WEB OF THINGS

# Getting Started with a W3C WoT Project

Eclipse Virtual IoT Meetup, 16 Jun 2016

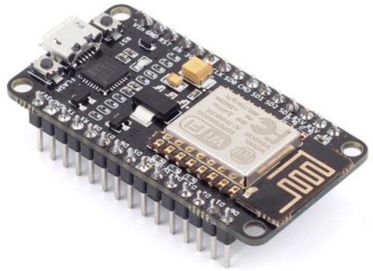
# What is the Web of Things?

Application Layer

Internet of Things: **Connectivity**

IEEE 802.15.4

Ethernet


Wi-Fi

Bluetooth

LoRa

…

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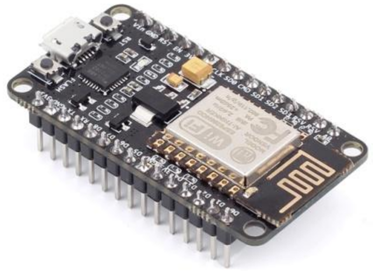
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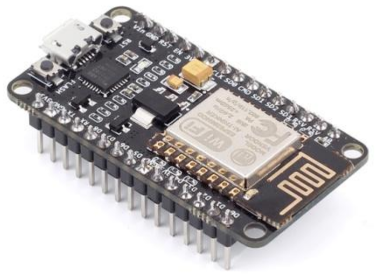
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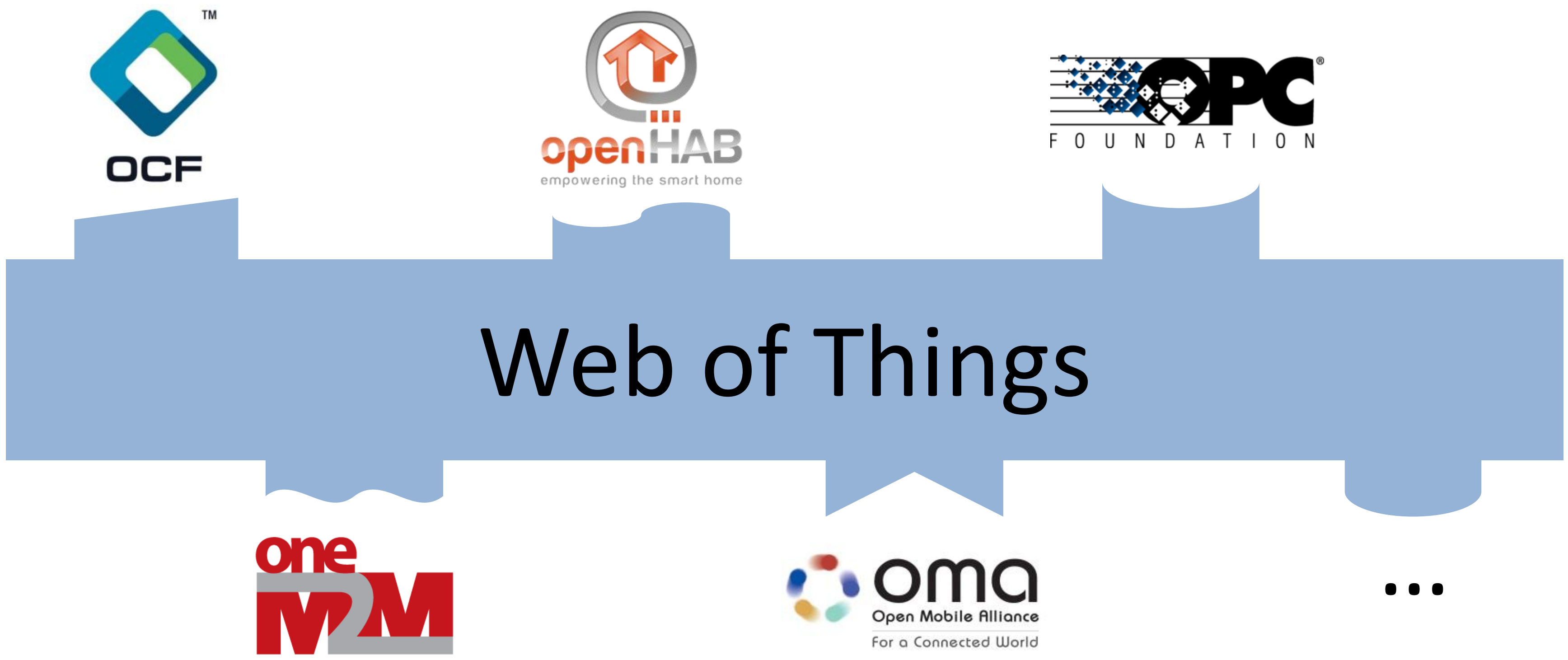
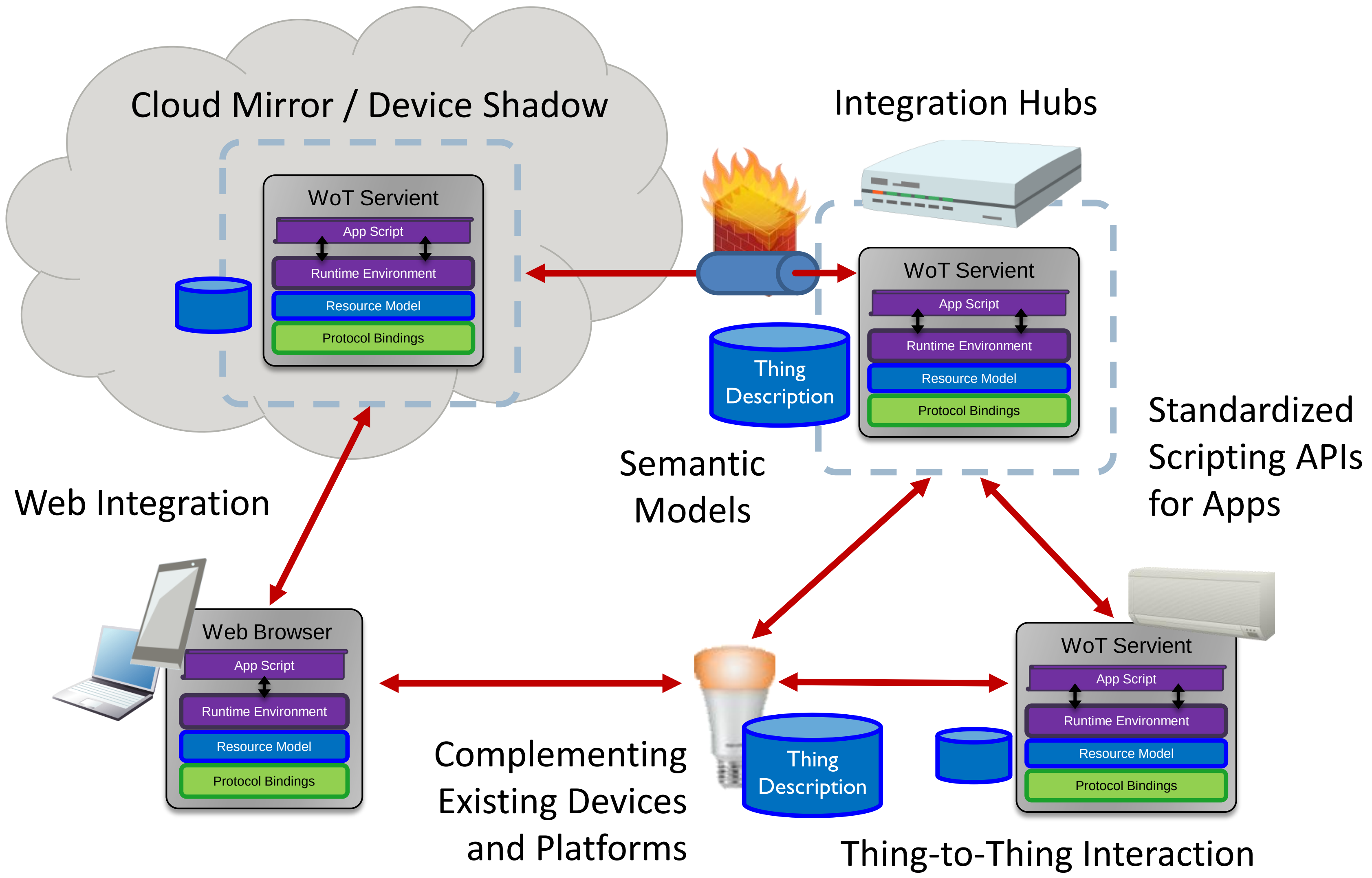
# W3C WoT Mission

Not to be yet another standard



“interconnecting existing Internet of Things platforms and complementing available standards”

# Overview of WoT Concepts



## Outline

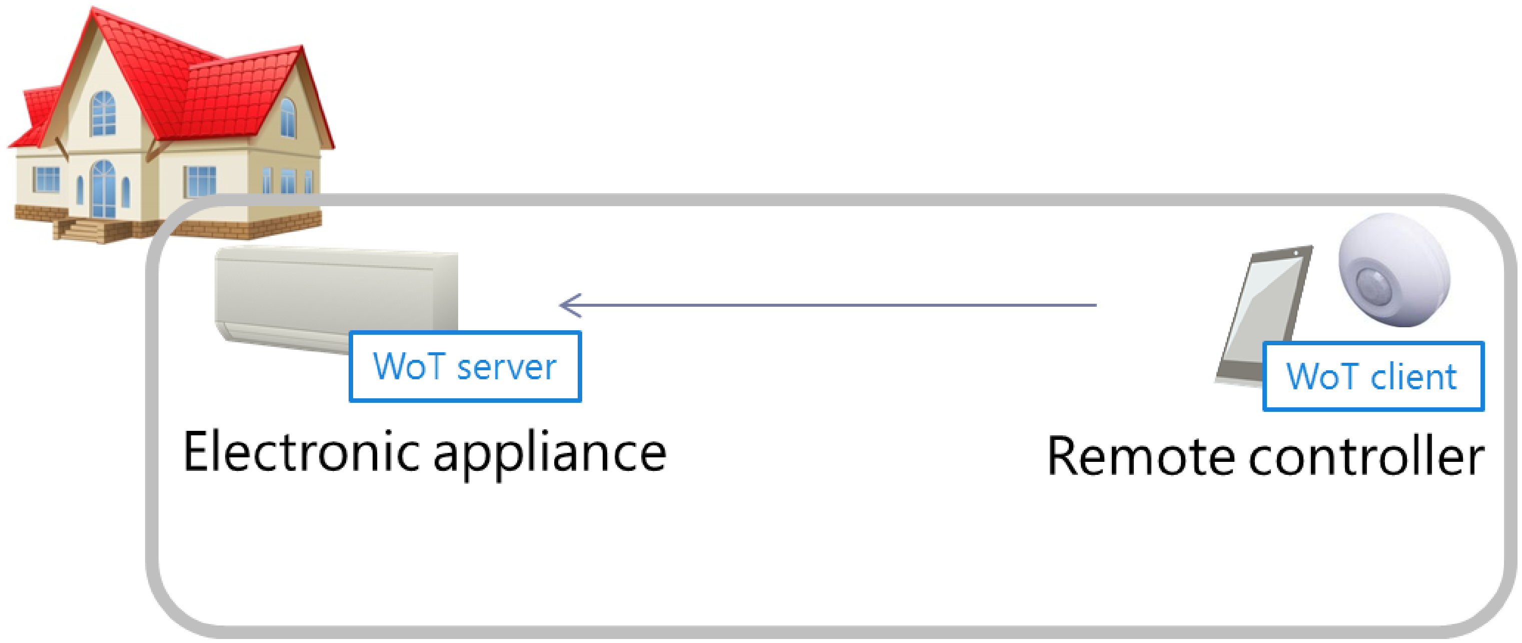
- Architecture
  - Things, Deployment Scenarios, and Servients
- WoT Interface
  - Protocol Bindings and the Web
- Thing Description (TD)
  - Metadata and Interactions
- Scripting API
  - Runtime Environment and Portable Apps

