Web of Things Working Group

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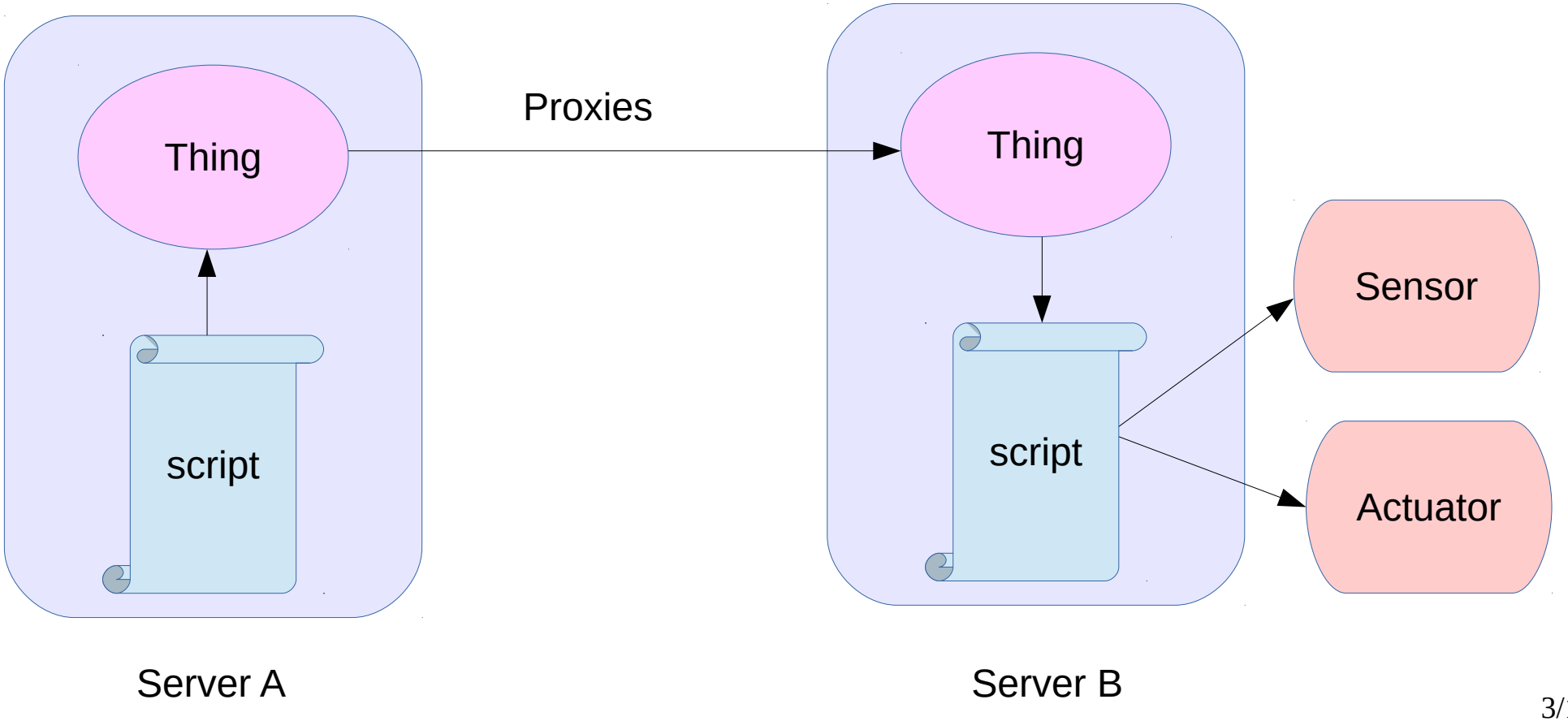
This work is supported by the European Union's 7th Research Framework Programme (FP7/ 2013-2015) under grant agreement n°317862 - Compose

From the Web of Pages to the Web of Things

- The IoT suffers from fragmentation and data silos
  - To realise the potential we need to break free of the silos
- Our solution is to connect IoT platforms through the Web
  - An abstraction layer above existing IoT platforms
  - Reducing costs through global reach of Web standards
  - Enabling open markets of services
  - Unleashing the power of the network effect
- Leveraging the fundamentals of Web architecture
  - URIs for identifying things
  - A variety of protocols for accessing things since no one protocol will be appropriate in all contexts
  - Linked Data for describing things as the basis for interoperability

Web of Things

- Virtual representations of physical or abstract entities for use by application scripts
  - Each thing has a URI for a description that can be used to create a proxy for that thing, allowing scripts to interact with a local proxy on behalf of a remote entity
  - Scripting things in terms of their metadata, events, properties and actions



