

# iot.schema.org

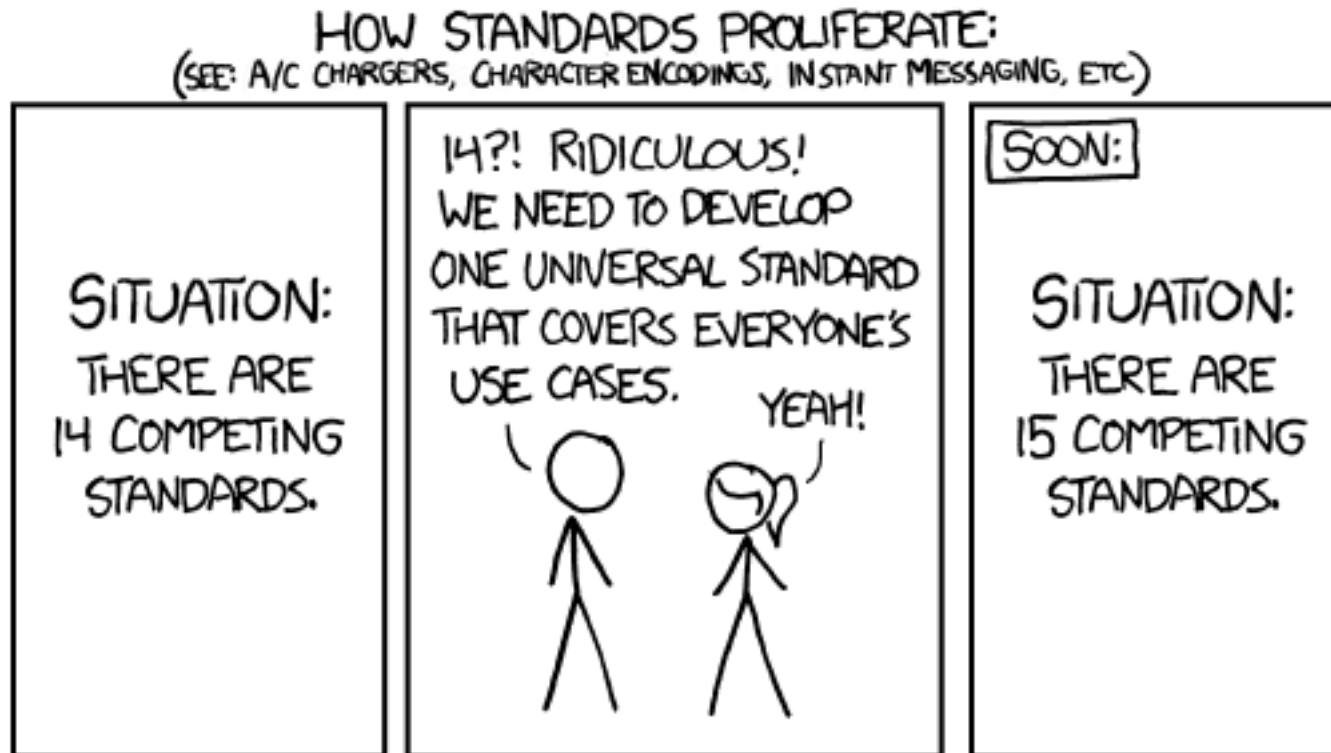
Practical Semantic Interoperability for Connected Things  
or - Avoiding the XKCD 927 Effect

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# This is mostly informational

- What problem is being solved ?
- What is [iot.schema.org](http://iot.schema.org) ?
- How does [iot.schema.org](http://iot.schema.org) work ?
- Who is [iot.schema.org](http://iot.schema.org) for ?
- How is [iot.schema.org](http://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/>

