T2TRG: Thing-to-Thing Research Group

IETF 104, March 26, 2019, Prague, CZ

Chairs: Carsten Bormann & Ari Keränen

Note Well

- You may be recorded

- The IPR guidelines of the IETF apply:
  see **http://irtf.org/ipr** for details.

Administrivia (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

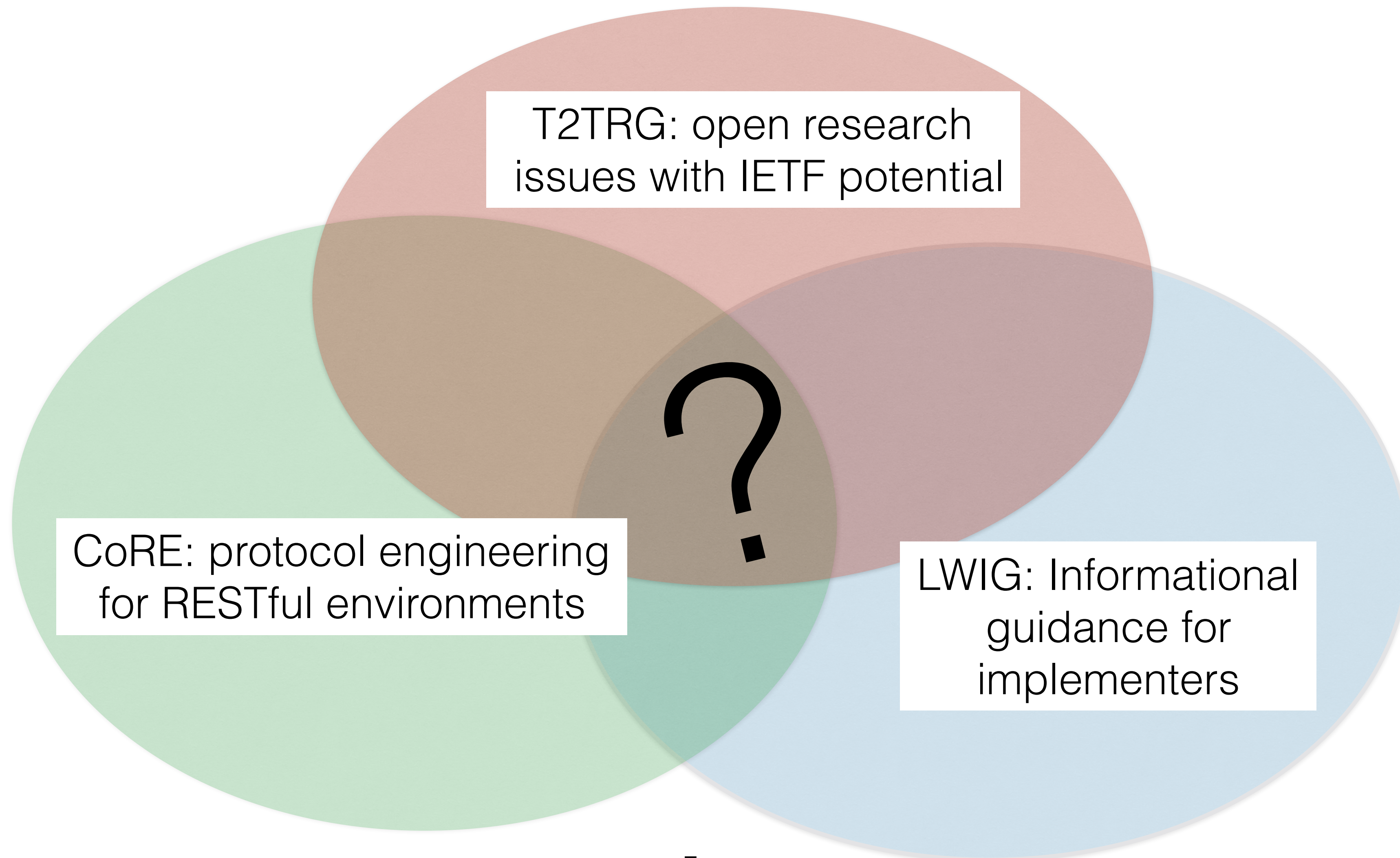| Time	Who	Subject	Docs
16:10	Chairs	Intro, RG Status	[draft-irtf-t2trg-iot-seccons](#) [draft-irtf-t2trg-rest-iot](#)
16:20	Chairs, various	Report from [WISHI](#), [Pre-IETF work meeting](#) and Hackathon	
16:40	Michael Koster	[W3C Community Group on Schema extensions for IoT](#); schema.org update	
16:55	Matthias Kovatsch	[W3C Web of Things](#) WG/IG update	
17:15	Klaus Hartke	Using [CoRAL](#) to bring more hypermedia to IoT	
17:50	Christian Amsüss	Resource Directory Replication	[draft-amsuess-core-rd-replication](#)
18:05	Chairs	Meeting Planning, Wrap-up	

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?

