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Towards a Binary Object Notation for RDF

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Introduction

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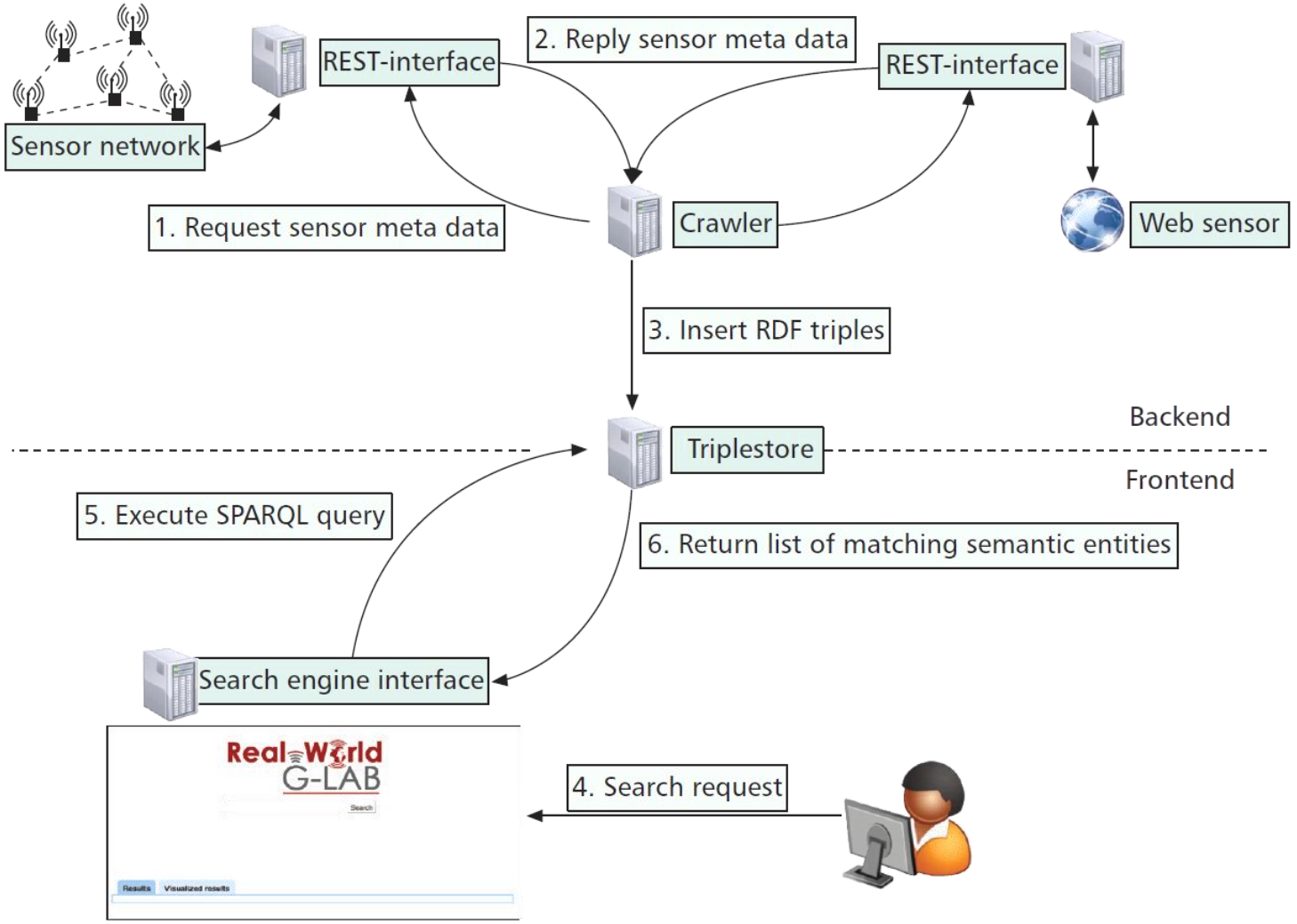
SPITFIRE



