iot.schema.org

Introduction and Overview

August 15, 2018

What is iot.schema.org ?

- An open, publicly available, repository of semantic definitions for connected things
- An extension of schema.org to enable descriptions of things in the physical world and their data
- A common set of tools and patterns, and a community process for contribution and publication of iot.schema.org definitions
- A way for domain experts to easily create semantic definitions that are relevant to their application domain

What Problem Does It Solve?

- There are many diverse connected devices and many standards for communication with connected devices
- These address specific use case requirements, and there will not be a single best protocol or format
- The Device SDOs are focused on device certification and protocol level interoperability with other devices of the same SDO
- The Device SDOs scope does not address broader considerations of application interoperability

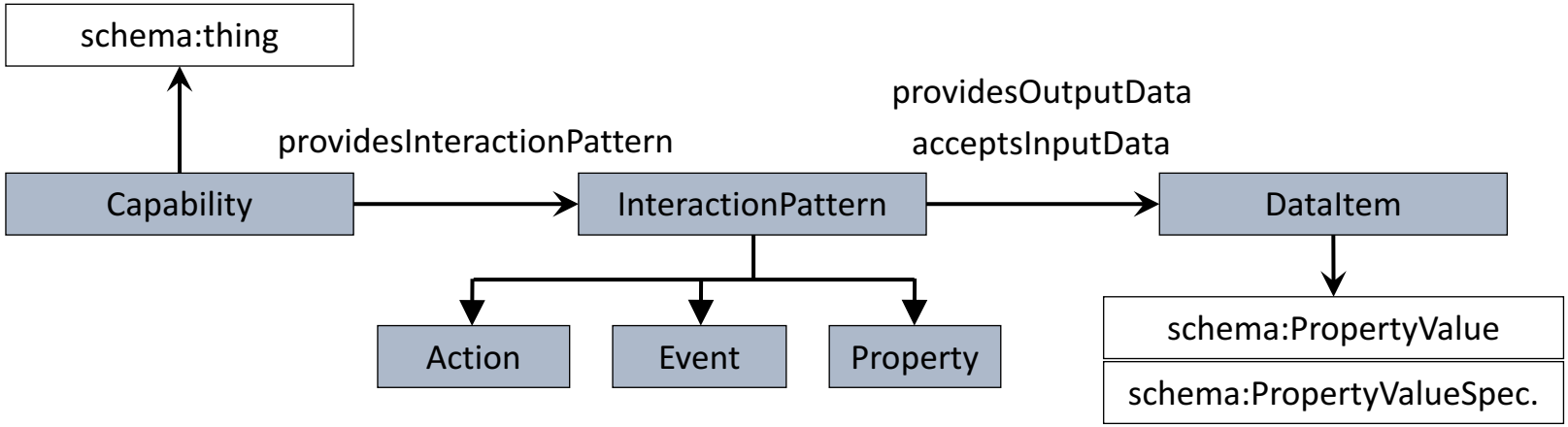
How does it Solve the Semantic Interoperability Problem?

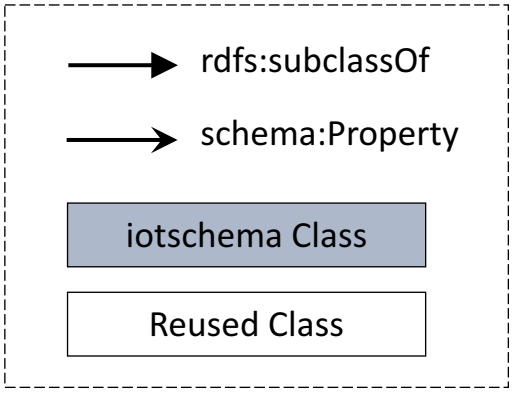
- iot.schema.org definitions provide a protocol- and format-neutral way for applications to understand the affordances of, and data provided by, connected things
- iot.schema.org definitions enable these affordances and data to be understood in relationship with the physical world
- iot.schema.org definitions are used to annotate instances of connected things and their data using simple markup with common formats like HTML, JSON, and web linking formats