T2TRG: open research issues with IETF potential

CoRE: protocol engineering for RESTful environments

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 <u>WISHI</u> 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?

RG Doc Status

- "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.
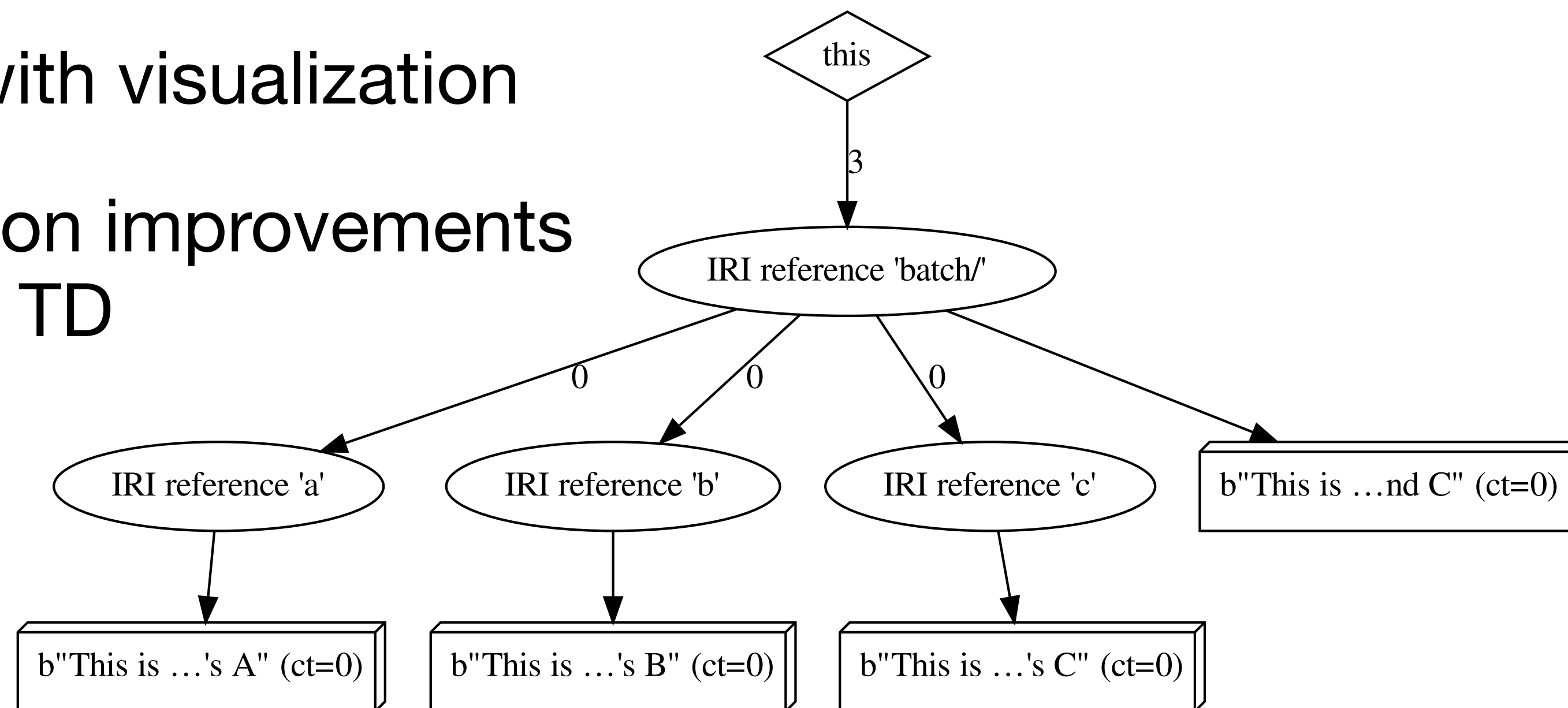
WISHI