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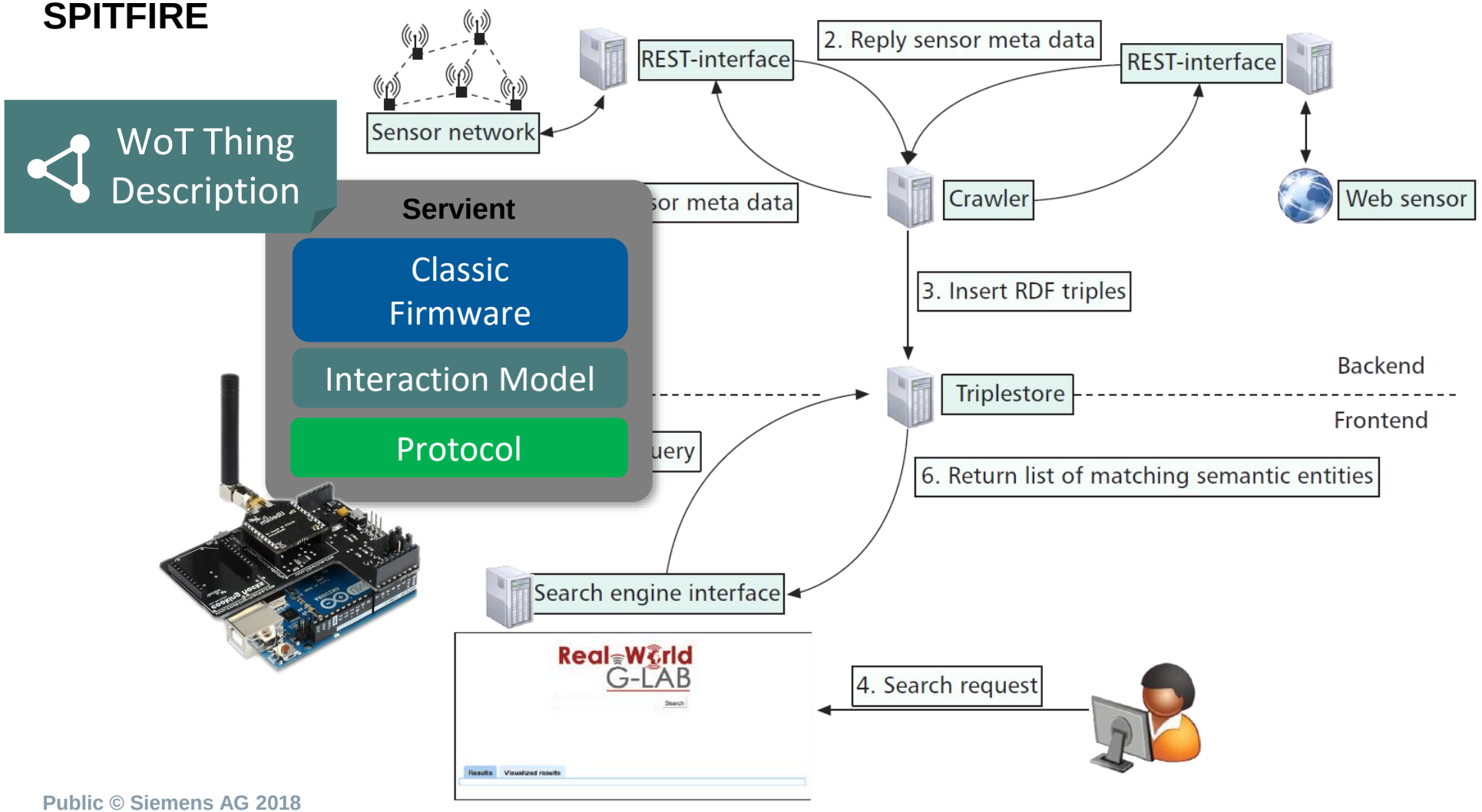

