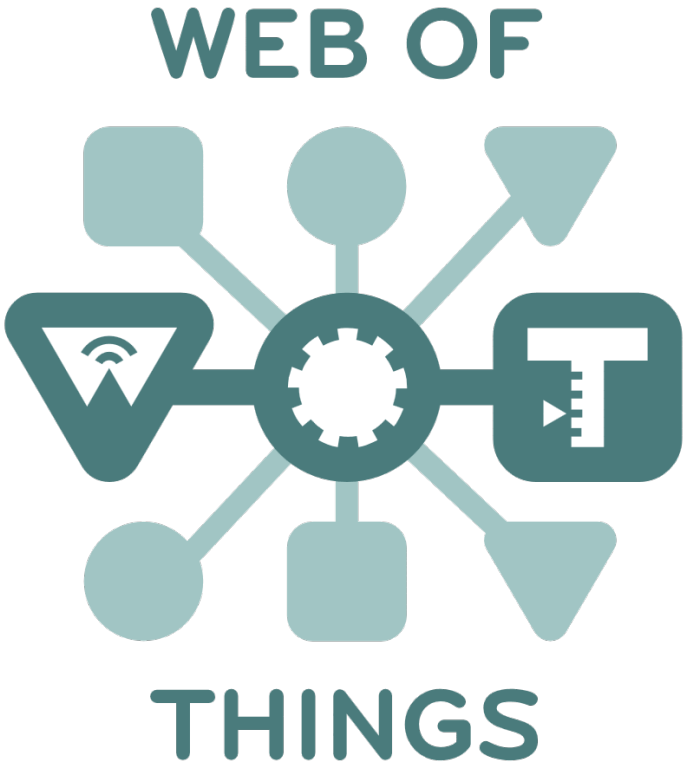


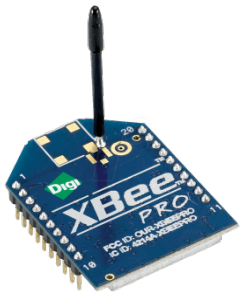
Getting Started with a W3C WoT Project

RIOT Summit, Berlin, Germany, 2016

What is the Web of Things?

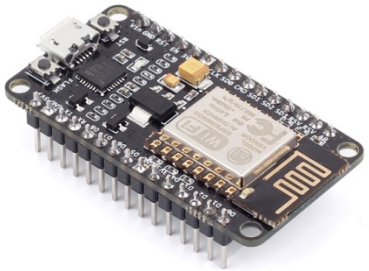
Application Layer

Internet of Things: **Connectivity**

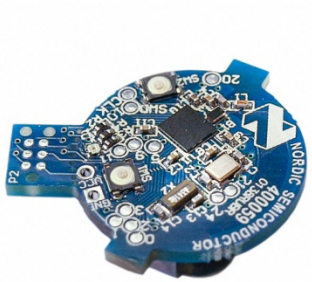


IEEE 802.15.4

Ethernet



Wi-Fi



Bluetooth

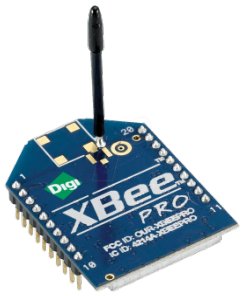
LoRa

...

What is the Web of Things?

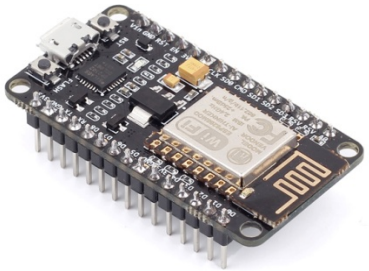
OCF™ oneM2M openHAB empowering the smart home oma Open Mobile Alliance For a Connected World OPC FOUNDATION

Internet of Things: **Connectivity**

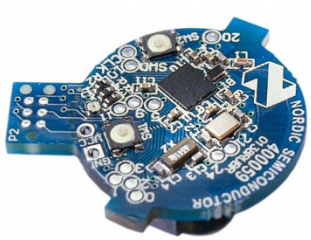


IEEE 802.15.4

Ethernet



Wi-Fi



Bluetooth

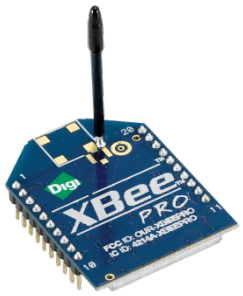
LoRa

...

What is the Web of Things?

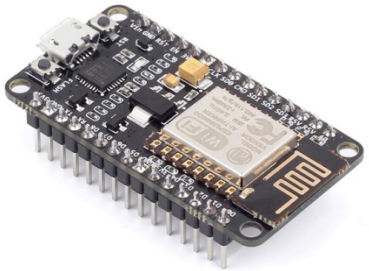
Web of Things: **Applications**

Internet of Things: **Connectivity**

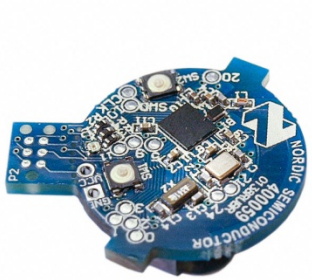


IEEE 802.15.4

Ethernet



Wi-Fi



Bluetooth

LoRa

...

W3C WoT Mission

Not to be yet another standard

Web of Things

...

"interconnecting existing Internet of Things platforms and complementing available standards"