How Does it Work ? (Categories)

- iot.schema.org semantic definitions consist of three categories, or classes, that describe a measurement or actuation, of some physical property or item
  - A **Capability** describes measurement and actuation of some physical variable or set of variables, for example the temperature of something, or the brightness of a light bulb. A Capability has some related Interactions.
  - An **Interaction** describes an affordance to the capability, which may be to read or write a value, or perform a complex action. This could annotate a link or a form.
  - **Data Item** descriptions contain data types, units, minimum and maximum values, and other information about the data model, for example a shape or schema

iot.schema.org Semantic Categories

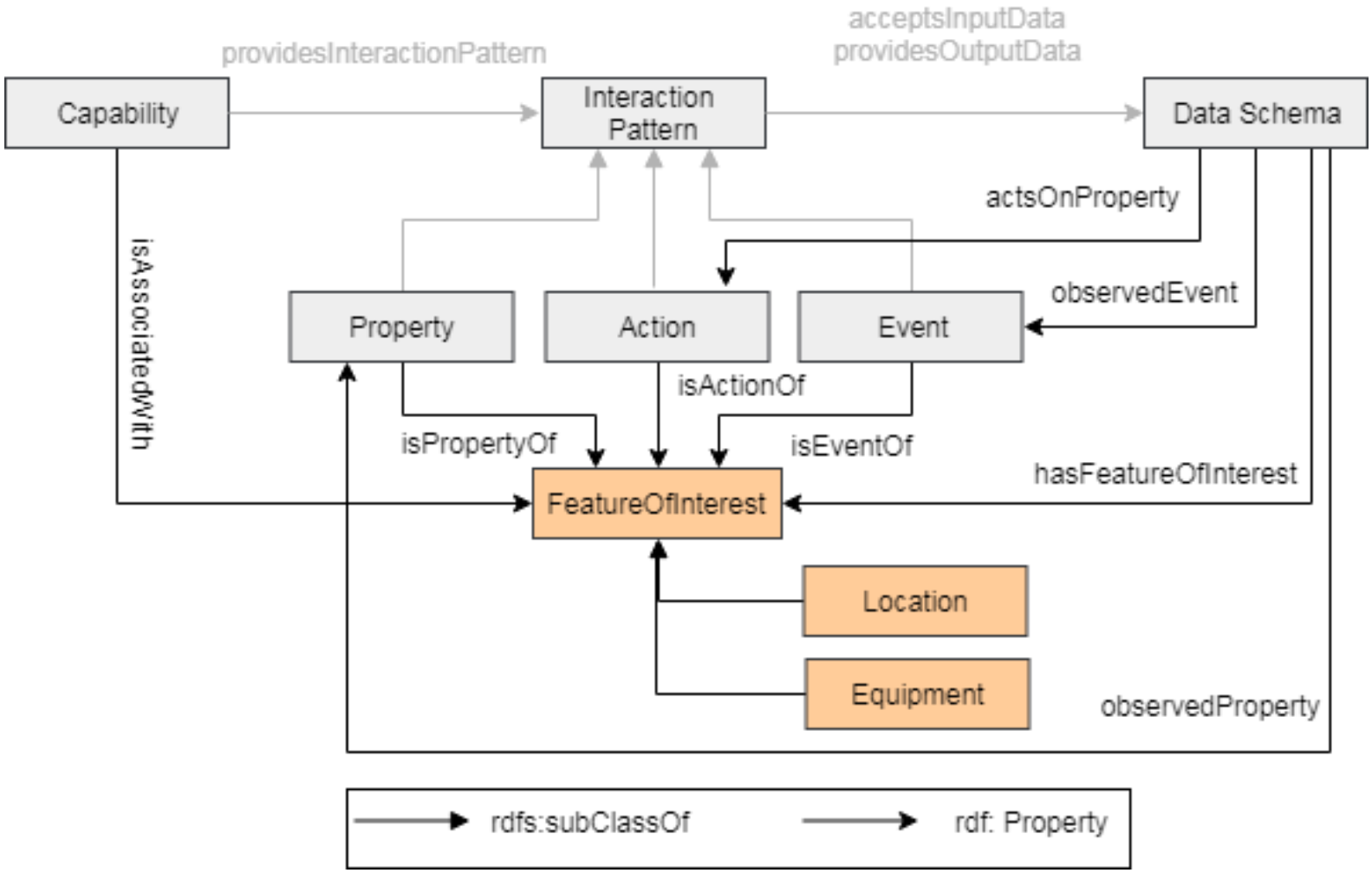




How Does it Work ? (FoI)

