Cloud IoT Connectivity with UDMI Schema

DELTA CONTROLS INC.

Headquarters in Vancouver BC
Innovating Since 1986

We are a **campus of innovation,** growth, differentiation, empowerm

We believe a **collective vision** surpasses an individual one.

We **respect our roots.**

We are proactive, providing the unexpected extra to **create 'Wow.'**

We **make the world a better place** by reducing energy consumption and creating better experiences.

We take **extreme ownership,** move quickly & succeed together.

We believe **leadership is a responsibility,** not an entitlement.

We are guided by **facts & data.**

We treat every external interaction as a **moment of truth.**

We debate, learn, celebrate & **deliver.**

We **believe** it can be done.

"At Delta Controls, we create and grow organizations and the people within them"

What makes a building ‘Smart’?

It has to be much more than a nice App…

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So, what really makes a building ‘Smart’?

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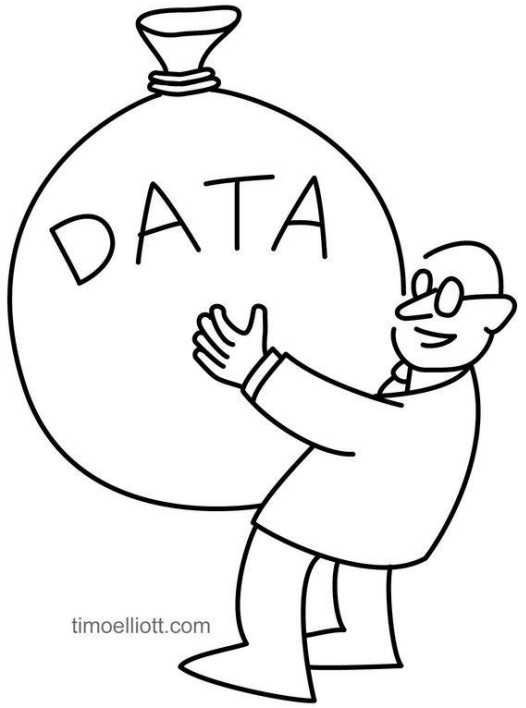
It's all about the data

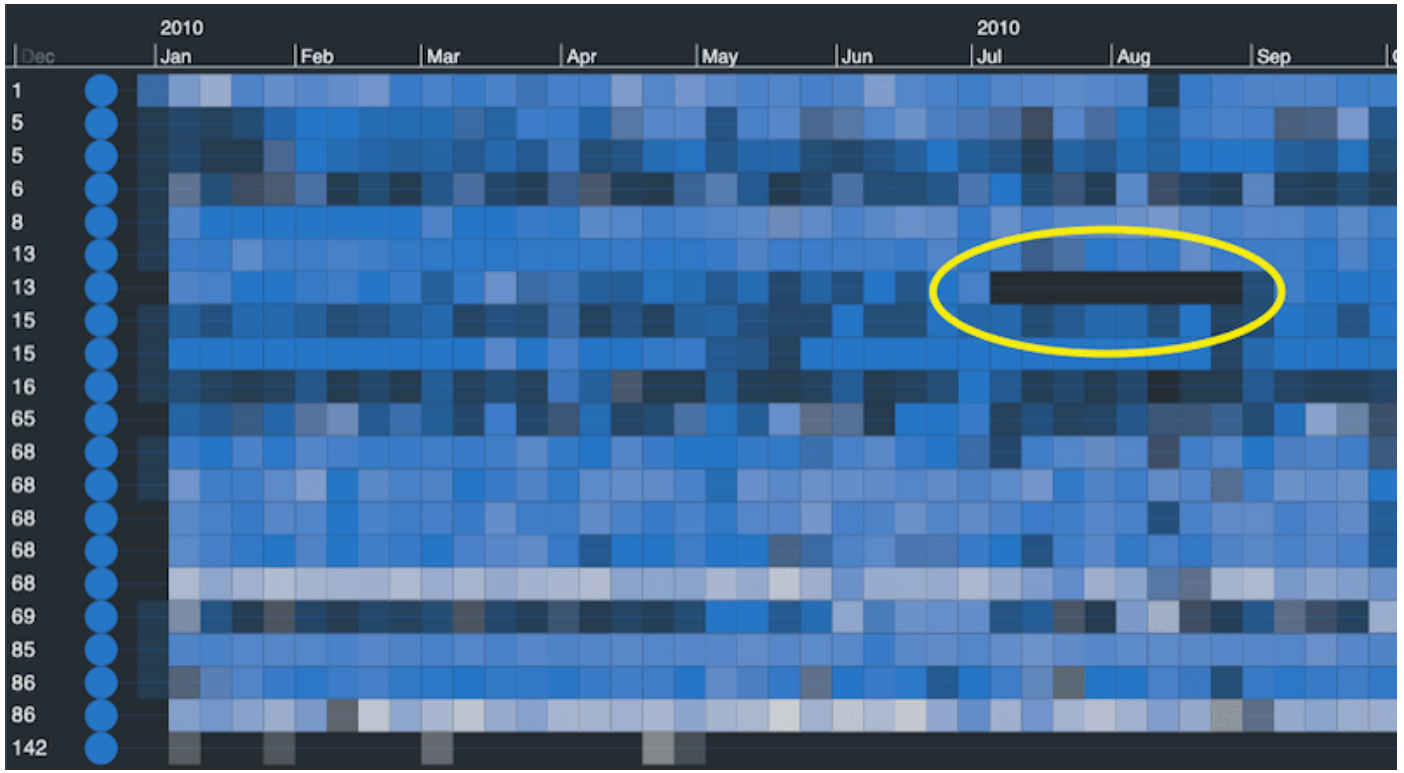
"We're outsourcing all our critical business decisions to a flawed algorithm with insufficient data — what could possibly go wrong?!"

"I'm just off to the bank..."




Data, data, everywhere

Artificial Intelligence & Machine Learning



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+ New chat

TLS MQTT Connection Setup

CSS Metallic Button Design

Free Weather Data Apps

Random Number Generated

GCL+ Random Number Gener

Make Metal Button CSS

Clear conversations

Dark mode

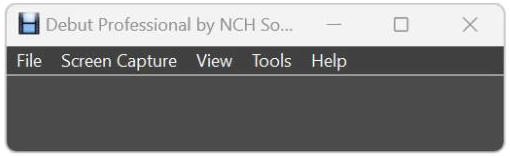
OpenAI Discord

Updates & FAQ

Log out

ChatGPT

Examples	Capabilities	Limitations
"Explain quantum computing in simple terms" →	Remembers what user said earlier in the conversation	May occasionally generate incorrect information
"Got any creative ideas for a 10 year old's birthday?" →	Allows user to provide follow-up corrections	May occasionally produce harmful instructions or biased content
"How do I make an HTTP request in Javascript?" →	Trained to decline inappropriate requests	Limited knowledge of world and events after 2021

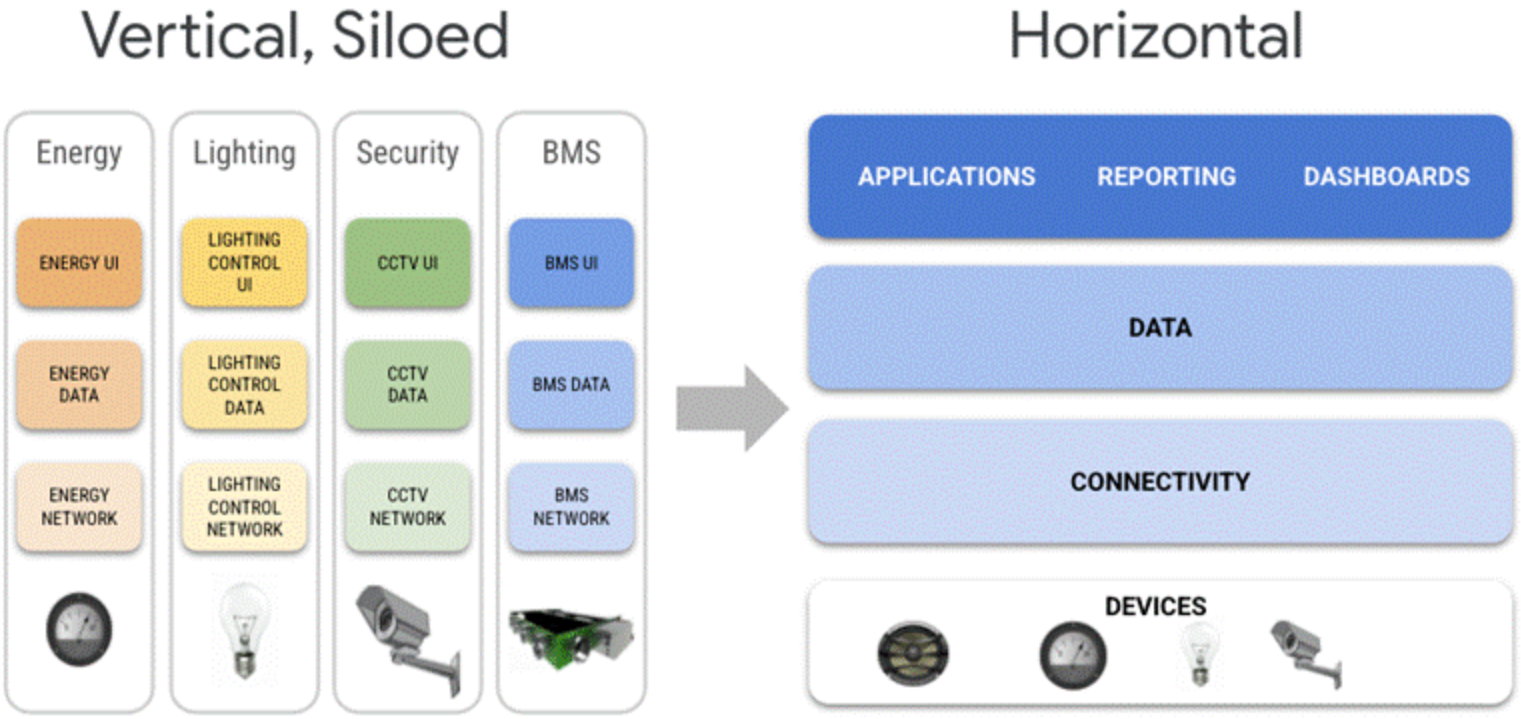


ChatGPT Jan 9 Version. Free Research Preview. Our goal is to make AI systems more natural and safe to interact with. Your feedback will help us improve.