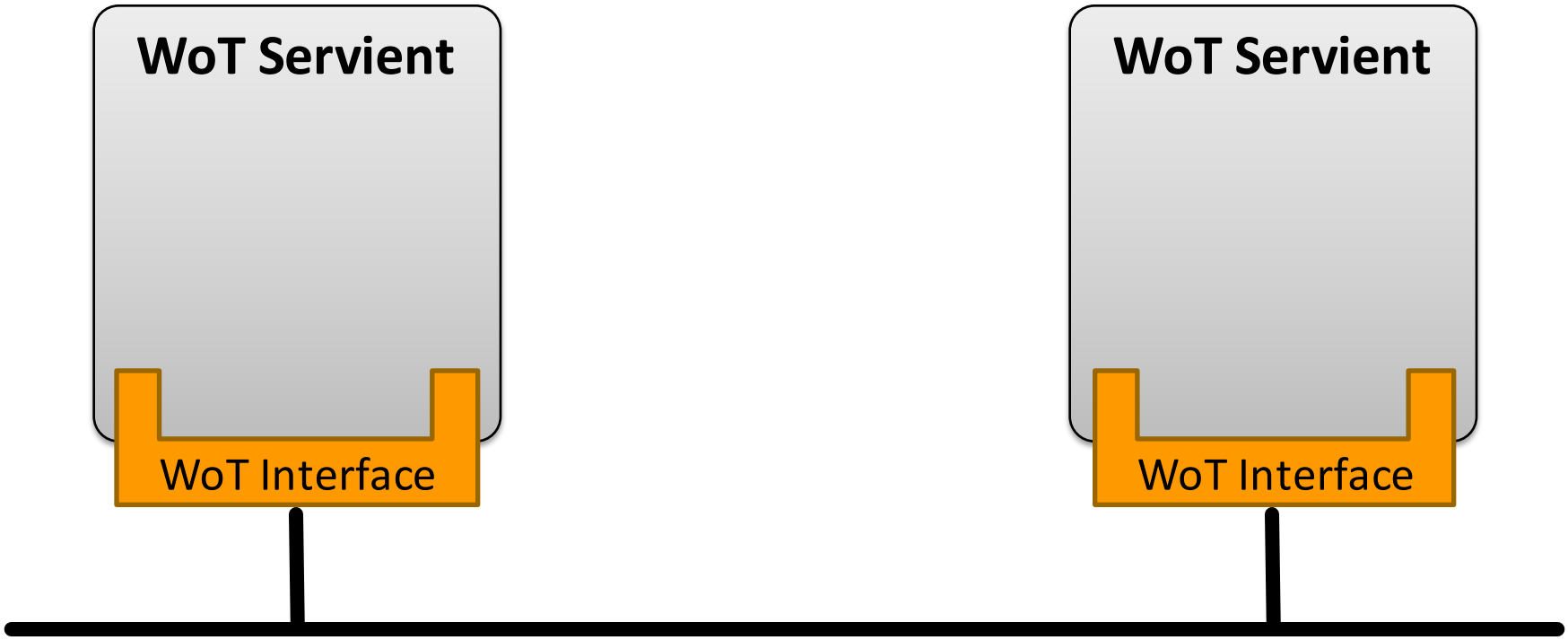
IoT Platforms and Protocol Bindings

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

WoT INTERFACE

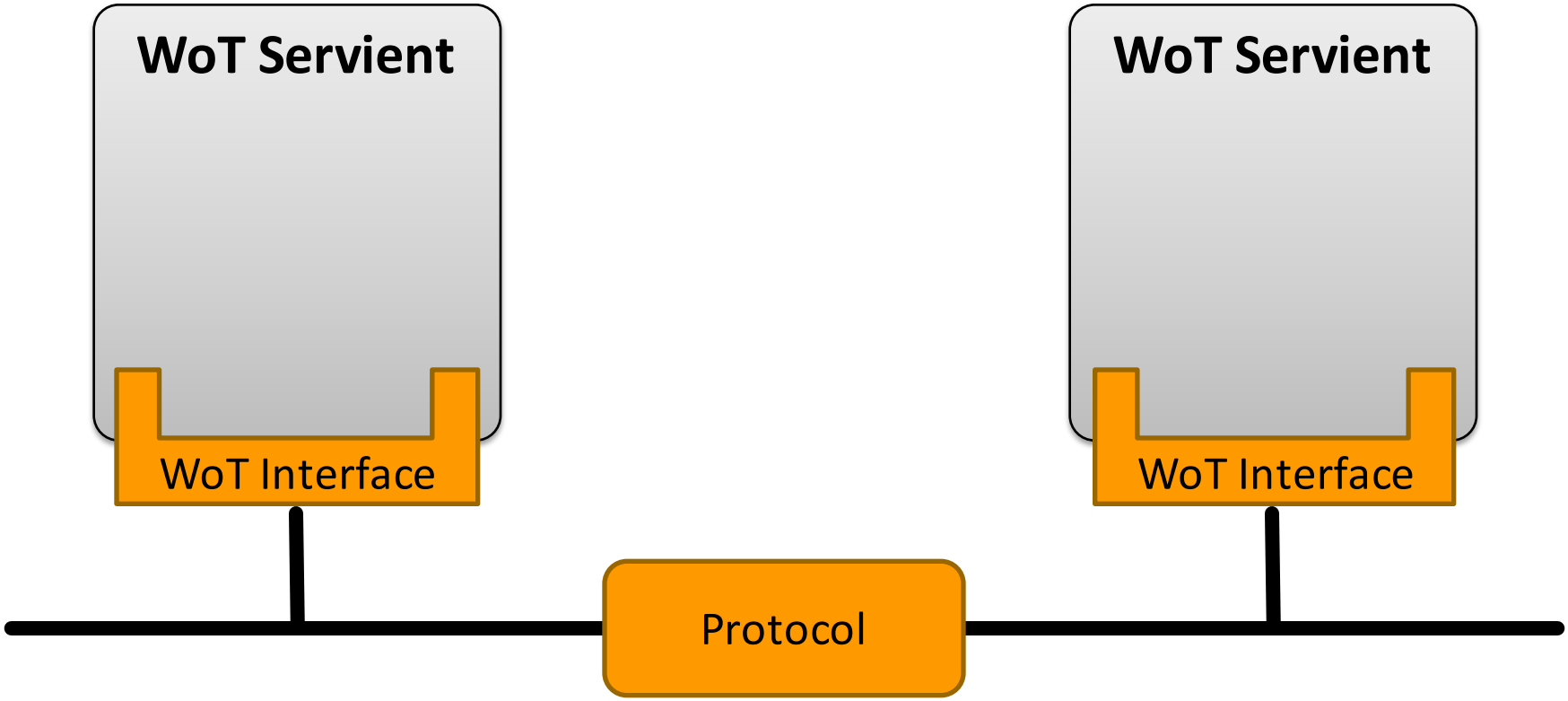
WoT Interface

- Interface exposed by Servients to the network



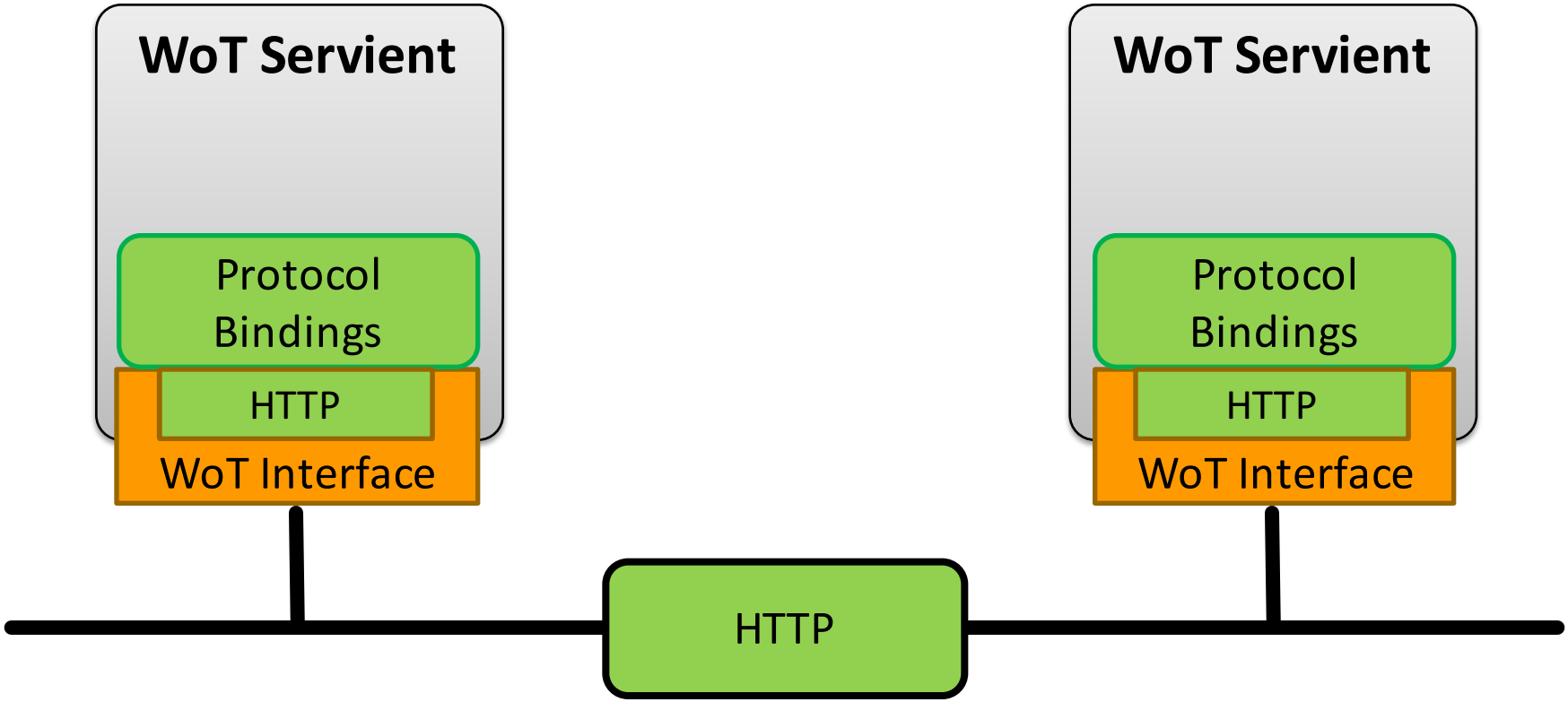
WoT Interface

- Interface exposed by Servients to the network



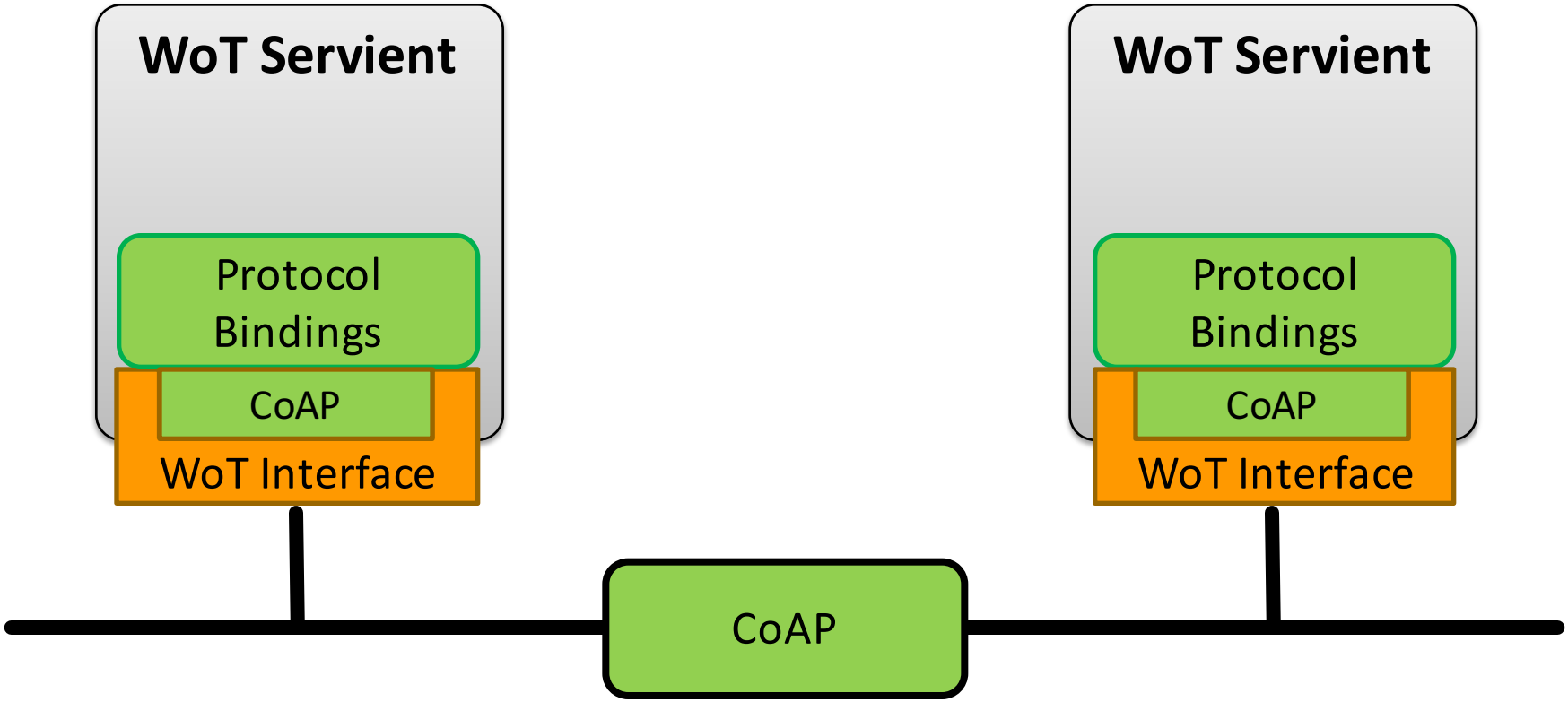
Protocol Bindings

- Interface can be bound to various protocols



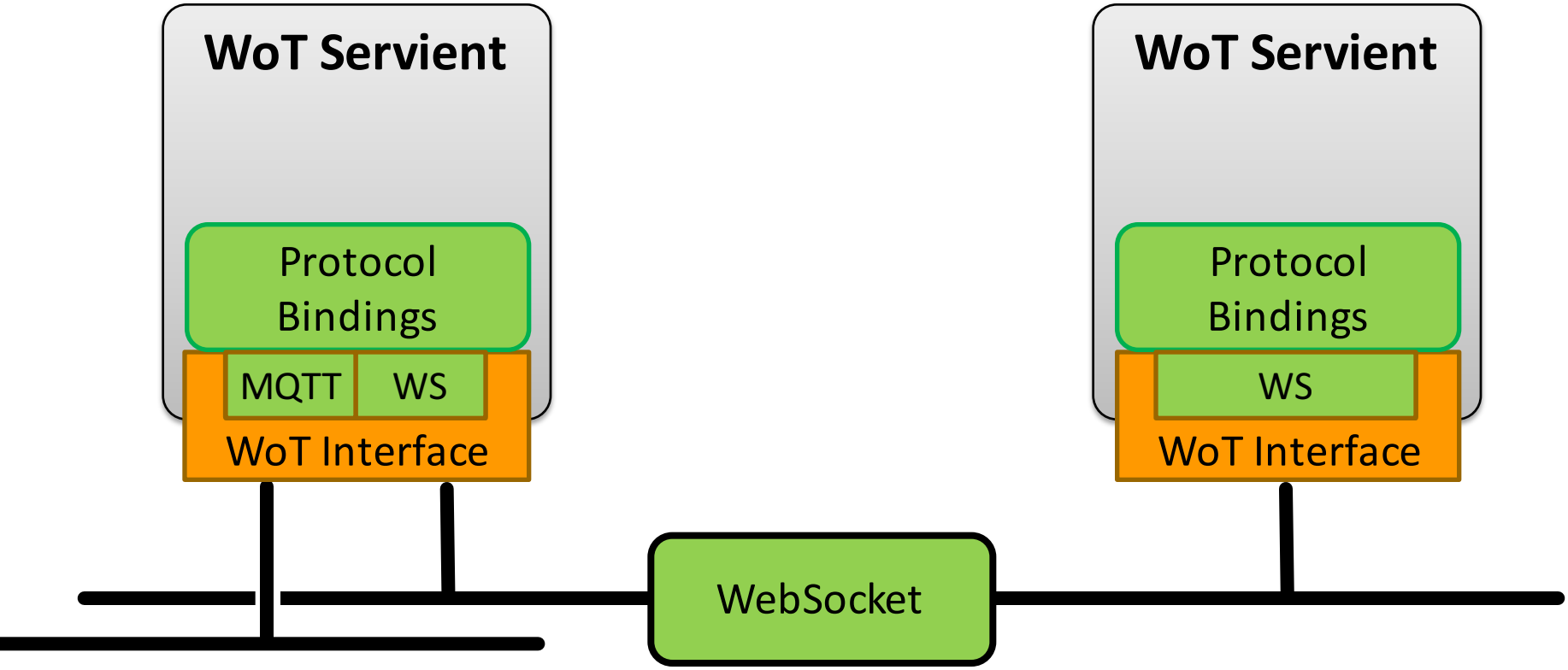
Protocol Bindings

- Interface can be bound to various protocols



