



Building the Web of Things

Interoperability for Connected Devices

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W3C Track

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Many Potential IoT Application Areas

each evolving rich capabilities



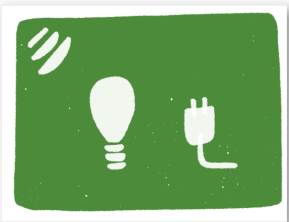
Smart Homes



Wearables



Healthcare



Power & Environment



Smart Cities



Manufacturing



The Internet of Things

Still very immature, but with massive potential

Lack of interoperability at the application level

End to end security is impractical across different platforms

Silos are holding back the potential

Open or closed system?

- Closed systems incentive: control
- Open systems prompt: reduced costs and increased market size
- Need for wide adoption of shared open standards





Analogy with early days of networking

Before the Internet, there were many non-interoperable network technologies

- IP made it simple to interconnect networks and create interoperable services
- The Internet grew exponentially as the opportunities were realised
- Likewise for the Web which took over from isolated information services

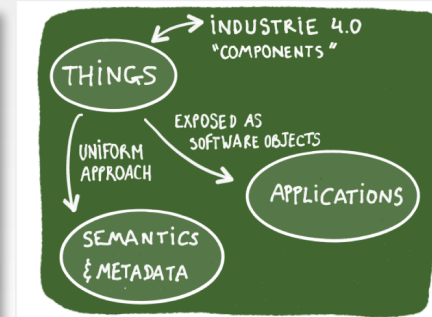
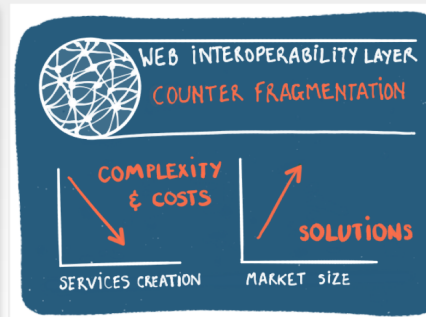
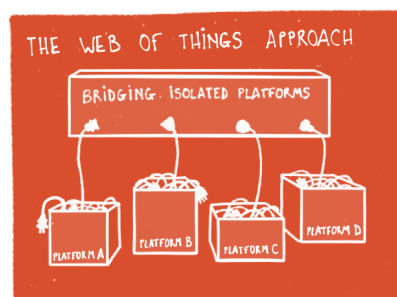
Direct analogy with today's IoT silos and their lack of interoperability

- The Web of Things is the equivalent of IP for semantic interoperability and end to end security
- The Web of Things will enable explosive growth as the barriers to interoperability are torn down





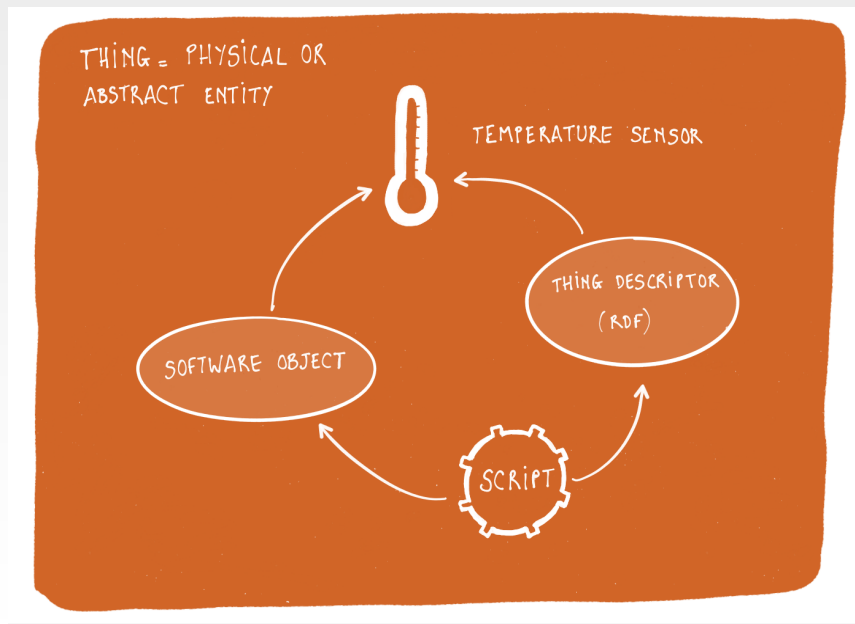
Web of Things



The Web is fuelling a transition from costly monolithic software to open markets of apps