ENG
UK

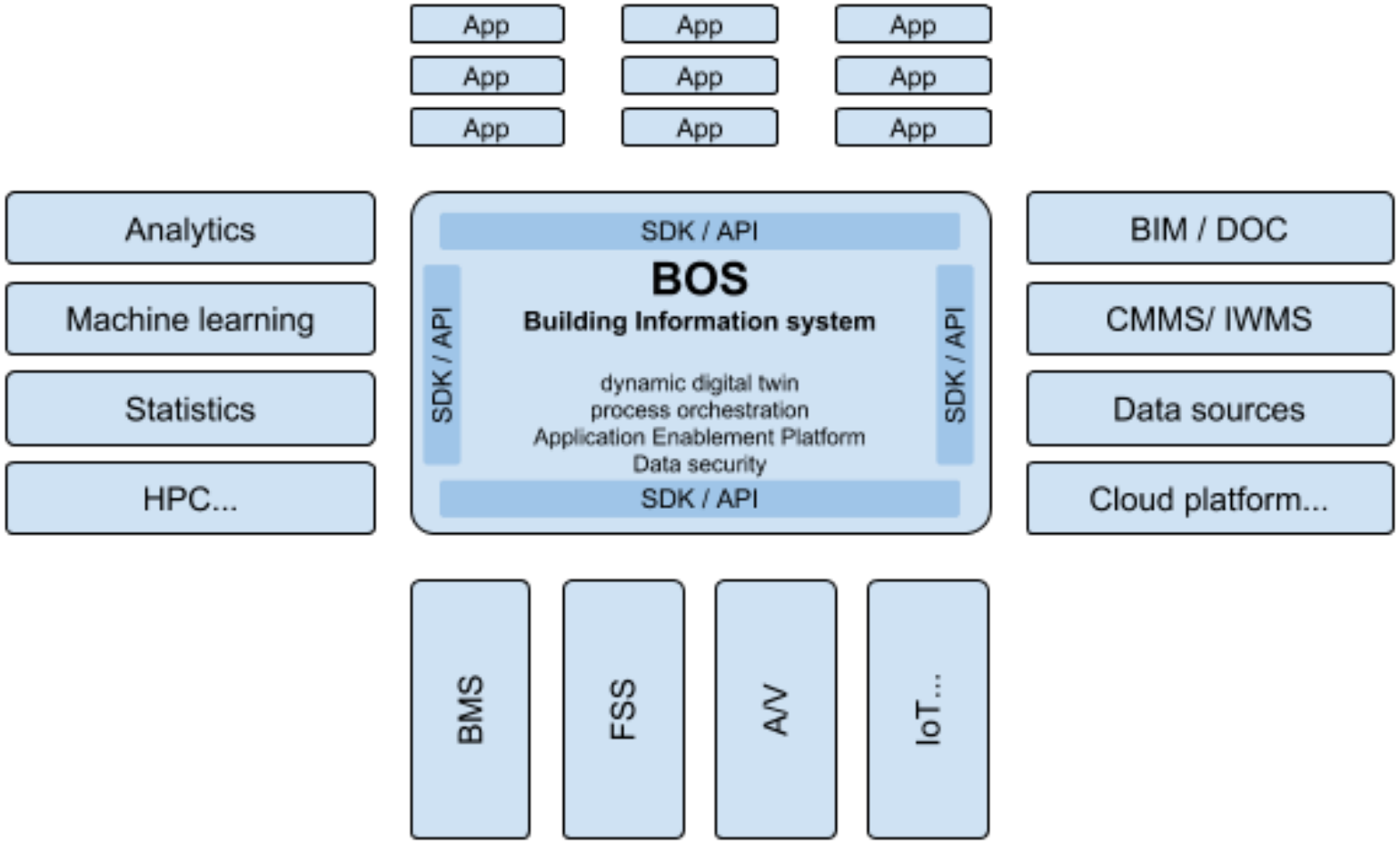
11:38
30/01/2023

Building Operating System



Ref: Google - Sabine Lam, Kathy Farrington, Trevor Perring, et al

Building Operating System



Ref: Jérémie Bellec, SpinalCom

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Simplifying BOS

1. Security and Network Capabilities (of IoT Devices) – Device Qualification
2. Syntax (moving data between device and cloud) - UDMI
3. Semantics (making sense of the data) - DBO

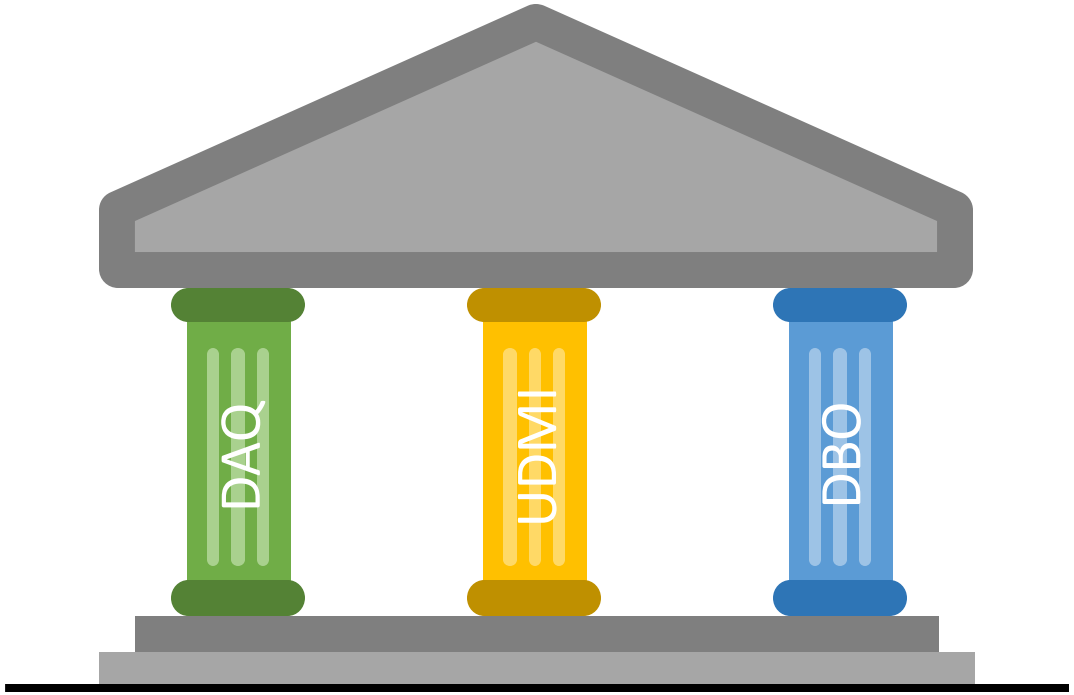
Three Pillars of the Building Operating System

DAQ

Device Automated Qualification

SECURITY

Tests the core functionality of a device to ensure IT/OT Security is at an acceptable level



DBO

Digital Buildings Ontology

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A naming convention and toolset that allows data mining applications to be developed for cloud-based processing, dashboards and analytics

UDMI

Universal Device Management Interface

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The protocol for communication with the Cloud. Covers configuration, status messages, telemetry and log events