Web Servers at Many Scales

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

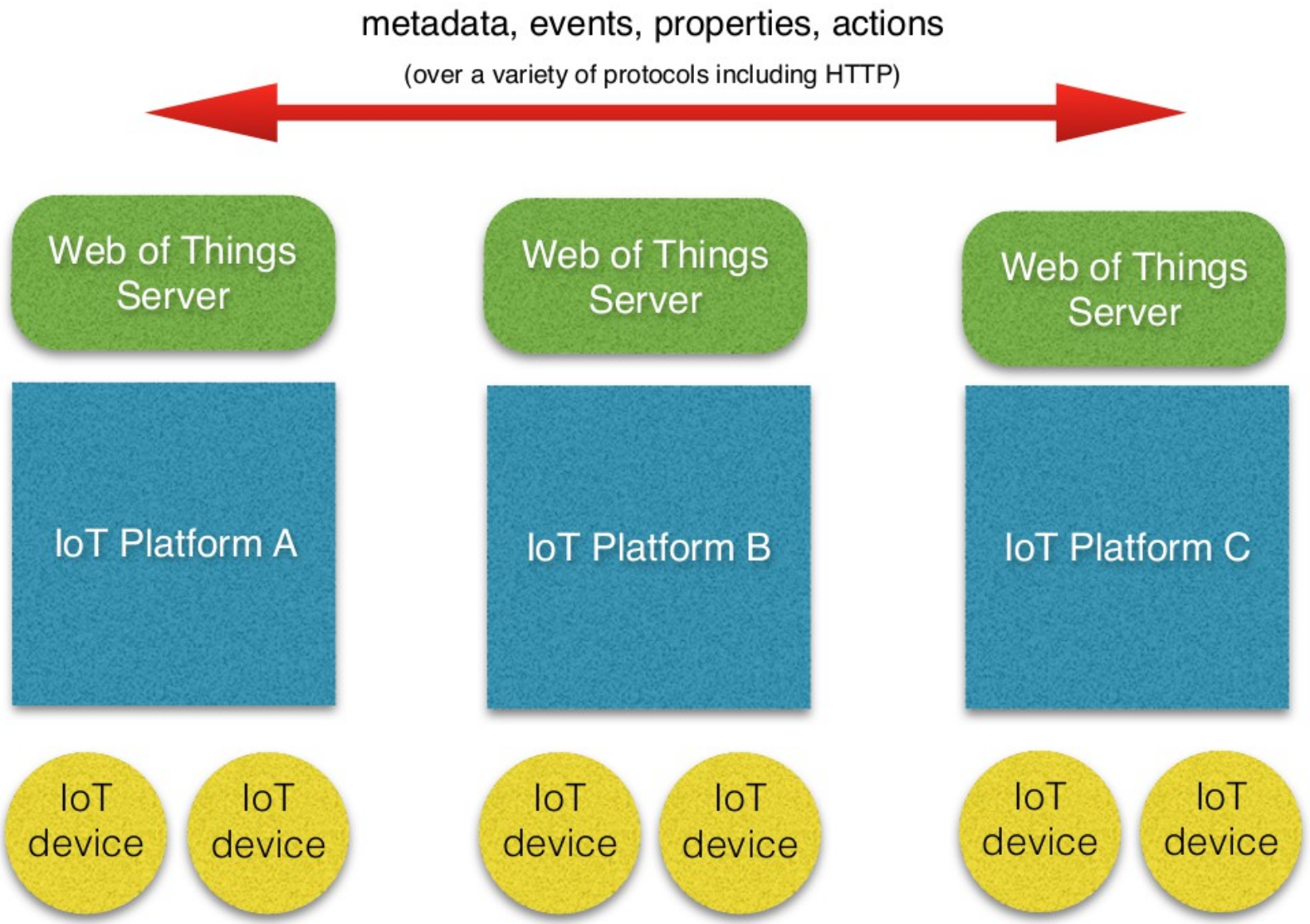
Home Hub: home/office server for access to smart home and wearables, running behind firewall