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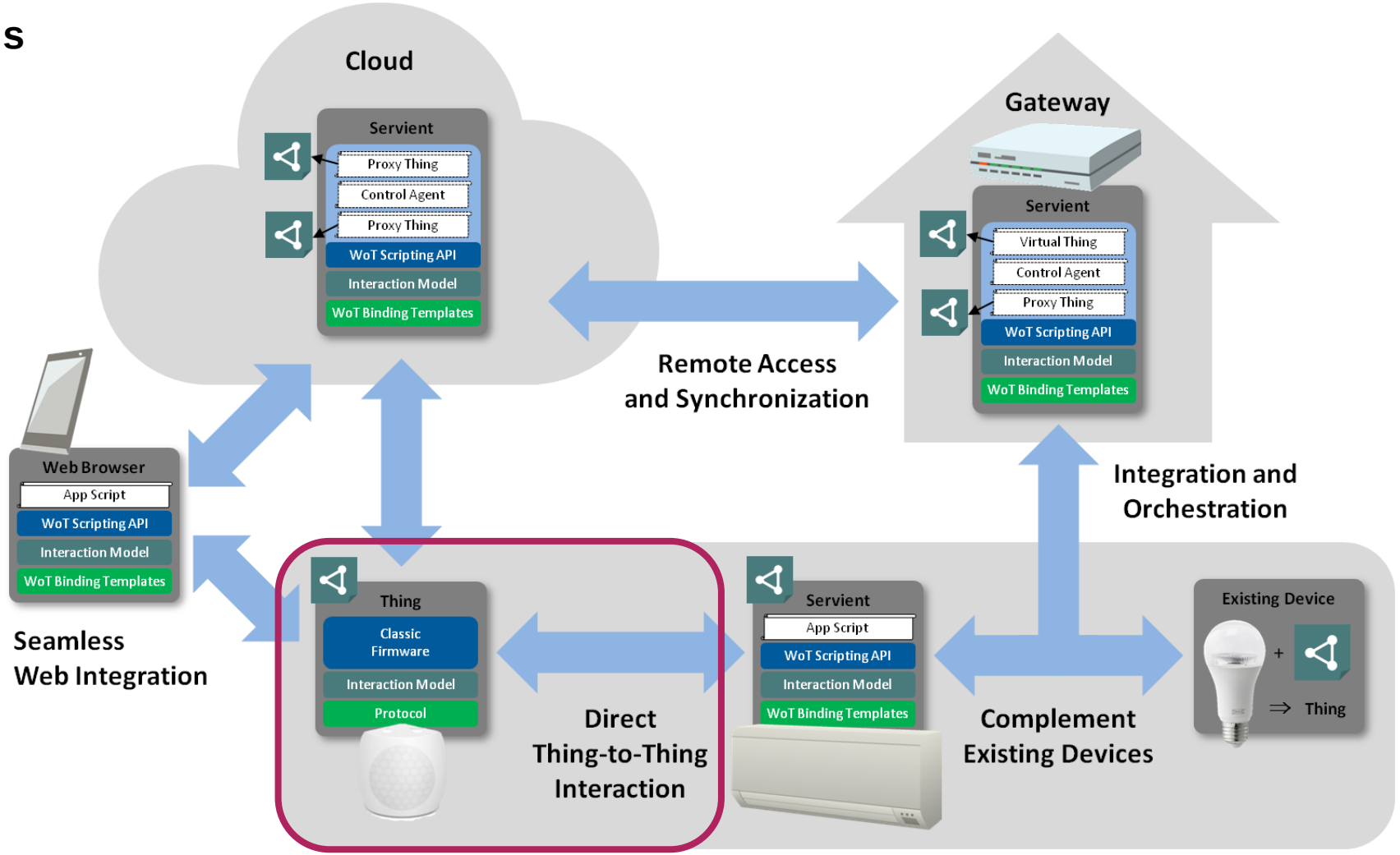
Web of Things



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Serializing RDF on Micro-controllers

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Wiselib Tuplestore

Statement table with tree-based IRI indexing

- Designed for micro-controllers
- Doesn't fit industrial memory requirements

HDT

Header-dictionary-triple, with binary triple index

- Very efficient for static data sets
- No update mechanism

k^2-triples

Based on HDT, with k^2-tree triple index

- Performs better than HDT (large datasets)
- Very high overhead on small datasets

RDF/EXI

RDF/XML serialized in binary XML (W3C EXI)

- Efficient towards typed literals
- Not efficient towards IRIs

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Processing RDF on Micro-controllers

