



ASIA-PACIFIC TELECOMMUNITY

The 28th APT Standardization Program Forum (ASTAP-28)

6- 10 March 2017, Bangkok, Thailand



Web of Things:

W3C Vision & Roadmap on IoT Standardizations

W3C/Beihang University
China

<http://www.chinaw3c.org>
<http://www.w3.org>



Lead the Web to Its Full Potential



Anyone

Anytime

Anywhere

Any Device

Global Presence of W3C



W3C Global Hosts



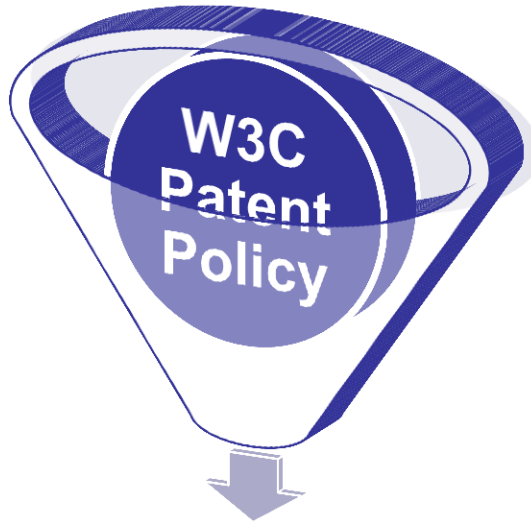
W3C Global Offices

A NEW WAVE OF TRANSFORMATIONS



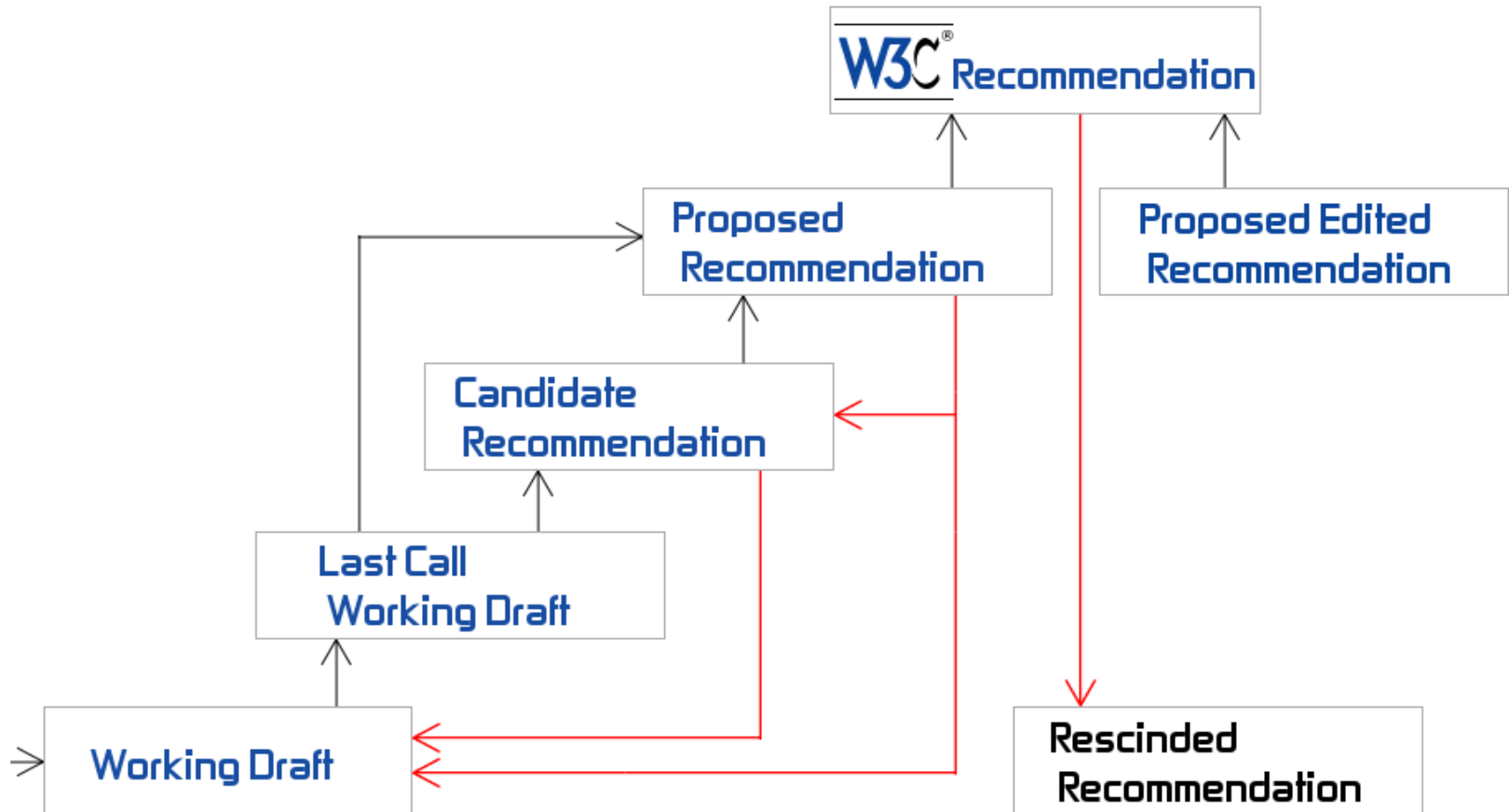


We Build Royalty-Free Standards!



Free Web Standards for All!

Process for W3C Recommendations



Many Potential IoT Application Areas

Each Evolving Rich Capabilities!