- **Features Of Interest** (FoI) describe the real-world targets of sensing and actuation
- Definitions may be developed in iot.schema.org, or more likely will come from domain experts
  - GENIVI/VSS is a Specification for Automotive Features of Interest, called Branches, and actuation/measurement points, called Attributes and Signals
  - BrickSchema is an adaptation of Haystack that defines Features of Interest of buildings and actuation or measurement points
- iot.schema.org defines relationships between Capabilities and Features of Interest to describe **connected physical systems**

Feature Of Interest Pattern



Who is it for?

- IoT platform providers will use iot.schema.org to make it easy for third party applications to use the platform
- Device vendors and SDOs will use iot.schema.org to publish protocol-neutral definitions of their devices to enable web scale adoption
- Domain experts will use iot.schema.org to create domain-specific languages for connected things and their applications
- Application providers will use iot.schema.org to make their applications portable across platforms

How is it used? (1)

- Annotation of Thing Descriptions (W3C Web of Things)
- Thing Descriptions have Action, Event, and Property Interaction definitions that can be annotated with iot.schema.org Interaction class terms
- Thing Descriptions have DataSchema elements that can be annotated with iot.schema.org Data Item class terms and constraints, such as data type, units
- Thing Description enables applications to interact with connected things independent of protocol and SDO profile

How is it used? (2)

- iot.schema.org enables web pages to be annotated using schema.org style annotation in RDFa or microformats
- iot.schema.org terms can be used to annotate machine hyperlinks using rfc6690
- The semantic categories (Capability, Interaction, Data Item) are each optional and can be used separately, enabling data plane decoupling and data analysis without needing to interact with the sensors or actuators

How do I Find Out More or Get Involved?

- Monthly teleconferences every third Thursday at 0900 Pacific time
- Join the W3C Community Group for definitions
- iotschema-collab github issues for comments on models

Backup:
What Is Semantic Interoperability?

- Description of the interoperability landscape
- W3C Web of Things + iot.schema.org

tl;dr

- The solution to diverse IoT device standards is to build a layer of Semantic Interoperability that includes common abstractions and enables protocol adaptation
- Practical *Semantic Interoperability* for the Internet of Things is a way of describing *what to do*, and connecting that knowledge with *how to do it*, across diverse applications, and diverse ecosystems of connected things
- Fully implementing Semantic Interoperability will enable *any application* to interact over *any network,* with *any connected thing*

The Problem

- Many standards organizations for connected things:
  - OCF, Zigbee, Z-Wave, Bluetooth, OMA Specworks
  - They mostly focus on Device Certification
  - Exclusive, require membership to participate
  - Lack focus on common interoperability
  - Compete with each other, focus on vertical integration
    because each wants to claim that they solve the interoperability problem
- Each defines a unique device level application layer with dedicated data models, but…
  - Similar high level design patterns
  - Converging on common communication protocols (IPV6, CoAP)
  - Some consolidation is already happening

Diverse application domains

- Connected Home
- Healthcare
- Automotive, IVI
- Factory Automation and Process Control
- Municipal Services
- Real Estate
- **How do I integrate applications across domains?**

Which Application Layer?