Things, Deployment Scenarios, and Servients

http://w3c.github.io/wot/architecture/wot-architecture.html

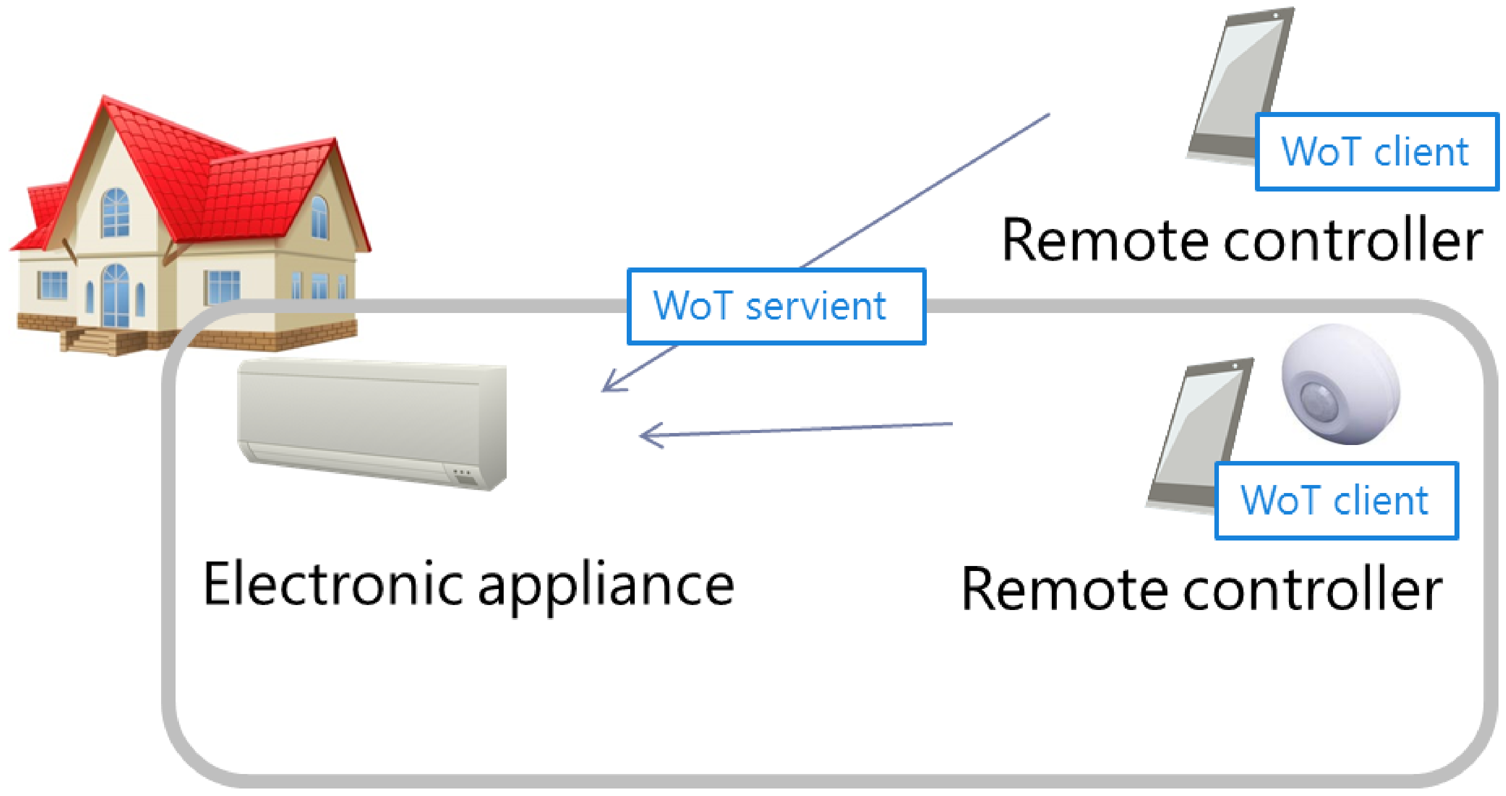
## WoT ARCHITECTURE

# Local **Thing-to-Thing**



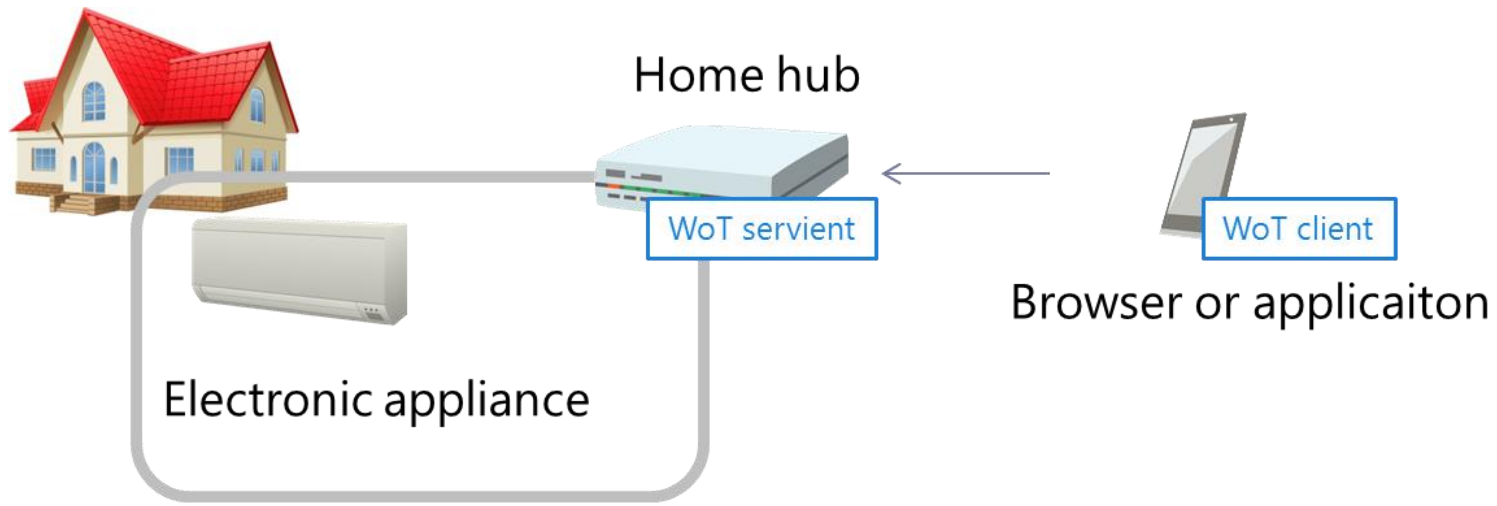
- Local discovery
- WoT server exposes “Interactions” through WoT Interface
- WoT client (UI or other Thing) interacts with WoT Interface

## Remote Access



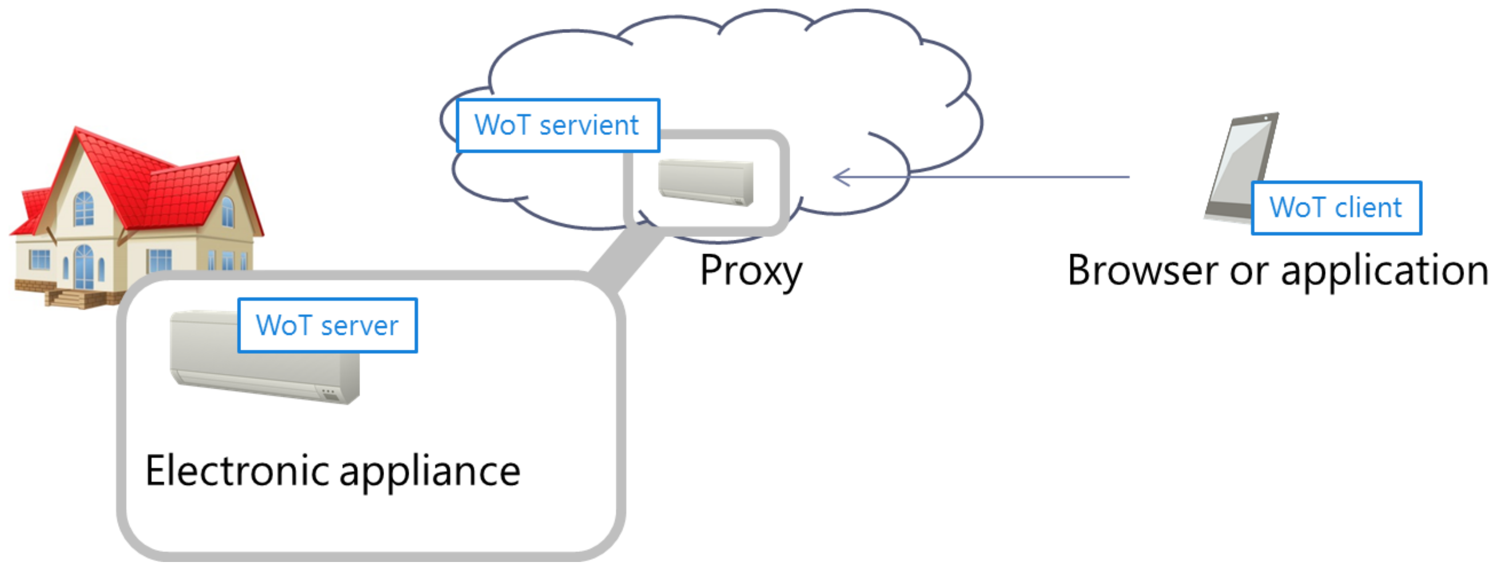
- Local and remote discovery
- Remote client gains access to local network (IPv6, NAT traversal, ...)

# Remote Access: Integration Hubs



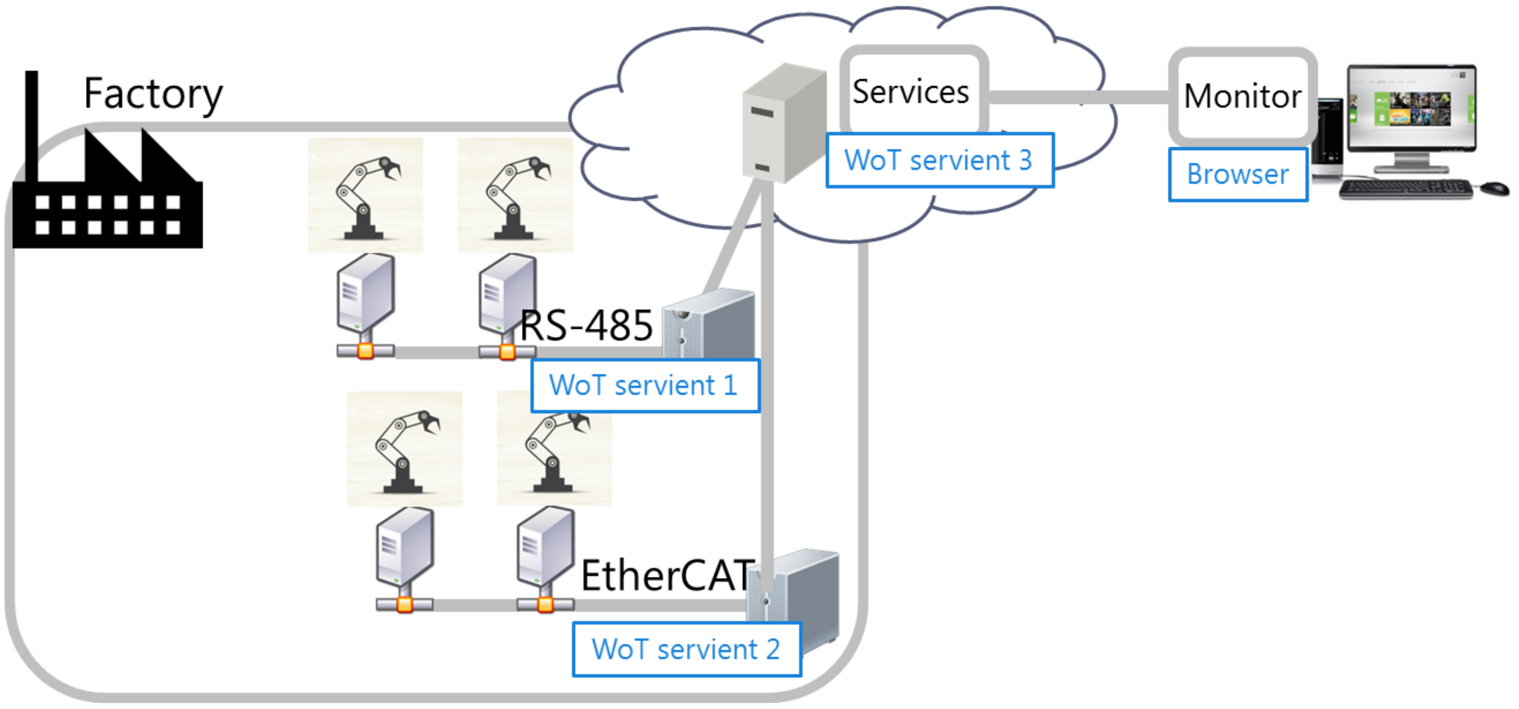
- Hub does local discovery and exposes Things
- Hub can provide virtual Things (e.g., rooms or sensor fusion)
- Hub can integrate and augment legacy devices (gateway)

