Eclipse Ditto™ and W3C Web of Things (WoT)

10/2022

Digital Twins

→ digital representation of physical devices

→ twin as broker for communicating with assets

→ applicable for both industrial and consumer-centric IoT scenarios

Twins in scope of Ditto

→ a pattern for working with **things** in the IoT

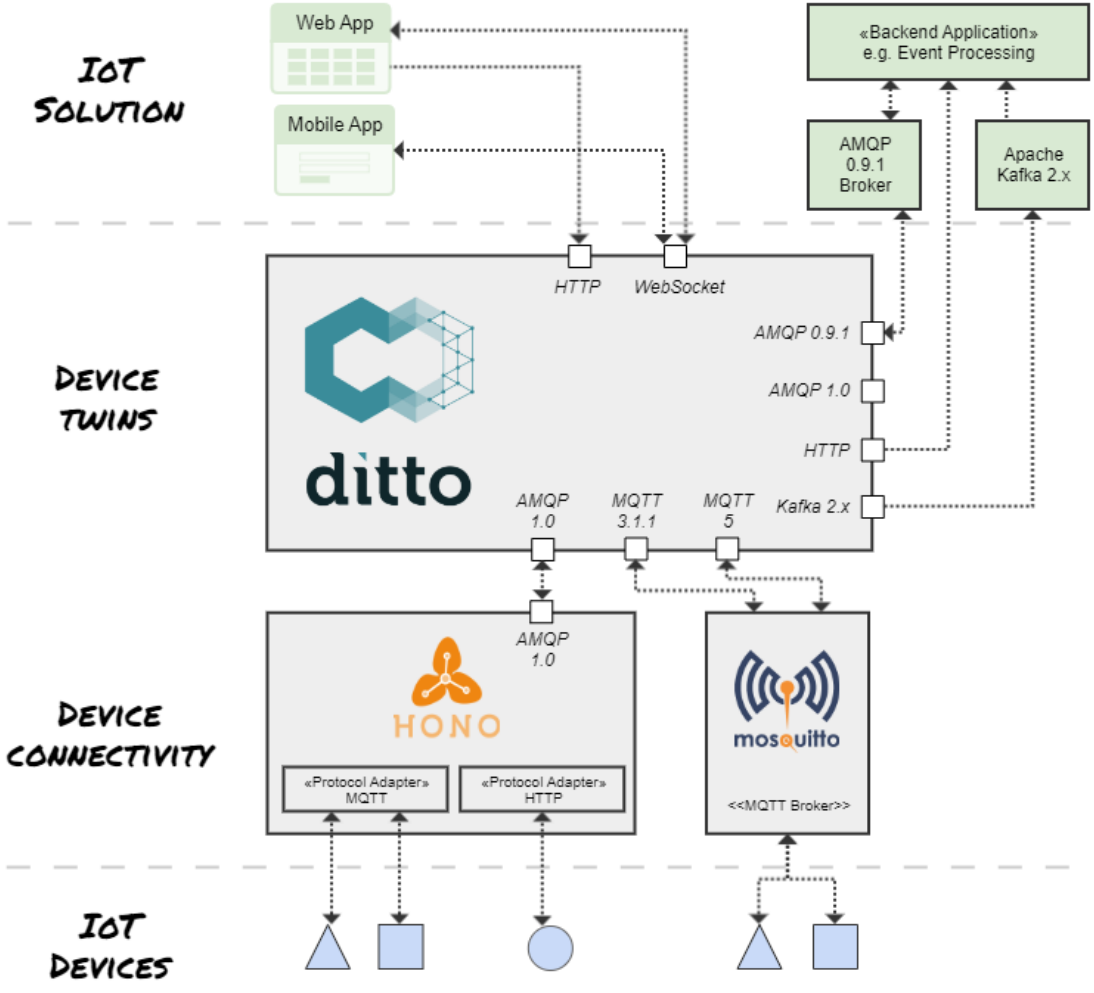
→ provide state **persistence** and **search** capabilities