Smart Homes



Wearables



Healthcare



Power & Environment

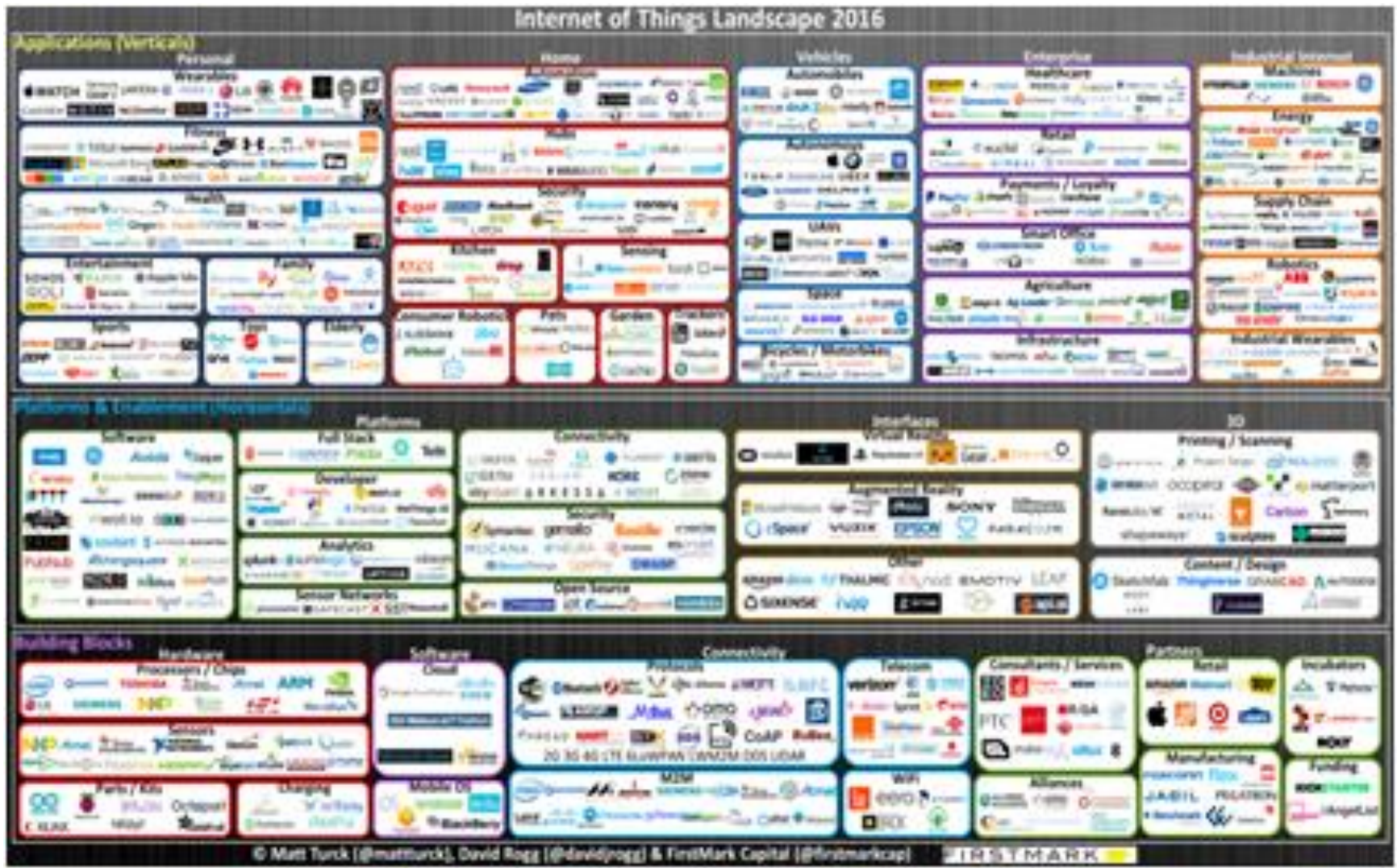


Smart Cities



Manufacturing

IoT Landscape



The Internet of Things

- Still very immature, but with massive potential
- Lack of interoperability at the application level
 - Data silos are holding back the potential
- Open or closed system?
 - Closed systems incentive: control
 - Open systems prompt: reduced costs and increased market size
 - Re-prise of “the Web”



Bridging the Silos

Isolated IoT products create data silos

- Vendors use fixed cloud address for devices to upload data to
- Incompatible protocols, formats and data models

Silos hinder creation of services that combine different data

- How to enable easy integration of data sources?

The Web is the framework that offers a unifying approach:

- For simplifying application development across many platforms
- For metadata as a basis for discovery, interoperability, and open markets of services



The IoT Standardization Challenge

❖ AIOTI WG03 IoT Standardization landscape (and still extending)

