

RDF Presentation and Correct Content Conveyance for Legacy Services and the Web of Things

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How to reach semantic interoperability at the data level between heterogeneous things and services?



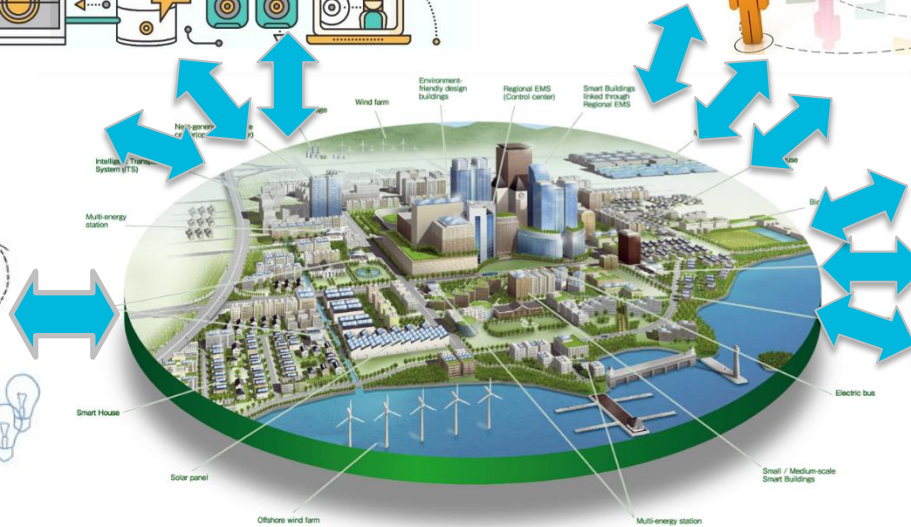
Smart Things



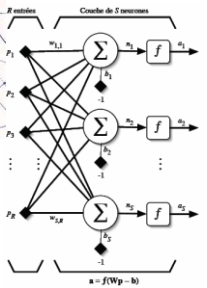
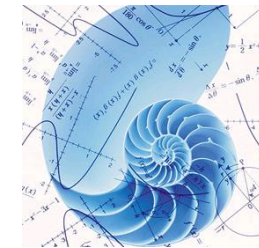
Humans



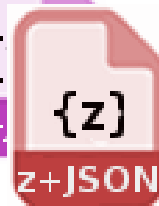
Data



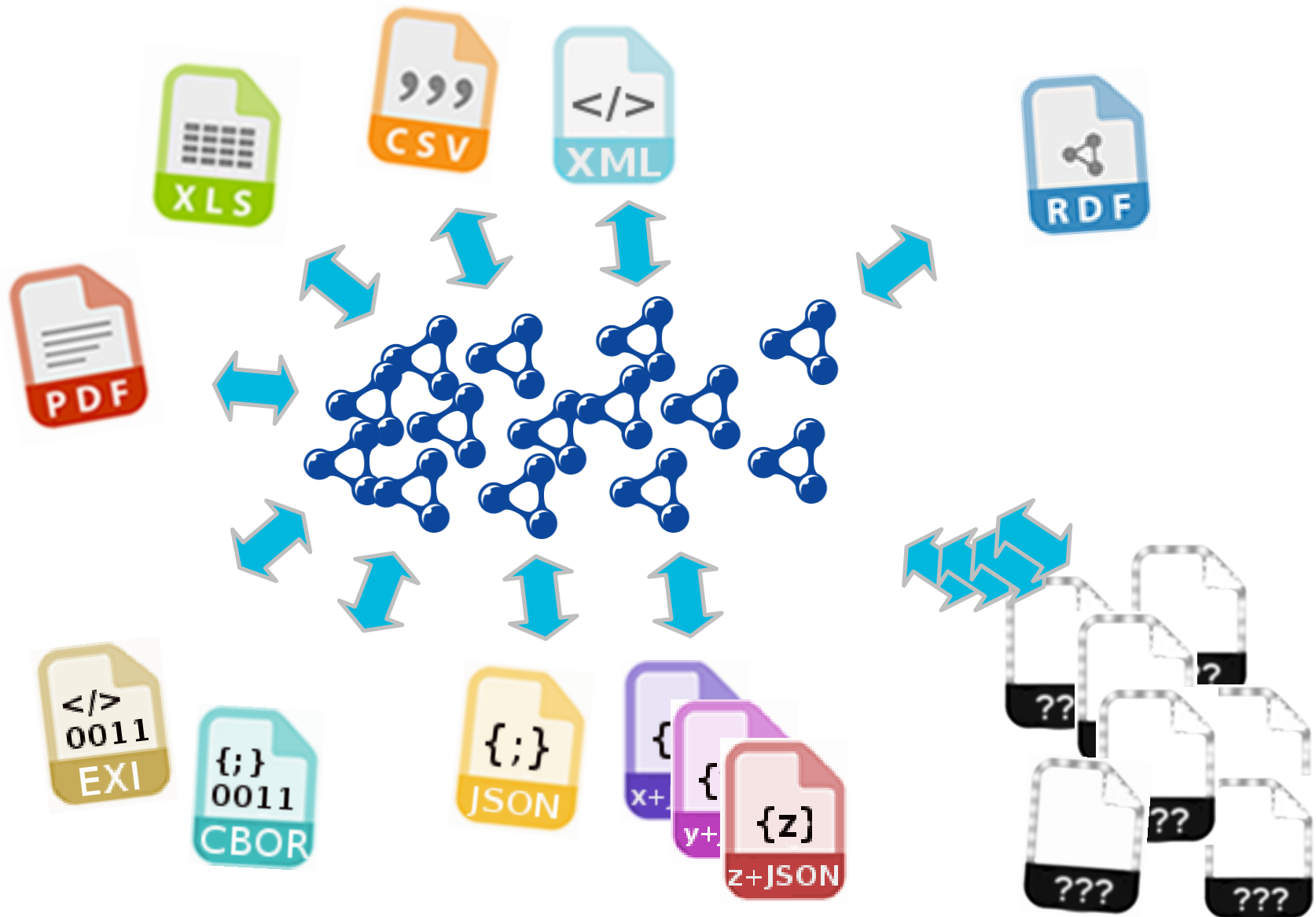
Services



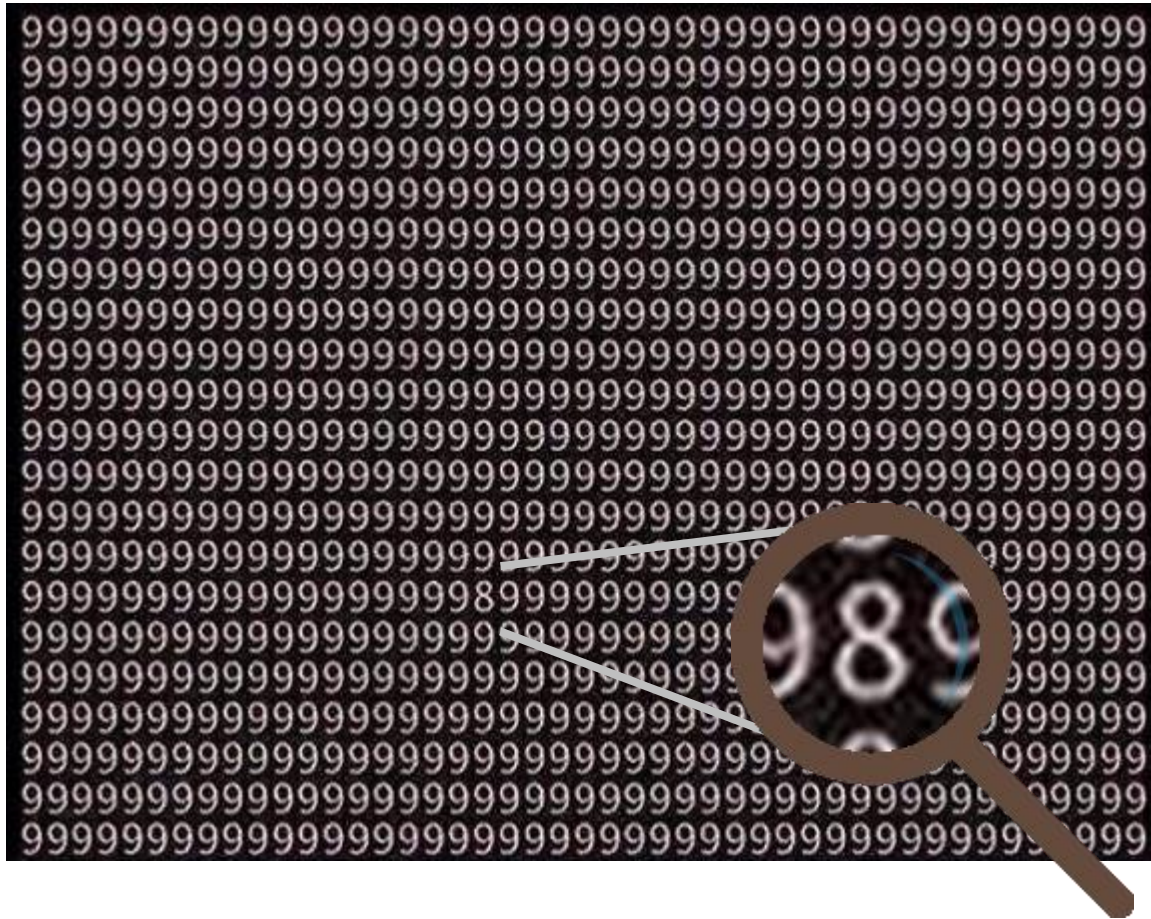
How to reach semantic interoperability at the data level between heterogeneous things and services?