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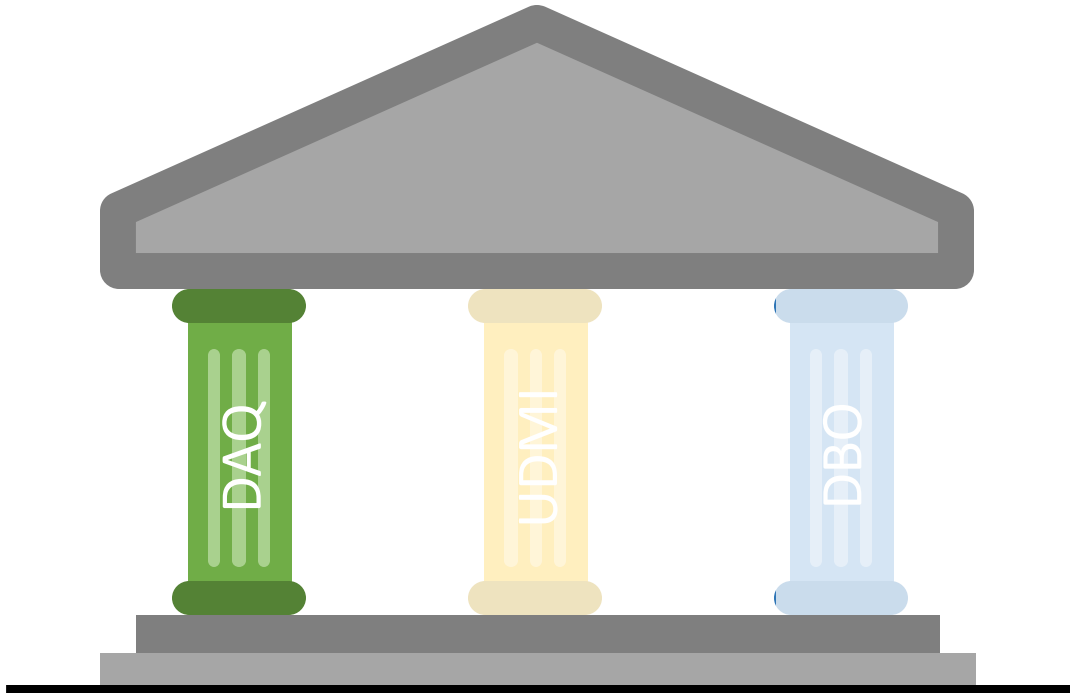

Device Automated Qualification

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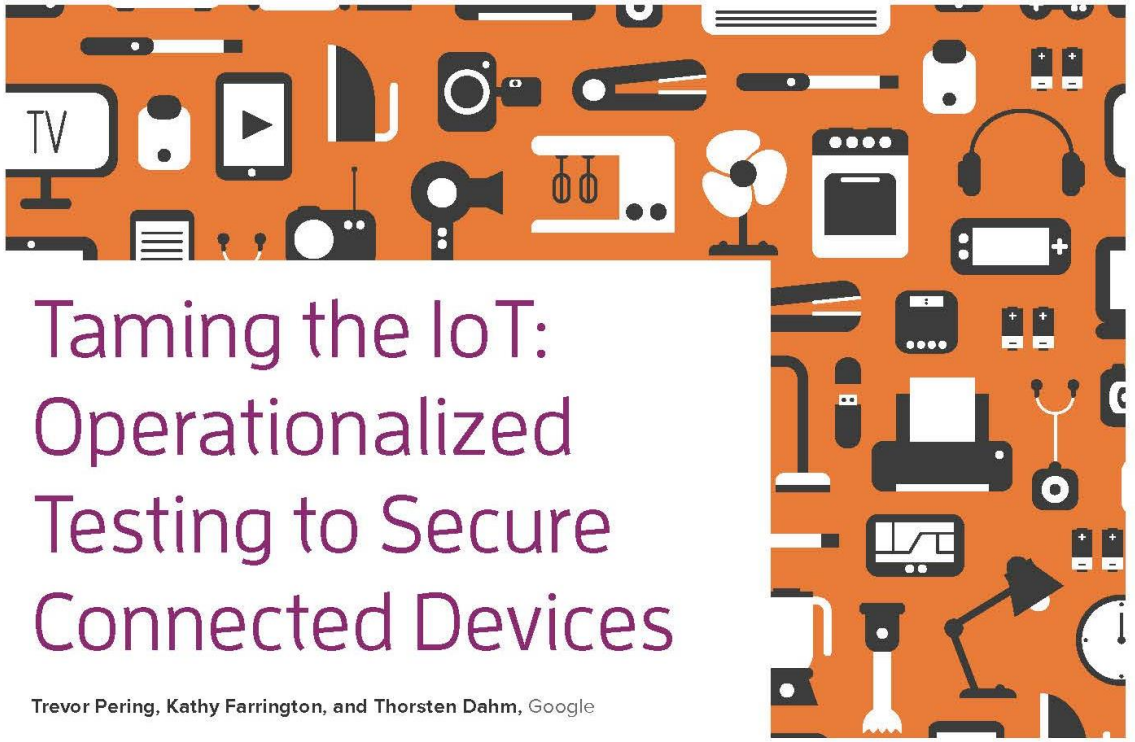
IoT and Its Security Challenges



Taming the IoT: Operationalized Testing to Secure Connected Devices

Trevor Pering, Kathy Farrington, and Thorsten Dahm, Google

Operationalized testing of built-environment

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Untamed IoT…

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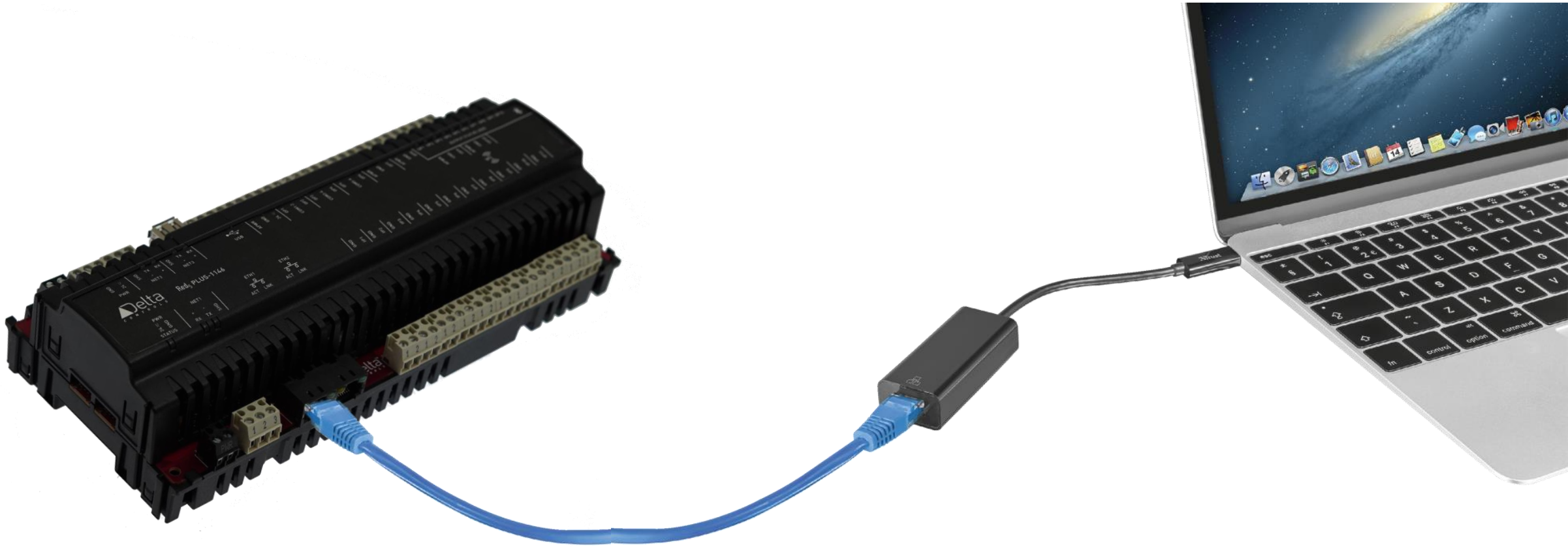
Device Automated Qualification

- Software tools for automatic testing for DAQ compliance
- Developed by a Google led consortium
- Linux based (Debian / Ubuntu 20.04 LTS)

DAQ Setup



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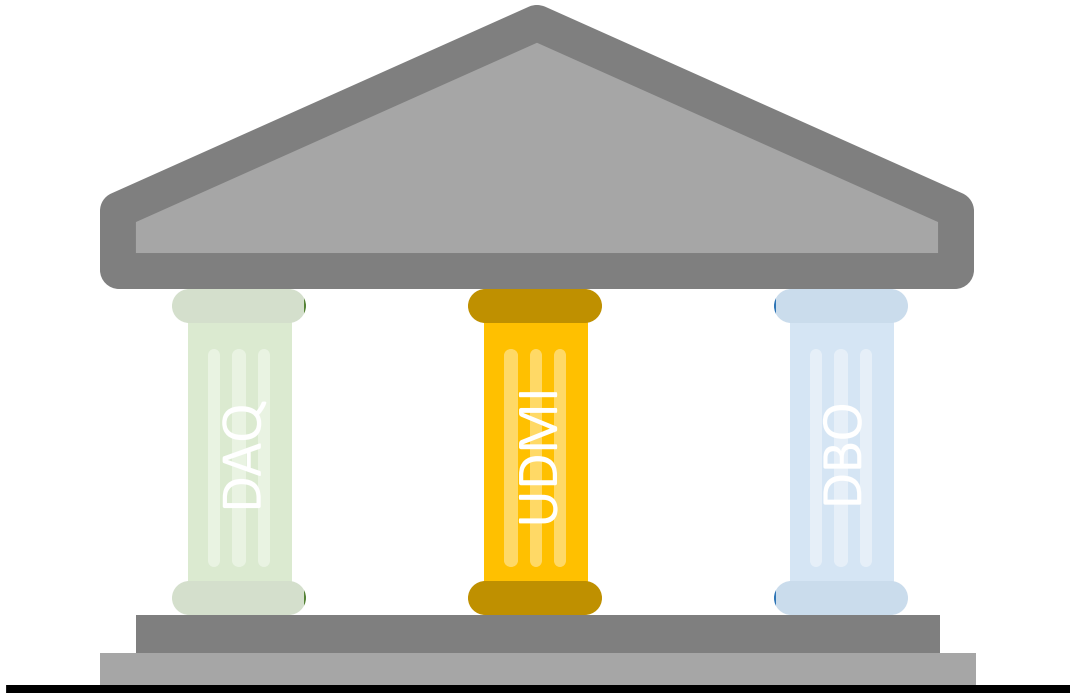