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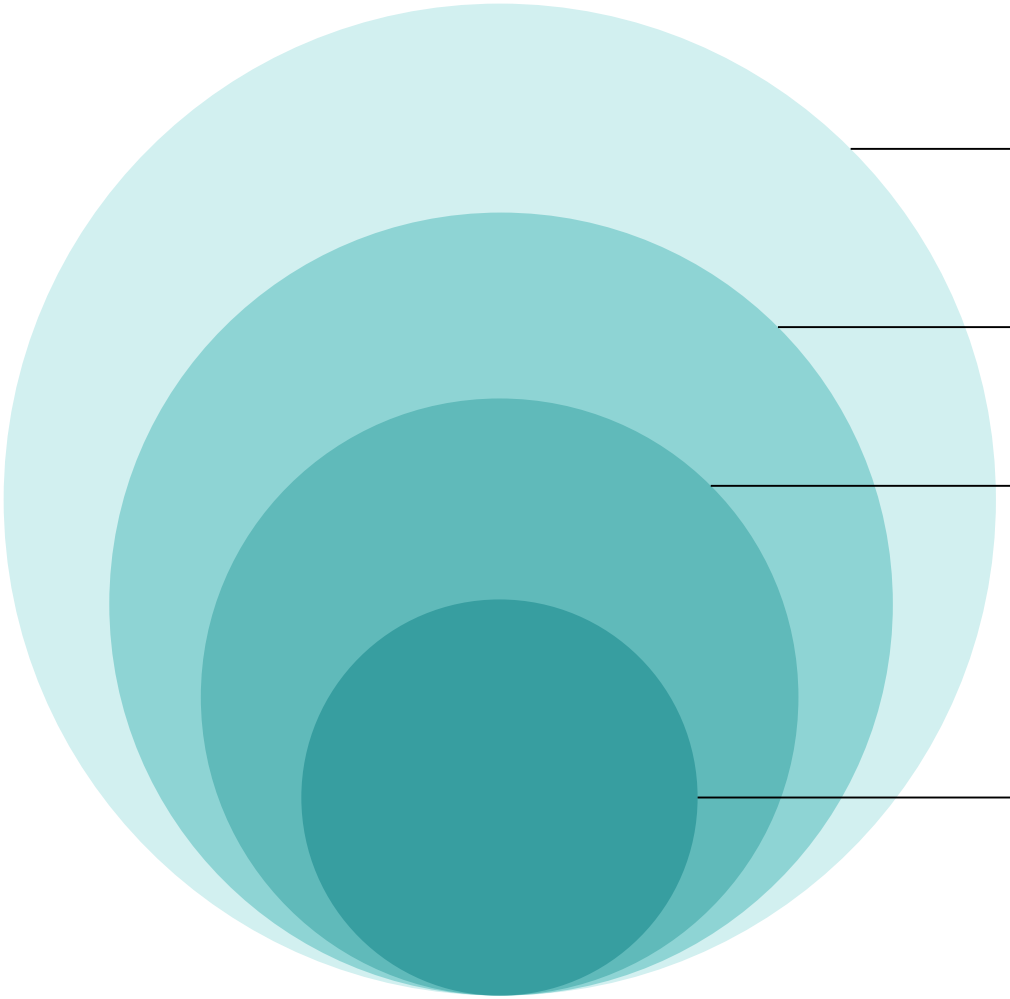

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JSON-LD: An Object Notation for RDF

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```
{
  "@graph": [
    {
      "@id": "_:sensor",
      "@type": "http://www.w3.org/ns/sosa#Sensor",
      "http://www.w3.org/ns/sosa#observes": "_:temp",
      "http://schema.org/gtin12": 000051826321
    },
    {
      "@id": "_:temp",
      "@type": "http://w3id.org/saref#Temperature",
      "http://www.w3.org/ns/ssn#isPropertyOf": "_:room"
    }
  ]
}
```

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JSON-LD: An Object Notation for RDF

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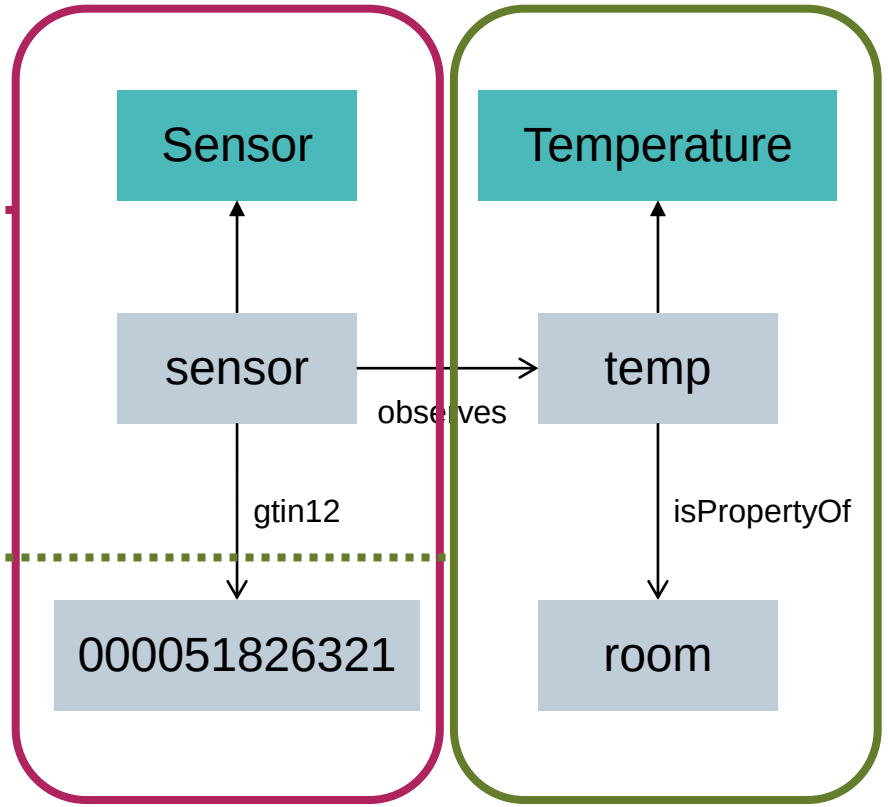
```
{
  "@graph": [
    {
      "@id": "_:sensor",
      "@type": "http://www.w3.org/ns/sosa#Sensor",
      "http://www.w3.org/ns/sosa#observes": "_:temp",
      "http://schema.org/gtin12": 000051826321
    },
    {
      "@id": "_:temp",
      "@type": "http://w3id.org/saref#Temperature",
      "http://www.w3.org/ns/ssn#isPropertyOf": "_:room"
    }
  ]
}
```



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JSON-LD: An Object Notation for RDF

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```
{
  "@context": "http://example.org/ctx",
  "@graph": [
    {
      "@id": "_:sensor",
      "@type": "Sensor",
      "observes": "_:temp",
      "schema:gtin12": 000051826321
    },
    {
      "@id": "_:temp",
      "@type": "Temperature",
      "foi": "_:room"
    }
  ]
}
```

```
{
  "@context": {
    "sosa": "http://www.w3.org/ns/sosa#",
    "ssn": "http://www.w3.org/ns/ssn#",
    "saref": "http://w3id.org/saref#",
    "schema": "http://schema.org",
    "Sensor": "sosa:Sensor",
    "observes": "sosa:observes",
    "Temperature": "saref:Temperature",
    "foi": "ssn:isPropertyOf"
  }
}
```