# Remote Access: Cloud Mirror



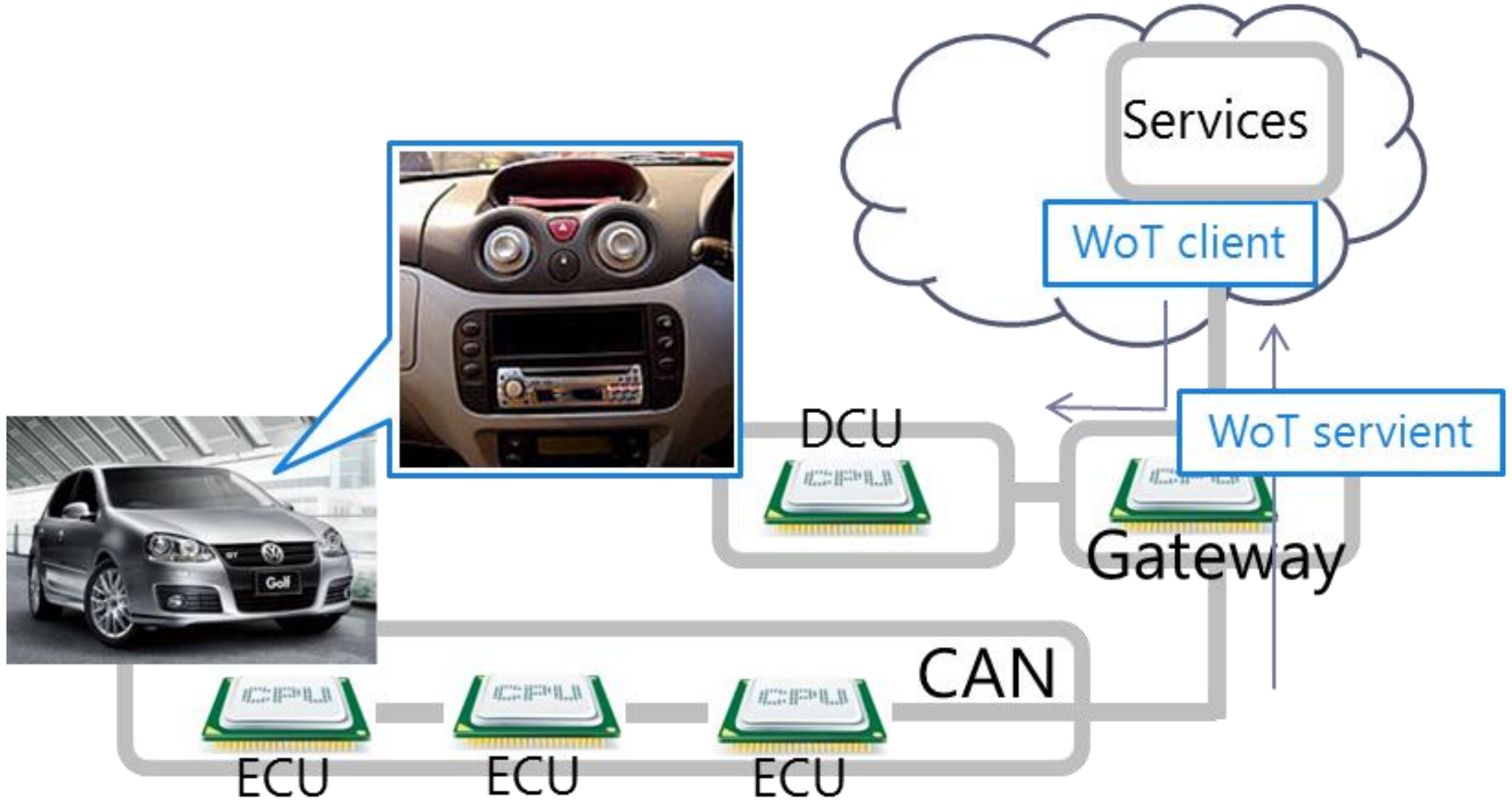
- WoT server is proxied in the cloud, which exposes Things
- Cloud can provide virtual Things (e.g., buildings or sensor fusion)
- Integrates with mobile app world and cloud-based IoT

# Smart Factory / Industrial



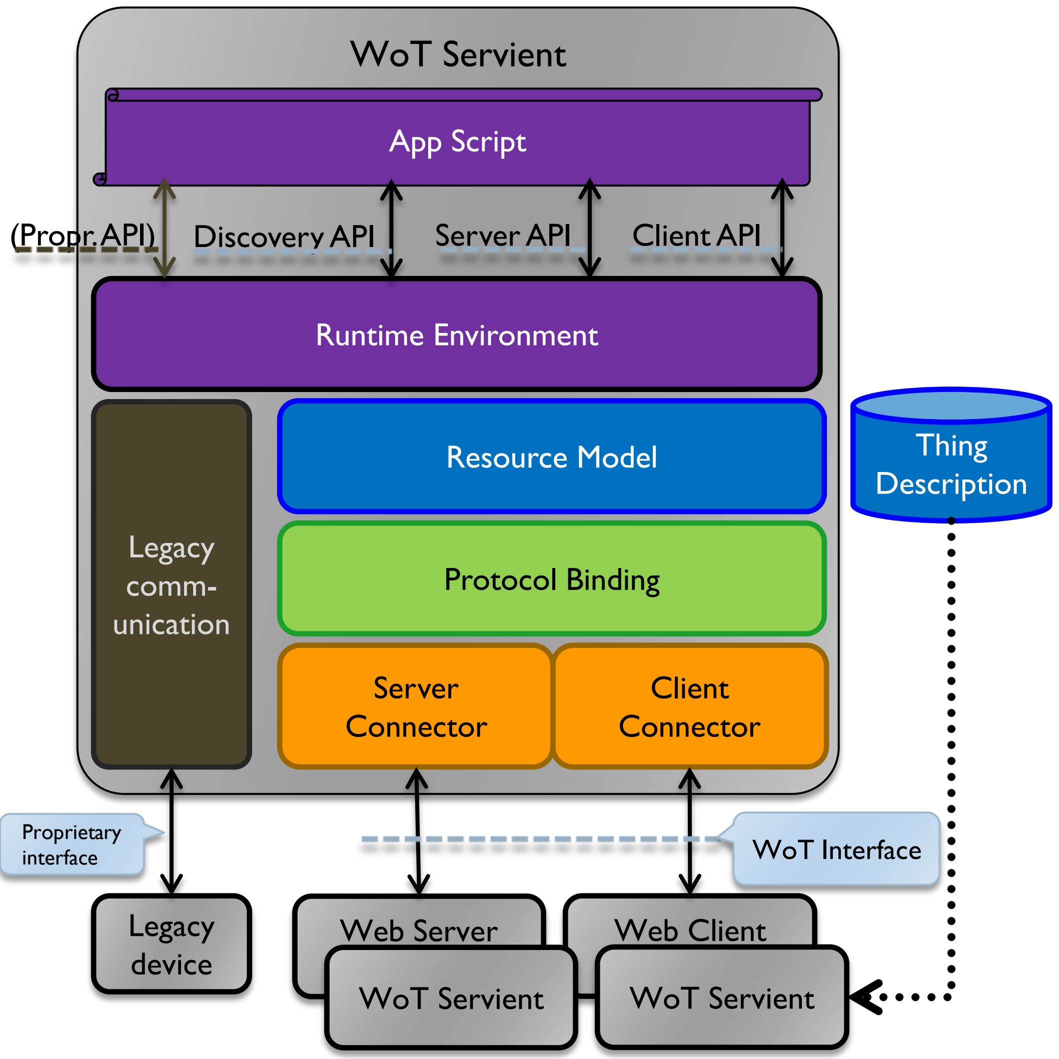
- WoT also targets requirements from industrial applications

# Automotive



- WoT activity is in contact with W3C Automotive work

# Thing Implementation: **WoT Servient**



## Application Logic:

It can access local hardware, locally connected legacy devices, and remote things through the WoT Interface. For this, the runtime environment must provide the Scripting API (Physical, Client, Server).

## Thing Description (TD):

Declares WoT Interface for interaction and provides (semantic) metadata for the Thing. TD is used by WoT clients to instantiate local software object of the Thing.

## Resource Model:

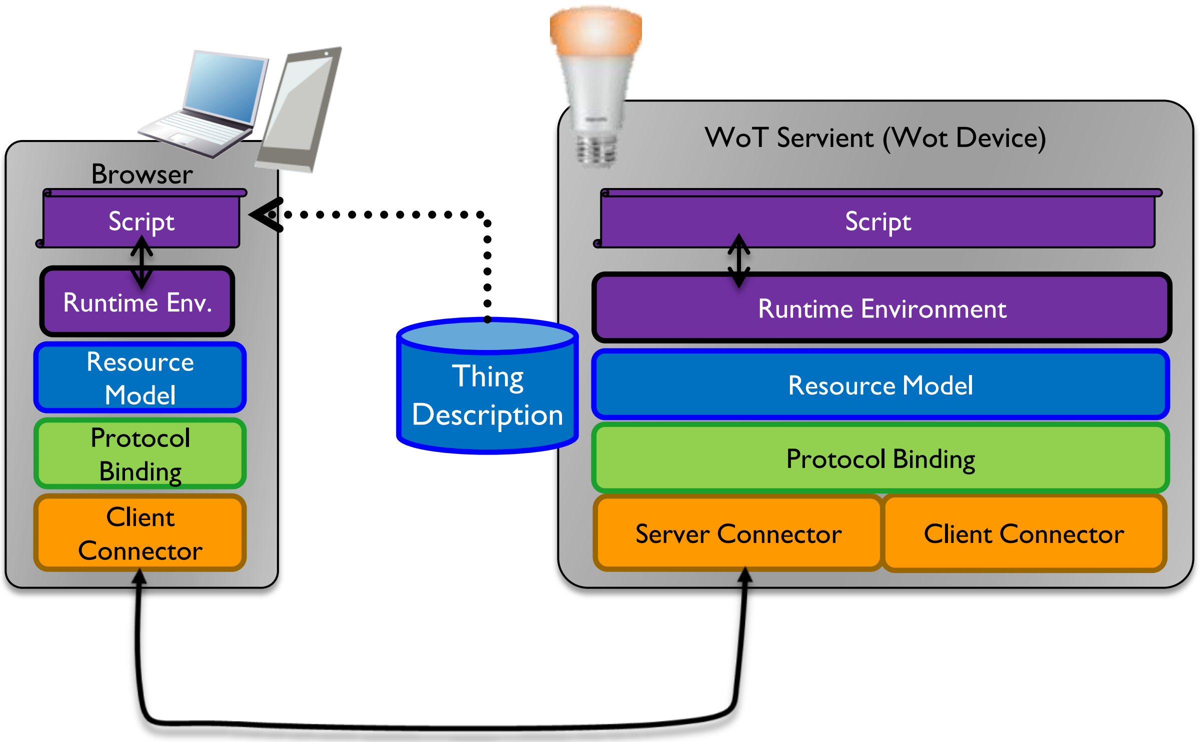
Provides a common abstraction across the different protocols. Just like the Web, it allows to identify and address interaction points with URIs.

## Protocol Binding:

Converts interactions with Things using information in TD in accordance with lower-layer protocols to have client and server connectors.