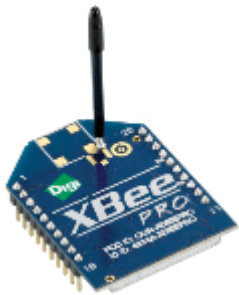


The Web of Things

Diversity Applications



Internet of Things: Connectivity



IEEE 802.15.4



Ethernet



Wi-Fi



Bluetooth

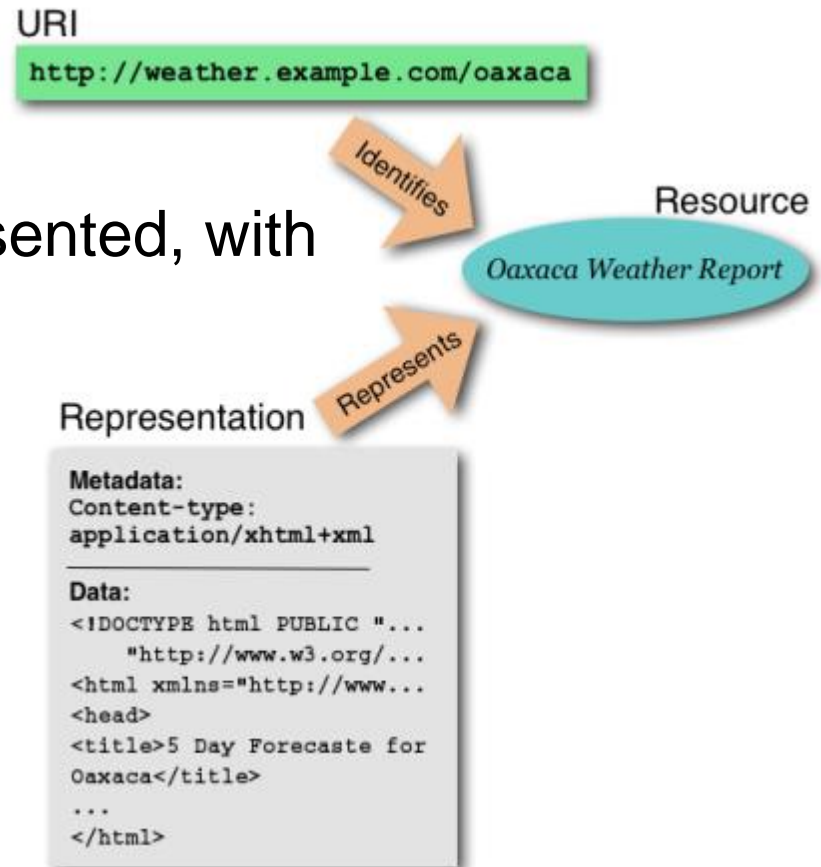


LoRa

Then, the Web!

- Web is a network of **resources**

- Resource is an abstract concept
- Resource need to be represented, with multiple approaches
- Resource can be operated with open protocols
- URI is the unique identifier of a resource



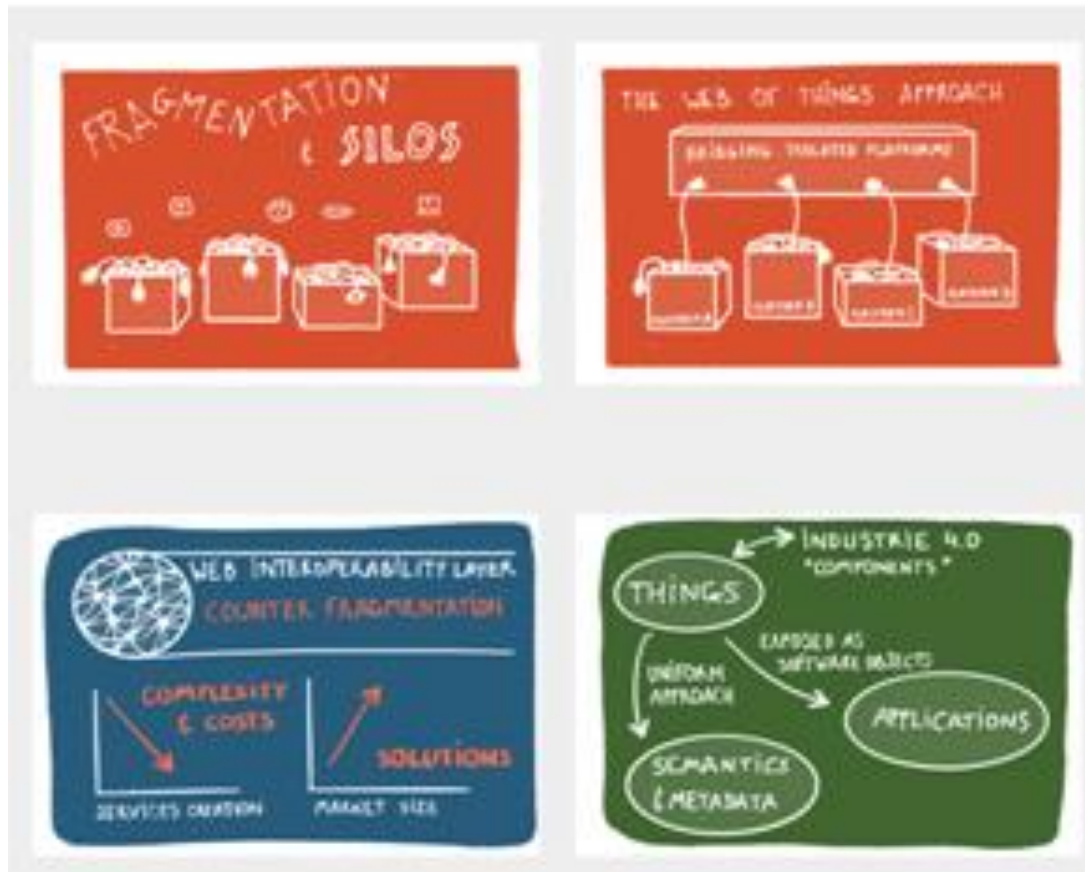
- <https://www.w3.org/TR/webarch/>



Then, the Web!