→ access twins always in an **authorized** way

→ provide APIs - **Device as a Service**

→ optionally **normalize** device payloads

Eclipse Ditto in context



Ditto as
Digital Twin
"middleware"

turn device data into APIs

```
{
  "thingId": "io.foo:car1",
  "policyId": "io.foo:car1",
  "attributes": {
    "manufacturer": "Foo",
    "data": {
      "serialNo": 4711
    }
  },
  "features": {
    "temp": {
      "properties": {
        "value": 23.42
      }
    }
  }
}
```

JSON repr. of a Thing

```
GET/PUT/DELETE /api/2/things/io.foo:car1
 /api/2/things/io.foo:car1/thingId
 /api/2/things/io.foo:car1/policyId
 /api/2/things/io.foo:car1/attributes
 /api/2/things/io.foo:car1/attributes/manufacturer
 /api/2/things/io.foo:car1/attributes/data
 /api/2/things/io.foo:car1/attributes/data/serialNo


 /api/2/things/io.foo:car1/features
 /api/2/things/io.foo:car1/features/temp
 /api/2/things/io.foo:car1/features/temp/properties
 /api/2/things/io.foo:car1/features/temp/properties/value
```

HTTP API of the Thing

→ docs

modeling thing capabilities

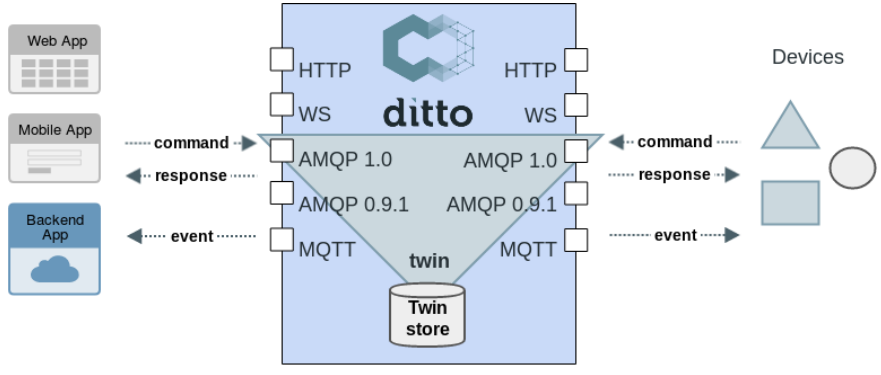
- → by default, thing attributes and feature properties are "schemaless"
- → a thing may be aware of one "definition"
- → a feature may be aware of several "definitions" linking to models

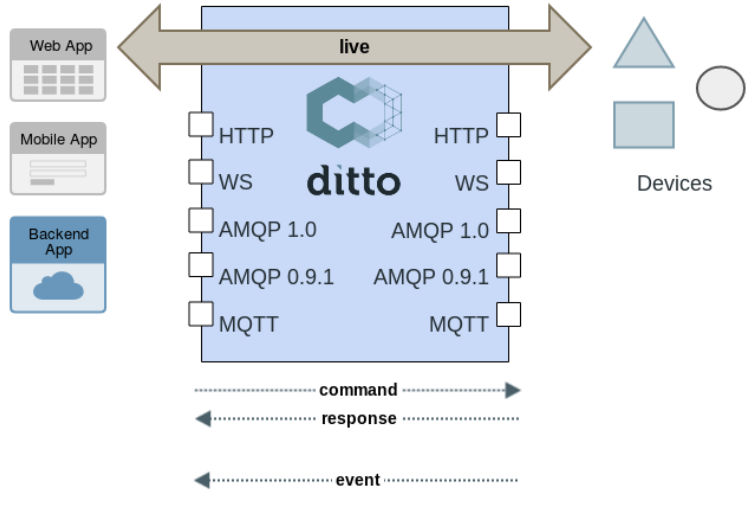
```
{
  "thingId": "io.foo:lamp-1",
  "policyId": "io.foo:lamp-1",
  "definition": "https://some.domain/floor-lamp-1.0.0.tm.j
  "attributes": {
    "Manufacturer": "Foo corp",
    "serialNo": "4711"
  },
  "features": {
    "Spot1": {
      "definition": [
        "https://some.domain/dimmable-colored-lamp-1.0.0.t
        "https://some.domain/colored-lamp-1.0.0.tm.jsonld"
        "https://some.domain/switchable-1.0.0.tm.jsonld"
      ],
      "properties": {
        "on": true,
        "color": {...
        }
      }
    }
  }
}
```