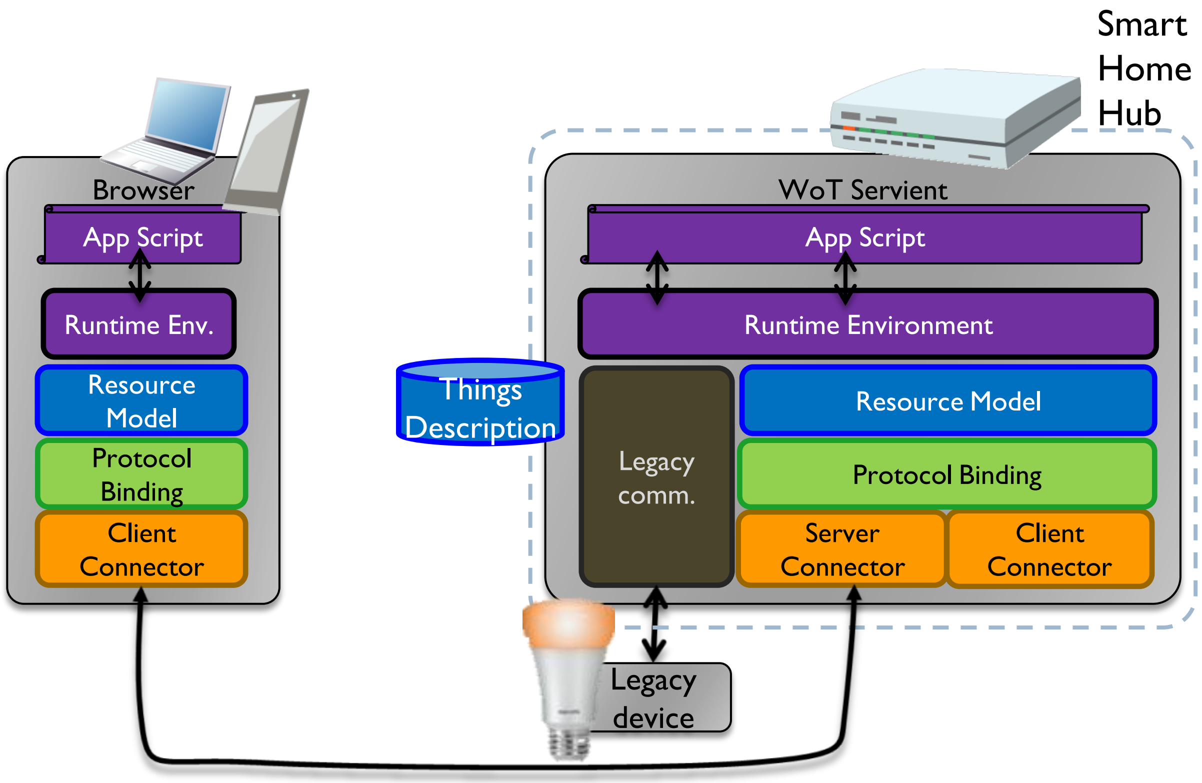
# WoT Servient on Thing Itself

- Native WoT Things host a servient directly
- TD is provided by Thing directly



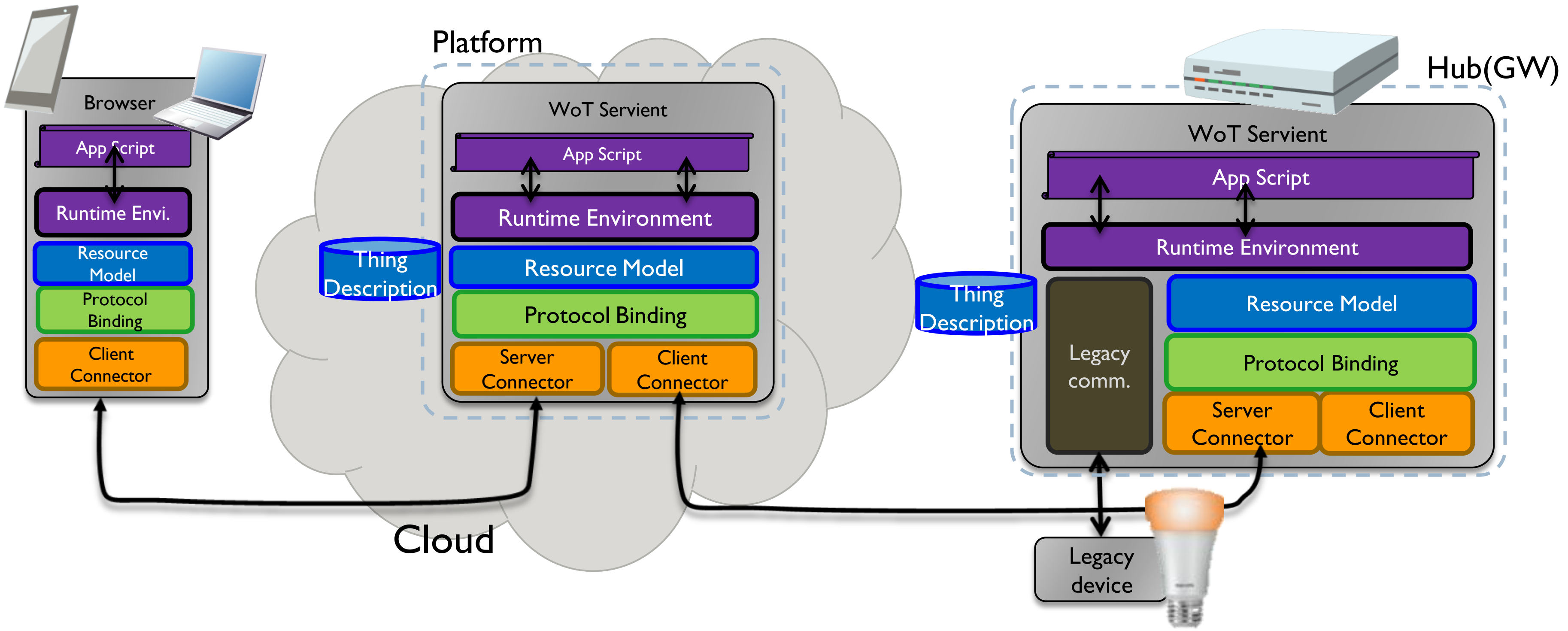
# WoT Servient on Integration Hub

- WoT servients can run on hubs (e.g., smartphone, gateway)
- Can act as agent for legacy devices
- Multiple servients can be instantiated through sandboxed apps



# WoT Servient in the Cloud

- A cloud mirror / device shadow can forward interactions
- Cloud mirror is synchronized with local servient