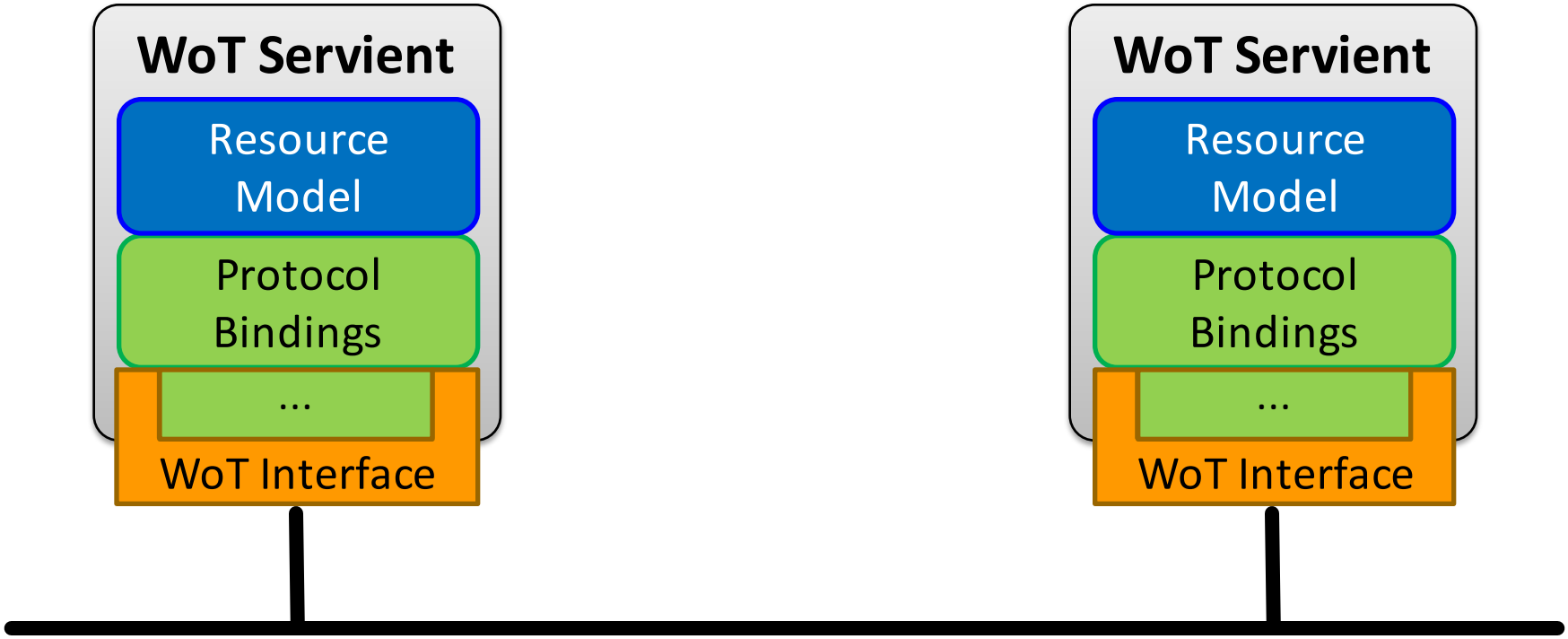
Protocol Bindings

- Multiple bindings possible on Things



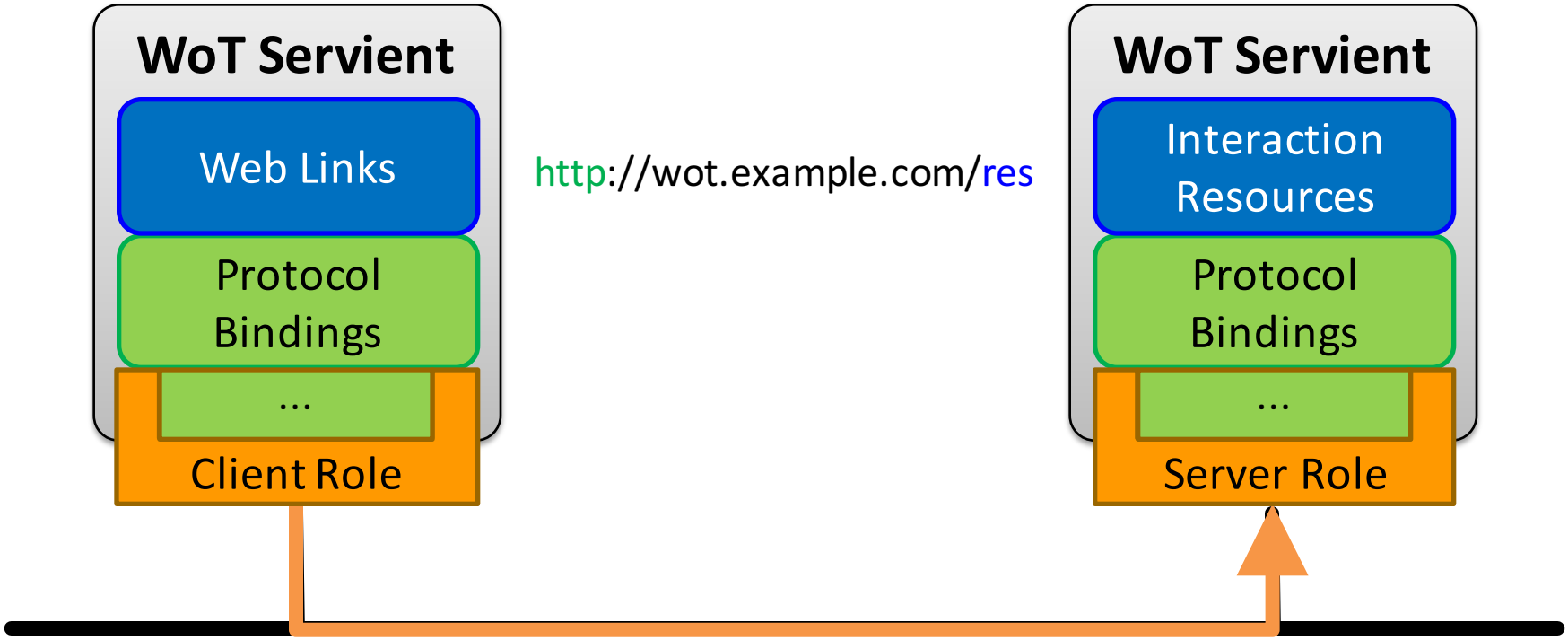
Resource Model

- Interaction points are Web resources



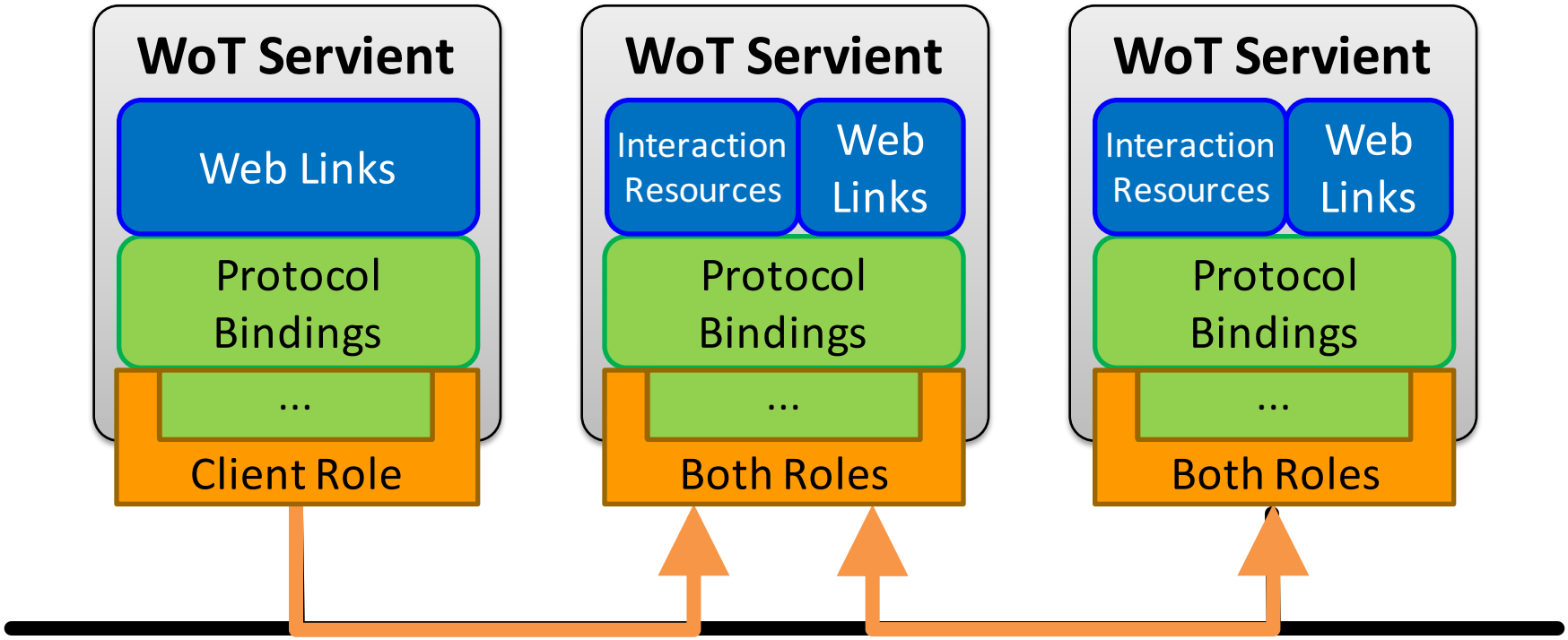
Servient Role

- Exposing Things are in server role
- Consuming Things are in client role



Servient Role

- Usually both roles at the same time → *Servient*



Metadata and Interactions

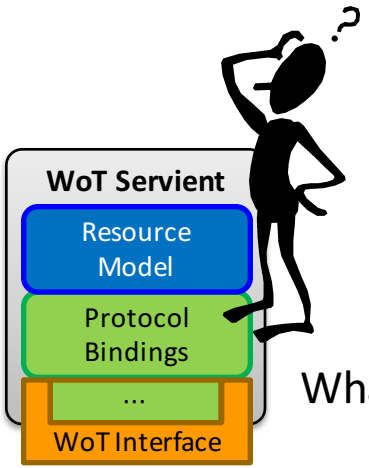
http://w3c.github.io/wot/current-practices/wot-practices.html#thing-description

THING DESCRIPTION

How to Interact with WoT Servients?

