W3C Web of Things Status and Applicatons

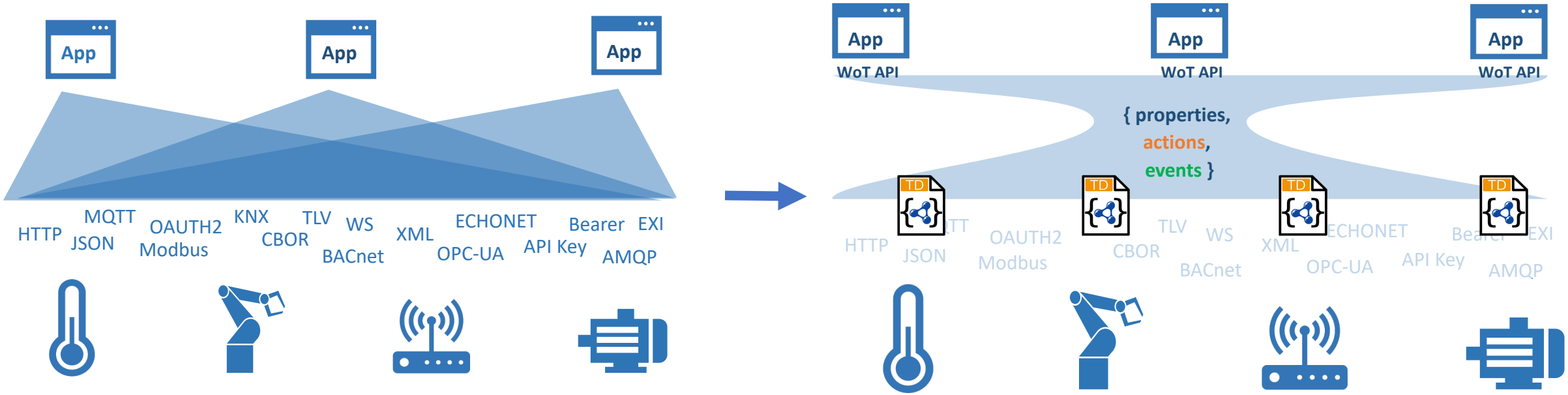
Michael McCool

11 January 2023

IEEE CCNC 2023 - IIWoT Workshop

W3C Web of Things (WoT)

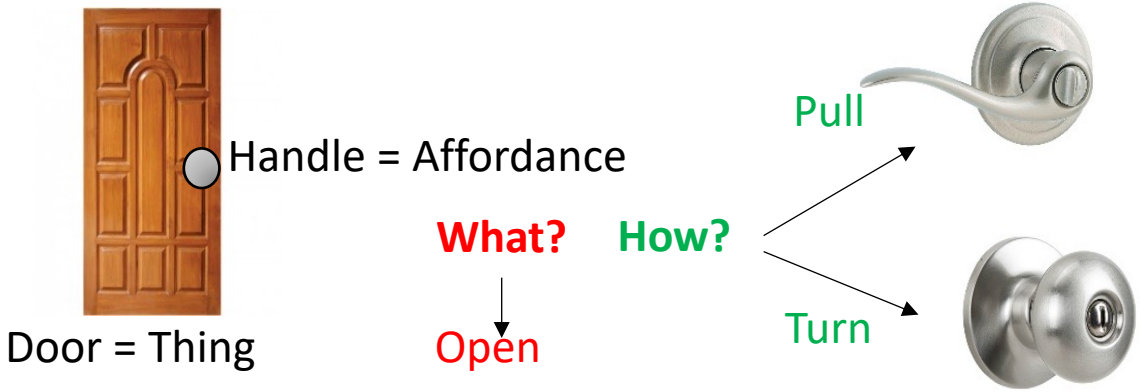
- W3C Working Group goal: Adapting web technologies to IoT
- Already published: Thing Description (TD) metadata format
  - TD describes the available interactions (network API) of a Thing
- New deliverables in progress, including Discovery and Profiles
  - How does a potential consumer obtain the TD for a Thing?
  - What constraints on TDs are appropriate for best practices and interoperability?



Descriptive Interoperability: TDs

WoT Architecture

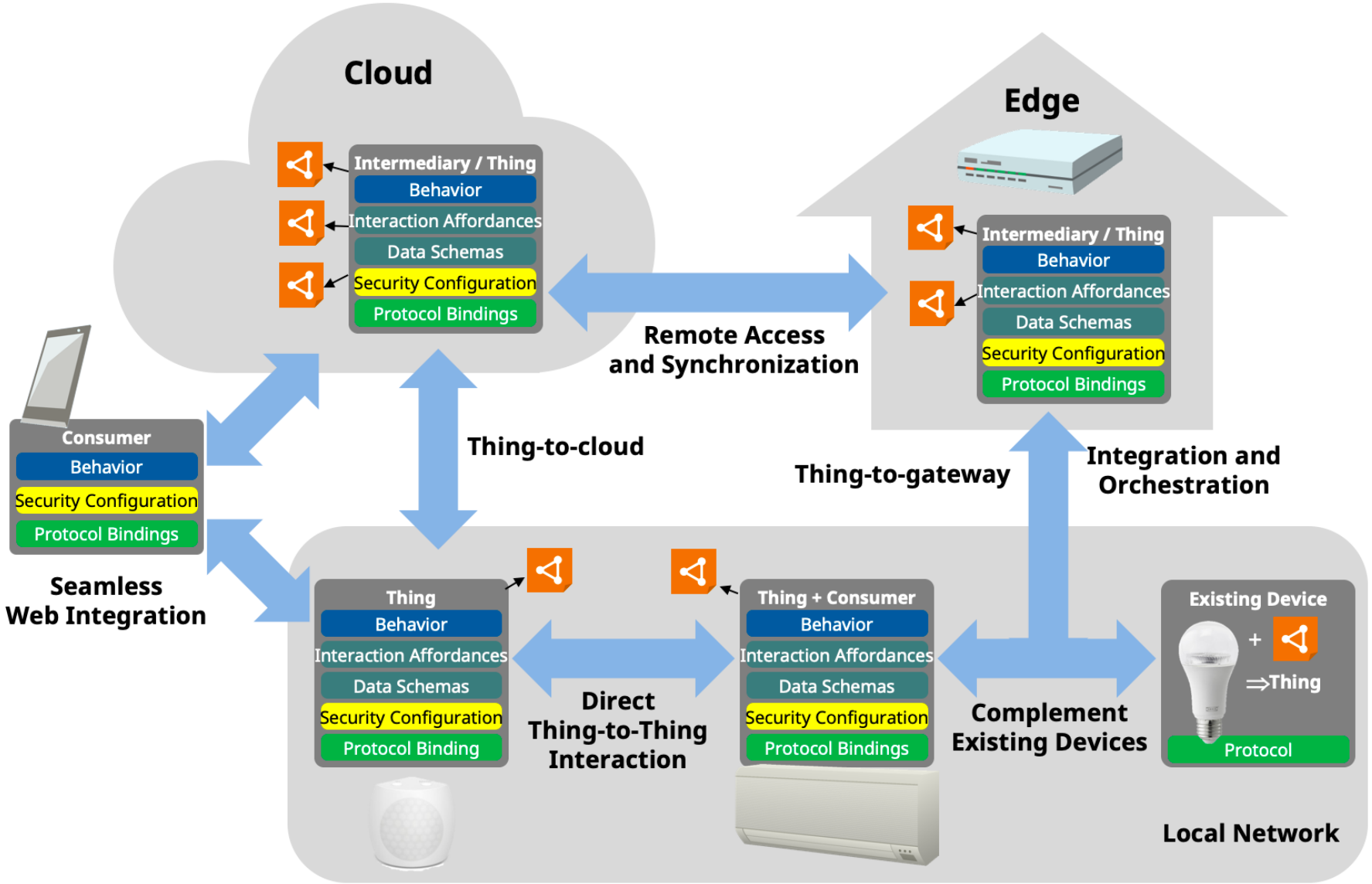
- Constraints
  - "Things" must have a TD
  - Must use URIs, IANA media types, etc.
- Thing Description Affordances
  - Describes WHAT the possible choices are
  - Describes HOW to interact with the Thing