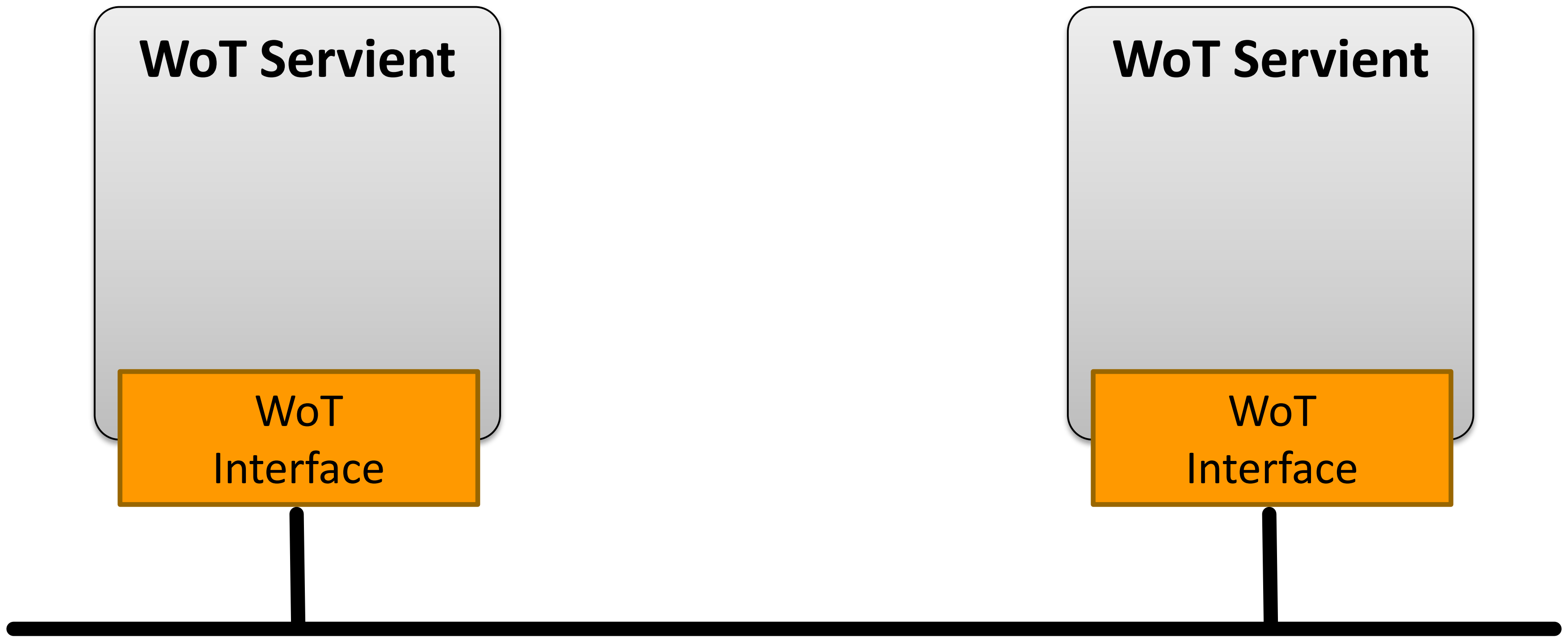
Protocol Bindings and the Web

http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#sec-wot-interface

## WoT INTERFACE

# WoT Interface

- Interface exposed by servient to the network



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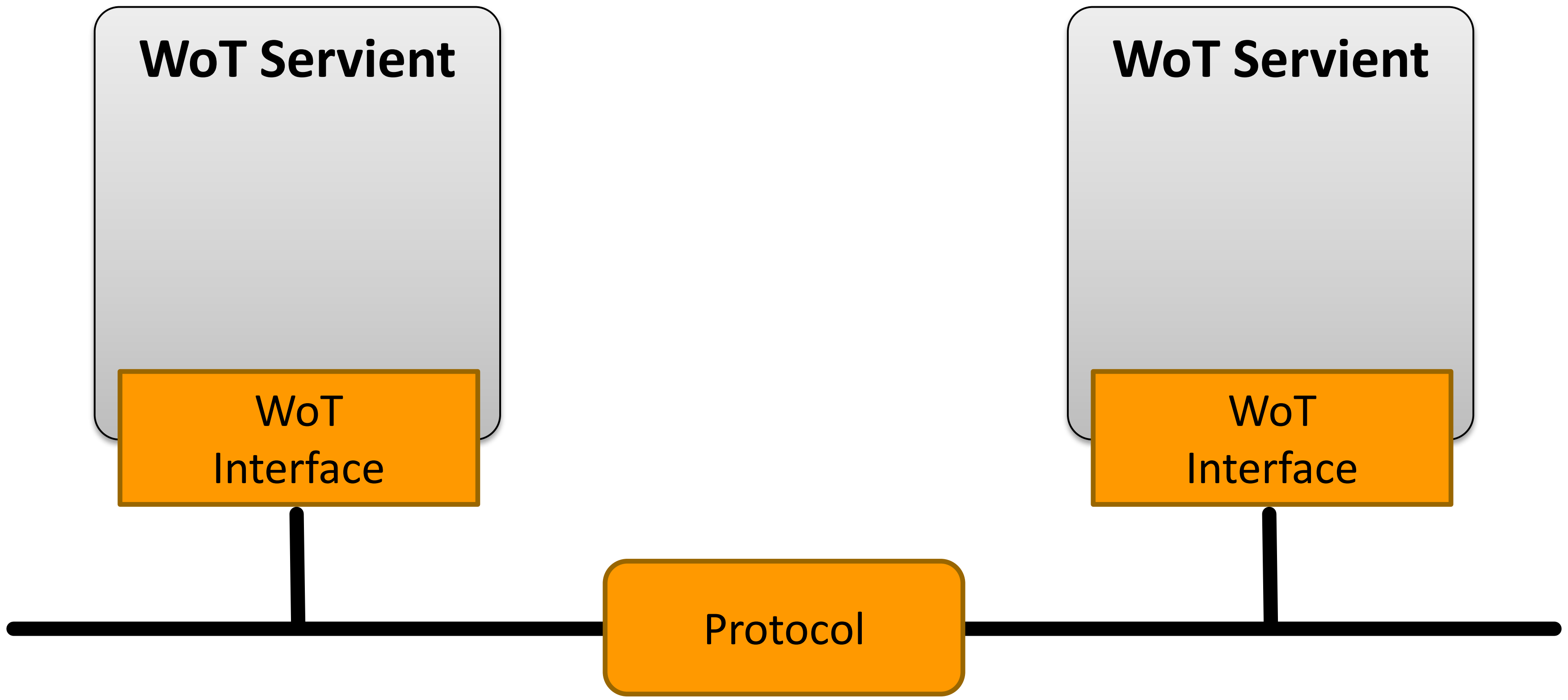
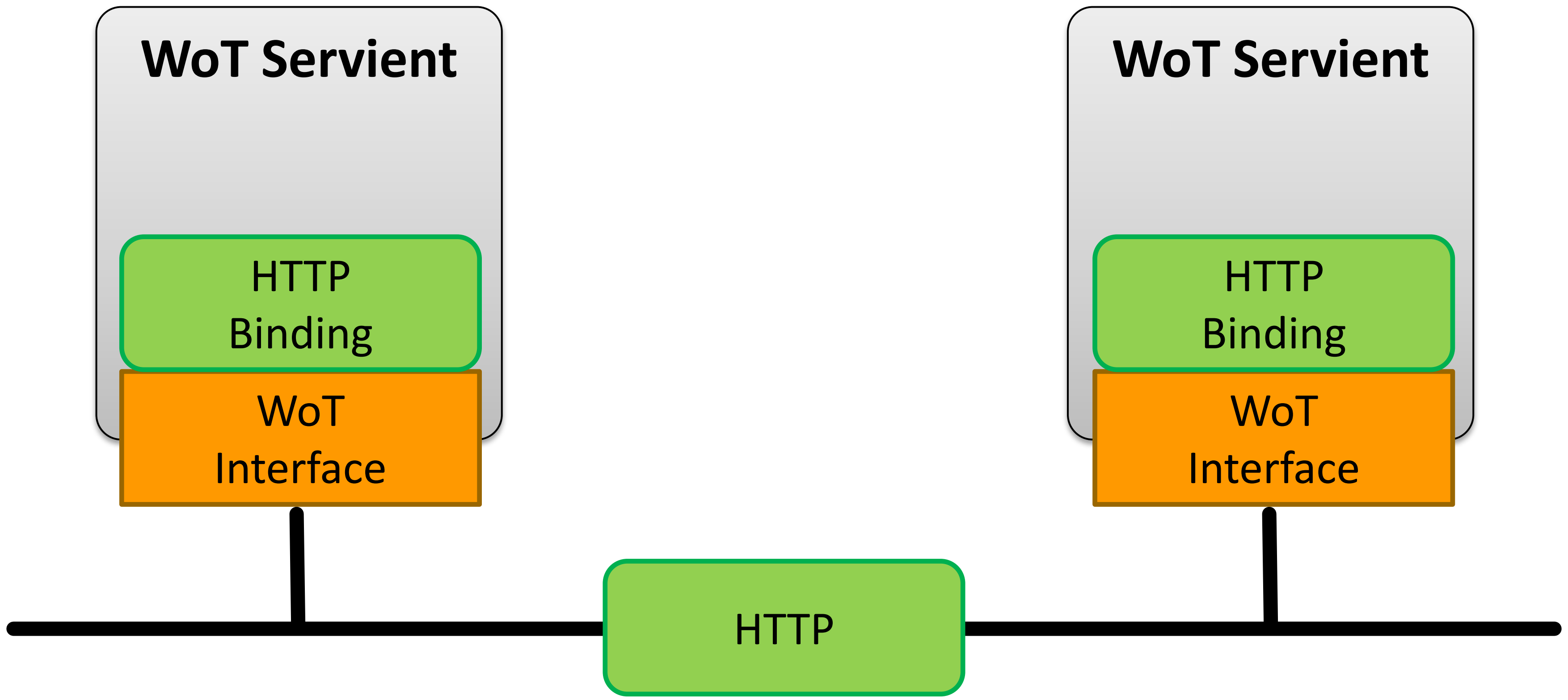


## Protocol Bindings

- Interface can be bound to various protocols



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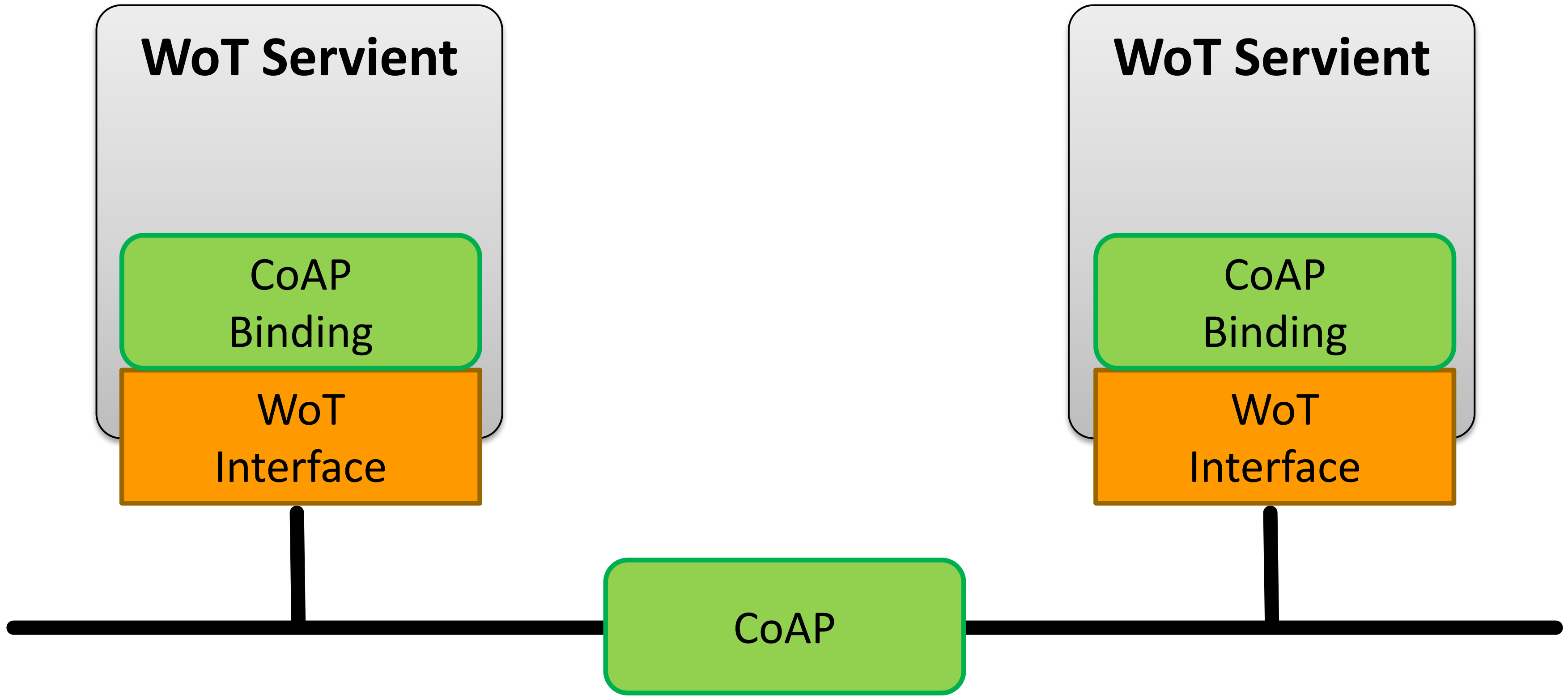
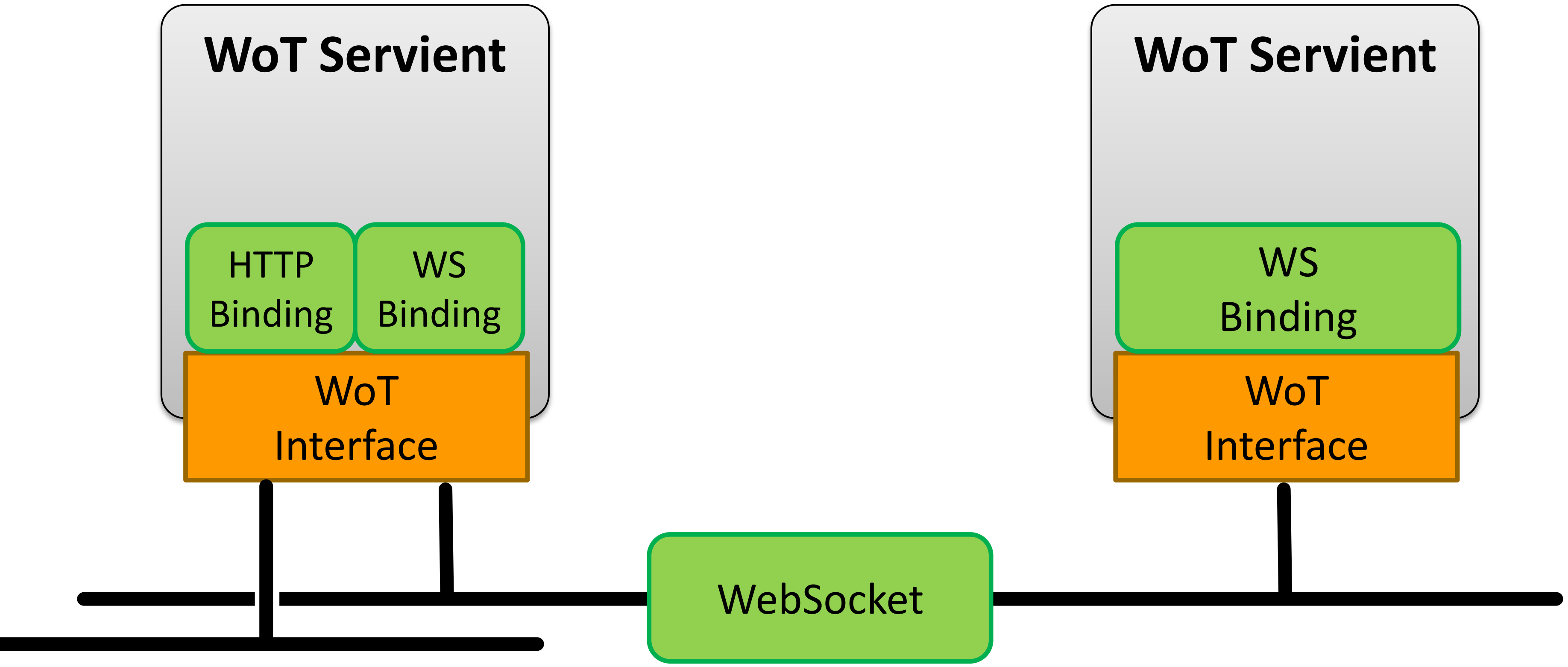