Web of Things



Applications act on software objects that stand for things

- Local “things”
- Remote “things”

Rich descriptions for every “thing”

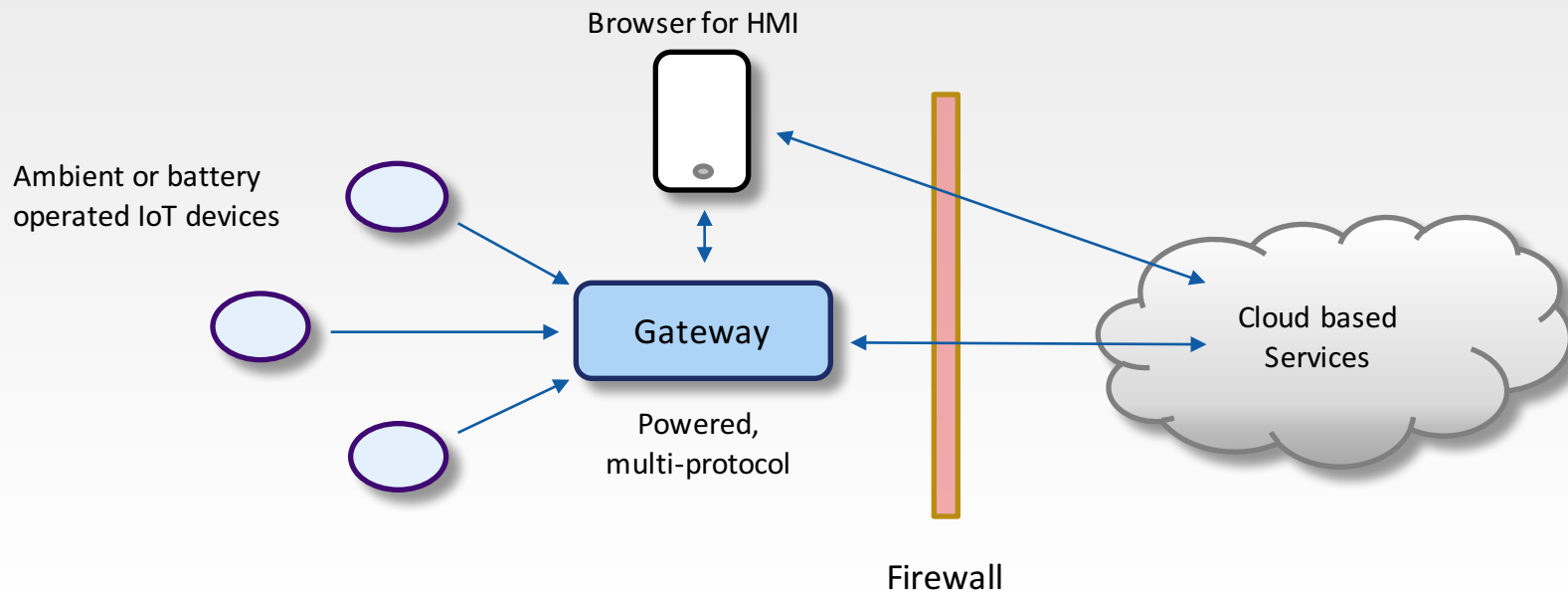
- Data models, semantics, metadata
- Ontologies that describe “things”