The Web is fueling a transition from costly monolithic software to open markets of apps, with introducing Thing as another Resource

Provide Resource Abstractions on the Web



Bridges & Interoperability

Reducing Complexity & Cost

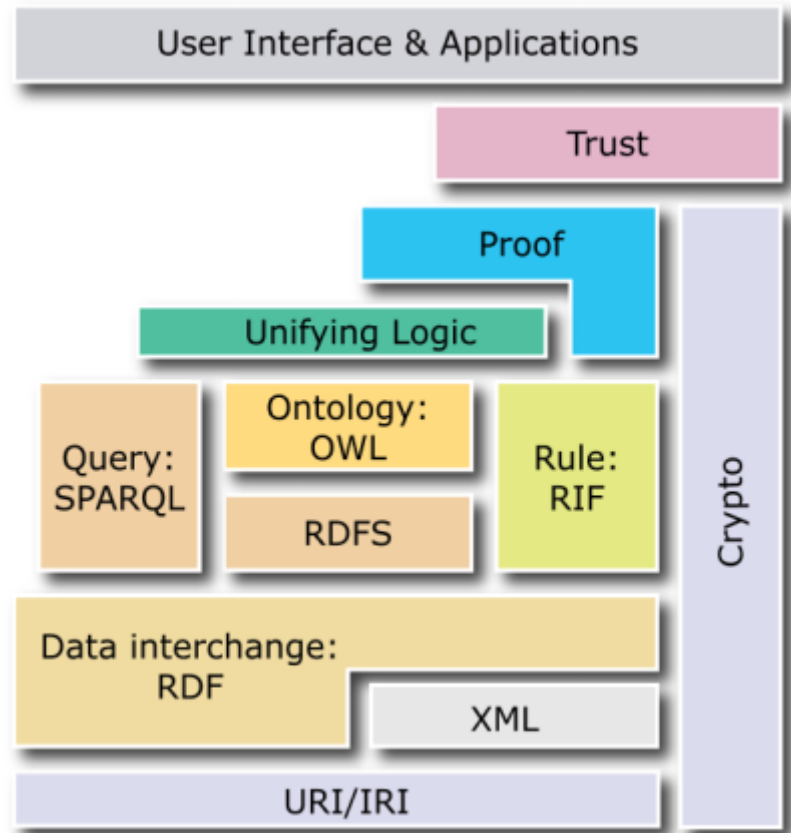
Extensive Semantics to support automation

Why is Semantics Important?

What is the relevance to digital automation?

- Shared **vocabularies** for entities and their relationships
- Describing the software objects that stand for physical or **abstract “things”**
- Intelligent **Discovery**: When searching for services with a given semantics
- **Workflow & Automation**: To facilitate the design of service compositions
- Optimal planning for flexible production of given products

W3C Semantic Web Standards Stack





WoT: Where the Web meets IoT

Diversity Applications



Web of Things



Internet of Things: Connectivity



IEEE 802.15.4



Ethernet



Wi-Fi



Bluetooth



LoRa

Communications Stack with A Clean Separation of Concerns

Application Developer (WoT focus)	Application	Scripts that define thing behaviour in terms of their properties, actions and events, using APIs for control of sensor and actuator hardware
	Things	Software objects that hold their state Abstract thing to thing messages Semantics and Metadata, Data models and Data
Platform Developer (IoT focus)	Transfer	Bindings of abstract messages to mechanisms provided by each protocol, including choice of communication pattern, e.g. pull, push, pub-sub, peer to peer, etc.
	Transport	REST based protocols, e.g. HTTP, CoAP Pub-Sub protocols, e.g. MQTT, XMPP Others, including non IP transports, e.g. Bluetooth
	Network	Underlying communication technology with support for exchange of simple messages (packets) Many technologies designed for different requirements

The Web of Things: Basic Ideas at W3C

- Making life easier for application developers by

0. Leveraging the existing comm protocols

1. Providing a **simple scripting model**

- Things standing for physical and abstract entities
- Things as software objects with properties, actions and events
- Applications scripts decoupled from underlying protocols which can be selected according to need
- Based upon rich metadata

2. Server creates a **software object (The Thing)** based upon the thing's description

- What properties, actions and events does it have?



The Things: An Abstraction

Applications act on software objects that stand for things

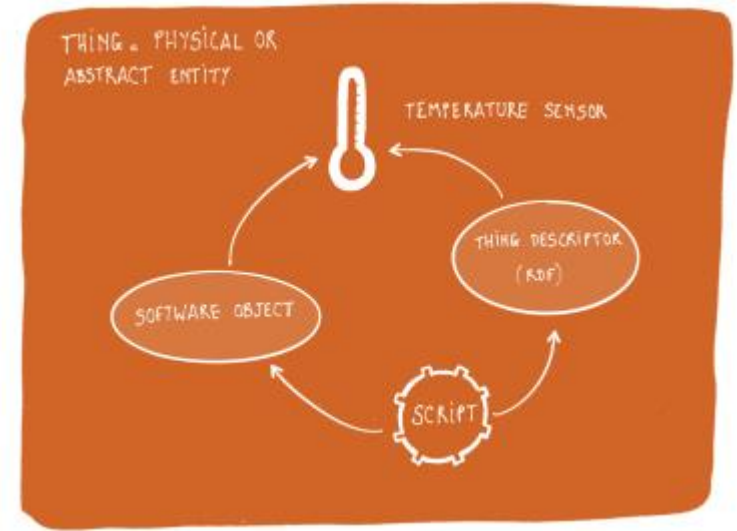
- Local “things”
- Remote “things”

Rich descriptions for every “thing”

- Data models, semantics, metadata
- Ontologies that describe “things”