What kind of data do you serve?

Who are you?



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

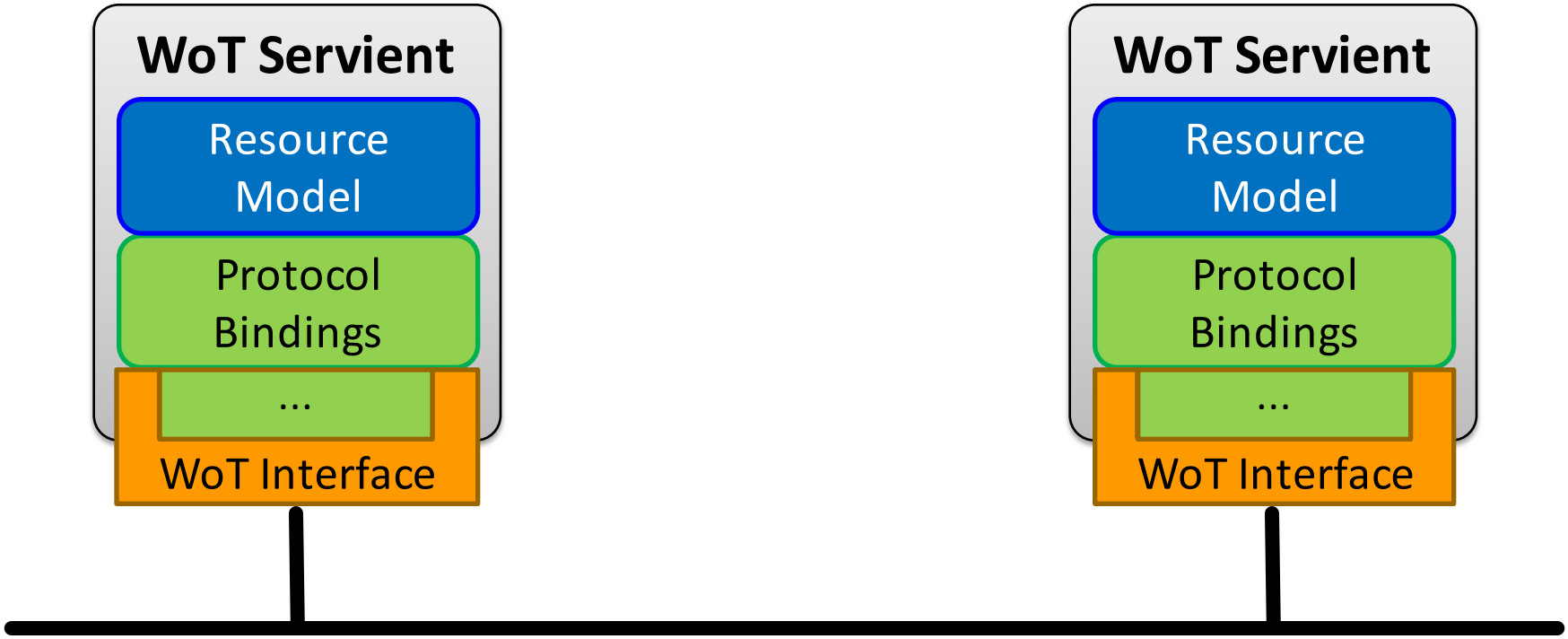
Semantic Description

- Reach interoperability through Linked Data vocabularies
  - subject, predicate, object triples
  - rooted in the RDF model

- W3C Thing Description
  - describes WoT Interface to interact with Things
  - extensible with domain-specific vocabulary
  - different serializations possible

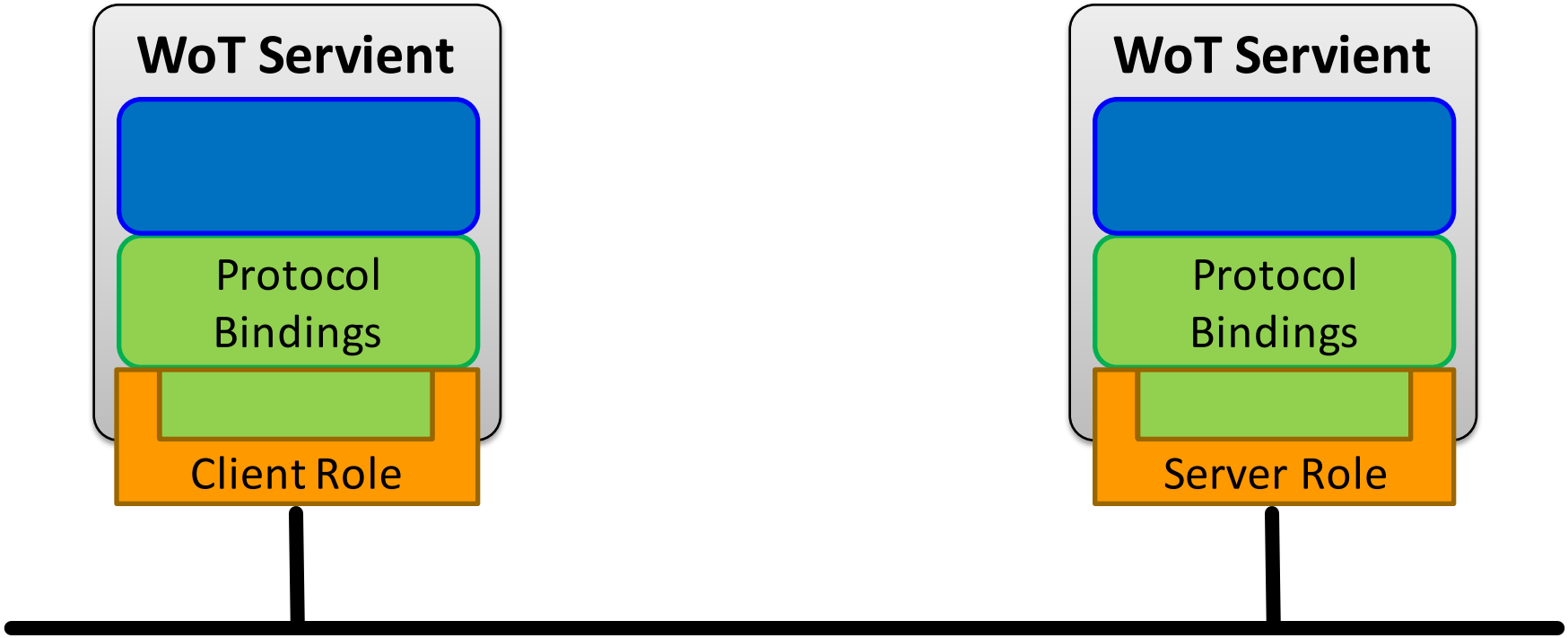
Thing Description (TD)

- Describes Thing metadata and interactions



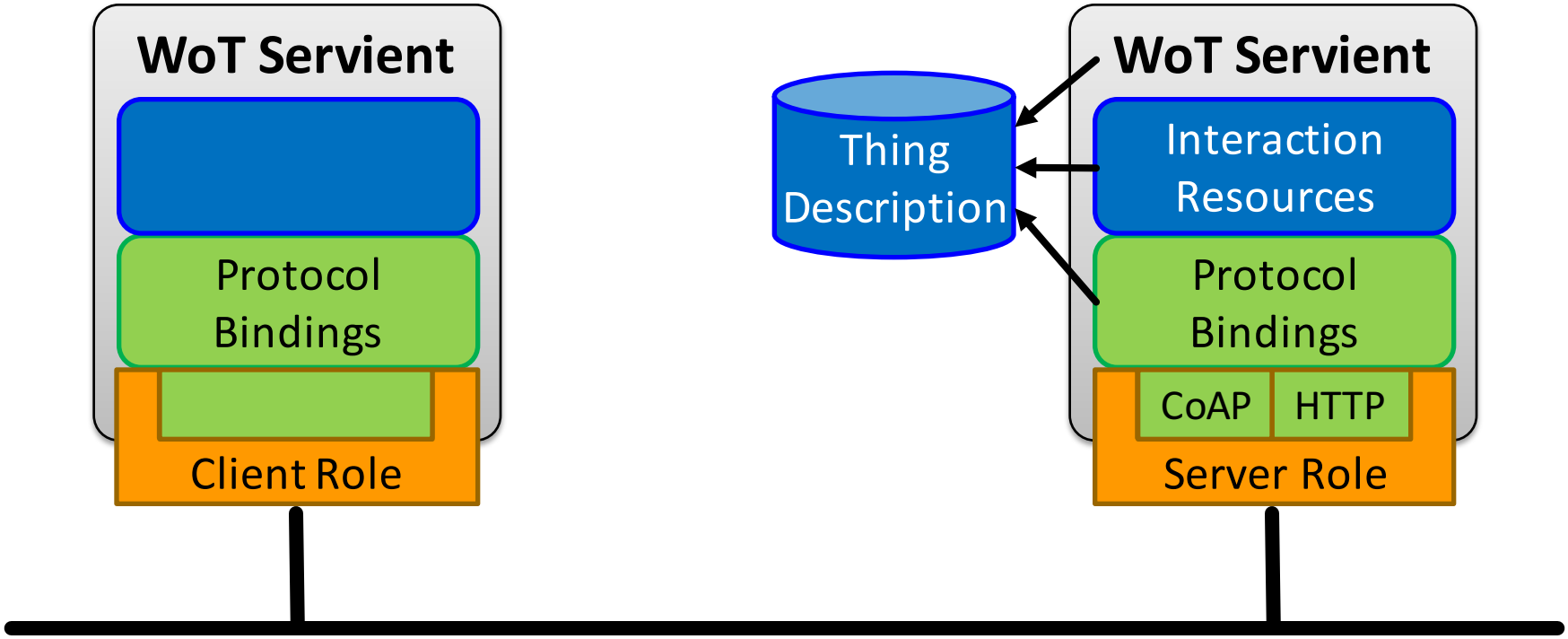
Thing Description (TD)