WoT Thing Description (TD)

```
{
  "@context": [
    "https://www.w3.org/2022/wot/td/v1.1",
    { "iot": "http://iotschema.org/" }
  ],
  "id": "urn:dev:org:32473:1234567890",
  "title": "MyLEDThing",
  "description": "RGB LED torchiere",
  "@type": ["Thing", "iot:Light"],
  "securityDefinitions": {
    "default": {"scheme": "bearer"}
  },
  "security": ["default"],
  "properties": {
    "brightness": {
      "@type": ["iot:Brightness"],
      "type": "integer",
      "minimum": 0,
      "maximum": 100,
      "forms": [ ... ]
    }
  },
  "actions": {
    "fadeIn": {
      ...
```

Usage Patterns Overview



Deliverables

New/Updated Normative Documents:

- Architecture 1.1: https://github.com/w3c/wot-architecture
- Thing Description 1.1: https://github.com/w3c/wot-thing-description
- Discovery: https://github.com/w3c/wot-discovery
- Profiles: https://github.com/w3c/wot-profile

New/Updated Informative Documents:

- Binding Templates: https://github.com/w3c/wot-binding-templates
- Scripting API: https://github.com/w3c/wot-scripting-api
- Use Cases and Requirements: https://github.com/w3c/wot-usecases

Community Resources:

- Web Site: https://www.w3.org/WoT/

Use Cases and Requirements

Informative Deliverable: https://github.com/w3c/wot-usecases

Purpose and Process:

- Identify specific use cases
- Identify application domains
  - Collect use cases from other W3C groups
  - Collect use cases from other stakeholders and SDOs
- Identify usage patterns
  - For example, hubs, proxies, automation, etc.
- Identify relevant technologies
  - For example, edge computing, digital twins, etc.

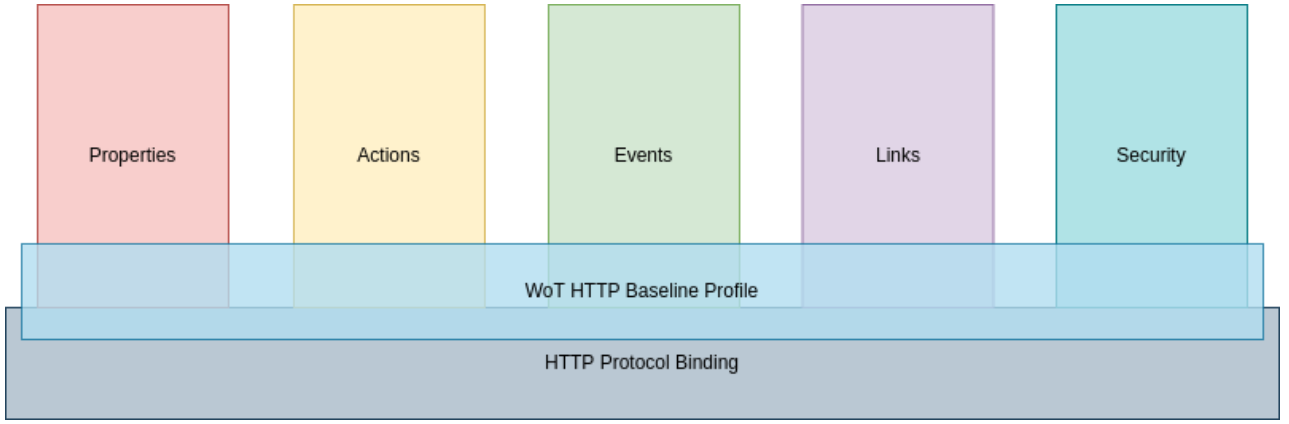
→ Extract common requirements to drive current and future work

Profiles

Set of constraints to:

- Improve interoperability
- Define best practices

- ***Prescriptive***
- Why:
  - TDs are descriptive
    - Some devices that need to be described do not follow best practices, e.g. for security
  - TDs are extensible
    - To interoperate device manufacturers need to know in advance what to expect