- Applications that are tightly coupled to devices, and device to device applications, will make up a smaller fraction of delivered value of connected things over time
- There will be more value in interoperable applications that can orchestrate behavior across diverse devices and device ecosystems in multiple application domains
- More devices will use Internet Protocols (IP) to connect to networks (Internet of Things)
- The job of adapting to different device ecosystems can now be done in software, in different locations
- **Now is the time to standardize a high level application layer, like the web, that works with all devices (Web of Things)**

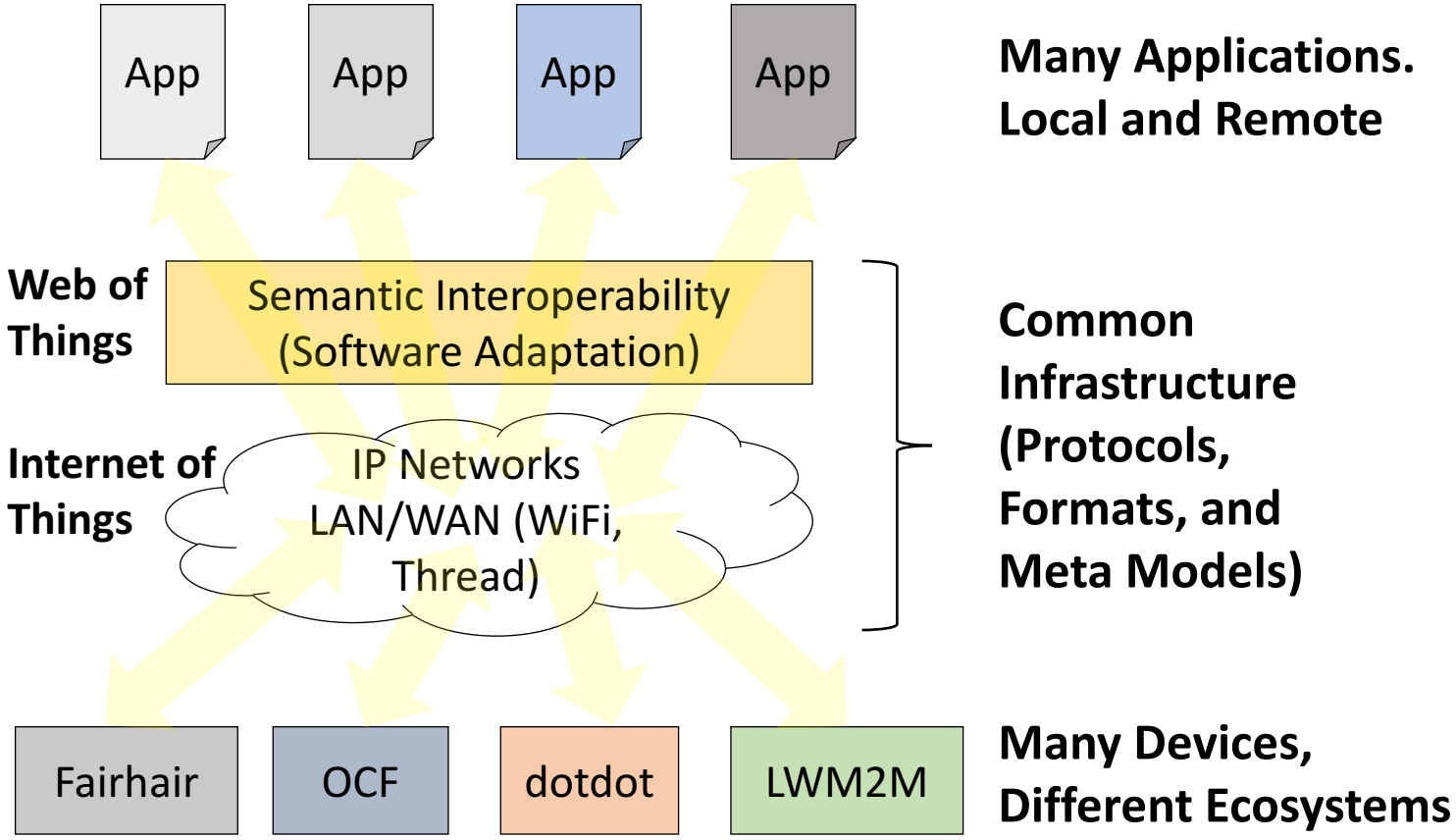
Some Background

- IOTSI Workshop, Organized 2015-2016
  - IoT Semantic Interoperability
  - > 80 submissions across industry
  - Duality of translation vs. common semantic models
  - What are the "atomic" concepts that are reusable?
- WISHI in conjunction with IETF 99
  - Workshop on Semantic and Hypermedia Interoperability
  - Contributions showed movement toward industry convergence around translations and meta-models
- Who?
  - SDOs (OCF, OMA LWM2M, OneM2M, BACnet…)
  - Industry (Siemens, Ericsson, Landis&Gyr, Schneider Electric, Microsoft, Verizon…)

What is Semantic Interoperability?

- Second "narrow waist" in system design
- For IoT, it enables applications to interact with connected things that expose diverse application protocols and data models
- Embrace diversity in application protocols to a point of specialization for use cases
- Standardize on meta-models that can be re-used across application domains and across diverse protocols