→ docs

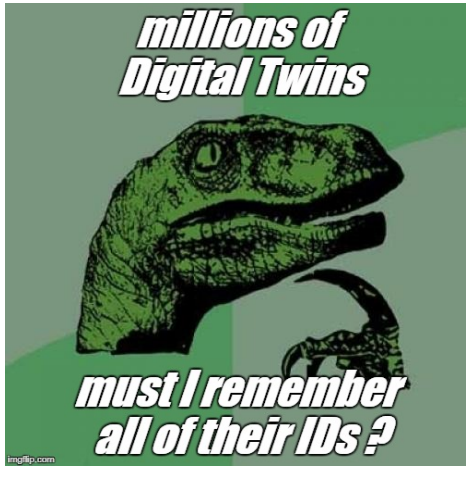
persistence of device state

- → devices are not always connected to the net
- → applications always need to be able to access their data
- → **twin** vs. **live** access on API level





search



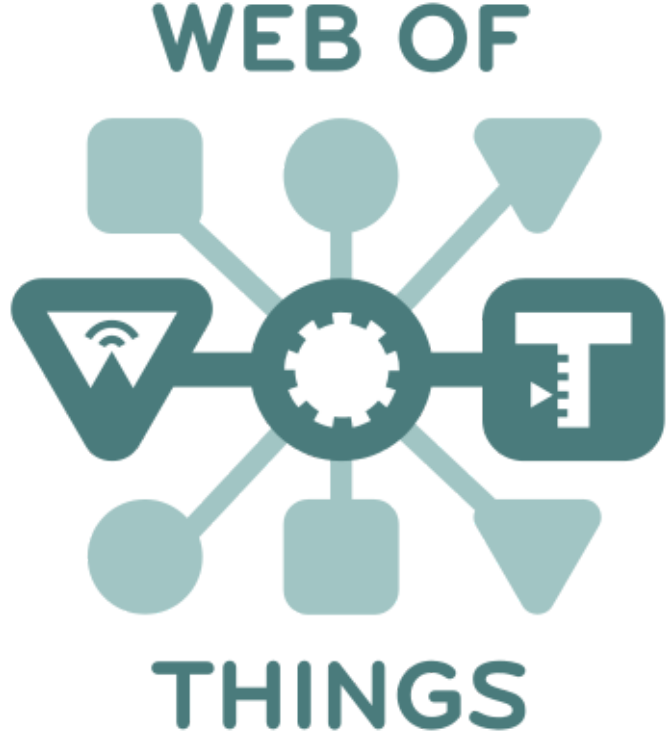
→ you must not
→ Ditto has you covered

```
GET /api/2/search/things
  ?filter=like(attributes/manufacturer,"Foo*")
```

```
GET /api/2/search/things
  ?filter=and(
    eq(features/*/definition,"https://some.domain/switchable-1.0.0.tm.
    like(attributes/manufacturer,"Foo*"),
    not(gt(attributes/counter,42))
  )
  &fields=thingId,attributes/manufacturer,features/*/properties/on
```

→ search for arbitrary data with RQL query → docs
→ Ditto again ensures authorization
→ apply field projection over the results
→ don't worry about indexing

Eclipse Ditto +



The what:

Let Ditto **provide** WoT **TDs** via Digital Twin APIs
by **referencing to** WoT **TMs** in Ditto "things"

The why: benefits for a WoT approach

- → devices do not need to "know" their TD or be able to provide it by themselves
- → deliver TDs for simulated twins
- → "retrofit" already connected devices with TDs - enabling "brownfield" scenarios
- → Ditto abstracts on how devices are connected - provided Protocol Binding: HTTP vocabulary

The why: benefits for Ditto and the digital twin pattern

- → Ditto managed things were "schemaless" until now - now a schema can be defined
- → using HTTP content negotiation, digital twins can be "introspected" asking for their capabilities
- → Ditto users will benefit from future tooling around the WoT standard