- 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 <u>encoder and parser</u> and <u>CIRI module</u> 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

this

3

IRI reference 'batch/'

0   0   0

IRI reference 'a'   IRI reference 'b'   IRI reference 'c'   b"This is …nd C" (ct=0)

b"This is …'s A" (ct=0)   b"This is …'s B" (ct=0)   b"This is …'s C" (ct=0)

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

- <u>Draft</u>: 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
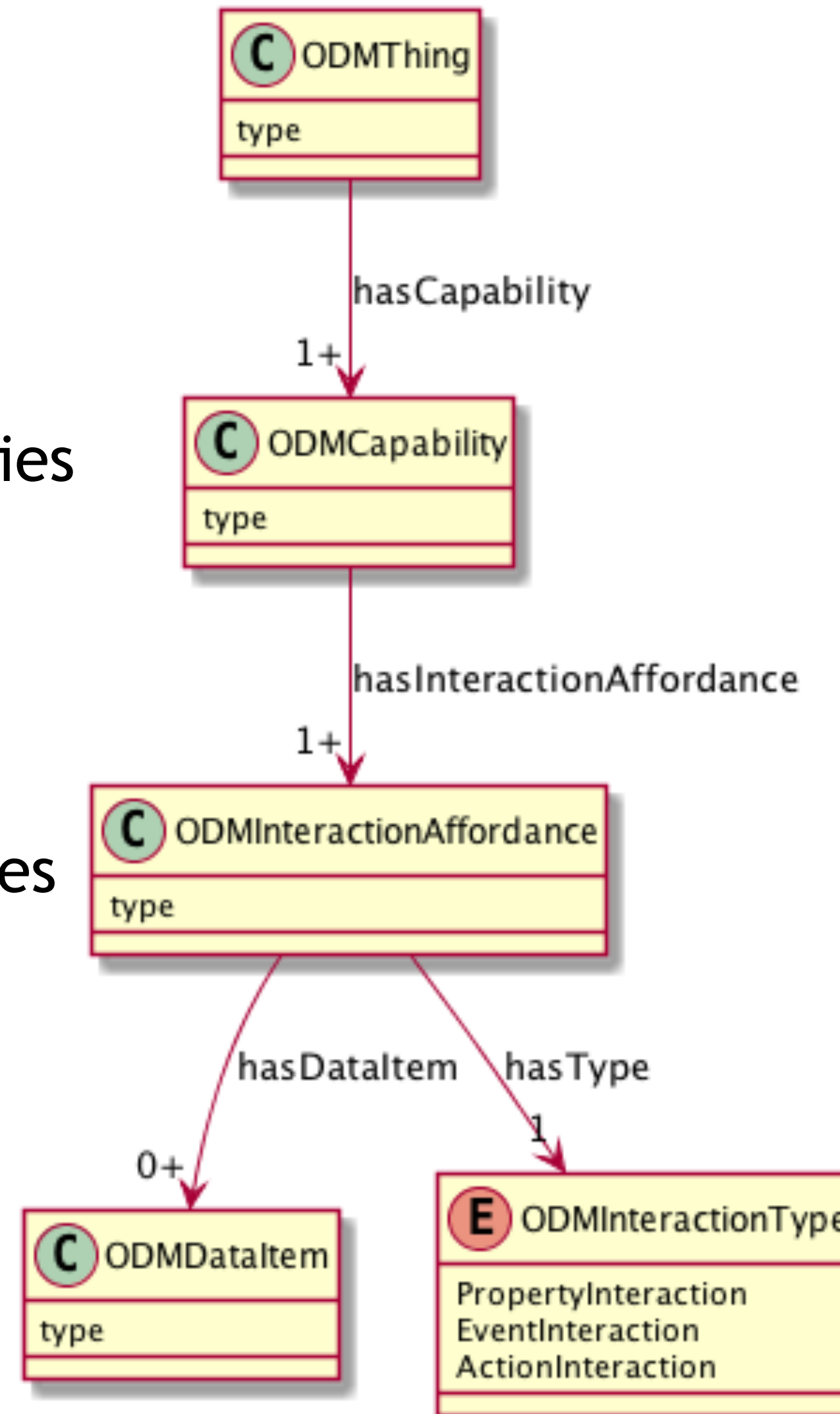
- https://github.com/mjkoster/ODM-Examples