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JSON-LD: An Object Notation for RDF

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```
{
  "@context": "http://example.org/ctx",
  "@graph": [
    {
      "@id": "_:sensor",
      "@type": "e",
      "f": "_:temp",
      "d:gtin12": 000051826321
    },
    {
      "@id": "_:temp",
      "@type": "g",
      "h": "_:room"
    }
  ]
}
```

```
{
  "@context": {
    "a": "http://www.w3.org/ns/sosa#",
    "b": "http://www.w3.org/ns/ssn#",
    "c": "http://w3id.org/saref#",
    "d": "http://schema.org",
    "e": "a:Sensor",
    "f": "a:observes",
    "g": "c:Temperature",
    "h": "b:isPropertyOf"
  }
}
```

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JSON-LD: An Object Notation for RDF

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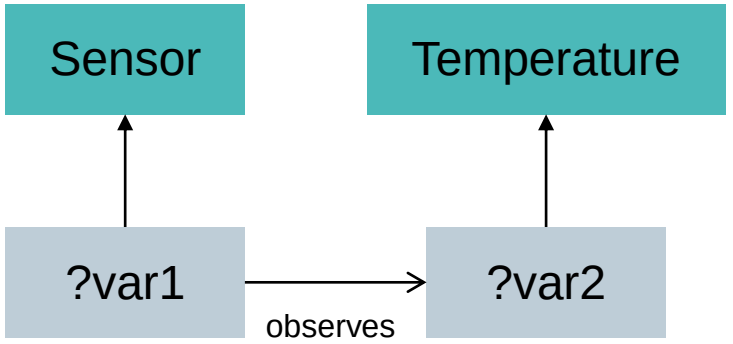
```
{
  "@context": "http://example.org/ctx",
  "@graph": [
    {
      "@id": "_:sensor",
      "@type": "Sensor",
      "observes": {
        "@id": "_:temp",
        "@type": "Temperature",
        "foi": "_:room"
      },
      "schema:gtin12": 000051826321
    }
  ]
}
```

```
{
  "@context": "http://example.org/ctx",
  "@type": "Sensor",
  "observes": {
    "@type": "Temperature"
  }
}
```



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JSON-LD on Micro-controllers

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Arbitrary RDF

```
_:s a <Sensor> .
_:s <gtin12> "…" .
_:s <observes> _:t .
_:t a <Temperature> .
_:t <foi> _:room .
```

Flattened JSON-LD

```
{ "@graph": [{
  "@id": "_:s",
  "@type": "Sensor",
  "observes": "_:t",
  "gtin12": "…"
}, {
  "@id": "_:t",
  "@type": "Temp",
  "foi": "_:room"
}]}
```

Compacted JSON-LD

