

Interoperability Challenges in the Internet of Things

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Internet of Things



- Everything that benefits from networking will eventually be networked
- As with previous major developments, the Internet will need to evolve to meet the demand
- There are tremendous cost and other advantages to using IP for all communications; yet we'll have to make sure our technology scales to the challenge
- Not a future thing – we are already there

The Effect on Internet Standards



- Internet of Things will use current Internet protocol stack, to a large extent
- We do not always need more research or standards!
- Expect some challenges and changes, however
 - Bigger capability variations than in the current internet, no human in the loop for most applications
- Many efforts already ongoing
 - Routing (RPL), IP over Foo (6LOWPAN), COAP, ...
 - Link layers, specific applications, specific architectures, policy issues discussed outside the IETF

Interoperability Challenges



- A capability mismatch between different devices
- Communications and processing bandwidth mismatch
- Need to agree on semantics (e.g., 1 => light on)
- Different internetworking protocol choices
- Solutions that are only suitable for some networks

Capability Differences



- MTU differences
- Simplified vs. full blown web protocol stack (COAP/UDP vs. HTTP/TCP)
- Single stack vs. dual stack
- Sleep schedule
- Security protocols
- Processing and communications bandwidth

The key question is whether there are *true capability differences* or just ones we created through incompatible standards?

Semantic Interoperability



- Do we want to build the *Internet of Things Transport Network* based on IP technology?
 - Everything over IP, IP over everything
 - Routers, firewalls, DNS, and basic stack common technology
- That would be tremendously useful, but not by itself an *interoperable Internet of Things*
- For true interoperability, we need to agree on what the messages mean
- Standards vs. code approach (HTML5 vs. Flash)

Authorized Interoperability



- Supporting the same security mechanisms on both end points is nice, but not enough
- Is my light switch part of the same PKI with your PDA?
- How do we build security infrastructure, authentication and authorization models, and trust relationships that enable communication between all the necessary parties?

Domain-Specific Solutions



- Some of the problems in this area are hard – really hard
- There is a desire to build optimized solutions that can solve the problem in a particular setting but may not be general enough for all situations
- This leads to point solutions and interoperability problems between them
- Examples: RPL storing vs. non-storing modes, XML vs. JSON vs. binary in transporting data from sensors, ...

Some Possible Actions



- Additional standards for applications, data formats
- IP/routing/transport/web protocols that scale down to IOT devices
- Architectures that employ gateways and middleware
- Building a suitable security infrastructure
- Leaving freedom for the "Skype" or "Flash" to appear
- Pushing back on baseless capability differentiation
- Pushing back on domain-specific solutions

Internet protocols were successful because they were good enough, scalable, useful, not because they were particularly optimized for any hardware back in the early days