Goal: RDF data *model* as lingua franca for Semantic Interoperability



Idea: just send RDF!



application/rdf+xml
text/turtle
application/ld+json
...
ERI
HDTQ

RDF data *formats* will never be the only ones on the web
Developers prefer JSON, ...

Idea: just send ~~RDF~~ JSON-LD!

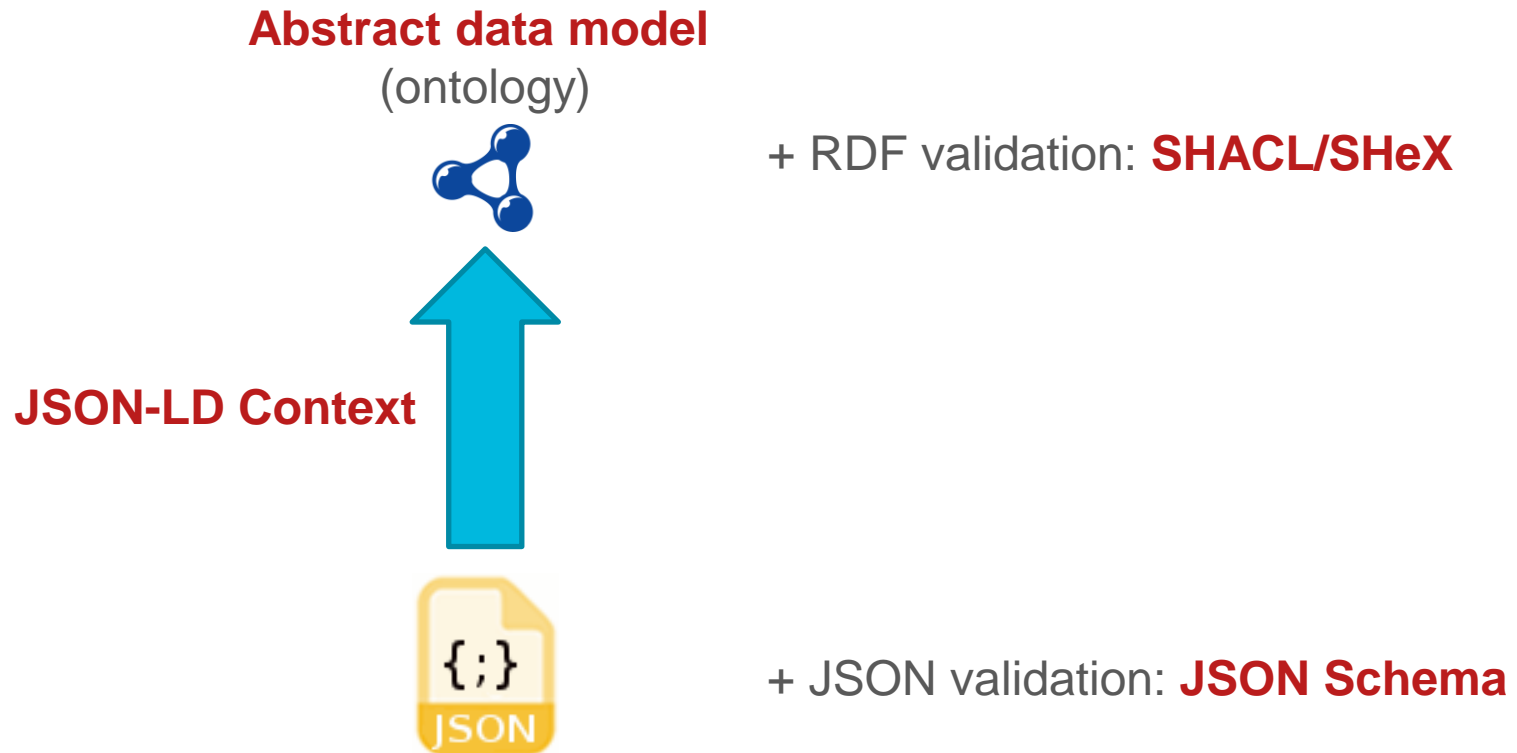


Solution:

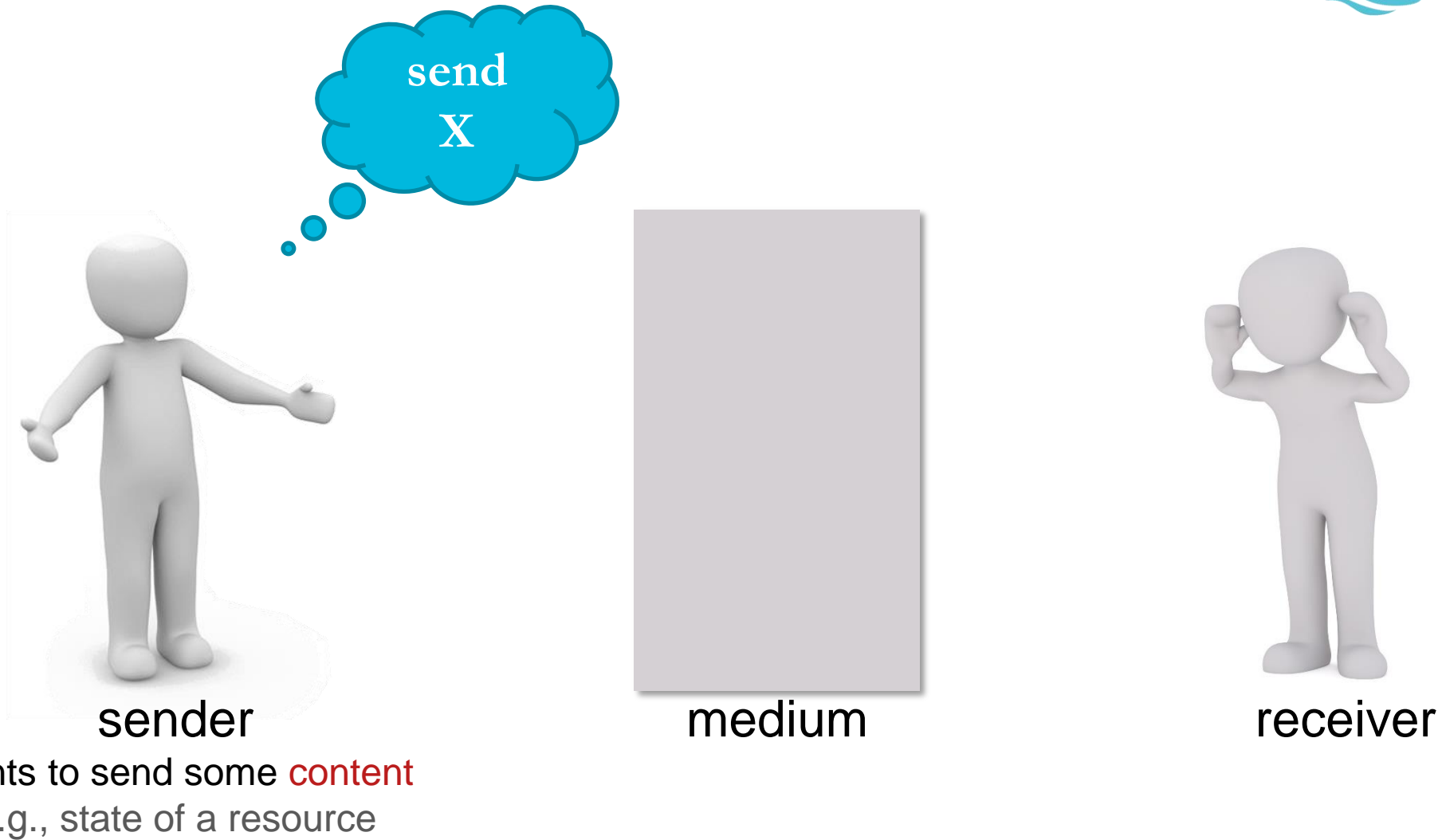
- to rely on *one* RDF syntax like JSON-LD

Requires:

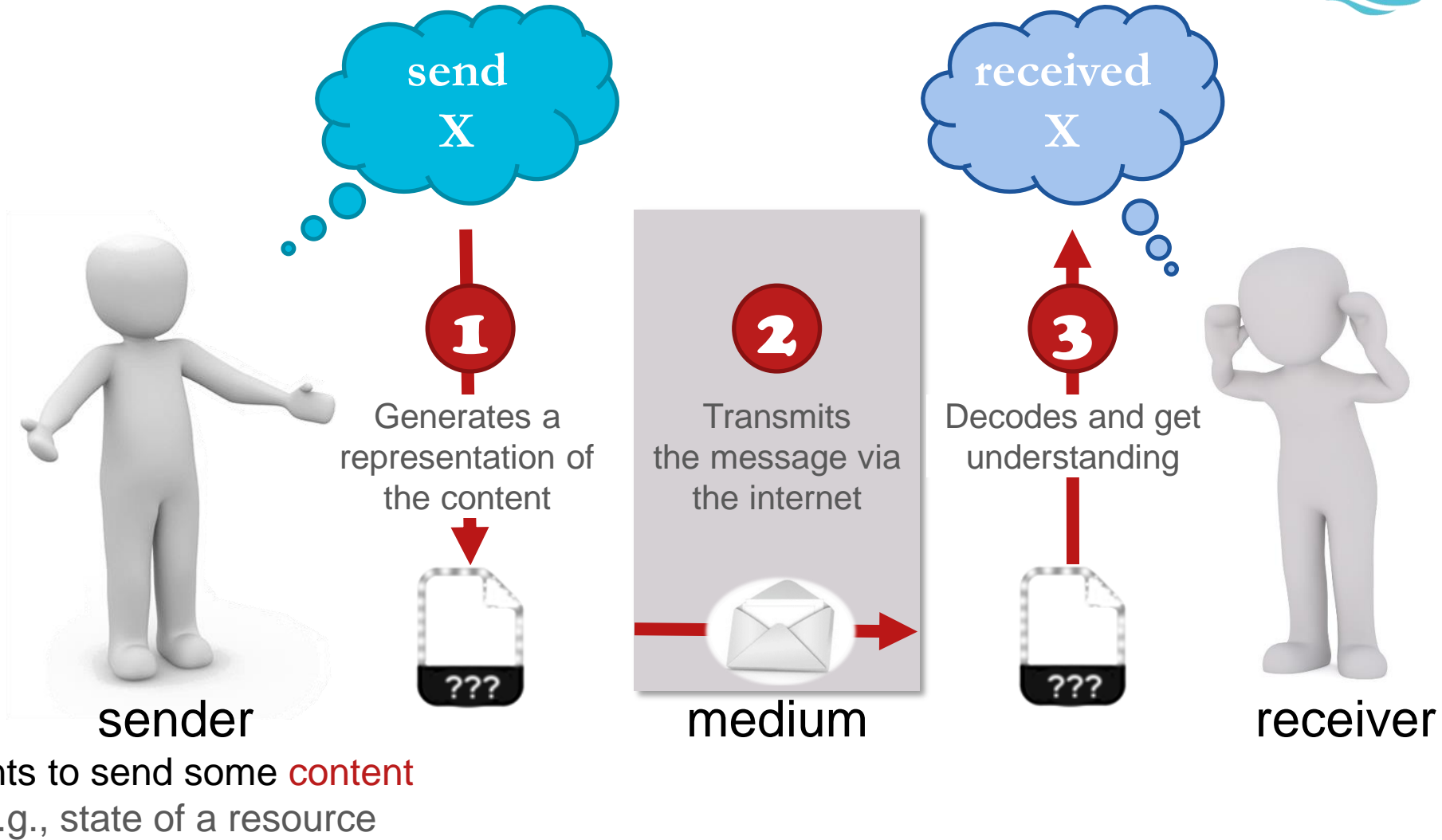
- Global adoption of JSON-LD **Utopian**
- Maintaining during the development or the evolution phase



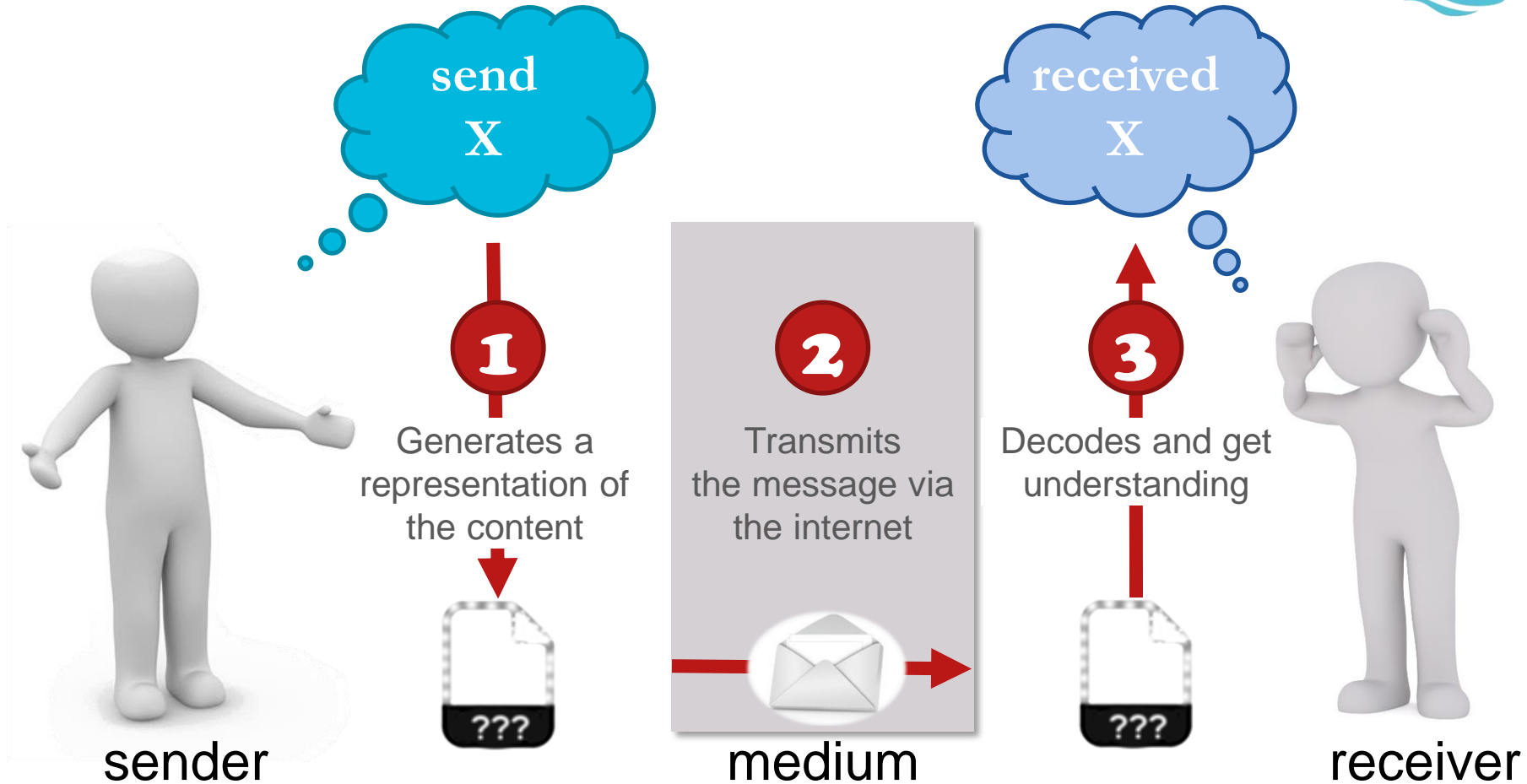
Approx. modeling of the communication between heterogeneous agents on the Web.



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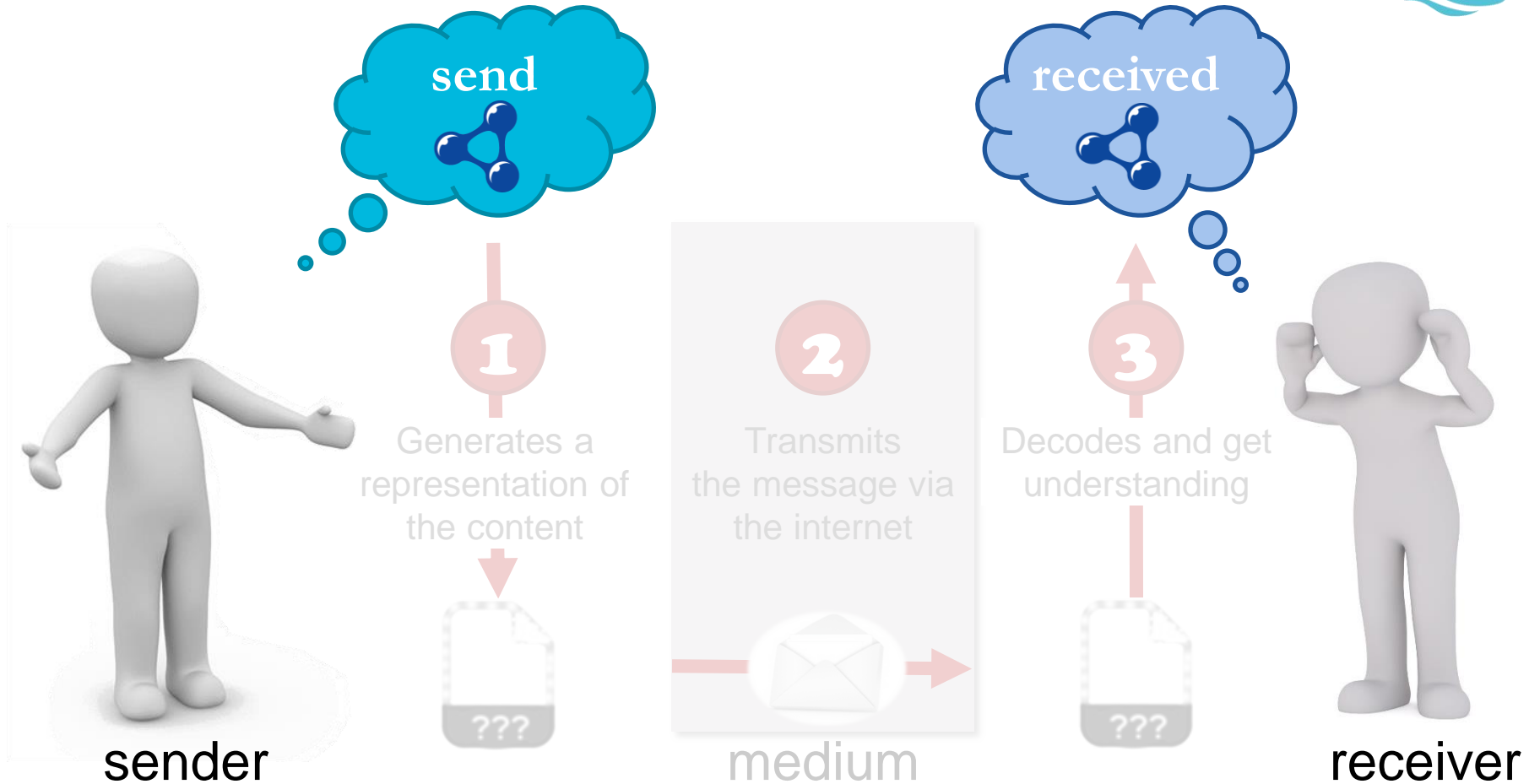
Approx. modeling of the communication between heterogeneous agents on the Web.