Things don’t need to be connected

- Abstract entities and unconnected physical objects



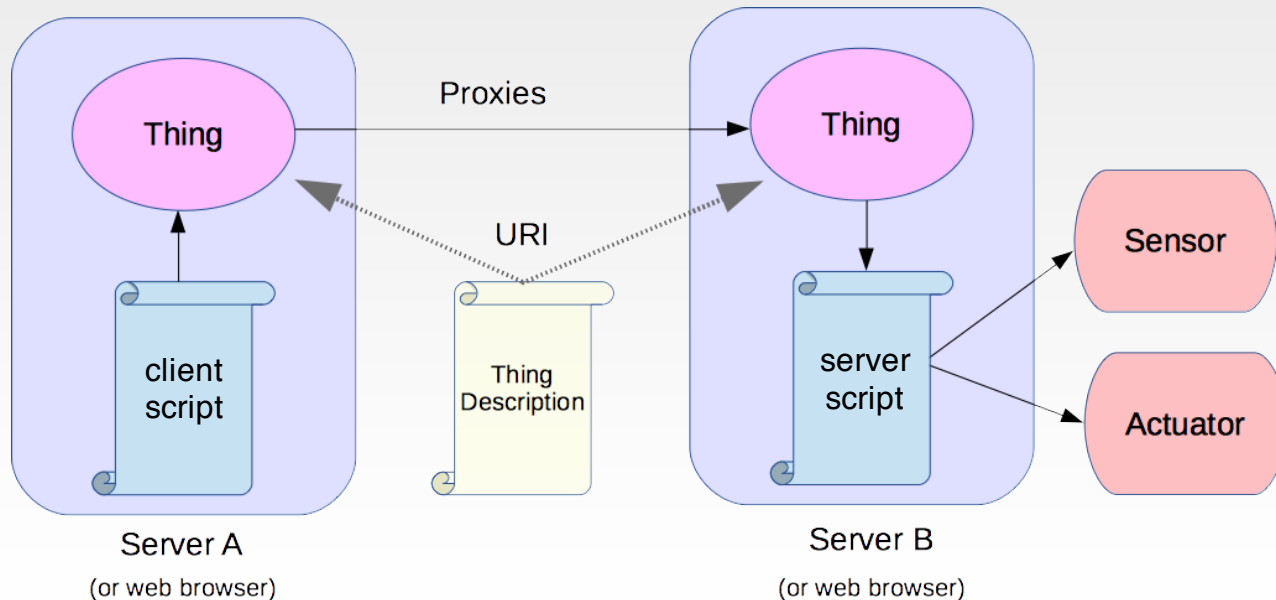
The Web of Things in the Home





Distributed Web of Things

- Thing descriptions can be used to create proxies for a thing, allowing scripts to interact with a local proxy for a remote entity
- Scripts can run on servers or as part of Web pages in Web browser for human machine interface
- Thing topologies
 - Peer to Peer, Peer to Peer via Cloud, Star, Device to Cloud, Star to Cloud





Communications Stack – Clean separation of concerns

Application
Developer
(WoT focus)

Application	Scripts that define thing behaviour in terms of their properties, actions and events, using APIs for control of sensor and actuator hardware <i>Focus on data types and APIs</i>
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Things	Software objects that hold their state Abstract thing to thing messages Semantics and Metadata, Data models and Data
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Transfer	Bindings of abstract messages to mechanisms provided by each protocol, including choice of communication pattern, e.g. pull, push, pub-sub, peer to peer, etc.
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Platform
Developer
(IoT focus)

Transport	REST based protocols, e.g. HTTP, CoAP Pub-Sub protocols, e.g. MQTT, XMPP Others, including non IP transports, e.g. Bluetooth
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Network	Underlying communication technology with support for exchange of simple messages (packets) Many technologies designed for different requirements
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Scalability

Web of Things servers can be realised at many scales from microcontrollers to clouds



Micro-controller: resource constrained, IoT devices or gateways, CoAP, running behind firewall

Home Hub:
home/office server for access to smart home and wearables, running behind firewall



Smart Phone:
personal server for access to smart home and wearables



Cloud-Based: highly scalable server for many users, devices and working with big data



Web of Things for the Maker Community

Open source projects are underway,
e.g. for the Arduino

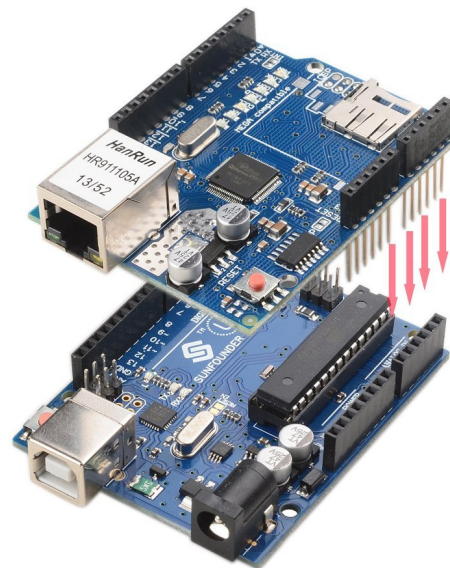
Arduino Ethernet Shield

- 16 KB RAM
- MicroSD card slot
- Controlled through SPI bus
- Polling or H/W interrupt
- Cost: 4.75 GBP on eBay