UML Model

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

```json
{
  "@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"
},
```
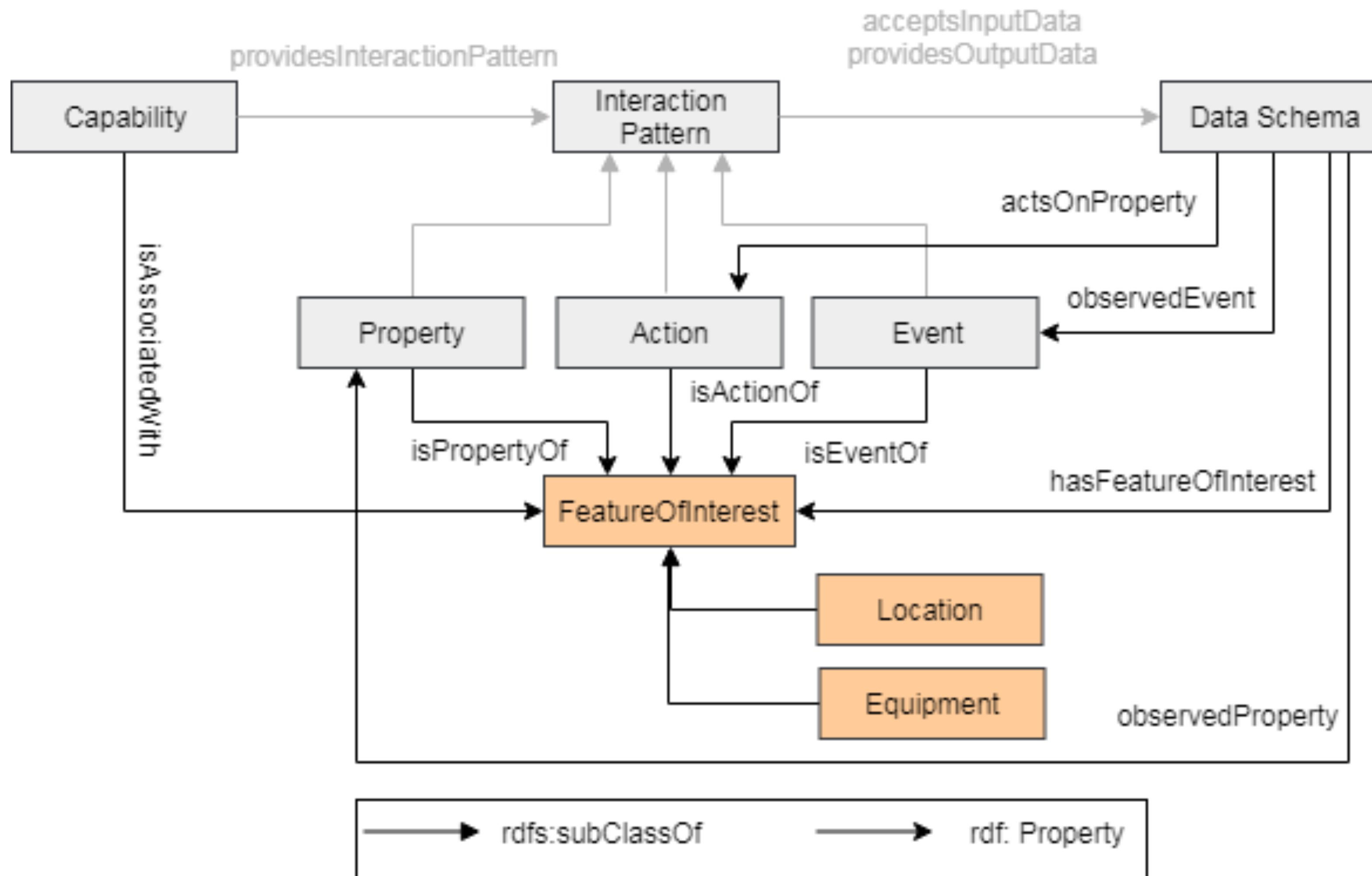
Schema.org integration