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

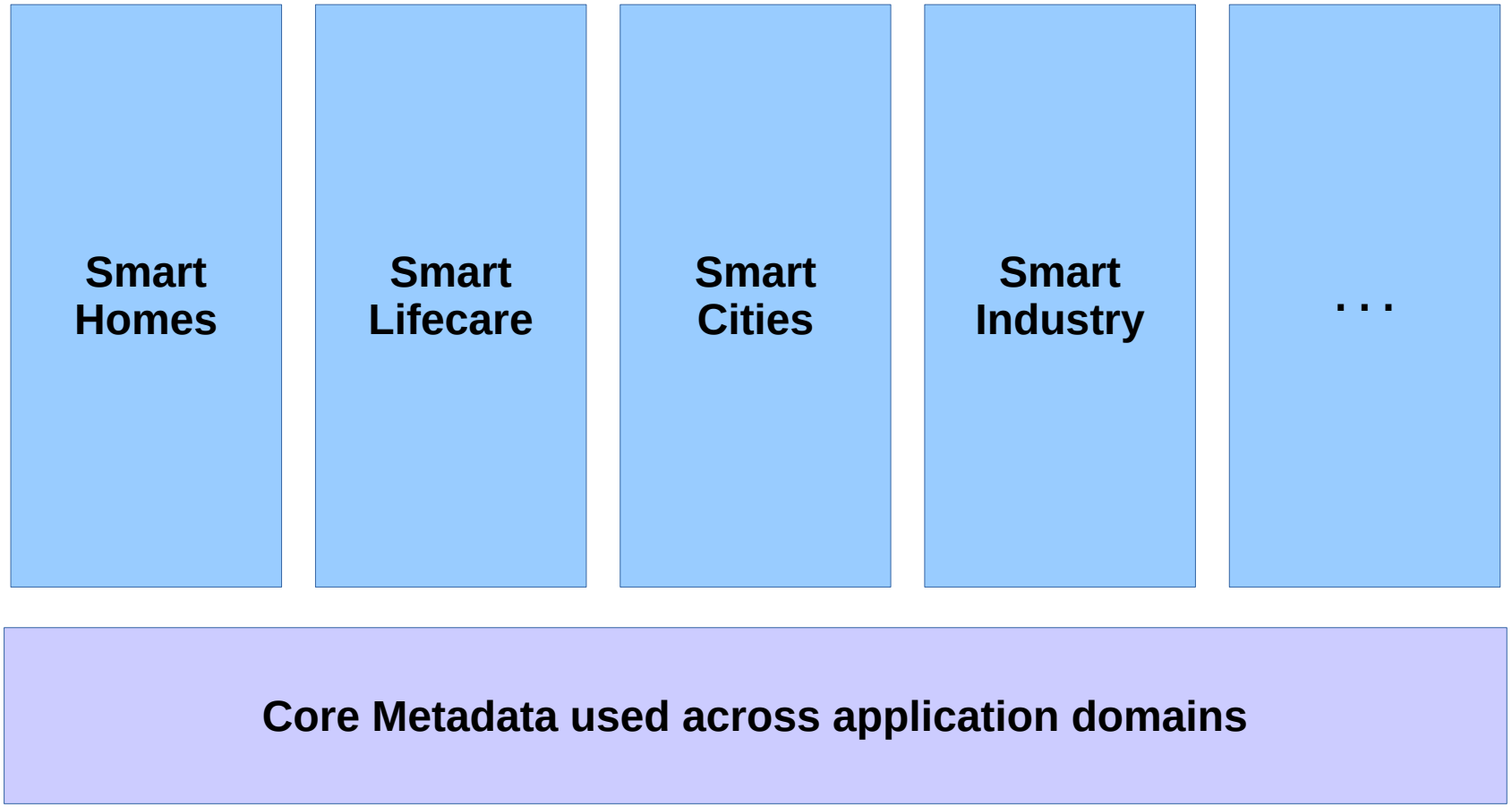
Smart Phone: personal server for access to smart home and wearables