Things don't need to be connected

- Abstract entities and unconnected physical objects

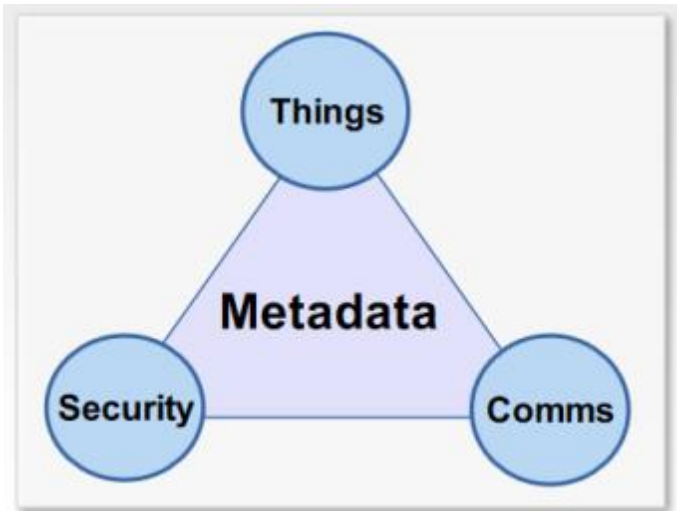


Metadata as key to Platform of Platforms

- Different platforms using different technology standards, different protocols and different data formats
- Web of Things as abstraction layer over these platforms
- Application logic decoupled from the underlying platforms
- Servers rely on rich metadata to communicate

One Level Deeper on Horizontal Metadata

Core metadata applicable across application domains



Communication related metadata

- Protocols and ports
- Data formats and encodings
- Multiplexing and buffering of data
- Efficient use of protocols

Thing descriptions

- Links to thing semantics
- Data models and relationships between things
- Dependencies and version management
- Discovery and provisioning
- Bindings to APIs and protocols

Security related metadata

- Security practices
- Mutual authentication
- Access control
- Terms and conditions -relationship to “Liability”
- Payments
- Trust and Identity Verification
- Privacy and Provenance
- Safety, Compliance and Resilience

Thing Descriptions

Server uses URI for a thing to download its description and create a local proxy object for use by scripts

- Door

```
{
  "events" : {
    "bell": null,
    "key": {
      "valid" : "boolean"
    }
  },
  "properties" : {
    "is_open" : "boolean"
  },
  "actions" : {
    "unlock" : null
  }
}
```

- Light switch

```
{
  "properties" : {
    "on" : {
      "type" : "boolean",
      "writable" : true
    }
  },
}
```

Vocabulary context defines bindings of core vocabulary to URIs for RDF nodes.
Data models may be defined explicitly or by reference to an external definition.

Thing as Agent

- Thing description

```
{
  "properties" : {
    "door" : {
      "type" : "thing",
      "uri" : "door12",
    },
    "light" : {
      "type" : "thing",
      "uri" : "switch12"
    }
  }
}
```

- It's behaviour

```
// invoked when service starts

function start () {
  door.observe("key", unlock);
}

function unlock(key) {
  if (key.valid) {
    door.unlock();
    light.on = true;
  }
}
```

This "thing" is an agent that is bound to a specific door and light switch. It unlocks the door and turns on the light when a valid key is presented.

Horizontal and Vertical Metadata Vocabularies

Industry specific groups are in best position to define vocabularies for each vertical



W3C core metadata vocabularies used across application domains

Enabled by Semantics, Metadata and Data Models

Discovery of services

- The benefits of a lingua franca, and its limitations

Composition of services

- From different vendors for an open market of services

Monetization of services

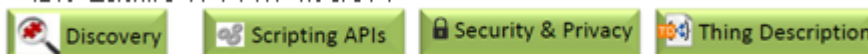
- Support for a wide variety of models

Security, privacy, safety, compliance, trust, resilience

Scaling on multiple dimensions

- From microcontrollers to massive cloud-based server farms

WoT Activities in W3C



W3C WoT IG: Targeting at:

- Discovery
- Scripting APIs
- Security & Privacy
- Thing Description

June 2014

Jan 2015

1st WoT Workshop

W3C Launch the WoT Interest Group

W3C WoT Community Group

provides an informal, pre-standards discussion forum to research, prototype, and create working systems for the Web of Things.

W3C WoT Interest Group

provides a forum for technical discussions to identify use cases and requirements for open markets of applications and services based upon the role of Web technologies for a combination of the Internet of Things (IoT) with the Web of data.



WoT Activities in W3C

Scope Summary

Thing Description:

Semantic vocabularies for describing the data and interaction models exposed to applications, the choice of communications patterns provided by protocols, and serialization formats suitable for processing on resource-constrained devices and transmission over constrained networks.

Scripting API:

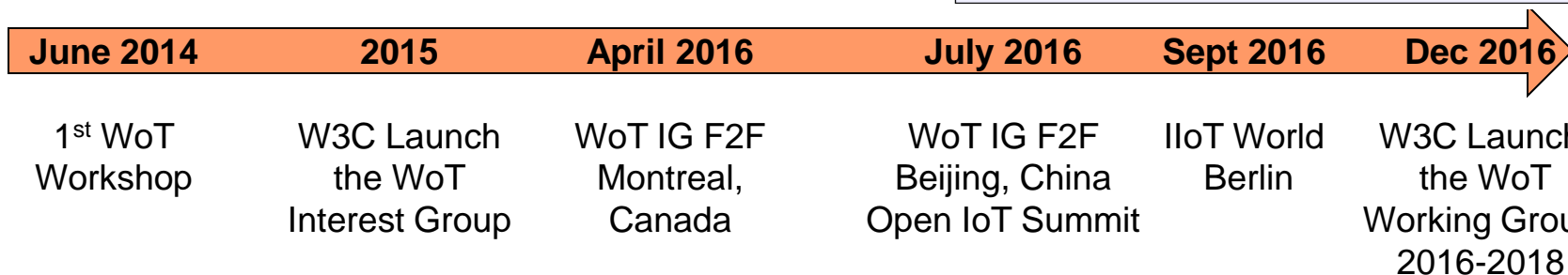
Platform-independent application-facing API for Thing-to-Thing interaction and Thing lifecycle management.