- Contribution to schema.org based on our prototype definition ontology (the terms need work)
- Capability, InteractionAffordance, Event, Action, Property, DataItem classes
- ProvidesInteractionPattern, AcceptsInputData, ProvidesOutputData property types
- DataItem constraints using PropertyValueConstraint or other suitable vocabilaries (e.g. JSON Schema)
- FoI 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
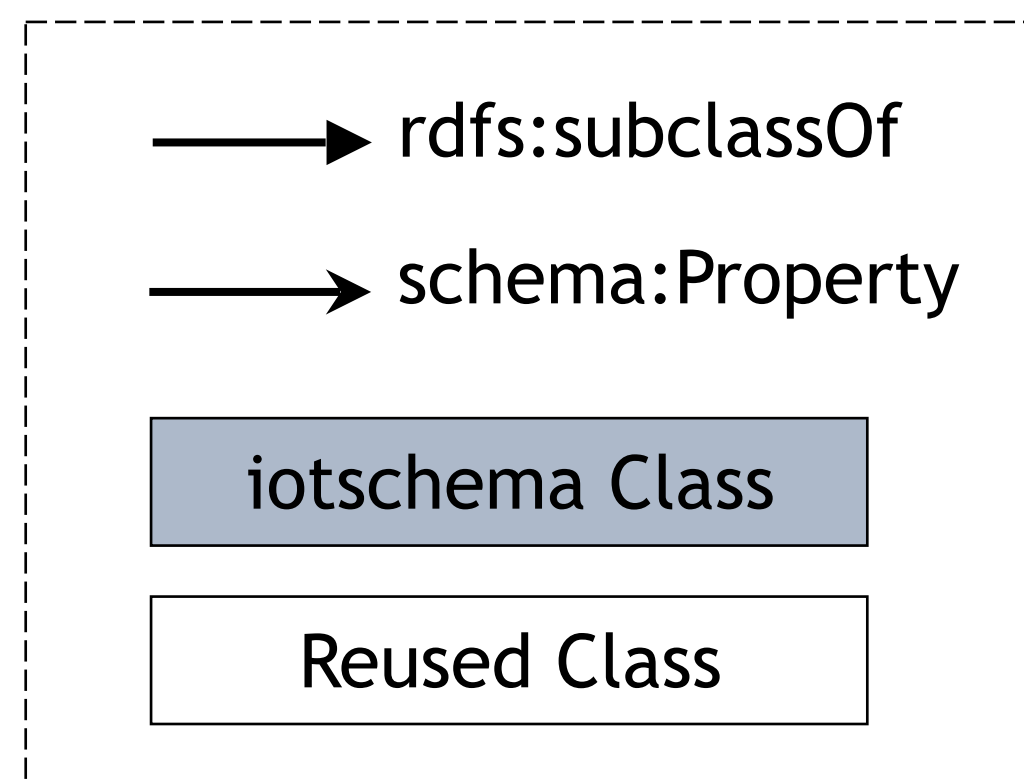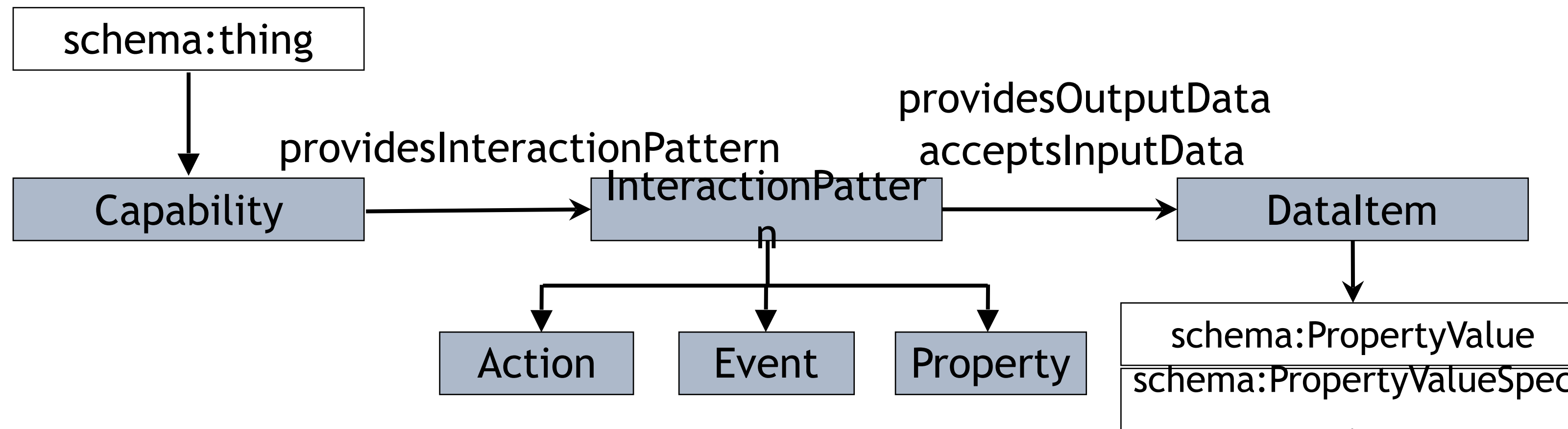
Feature of Interest Properties