***Correct Content Conveyance* iif:**

1. all of the essential characteristics of the content is encoded in the message
2. the encoding and the decoding phase are symmetric
3. the message is not altered in the transmission medium

Assumption: content is always a RDF graph



***Correct Content Conveyance* iif:**

The RDF graph the sender encodes is equivalent to the RDF graph the receiver obtained after decoding the message

Approach



Knowledge engineering methodology

1. Formalize the domain
2. Develop scenarios.
3. Extract competency questions to define the scope of the ontology.
4. Develop an ontology to model the knowledge.
5. Qualitatively validate the ontology by showing how it answers the competency questions.

Conform to and leverage

1. Web's architectural principles
2. The linked data principles

W3C Recommendation

W3C

Architecture of the World Wide Web, Volume One

W3C Recommendation 15 December 2004

This version:
<http://www.w3.org/TR/2004/REC-arch-20041215/>

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Abstract

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Status of this document

This section describes the real world—people, organizations, and resources in the real world. This section provides both the context and the pointers to several key resources.

This is the 15 December 2004 version of the document.

W3C Interest Group Note

W3C

Cool URIs for the Semantic Web

W3C Interest Group Note 03 December 2008

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Abstract

The Resource Description Framework (RDF) is a standard model for data interchange on the Web. It is a simple, flexible, and extensible framework for describing resources and their relationships. The Resource Description Framework (RDF) is a standard model for data interchange on the Web. It is a simple, flexible, and extensible framework for describing resources and their relationships.

W3C Recommendation

W3C

RDF 1.1 Concepts and Abstract Syntax

W3C Recommendation 25 February 2014

This version:
<http://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/>

Latest published version:
<http://www.w3.org/TR/rdf11-concepts/>

Previous version:
<http://www.w3.org/TR/2014/PR-rdf11-concepts-20140109/>

Previous Recommendation:
<http://www.w3.org/TR/rdf-concepts/>

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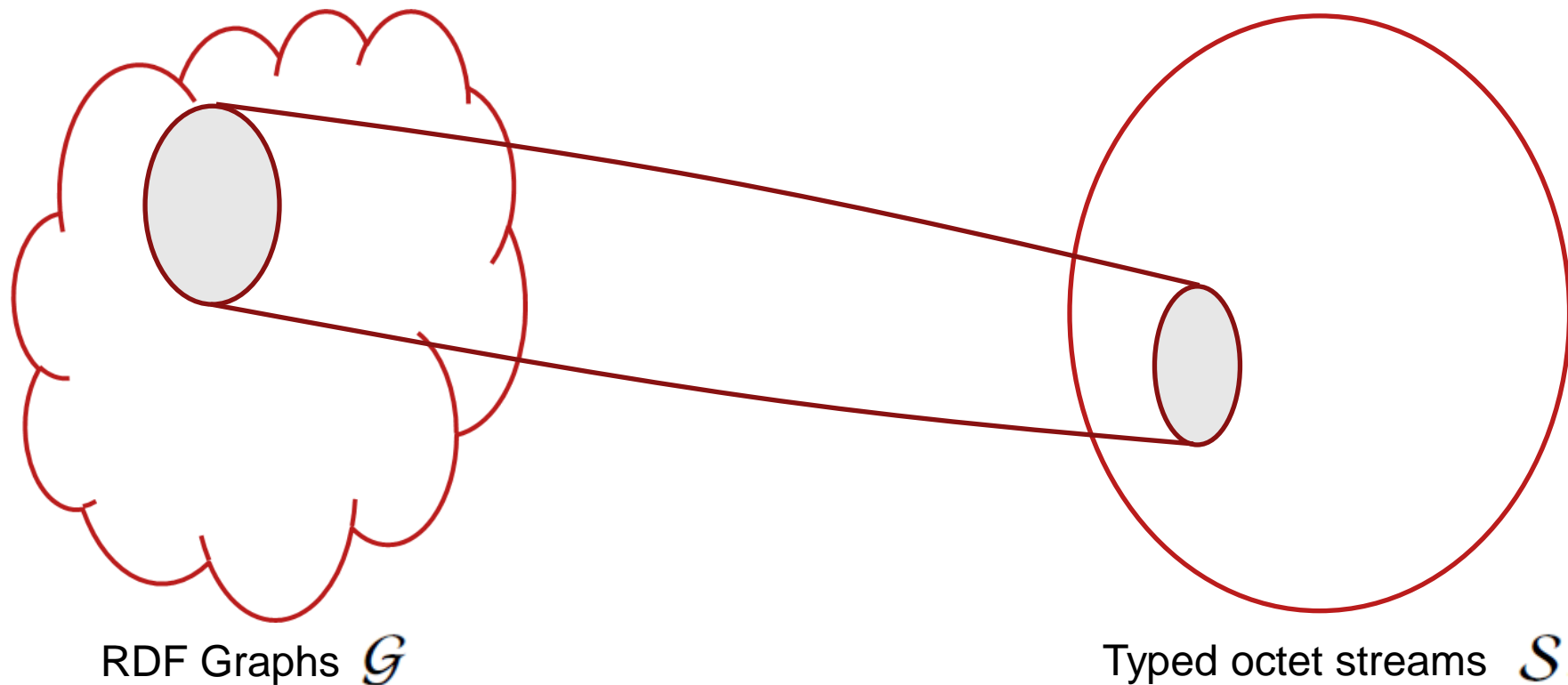
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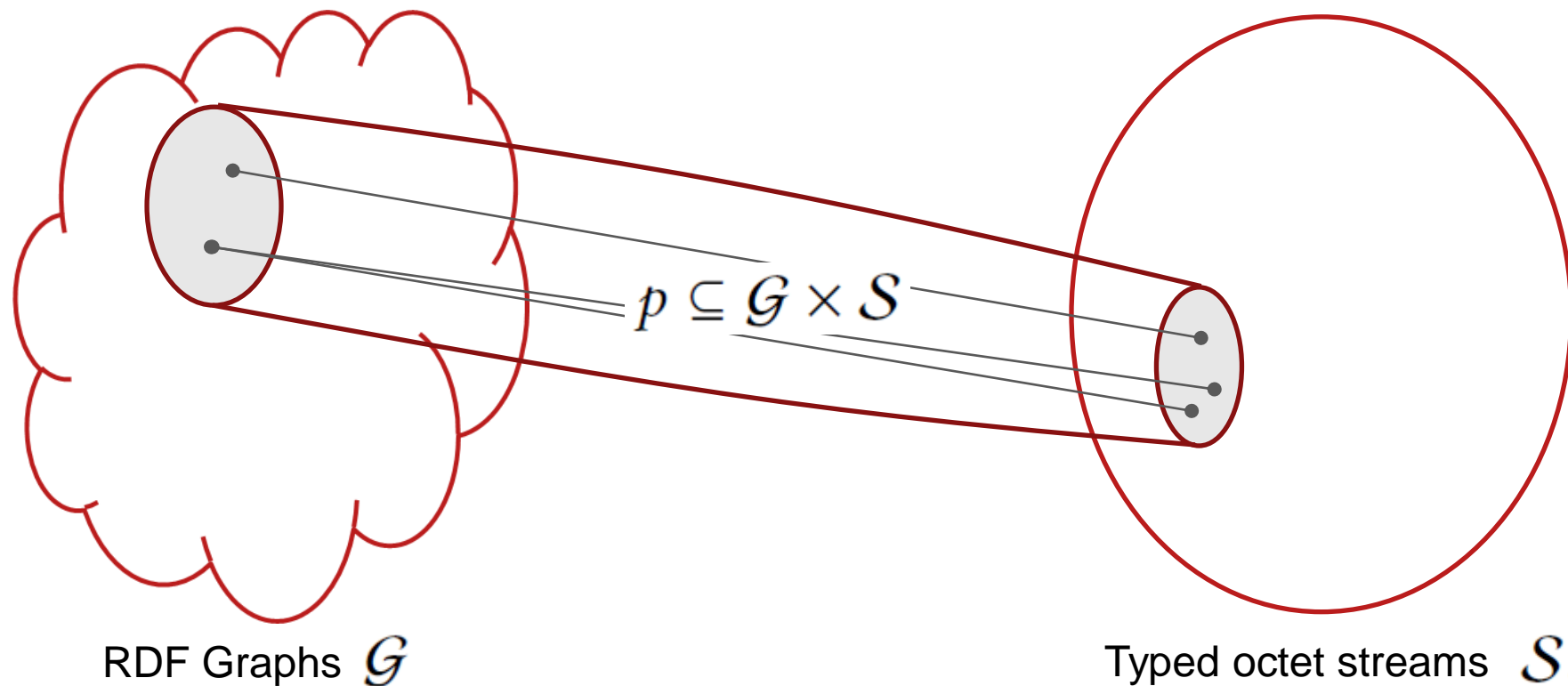
Abstract