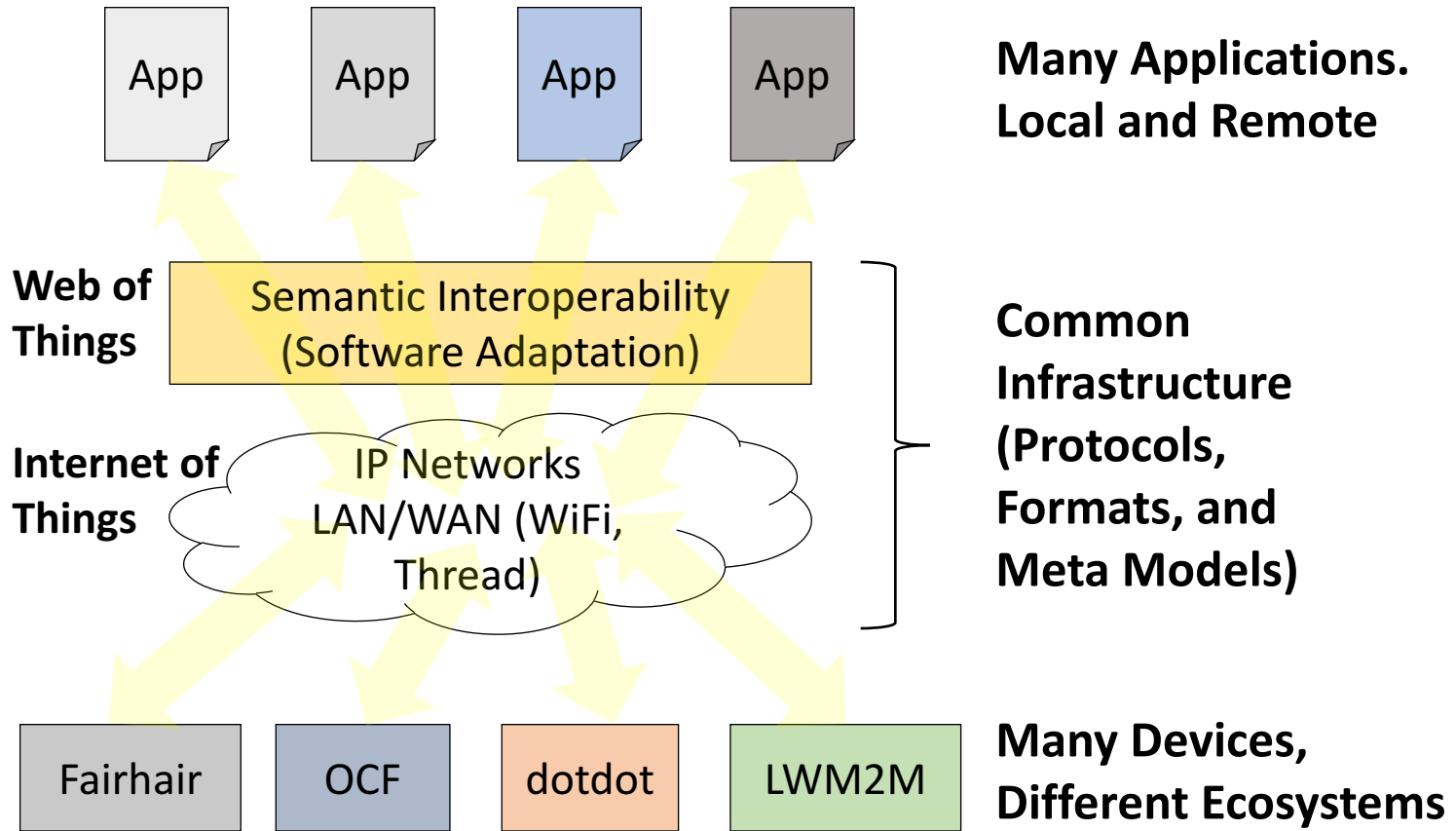
# Background

- IoTSI - IoT Semantic Interoperability Workshop
- WISHI – Work on IoT Semantic and Hypermedia i15
- 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