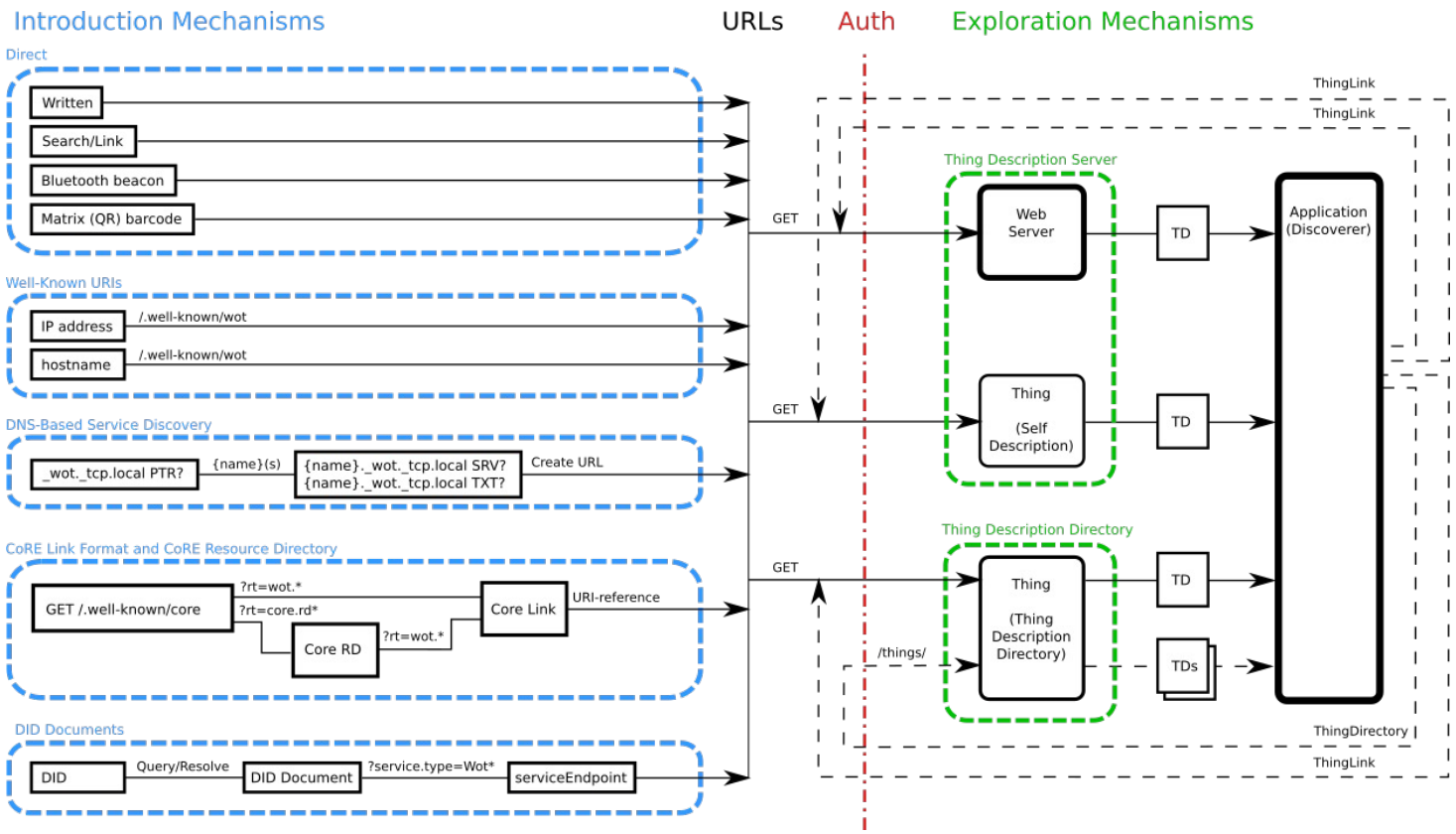
- Currently focused on HTTP Baseline Profile and two sub-profiles for SSE and WebHook Event mechanisms
- TDs satisfying profile set "profile" member and must follow constraints of profile
- Things and Consumers that implement profile also need to satisfy a set of other assertions

Discovery

Goal: Obtain TD of interest

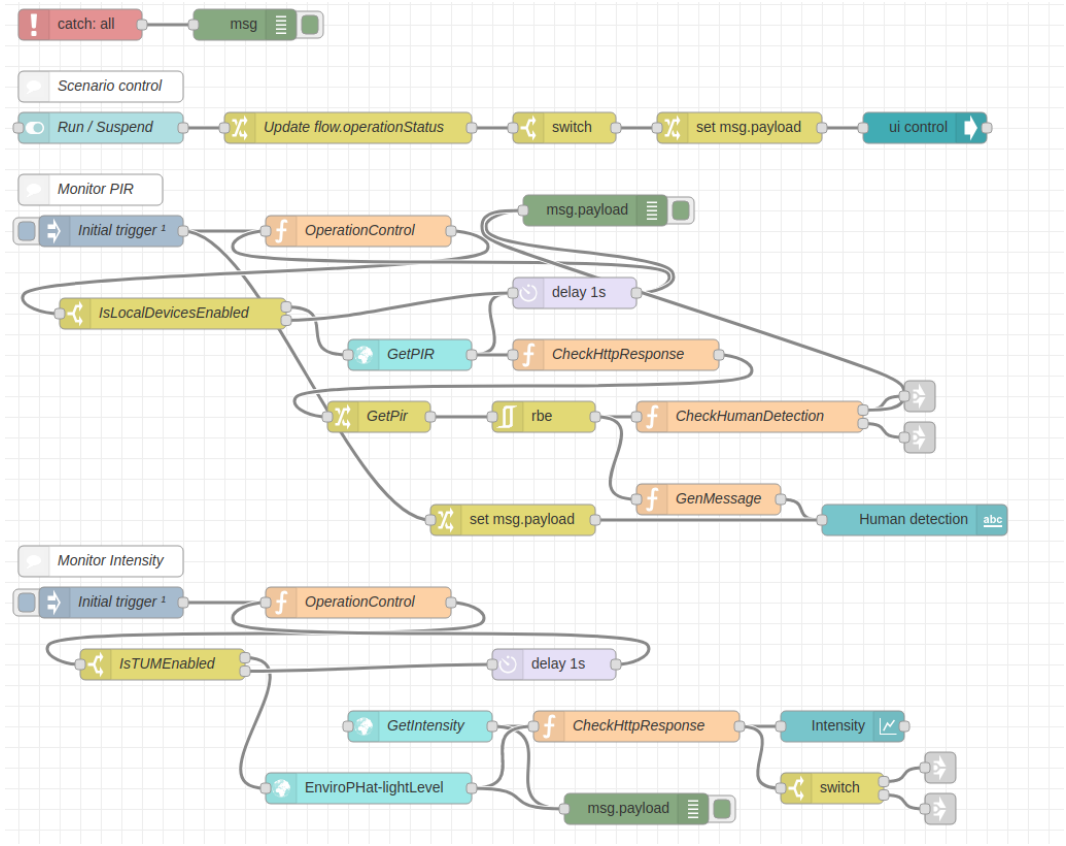
- Not limited to local network
- Scalable to many TDs
- Need to preserve privacy
- Phased access:
  1. Introduction: open
  2. Exploration: controlled
- Searchable via JSON Path, XPath, or SPARQL