The how: generation of WoT TDs based on referenced TMs

- → Ditto downloads and caches referenced TMs during runtime
- → resolving extensions via `tm:extends` and imports via `tm:ref`, Thing level compositions via `tm:submodel` and TM placeholders
- → Ditto generates TDs, injecting forms with HTTP API endpoints

```
curl -u ditto:ditto \
  'https://ditto.eclipseprojects.io/api/2/things/io.eclipseprojects.ditto:floor-lamp-0815' \
  -H 'Accept: application/td+json'
```

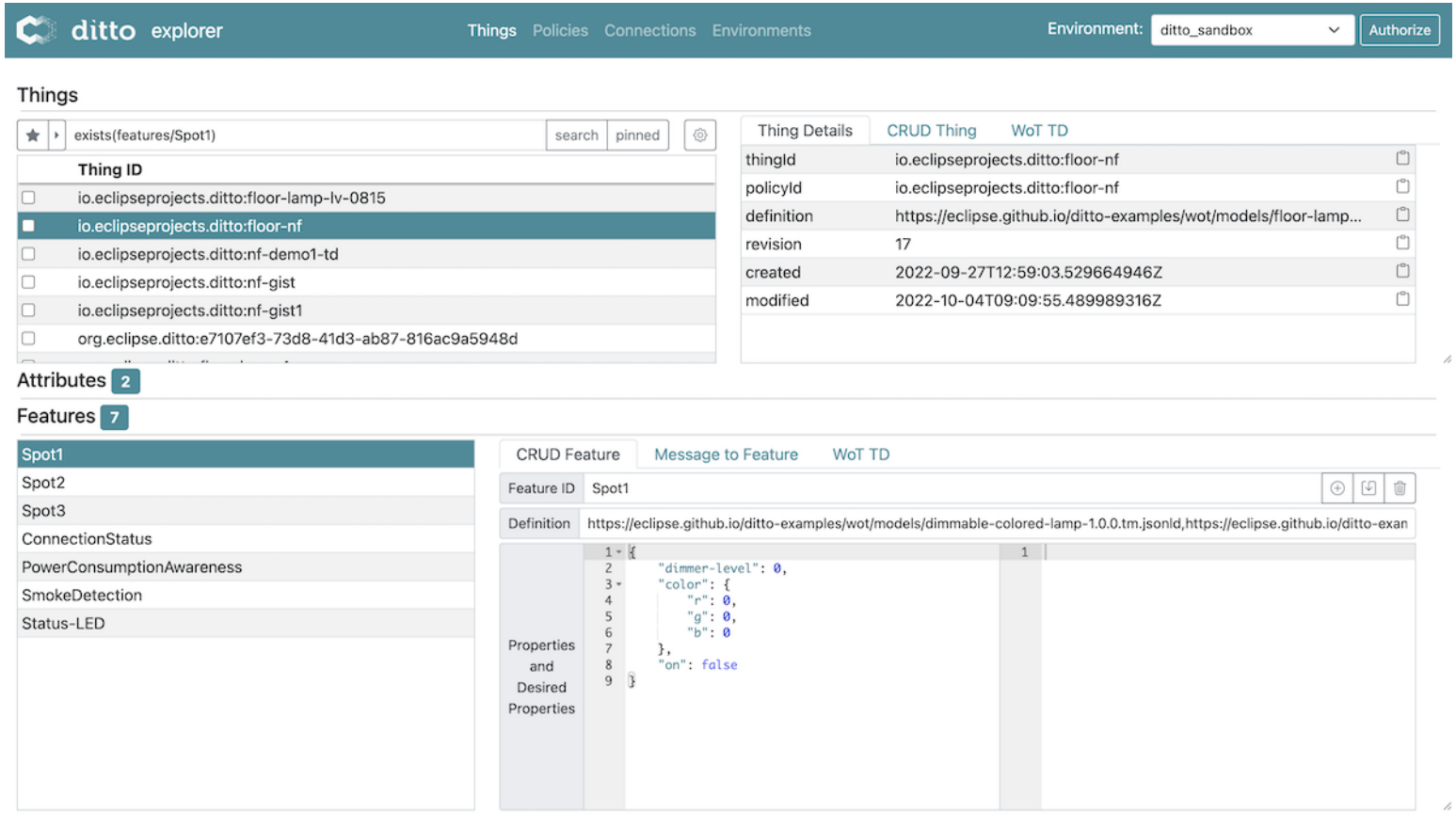

```
{
  @context":["https://www.w3.org/2022/wot/td/v1.1", ...],
  "title":"Floor Lamp",
  "@type":"Thing",
  "id":"urn:io.eclipseprojects.ditto:floor-lamp-0815",
  "base":"https://ditto.eclipseprojects.io/api/2/things/io.eclipseprojects.ditto:floor-lamp-0815",
  "version":{"model":"1.0.0","instance":"1.0.0"},
  "links":[{
    "rel":"type",
    "href":"https://eclipse.github.io/ditto-examples/wot/models/floor-lamp-1.0.0.tm.jsonld",
    "type":"application/tm+json"
   },{
    "rel":"item",
    "type":"application/td+json",
    "href":"/features/Spot1"
   },...],
   "security":"basic_sc",
   "securityDefinitions":{"basic_sc":{"in":"header","scheme":"basic"}},
   "forms":[{"op":"readallproperties","href":"/attributes{?channel,timeout}","htv:methodName":"GET","contentType":"application/json"
  ...
}
```

