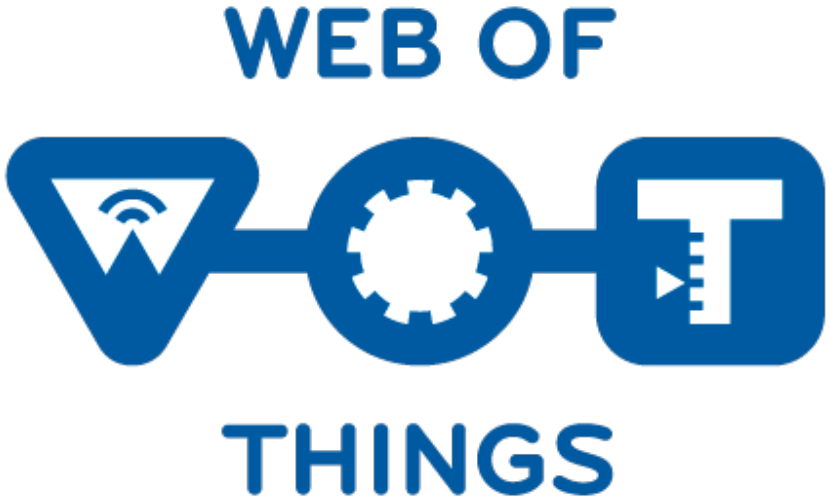
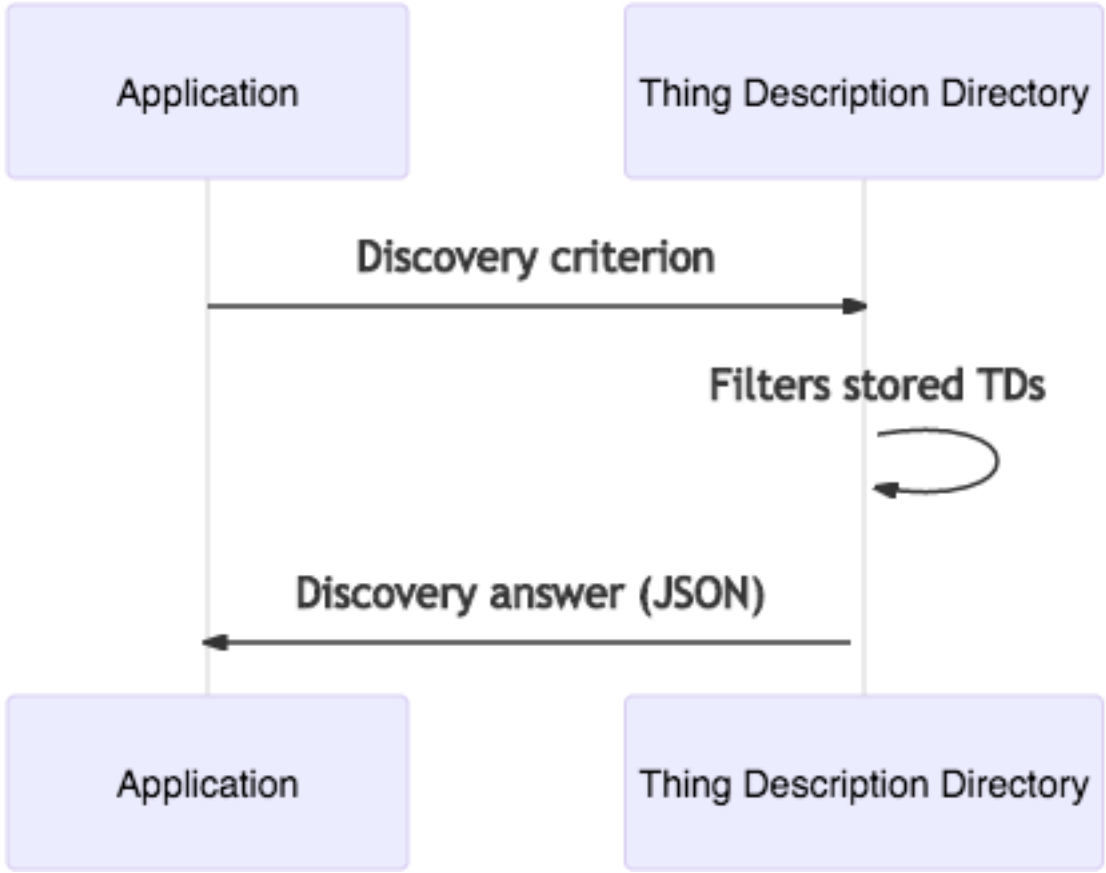