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
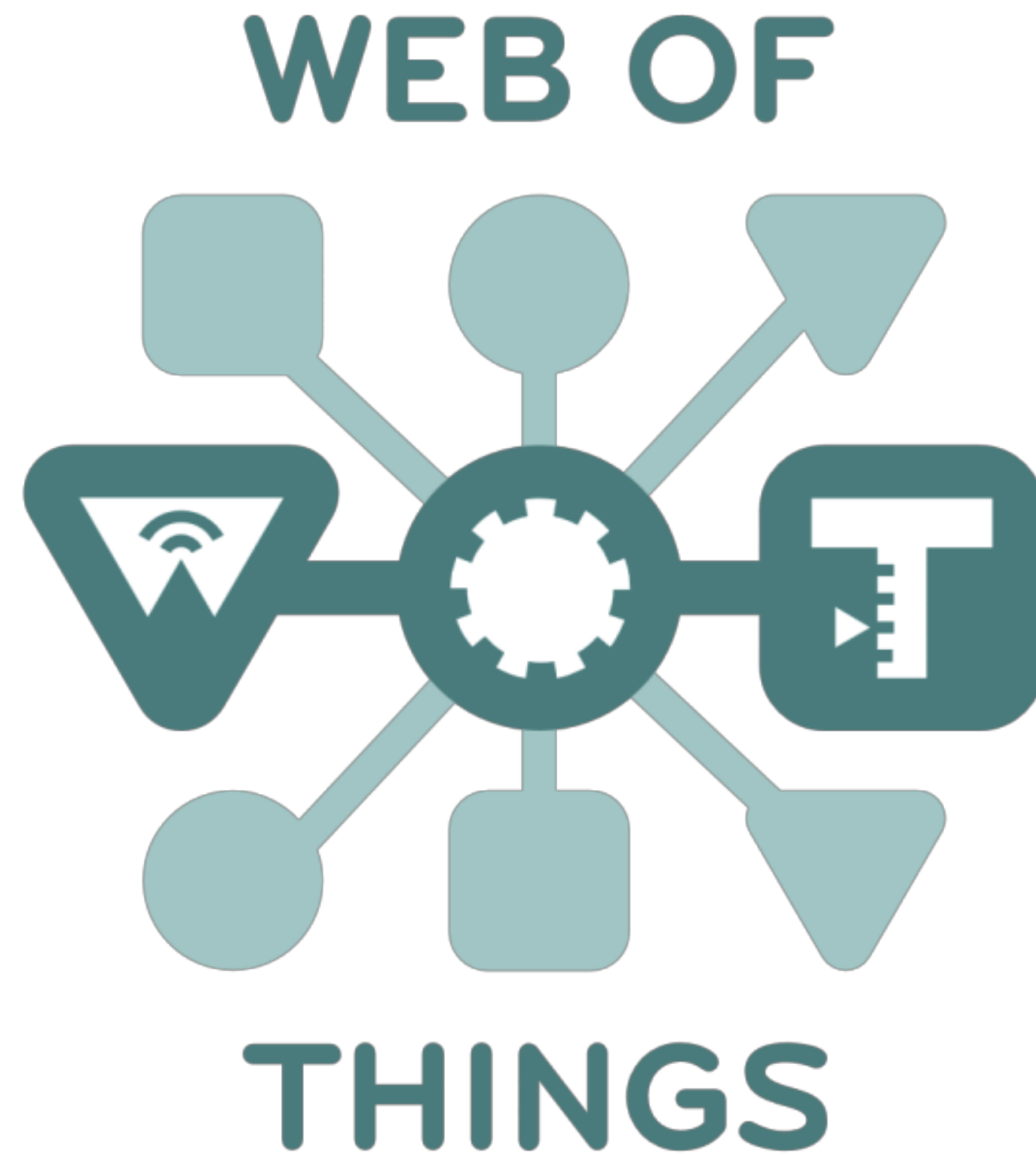
W3C WoT Update

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

Properties

Actions

Events

Security Guidelines

Common Runtime

Application Script

Scripting API

Interaction Model

Protocol Bindings

TD

HTTP
CoAP
MQTT …

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.