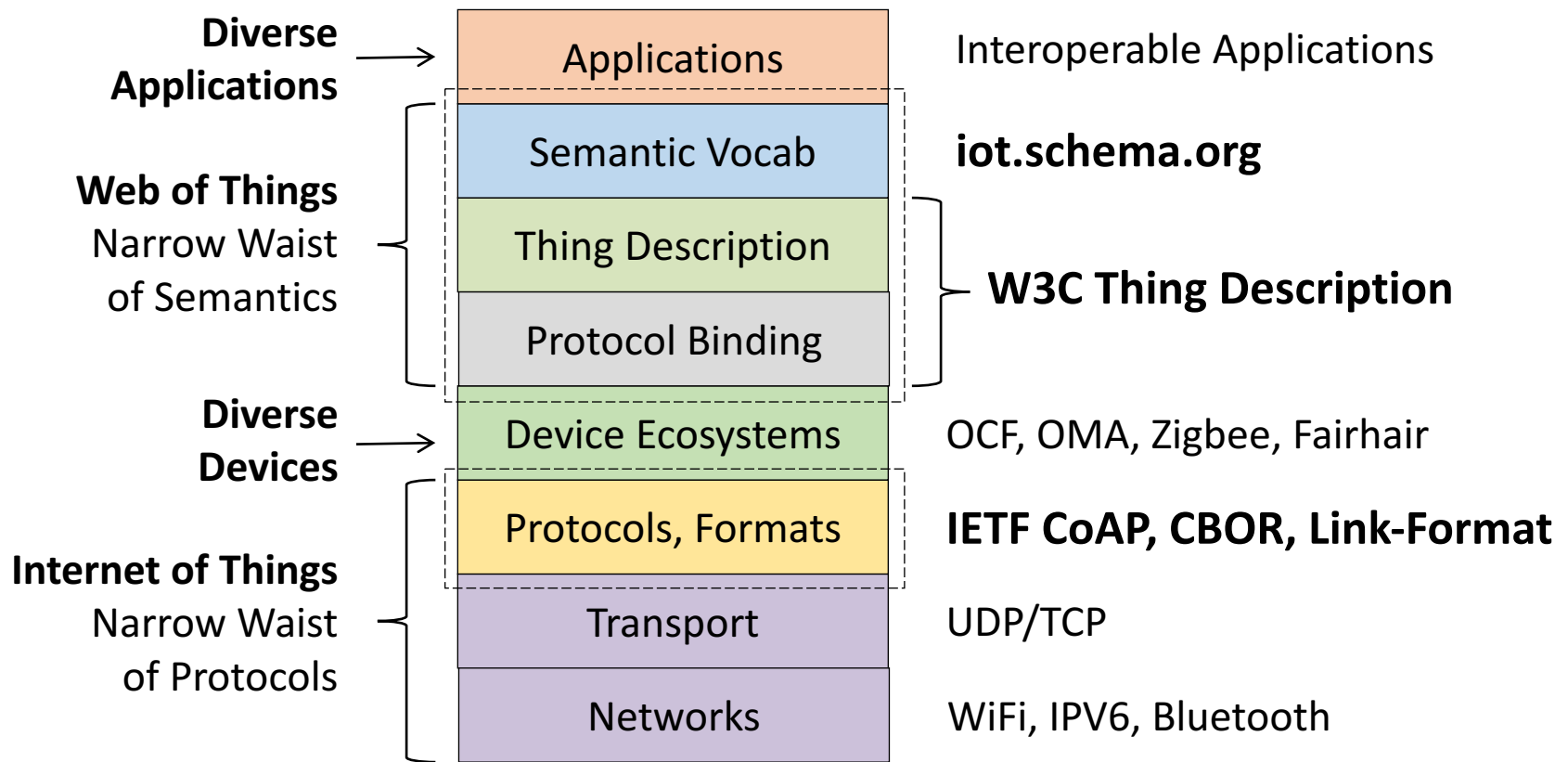
# Problem being solved – Semantic Interoperability for IoT

- 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



# Diverse Devices and Applications, Common Protocols and Semantics



# What is [iot.schema.org](http://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



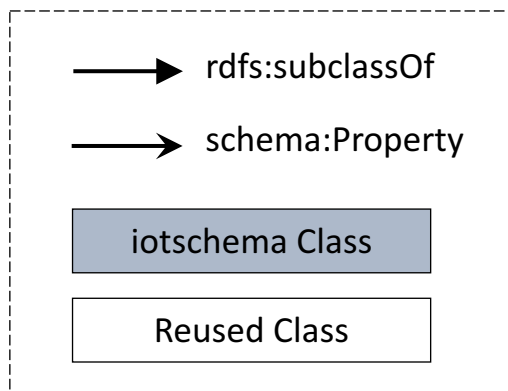
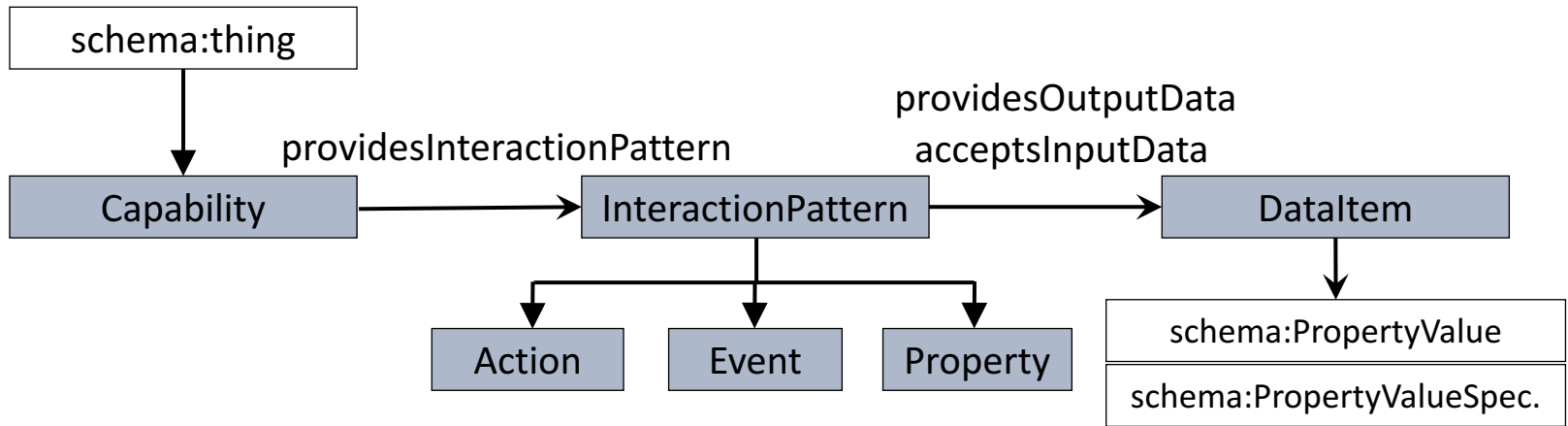
# iot.schema.org Definitions

