• You may be recorded

• The IPR guidelines of the IETF apply: see http://irtf.org/ipr for details.
Adminstrivia (I)

- Pink Sheet
- Note-Takers
- Off-site (Jabber, Hangout?)
  - `xmpp:t2trg@jabber.ietf.org?join`
- Mailing List: `t2trg@irtf.org` — subscribe at: https://www.ietf.org/mailman/listinfo/t2trg
- Repo: https://github.com/t2trg/2019-ietf104
# Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Who</th>
<th>Subject</th>
<th>Docs</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:10</td>
<td>Chairs</td>
<td>Intro, RG Status</td>
<td><a href="#">draft-irtf-t2trg-iot-seccons</a> <a href="#">draft-irtf-t2trg-rest-iot</a></td>
</tr>
<tr>
<td>16:20</td>
<td>Chairs, various</td>
<td>Report from <a href="#">WISHI</a>, <a href="#">Pre-IETF work meeting</a> and Hackathon</td>
<td></td>
</tr>
<tr>
<td>16:40</td>
<td>Michael Koster</td>
<td><a href="#">W3C Community Group on Schema extensions for IoT</a>; schema.org update</td>
<td></td>
</tr>
<tr>
<td>16:55</td>
<td>Matthias Kovatsch</td>
<td><a href="#">W3C Web of Things</a> WG/IG update</td>
<td></td>
</tr>
<tr>
<td>17:15</td>
<td>Klaus Hartke</td>
<td>Using <a href="#">CoRAL</a> to bring more hypermedia to IoT</td>
<td></td>
</tr>
<tr>
<td>18:05</td>
<td>Chairs</td>
<td>Meeting Planning, Wrap-up</td>
<td></td>
</tr>
</tbody>
</table>
CORAL Side Meeting

- Wednesday 15:00..17:00, Tyrolka
T2TRG scope & goals

• Open research issues in turning a true "Internet of Things" into reality
  • Internet where low-resource nodes ("things", "constrained nodes") can communicate among themselves and with the wider Internet

• Focus on issues with opportunities for IETF standardization
  • Start at the IP adaptation layer
  • End at the application layer with architectures and APIs for communicating and making data and management functions, including security
IRTF and IETF?

CoRE: protocol engineering for RESTful environments

T2TRG: open research issues with IETF potential

LWIG: Informational guidance for implementers
Recent activities

- Work on IoT/Semantic Hypermedia Interoperability (WISHI): bi/tri-weekly calls and hackathons

- WebEx session with OMA SpecWorks on IETF technologies and LwM2M

- Friday work meeting at IETF 104
Next meetings

• Regular WISHI calls (~ monthly / bi-weekly; continue in May)
• Virtual meetings with OCF
• Virtual meetings with OMA SpecWorks (LwM2M & IPSO)
• W3C WoT workshop June 3..5
• Montreal IETF 105 (July 20..26)
  • WISHI hackathon Sat/Sun, July 20/21
  • Joint meeting with OMA SpecWorks Fri, July 19
• Co-locating with academic conferences 2019?
“State-of-the-Art and Challenges for the IoT Security” RFC Editor Queue

“RESTful Design for IoT” (next slides)

Upcoming:

- Edge & IoT
- CoRE apps, collections part from CoRE interfaces, ... (see Friday meeting notes)
- Layer 3 considerations?
- WISHI notes (see WISHI wiki)
- Document(s) to be shaped from CoRAL drafts
RESTful Design for IoT next steps

- Adding new terminology
- Experiences from building IoT systems with (constrained) RESTful+ methods
- More outside (of IRTF/IETF) reviews
- Ready for publication by IETF 105?
RESTful Design for IoT Terminology

• New terms: "transfer protocols" and "transfer layer"

• Has been used in CoRE WG and T2TRG for a decade but not yet formally defined

• Examples: CoAP, (all versions of) HTTP; also AMQP, MQTT, XMPP, ...

• Draft definitions:
  
  • Transfer protocols: in particular in IoT domain, protocols above transport layer that are used to transfer data objects and provide semantics for operations on the data.