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

The Web as the Global Data Bus



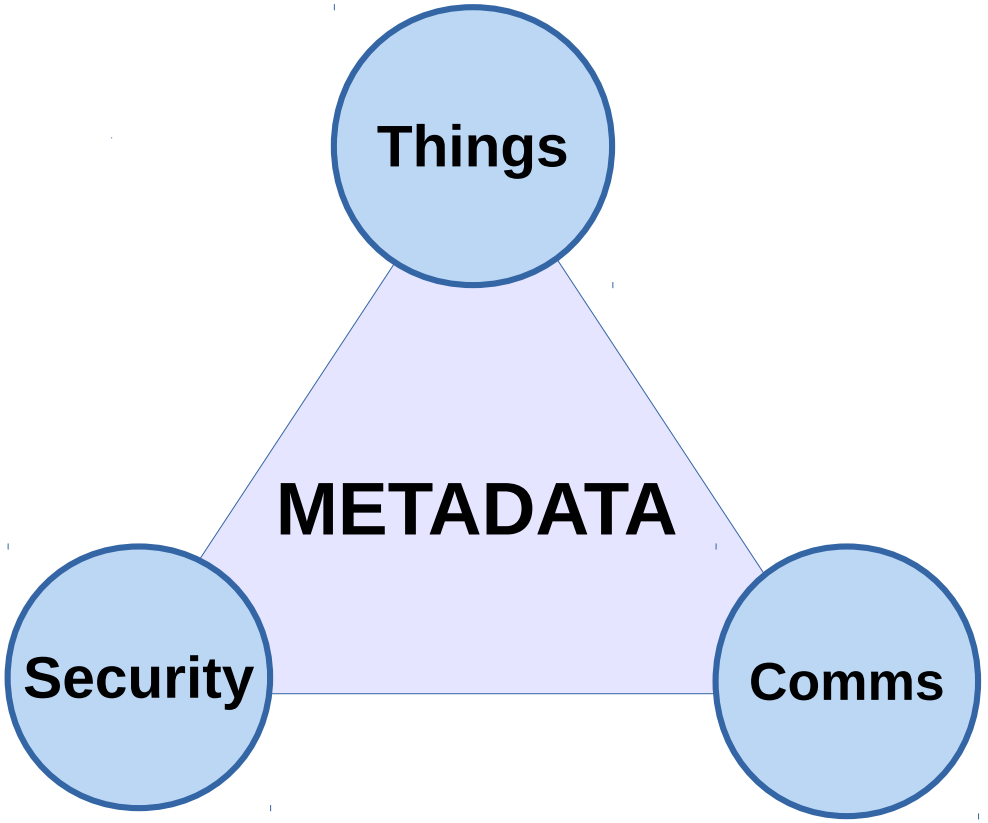
Horizontal & Vertical Metadata



Industry specific groups are in best position to define metadata for each vertical

Focus of W3C Contribution

Core metadata applicable across application domains



- **Thing descriptions**
  - Links to thing semantics
  - Data models & relationships between things
  - Dependencies and version management
  - Discovery and provisioning
  - Bindings to APIs and protocols
- **Security related metadata**
  - Security practices
  - Mutual authentication
  - Access control
  - Terms & conditions
    - Relationship to “Liability”
  - Payments
  - Trust and Identity Verification
  - Privacy and Provenance
  - Resilience
- **Communication related metadata**
  - Protocols and ports
  - Data formats & encodings
  - Multiplexing and buffering of data
  - Efficient use of protocols
  - Devices which sleep most of the time

Role of WoT Interest Group

- Collecting use cases
- Studying requirements
- Building a shared vision
- Helping with outreach and liaisons
  - Showing how the Web of Things applies to different IoT platforms
- Preparing the ground for standardisation in Working Groups
  - Well defined, narrowly scoped work items
  - Rough consensus and running code
- Ongoing role to support work that is not yet ready for standardisation
  - e.g. work on security, privacy, discovery, provisioning, dependency management of distributed systems, ...

Web of Things Working Group

Proposed Scope and Work Items

- Define a core vocabulary for describing thing data models and links to domain models
  - Addressing use cases provided by Web of Things IG
- Define a serialization to JSON-LD with a Content type and an associated default context
  - Default context declares bindings of names to URIs
- Define bindings to common Internet protocols
  - In collaboration with external groups
- Define a vocabulary for servers to describe which protocols, data formats and encodings they support
  - So that servers know how to talk to each other
- Optionally, define a compact encoding format for use by resource constrained devices
  - To minimise memory needs and enable smaller messages

Some Considerations

- The need to check that the Working Group's decisions are appropriate for a range of stake holders, e.g.
  - Web developers
  - Embedded system designers
  - Linked data specialists
  - Big data specialists
- Horizontal review for
  - Accessibility
  - Internationalisation
  - Security
  - Privacy

Data Models – Objectives

- A standard vocabulary for thing data models will enable servers to construct virtual objects for things for use by application scripts
- Enabling developers to interact with things without needing to know about the underlying transport protocols
- The aim is to enable the description of data models, not to standardise those models, which are likely to be domain specific
- To be able to link to domain specific semantic models for interoperability based upon shared semantics.