Binding Templates:

Example mappings from the abstract messages to specific common platforms and protocols in collaboration with the corresponding organizations.

Security and Privacy:

Cross-cutting policies and mechanisms integrated into the other building blocks to describe and implement security and privacy policies to enable secure and safe interaction across different IoT platforms.



W3C WoT Working Group

chartered to develop cross platforms standards for thing descriptions and APIs, as well as collaborating with external groups on support for particular IoT platforms.

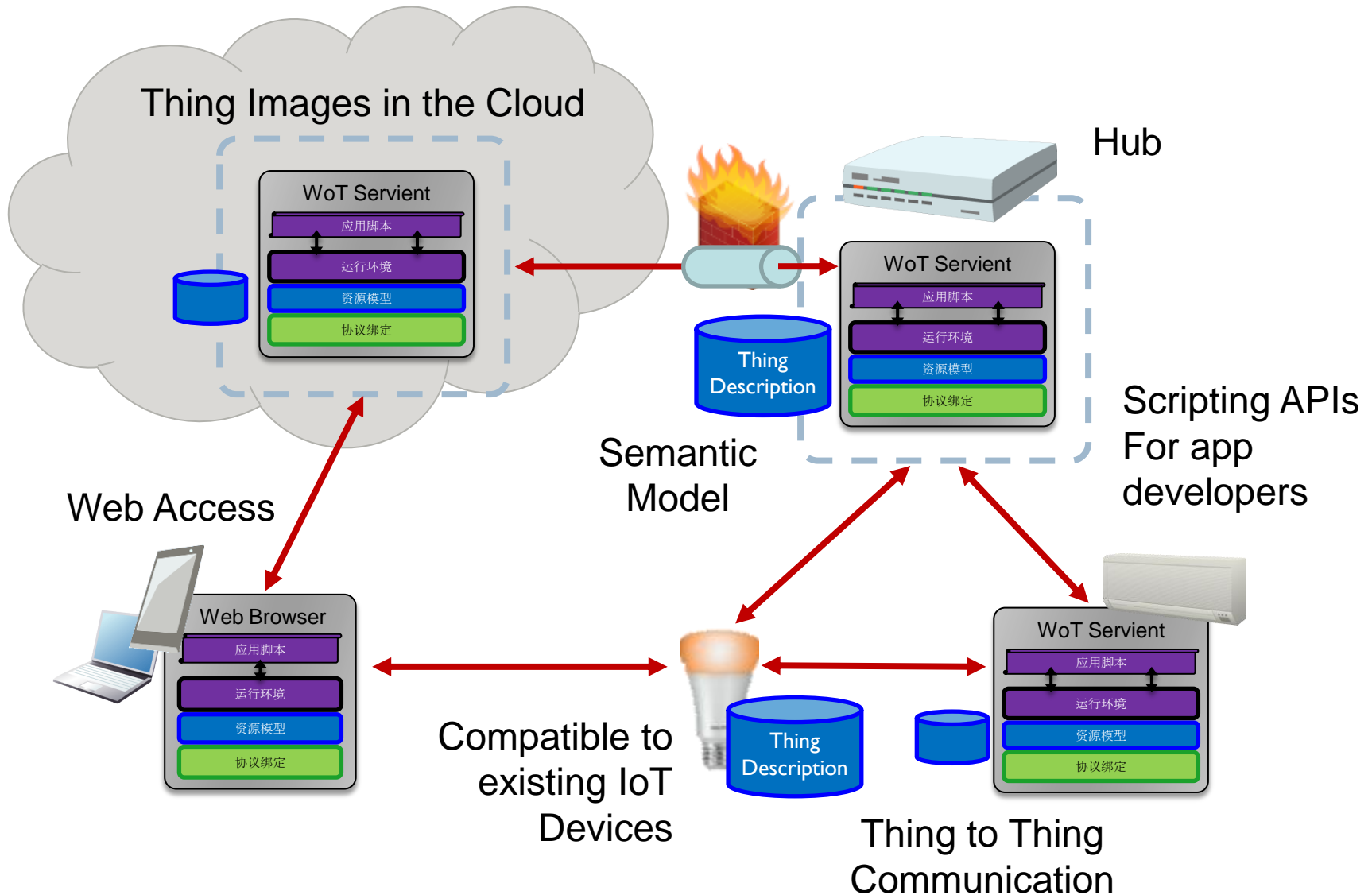
Homepage: <https://www.w3.org/2016/12/wot-wg-2016.html>

Roadmap: Deliverables of W3C WoT WG

- Normative Specifications
 - WoT Architecture (in 12 months)
 - WoT Thing Description (in 22 months)
 - WoT Scripting APIs (in 22 months)
- Informative Specifications
 - WoT Binding Templates
- Other Deliverables
 - WoT Test Cases