The how: upon creation of new Things, generation of a ”JSON skeleton” following the WoT TM

```
curl -X PUT -u ditto:ditto \
  'https://ditto.eclipseprojects.io/api/2/things/io.eclipseprojects.ditto:floor-lamp-0815' \
  -H 'Content-Type: application/json' \
  --data-raw '{
    "definition": "https://eclipse.github.io/ditto-examples/wot/models/floor-lamp-1.0.0.tm.jsonld"
  }'
```

```
{
  "thingId": "io.eclipseprojects.ditto:floor-lamp-0815",
  "policyId": "io.eclipseprojects.ditto:floor-lamp-0815",
  "definition": "https://eclipse.github.io/ditto-examples/wot/models/floor-lamp-1.0.0.tm.jsonld",
  "attributes": {
    "manufacturer": "",
    "serialNo": "https://some.domain/switchable-1.0.0.tm.jsonld"
  },
  "features": {
    "Spot1": {
      "definition": [
        "https://eclipse.github.io/ditto-examples/wot/models/dimmable-colored-lamp-1.0.0.tm.jsonld",
        "https://eclipse.github.io/ditto-examples/wot/models/colored-lamp-1.0.0.tm.jsonld",
        "https://eclipse.github.io/ditto-examples/wot/models/switchable-1.0.0.tm.jsonld"
      ],
      "properties": {
        "dimmer-level": 0.0,
        "color": {
          "r": 0,
          "g": 0,
          "b": 0
        },
        "on": false
      }
    ...
```

Demo


ditto explorer
Things
Policies
Connections
Environments
Environment:
ditto_sandbox
Authorize
Things
exists(features/Spot1)
search
pinned
Thing ID
io.eclipseprojects.ditto:floor-lamp-lv-0815
io.eclipseprojects.ditto:floor-nf
io.eclipseprojects.ditto:nf-demo1-td
io.eclipseprojects.ditto:nf-gist
io.eclipseprojects.ditto:nf-gist1
org.eclipse.ditto:e7107ef3-73d8-41d3-ab87-816ac9a5948d
Thing Details
CRUD Thing
WoT TD
thingId
io.eclipseprojects.ditto:floor-nf
policyId
io.eclipseprojects.ditto:floor-nf
definition
https://eclipse.github.io/ditto-examples/wot/models/floor-lamp...
revision
17
created
2022-09-27T12:59:03.529664946Z
modified
2022-10-04T09:09:55.489989316Z
Attributes 2
Features 7
Spot1
Spot2
Spot3
ConnectionStatus
PowerConsumptionAwareness
SmokeDetection
Status-LED
CRUD Feature
Message to Feature
WoT TD
Feature ID
Spot1
Definition
https://eclipse.github.io/ditto-examples/wot/models/dimmable-colored-lamp-1.0.0.tm.jsonld,https://eclipse.github.io/ditto-exan
Properties and Desired Properties
{
"dimmer-level": 0,
"color": {
"r": 0,
"g": 0,
"b": 0
},
"on": false
}

Links

→ Ditto Blogpost about WoT integration
→ Ditto docs about WoT integration
→ GitHub - please give us a star ;)
→ Chatroom to ask more questions