Arduino Uno with ATmega328P MCU

- 2 KB RAM
- 1 KB EEPROM
- 32 KB FLASH
- Lots of I/O pins
- Cost: 2.33 GBP on eBay

<https://github.com/w3c/wot-arduino>





Web of Things

Activity



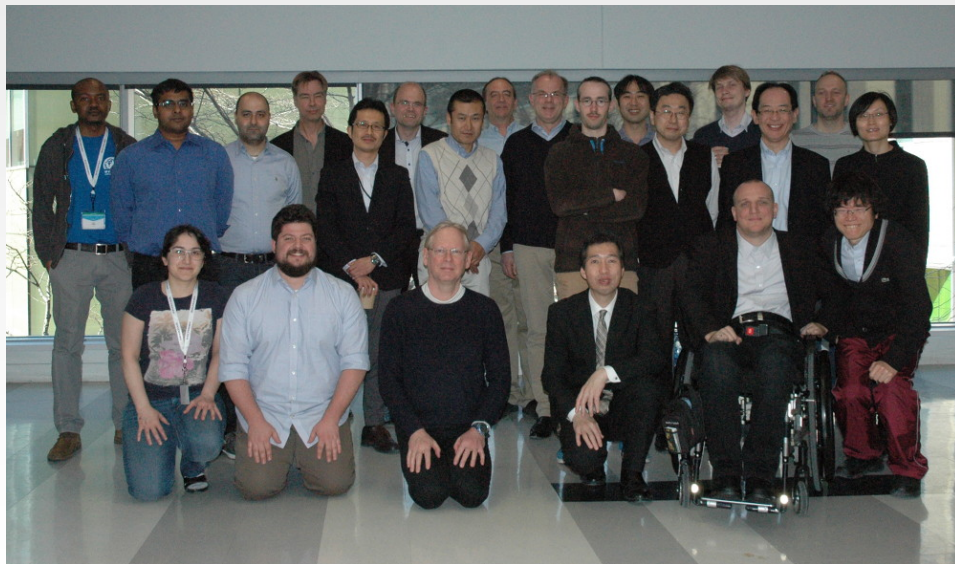
W3C Web of Things Interest Group

Workshop in Berlin (June 2014)

- Launch of Web of Things IG in 2015
- Chaired by Jörg Heuer, Siemens
- Task forces
 - Thing descriptions
 - APIs and protocols
 - Discovery and provisioning
 - Security, privacy and resilience
 - Communications and collaboration

Strong emphasis on implementation experience

- Demos and plug-fests
- Helps to build a shared understanding



Montreal Face to Face, 11-13 April 2016



Members of the Web of Things Interest Group





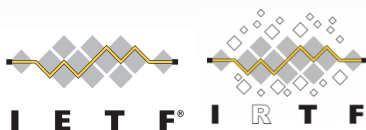
Liaisons and Collaborations

Reaching out to industry alliances and SDO's to drive convergence to unleash the potential

- Plattform Industrie 4.0
 - Especially the “semantics” subgroup
- Industrial Internet Consortium
- Open Connectivity Foundation
- OPC Foundation
- IETF/IRTF
- oneM2M
- AIOTI



OPEN
CONNECTIVITY
FOUNDATION™





Web of Things Working Group

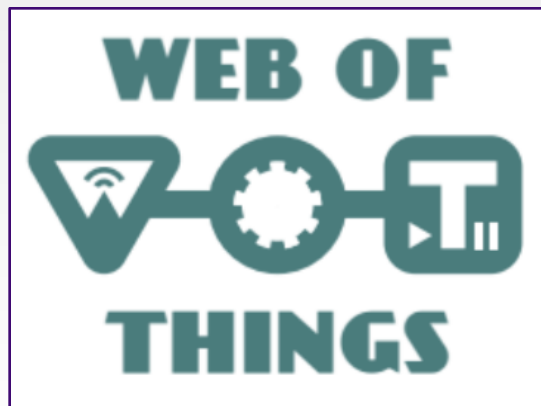
The Interest Group (IG) is working on

- Use cases, requirements, technology landscape and plans for launching working groups (WG)
- IGs prepare the ground for standards but don't develop standards
- WGs are chartered to develop standards (W3C Recommendations)

We're collecting ideas for a Working Group including

- Horizontal metadata vocabularies (things, security, communications)
- Serialisations of metadata, e.g., as JSON-LD
- APIs and bindings to specific protocols and platforms in collaboration with the platform owners

Web of Things Working Group to be launched in 2016





Web of Things

What, why, how, actions



C-level corporate decision makers

What is the problem to be addressed?