Semantic Discovery in Directories

Andrea Cimmino (Universidad Politécnica de Madrid)

17/03/21

Discovery in a nutshell



Thing Description Directory (TDD) and discovery

- TDD syntactic discovery criterion:
  - (Syntactic discovery) MUST support JSONPath as discovery criterion
  - (Syntactic discovery) SHOULD support XPath as discovery criterion

- TDD semantic discovery criterion:
  - (Semantic discovery) May support SPARQL as discovery criterion

- TDD discovery answer:
  - A set (array) of Thing Descriptions (TD) meeting the criterion are found
  - A set (array) of Thing Descriptions (TD) fragments fulfilling the criterion are found
  - Discovery results could be paginated (depending on the discovery criterion)

SPARQL semantic discovery API

- The discovery criterion is a SPARQL query
  - https://www.w3.org/TR/rdf-sparql-query/
  - W3C standard
  - All SPARQL queries should use content-negotiation to return JSON-LD or JSON
  - Supported: SELECT, ASK, CONSTRUCT, and DESCRIBE
  - Not-Supported: UPDATE

- Response code:
  - 200 (Ok) with application/json Content-Type header

- Error codes:
  - 400 (Bad Request): SPARQL query not provided or contains syntax errors.
  - 401 (Unauthorized): No authentication.
  - 403 (Forbidden): Insufficient rights to the resource.
  - 501 (Not Implemented): SPARQL API not supported.

SPARQL queries

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX sch: <https://www.w3.org/2019/wot/json-schema#>
PREFIX hyp: <https://www.w3.org/2019/wot/hypermedia#>

SELECT DISTINCT ?href WHERE {
        ?device wot:hasPropertyAffordance ?property .
        ?property sch:propertyName "status" .
        ?property wot:hasForm ?form .
        ?form hyp:hasTarget ?href .
}
```

Find the href of devices that have the property status
- XPath: *//properties/status//href

SPARQL queries

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX sch: <https://www.w3.org/2019/wot/json-schema#>
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SELECT DISTINCT ?href WHERE {
        ?device wot:hasPropertyAffordance ?property .
        ?property sch:propertyName "status” .
        ?property wot:hasForm ?form .
        ?form hyp:hasTarget ?href .
}
```

```
PREFIX%20wot%3A%20%3Chttps%3A%2F%2Fwww.w3.org%2F2019%2Fwot%2Ftd%23%3E%0APREFIX%20sch%3A%20%3Chttps%3A%2F%2Fwww.w3.org%2F2019%2Fwot%2Fjson-schema%23%3E%0APREFIX%20hyp%3A%20%3Chttps%3A%2F%2Fwww.w3.org%2F2019%2Fwot%2Fhypermedia%23%3E%0A%0ASELECT%20DISTINCT%20%3Fhref%20WHERE%20%7B%0A%3Fdevice%20wot%3AhasPropertyAffordance%20%3Fproperty%20.%0A%3Fproperty%20sch%3ApropertyName%20%22status%E2%80%9D%20.%0A%3Fproperty%20wot%3AhasForm%20%3Fform%20.%0A%3Fform%20hyp%3AhasTarget%20%3Fhref%20.%0A%7D%0A%00
```

SPARQL semantic discovery API example

```
"searchSPARQL": {
        "description": "SPARQL semantic search",
        "uriVariables": {
          "query": {
            "title": "A valid SPARQL 1.1. query",
            "type": "string",
            "format": "iri-reference"
          }
        },
        "forms": [
          {
            "href": "/search/sparql?query={query}",
            "htv:methodName": "GET",
            "response": {
              "description": "Success response",
              "htv:statusCodeValue": 200
            },
           "scopes": "search"
          },
          {
            "href": "/search/sparql",
            "htv:methodName": "POST",
            "response": {
              "description": "Success response",
              "htv:statusCodeValue": 200
            },
            "scopes": "search"
          }
        ]
      }
```