- Future work:
  - Find "nearby" Things using geospatial data



Orchestration

Node-RED/node-gen



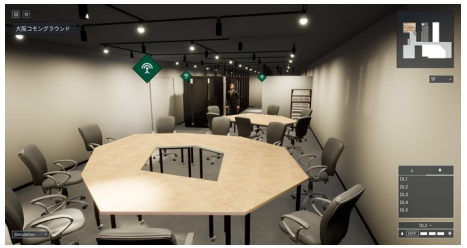
node-wot/Scripting API

```
WoTHelpers.fetch( "coap://localhost:5683/counter" ).then( async (td) => {
 // using await for serial execution (note 'async' in then() of fetch())
 try {
  const thing = await WoT.consume(td);
  console.info( "=== TD ===" );
  console.info(td);
  console.info( "==========" );

  // read property #1
  const read1 = await thing.readProperty( "count" );
  console.info( "count value is" , await read1.value());

  // increment property #1 (without step)
  await thing.invokeAction( "increment" );
  const inc1 = await thing.readProperty( "count" );
  console.info( "count value after increment #1 is" , await inc1.value());

  // increment property #2 (with step)
  await thing.invokeAction( "increment" , {'step' : 3});
  const inc2 = await thing.readProperty( "count" );
  console.info( "count value after increment #2 (w/ step 3) is" , await inc2.value());

  // decrement property
  await thing.invokeAction( "decrement", undefined, {
     formIndex: getFormIndexForDecrementWithCoAP(thing);
  } );
  const dec1 = await thing.readProperty( "count" );
  console.info( "count value after decrement is" , await dec1.value());

 } catch(err) {
  console.error( "Script error:", err);
 }

}).catch( (err) => { console.error( "Fetch error:", err); });
```

Recent Activity

- Testing new Candidate Recommendations
  - https://github.com/w3c/wot-testing/tree/main/events
- New Commercial Usages
  - Takenaka Construction, Netzo, Siemens, Deutsch Telekom, Ditto, ...
- Directory Implementations
  - WoT Hive, LogiLab (SPARQL based), Fraunhofer LinkSmart, TinyIoT, Zion
- IETF Relationships: JSON Path, CoreRD, COSE/JOSE, ASDF
- Under Discussion:
  - New Charter: New Deliverables, Updates to existing specifications, Liaisons
  - Geolocation, Onboarding, Historical data: proposals/deliverable-proposals

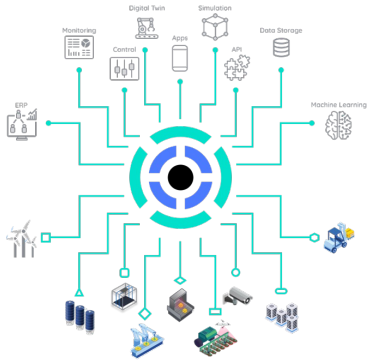
Applications



https://www.takenaka.co.jp/news/2021/05/02/

Takenaka Corporation

- CGLL Platform - BIM



https://netzo.io/

Netzo

- IoT Data Hub
- Dashboards

https://new.siemens.com/global/en/products/buildings/automation/desigo.html

https://www.evosoft.com/en/digitalization-offering/saywot/

https://www.evosoft.com/en/application-of-the-w3c-web-of-things-standard-in-the-wunsiedel-hydrogen-generation-plant/

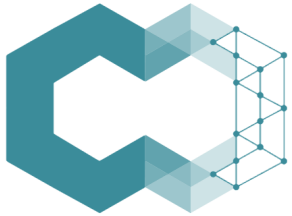
Siemens AG

- Desigo CC – BIM
- Asset Performance Suite
- Say WoT! (Evosoft)
- Wunsiedel (H_2 Generation plant)

https://www.smarthome.de/magentazuhause-app

Deutsche Telekom AG

- Smart Home
- App/Hub/Cloud



ditto

https://www.eclipse.org/ditto/2022-03-03-wot-integration.html

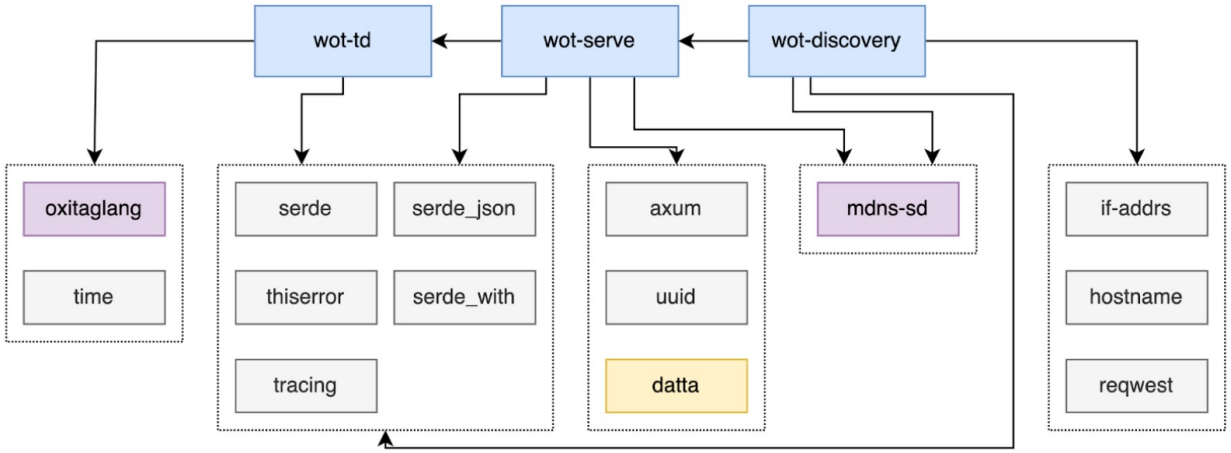
- Eclipse (Bosch, Siemens, ...)
- Digital twin

https://www.sifis-home.eu/

- Horizon 2020 Project
- Trustworthy Connected Home

SIFIS Home

- Horizon 2020 Project
  - https://www.sifis-home.eu/
- Secure and trustworthy full-stack internet of things for Smart Home
- Open Standards
- Using Rust to avoid memory bugs
- wot-rust implementation