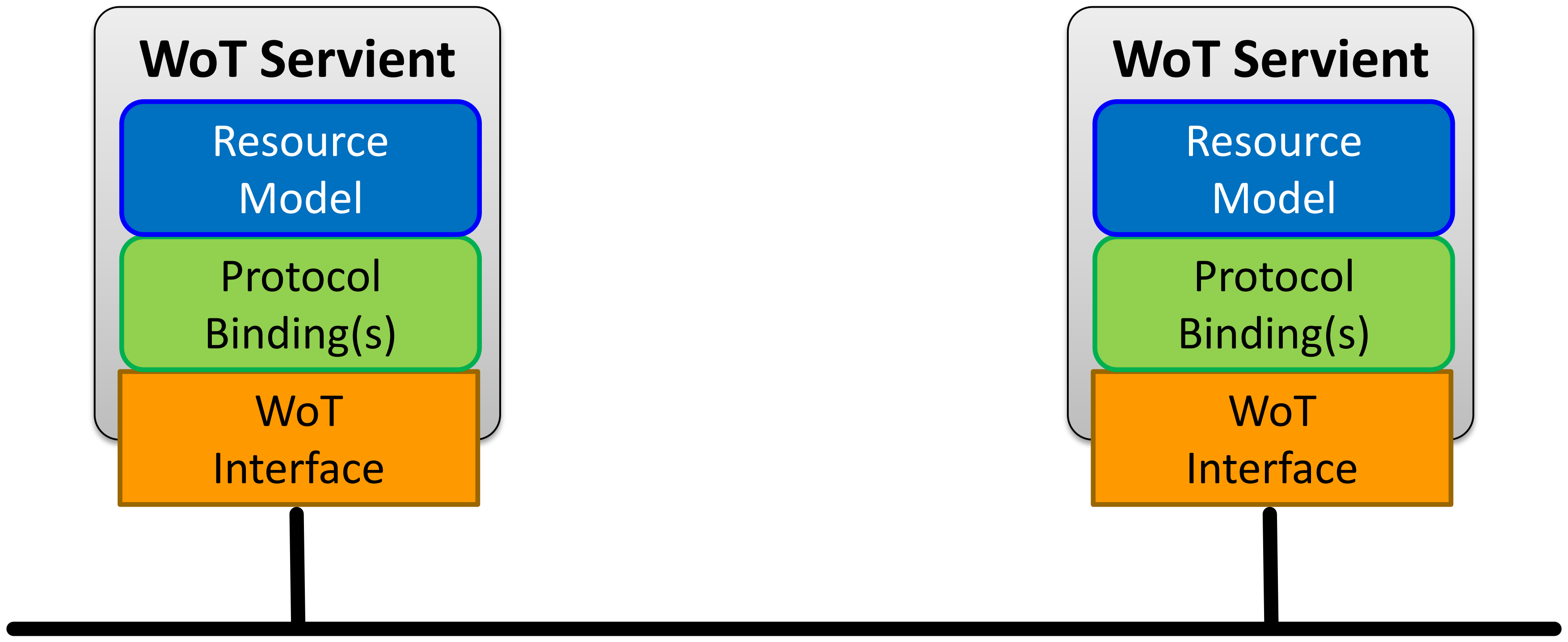
# Protocol Bindings

- Multiple bindings possible



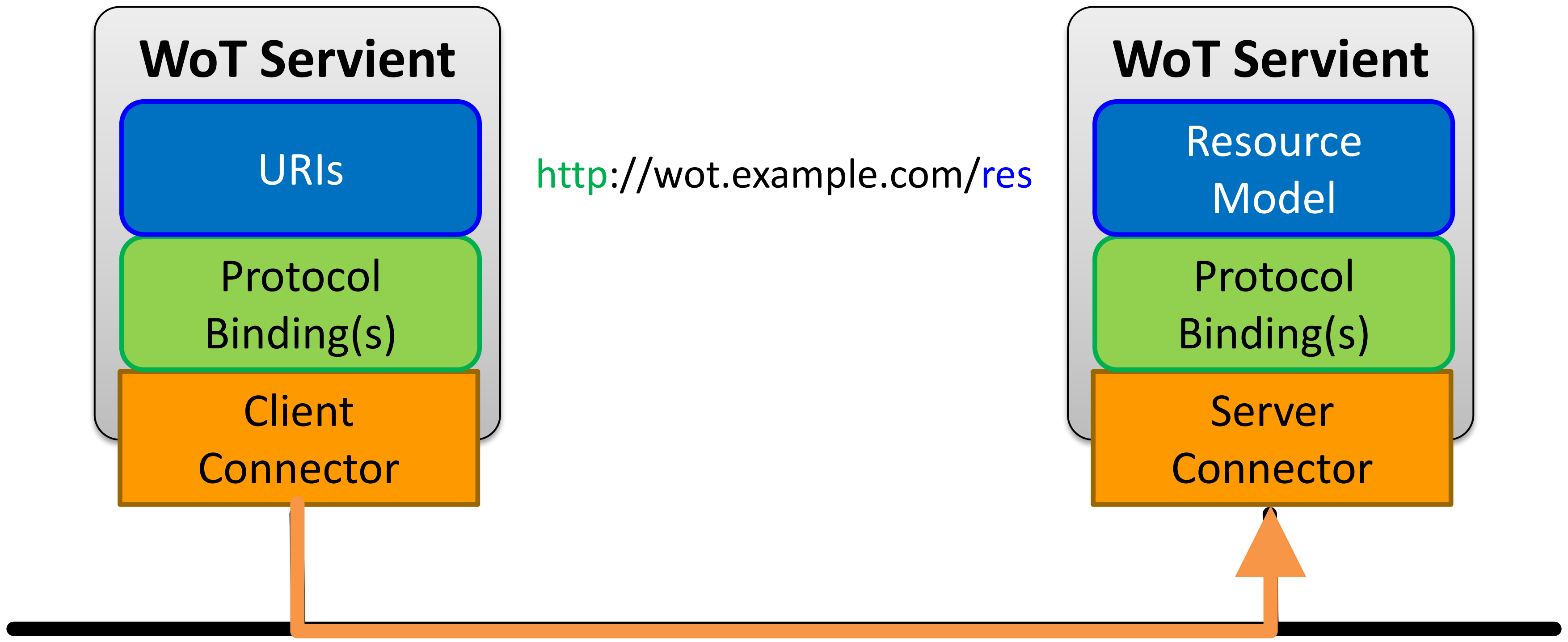
# Resource Model

- Interaction points are Web resources



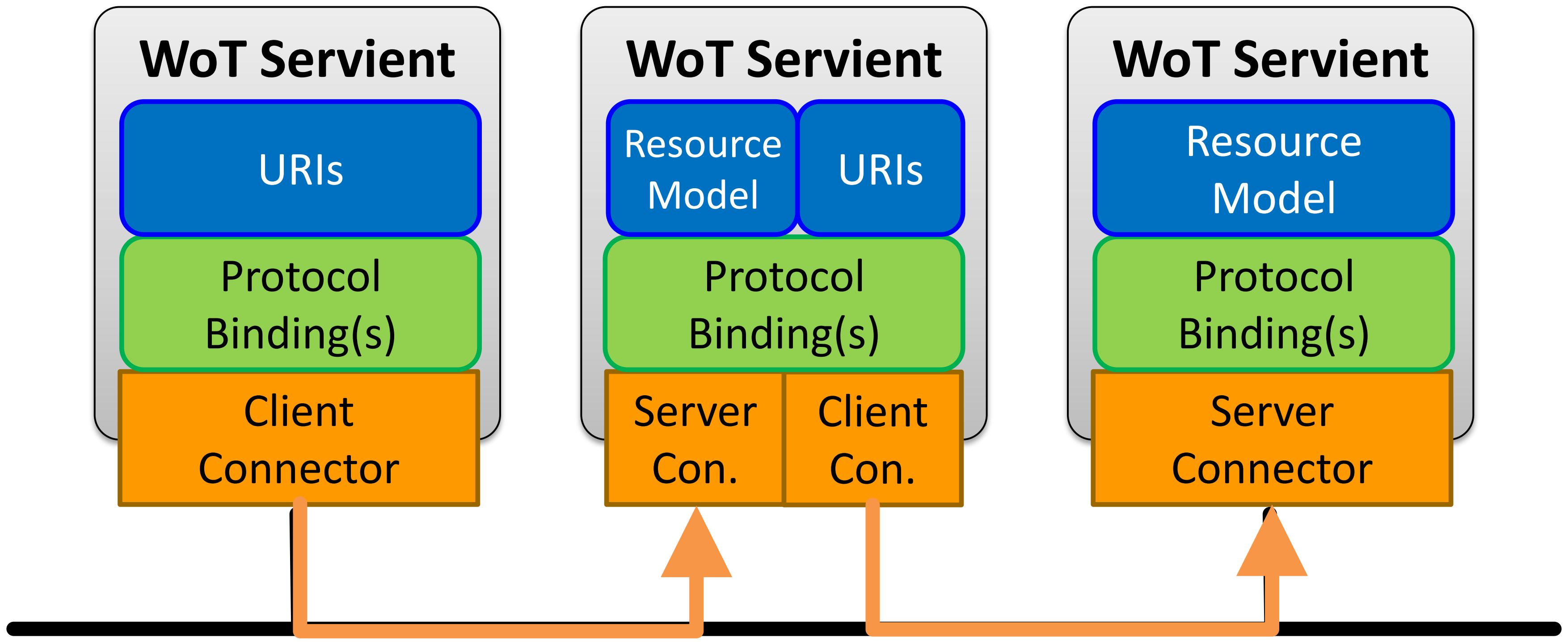
## Servient Role

- Servient can act as client or server



# Servient Role

- … or both at the same time



Metadata and Interactions

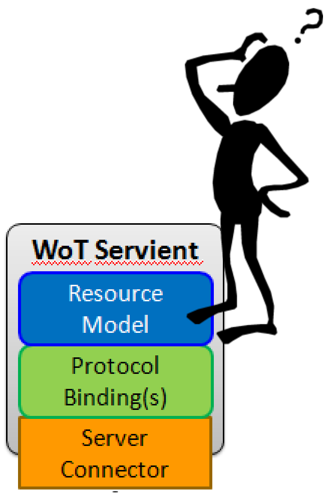
http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#thing-description

## THING DESCRIPTION

# I Want to Use a WoT Servient

Who are you?

What kind of data do you serve?



How can I access the data/function?

What kind of functions do you have?

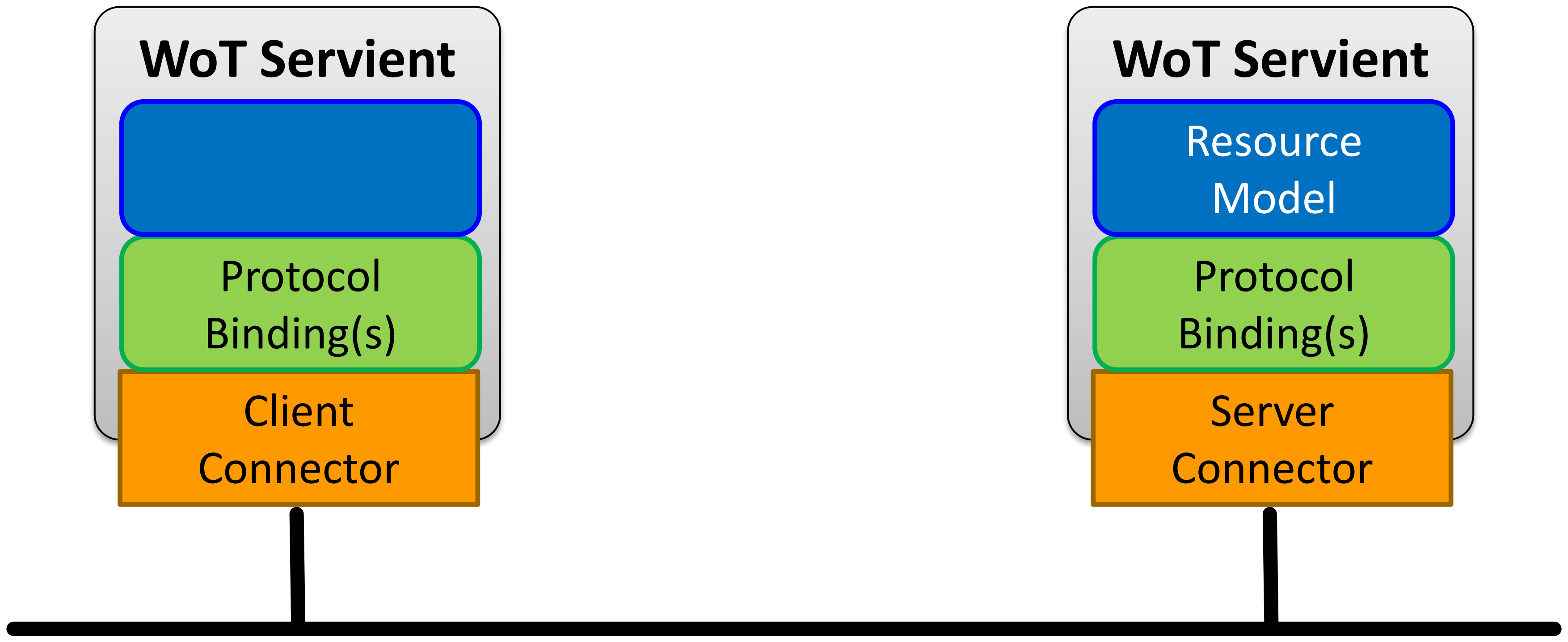
What kind of protocols/encodings do you support?

Are there some security constrains?