- Semantic definitions that follow the design patterns and interaction affordances of connected things
- 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/Classes



# 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



iot.schema.org  
Definition

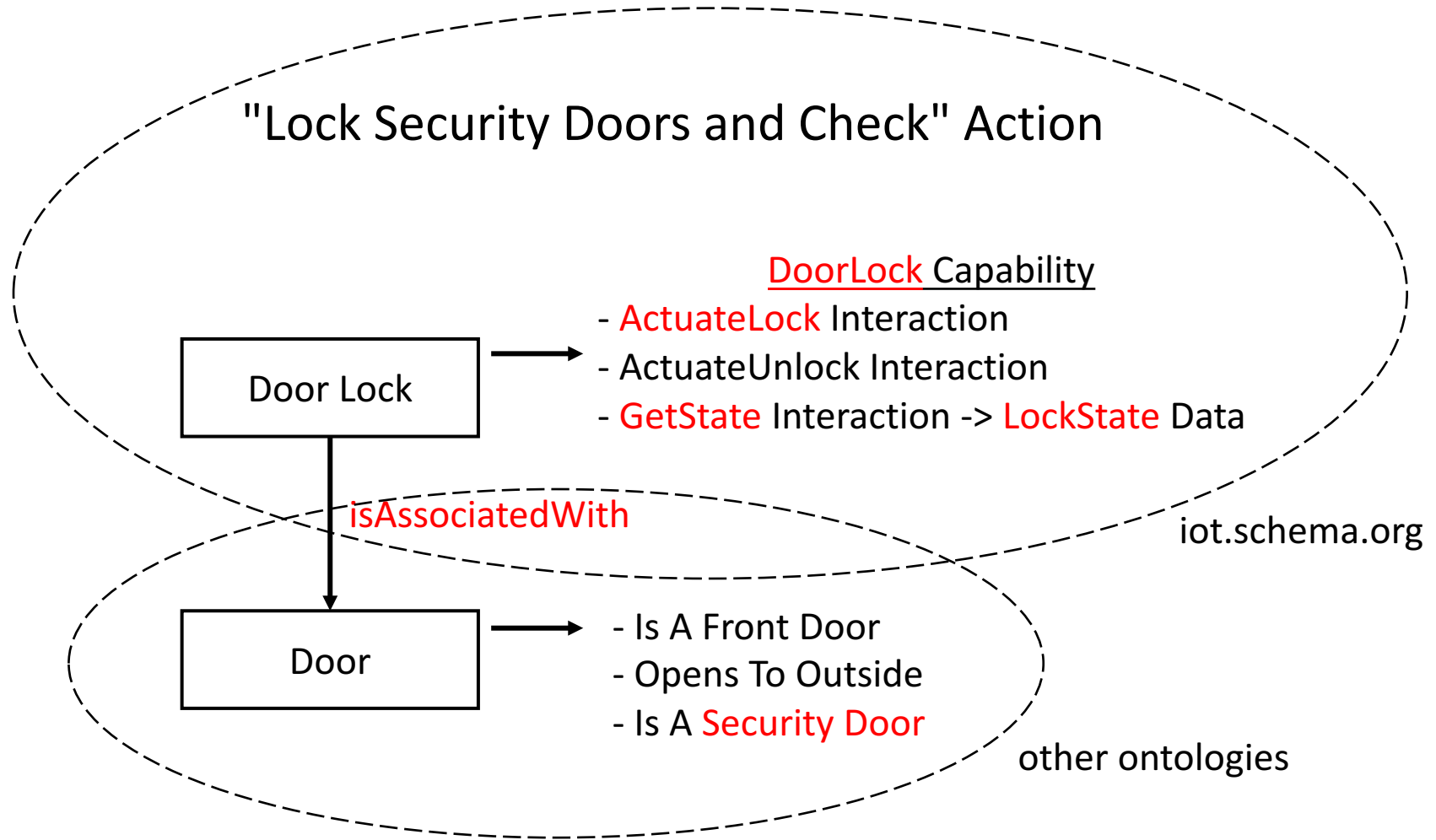
Software  
Affordances



