In the course of the digital transformation of industrial production processes, physical assets are encapsulated with software components, where a set of such computing entities working in unison form and build the cyber-physical systems (CPS). The Platform Industry 4.0 (PI4.0) provides a standardized meta-model in terms of submodels and submodel elements to digitally represent information about an asset. The submodels are used to represent a wide range of information like the asset nameplate, administrative aspects, technical specifications and even the accessibility information. Some of these data have to be acquired from the asset. The W3C Web of Things provides the Thing Description meta-model to represent the accessibility runtime information of these assets.

This paper aims to map the W3C Web of Thing (WoT) Thing Description (TD) to the submodel and the submodel elements of the PI4.0 Asset Administration Shell (AAS). A standard submodel template encapsulating each of the Thing Description classes would be the outcome of this paper and also a plugin module embedded into the AAS package explorer that utilizes this template to automatically generate AAS submodel representation from TD for any given asset. This paper also presents a brief description of a use-case consisting of a Delta Robot which can be accessed via an OPC UA server.

Keywords: automation systems, cyber physical systems, Asset Administration Shell, Web of Things

1. Introduction

Cyber Physical Systems (CPS) is the network of a finite set of computing devices that are encapsulated

<https://opendata.uni-halle.de//handle/1981185920/41527>