→ W3C Thing Description (TD)

# Thing Description

- Describes Thing metadata and interactions



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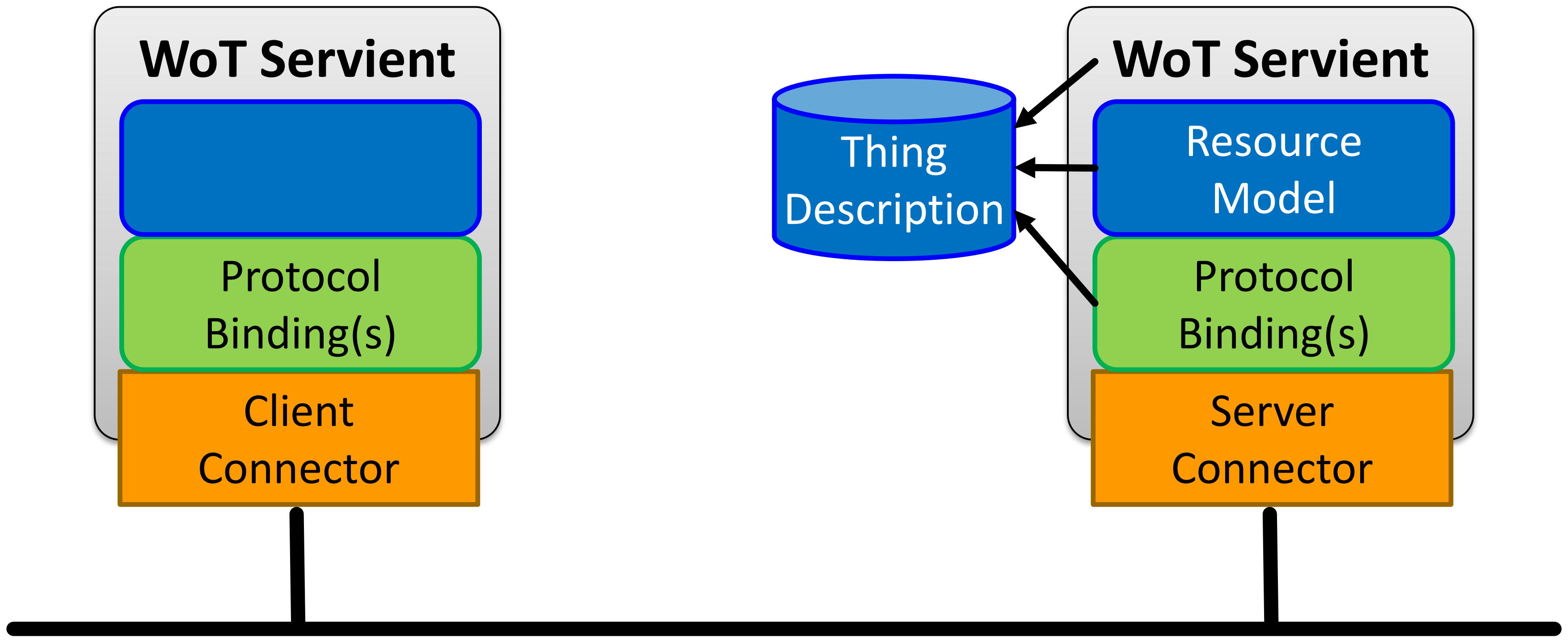
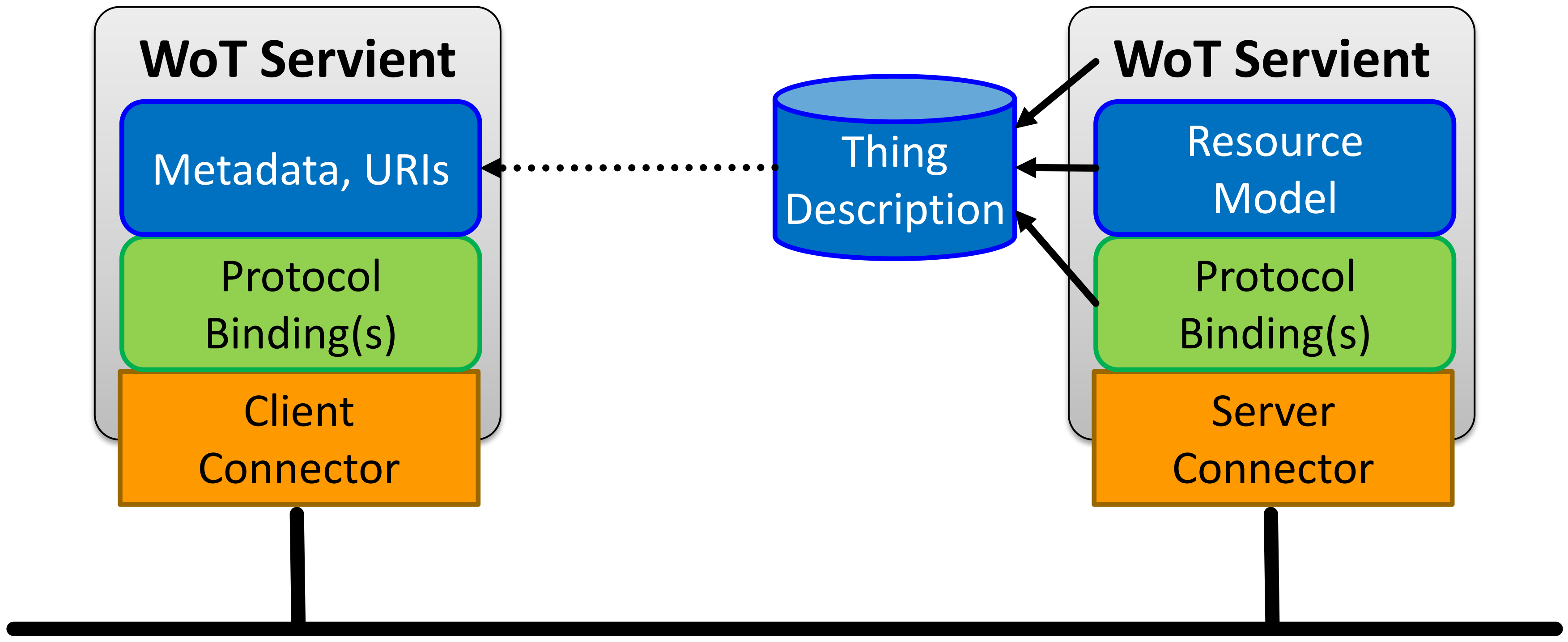


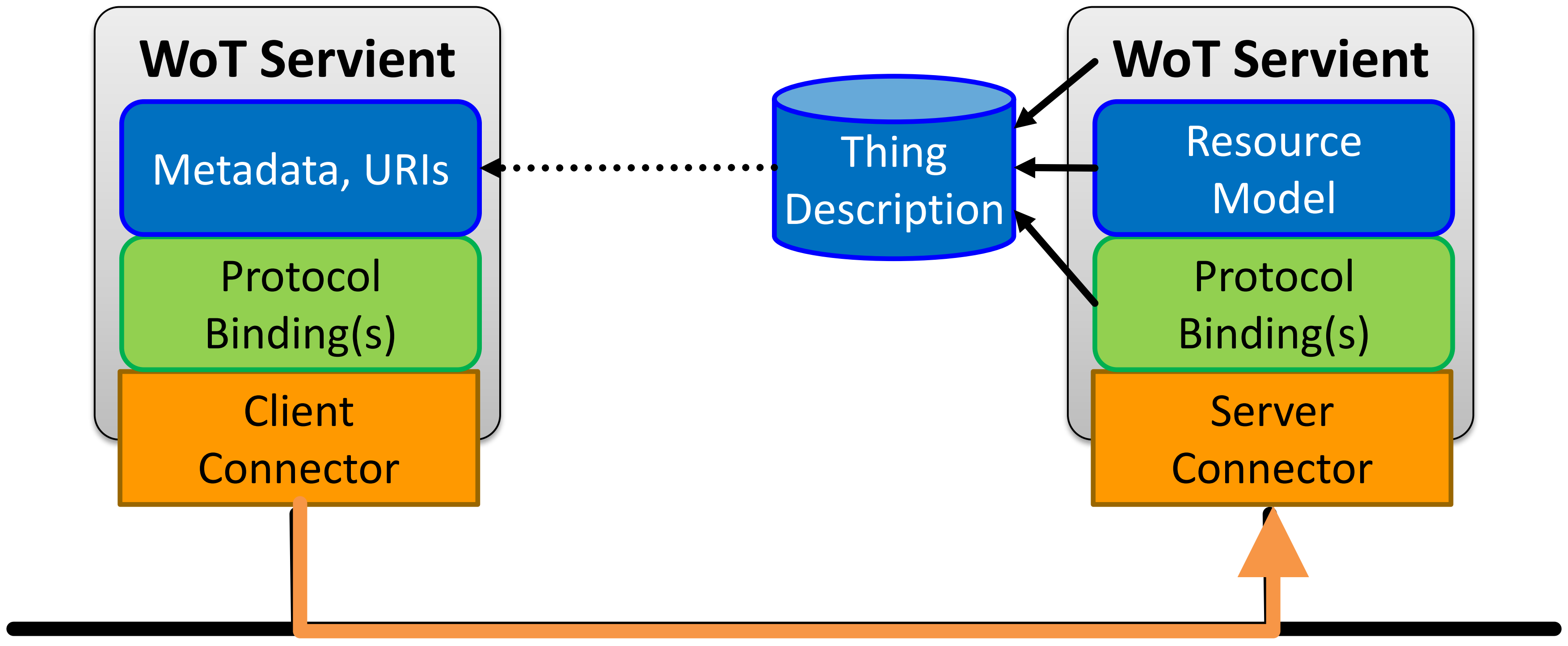
# Thing Description

- Machine clients can understand WoT Interface



# Thing Description

- Thing-to-thing communication



## Describe your Thing based on JSON-LD

- Reach interoperability by a semantic description language
  - based on well established JSON format
  - enables machine interoperability by using (standardized) vocabularies from given *@context*

- JSON-LD is rooted in the RDF model
  - subject, predicate, object triples

# TD Example

```
{
  "@context": [
    "http://w3c.github.io/wot/w3c-wot-td-context.jsonld",
    { "actuator": "http://example.org/actuator#" }
  ],

  "@type": "Thing",
  "name": "MyLEDThing",

  "uris": [
    "coap://myled.example.com:5683/",
    "http://mything.example.com:8080/myled/"
  ],

  "encodings": ["JSON", "EXI"],
  "security": {
    "cat": "token:jwt",
    "alg": "HS256",
    "as": "https://authority-issuing.example.org"
  },

  "properties": [
  "properties": [
    {
      "@type": "actuator:onOffStatus",
      "name": "status",
      "valueType": { "type": "boolean" },
      "writable": true,
      "hrefs": [ "pwr", "status" ]
    }
  ],
  "actions": [
    {
      "@type": "actuator:fadeIn",
      "name": "fadeIn",
      "inputData": {
        "valueType": { "type": "integer" },
        "actuator:unit": "actuator:ms"
      },
      "hrefs": [ "in", "led/in" ]
    },
    {
      "@type": "actuator:fadeOut",
      "name": "fadeOut",
      "inputData": {
        "valueType": { "type": "integer" },
        "actuator:unit": "actuator:ms"
      },
      "hrefs": [ "out", "led/out" ]
    }
```

# Type System

- Default currently based on JSON Schema http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#type-system
- Best start with simple types
  - boolean
  - integer
  - number
  - String
- Other systems can be plugged in under "valueType"

## How to Create a TD?

- Manually copy, paste, and modify
  - http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#td-examples
  - or look into the TD repository http://vs0.inf.ethz.ch:8080 (might be offline from time to time)
- Generate from development framework
  - Serialization based on the interactions provided