SIFIS Home

```
.property("on", |b| {
    b.finish_extend_data_schema()
        .attype("OnOffProperty")
        .title("On/Off")
        .description("Whether the lamp is turned on")
        .form(|b| {
            b.href("/properties/on")
                .http_get(get_on_property)
                .http_put(put_on_property)
                .op(wot_td::thing::FormOperation::ReadProperty)
                .op(wot_td::thing::FormOperation::WriteProperty)
        })
        .bool()
})
.property("brightness", |b| {
    b.finish_extend_data_schema()
        .attype("BrightnessProperty")
        .title("Brightness")
        .description("The level of light from 0-100")
        .form(|b| {
            b.href("/properties/brightness")
                .http_get(get_brightness_property)
                .http_put(put_brightness_property)
                .op(wot_td::thing::FormOperation::ReadProperty)
                .op(wot_td::thing::FormOperation::WriteProperty)
        })
        .integer()
        .minimum(0)
```

```
"properties": {
  "brightness": {
    "@type": "BrightnessProperty",
    "description": "The level of light from 0-100",
    "forms": [
      {
        "href": "/properties/brightness",
        "op": [
          "readproperty",
          "writeproperty"
        ]
      }
    ],
    "maximum": 100,
    "minimum": 0,
    "readOnly": false,
    "title": "Brightness",
    "type": "integer",
    "unit": "percent",
    "writeOnly": false
  },
  "on": {
    "@type": "OnOffProperty",
    "description": "Whether the lamp is turned on",
    "forms": [
      {
        "href": "/properties/on",
```

```
    Running `target/debug/lamp`
2022-09-19T16:39:22.278330Z DEBUG mdns_sd::service_daemon: new socket bind to 0.0.0.0:5353
2022-09-19T16:39:22.278714Z DEBUG lamp: listening on 0.0.0.0:3000
2022-09-19T16:39:22.299215Z DEBUG mdns_sd::service_daemon: register service ServiceInfo { ty_domain: "_wot._tcp.local.", sub_domain:
None, fullname: "mybf2fafe3139540509dbecfbb1207666c._wot._tcp.local.", server: "enyo.lan.local", addresses: {192.168.1.212}, port: 30
00, host_ttl: 120, other_ttl: 4500, priority: 0, weight: 0, properties: {"td": "/.well-known/wot", "type": "Thing"}, last_update: 166
3605562278 }
2022-09-19T16:39:22.299344Z DEBUG mdns_sd::service_daemon: broadcast service mybf2fafe3139540509dbecfbb1207666c._wot._tcp.local.
```

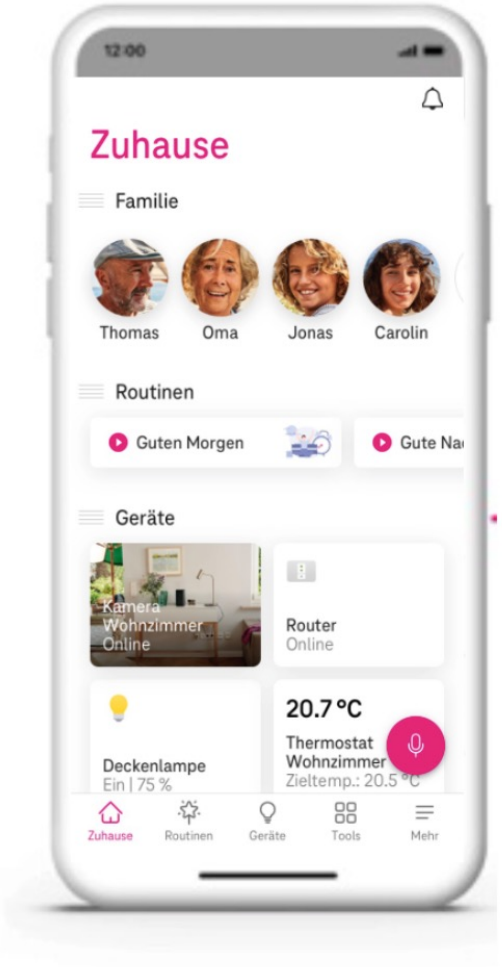
```
> dns-sd -B _wot._tcp
Browsing for _wot._tcp
DATE: ---Mon 19 Sep 2022---
18:40:34.085  ...STARTING...
Timestamp     A/R    Flags  if Domain               Service Type         Instance Name
18:40:34.086  Add        3   6 local.              _wot._tcp.           mybd729b6943214caeb527e15626162967
18:40:34.086  Add        2   6 local.              _wot._tcp.           mybf2fafe3139540509dbecfbb1207666c
```

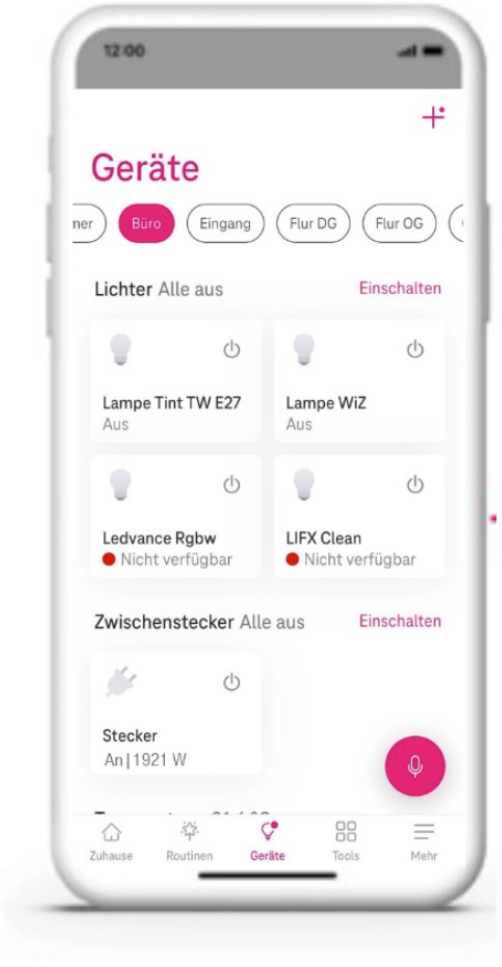
MagentaZuhause App

We help you create a connected home that takes care of the people and things inside.

