T2TRG: Thing-to-Thing Research Group

W3C WoT joint meeting
September 2016, Lisbon, Portugal

Chairs: Carsten Bormann & Ari Keränen
Note Well

• You may be recorded

• The IPR guidelines of the IETF apply: see http://irtf.org/ipr for details.
Administrivia (I)

- Pink Sheet
- Note-Takers
- Off-site (Jabber, Hangout?)
  - `xmpp:t2trg@jabber.ietf.org?join`
- Mailing List: `t2trg@irtf.org` — subscribe at: [https://www.ietf.org/mailman/listinfo/t2trg](https://www.ietf.org/mailman/listinfo/t2trg)
- Repo: [https://github.com/t2trg/2016-09-w3c-wot](https://github.com/t2trg/2016-09-w3c-wot)
Overview, Beyond REST
10:00 Chairs Welcome, Meeting overview, T2TRG Status
10:20 (all) News and Surprises from W3C WoT, Agenda Bashing
10:40 Klaus Hartke CORAL vs. HSML – way forward?
11:00 Michael Koster HSML vs. CORAL – way forward?
11:20 (all) way forward?
11:40 Carsten Bormann Impulse talk “events and time series”
12:00 (all) Structure into breakouts
12:15 Lunch (lunch by breakout)
13:30 (all) Space for breakouts
14:15 (all) breakout reports, Wrapup “Beyond REST” discussion
Agenda (2)

*Type Systems, Models, Model Translation*
14:40 Jaime Jiménez  “Mapping from LWM2M model to CoMI YANG model”
15:00 Ari Keränen  Bluetooth URIs
15:20 Coffee break
15:50 Daniel Lux  “Seluxit REST-ful open API for Lemonbeat devices”
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Breakouts
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Next meetings

- **SDOs**: Co-locate with W3C WoT meeting @ TPAC in Lisbon (Thu/Fri Sep 22/23): Sat/Sun Sep 24/25

- Open-Source (CoAP Implementers): October 27 near EclipseCon

- Meet with ICN RG in Seoul before IETF97 (Sun Nov 13)?

- **Academic**: February @EWSN?
Lunch

- Table of 15 booked at 12:15 at:
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T2TRG View: Surprises, Actions

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HSML

https://tools.ietf.org/html/draft-koster-t2trg-hsml-00

Media Types for Machine Interaction
Why HSML

• Develop the REST and hypermedia design style for machine interaction
• Build on IETF CoRE standards
• Standardized data model and interaction model for interoperability – like HTML
• Introduce new design patterns to extend REST for machine control applications
What is HSML

• Serialization
  – JSON, CBOR
• Data models
  – CoRE Link-Format, SenML => HSML Collections
• Interaction model optimized for machine workflow
  – Machine comprehensible hyperlinks and forms
  – Link embedding and transclusion
  – Separate or combined data and hypertext
• Transfer layer abstraction
  – Generalizes forms and other message based controls
  – Enables REST and Pub/Sub protocol binding
Design Patterns

• Extensions to the REST design style
• Enable machine control and asynchronous interaction using stateless client and REST
  – Hypermedia based discovery
  – RESTful actuation
  – RESTful asynchronous notification
  – Machine proxy, "device shadow" interaction
• Servient Client + Server integration
  – Consume and expose resources at the same time
• Link annotation for application semantics
CoRAL and HSML

Media Types for Machine Interaction
Klaus Hartke and Michael Koster
Comparison

• Similarities
  – Collections of links and items
  – Forms to drive resource state updates
  – Interoperable data models

• Differences
  – CoRAL uses a data model derived from HAL
  – HSML uses CoRE Link-Format and SenML
  – CoRAL uses media types to define application semantic vocabulary and data serialization
  – HSML uses link annotation to embed application semantics
Next Steps

• Create a common use case prototype to evaluate both approaches
  – Cross-domain interoperability
  – How does the difference in semantic annotation impact application design?
  – Discovery, resource construction, application interaction

• Converge to a single representation format and interaction model over time
Project

• Take CoRE Apps lighting example and translate to HSML
• Implement BB in HSML
• Implement RD as an alternate discovery to BB
• Compare HSML and CoRAL
• Compare RD and BB
  – HSML + BB
  – HSML + RD
  – CoRAL + BB
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Events, time series, streams, pub-sub, low-latency data, …

• Lots of names, each used by different people for very different things

• Differences at many levels: Semantics, representation, transport, …

• Can we get a taxonomy?
Levels

- transport (as in TCP, UDP, …)
  e.g., sending several packets within one RTT

- transfer (as in HTTP, CoAP, XMPP, AMQP)
  e.g., handling data sequences in the transfer primitives

- serialization (as in ASN.1, XML, JSON, CBOR, TS, MKV)
  e.g., streaming serialization

- data modeling (talk about modeling later)
  e.g., modeling the time series
“Streamy” aspects

- transport/transfer: possibly more than one packet per RTT
- periodicity: possibly regular intervals
- data volume/“heavy streams”: may require special handling
- separation of setup and data
  - once set up, producer and consumer are coupled
Interaction, Latency