  • Transfer layer: re-usable part of the application protocol used to transfer the application specific data items using a standard set of methods that fulfill application-specific operations.
• Six online meetings since IETF103, discussing e.g.:
  • Splot Object Model
  • IoT extensions to schema.org
  • Best practices for data model component re-usability
  • Adding semantics to existing instances of data
  • Parsing & translating binary data
  • Exposing more structured media types in hypermedia exchanges
WISHI hackathon results

• 5th WISHI IETF Hackathon

• ~12 participants (1 remotely)

• Connecting things from different ecosystems using shared semantics and hypermedia
What got done

- New parser for text form CoRAL
- Basic CoRAL encoder and parser and CIRI module for RIOT OS
- CoRAL examples and use cases
- Web of Things (WoT) Thing Description (TD) to CoRAL translation
- Python CoRAL implementation with visualization updated to latest CoRAL
- Resource Directory implementation improvements
- LwM2M TD generator with latest TD
What we learned

• CoRAL works (for resource discovery and beyond)

• Hackathons useful for getting implementation and testing guidance

• We have now better idea(s) on how all this should be integrated to achieve interoperability
Friday work meeting

- Data model component reusability
- Using CoRAL to bring more hypermedia to IoT
- Common Metamodel Language
- T2TRG deliverables on IoT security
- Edge and IoT
- Layer 3 considerations: T2T end-to-end
Data model component reusability

• Vocabulary definitions and terms mapping needed
  • affordances, traits, resources, objects, attributes, primary/secondary purpose, inherent/external features...
• Need tools to describe the aspects in data models
• Need language independent from transport
• Need guidelines on the tradeoffs of fixed/dynamic features
• Common Metamodel Language
• How to expose things at hypermedia level
Using CoRAL to bring more hypermedia to IoT

• CoRAL comes without batteries today: we need to build a base set of batteries
  • Common, composable vocabulary
    In particular: Link relation types
  • Tools
• Authorization topics and relation to RD interesting
• Exploring CoRAL complexity and ROMability
Common Metamodel Language

• Abstraction with expressive power for high fidelity details of different models
• Each ecosystem mapping to same model
• Protocol bindings and semantic annotations
• How to make usable for domain experts: “core dump” vs. “language”
T2TRG deliverables on IoT security

- Draft: Enabling network access for IoT devices from the cloud
- Success factors / lessons learned of security mechanisms for joining networks (e.g., EAP)
- Specific (constrained) IoT requirements for new crypto
Edge and IoT

• Together with COINRG and DINRG
• Thing-centric view to edge computing?
• Beyond edge and abyss computing
• Pub/sub broker & RD as instances of network storage
• Terminology and fragments of architecture useful
• Draft: IoT Integrated with Edge Computing

• Industrial IoT topic
L3 considerations: T2T end-to-end

• Routing/reachability problems when connecting constrained node-networks (e.g., Thread) with other LANs (e.g., home network) in between
  • Need infra management (e.g., HNCP)
• Discovery with e.g., CoRE RD -- and RD discovery
• Isolation control and SWORN

• Someone should implement all this and see where are the gaps
IoT Extensions for schema.org

T2TRG IETF 104
March 26, 2019
Brief Status

• Community Group formed but still not active
  • Need to elect chairs and create the mail list
• One Data Model proposal
• Integration of IoT extensions into schema.org
One Data Model Proposal

- High level semantic model that is aligned with the pattern we have been using for the prototype definitions
- "has" property types
- `DataItem` class without any directionality
- Protocol Binding based on `@type` annotations in OCF/Swagger definition files - same format as the WoT TD annotation

- [https://github.com/mjkoster/ODM-Examples](https://github.com/mjkoster/ODM-Examples)
UML Model