Universal Device Management Interface

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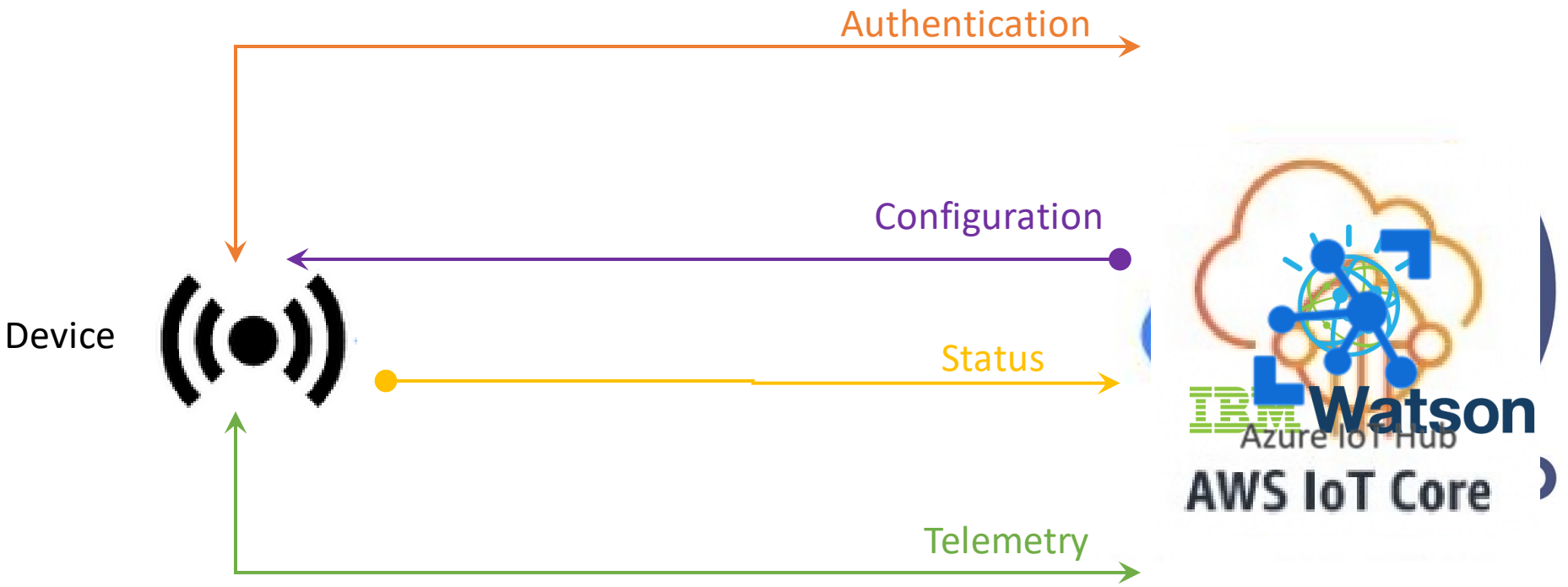
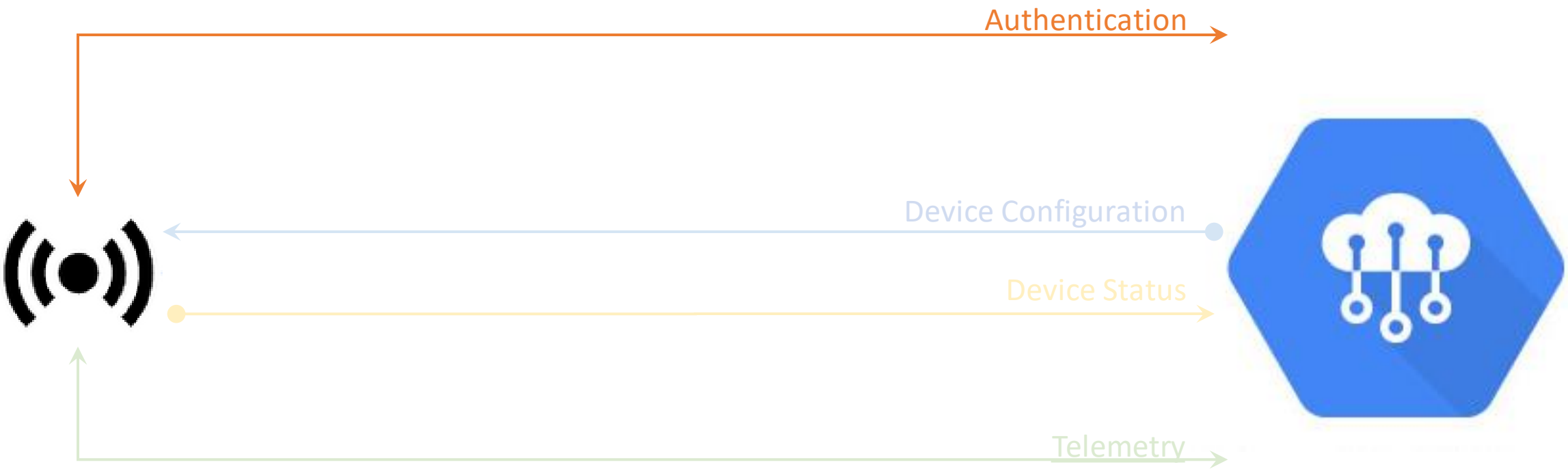
UDMI - Visually



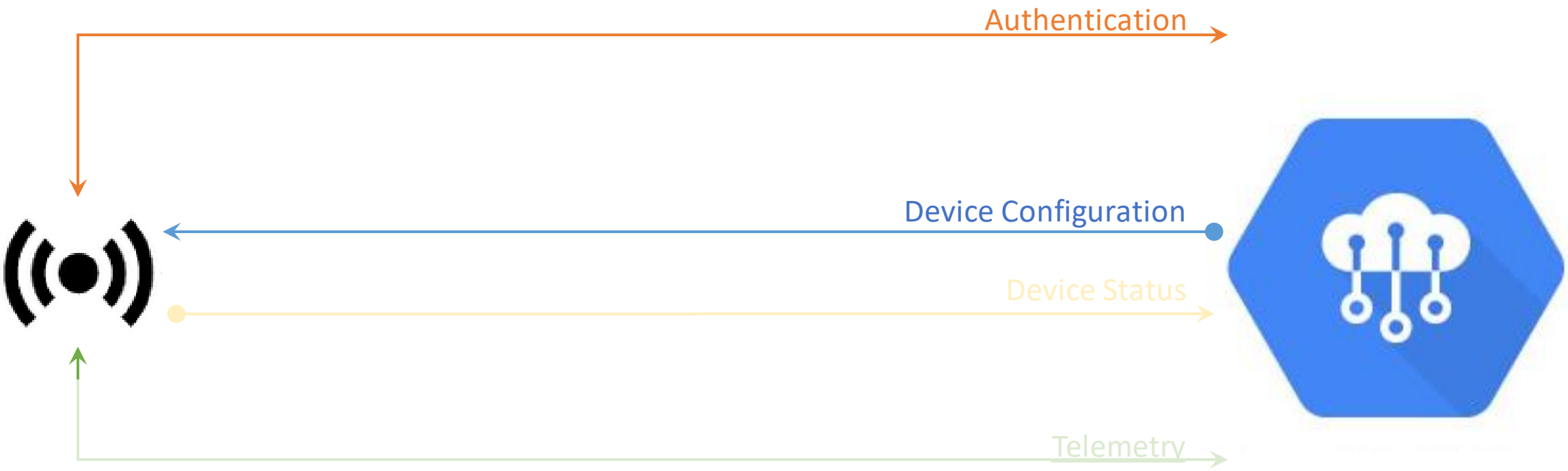
UDMI - Visually



Connect to MQTT bridge/broker using TLS authentication and encryption using a JSON Web Token

The endpoint used is ‘projects/***{project}***/locations/***{region}***/registries/***{registry}***/devices/***{device}***’