- Support software adaptation and translation

Narrow Waist in System Design



What needs to be built?

- Application level semantic interoperability
  - Well known formats to describe common affordances of connected things
  - **What does it do? What can I control?**
  - A way to describe how to interact with connected things from different device ecosystems, which have similar protocols but diverse data models
  - **How do I control it? What can I expect of the protocol?**
  - Enable easy implementation of Bridges, Libraries, Translators, Mappings, Bindings, Proxies

Landscape of Semantic Models

- Abstract models
  - Web of Things - framework
  - iot.schema.org - definitions
  - Ontologies and Vocabularies, e.g. Haystack
- Embedded models
  - OCF Resource Types
  - Zigbee Cluster model
  - Z-Wave Command Classes
  - SmartThings Capability Model

W3C Web of Things - Thing Description

- Abstract Interaction Model – What to do
  - Abstract interactions
  - Events, Actions, Properties
  - Semantic annotation
  - *Temperature* Property, *Lock Door* Action
- Concrete Protocol Binding – How to do it
  - Resource addresses
  - Media types
  - Protocol methods
  - Protocol header options and settings

W3C Web of Things - Overview

- Thing Description
  - protocol-neutral and domain-neutral meta-model and mediatypes
  - Semantic Annotation using external diverse vocabularies
- Scripting API
  - Standard Programming API for exposing things, discovering things, and consuming things
- Thing Directory
  - Based on CoRE Resource Directory
  - Semantic Lookup
- Who
  - Siemens, Panasonic, Fujitsu, Sony, Hitachi, Intel, Mozilla, Samsung, Ericsson, Eurecom, …