- Consuming Things are in client role
- Exposed Things are in server role



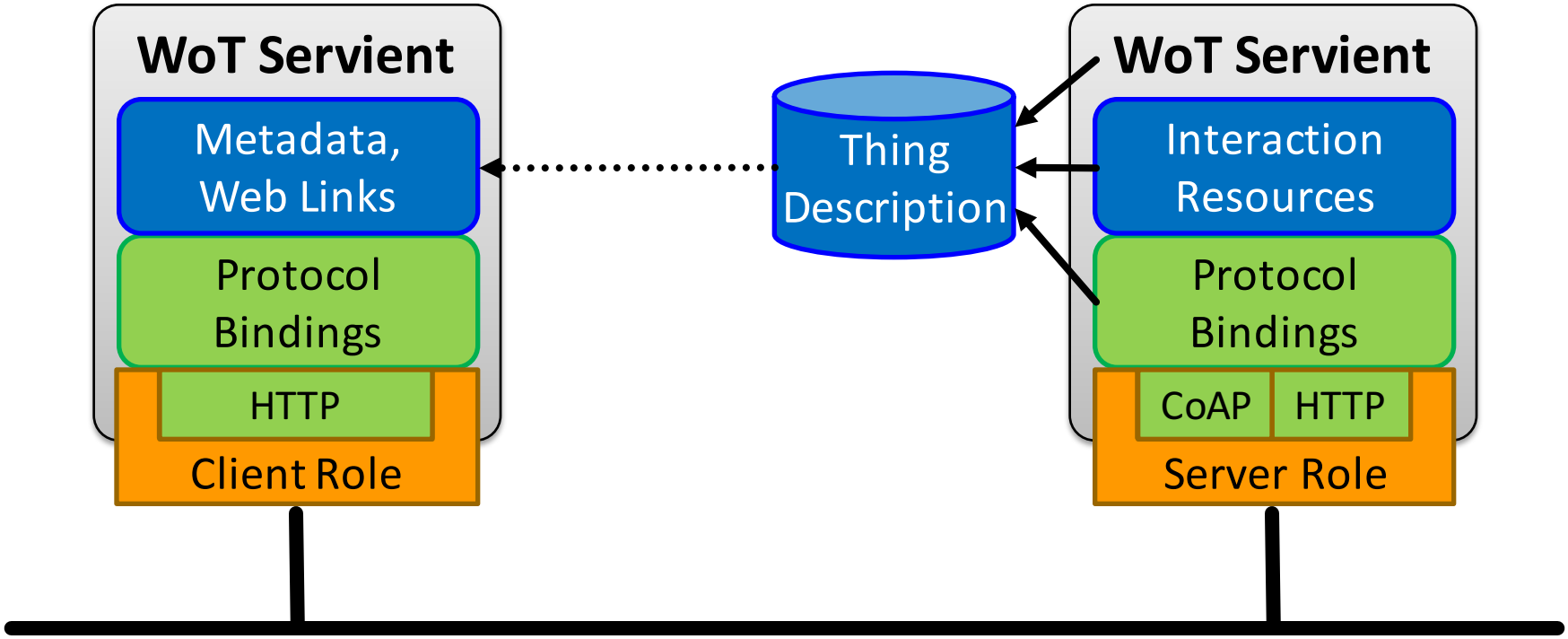
Thing Description (TD)

- Exposed Things provide Thing Description



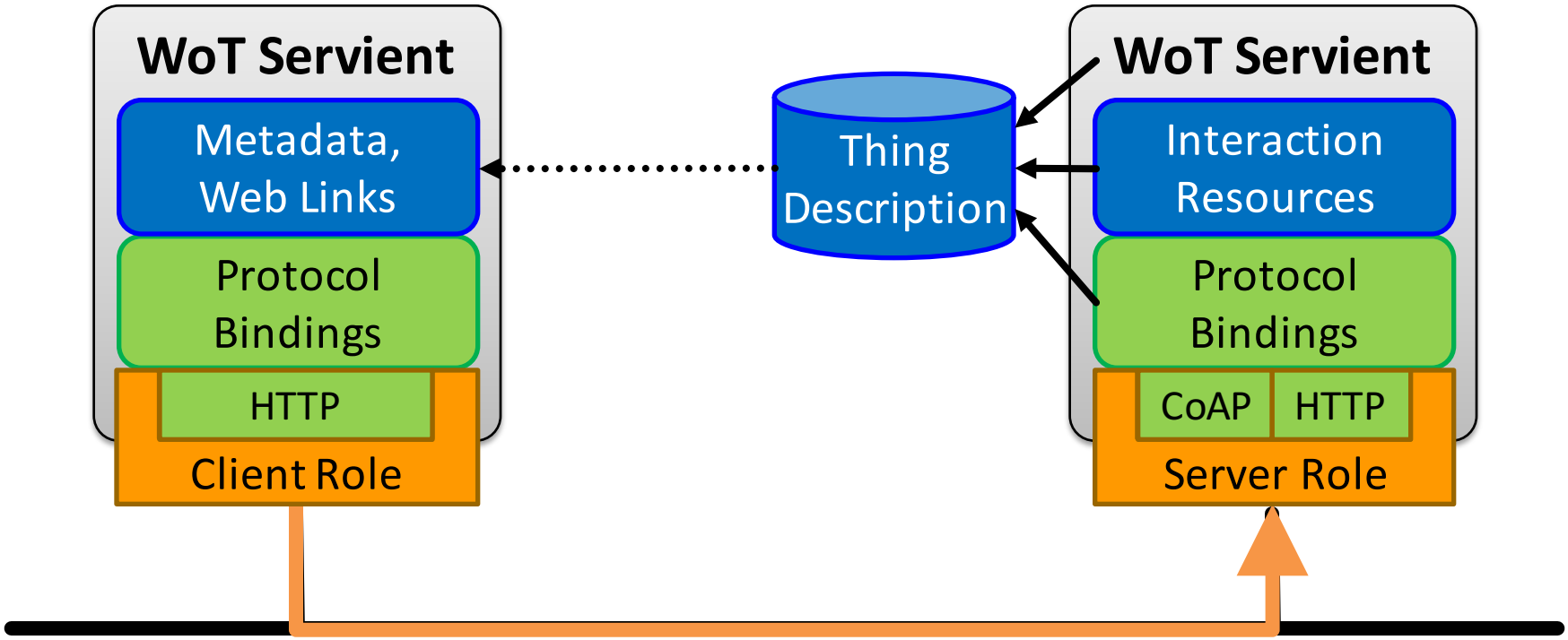
Thing Description (TD)

- Consuming Things learn WoT Interface from TD



Thing Description (TD)

- Thing-to-thing communication



Thing Description (TD)

- Default serialization is JSON-LD
  - based on well established JSON format
  - different implementations and tools available
  - @context defines vocabularies
  - See TD example