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            "htv:methodName": "POST",
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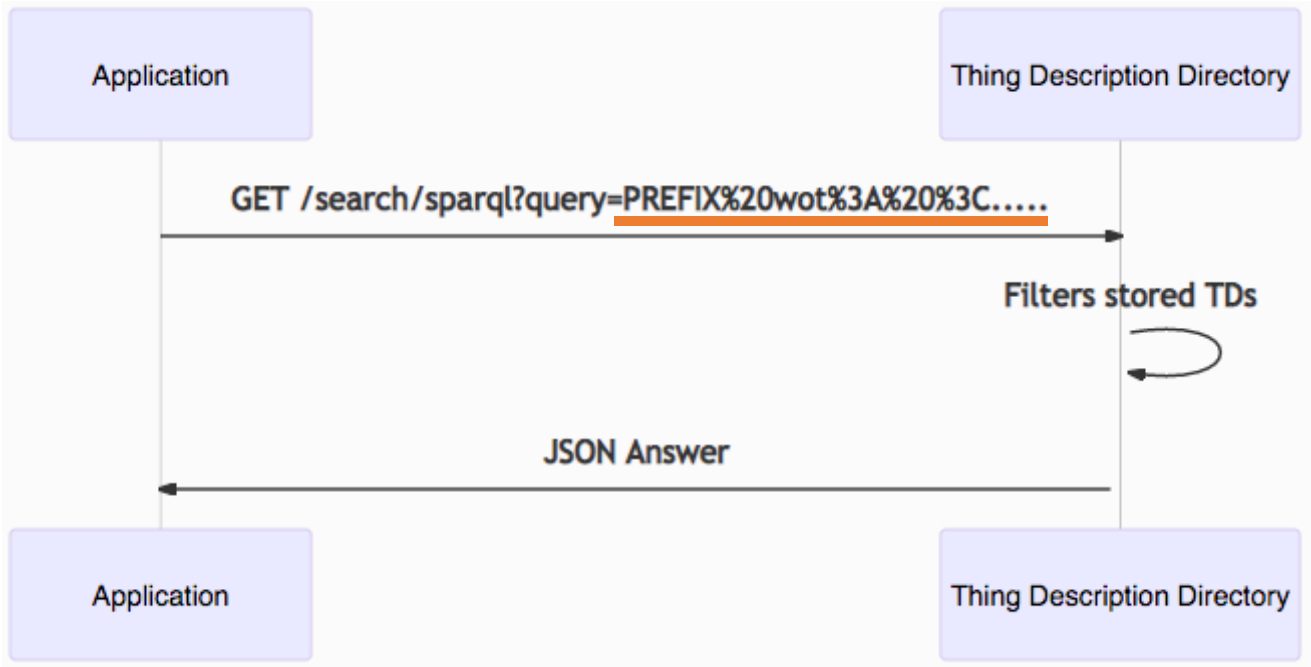