Device Type and Constraints e.g. Thermostat, Light

Composable Capabilities e.g. onoff, level, temperature

Events, Actions, Properties

Data Types, Enums
Capabilities

{
    "@id": "st:SwitchCapability",
    "rdfs:subClassOf": "odm:Capability",
    "rdfs:comment": "Basic On/Off Switch Capability",
    "rdfs:label": "SmartThings Switch Capability",
    "odm:hasInteractionAffordance": [
        "st:Switch.valueProperty",
        "st:Switch.onAction",
        "st:Switch.offAction"
    ]
},
{
    "@id": "st:SwitchLevelCapability",
    "rdfs:subClassOf": "odm:Capability",
    "rdfs:comment": "Capability to control the level",
    "rdfs:label": "SmartThings SwitchLevel Capability",
    "odm:hasInteractionAffordance": [
        "st:SwitchLevel.levelProperty",
        "st:SwitchLevel.setLevelAction"
    ]
}
Properties, Actions, Events

```
{
    "@id": "st:SwitchLevel.levelProperty",
    "rdfs:comment": "The current level setting",
    "rdfs:label": "SwitchLevel levelProperty",
    "@type": "odm.PropertyInteraction",
    "rdfs:subClassOf": "odm:InteractionAffordance",
    "odm:hasDataItem": "st:SwitchLevel.levelData"
},
{
    "@id": "st:SwitchLevel.setLevelAction",
    "rdfs:comment": "Action to set the level",
    "rdfs:label": "SwitchLevel setLevelAction",
    "@type": "odm:ActionInteraction",
    "rdfs:subClassOf": "odm:InteractionAffordance",
    "odm:hasDataItem": [
        "st:SwitchLevel.levelData",
        "st:SwitchLevel.rateData"
    ]
}
```
Data Items

{
    "@id": "st:Switch.valueData",
    "rdfs:comment": "value data for Switch (on/off string encoding)",
    "rdfs:label": "SmartThings SwitchLevel.levelData",
    "rdfs:subClassOf": "odm:DataItem",
    "odm:DataItemType": "js:string",
    "js:enum": ["on", "off"]
},
{
    "@id": "st:SwitchLevel.levelData",
    "rdfs:comment": "Level data for SwitchLevel",
    "rdfs:label": "SmartThings SwitchLevel.levelData",
    "rdfs:subClassOf": "odm:DataItem",
    "odm:DataItemType": "js:integer",
    "js:minimum": 0,
    "js:maximum": 100
},
{
    "@id": "st:SwitchLevel.rateData",
    "rdfs:comment": "Rate time data for setLevelAction",
    "rdfs:label": "SmartThings SwitchLevel.rateData",
    "rdfs:subClassOf": "odm:DataItem",
    "odm:DataItemType": "js:integer",
    "js:minimum": 0,
    "js:maximum": 65535
}
OCF Definition with annotated paths and operations

"paths": {
  "/BinarySwitchResURI" : {
    "@type": [ 
      "ocf:BinarySwitch.valueProperty",
      "ocf:BinarySwitch.OnAction",
      "ocf:BinarySwitch.OffAction"
    ],
    "get": { 
      "@type": "ocf:BinarySwitch.valueProperty",
    }
  }

  "post": { 
    "@type": [ 
      "ocf:BinarySwitch.valueProperty",
      "ocf:BinarySwitch.OnAction",
      "ocf:BinarySwitch.OffAction"
    ],
  }
}
OCF Definition with data annotations

(...)
"minItems": 1,
"readOnly": true,
"type": "array"
},
"value":
{
"@type": [
"ocf:BinarySwitch.valueData",
"ocf:BinarySwitch.OnValueData",
"ocf:BinarySwitch.OffValueData"
],
"description": "Status of the switch",
"type": "boolean"
},
Schema.org integration

• Contribution to schema.org based on our prototype definition ontology (the terms need work)
• Capability, InteractionAffordance, Event, Action, Property, DatalItem classes
• ProvidesInteractionPattern, AcceptsInputData, ProvidesOutputData property types
• DatalItem constraints using PropertyValueConstraint or other suitable vocabularies (e.g. JSON Schema)
• Fol property types
• The definitions can be in external namespaces, only the core model needs to be accepted to start
schema.org IoT Extension
Core Model

schema:thing

providesInteractionPattern

Capability

InteractionPattern

providesOutputData

acceptsInputData

DataItem

Action

Event

Property

schema:PropertyValue

schema:PropertyValueSpec

rdfs:subclassOf

schema:Property

iotschema Class

Reused Class
Feature of Interest Properties
Schema.org integration

• Drive it through issues and discussion on our iotschema-collab github organization and in the new CG