TD Example

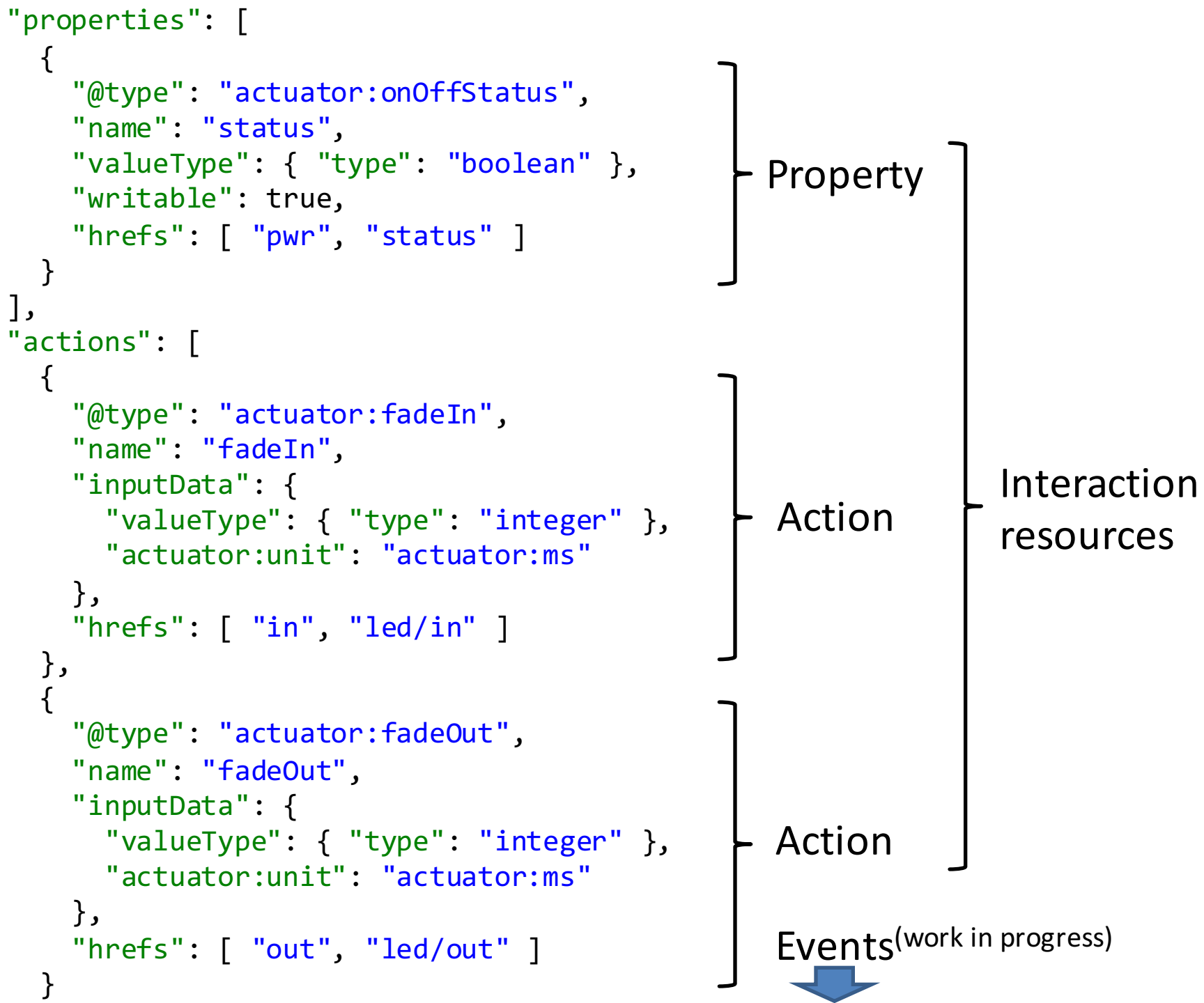
```
{
  "@context": [
    "http://w3c.github.io/wot/w3c-wot-td-context.jsonld",
    { "actuator": "http://example.org/actuator#" }
  ],

  "@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"]
}
Property
Action
Action
Interaction resources
Events (work in progress)

Type System

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

How to Create a TD?

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

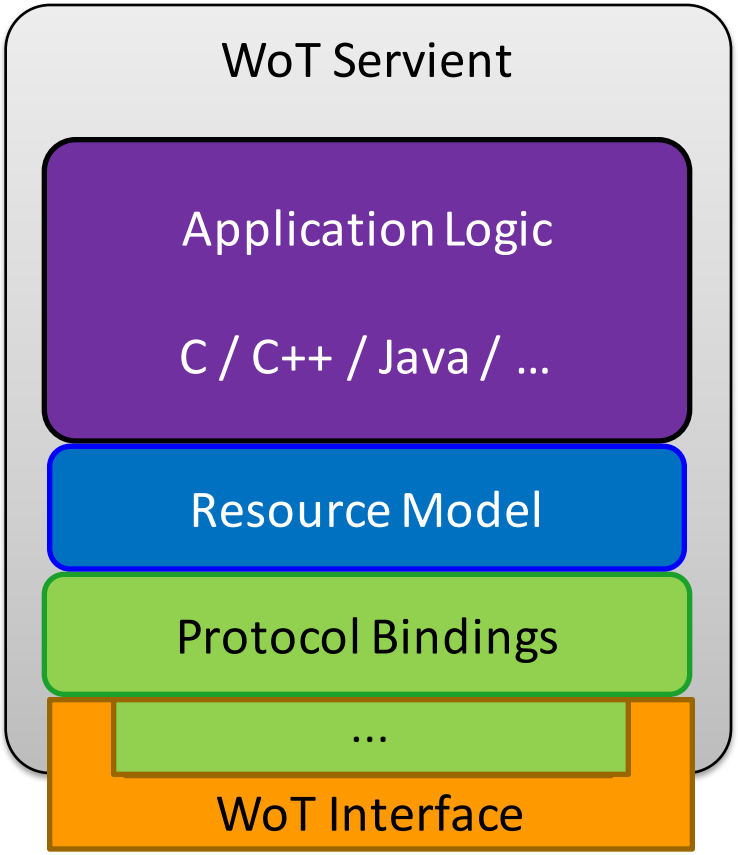
Runtime Environment and Portable Apps

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

SCRIPTING API

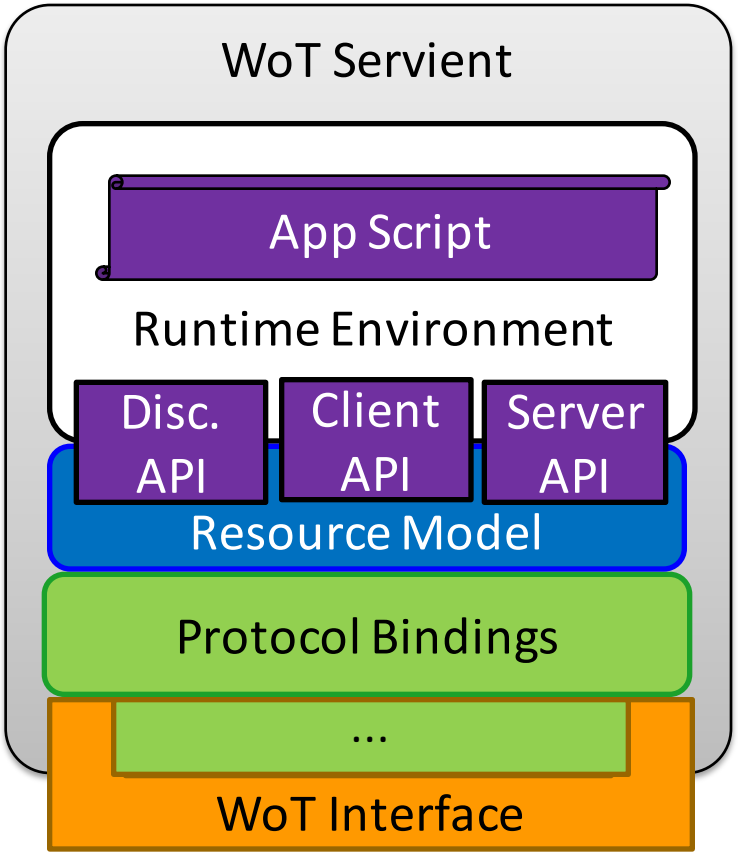
Without Scripting API

- Application logic often implemented natively



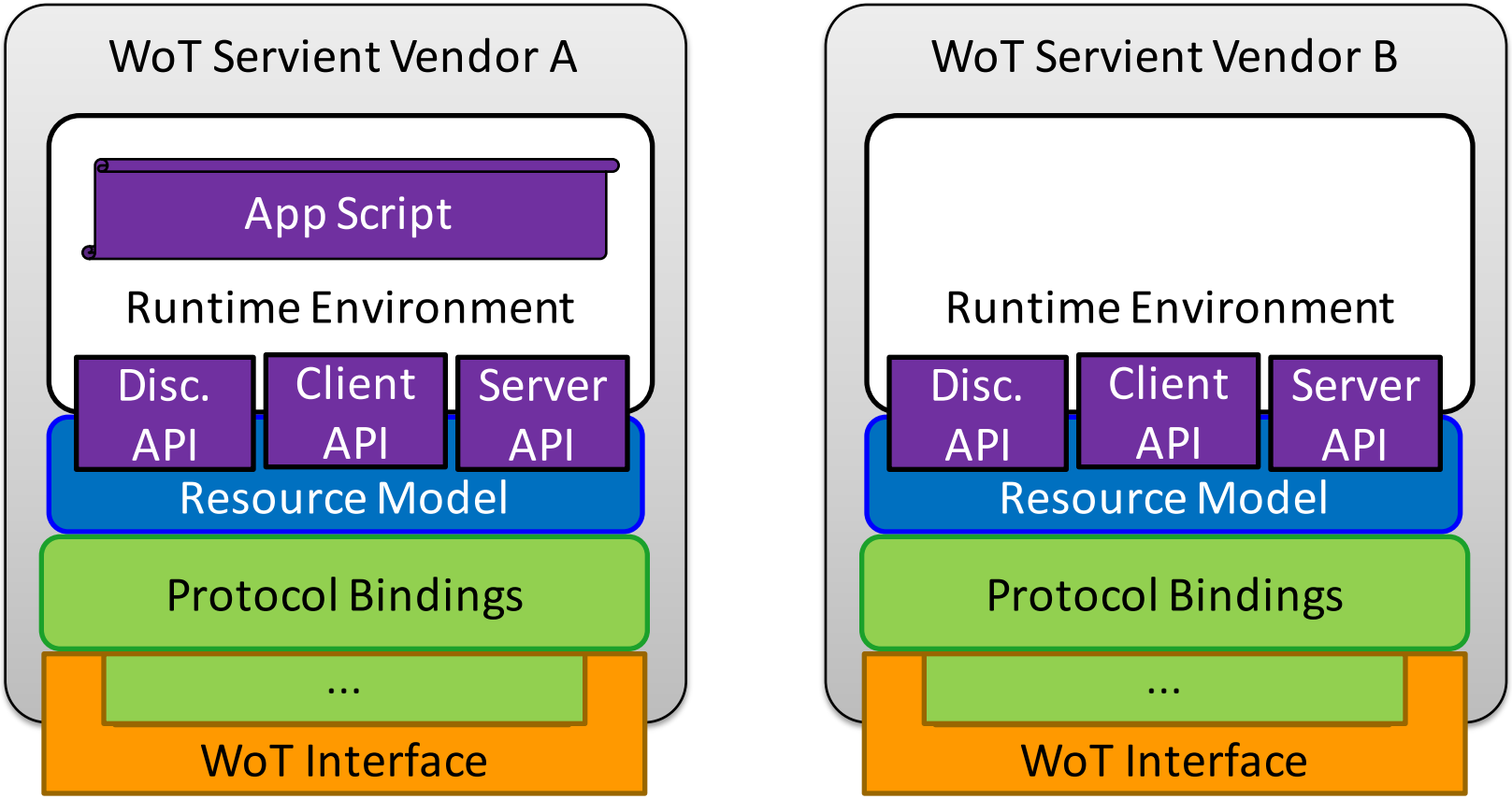
Scripting API

- Common runtime enables portable apps



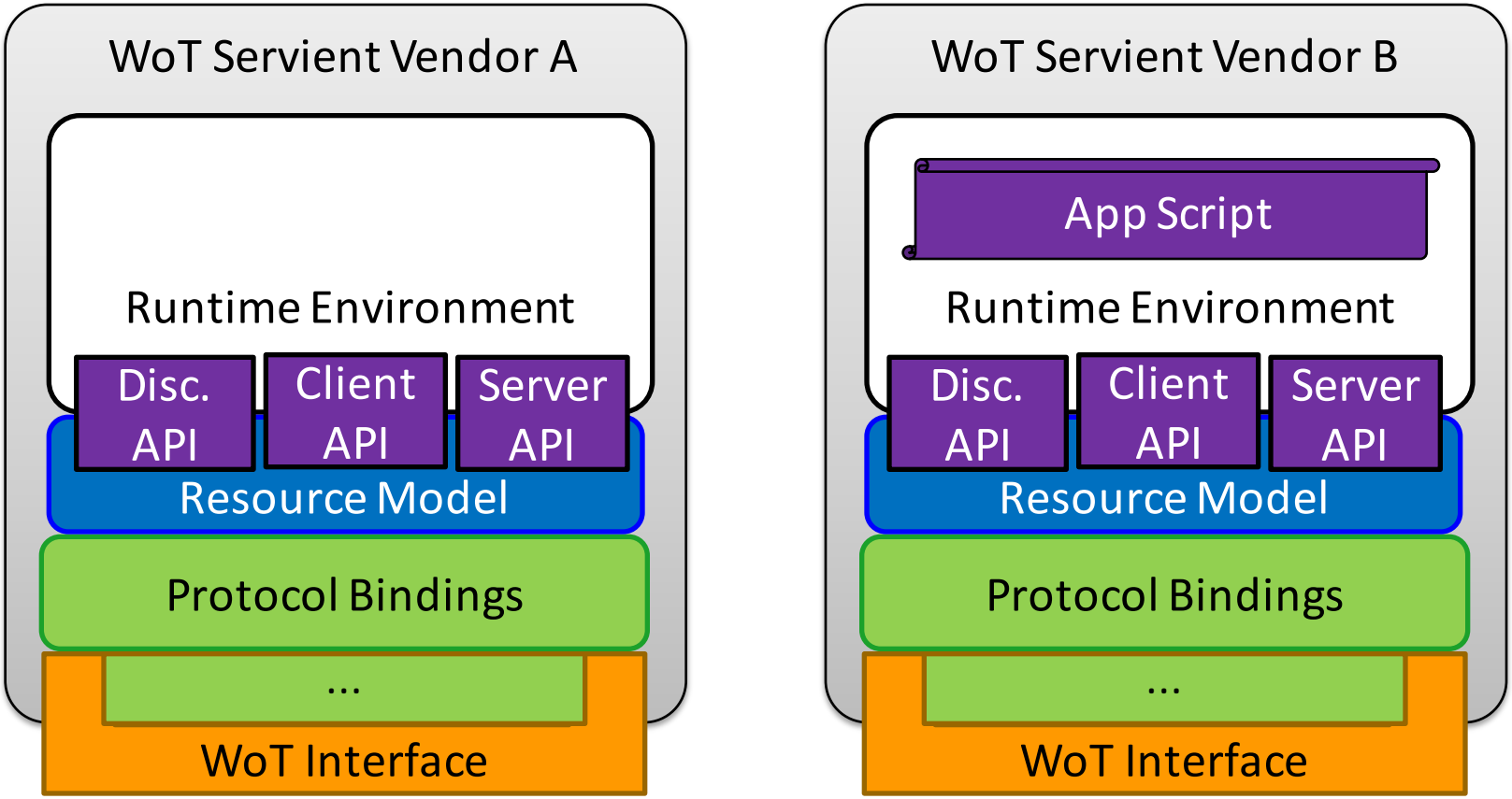
Scripting API

- Common runtime enables portable apps



Scripting API

- Common runtime enables portable apps



WoT Root Element (with Discovery)