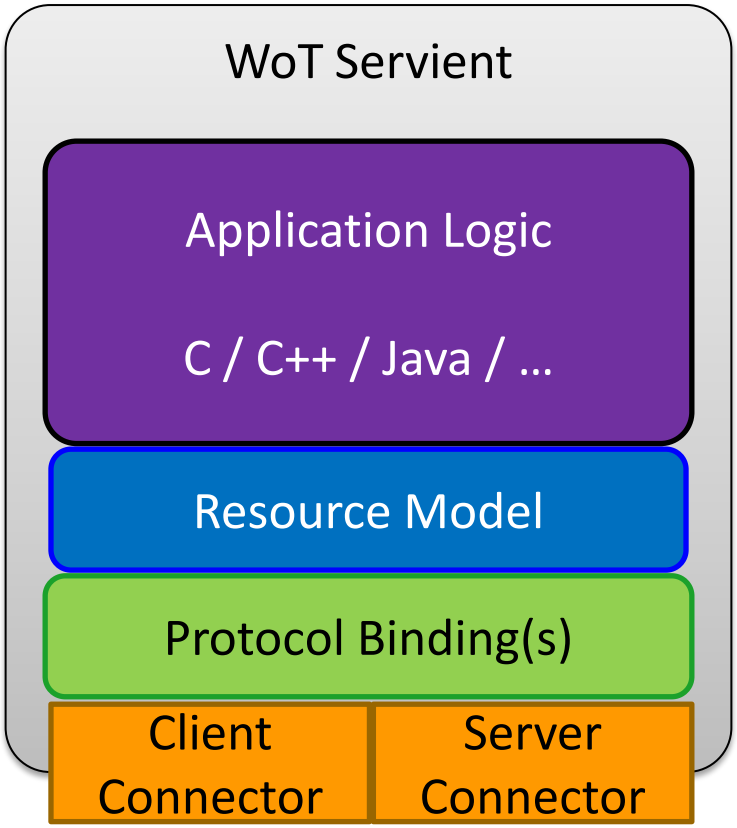
Runtime Environment and Portable Apps

http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#scripting-api

## SCRIPTING API

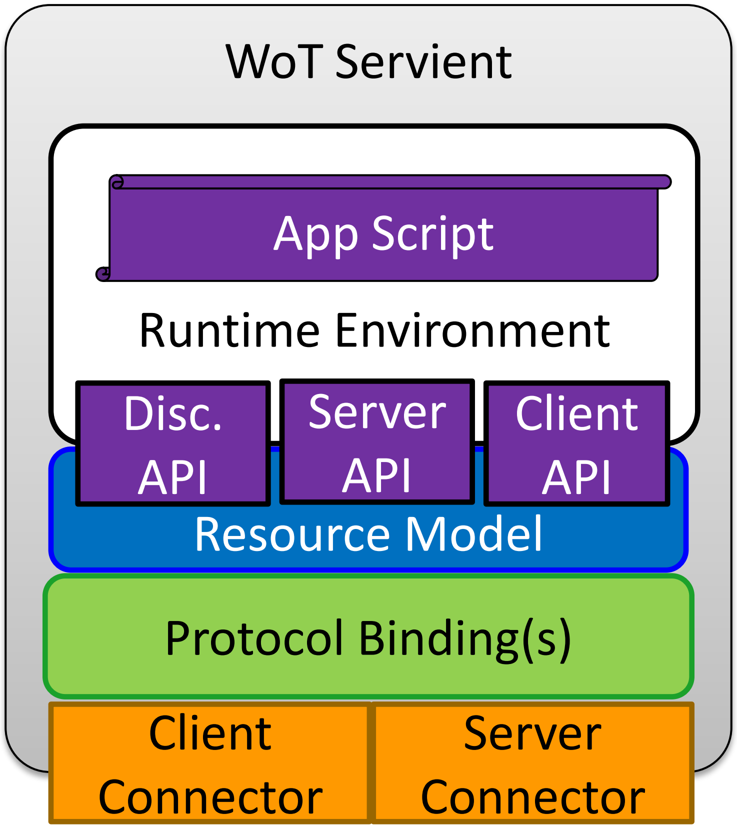
# Without Scripting API

- Application logic often implemented natively



# Scripting API

- Common runtime enables portable apps



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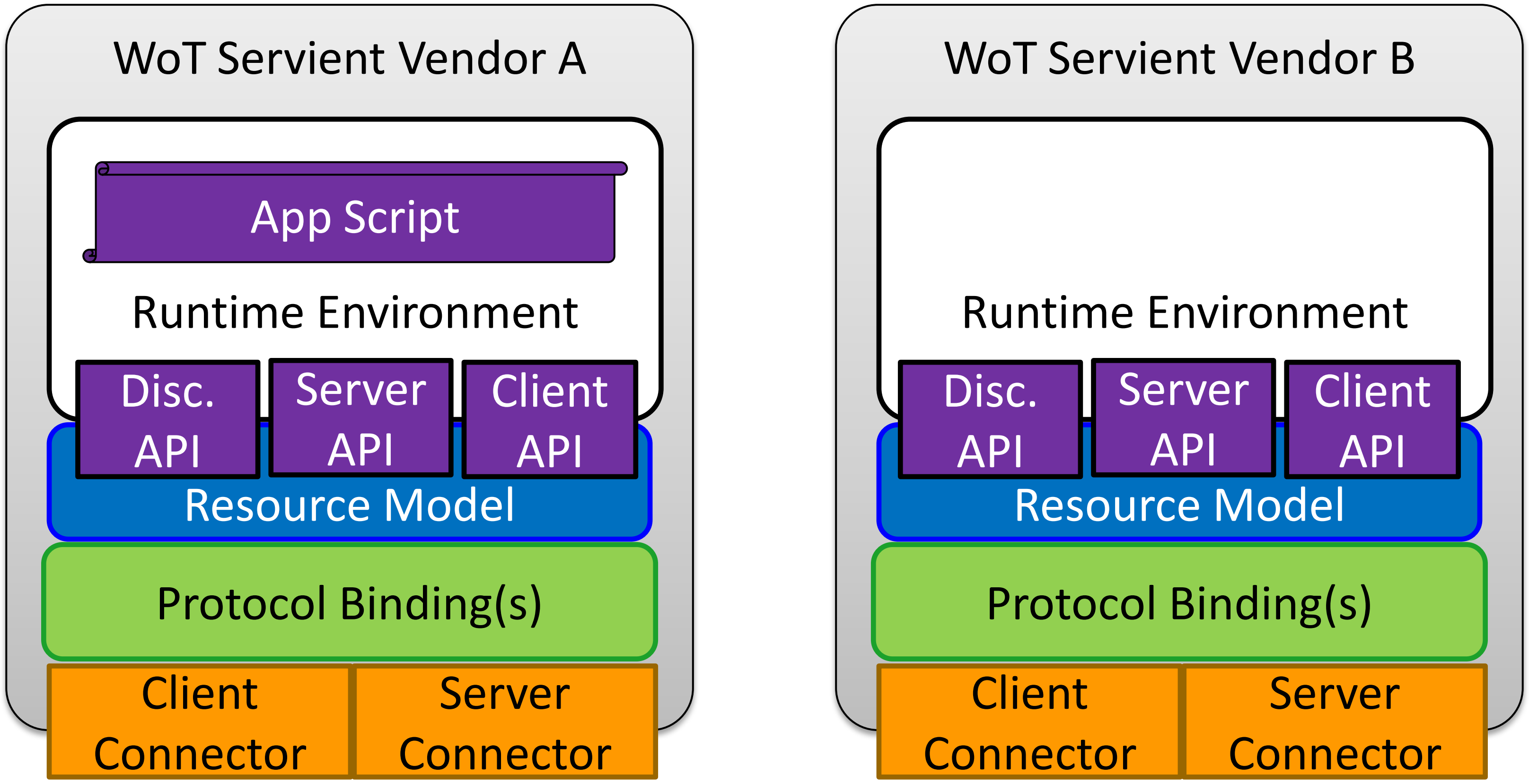

# Scripting API

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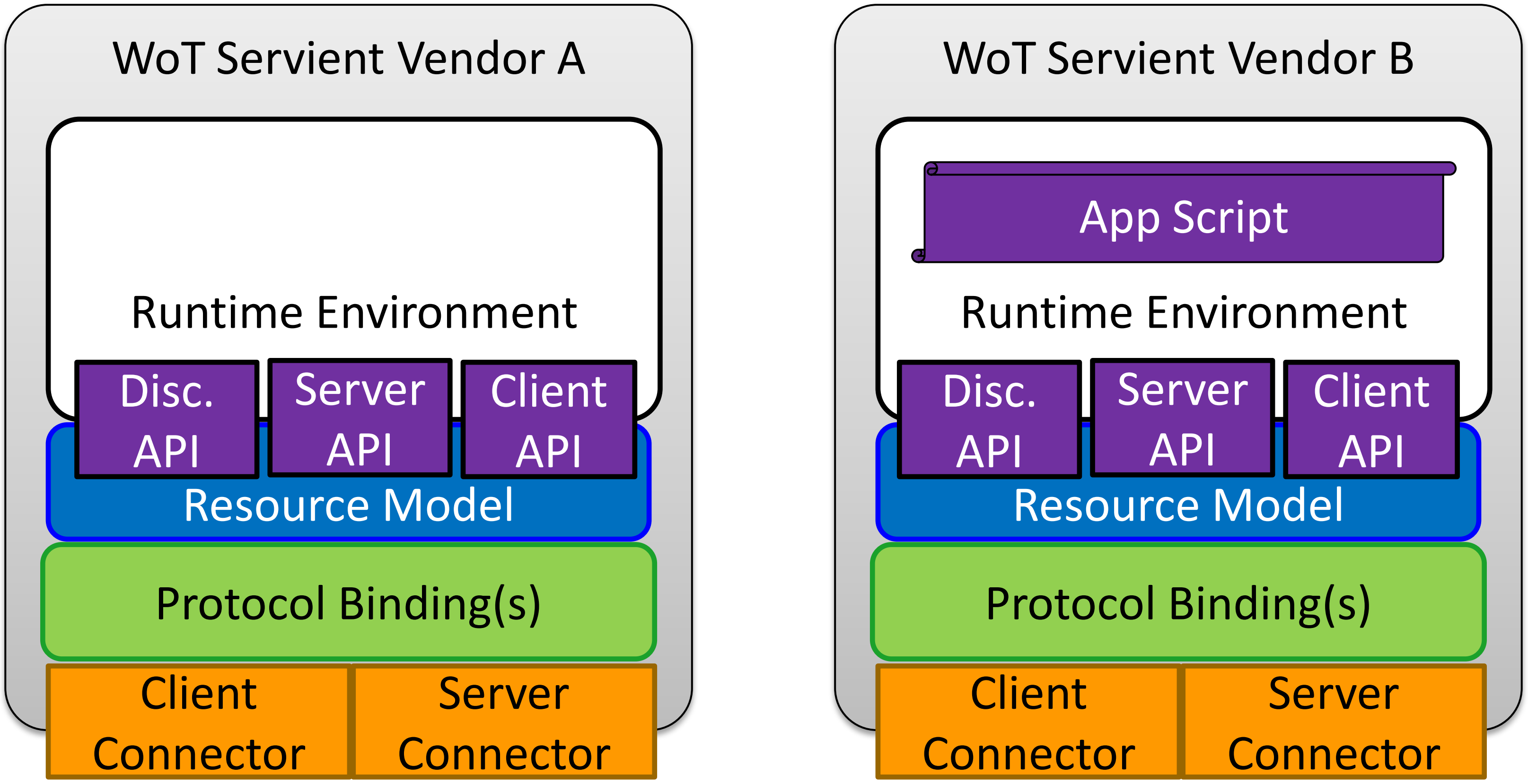

How to get started?

http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html#participation-howto

## PARTICIPATION HOWTO

## Pick Your Servient Role

- Client Role
  - User interface
  - Machine agent
- Server Role
  - Sensor/actuator
  - Device simulators
- Both (“servient”)
  - Configurable client
  - Aggregator using other Things

# Pick Your Platform

| | |
|---|---|
| • Client Role | |
| – User interface | Angular.js and Web browser |
| – Machine agent | Python, Ruby, Java, C++, … |
| • Server Role | |
| – Sensor/actuator | Arduino, ESP8266, mbed, … |
| – Device simulators | Node.js, Java |
| • Both | |
| – Hub | Raspberry Pi, smartphone |
| – Cloud proxy | Java |

## Pick Your Protocol(s)

- HTTP
  - Node.js, Jetty, RESTX.io, lighttpd, …
  - Platform-specific (Arduino, Contiki, NodeMCU, …)
- CoAP
  - Californium, node-coap, libcoap
  - Platform-specific (Contiki, mbed, NodeMCU, …)
  - http://coap.technology/
- Others? Design the binding!
  - e.g., MQTT: https://www.eclipse.org/paho/

# Pick Your Logic Implementation

- Start with native application logic

- Once familiar, follow the Current Practices document for the Scripting API http://w3c.github.io/wot/current-practices/wot-practices.html

# Online Resources

- Interest Group
  - https://www.w3.org/WoT/IG/
  - https://lists.w3.org/Archives/Public/public-wot-ig/ (subscribe to mailing list)
- Documents (for implementers)
  - http://w3c.github.io/wot/architecture/wot-architecture.html
  - http://w3c.github.io/wot/current-practices/wot-practices.html (living document)
    Beijing 2016 Release:
    http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html
- GitHub (documents and proposals)
  - https://github.com/w3c/wot
- Wiki (organizational information: WebConf calls, Face-to-Face meetings, …)
  - https://www.w3.org/WoT/IG/wiki/Main_Page
- WoT Projects (implementing WoT Current Practices)
  - https://github.com/thingweb/
  - https://github.com/mkovatsc/wot-demo-devices
  - Please add yours!