Good & safe family life
Take care of your loved ones and manage everyday family coordinatio with ease.

Smarter home
Gain security and comfort for your home.





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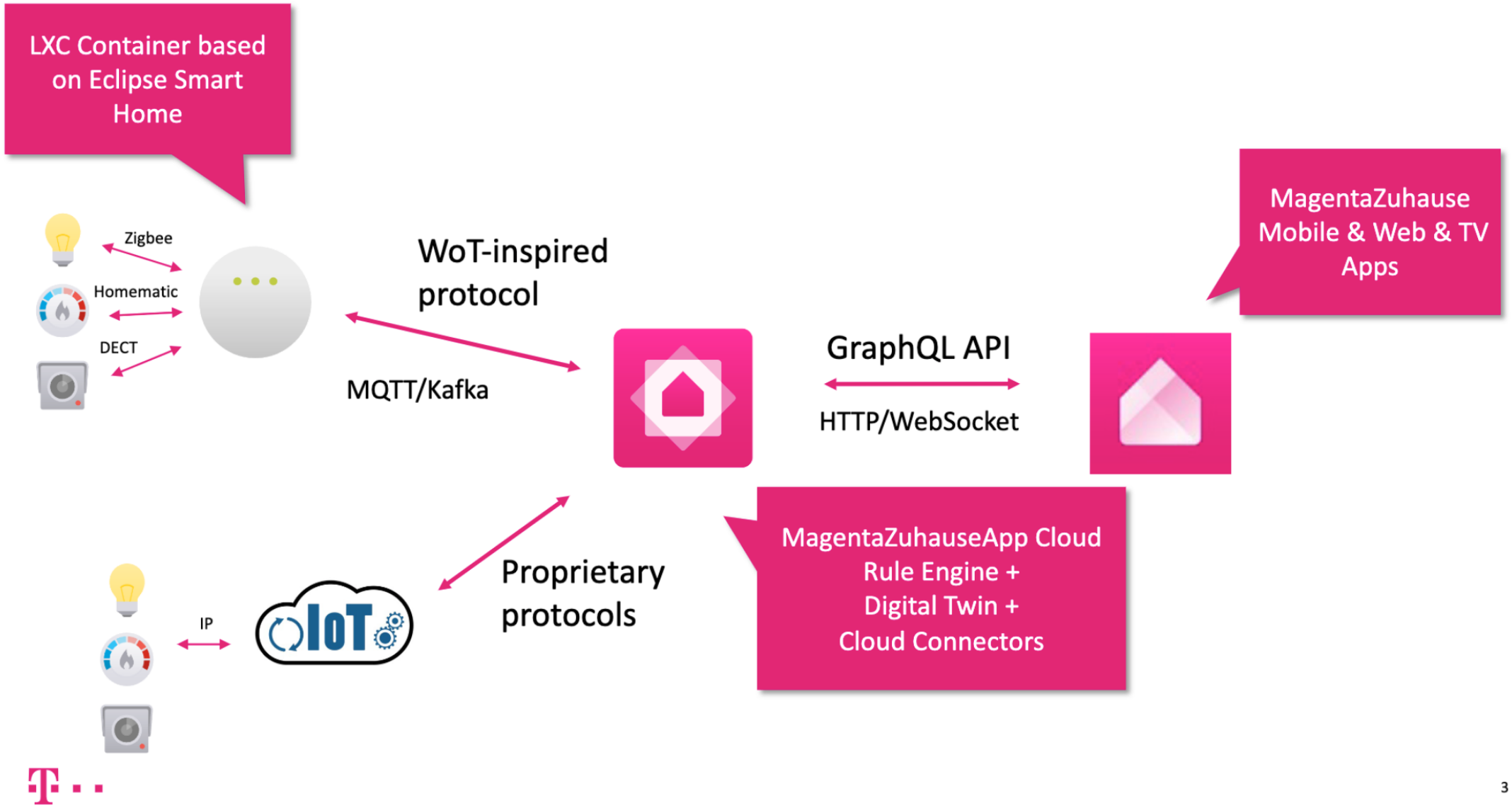
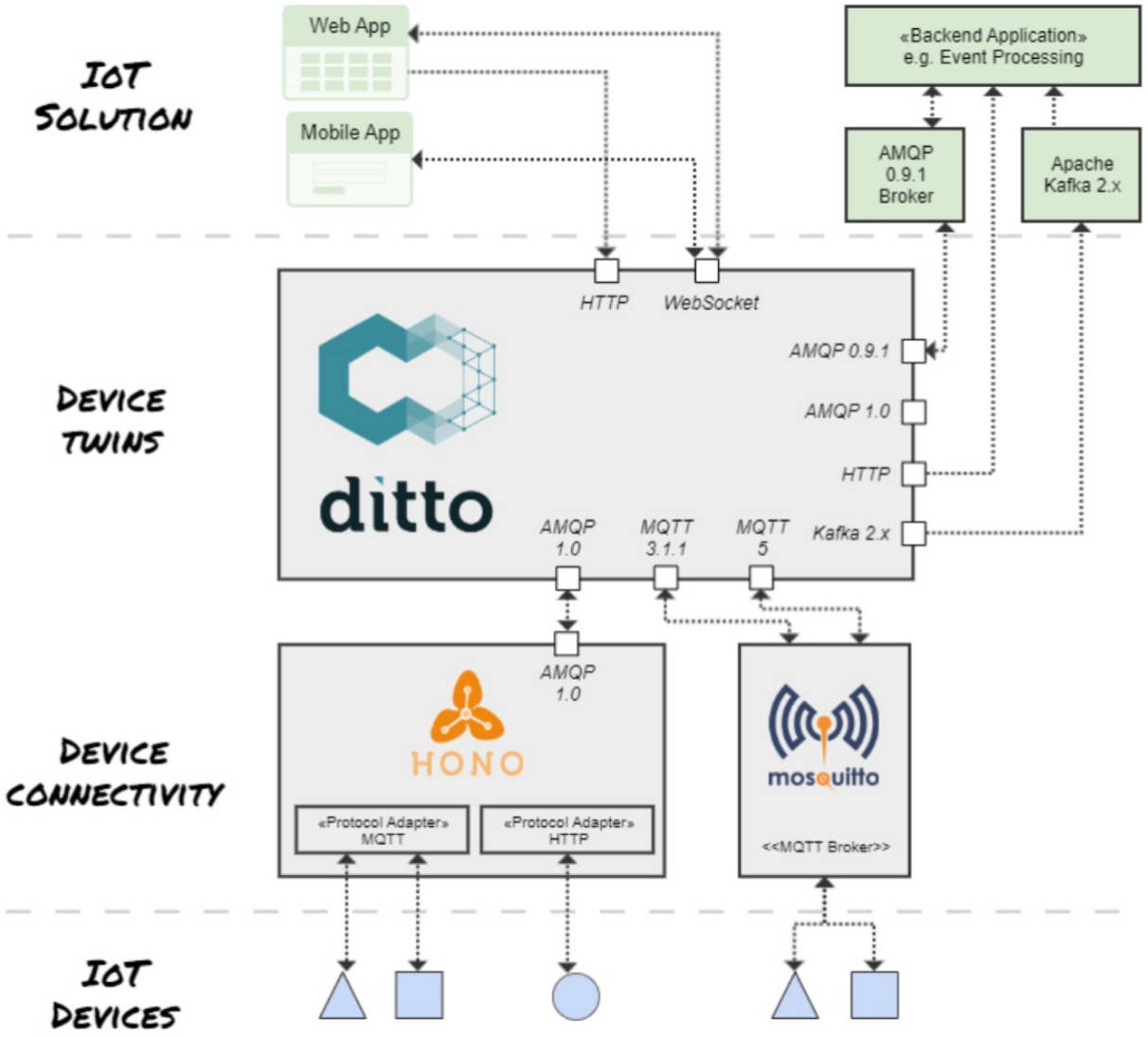