```
interface WoT {
    Promise<sequence<ConsumedThing>> discover(ThingFilter filter);
    Promise<ConsumedThing> consumeDescription(Object td);
    Promise<ConsumedThing> consumeDescriptionUri(DOMString uri);
    Promise<ExposedThing> createThing(DOMString name);
    Promise<ExposedThing> createFromDescription(Object td);
    Promise<ExposedThing> createFromDescriptionUri(DOMString uri);
};
```

Client API: ConsumedThing

```
interface ConsumedThing {
    readonly attribute DOMString name;
    Promise<any> getProperty(DOMString propertyName);
    Promise<any> setProperty(DOMString propertyName, any newValue);
    Promise<any> invokeAction(DOMString actionName, any parameter);
    ConsumedThing addListener(DOMString eventName,
                              ThingEventListener listener);
    ConsumedThing removeListener(DOMString eventName,
                              ThingEventListener listener);
    ConsumedThing removeAllListeners(DOMString eventName);
    Object getDescription();
};
```

Server API: ExposedThing

```
interface ExposedThing {
    readonly attribute DOMString name;
    ExposedThing addProperty(DOMString name, object type);
    ExposedThing addAction(DOMString name, Object input, Object output);
    ExposedThing addEvent(DOMString name, Object output);
    Promise<any> getProperty(DOMString propertyName);
    Promise<any> setProperty(DOMString propertyName, any newValue);
    Promise<any> emitEvent(DOMString eventName, any payload);
    ExposedThing onUpdateProperty(DOMString n, PropertyChangeListener cb);
    ExposedThing onInvokeAction(DOMString actionName, ActionHandler cb);
    Object getDescription();
};
```

Script Example (Consume Thing)

```
WoT.consumeDescriptionUri("http://servient.example.com/things/counter")
    .then(function(counter) {
        counter
            .invokeAction("increment", {}).then(function() {
                console.log("incremented");
                counter
                    .getProperty("count").then(function(count) {
                        console.log("new count state is " + count);
                    });
            })._catch(console.error);
    })
    ._catch(function(err) {
        console.error(err);
    });
```

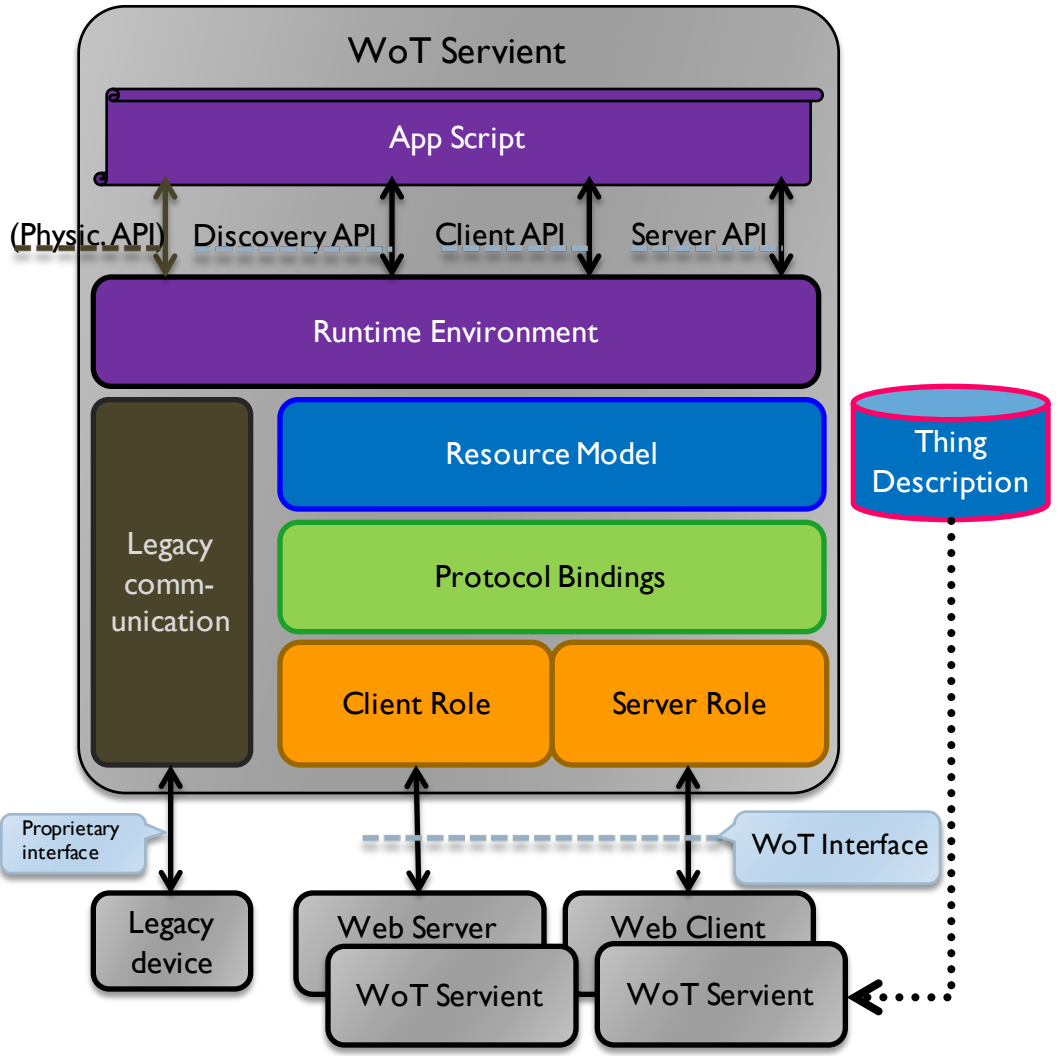
Script Example (Expose Thing)