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step1

Step 1: Analyze the domain



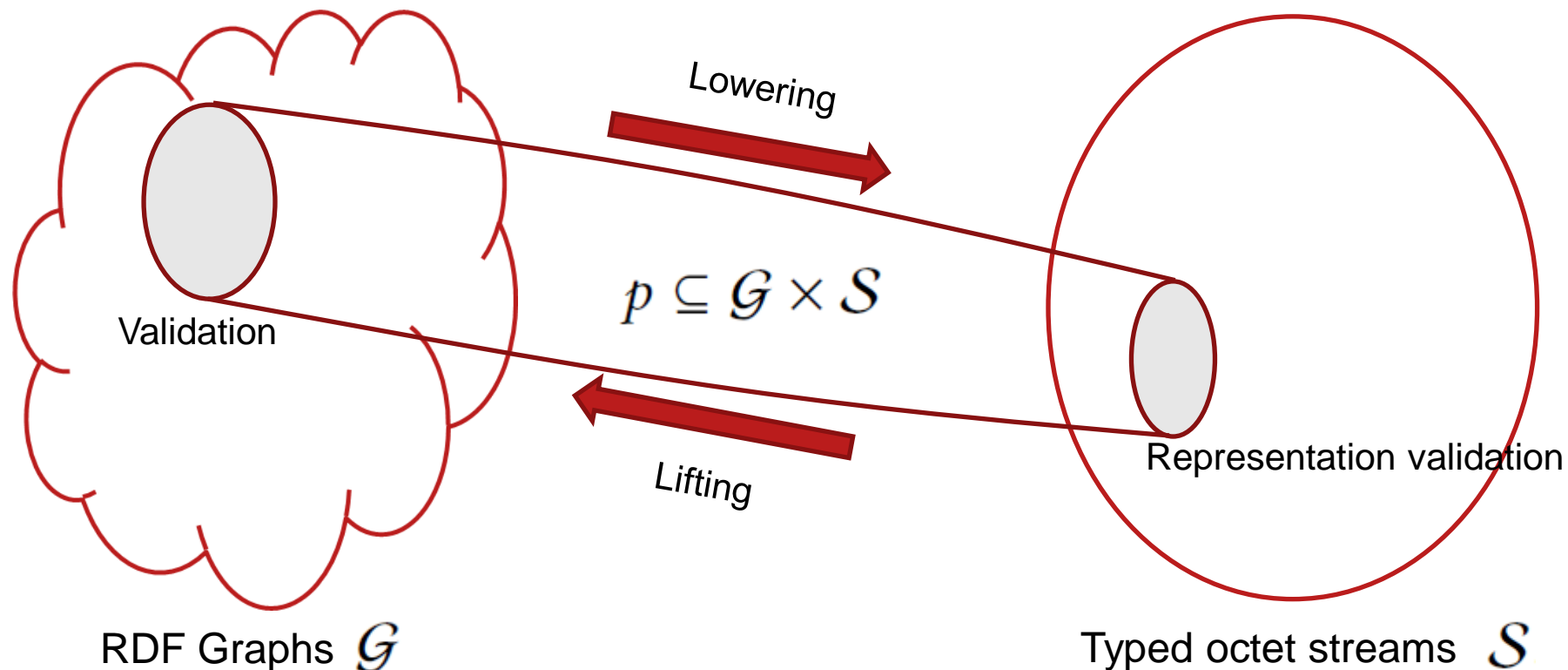


RDF Presentation

$$\forall \langle g, s \rangle, \langle g', s' \rangle \in p, \text{type}(s) = \text{type}(s') = t$$

$$\forall \langle g, s \rangle, \langle g', s' \rangle \in p, s = s' \Rightarrow g = g'$$

Define lifting, lowering, valid.



Lifting rule maps all the *tos* in p to their corresponding graph (unique)

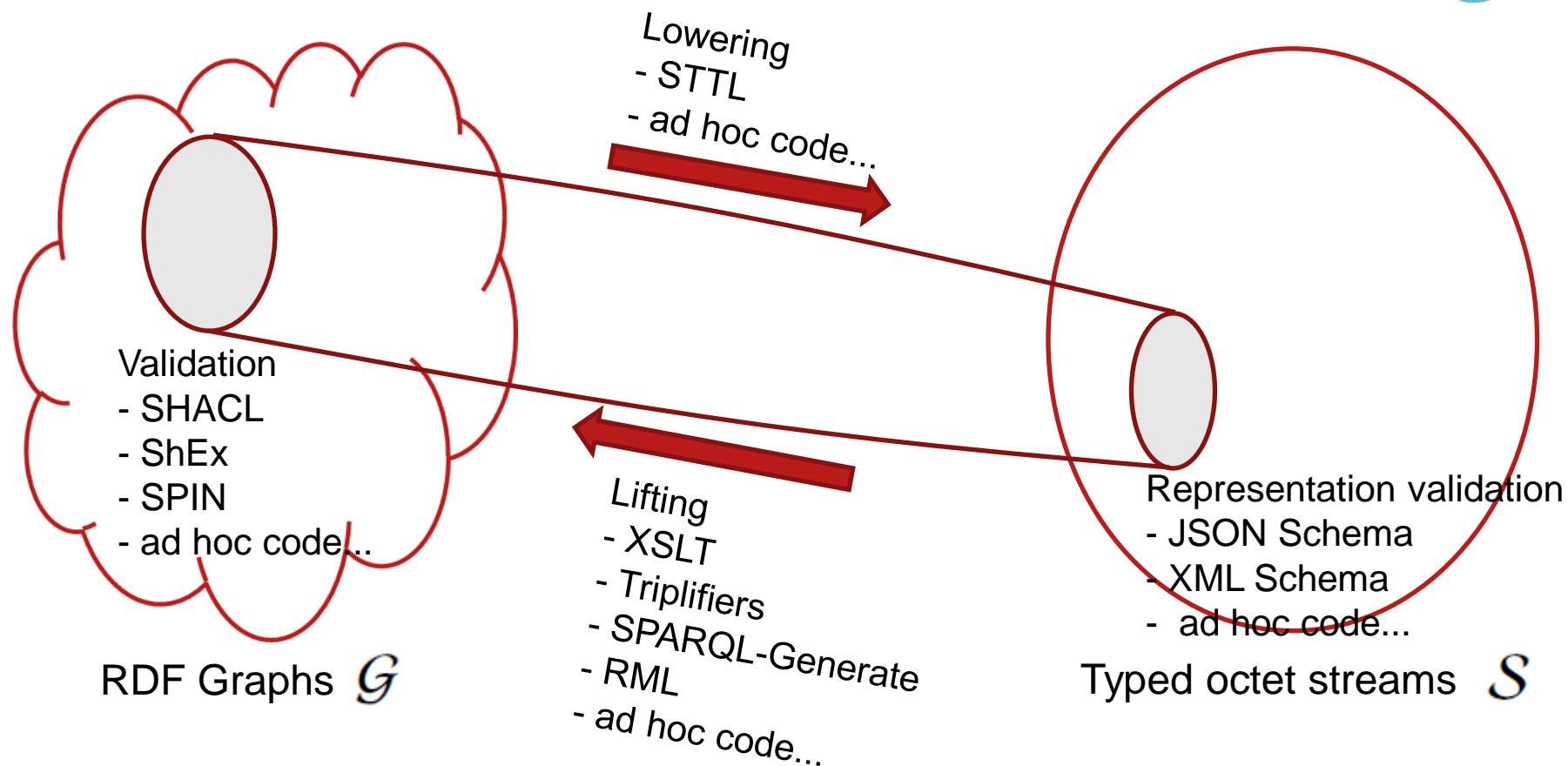
Lowering rule maps all the graphs in p to a *chosen* corresponding typed stream

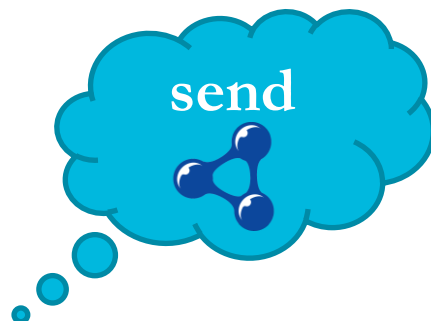
Validation rule checks if there is a pair with that graph

Representation validation rule checks if there is a pair with that *tos*

step1

+ categorisation of tools + analysis of RDF formats





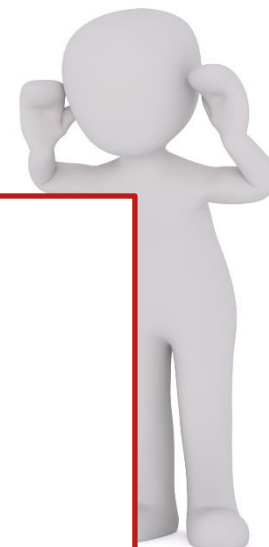
send

The sender can be...