Data Models – Details

- Properties values can range from basic to complex types
- Basic types including null, boolean, number, string, enumeration
  - Leverage existing standards for these
- Complex types including lists and maps from names to values
- Static and dynamically typed values
- The ability to define and reuse complex data types
  - Analogous to “typedef” in C family of programming languages
- Events may carry data
- Actions may be passed data when invoked, and may return data as an asynchronous response
- Streams as a first class data type, e.g. ECG sensor stream
  - Sequence of data points
    - Simple values vs complex values with named properties
    - Buffered for access to historic values
  - Metadata, e.g. time stamps or sampling interval
  - Access methods, e.g. for values within a given interval
- Embedded opaque data that needs to be passed on to another service

JSON-LD

- RDF – W3C's building block for metadata
  - *<Subject, Predicate, Object>* triples
    - All three can be URLs which act as global names
      - Use HTTP GET on these URLs to retrieve further triples
    - Literals: numbers, strings, booleans
- JSON based serialization of RDF
  - W3C spec http://www.w3.org/TR/json-ld/
- Why do we need JSON-LD?
  - Web developers are very comfortable with JSON
    - Popular choice for use in APIs and message formats
  - JSON-LD as simple way to use JSON for linked data
- @context as a means to bind names to URIs
  - Integral to keeping JSON-LD syntax clean and simple
    - Using simple names in place of name space prefixes and full URLs

JSON-LD and Data Types

- RDF re-uses many of the XML Schema built-in datatypes
  - RDF 1.1 Concepts and Abstract Syntax
    - XML Schema 1.1 Part 2: Datatypes
  - Booleans, different types of numbers, strings, and dates**
    - e.g. http://www.w3.org/2001/XMLSchema#boolean
- JSON-LD context would allow “boolean” in place of
    - http://www.w3.org/2001/XMLSchema#boolean
- WG would define default JSON-LD context for descriptions delivered using new MIME type ***“application/tdl”***
  - See IANA registry of application MIME types
- This context would also cover additional terms, e.g.
  - events, properties and actions
  - The terms for the stream data type
  - “writeable” as an annotation for properties

** As far as I know XML Schema doesn't define “null” so we may need to define that

Bindings to Protocols

- Defining a standard for how to signal events, property updates, action invocations, action results, metadata updates, etc.
- We would need to define this for common protocols, e.g.
  - HTTP, Web Sockets, CoAP, MQTT, MQTT-SN, XMPP, AMQP
- To do so in coordination with SDO responsible for each protocol
  - IETF for HTTP, Web Sockets, CoAP, XMPP
  - OASIS for MQTT and AMQP
- JSON based messages could be a reasonable approach when applicable
  - Along with compact encodings
- Single Web Socket connection could be used for multiple things
  - Re-use of connection between a given pair of web servers
  - Messages thus need to indicate which thing they refer to
- MQTT uses topics for routing messages to subscribers
  - Need a topic for all proxies for a given thing
    - e.g. “wot/<id>/proxies”
  - Need a topic specific to a given thing
    - e.g. “wot/<id>/thing”

Compact Encoding

- IoT devices with limited memory and packet sizes
  - Strings and text based formats are thus a problem
- Very high throughput servers in the cloud
  - Minimising the time and memory needed to process each message
- The data model of a thing is known to sender and receiver of messages
  - This enables the use of compact binary encodings
  - Strings replaced by numeric identifiers**
- A compact encoding of JSON and JSON-LD could be used for
  - Messages for property updates etc.
  - Transferring data models for things
- The Working Group would choose whether they want to specify a compact encoding format
  - Along with the precise technical approach in consultation with stakeholders
    - e.g. based upon EXI or some other solution

** Note complications when data model is changed at run-time

Out of Scope

- Vocabularies for specific application domains
  - Where domain specialists are needed
- Work related to security, assurance, privacy and resilience
  - It is not yet completely clear what W3C should do, e.g. in respect to authentication and access control
  - These are topics for the Web of Things Interest Group to explore in collaboration with other groups
- Could be added to future versions of Working Group Charter

Opportunities

- Where there is a clear need based upon agreed use cases, the Working Group could standardise vocabularies for
  - Dependencies and version management
    - In a distributed system you need to know whether your app is compatible with a thing it depends upon
    - In some cases apps can ignore properties they don't recognize
    - Apps may need to pass through data they don't understand to other services that do
      - Potential role of content types for opaque data types
    - Apps may require certain properties or values in order to work correctly
    - Version numbering and version ranges
      - Apps compatible with things within a given version range
      - Analogies with Linux package and library management
  - Discovery, provisioning and maintenance
  - Communications metadata
    - Enabler for servers to understand how to communicate with each other
  - Future charters could include work on security related metadata
    - Including credentials, access control, trust & conditions

What Next?

- W3C staff contacts to prepare draft charter
- Use GitHub for review and updates based upon feedback from WoT IG members and external stakeholders
- Identify candidates for role of WG (co-)Chair
- Seek approval from W3C Management to proceed to Advisory Committee Review
- Address AC Review comments
- Launch the new Working Group
- First face to face meeting in early 2016
  - Seeking offers for hosting the meeting
  - Co-location with Web of Things IG face to face?