UDMI - Visually

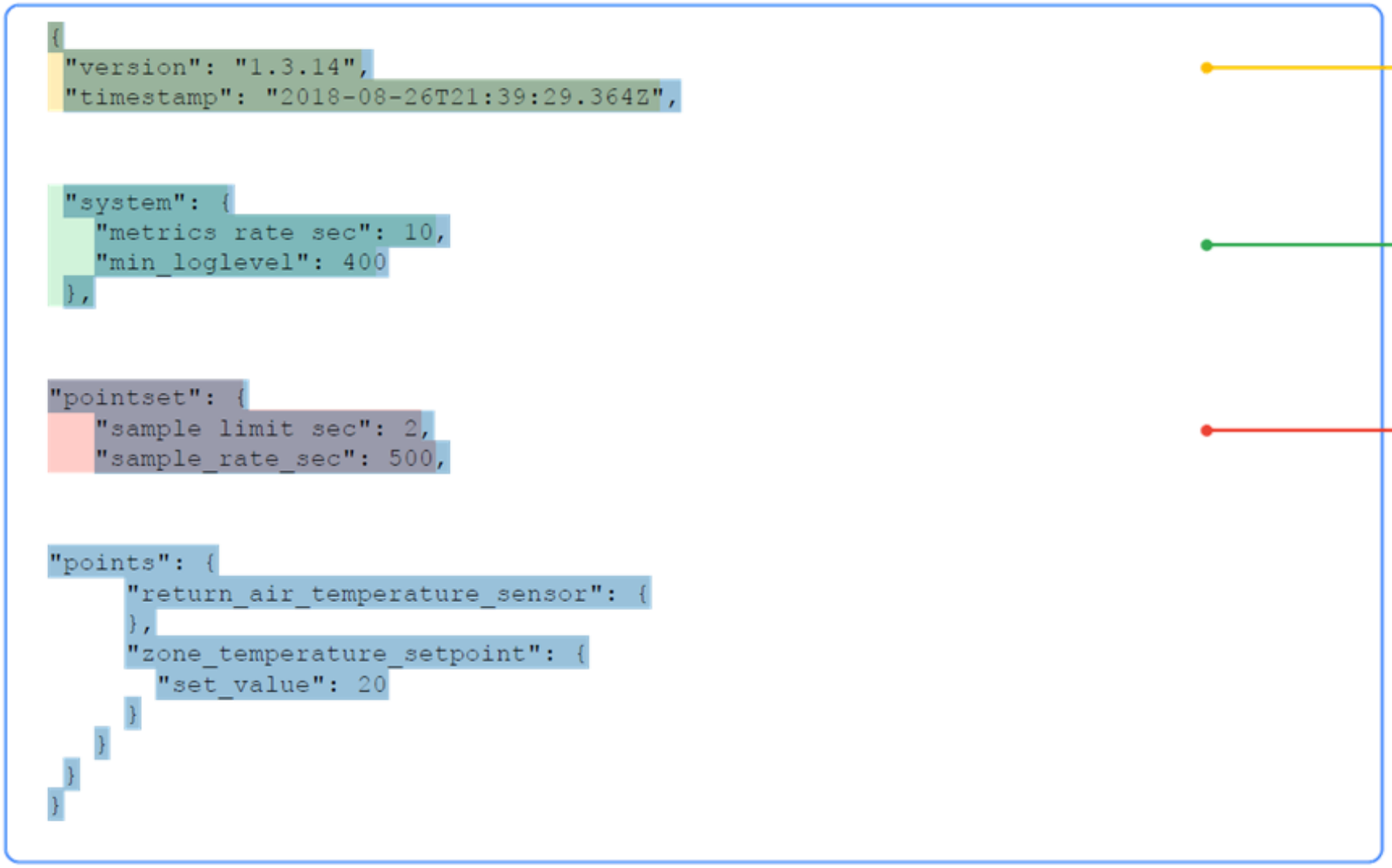


When a device attaches the Configuration previously provisioned on the cloud side is published to the ‘config’ topic

The MQTT topic used is ‘/devices/***{device-id}***/config’

The config message defines what the Cloud wants the device to do

UDMI Device Configuration



```
{
  "version": "1.3.14",
  "timestamp": "2018-08-26T21:39:29.364Z",

  "system": {
    "metrics_rate_sec": 10,
    "min_loglevel": 400
  },

"pointset": {
    "sample_limit_sec": 2,
    "sample_rate_sec": 500,

"points": {
      "return_air_temperature_sensor": {
      },
      "zone_temperature_setpoint": {
        "set_value": 20
      }
    }
  }
}
```

Configuration timestamp and versioning

System sub-block defining configuration

Pointset subblock defining configuration of the device's points, indicating the expected points, sample rate, cloud-to-device control, etc.

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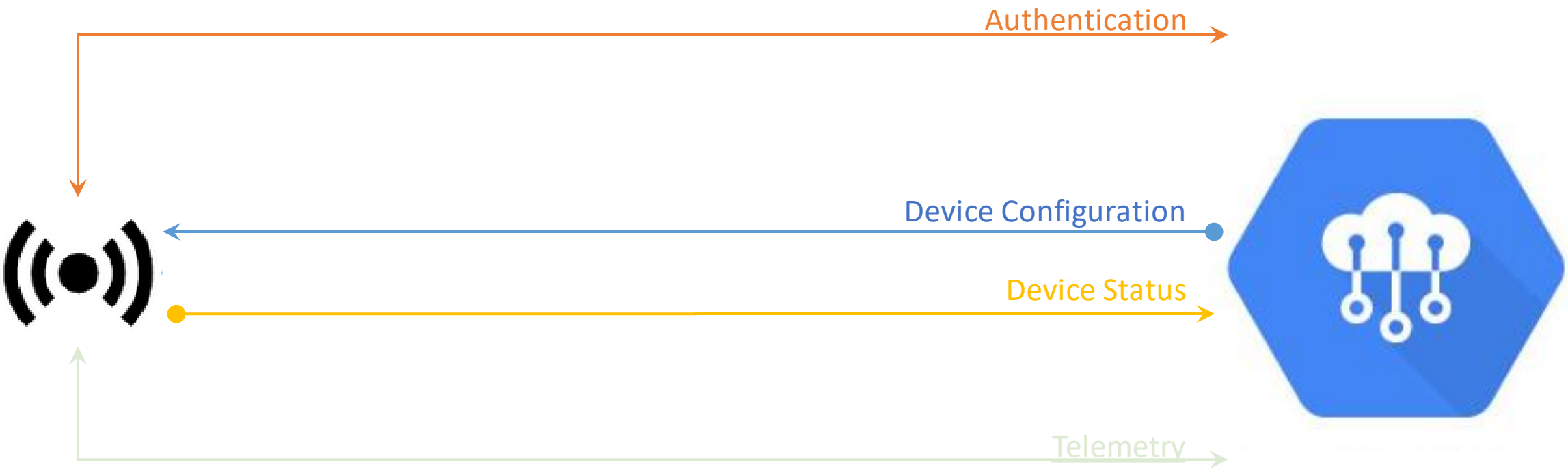
UDMI - Visually



Periodically and when the device receives a valid Configuration message the device publishes a status message

The MQTT topic used is '/devices/***{device-id}***/status'

UDMI Device Status

```
{
 "version": "1.3.14",
 "timestamp": "2018-08-26T21:39:29.364Z",

 "system": {

  "last_config":"2018-08-26T21:49:29.364Z",

  "hardware": {
     "make": "ACME",
     "model": "Bird Trap"
   },
   "software": {
     "firmware": "3.2a"
   },
  "serial_no": "182732142",
```

Standard UDMI header found in all messages

System sub-block containing information about the device

Timestamp of the last config received and accepted by the device

Information about the physical hardware and software (e.g., firmware, operating systems) running on the device and serial number

UDMI Device Status

```
  "operational": true,
  "status": {
     "message": "Tickity Boo",
     "category": "device.state.com",
     "timestamp": "2018-08-26T21:39:30.364Z",
     "level": 600
   }
 },
"pointset": {
   "status": {  // Status scoped to overall pointset operation
     "message": "Invalid sample time",
     "category": "pointset.config",
     "timestamp": "2018-08-26T21:39:28.364Z",
     "level": 500
   },
   "points": {
     "return_air_temperature_sensor": {
       "status": {  // Status scoped to a specific point in a pointset
         "message": "Point return_air_temperature_sensor unable to read value",
         "category": "pointset.points.telemetry",
         "timestamp": "2018-08-26T21:39:28.364Z",
         "level": 500
       }
     },
     "zone_temperature_setpoint": {
     }
   }
 }
}
```

