Open Information Models for an Interoperable Internet Of Things

Michael Koster
The Goal: Web Scale Interoperability

• IoT is connecting software to the physical world
• Application interoperability: linking resource endpoints to application software components
• Application software can run in devices, gateways, and cloud servers
• Like the web:
  – permission-less, making it easy to innovate
  – high value in reuse of components
  – high value in the network effect
Machine Interoperability Problem

- The web of people and documents is based on hyperlinks that are human-understandable
- Relying on visual metaphor and human cognitive processing
- Machines have limited ability to reason
- Machines therefore need hyperlinks with explicit meaning
Machine-Understandable Hyperlinks

• Hyperlinks which contain embedded metadata of the general form:

  \[ <\text{subject URL}> \ ; \text{relation}=value \]
  \[ <\text{sen}/3303/0/5700> \ ; \text{resourceType}=temperature \]

• Basic s,p,o construct maps to XML, JSON, RDF

• Subset of web linking and semantic web

• An Information Model is a collection of such links that describes some resource
Web Objects and REST API

• URL points to structured object containing resource endpoints and metadata
• Resource endpoints and semantic hyperlinks encapsulated in a self-describing Web Object
• REST API enables discovery and linking resources to application software with a minimum of program logic – GET and PUT are easy to use without further instruction
Resource Discovery

- Resource Directories and catalogs: collections of semantic links that describe resources
- Devices register with a RD and upload semantic links
- Applications discover resources by performing relation/attribute queries on the RD server
- CoRE RD and Hypercat are two practical examples
Interoperability Requires Consistency

• At the data model level
  – Representations
  – Formats
• And at the Information Model level
  – Vocabulary
  – Concepts
  – Design patterns, how they are used in the system
• Application level interoperability is driven by common vocabulary and design patterns
Levels Of Interoperability

- CoAP, HTTP, MQTT
- JSON, CBOR, XML
- Core-Link Format, Linked Data
- Vocabularies and Patterns
- Application Software

- Application Interoperability is driven by common Information Models

- INFORMATION MODELS
- DATA, OBJECT MODELS
- REPRESENTATIONS
- PROTOCOLS
W3C Potential Involvement

• Information standards and architecture for interoperability
• Like HTML for the web of people & documents, hypermedia for machines
• Standards for metadata construction and design patterns
• Resource Discovery and Linking
• Lightweight and compatible with the Semantic Web