Fragmentation of the IoT into many non-interoperable platforms

Why is it important?

Solving this will enable exponential growth as we saw with the Internet and the Web

- The network effect: Metcalfe's law

How it is to be solved?

Inter-platform standards that play an analogous role to IP for connecting previously incompatible networks

- Decoupling applications from protocols
- Enabling different platforms to interoperate
- Complementing, not competing, with platforms

What action are we seeking?

Commit to join W3C & assign staff to participate in Web of Things groups

Ensure your company is in the driving seat for the open IoT



SDO's and Industry Alliances

What is the problem to be addressed?

Difficulty of creating services spanning different platforms due to a lack of semantic interoperability and a miss match of assumptions around trust and security

Why is it important?

Solving this would enable exponential growth in services like we saw for IP and the Web

How it is to be solved?

Inter-platform standards defining an interlingua for metadata, and shared assumptions in respect to end to end security across different platforms

What action are we seeking?

Active collaboration on integration with the Web of Things and alignment of marketing messages



Engineers and Developers

What is the problem to be addressed?

Fragmentation of platforms and IoT technologies, and high cost of integration with a piecemeal approach

Barriers for semantic interoperability and end to end security

Why is it important?

Simpler, faster, more flexible application development

Leveraging existing services and communities in the Web ecosystem

Be part of the next big thing, strong growth in job opportunities

How it is to be solved?

Open standards for Web based abstraction layer, complementing existing platforms and standards, and enabling platforms to interoperate securely

What action are we seeking?

Joint work on experimental implementations that explore what it means to integrate with the web of things – help to create evaluation kits, and spread the word

Joint work on white papers to forge a shared understanding across companies, alliances and SDOs

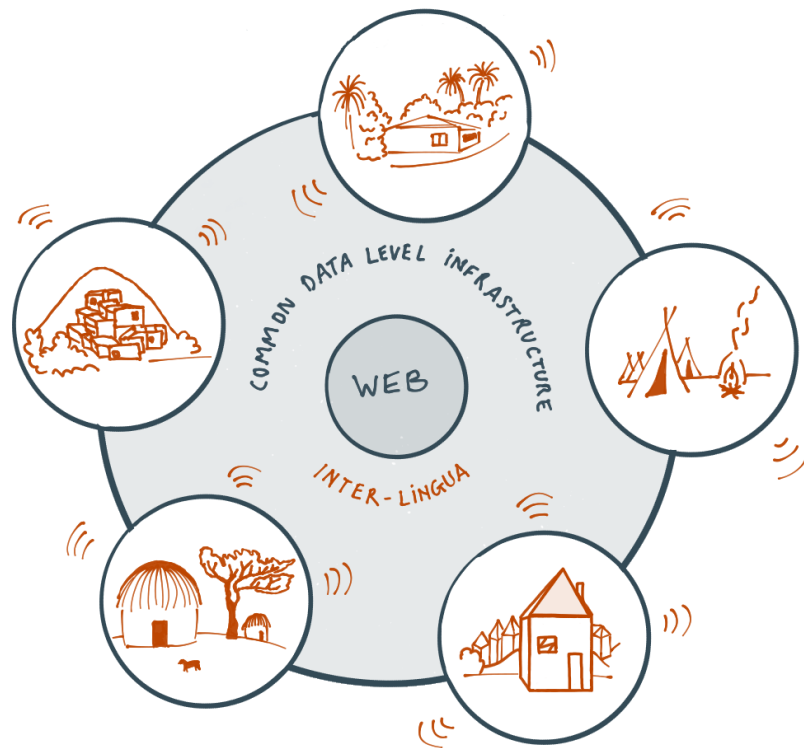


The Bottom Line

*The Web is essential
for realizing the full
potential of the IoT*

*The Web provides a
unifying framework for
semantic interoperability*

*The Web acts as a global
marketplace for suppliers
and consumers of services*





Work with us to build
the Web of Things!

For more information on W3C see:

www.w3.org

Thank you!