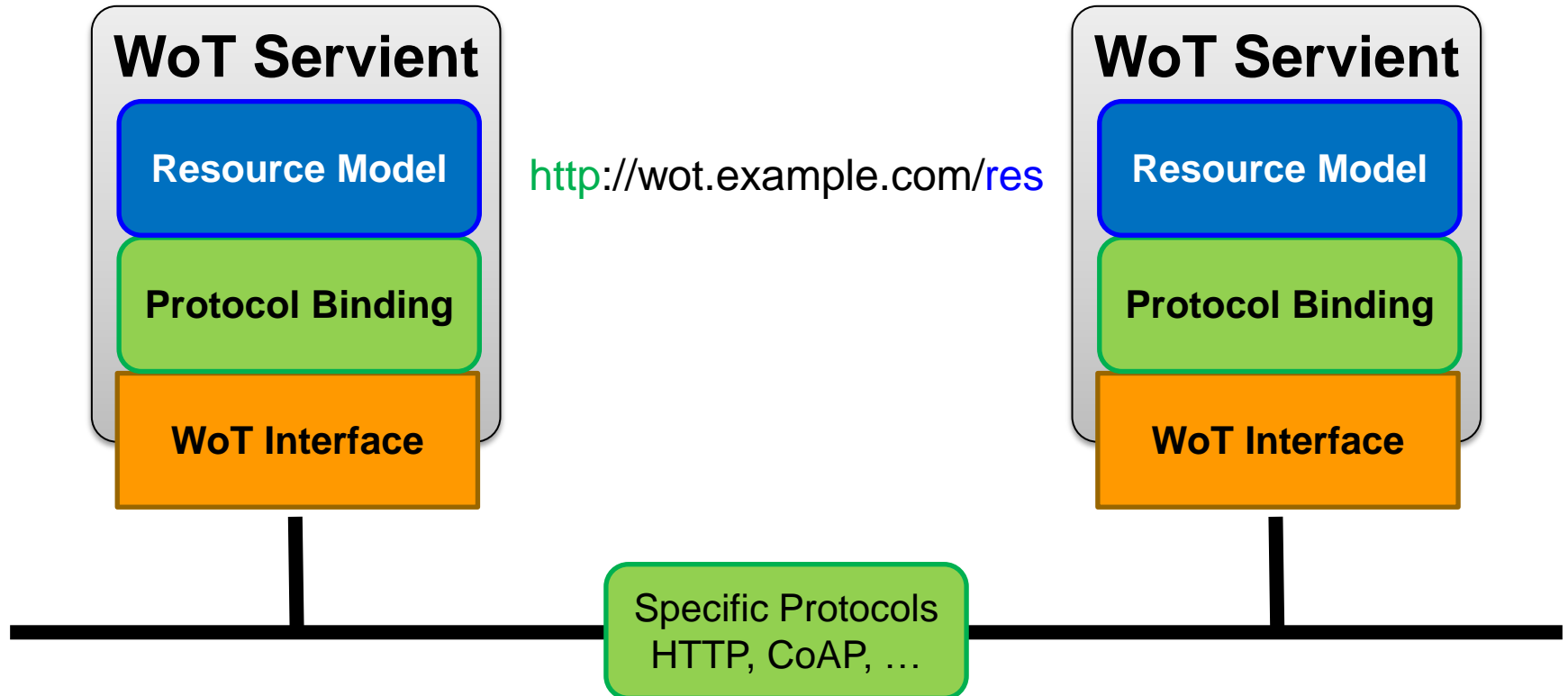


Referenced Architecture for WoT

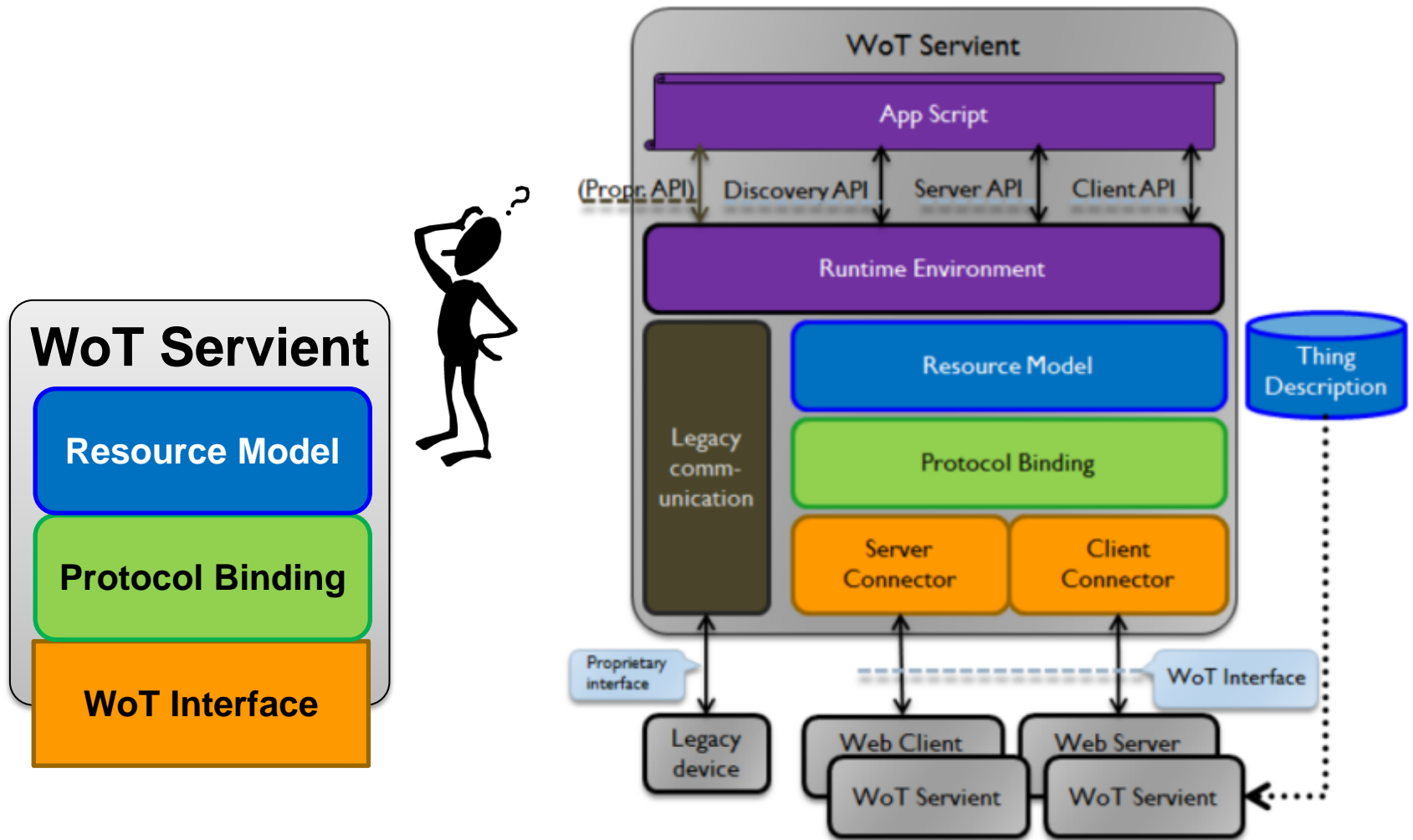


WoT Interfaces, Servients & Protocol Bindings

- WoT Interface is an network accessible interface of servient
- Servient hosts multiple Things with URI as resource identifier



How to implement a WoT Servient?



→ Abstract WoT Servient Model

Interoperability Demo & Test: Plugfest

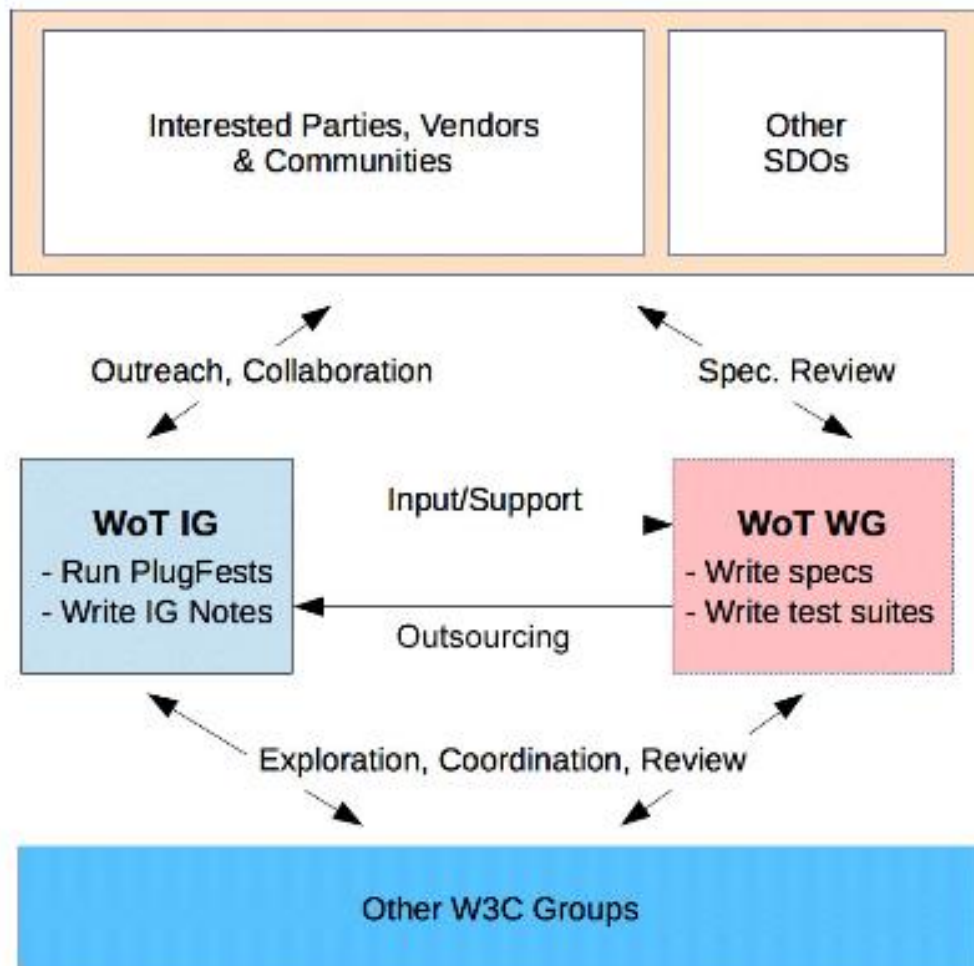
- Coordinated by WoT IG



Global Participation



W3C Activities in WoT



Peer Organizations

- IETF Authentication and Authorization for Constrained Environments (ace) Working Group
- IETF Core Working Group
- OneM2M
- OPC Foundation Open Connectivity Foundation
- IPSO Alliance
- GSMA
- Industrial Internet Consortium
- IoT Security Foundation
- Plattform Industrie 4.0

W3C Groups

- Web of Things Interest Group
- Accessible Platform Architectures Working Group
- Device and Sensors Working Group
- Efficient XML Interchange Working Group
- Spatial Data on the Web Working Group
- Web and Automotive Business & Working Groups
- TV Control Working Group

Enables An Open Market of Things

Apps for connecting suppliers and consumers

- Analogous to marketplaces of apps for smart phones
- SME's can script apps to suit their specific needs

Marketplace features

- Discovery, reviews, recommendations, ranking/reputation
- Dynamic composition to match given requirements
- Automated negotiation of contracts to save time and money

Lifecycle support

- Developing, testing, publishing, vetting, updates, obsolescence



Thank You!

Join W3C to Build a Great Web of Things!

- Acknowledgements:

- The contents of the slides is reproduced from Jeff Jaffe, Dave Ragget , Philip Hoschka, Yingying Chen, Angel Li, and other materials from W3C global team and WoT IG/WG homepage
- Thanks goes to Angel Li for generating the initial draft of this slides.
- More Information, please refer to www.w3.org , and www.chinaw3c.org .