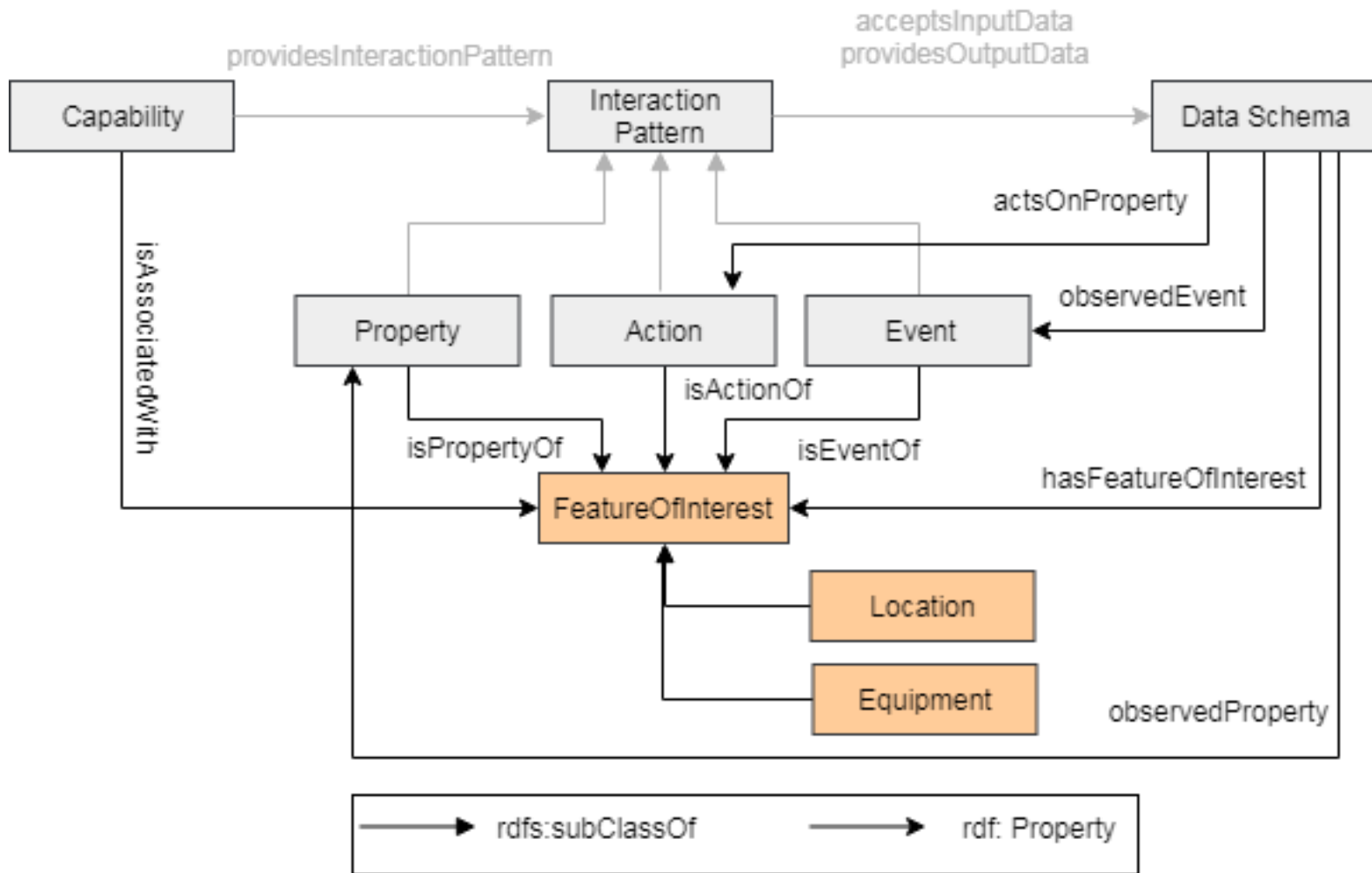
Quantities, Units, Shapes,  
Property Value Constraint

# Connect things to the real world

## "Lock Security Doors and Check" Action



# Feature of Interest Properties





# iot.schema.org 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/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 ?