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Visions of Things to Come

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A Vision

The challenge of writing applications to manage and make sense of data in the Internet of Things (IoT) of tomorrow will be driven by the complexities of not just gathering but also in combining and understanding the data that streams out of the IoT.

We have a vision of an IoT in which the individual boxes, big or small, can be described in terms of their purpose, what they do, what they measure, much more than merely in terms of the kinds of data that they provide and how to pull out those numbers.

In our vision, we have a framework for dissemination of such conceptual information that is equally applicable to constrained devices as well as bigger boxes comprising several different functions.

An Idea

Our suggestion is to work towards a formal ontology that focuses on purposes and concepts of nodes in the IoT. In other words, this is about describing a “temperature sensor” rather than specifying an attribute that holds a value in Celsius.

While not necessarily in conflict with specifying how to retrieve values or the types of such values, one could see this as the topmost layer of concepts in a stack that has the network protocols at the bottom and data models describing attributes and values somewhere in the middle. This conceptual model is less concerned with how values are represented. It is the difference between thinking in terms of “temperature sensor” versus `entPhySensorValue`; both are obviously connected to a value that expresses a measured temperature, but in terms of the proposed ontology, the wheres and hows are less important; a value is in there somewhere but the ontology will try to look upon temperature as a concept in itself.

Such a semantically focused ontology may also be useful in case multiple data models or even multiple information models may emerge. A management application can use the overlying ontology to work at a higher level and, in the fusing and sense-making of the incoming data, to work with the purpose of the boxes. The ontology can become the Rosetta Stone to applications when trying to bridge a big heterogenous network of more or less constrained devices and in the attempts to take the different kinds of data into a coherent framework of high-level concepts.

An ontology could also facilitate the ability of an application to work on appropriate levels of abstractions. In the object oriented nature of ontologies, one can use multiple inheritance to pull in properties from different parts of the framework. As an example, a weather station could inherit from both the “temperature sensor” and “barometric pressure sensor” classes. The combination would exhibit behaviours associated with either while at the same time being able to appear in all places a “temperature sensor” or a “barometric pressure sensor” may logically appear. And even if more sophisticated kinds of temperature sensors were later to be added to the ontology, our prototypical weather station device would continue to be a valid “temperature sensor” and applications needing readings from “temperature sensor” devices would continue work, no matter how many specializations would be added beneath the concept of “temperature sensor”.

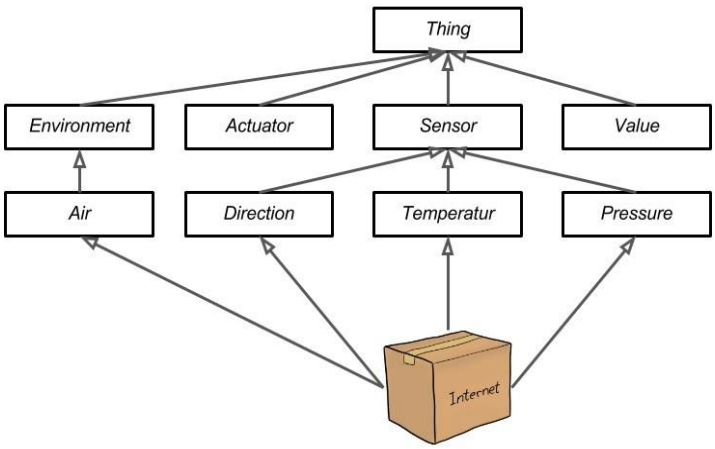
A Sketch

To provide a kind of an example, here are a few quick notes on how this could be realized in slightly more practical terms.

First one should imagine the existence of a domain ontology covering the central concepts of IoT and the world in which IoT devices are working. This would formally define a set of concepts as (partly) illustrated in the below figure. A concrete device would then conceptually be considered an instance of an ad hoc defined class that inherits from a number of classes defined in the ontology.

As mentioned above, the ontology would most likely continue to evolve as new types of devices appears or new types of measurements are identified. However, ideally, the upper part of the ontology remains stable. Sensing temperature will be a foundational part of the ontology and the nature of temperature sensing does not change just because more specific kinds of temperature sensing appears. The precise path to actually extracte a concrete temperature value from a concrete device presumably will keep varying with devices, manufacturers and time, but the base concept of temperature remains stable.

While the ontology would most likely be developed, documented and disseminated via some appropriate existing high-level tool/formalism (like W3C OWL), one could also devise a compact representation which in nature might look much like the OID trees we know from SNMP data-models. We believe that it would be highly beneficial if devices would be able to self-identify according to the conceptual framework. As we believe the framework should be applicable also to constrained devices, it would be unfortunate to base any information modelling on elaborate XML renditions or even query based systems as that would provide an unattractive barrier to entry for smaller devices. We want something that encompasses the entire range of IoT devices, from a DIY home-grown arduino board to a polished big-company consumer device.



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