        ]
      }
```



SPARQL semantic discovery API example

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            "scopes": "search"
          }
        ]
      }
```
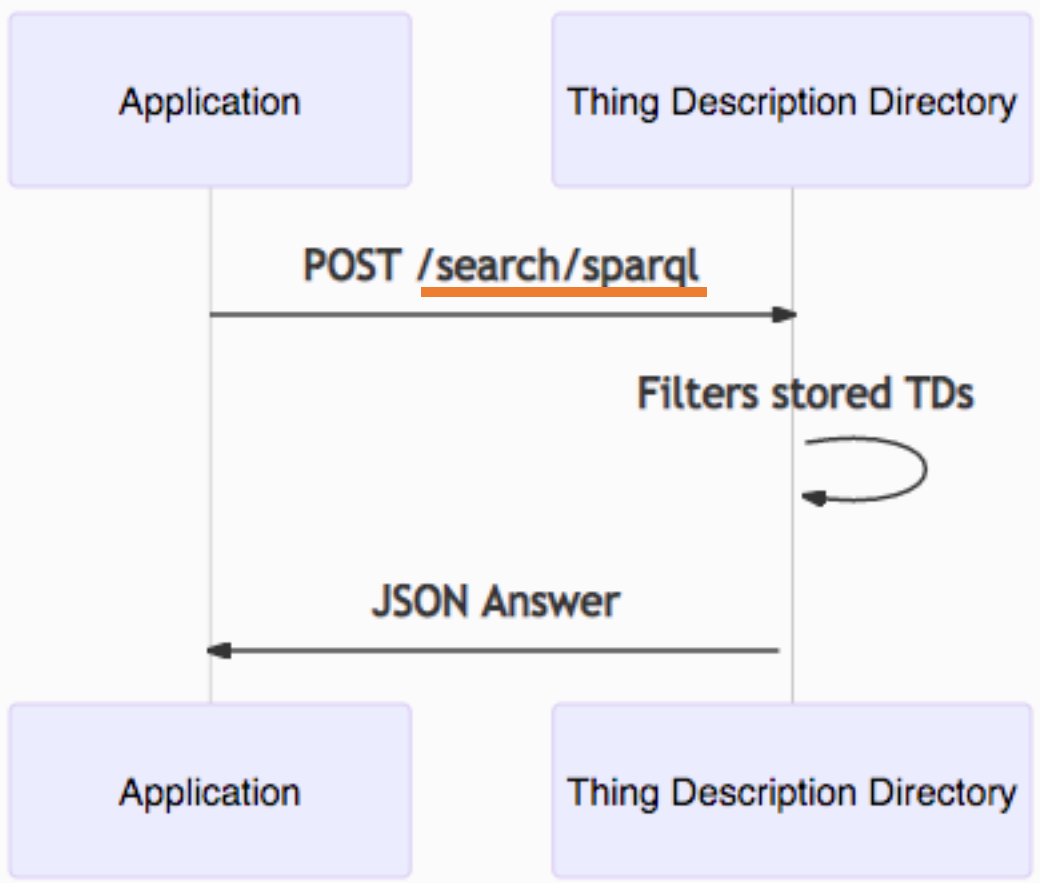
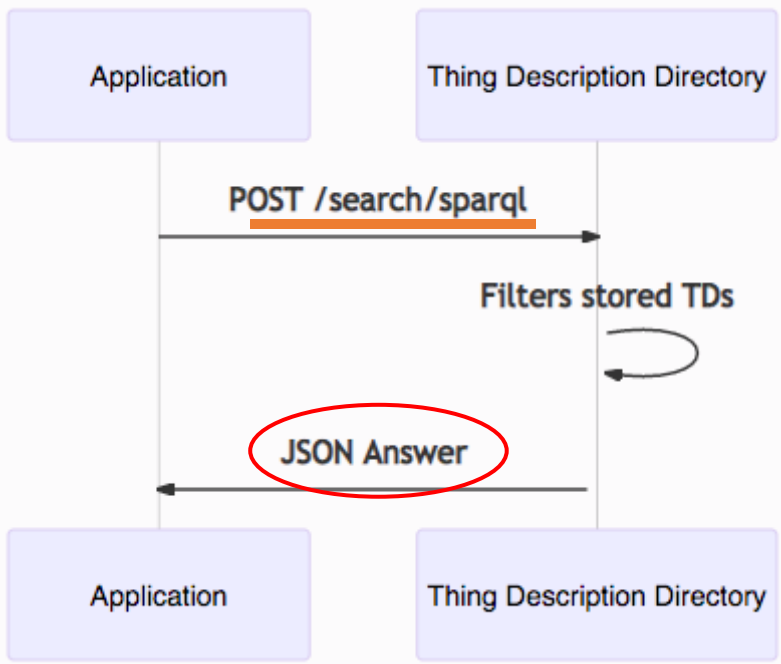
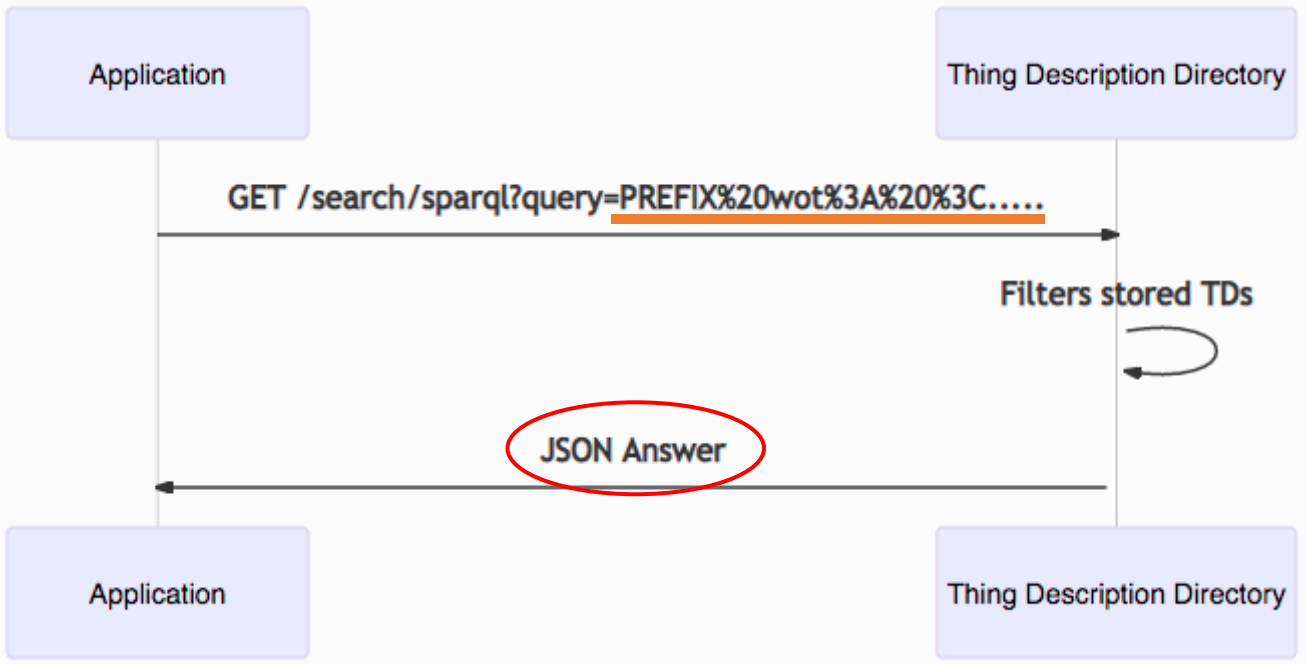
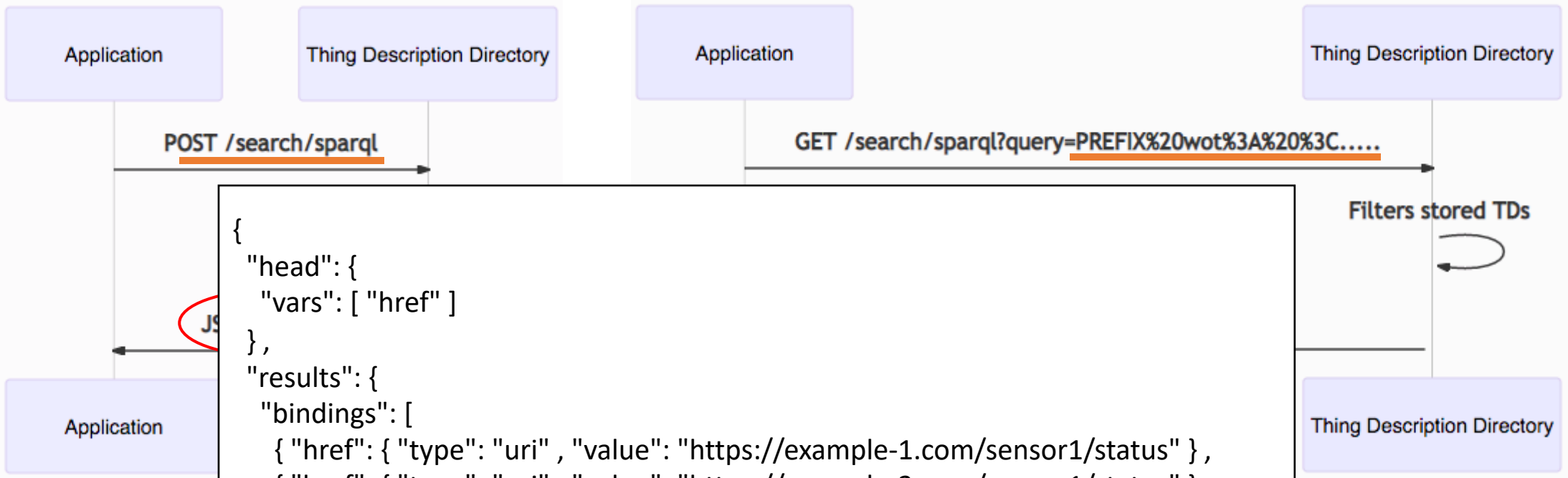