System operational and status information

System operational and status information

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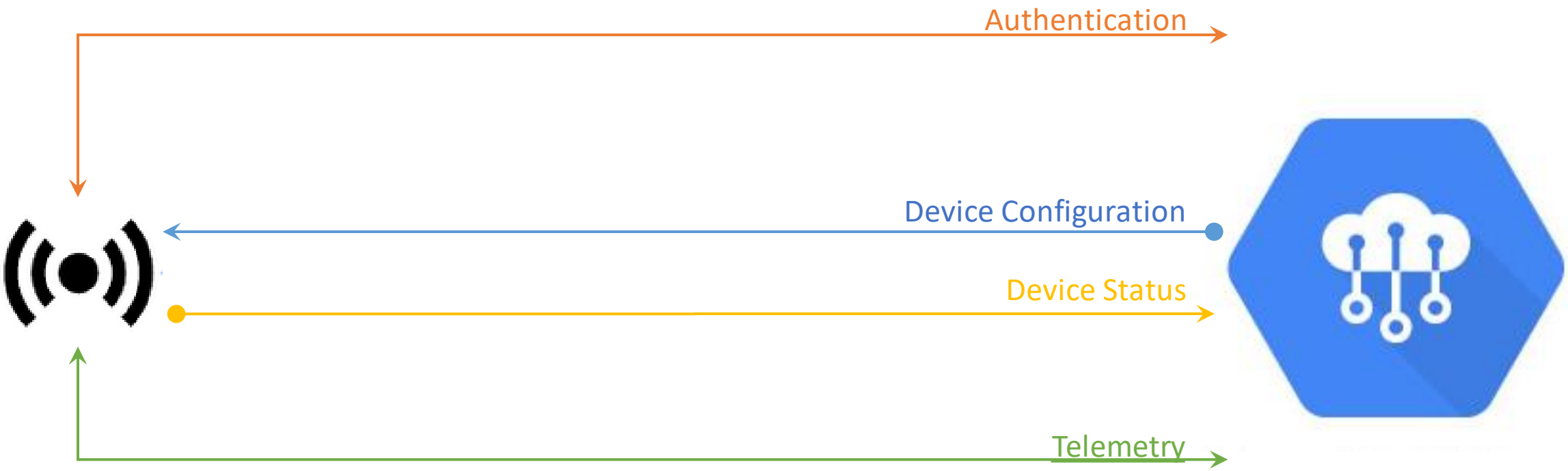
UDMI - Visually



Periodically the gateway device on premises will collect the data for the pointset defined in the device configuration metadata and publish this to the MQTT topic '/devices/***{device-id}***/events/pointset'

It will also publish event messages to the MQTT topic '/devices/***{device-id}***/events/system'

UDMI Device System Event Telemetry

System events


```
{
 "version": "1.3.14",
 "timestamp": "2018-08-26T21:39:29.364Z",
 "logentries": [
    {
      "message": "Configuration received",
      "detail": "Message ID 356633457687432",
      "timestamp": "2018-08-26T21:39:19.364Z",
      "category": "system.config.receive",
      "level": 300
    }
 ]
}
```


The system log entry information

UDMI Device Pointset Event Telemetry

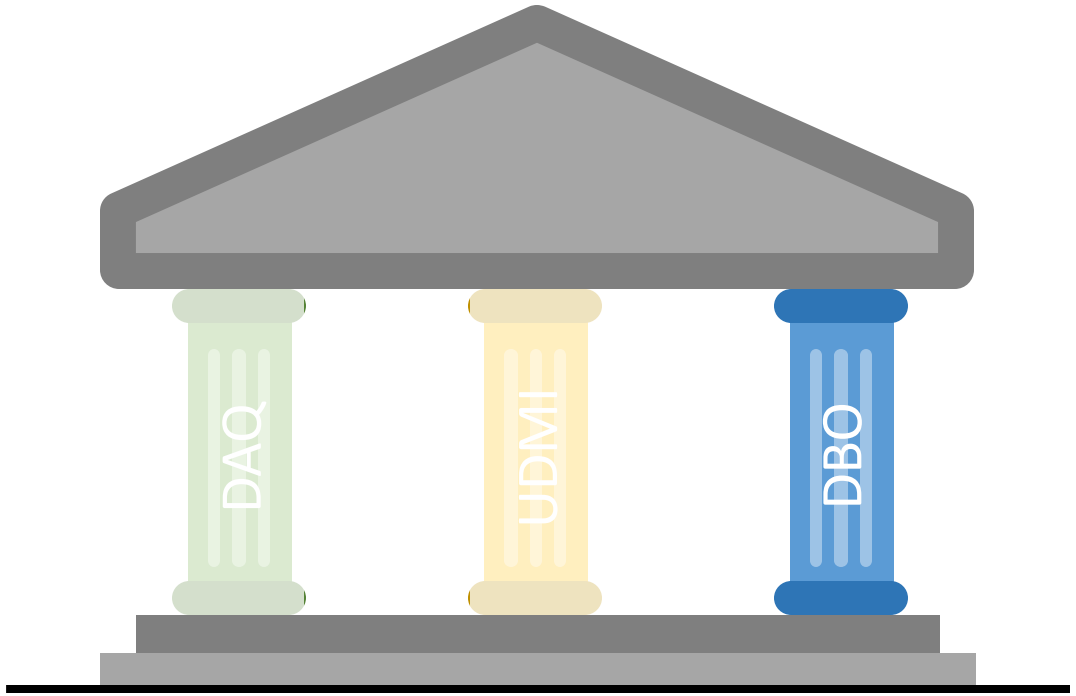
Pointset events

```
{
 "version": "1.3.14",
 "timestamp": "2019-01-17T14:02:29.364Z",


 "points": {
   "return air temperature setpoint": {
     "present_value": 21.30108642578125
   },
    "zone temperature setpoint": {
     "present_value": 23
   }
 }
}
```

Standard UDMI header found in all messages

The values of the different points on the device



Digital Buildings Ontology

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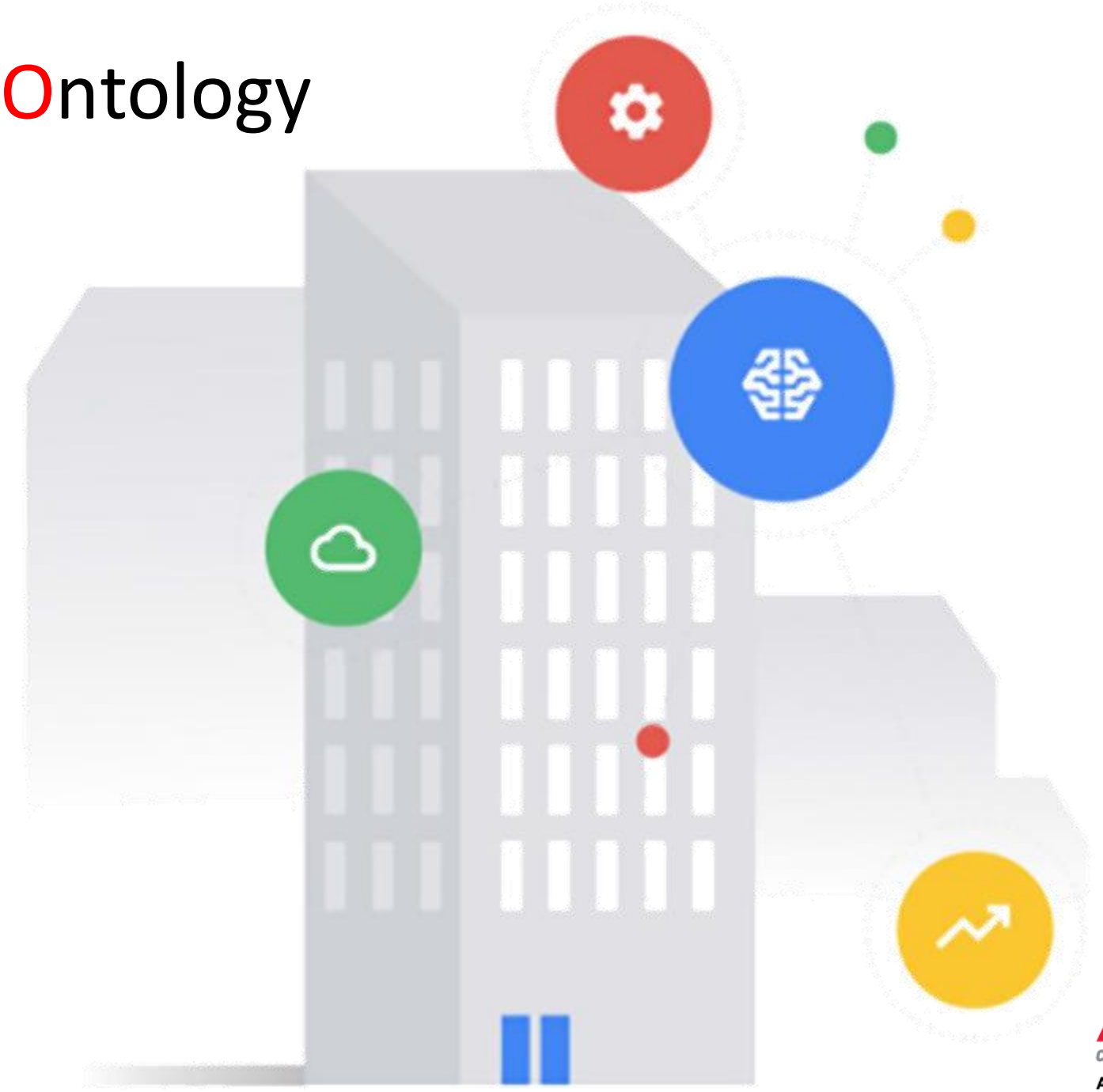