LXC Container based on Eclipse Smart Home
Zigbee
Homematic
DECT
WoT-inspired protocol
MQTT/Kafka
GraphQL API
HTTP/WebSocket
MagentaZuhause Mobile & Web & TV Apps
IP
IoT
Proprietary protocols
MagentaZuhauseApp Cloud
Rule Engine +
Digital Twin +
Cloud Connectors
3

Eclipse Ditto



Ditto as Digital Twin "middleware"

Eclipse Ditto

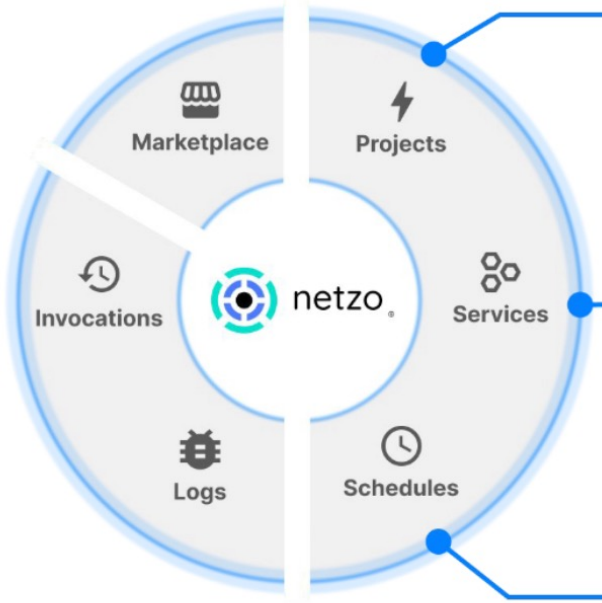
- → Ditto downloads and caches referenced TMs during runtime
- → resolving extensions via `tm:extends` and imports via `tm:ref`, Thing level compositions via `tm:submodel` and TM placeholders
- → Ditto generates TDs, injecting forms with HTTP API endpoints

```
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"
  ...
}
```

Netzo

Deploy JavaScript and TypeScript to URL endpoints instantly. Connect essential APIs, automate processes and build tools faster, without managing infrastructure.



Production deployments on a click

Instantly turn scripts into custom workflows and UIs at URL Endpoints.

Integrate anything with an API

Integrate business apps directly or from the open-source Marketplace.