```
WoT.newThing("counter")
    .then(function(thing) {
        thing
            .addProperty("count", {"type": "integer"})
            .addAction("increment")
            .onInvokeAction("increment", function() {
                console.log("incrementing counter");
                var value = thing.getProperty("count") + 1;
                thing.setProperty("count", value);
                return value;
            });
        thing
            .setProperty("count", 0)
    });
```

W3C Web of Things

SUMMARY

Thing Implementation: **WoT Servient**



Application Logic:

Can consume remote Things through the Client API, local hardware and connected legacy devices through a Physical API (t.b.d.), and expose Things through the Server API. To allow portable app scripts, the Servient must povide a runtime environment.

Resource Model:

Provides a common abstraction with uniform interface across the different protocols. Like the Web, it allows to identify and address interaction points through URIs.

Thing Description (TD):

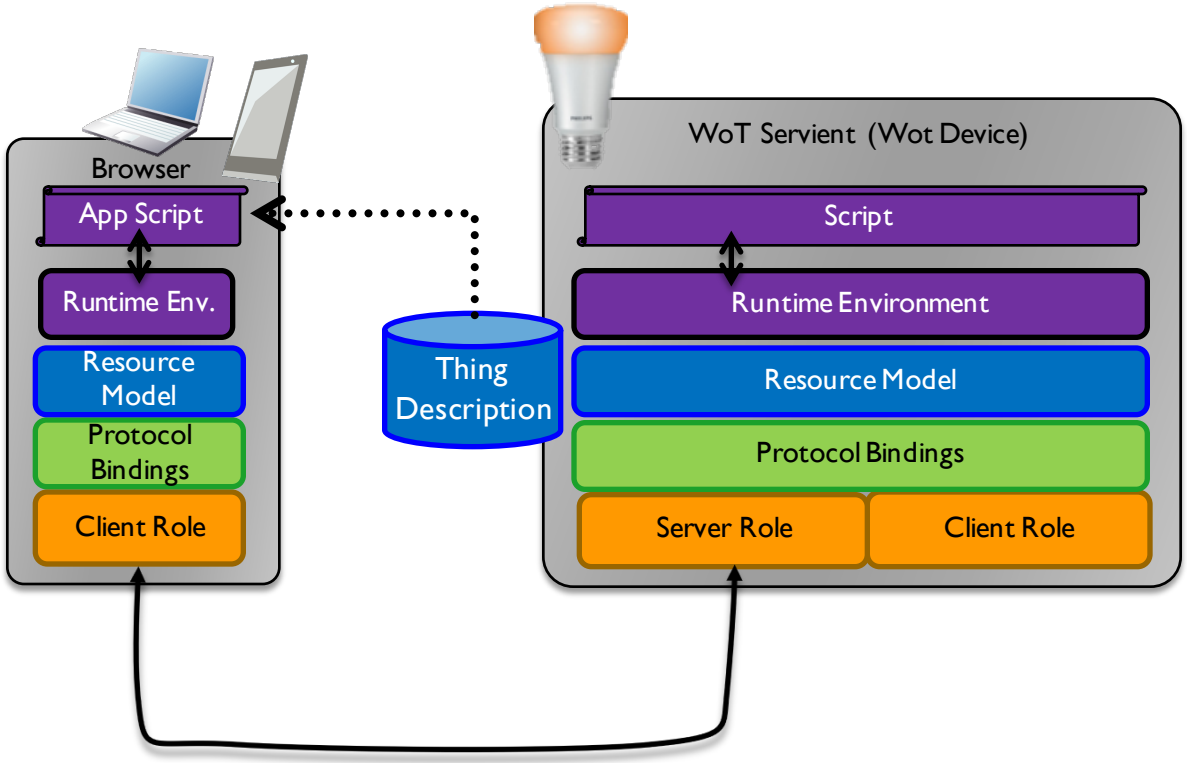
Declares WoT Interface for interaction and provides (semantic) metadata for the Thing. TD is used by WoT clients to instantiate local software object of the Thing.

Protocol Binding:

Converts abstract interactions with Things to different protocols using the information from TD.

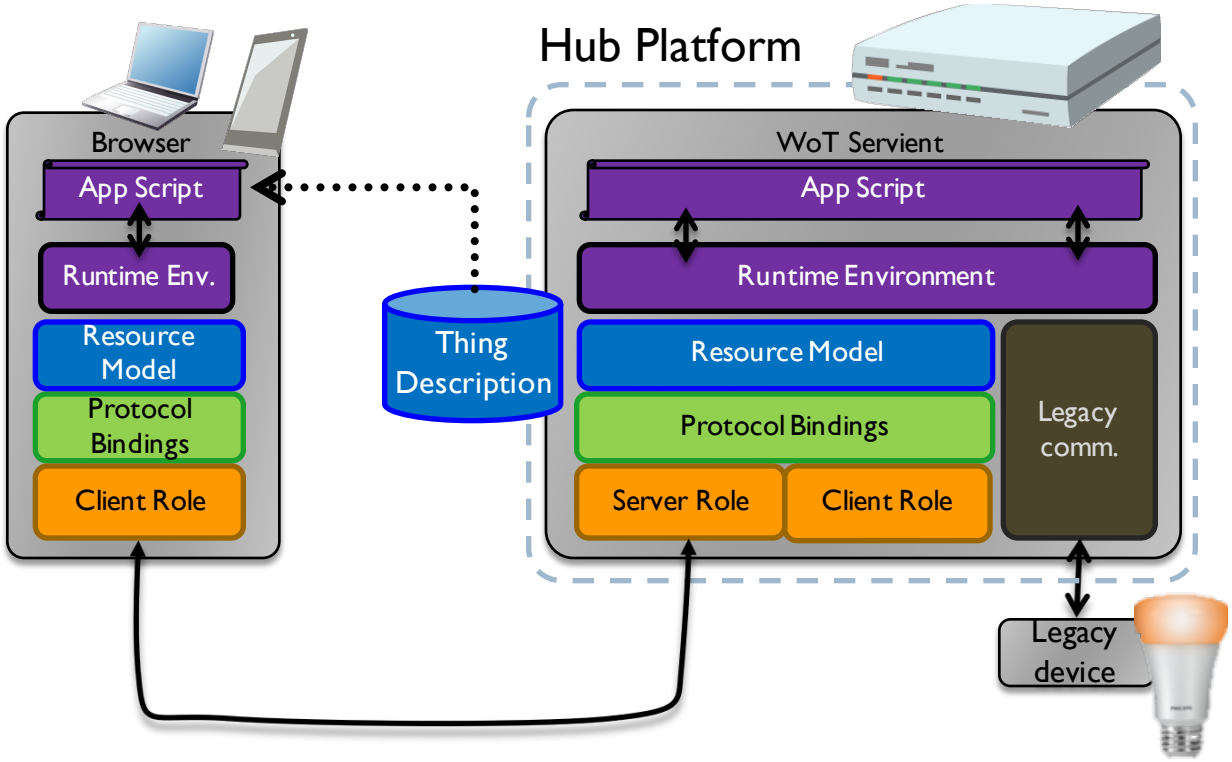
WoT Servient on Thing Itself

- Native WoT Things host a Servient directly
- TD is provided by Thing or supporting host on the Web



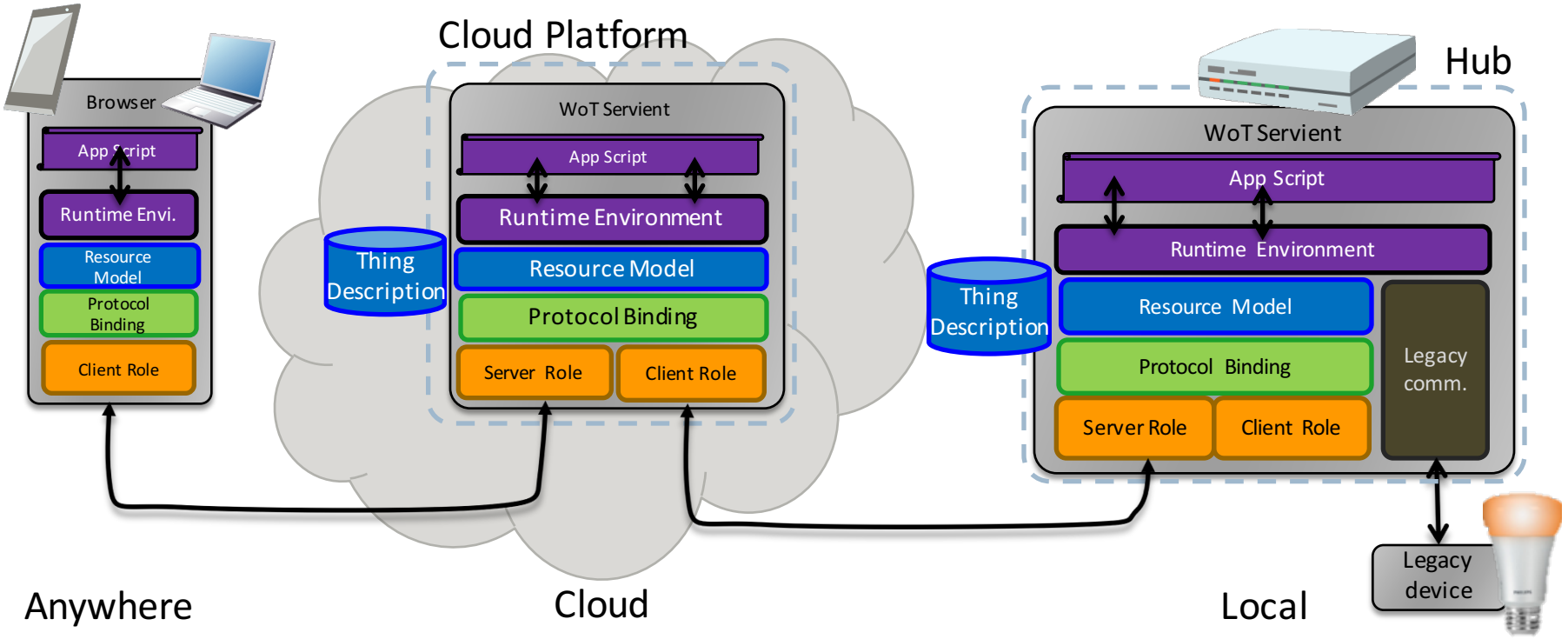
WoT Servient on Integration Hub

- WoT Servients can run on hubs (e.g., smartphone, gateway)
- Multiple Servients can be instantiated through sandboxed apps
- Apps can act as agents/proxies for legacy devices



WoT Servient in the Cloud

- A cloud mirror (device shadow) enables scalable remote access
- Is synchronized with local Servient
- Can forward interactions and cache data



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!

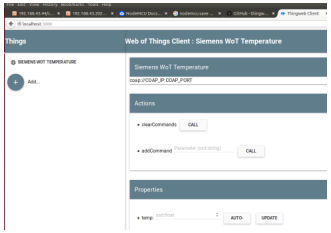
W3C WoT F2F Beijing 2016

PLUGFEST

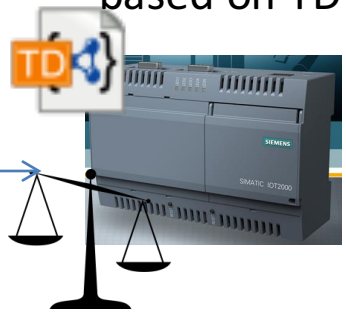
Scenario 1 – ‘Hello WoT‘

WoT TD interpreter for human interaction

Setup servient interaction based on TD



/voteTooHot

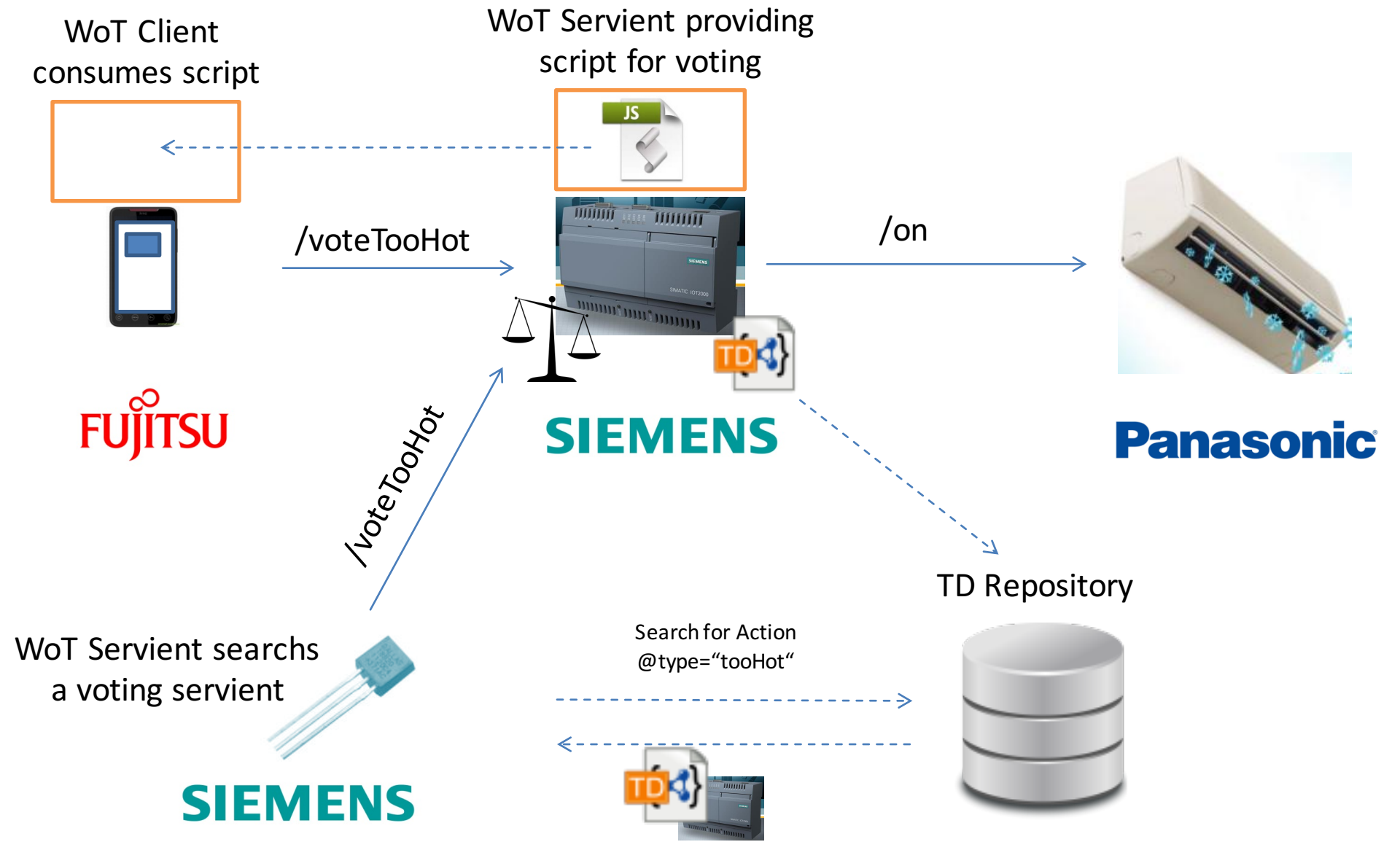


/on

SIEMENS

Panasonic

Scenario 2 – ‘Full WoT‘



Scenario 3 – ‘Mini Automation‘

Consume brightness sensor
to control curtain

SIEMENS

FUJITSU

Online Resources

- Current Practices (Beijing Release)
  - http://w3c.github.io/wot/current-practices/wot-practices-beijing-2016.html
- Organization Wiki
  - https://www.w3.org/WoT/IG/wiki/F2F_meeting,_July_2016,_China,_Beijing#PlugFest
- Test Cases
  - https://github.com/w3c/wot/blob/master/plugfest/2016-beijing/plugfest-test-cases-beijing-2016.md
- Report Template
  - https://github.com/w3c/wot/blob/master/plugfest/2016-beijing/TestCaseCoverage.xlsx (t.b.d.)