Web Standards for the IoT
IRTF T2TRG WISHI
Prague, Czech Republic, July 2017
Problem: Application/Platform Silos

Internet of Things: Connectivity

IEEE 802.15.4  Ethernet  Wi-Fi  Bluetooth  LoRa  ...
W3C WoT Mission

Not to be yet another standard

SITUATION: THERE ARE 14 COMPETING STANDARDS.

14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES. YEAH!

SITUATION: THERE ARE 15 COMPETING STANDARDS.

SOON:
W3C WoT Mission

Not to be yet another standard

Web of Things: “glue in-between”

Extend Web technologies to the IoT to complement IoT standards by being *descriptive* instead of prescriptive
WoT: cross-platform, cross-domain
W3C WoT Approach

- **Platform A**
  - Application
  - Platform API
  - Data Model
  - Protocol

- **Platform B**
  - Application
  - Platform API
  - Data Model
  - Protocol

**Semantic Metadata**
- complement
- learn how to interact with Thing
- describe Thing
- easy integration across platforms

"WoT Interface"
Describe: Machine-understandable Model

- Linked Data vocabularies
  - Simple interaction model
  - Generic data model (JSON-like)
  - Semantic Web ontology
- Extension points
  - Domain-specific vocabularies
  - New interaction patterns
- Multiple serializations
  - JSON-LD (first CR release)
  - JSON, CBOR, EXI, ...

Start with versatile core and evolve like the Web

*CR: W3C Candidate Recommendation*
Linked Data

JSON-LD Serialization

```json
{
    "@context": [
        "http://w3c.github.io/wot/w3c-wot-td-context.jsonld",
        { "domain": "http://example.org/actuator#" }
    ],
    "@type": "Thing",
    "name": "MyLEDThing",
    "security": {
        "cat": "token:jwt",
        "alg": "HS256",
        "as": "https://authority-issuing.example.org"
    },
    "interaction": [
        {
            "@type": ["Action", "domain:fadeIn"],
            "name": "fadeIn",
            "inputData": {
                "type": "integer",
                "minimum": "0",
                "domain:unit": "domain:ms"
            },
            "link": [ { "href": "coaps://myled.example.com:5684/in" }, ..snip.. ]
        }
    ]
}
```

W3C WoT TD vocabulary

domain-specific vocabulary

JSON Schema base types plus semantics

Linked Data domain-specific vocabulary

W3C WoT TD vocabulary
Complement: Building Blocks

- WoT Thing Description (TD)
  - Machine-understandable format
  - Uniform documentation

- WoT Binding Templates
  - Descriptions for specific protocols and platforms
  - Used in Thing Description
  - Re-usable binding “drivers”

- WoT Scripting API
  - Browser-like runtime for platform-independent IoT applications
W3C WoT Building Blocks

Platform A

- Application
- Platform API
- Data Model
- Protocol
W3C WoT Building Blocks

WoT Thing Description (TD) with simple interaction model

Properties
Events
Actions

Thing Description

WoT Servient

Runtime Environment

App Script 1

App Script 2

Scripting API

Interaction Model

Binding Templates

Server

Client

Expose

Consume

Local Hardware

WoT Binding Templates to connect to different platforms and ecosystems

HTTP
OCF
BACnet
CoAP
OneM2M

Things can be in client and/or server role: “Servient”

WoT Scripting API for browser-like runtime environment

JavaScript
Lua

JavaScript
Lua
W3C WoT Architecture Patterns

Cloud

- Servient
  - Digital Twin
  - Orchestr. Client
  - Digital Twin
  - Scripting API
  - Interaction Model
  - Binding Templates

Edge Hubs

- Servient
  - Virtual Thing
  - Orchestr. Client
  - Proxy Thing
  - Scripting API
  - Interaction Model
  - Binding Templates

Direct Thing-to-Thing Interaction

Web Integration

- Web Browser
  - App Script
  - Scripting API
  - Interaction Model
  - Binding Templates