SPARQL semantic discovery API example





SPARQL semantic discovery API example




```
{
 "head": {
  "vars": [ "href" ]
 } ,
 "results": {
  "bindings": [
   { "href": { "type": "uri" , "value": "https://example-1.com/sensor1/status" } ,
   { "href": { "type": "uri" , "value": "https://example-2.com/sensor1/status" } ,
   { "href": { "type": "uri" , "value": "https://example-3.com/sensor1/status" } ,
    ....
   ]
}
```

SPARQL queries examples: SELECT

- Useful for filtering TDs
  - filtering and exploratory queries
- As result return a JSON

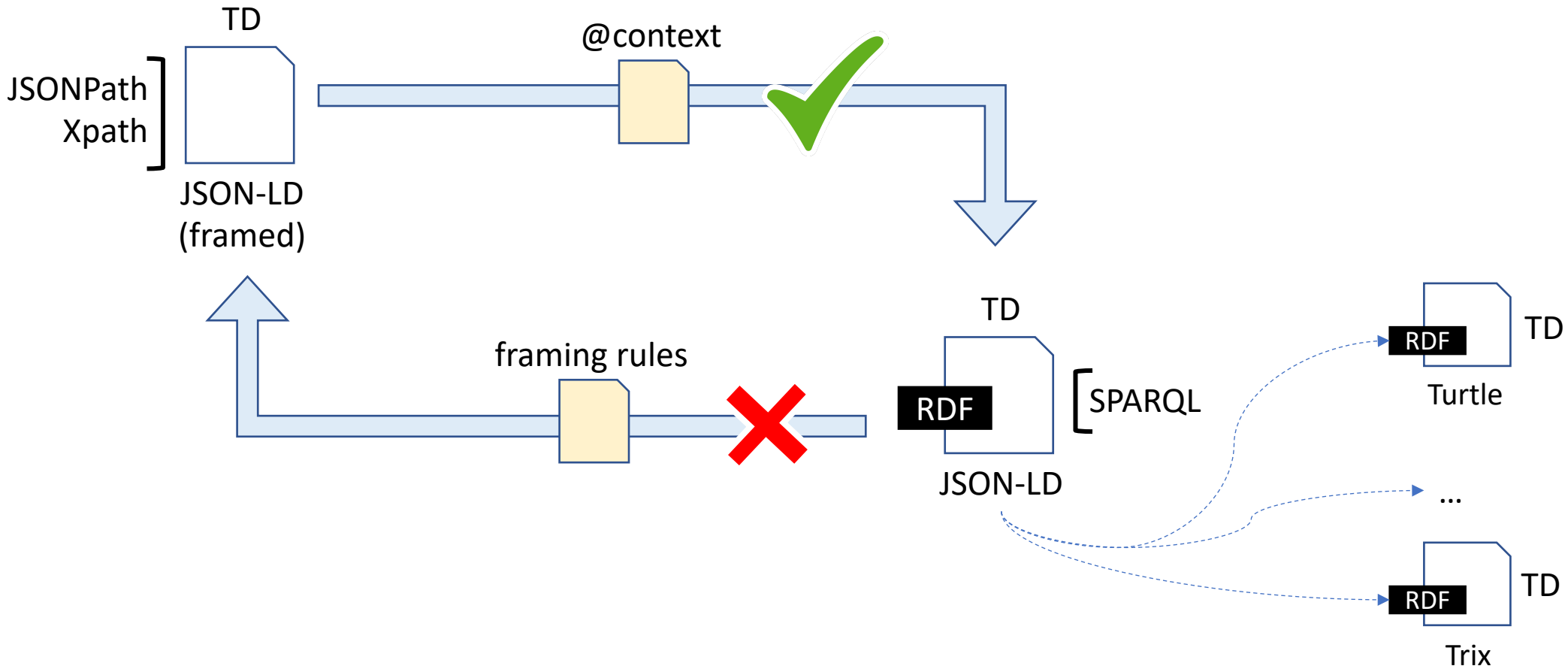
```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX sch: <https://www.w3.org/2019/wot/json-schema#>
PREFIX hyp: <https://www.w3.org/2019/wot/hypermedia#>

DESCRIBE DISTINCT ?href WHERE {
        ?device wot:hasPropertyAffordance ?property .
        ?property sch:propertyName "status" .
        ?property wot:hasForm ?form .
        ?form hyp:hasTarget ?href .
}
```