- Req/Res: client sends some content to the server
- Req/Res: server responds to the client
- Pub/Sub: client broadcasts some content to its subscribers

Both agents can also...

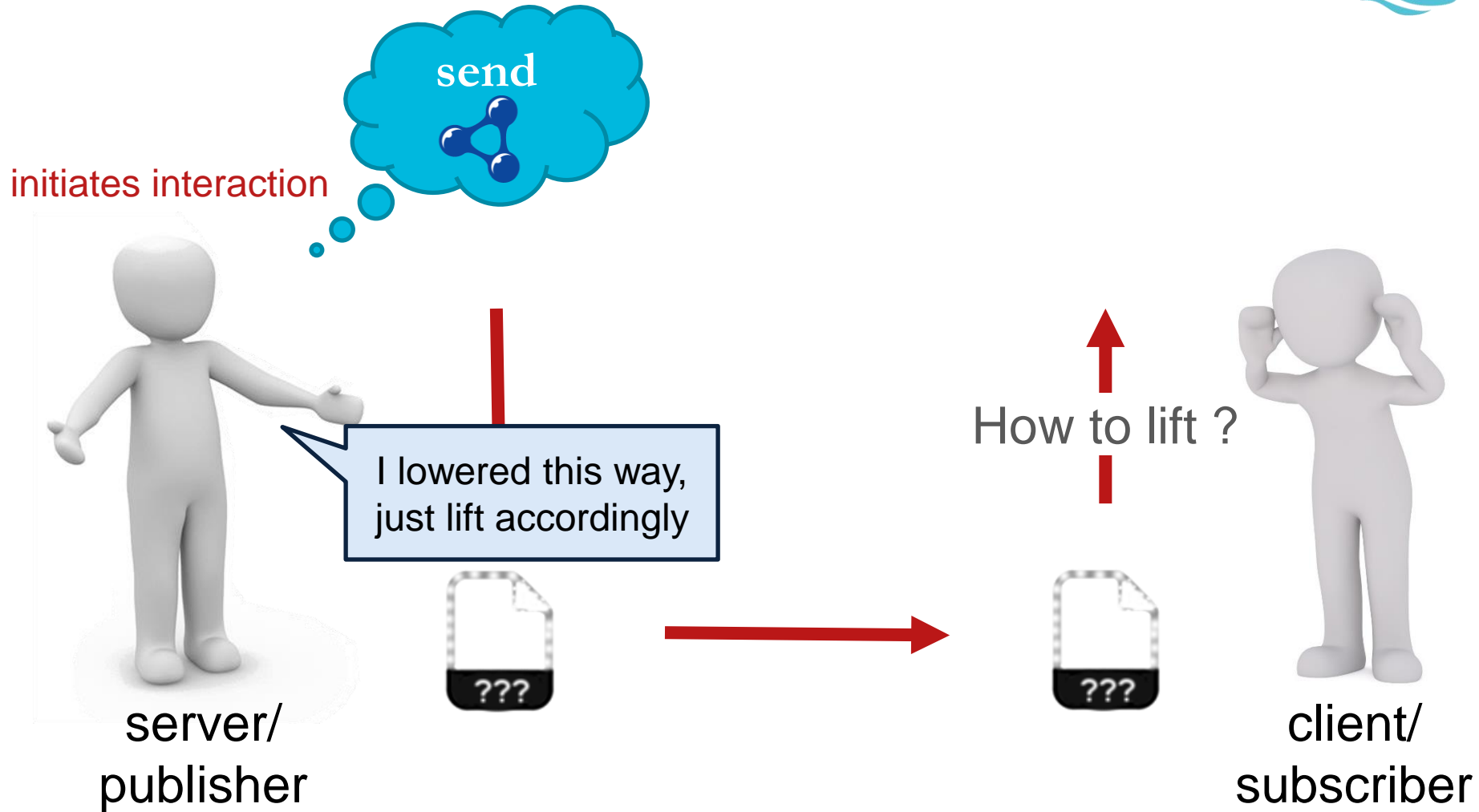
- be constrained in some ways (battery, storage, comput,...)
- implement some of the principles we devise (be *semantically flexible*)
- rely on a third party to operate lifting/lowering/ ...



ceiver

step2

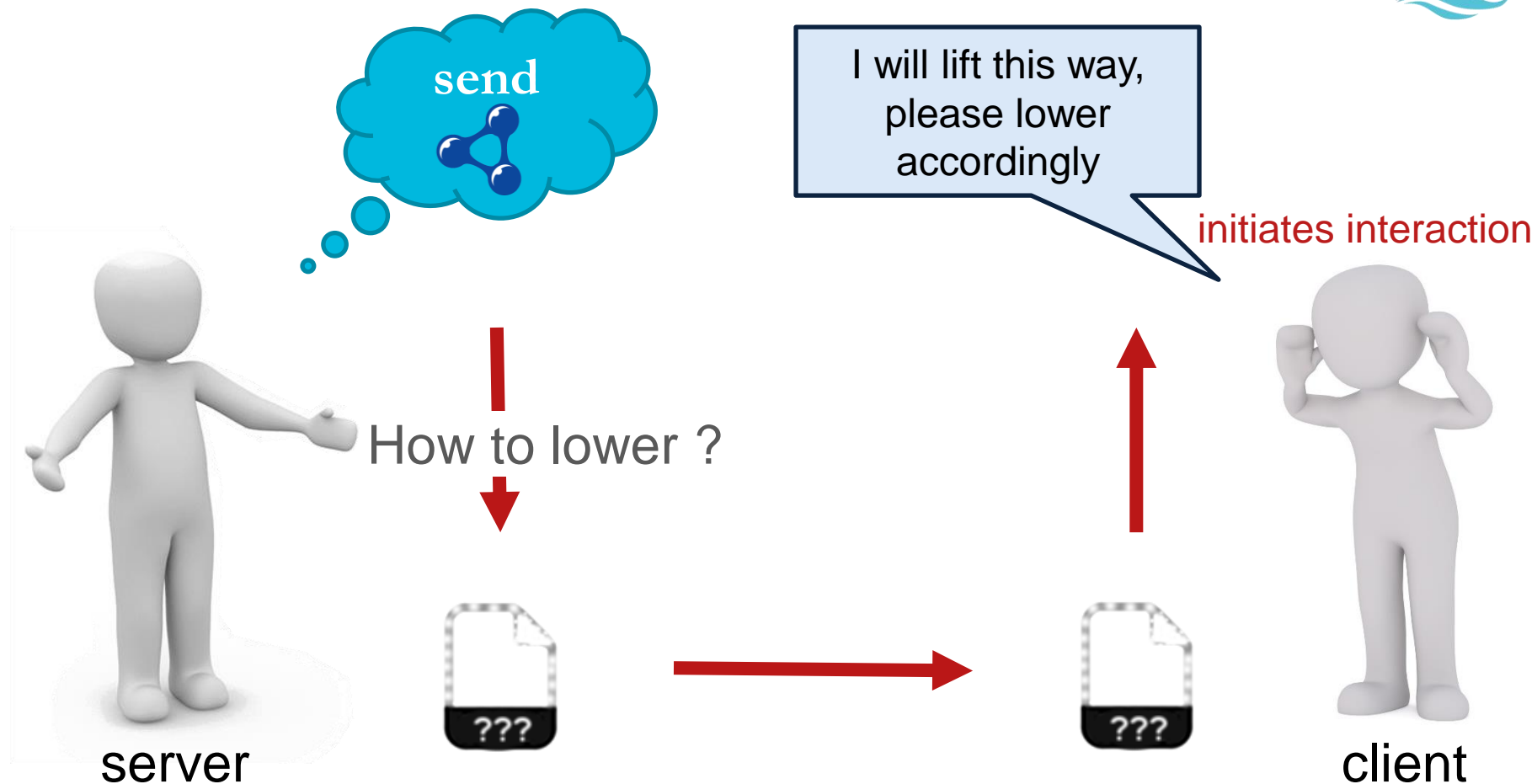
Scenario 1: server/publisher sends its message to a client/subscriber



receiver discovers how to lift (from the sender, or elsewhere)
sender can be constrained... / receiver can be constrained...