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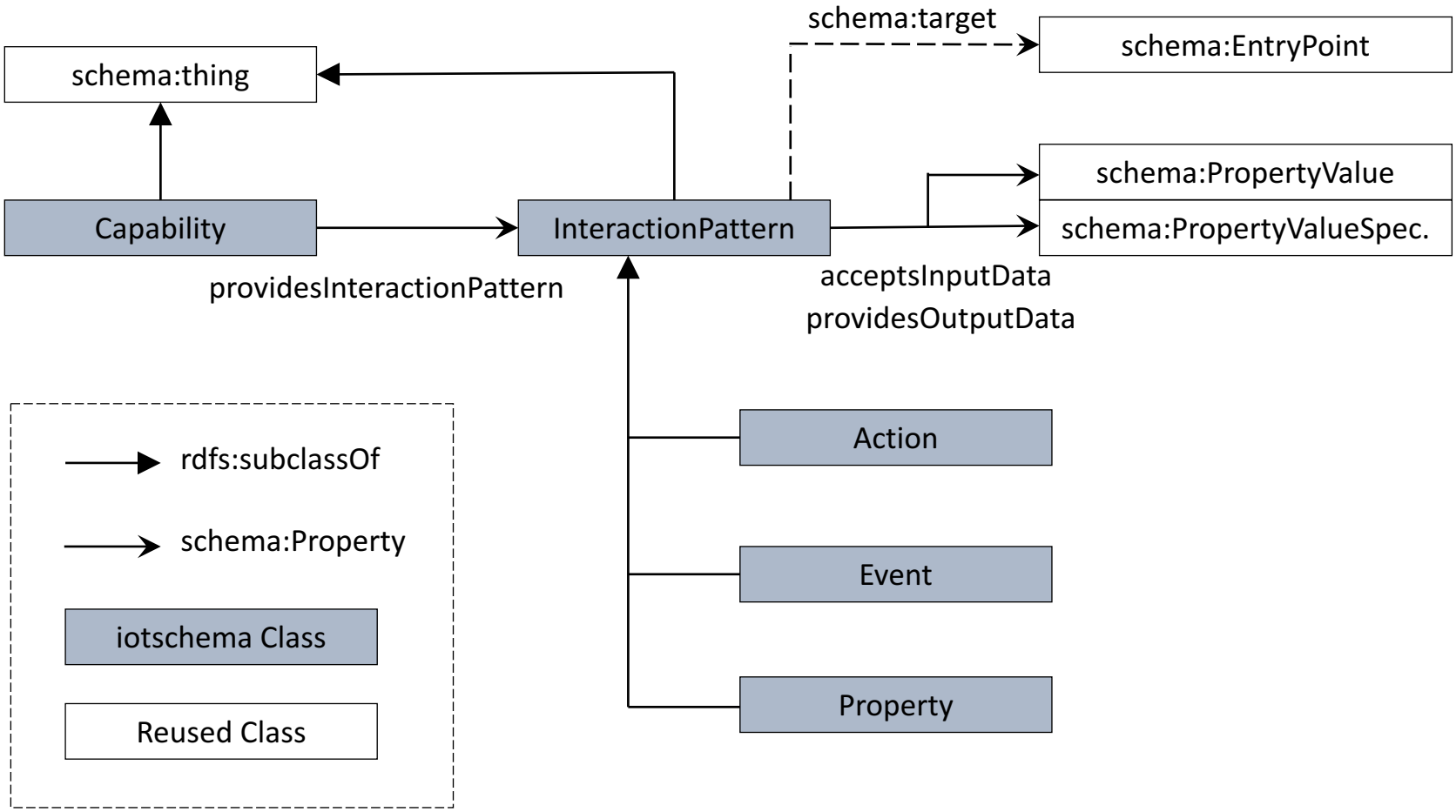
- Simple meta-model to standardize semantic annotation, based on definitions – dictionary model
- Orchestrates more sophisticated ontologies "behind the scenes" e.g. Haystack, Brick, SOSA, QUDT
- Annotation vocabulary for Web of Things and general hypermedia controls
- Follow the schema.org model of a public semantic resource with open contribution
- Broad participation across application domains and SDOs

iotschema Common Pattern



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- Organization Building, about 18 months along
- Prototype definitions are hosted and being used in W3C Plugfests and WISHI Hackathons
- Monthly Community Teleconferences
- Re-use W3C Community Group to incubate new definitions
- Expected to act as an extension to schema.org

WISHI

- Ongoing work on integrating Semantic Interoperability with Hypermedia based systems
- Using the Web of Things framework as a reference platform
- Research questions include semantic annotation of existing systems, e.g. OMA LWM2M
- Hackathons and breakout meetings in conjunction with IETF meetings, starting with IETF 100