SPARQL queries examples: ASK

- Useful to know if a TD with some restrictions exists
- As result returns a boolean value inside a JSON

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX sch: <https://www.w3.org/2019/wot/json-schema#>
PREFIX hyp: <https://www.w3.org/2019/wot/hypermedia#>

ASK {
        ?device wot:hasPropertyAffordance ?property .
        ?property sch:propertyName "status" .
        ?property wot:hasForm ?form .
        ?form hyp:hasTarget ?href .
}
```

Translating TDs (using JSON-LD 1.1 spec)



SPARQL queries examples: DESCRIBE

- Useful to retrieve TDs fulfilling some restrictions
- As result returns RDF → JSON-LD **(problem to translate to JSON-LD framed)**

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>

DESCRIBE  ?thing {
      ?thing a wot:Thing  .
}
```

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX dc: <http://purl.org/dc/terms/>

DESCRIBE ?thing {
  ?thing a wot:Thing .
  ?thing  dc:title "Smart-Coffee-Machine"@en .
}
```

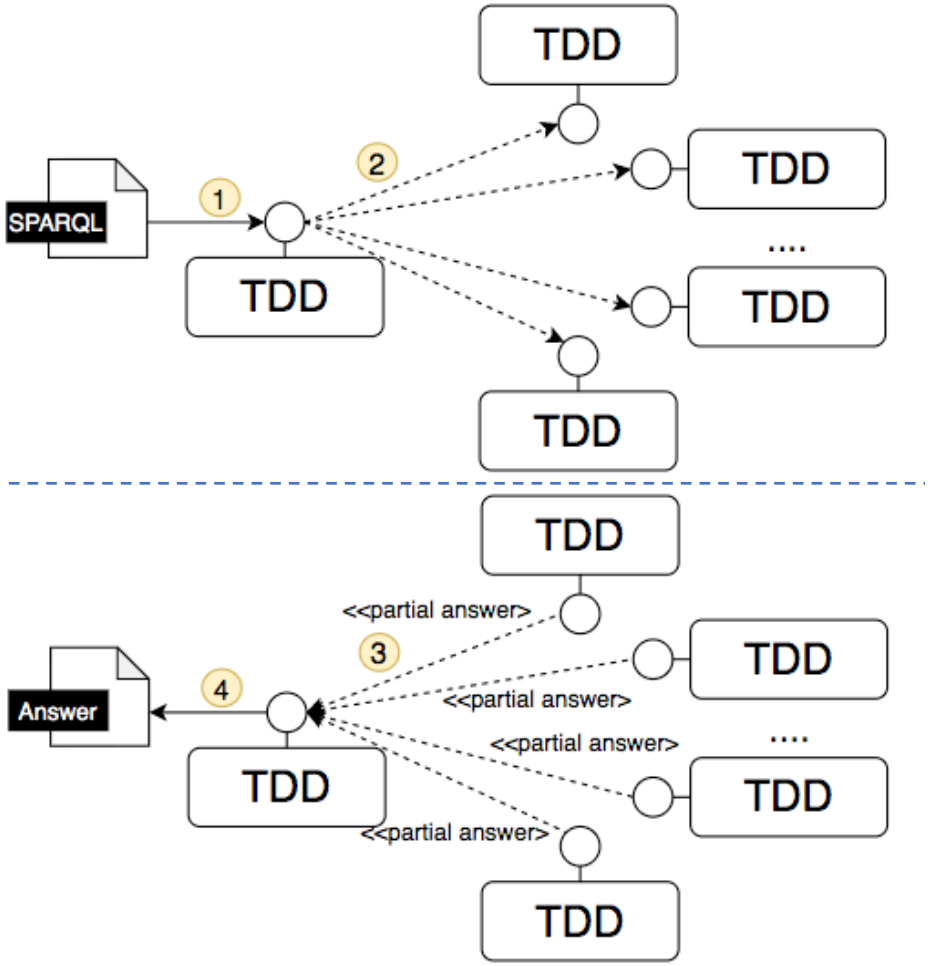
SPARQL queries examples: CONSTRUCT

- Not very useful for discovery
  - Generates RDF from a set of restrictions and allows to introduce new triples
  - Does not modifies the original stored TD
- As result returns RDF → JSON-LD **(problem to translate to JSON-LD framed)**

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX dc: <http://purl.org/dc/terms/>

CONSTRUCT {
        ?thing dc:title “new property”.
        ?thing ?p ?o .
} WHERE {
        ?thing a wot:Thing  .
        ?thing ?p ?o .
}
```