step2

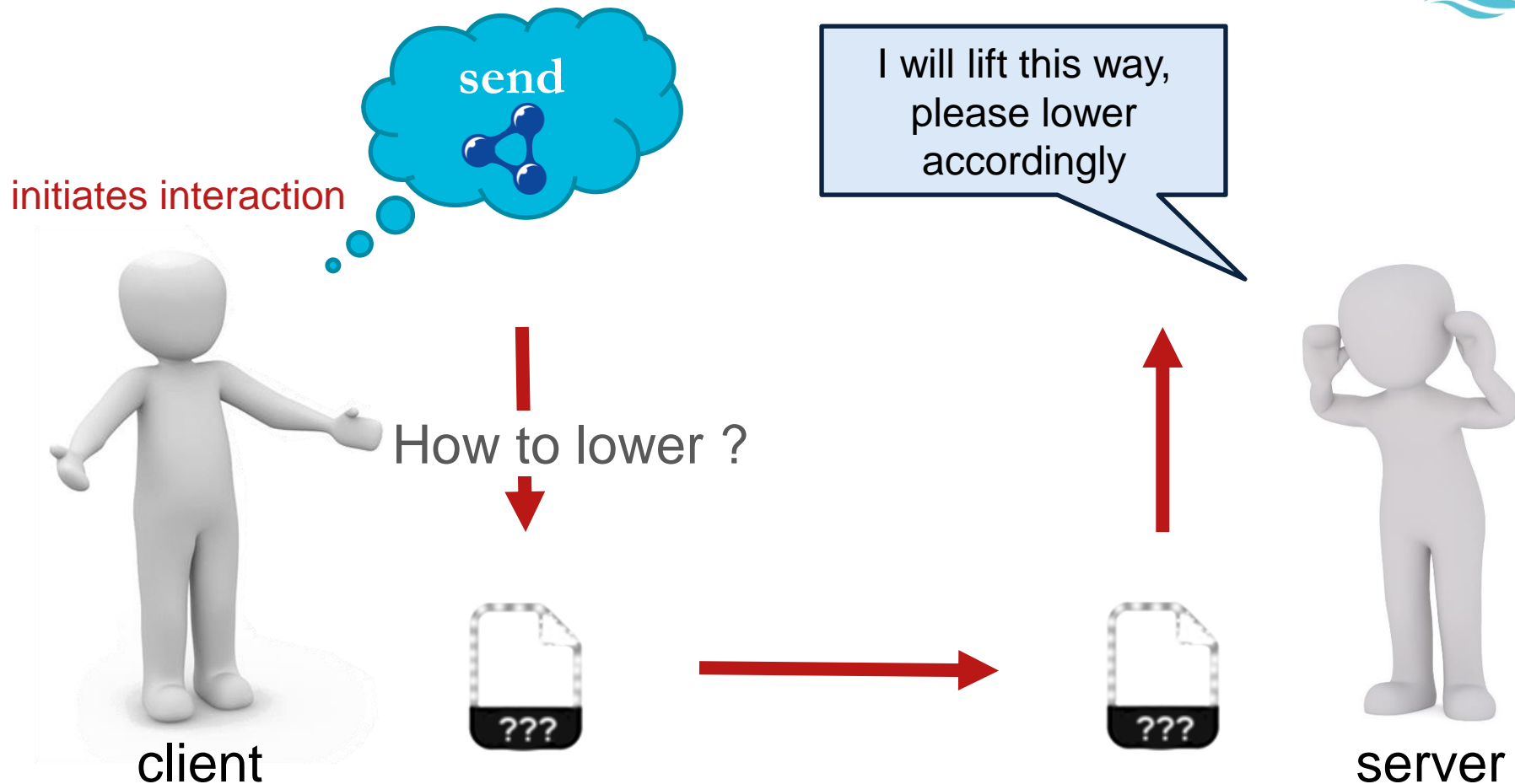
Scenario 2: A client asks a server for the representation of a resource



server discovers a presentation suitable for the client
client can be constrained... / server can be constrained...

step2

Scenario 3: A client sends some encoded content to a server



client discovers a presentation suitable for the server
client can be constrained... / server can be constrained...

CQ1-CQ4

How to represent/use

CQ5-CQ8

How to discover

CQ9-CQ11

Combine with SSN and TD

CQ1: What are the RDF lifting and lowering procedures one can use for a specific RDF presentation?

[...]

CQ5: How can a server inform its client on the RDF presentation it can use to lift the message?

CQ6: How can a server directly inform its client of the RDF lifting procedure it can use to lift the message?

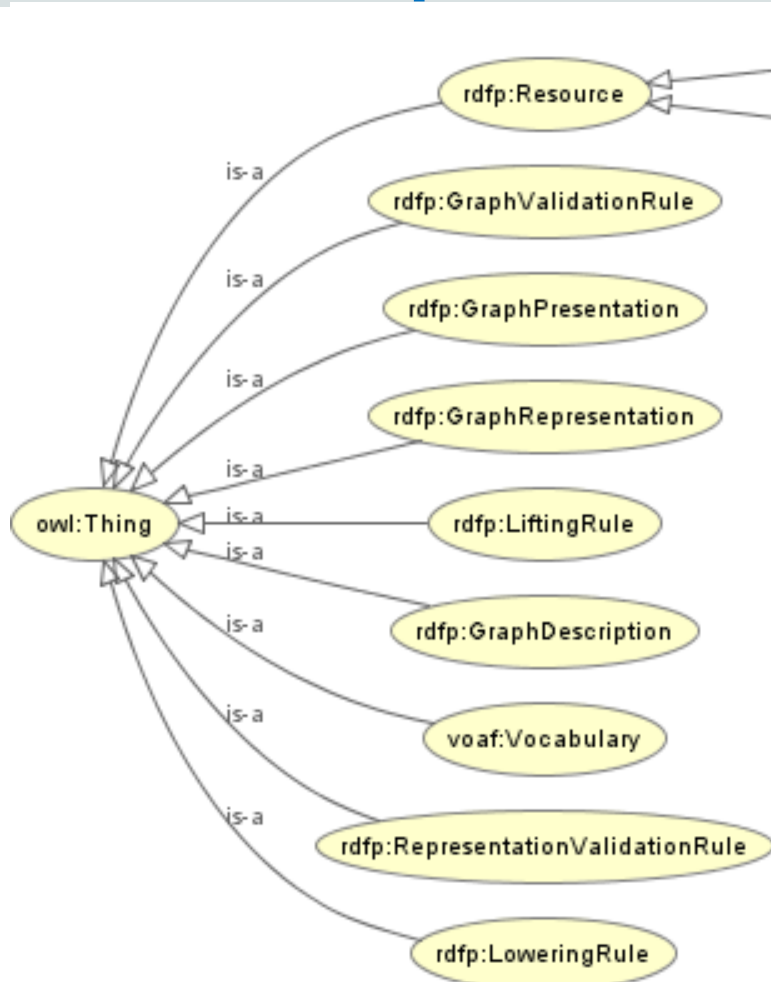
[...]

CQ10: How can one describe the RDF presentation that is used in the output of a sensor?

CQ11: How can one describe the RDF presentation that is used in the input and output of the interaction pattern a thing implements?

The RDFP Ontology

<https://w3id.org/rdfp/>



SEAS
Smart Energy Aware Systems
Last Published: 2017-08-25 | Version: 1.2.2-SNAPSHOT

The RDF Presentation ontology

- This version: v1.0 - <https://w3id.org/rdfp/rdfp-1.0>
- Latest published version: <https://w3id.org/rdfp/>
- Creators:
 - <http://maxime.lefrancois.info/mef/>
- Issues: 2016-08-31
- Modified: 2016-08-08
- Other visualizations: [VOWL](#), [Turtle](#), [RDF/XML](#)

RDF Presentation and RDF Presentation Negotiation

To cite our work:

Maxime LeFranois
Actes
2017

An RDF graph can be presented in several ways, using different media types. Examples of RDF media types include "application/rdf+xml", "text/turtle", "application/json+ld".

```

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# You may obtain a copy of the License at
#
#     http://www.apache.org/licenses/LICENSE-2.0
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# distributed under the License is distributed on an "AS IS" BASIS,
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
# See the License for the specific language governing permissions and
# limitations under the License.

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix dc: <http://purl.org/dc/terms/> .
@prefix vann: <http://purl.org/vocab/vann/> .
@prefix voaf: <http://purl.org/vocabs/voaf/> .
@prefix vs: <http://www.w3.org/2003/06/sv-vocab-status/ns#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .

@prefix rdfp: <https://w3id.org/rdfp/> .
@base <https://w3id.org/rdfp/> .

rdfp: rdfs:type voaf:Vocabulary , owl:Ontology ;
dc:title "The RDF Presentation ontology" ;
dc:description "The RDF Presentation and RDF Presentation Negotiation" .

**To cite our work:**

> Maxime LeFranois, Interop@Brilliance sémantique lib@rale pour les services et les objets, Actes de la 11ème conférence Extraction et Gestion des Connaissances, EGC, Jan 2017, Grenoble, France - (PDF) [http://www.maxime-lefrancois.info/docs/lefrancois-EGC2017-Interoperabilite.pdf] - [Bibtex] (lefrancois-EGC2017-Interoperabilite.bib)

An RDF graph can be presented in several ways, using different media types. Examples of RDF media types include "application/rdf+xml", "text/turtle", "application/json+ld".
  