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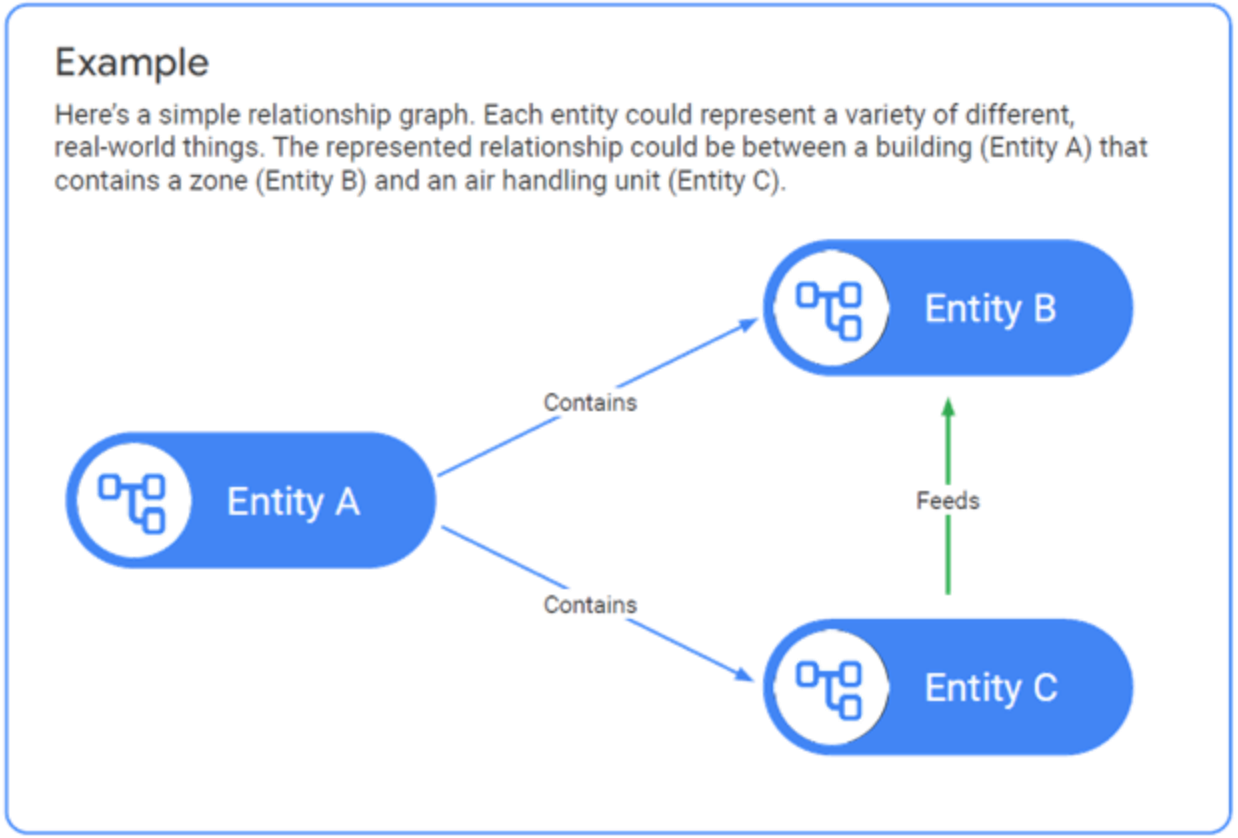
DBO Data Model

- **Entities** – represent a real world ‘thing’
- **Entity Types** – represent the class (or class hierarchy) of a specific entity
- **Properties** – describe the data fields of an entity
- **Relationships** – connect two or more enties



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Typical DBO Entity

UDMI Device Pointset Event Telemetry


```
{
  "version": "1.3.14",
  "timestamp": "2022-09-08T14:36:31.262158",
  "points": {
    "fcu_901_heating_valve": {
      "present_value": 0.0
    },
    "fcu_901_cooling_valve": {
      "present_value": 0.0
    },
    "fcu_901_fan_speed": {
      "present_value": 70.0
    },
    "fcu_901_bms_remote": {
      "present_value": "active"
    },
    "fcu_901_fcu_run_status": {
      "present_value": "active"
    },
    "fcu_901_room_temp": {
      "present_value": 19.79
    },
    "fcu_901_supply_air_temp": {
      "present_value": 20.0
    },
    "fcu_901_setpoint": {
      "present_value": 20.0
    },
    "fcu_901_minimum_fan_speed": {
      "present_value": 20.0
    },
    "fcu_901_maximum_fan_speed": {
      "present_value": 100.0
    },
    "fcu_901_design_fan_speed": {
      "present_value": 70.0
    },
    "fcu_901_comfort_kpi_score": {
      "present_value": 70.04
    }
  }
}
```


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DBO Toolkit

- Ontology Extension Validator
  Checks if extension are backwards compatible and don't interfere with other entity types that are already defined

- Instance Validator
  Checks if the building config is formatted properly and the DBO is applied accurately.

- RDF/OWL Generator
  Generates an RDF version of the YAML format configs and extensions

Remember the ‘Three Pillars’?

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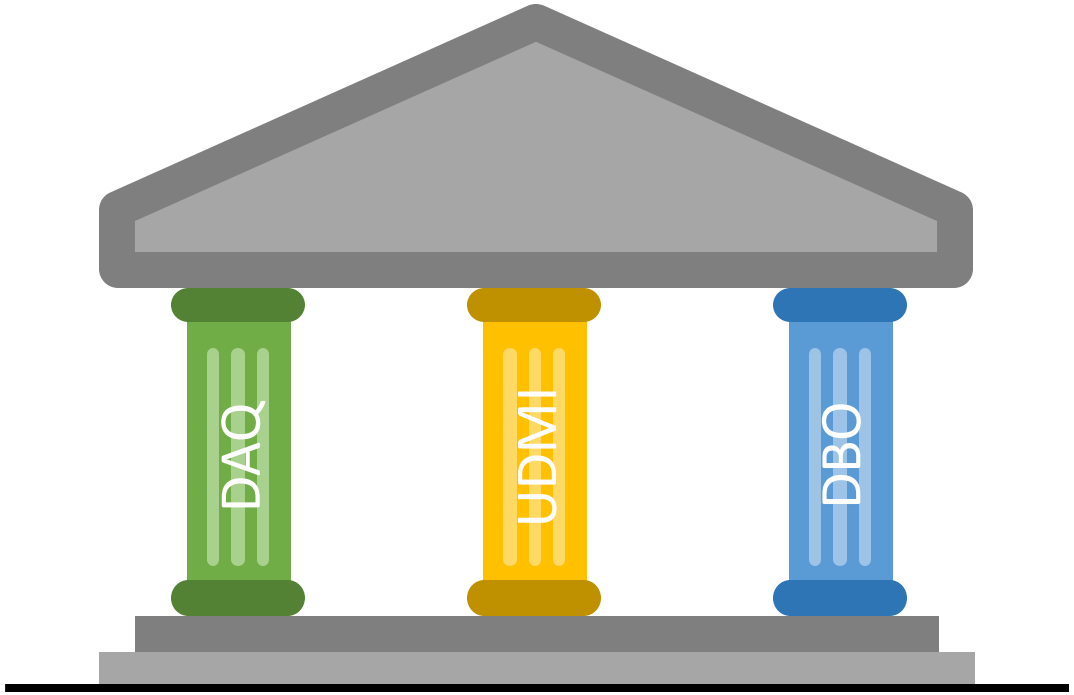
Device Automated Qualification

SECURITY

Tests the core functionality of a device to ensure IT/OT Security is at an acceptable level



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BOS Device Qualification

Security & Function

Device Automated Qualification

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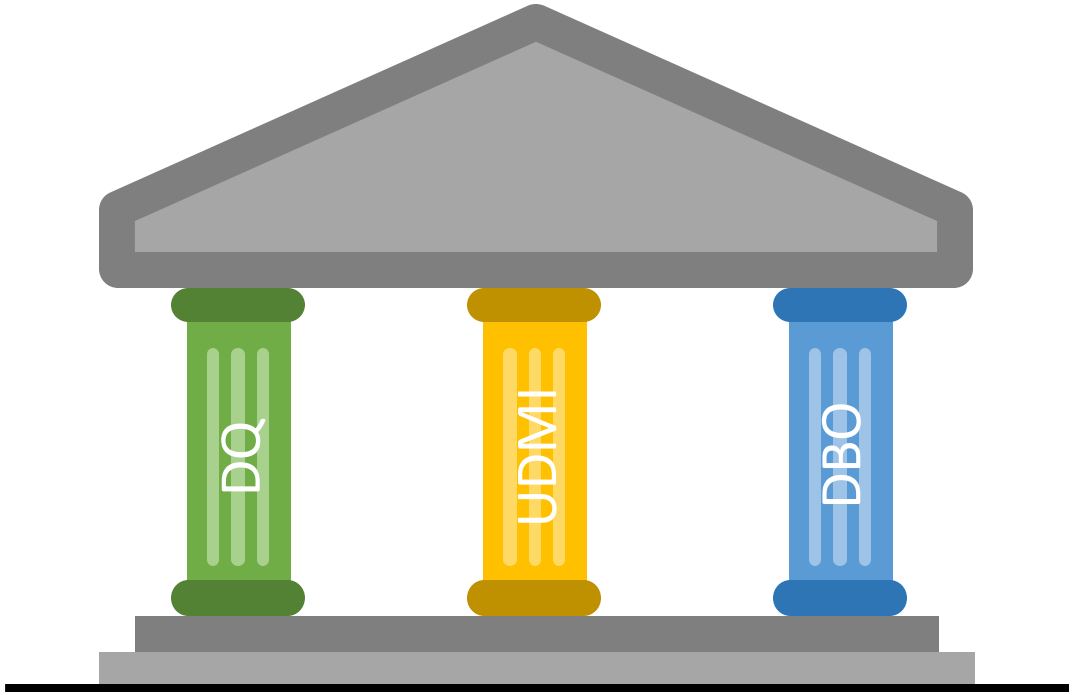