```
{ "@graph": [{
  "@id": "_:s",
  "@type": "e",
  "f": "_:t",
  "i": "…"
}, {
  "@id": "_:t",
  "@type": "g",
  "h": "_:room"
}]}
```

EXI4JSON, CBOR

```
80 40 a5 f3 63 42 e6
77 26 17 06 8a 80 00
01 d7
```

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Experiments

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	BTCSAMPLE	NODE	SSP	DESIGO
Nb. of triples	174	73	4859	84908
Nb. Of distinct subjects/nodes	174	26	1345	21527
Nb. of pieces	-	-	313	1843
Avg. nb. of triples (piecewise)	-	-	15	70
Min. nb. of triples (piecewise)	-	-	13	5
Max. nb. of triples (piecewise)	-	-	19	662

https://github.com/vcharpenay/urdf-store-exp

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Experiments

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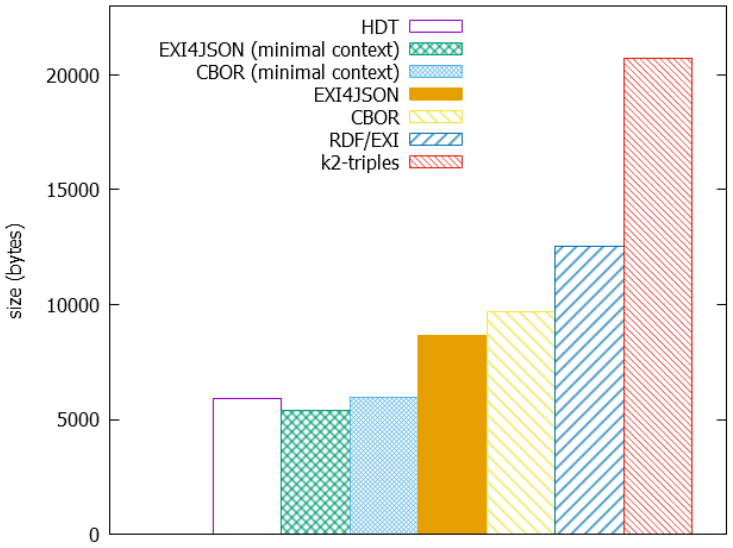
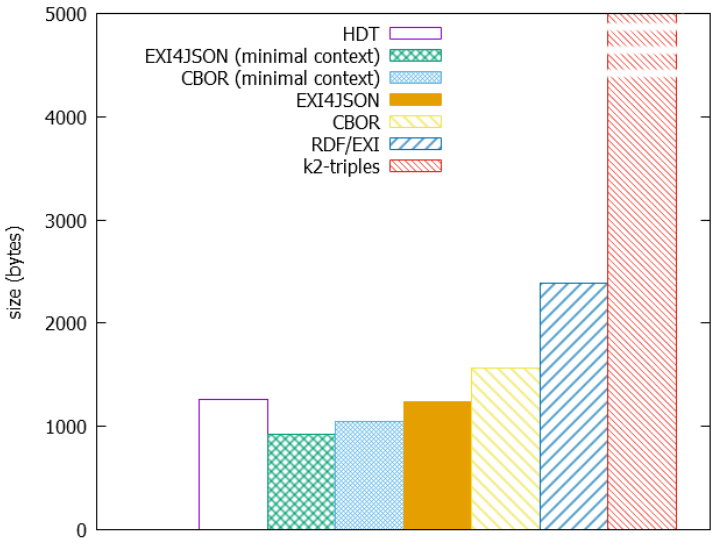
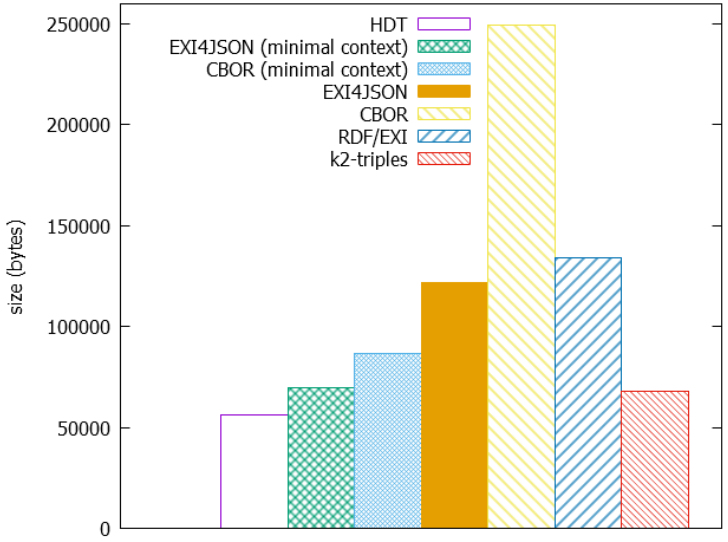


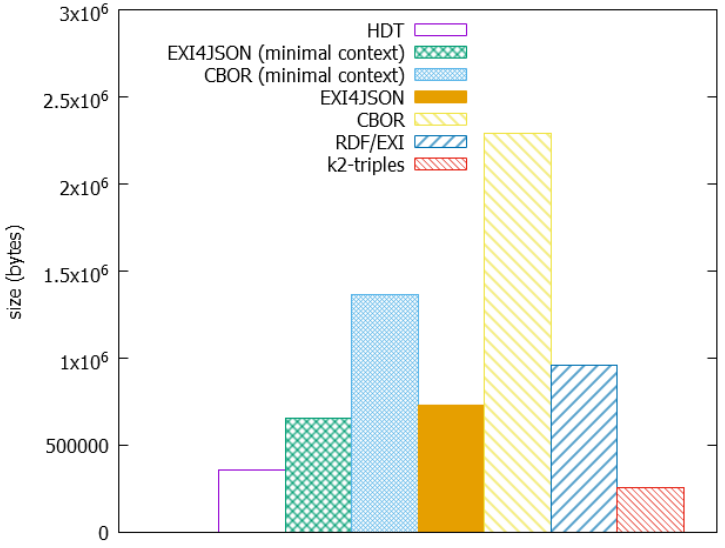
BTCSAMPLE



NODE



SSP



DESIGO

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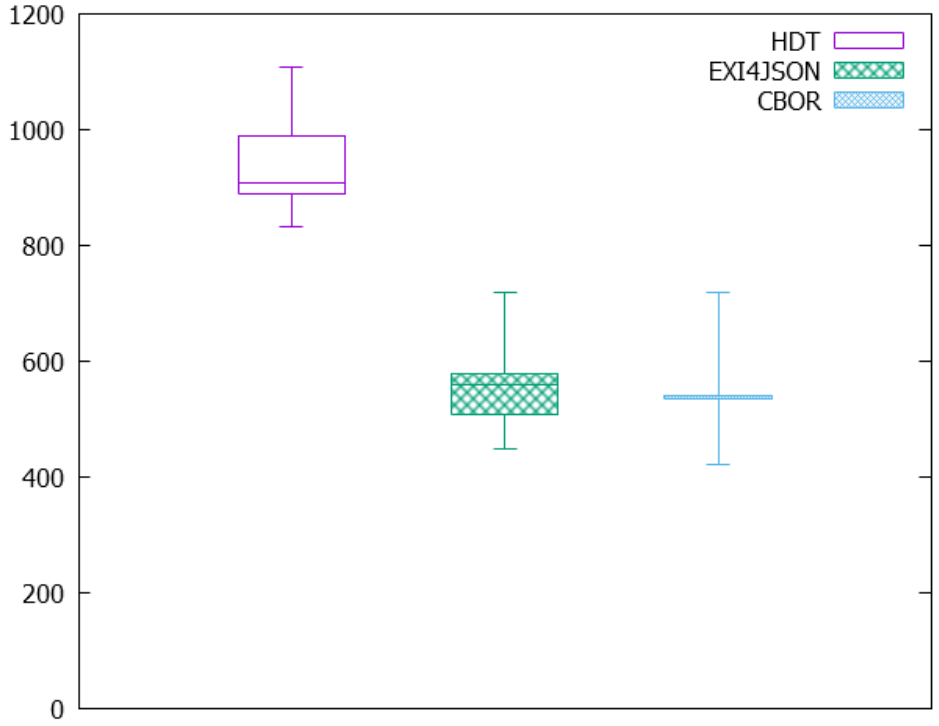
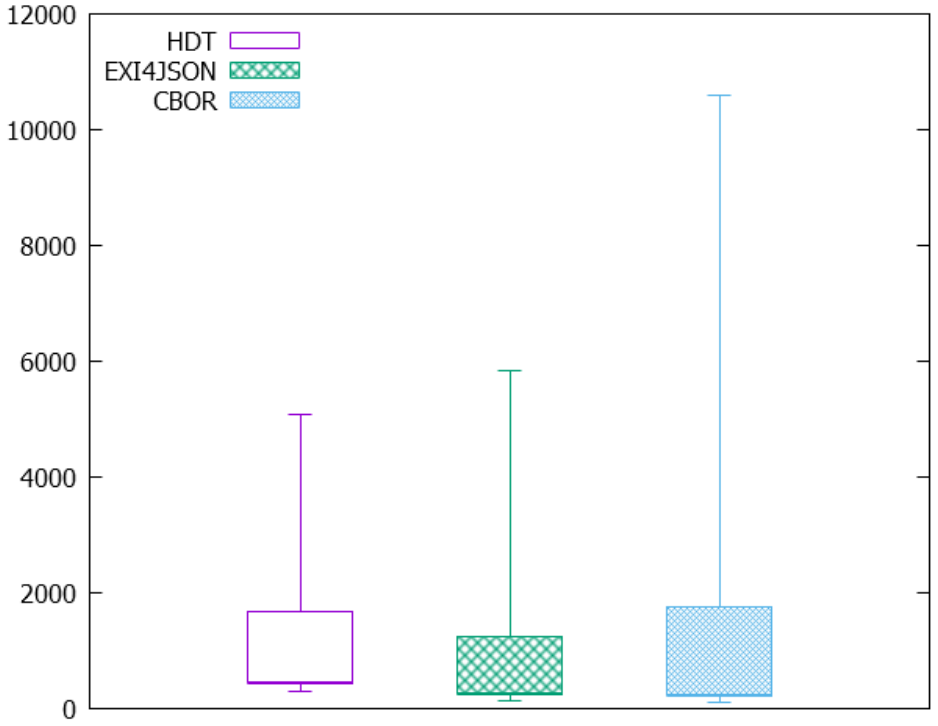