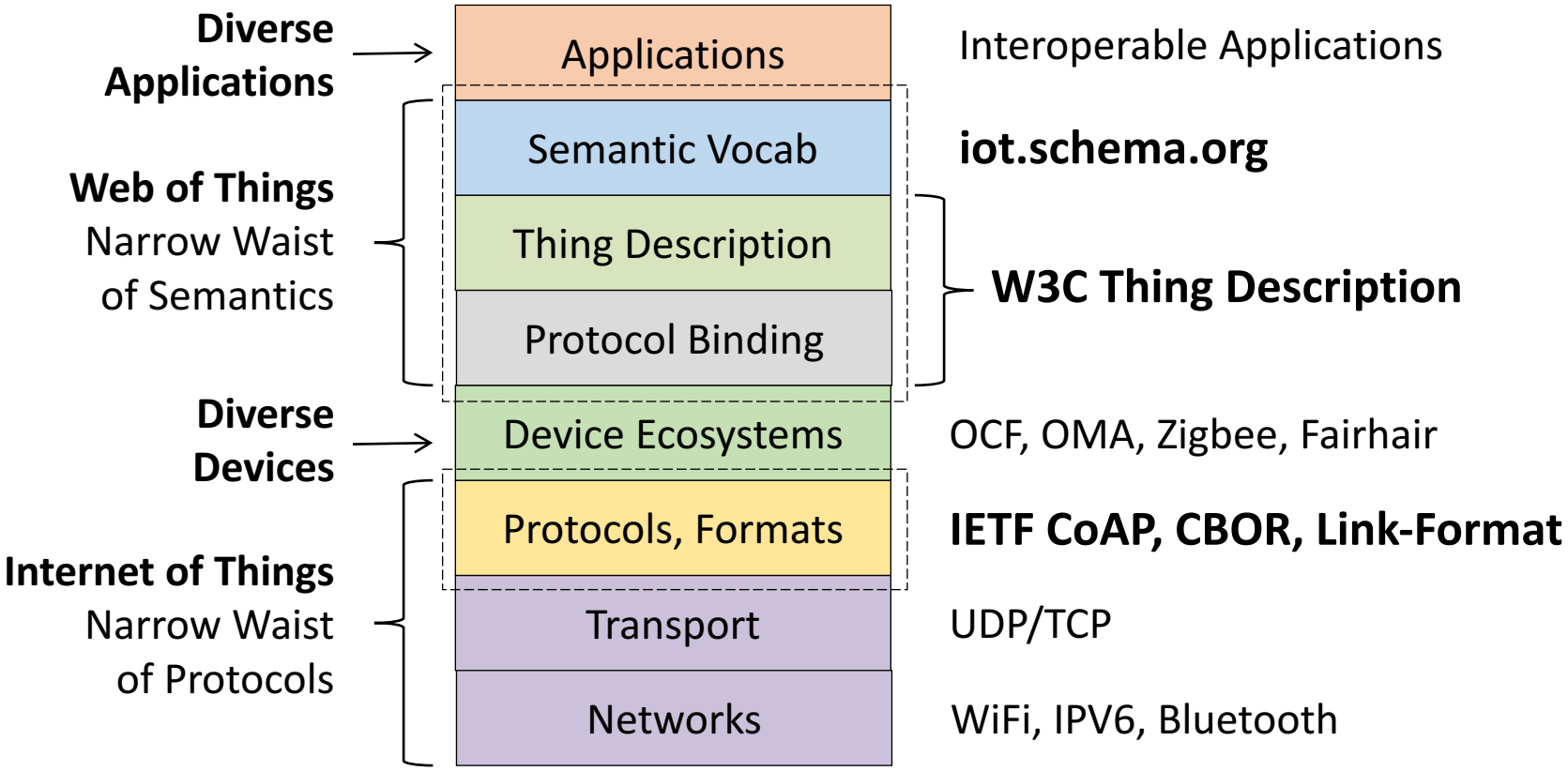
Summary

- Build value in the emerging application ecosystem for connected things
- Don't place bets on any device ecosystem, support diversity
- Focus on IETF, IRTF, W3C Web of Things, and iot.schema.org
- Extend basic protocols with common design patterns, vocabularies, and media types
- Deliver web scale interoperability for connected things

Hands-on Development

- Web of Things weekly teleconferences, and face to face meetings with 2-day semantic interoperability plugfest 3-4x yearly
- WISHI Semantic Interoperability 2x monthly teleconference and 3x yearly hackathon in conjunction with IETF meetings
- iot.schema.org providing definitions and semantic annotation vocabulary for both these – W3C Community Group venue going forward
- Adding automotive and industrial application domains, Feature of Interest modeling

Diverse Devices and Applications, Common Protocols and Semantics



Any Application

Any Network

Any Connected Thing