W3C Web of Things – Building Block Approach

REC Track

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 Things' interfaces with **metadata**. Uses **formal interaction model** and **domain-specific vocabularies** to uniformly describe how to use Things, which enables semantic interoperability.

REC Track

The *index.html* for Things

TD

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HTTP
CoAP
MQTT …

WoT Scripting API

Standardized **JavaScript** object API for an IoT runtime environment **similar to the Web browser**. Eases development of IoT applications and services by providing an abstraction layer between vendor, device, edge, and cloud.

Downgrade to WG Note

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.

W3C Web of Things – Timeline

Now

21 Jan 2015
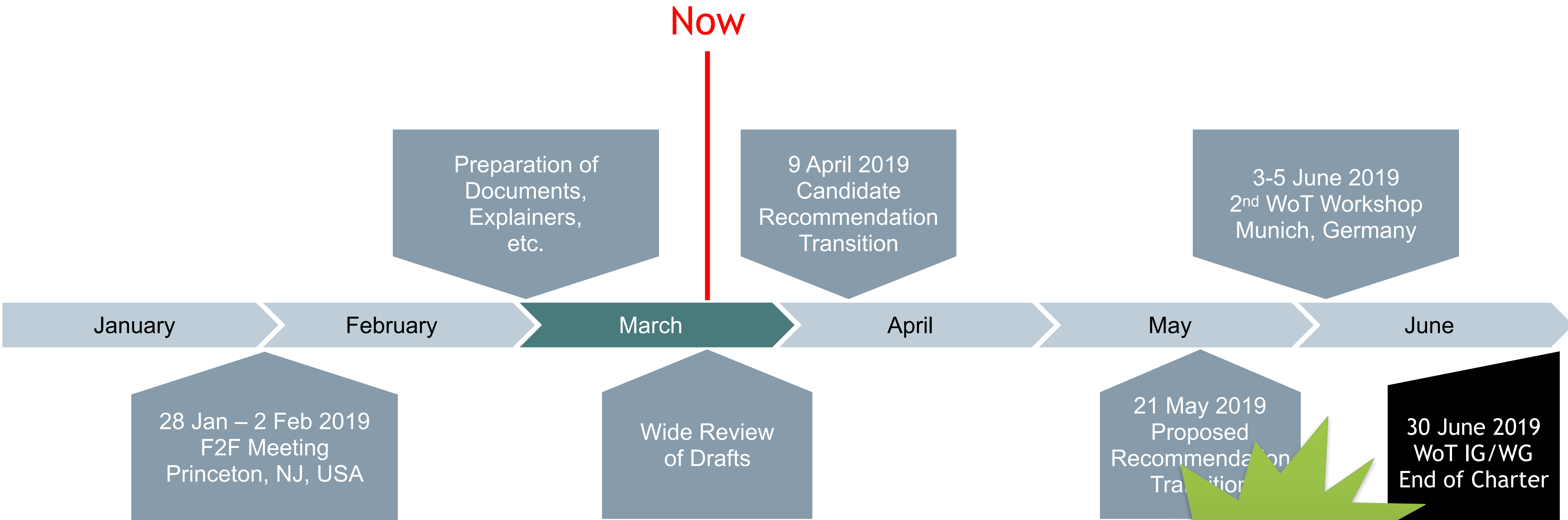WoT Interest Group
(IG) Chartered

27 Dec 2016
WoT Working Group
(WG) Chartered

3-5 June 2019
2nd WoT Workshop
Munich, Germany

2014   2015   2016   2017   2018   2019

25-26 June 2014
WoT Workshop
Berlin, Germany

1 Aug 2016
WoT IG
Re-chartered

15 June 2018
JSON-LD 1.1 WG
Chartered

30 June 2019
WoT IG/WG
End of Charter

W3C Web of Things – Timeline

Now

| Preparation of Documents, Explainers, etc. | 9 April 2019 Candidate Recommendation Transition | 3-5 June 2019 2nd WoT Workshop Munich, Germany |

January · February · March · April · May · June

28 Jan – 2 Feb 2019 F2F Meeting Princeton, NJ, USA

Wide Review of Drafts

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
  - Deadline: 15 April 2019
  - Notification: 29 April 2019

- https://www.w3.org/WoT/ws-2019/cfp.html

Contact

https://www.w3.org/WoT/WG/

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