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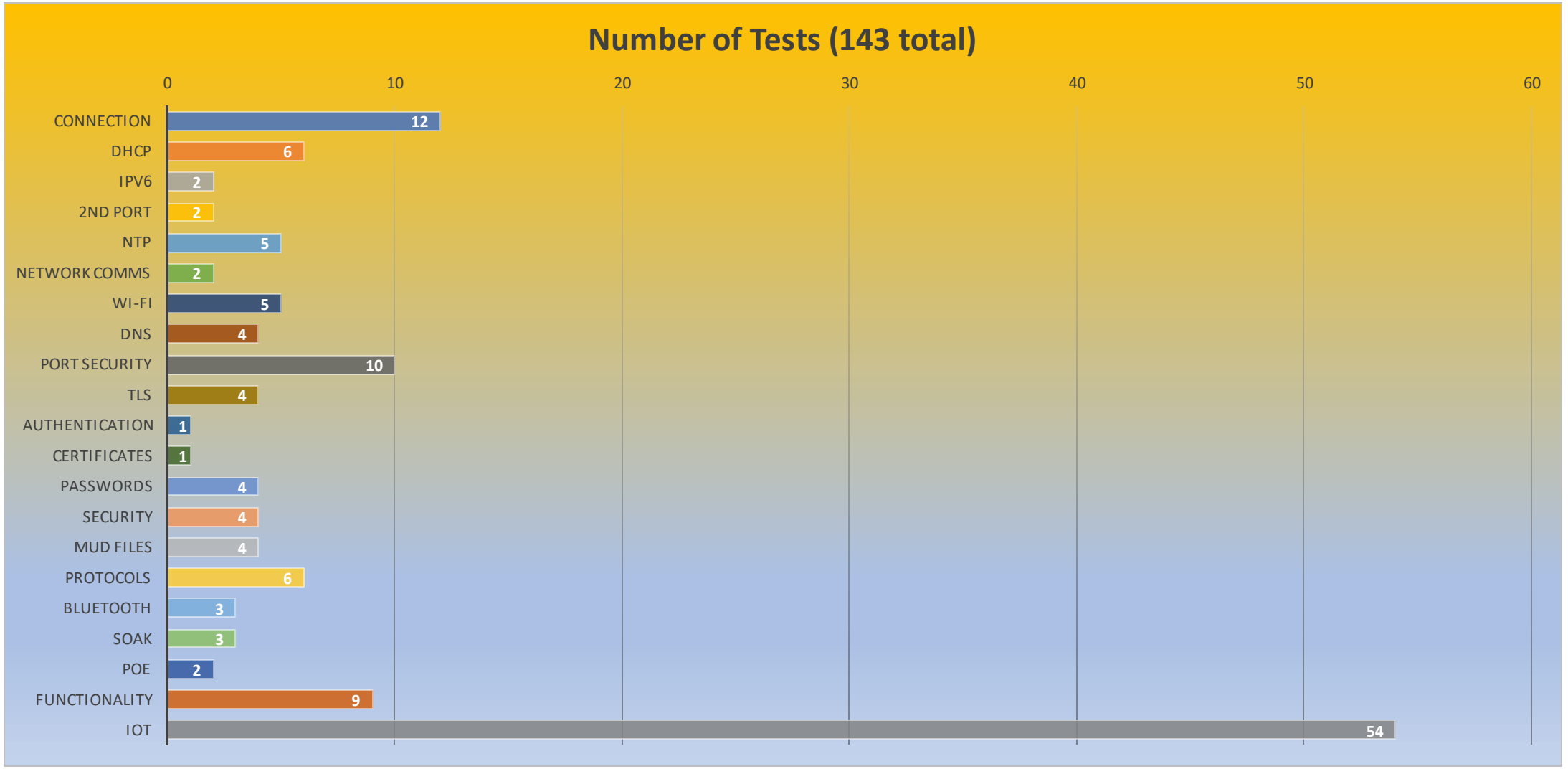
Device Compliance Testing



Source: Clare Meredith, Google

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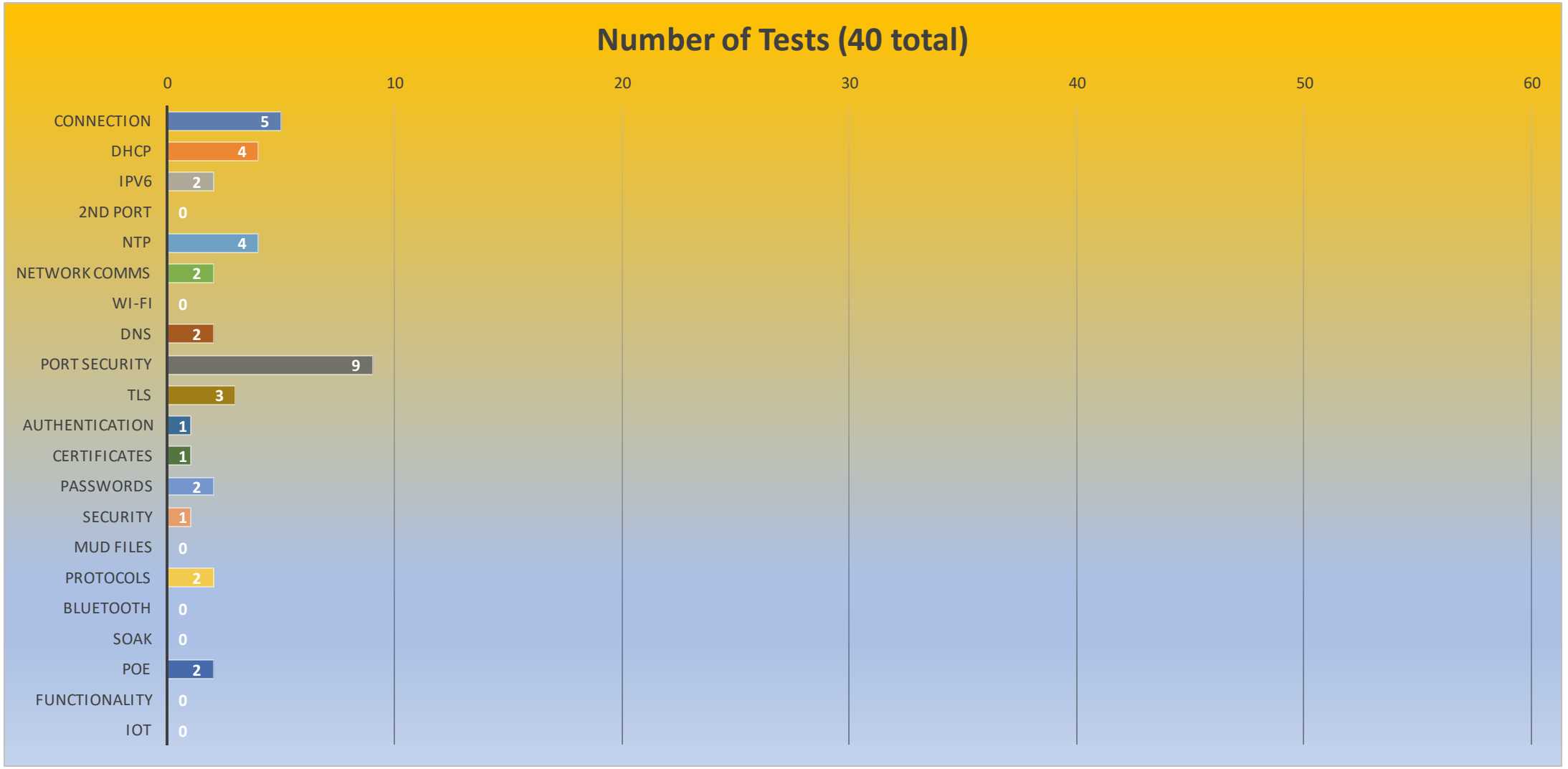
DAQ Testing



Source: Clare Meredith, Google

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Device Compliance Test Labs

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DAQ Resources

- Overview & Tool Set
  https://github.com/faucetsdn/udmi

- Documentation
  https://faucetsdn.github.io/udmi/docs/
  https://github.com/faucetsdn/udmi/tree/master/docs/learning

- Interactive Viewer
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Digital Buildings Ontology

https://google.github.io/digitalbuildings/

Ontology of permissible nomenclature for use in representing building services components on the IoT

Open-source uniform schema and toolset for representing structured information about buildings and building-installed equipment


Q+A
Questions + Answers

Thank You