```

step4

The RDFP Ontology

<https://w3id.org/rdfp/>

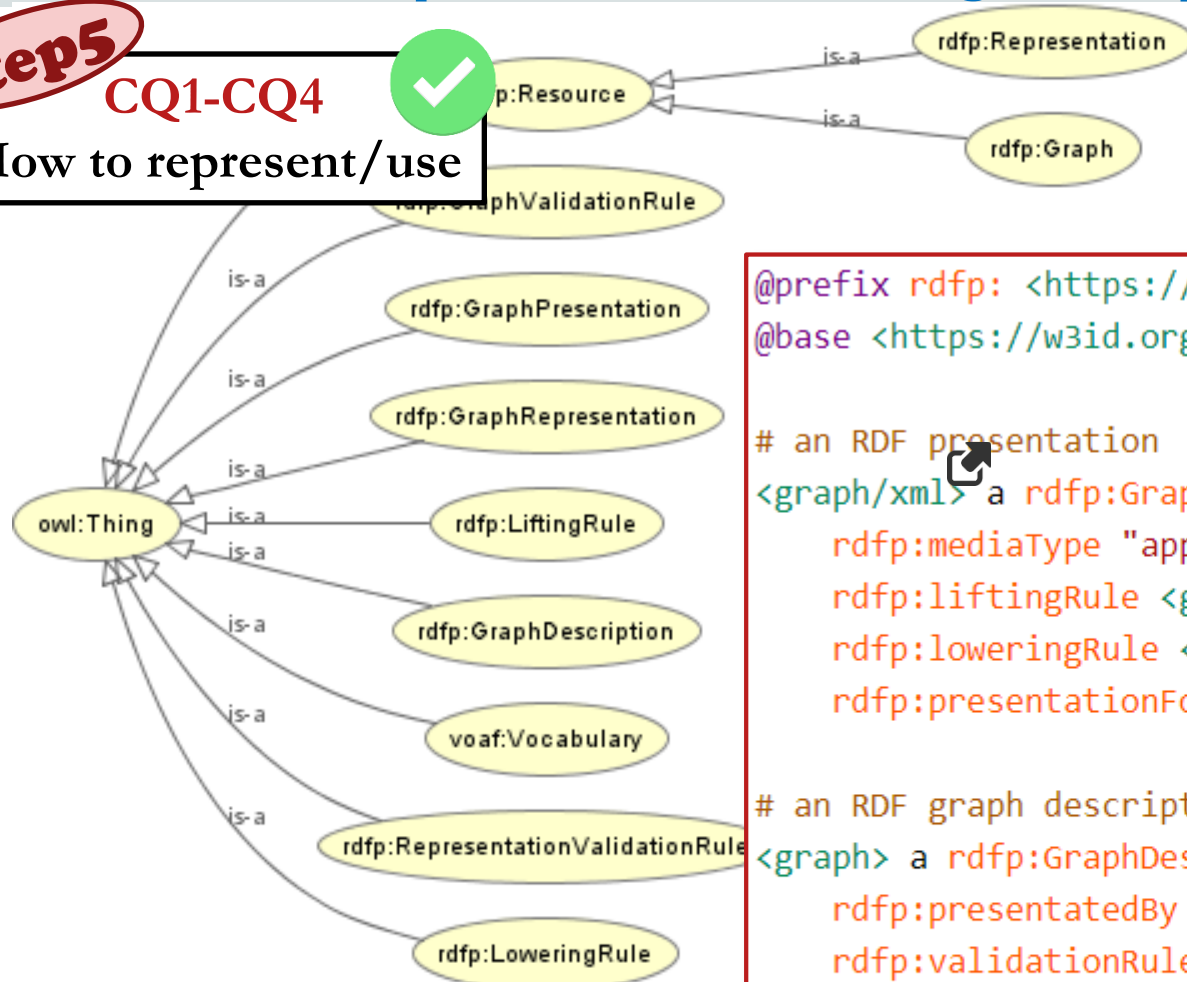


step5

CQ1-CQ4



How to represent/use



```
@prefix rdfp: <https://w3id.org/rdfp/>.
@base <https://w3id.org/rdfp/example/>.
```

an RDF presentation

```
<graph/xml> a rdfp:GraphPresentation ;
  rdfp:mediaType "application/xml" ;
  rdfp:liftingRule <graph/xml/liftingRule> ;
  rdfp:loweringRule <graph/xml/loweringRule> ;
  rdfp:presentationFor <graph> .
```

an RDF graph description

```
<graph> a rdfp:GraphDescription ;
  rdfp:presentedBy <graph/xml> , <graph/json> ;
  rdfp:validationRule <validationRule> .
```

a specific RDF graph

```
<sensorOutput154> a rdfp:Graph ;
  rdfp:describedBy <graph> .
```

step4

The RDFP Ontology

<https://w3id.org/rdfp/>



step5

CQ9-CQ11

Combine with SSN and TD



Semantic Sensor Network Ontology



W3C Recommendation 19 October 2017 (Link errors corrected 08 December 2017)

This version:

<https://www.w3.org/TR/2017/REC-vocab-ssn-20171019/>

Latest published version:

<https://www.w3.org/TR/vocab-ssn/>

Latest editor's draft:

<https://w3c.github.io/sdw/ssn/>

Implementation report:

<https://w3c.github.io/sdw/ssn-usage/>

Previous version:

<https://www.w3.org/TR/2017/PR-vocab-ssn-20170907/>

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Joshua Lieberman, [Tumbling Walls](#)
Claus Stadler, [Universität Leipzig](#)

```
<DHT22#Procedure> a sosa:Procedure ;
    ssn:hasOutput <DHT22#output> .

<DHT22#output> a ssn:Output , rdfp:GraphDescription ;
    rdfs:comment ""The output is a RDF Graph that describes both
    the temperature and the humidity. It can be
    validated by a SHACL shapes graph.""@en ;
    rdfp:validationRule <shacl_shapes_graph> ;
    rdfp:presentedBy [
        a rdfp:GraphDescription ;
        rdfp:mediaType "application/json" ;
        rdfp:validationRule <schema.json> ;
        rdfp:liftingRule <lifting-json.rqg> |
    ] .
```


step4

The RDFP Ontology

<https://w3id.org/rdfp/>



step5

CQ9-CQ11

Combine with SSN and TD



Web of Things (WoT) Thing Description

W3C Working Draft 5 April 2018

W3C

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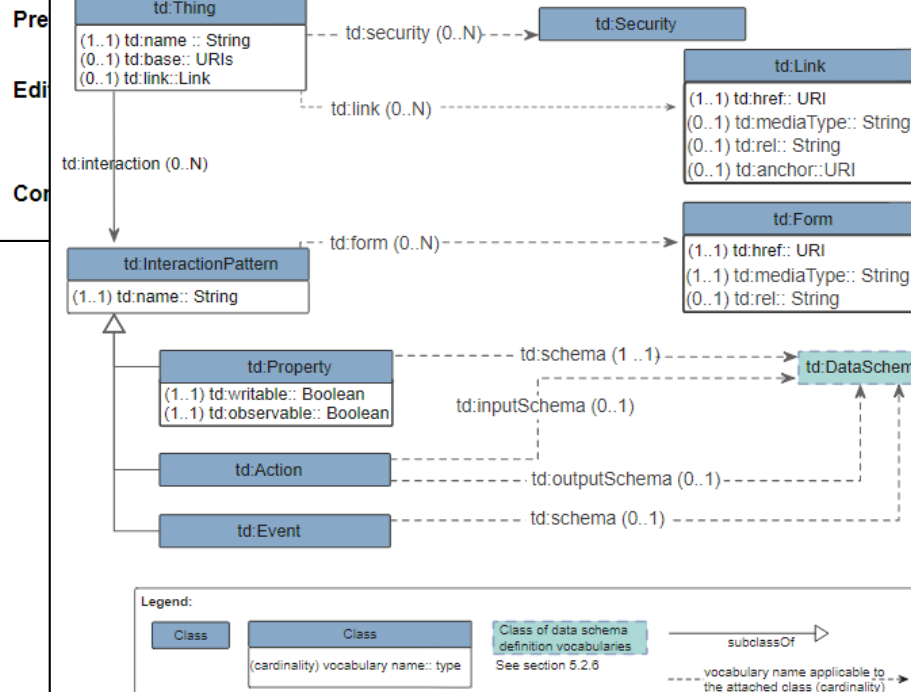
<https://www.w3.org/TR/2018/WD-wot-thing-description-20180405/>

Latest published version:

<https://www.w3.org/TR/wot-thing-description/>

Latest editor's draft:

<https://w3c.github.io/wot-thing-description/>



```
{ "interaction": [
  {
    "@type": ["Property", "iot:CurrentLevel"],
    "name": "exposure",
    "writable": true,
    "observable": true,
    "form": ["..."],
    "schema": {
      "@type": ["rdfp:GraphDescription"],
      "validationRule": "ex/shacl.rdf",
      "presentedBy": [
        {
          "@type": [ "rdfp:GraphPresentation" ],
          "mediaType": "application/json",
          "liftingRule": "ex/lifting.rqg",
          "validationRule": "ex/schema.json"
        }
      ]
    }
  }
]
... }
```

Direct discovery



step5

CQ5-CQ8

How to discover

Indirectly using RDF



Indirectly using
CoRE Link Format

Directly *during a
single interaction*

Direct discovery



step5

CQ5-CQ8

How to discover

Indirectly using RDF

Indirectly using
CoRE Link Format

Directly *during a
single interaction*

OPTION A

```
<http://ex.org/lower>;rel="lowering";anchor="/actuator",  
<http://ex.org/lift>;rel="lifting";anchor="/sensor"
```

OPTION B

```
</actuator>;rt="light-switch";  
  if="POST";lowering="http://ex.org/lower",  
</sensor>;rt="presence-sensor";  
  if="GET";lifting="http://ex.org/lift"
```

Direct discovery



step5

CQ5-CQ8

How to discover

Indirectly using RDF

Indirectly using
CoRE Link Format

Directly *during a
single interaction*

HTTP headers fields – CoAP options

Examples

Content-Lifting-Rule: <http://example.org/api/temp/sparql-generate-rule>

Accept-Lowering-Rule: <http://example.org/api/temperature/sttl-transformation>

Conclusion

- RDF as an abstract data model for messages passed on the Web
- Different scenarios where Web agents can adapt one to another (be *flexible*)
- Scenarios for non-constrained but also constrained agents (using third agent)
- Conceptual framework, formalized
- RDF Presentation (RDFP) ontology to describe presentations
- Direct and indirect discovery of (some information about) presentations

Future work

- Experimental settings to demonstrate the flexibility
- Settings with different frameworks and standards
- Evaluation of the ease of use, adoption
- Cost of the flexibility?

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