Advanced SPARQL queries

- Query Federation
  - SPARQL allows query federation
  - TDD forwards the query to other TDDs
  - Former TDD Returns a unified query answer
- Pros
  - Allows extending discovery criterion to other TDDs easily
  - Extends the discovery scope
- Cons
  - TDDs addresses must be known beforehand
    - Previous service discovery
  - Brute force forwarding



Advanced SPARQL queries example

- Assuming the following TDDs:
  - http://tdd-example-1.org,
  - http://tdd-example-2.org ,
  - http://tdd-example-3.org ,
  - …
  - http://tdd-example-100.org

```
PREFIX wot: <https://www.w3.org/2019/wot/td#>
PREFIX sch: <https://www.w3.org/2019/wot/json-schema#>
PREFIX hyp: <https://www.w3.org/2019/wot/hypermedia#>

SELECT DISTINCT ?href WHERE {
        SERVICE ?tdd {
                ?device wot:hasPropertyAffordance ?property .
                ?property sch:propertyName "status" .
                ?property wot:hasForm ?form .
                ?form hyp:hasTarget ?href .
        } VALUES ?tdd {
                <http://tdd-example-1.org>,
                ….,
                <http://tdd-example-100.org>
        }
}
```

Pros and Cons of SPARQL

- Pros
  - Expressive, takes advantages of ontology semantics and linked data
    - E.g., reasoning over data
    - E.g., linked Thing Descriptions → distributed TDs
  - SPARQL is a query language
    - Has functions, e.g., for aggregation or data cleaning
    - Allows complex queries
      - Query federation
  - SPARQL is a W3C standard
  - Federated queries
    - Including SPARQL endpoints from directories and URLs of LinkDescriptions
- Cons
  - Simple queries are more verbose than those expressed in JSONPath or Xpath
  - Consumes more resources than XPath and JSONPath?
  - SPARQL can be complex and not easy to learn

Conclusion

- Semantic discovery allows to filter registered TDs using:
  - (MAY) SPARQL queries

- Semantic discovery (SPARQL) is very flexible:
  - Allows complex queries with functions
  - Exploits the semantics of ontologies, reasoning
  - Implementing SPARQL 1.1 enables query federation

- Privacy & Security
  - Discovery is binded to security and privacy policies defined in a TDD