Existing Device

- Thing
  - App Script
  - Scripting API
  - Interaction Model
  - Protocol

- Thing
  - Classic Firmware
  - Interaction Model
  - Protocol

- Virtual Thing
  - Scripting API
  - Interaction Model
  - Binding Templates

Complement Existing Devices
# W3C WoT Process

<table>
<thead>
<tr>
<th>Interest Group (IG)</th>
<th>Working Group (WG)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://www.w3.org/2016/07/wot-ig-charter.html" alt="Image of W3C WoT Process" /></td>
<td><img src="https://www.w3.org/2016/12/wot-wg-2016.html" alt="Image of W3C WoT Process" /></td>
</tr>
<tr>
<td>• Started spring 2015</td>
<td>• Started December 2016</td>
</tr>
<tr>
<td>• 220 participants</td>
<td>• 92 participants</td>
</tr>
<tr>
<td>• Informal work, outreach</td>
<td>• Normative standardization</td>
</tr>
<tr>
<td>• Explorative work, validation</td>
<td>• Work on deliverables</td>
</tr>
<tr>
<td>• PlugFests with running code</td>
<td>• W3C Patent Policy for royalty-free standards</td>
</tr>
<tr>
<td>• Liaisons and collaborations with other organizations and SDOs (+ “OpenDays”)</td>
<td>• Member organizations and Invited Experts</td>
</tr>
</tbody>
</table>
W3C WoT Process

• IG: https://github.com/w3c/wot/
• WG:
  – https://github.com/w3c/wot-architecture
  – https://github.com/w3c/wot-thing-description
  – https://github.com/w3c/wot-scripting-api/
  – https://github.com/w3c/wot-binding-templates
• Open Issues to comment, Pull Requests to contribute
W3C WoT Progress

• 2014: Stakeholders identified at W3C Workshop
• 2015: IG started to identify initial building blocks
  – Practical evaluation in “PlugFests”
• 2016/17: WG chartered until end of 2018
  – Editor’s Drafts available
  – First Public Working Drafts expected August 2017
  – Candidate Recommendations end of 2018…
• 2019: WG re-chartering for next building blocks
  – IG is continuously exploring and identifying
Opportunities for Reuse/Integration

- Royalty-free Web standards
- Technological building blocks
  - Non-prescriptive: take what you need
  - Open source reference implementation
    [https://github.com/thingweb/node-wot](https://github.com/thingweb/node-wot)
- Extension points
  - Semantic vocabulary ➔ iot.schema.org, oneM2M, ...
  - Binding Templates ➔ Web, CoRE, OCF, oneM2M, ...
  - Libraries on top of Scripting API ➔ individual Members
Opportunities for Collaboration

1. OpenDay at W3C WoT Face-to-Face
   – Proposed and invited talks for awareness

2. W3C WoT Call invites
   – Opportunity for more detailed discussions

3. Liaisons as formal collaboration
   – Chance for mutual alignment
   – Liaison inputs taken into account for WoT design

4. W3C WoT Group Member
   – Organization needs to be W3C Member
   – Invited Expert status
   – Note W3C Patent Policy for WG contributions
     (https://www.w3.org/Consortium/Patent-Policy-20040205/)
Opportunities for Research

• Machine-understandable interaction models
  – Hypermedia controls → IRTF T2TRG
  – Programming abstractions for orchestration
  – Recovery from errors
• Semantic Web beyond knowledge management
  – Dynamic graphs
  – Privacy preservation
  – Reasoning in constrained environments
• Security in loosely-coupled systems
  – Object signing and encryption
W3C WoT Online Resources

• W3C WoT Wiki (IG+WG organizational information)
  – https://www.w3.org/WoT/IG/wiki/Main_Page

• W3C WoT Interest Group
  – https://www.w3.org/2016/07/wot-ig-charter.html (charter)
  – https://lists.w3.org/Archives/Public/public-wot-ig/ (subscribe to mailing list)
  – https://github.com/w3c/wot (technical proposals)

• W3C WoT Working Group
  – https://www.w3.org/2016/12/wot-wg-2016.html (charter)
  – https://www.w3.org/WoT/WG/ (dashboard)

• W3C WoT Editor’s Drafts
  – https://w3c.github.io/wot-architecture/
  – https://w3c.github.io/wot-thing-description/
  – https://w3c.github.io/wot-scripting-api/
  – https://w3c.github.io/wot-binding-templates/