- Conversational interaction: Latency is highly important (< 150 ms), extra low latency even below that

- “Streaming” interaction: Latency still important, but a few seconds tolerable

- Reliable transfer: Reliability takes priority over latency
“Time Series” aspects

• A sensor can make a series of measurements
  • … or an actuator can be operating on a time base

• Each measurement/actuator setting is attached to a time
Example: Web Streaming

- Web video streams usually use HTTP to transfer
  - A control file (e.g., m3u8) containing links to snippets
    - may continue to grow
  - A sequence of snippets (e.g., MPEG TS)
- Receiver can change quality dynamically by selecting appropriate snippets per slot
Example: Enterprise Service Bus

- Processes Events
  - Generally MUST NOT be lost
- The Bus is not infrastructure, but part of the application ("programmable bus")
  - Bus *processes* events and distributes to appropriate receivers
- Permissionless innovation is **not** a goal
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Type Systems

- **Data** are what stays!
- Model the data
  - During specification time
  - To control behavior at runtime
- Self-describing vs. separate metadata
- Modeling languages
Why model

• The promise of code generation
• For conformance checking
• To attach semantics to data received at runtime
• As a way for humans to interact at specification time (discussion, documentation)
What is being modeled

• Data being interchanged (XML, JSON, …)
  • Syntax (what can/cannot be there)
  • Semantics (what do the parts mean)
• Data at rest (e.g., netconf datastore ➔ YANG)
  • Often implies derived interchange specification
    • Interactions need inputs and outputs
    • Interaction model implied and/or explicit
  • Extreme case: RPC
    describes interactions, not data (just for I/O)
Models

- Language vs. interchange format
  - Optimized for humans vs. for machine interchange
  - Tool vendor view vs. common language
- Syntax model vs. data model vs. information model
- Underlying theory (if at all well-defined!)
  - Tree grammars/production systems (~BNF)
  - Constraint systems
  - Collection of predicates
Language considerations

- Evolvability
  - of the language
  - of the models written in the language
- Modularization
Models vs. Serialization

- Is the model tied to a serialization?
  - What can be expressed (e.g., graph vs. tree)
- Do detail semantics depend on serialization? (YANG!)
- If cross-serialization: What is the common/generalized data model?
Example: CDDL

- Define **structure** of data for **interchange**
- Model at data model level (close to information model)
  - Abstraction based on CBOR/JSON data model
- Production system, based on tree grammars (plus some minimal constraints)
- Language: Readable by humans
- Tool support: instance validation, generation
  - (+ Some information extraction for code generation)
Model translation

- What can be translated?
  - e.g., at-rest ≠ in-motion; tree vs. graph
- Expressibility limitations
- Up-Conversion issues (recognizing structure)
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Coffee mug &
coffee machine

An IoT Scenario
Stefanie Gerdes, Klaus Hartke, Carsten Bormann
Imagine…

• You own a coffee mug, with NFC
• Coffee machines have NFC near their outputs
• when you put in the mug, it can talk to the machine
• mug and machine can negotiate for a coffee that
  • you find tasty
• the coffee machine owner is interested to provide
Assume

- The coffee machine is in the IoT
- The coffee mug can use the machine’s network connection through the NFC
- Many coffee machines want payments, others are happy if they are run by the mug’s owner’s employer
- You have payment-enabled and employer-accredited your mug previously
- The coffee machine has parameters (strength, milk, sugar, even rum can be added) and your mug knows your favorite settings
Make me coffee

• Coffee machine provides a form:

• POST coap://coffee-machine/make_me_coffee
  form relation type: make_coffee_with
  [:and,
   [:and,
    [:field, "strength", [:range, 0, 100]]
    [:field, "milk", [:boolean]]
    [:field, "sugar", [:boolean]]
    [:field, "rum", [:boolean]]]
Security is not optional

[ :and,
  [ :field, "strength", [ :range, 0, 100 ] ]
  [ :or,
    [ :field, "payment-proof",
    [ :field, "employee-proof",
  [ :or
    [ :field, "rum", [ :value, false ]
    [ :and,
      [ :field, "rum", [ :value, true ]
      [ :field, "over-18-proof",
        [ :or,
          [ :token, "coap://passport/dcaf/over-18-oe" ]
Security is not optional

[:and,
    [:field, "strength", [:range, 0, 100]]
    [:field, "milk", [:boolean]]
    [:field, "sugar", [:boolean]]
    [:or,
        [:field, "payment-proof",
            [:token, "coap://pay-desk/dcaf/payment-oe"]],
        [:field, "employee-proof",
            [:token, "coap://employer/dcaf/employee-oe"]]
    ],
    [:or,
        [:field, "rum", [:value, false]]
        [:and,
            [:field, "rum", [:value, true]],
            [:field, "over-18-proof",
                [:or,
                    [:token, "coap://passport/dcaf/over-18-oe"],
                    [:token, "coap://employer/dcaf/over-18-oe"]]
            ]]]]
The plumbing (L2)
The plumbing (L3+)
Add payment processor, employer, government/bank

The Internet

Service 1

Mug AM

The Internet

Mug

The Internet

Service n

Machine AM

The Internet

Machine

NFC