Practical Semantic Interoperability for Connected Things or - Avoiding the XKCD 927 Effect

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This is mostly informational

- What problem is being solved?
- What is iot.schema.org?
- How does iot.schema.org work?
- Who is iot.schema.org for?
- How is iot.schema.org intended to be used?
- What is the status, the gaps?
- How do I get involved?
This is the Problem being solved:

Source: https://xkcd.com/927/
Background

- IoTSI - IoT Semantic Interoperability Workshop
- WISHI – Work on IoT Semantic and Hypermedia
- Many different models and protocols for a common set of high level patterns
- Semantic Normalization vs. Protocol Translation
- Diversity in device protocols is a feature
Problem being solved – Semantic Interoperability for IoT

• Acknowledge the diversity of IoT device ecosystems
  • Not another device standard
  • Adaptive to diverse protocol, language, and data models
  • Distill the common and stable operational features
  • Second "narrow waist" for systems above IP networks

• Address the ease of use of Semantic Web for IoT and use of IoT for Semantic Web
  • Not another IoT ontology
  • A conceptual layer that models connected things in relation to existing ontologies
Narrow Waist in System Design

Many Applications. Local and Remote

Common Infrastructure (Protocols, Formats, and Meta Models)

Many Devices, Different Ecosystems

Web of Things

Semantic Interoperability (Software Adaptation)

Internet of Things

IP Networks
LAN/WAN (WiFi, Thread)

Fairhair  OCF  dotdot  LWM2M
Diverse Devices and Applications, Common Protocols and Semantics

- Diverse Applications
  - Web of Things: Narrow Waist of Semantics
  - Internet of Things: Narrow Waist of Protocols

  - Applications
    - Semantic Vocab
    - Thing Description
    - Protocol Binding
    - Device Ecosystems
      - Protocols, Formats
        - Transport
        - Networks

  - Interoperable Applications
    - Narrow Waist of Protocols
      - iot.schema.org: W3C Thing Description
      - IETF CoAP, CBOR, Link-Format
      - OCF, OMA, Zigbee, Fairhair
      - UDP/TCP
      - WiFi, IPV6, Bluetooth
What is iot.schema.org

• A layer to bridge between device ecosystems and Semantic Web technology, consisting of
• Publicly available, reusable, interoperable, and compose-able definitions for connected things
• Property and relation types to enable reuse of existing ontologies and definitions
  • SSN, SOSA, SAREF, QUDT
  • Property types for e.g. Feature of Interest
• Follow the example and align with Schema.org
  • Extend the schema.org patterns
  • Community contributions and open license
iot.schema.org Definitions

• Semantic definitions that follow the design patterns and interaction affordances of connected thongs
• Interoperable due to a set of static and dynamic semantic constraints
• Define a "Capability" that represents – typically – the smallest practical compose-able unit of functionality
• For example, a temperature sensor, or a door lock
iot.schema.org Capabilities

• Abstract functionality around a simple functional concept, e.g. **temperature sensor**, or **door lock**
• Often associated with a class of physical quantity or artifact, e.g. "temperature" or "door"
• Capabilities are associated with Interactions and Data Items in the iot.schema.org conceptual model
• The Interactions and Data Items are the basis for protocol and data-model neutral definitions
iot.schema.org Categories

• Capability
  • Discovery of things that satisfy application requirements
  • Static constraints as part of the definition

• Interaction
  • Adaptation of the application to the affordances of the connected thing
  • Static constraint with compose-able elements

• Data Item
  • Adaptation of the application to the data format, types, engineering units, range and scale
  • Static or dynamic constraints
iot.schema.org Conceptual Integration with other ontologies

• Feature of Interest concepts and property types to describe location, equipment, or other classifiers
• For example, BrickSchema definitions from Haystack
• Quantity and Units constraints can use QUDT concepts and appropriate identifiers
• SSN, SOSA, SAREF concepts can extend a definition
• Definitions and instances may be annotated in RDF
Integration with other Ontologies

Enables Well-Characterized interactions with Physical Entities

Feature of Interest, O&M
Situation, Provenance

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Definition

Quantities, Units, Shapes,
Property Value Constraint

Software
Affordances
Connect things to the real world

"Lock Security Doors and Check" Action

Door Lock

- ActuateLock Interaction
- ActuateUnlock Interaction
- GetState Interaction -> LockState Data

isAssociatedWith

Door

- Is A Front Door
- Opens To Outside
- Is A Security Door

DoorLock Capability

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other ontologies
Feature of Interest Properties
Specific Use Cases

- Semantic annotation of thing and data instances
  - RDF instances, LDP, etc.
  - WoT Web of Things Thing Description
  - HTML Web page using microformats or JSON-LD in `<script>` tag
  - Target attributes in web links (RFC8288 et. al.)
  - Metadata for ad-hoc annotation as type

- Selective Semantic Discovery using YFQL
- Automatic configuration of IoT applications, rules, and behaviors
- Standalone semantics for data analysis, data at rest
Extended use Cases are enabled

- Declarative Semantic API using the meta-interaction model directly
- Abstract constructor language for building and composing instances of exposed things
  - OCF, OMA LWM2M/IPSO, Zigbee/dotdot, BLE
  - C2C API management (OpenAPI + Semantic Annotation)
  - HAL, Hydra, JSON-Hyperschema,..
- Interoperable definitions for orchestrations: rules, behaviors, scenes, and enumerations
W3C WoT Thing Description

• Semantic annotation for Thing Description instances
• Describes Things using Capability identifiers
• Describes TD Events, Actions, and Properties using Interaction identifiers
• Describes DataSchema instances using Data Item identifiers and constraint systems
• Thing Description contains concrete Protocol Bindings for specific transfer layer operations
Status

• Monthly Teleconferences since mid-2017
• Examples of Definitions in a Github repository
• Fol annotation examples are also in the repo
• Prototypes tested at W3C Web of Things Plugfests and WISHI/IETF Hackathons from mid 2017
• Some contributors are ready to begin submitting definitions
• We need to build out some tools and processes
• W3C Community Group with Web of Things
References

• iot.schema.org
  • https://github.com/iot-schema-collab/teleconferences/blob/master/README.md
  • https://github.com/iot-schema-collab/intro-materials
  • https://github.com/iot-schema-collab/teleconferences

• W3C Web of Things IG/WG
  • https://www.w3.org/WoT/WG/
Thank You!

• Questions ?