• At some key point, create issues on the schema.org github organization
Technical Plan – Schema.org Integration

• Develop the existing ontology to be suitable for integration into schema.org
  • Terminology needs broad agreement

• Develop the references and browser navigation hooks to definitions in external namespaces
Technical Plan – Definitions

• Create example definition sets from existing ecosystems - Annotation and Feature Extraction
  • ZCL/dotdot, OCF, LWM2M, SmartThings

• Create a Developer Guideline for new definitions and for using existing definitions

• Collect useful tools and scripts

• New classes
  • Data classes
  • Capability sets for common Thing types?
  • Definitions for common Enumerations?
Technical Plan – Web Interface

• Add Shapes Constraints to the definitions
• Develop the browser navigation hooks
• Determine namespace references from schema.org
Technical Plan – Feature of Interest

- Develop integrations for external FoI ontologies
  - Automotive (VSS Schema)
  - Buildings (Brick Schema)
  - Sensor data and geospatial (W3C, OGC)
  - Industrial (IIC collaboration?)

- Examples of annotations including domain-specific FoI definitions
W3C WoT Update

IETF 104, T2TRG, Prague, Czechia, March 2019
**W3C Web of Things - Building Block Approach**

**WoT Architecture**
Overarching umbrella with architectural constraints and guidance on how to use and combine building blocks.

**WoT Thing Description (TD)**
- JSON-LD representation format to describe Thing instances with metadata. Uses formal interaction model and domain-specific vocabularies to uniformly describe how to use Things, which enables semantic interoperability.
- **The index.html for Things**

**Security Guidelines**

**WoT Scripting API**
Standardized JavaScript object API for an IoT runtime system similar to the Web browser. Provides an interface between applications and Things to simplify IoT application development and enable portable apps across vendors, devices, edge, and cloud.

**WoT Binding Templates**
Capture how the formal Interaction Model is mapped to concrete protocol operations (e.g., CoAP) and platform features (e.g., OCF). These templates are re-used by concrete TDs.

**Protocol Bindings**
- HTTP
- MQTT
- CoAP

**Interaction Model**

**Application Script**

**Common Runtime**

**Scripting API**
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**The index.html for Things**
Properties
Events
Actions

**Common Runtime**
Application Script

**Scripting API**
Interaction Model
Protocol Bindings

HTTP
MQTT
CoAP
W3C Web of Things - Timeline

- 2014: 25-26 June 2014 WoT Workshop, Berlin, Germany
- 2015: 21 Jan 2015 WoT Interest Group (IG) Chartered
- 2016: 27 Dec 2016 WoT Working Group (WG) Chartered
- 2016: 1 Aug 2016 WoT IG Re-chartered
- 2018: 15 June 2018 JSON-LD 1.1 WG Chartered
- 2019: 3-5 June 2019 2nd WoT Workshop, Munich, Germany
- 2019: 30 June 2019 WoT IG/WG End of Charter
W3C Web of Things - Timeline

- Preparation of Documents, Explainers, etc.
- 28 Jan – 2 Feb 2019 F2F Meeting Princeton, NJ, USA
- Wide Review of Drafts
- 9 April 2019 Candidate Recommendation Transition
- 3-5 June 2019 2nd WoT Workshop Munich, Germany
- 21 May 2019 Proposed Recommendation Transition
- 30 June 2019 WoT IG/WG End of Charter

Tell your AC Rep

https://w3c.github.io/wot-architecture/
https://w3c.github.io/wot-thing-description/
2nd W3C Workshop on the Web of Things

Disseminate the findings and discuss the way forward

• When: 3-5 June 2019
• Where: Munich, Germany

• Call for Participation
  – Expressions of interest OR position paper (1-5 pages) REQUIRED
  – [http://www.easychair.org/conferences/?conf=wotws2](http://www.easychair.org/conferences/?conf=wotws2)
  – Deadline: 15 April 2019
  – Notification: 29 April 2019

• [https://www.w3.org/WoT/ws-2019/cfp.html](https://www.w3.org/WoT/ws-2019/cfp.html)
Contact

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