Experiments



SSP



DESIGO

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Conclusion

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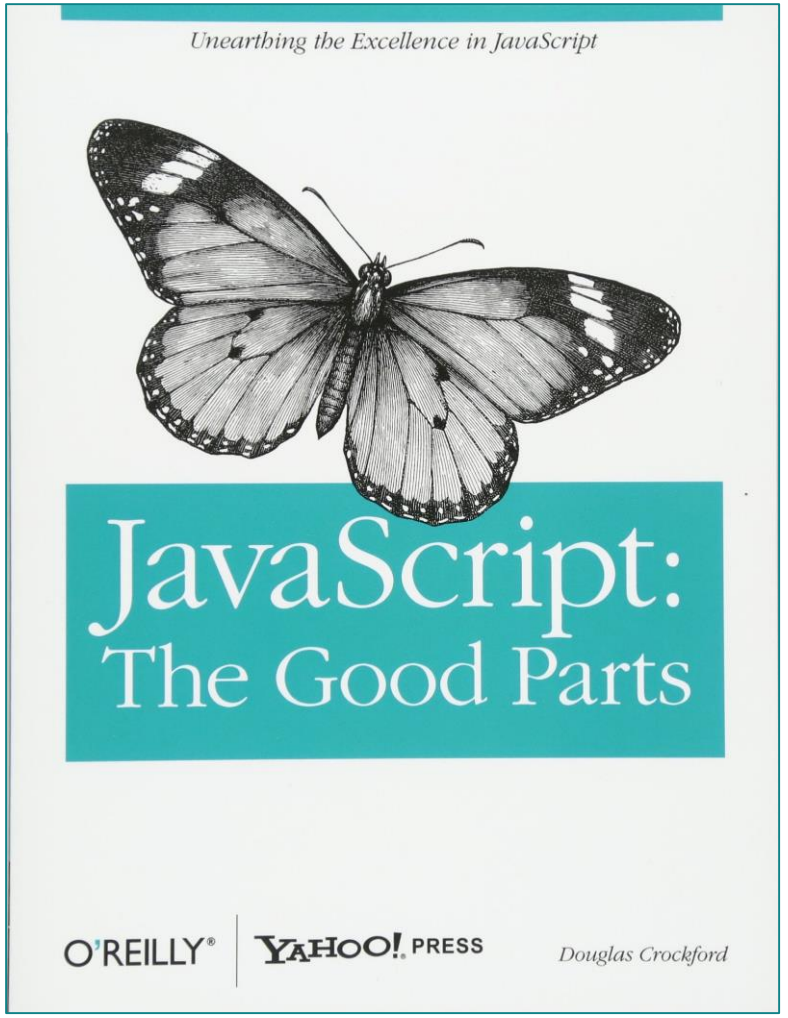
Summary

- Binary object notation for RDF
  - Compacted JSON-LD with custom context
  - Binary JSON serialization (EXI4JSON or CBOR)
- Efficient for small datasets (< 100 triples)

Perspective

- JSON-LD has been successful in Web API design
- It might become popular in the Web of Things as well



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