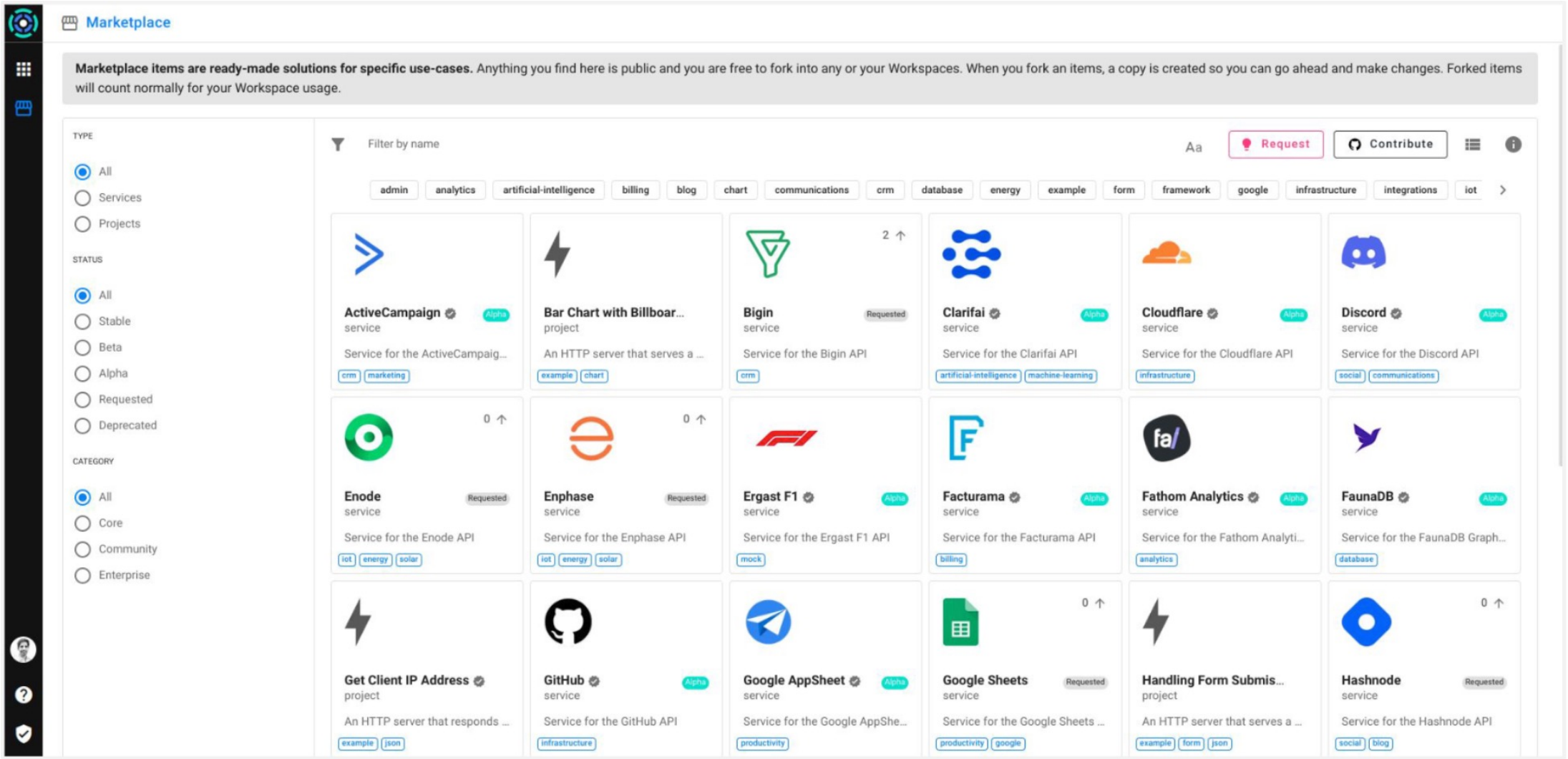
Run anything on a schedule

Configure jobs and workflows to run at specific times and intervals.

- Webhook Handling
- Request Proxying
- Data Processing
- Admin Panels
- Form Handling
- Server-side Rendering (with JSX)
- KPI Dashboards
- Request Scheduling (Cron Jobs)
- Workflow Automation

and more...

Netzo

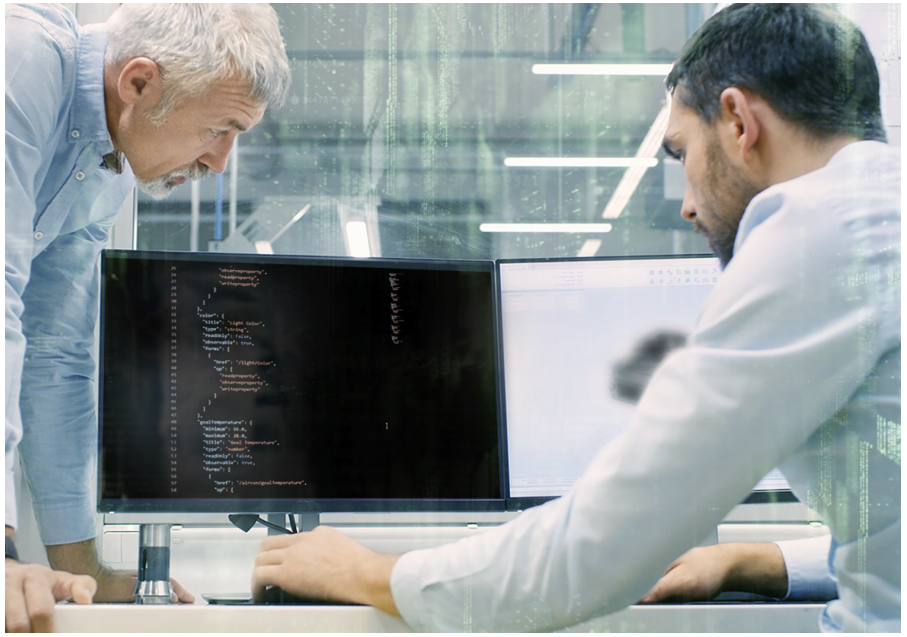

Marketplace
Marketplace items are ready-made solutions for specific use-cases. Anything you find here is public and you are free to fork into any or your Workspaces. When you fork an items, a copy is created so you can go ahead and make changes. Forked items will count normally for your Workspace usage.
TYPE
All
Services
Projects
STATUS
All
Stable
Beta
Alpha
Requested
Deprecated
CATEGORY
All
Core
Community
Enterprise
Filter by name
Aa
Request
Contribute
admin
analytics
artificial-intelligence
billing
blog
chart
communications
crm
database
energy
example
form
framework
google
infrastructure
integrations
iot
ActiveCampaign
service
Service for the ActiveCampaig...
Bar Chart with Billboar...
project
An HTTP server that serves a ...
Bigin
service
Service for the Bigin API
Clarifai
service
Service for the Clarifai API
Cloudflare
service
Service for the Cloudflare API
Discord
service
Service for the Discord API
Enode
service
Service for the Enode API
Enphase
service
Service for the Enphase API
Ergast F1
service
Service for the Ergast F1 API
Facturama
service
Service for the Facturama API
Fathom Analytics
service
Service for the Fathom Analyti...
FaunaDB
service
Service for the FaunaDB Graph...
Get Client IP Address
project
An HTTP server that responds ...
GitHub
service
Service for the GitHub API
Google AppSheet
service
Service for the Google AppShe...
Google Sheets
service
Service for the Google Sheets ...
Handling Form Submis...
project
An HTTP server that serves a ...
Hashnode
service
Service for the Hashnode API

Siemens – Desigo CC

Building Information Management (BIM)

- View status in context of 3D model
- Security
- Energy Efficiency
- Maintenance management

Siemens - EvoSoft



SayWoT!

https://www.evosoft.com/en/digitalization-offering/saywot/

Thing Models, Thing Descriptions, Protocol adapters...

Wunsiedel H_2 Generation Plant

https://www.evosoft.com/en/application-of-the-w3c-web-of-things-standard-in-the-wunsiedel-hydrogen-generation-plant/

Application of SayWoT to cloud integration

Discussion: Open Problems/Next Steps

- GIS Integration
  - Geospatial data and discovery
- Data Management
  - Digital Twins and shadows
  - Event and action modelling
  - Data management
- Security
  - Key provisioning and onboarding
  - Secure LAN access
  - Proxy services
  - Access control and ad-hoc sharing
  - MUDS
- Accessibility
  - Sensory modality mapping
  - Textual/descriptive interfaces
  - Service location
  - Mobility services
- Advanced Use Cases
  - Transportation
  - Logistics
  - Distributed energy management
  - AR visualization
  - Analytics integration e.g. for health and safety monitoring

Resources and Contacts

https://www.w3.org/WoT

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Technology Pathfinding

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Dr. Sebastian Kaebisch
Senior Key Expert

Siemens
Technology

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