I4.0@BOSCH –

CENTRAL CHALLENGES AND OPPORTUNITIES IN REALIZING THE CONNECTED INDUSTRY

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Definition

Fusion of the **physical world** of production with the **virtual world** of information technology and the internet.

Humans, **machines**, **objects** and **systems** are **connected** via ICT and the internet and communicate in a dynamic, real time optimised and self-organised way.

In these **intelligent production systems**, **all instances** of the added value chain from the supplier over logistics to the customer are connected **across the company**.

The industrial production can implement **individualized customer requests** on the well-known high-quality level, while reaching higher **flexibility** and **robustness** as well as **optimal resource allocation**.

ICT = Information and communication technology

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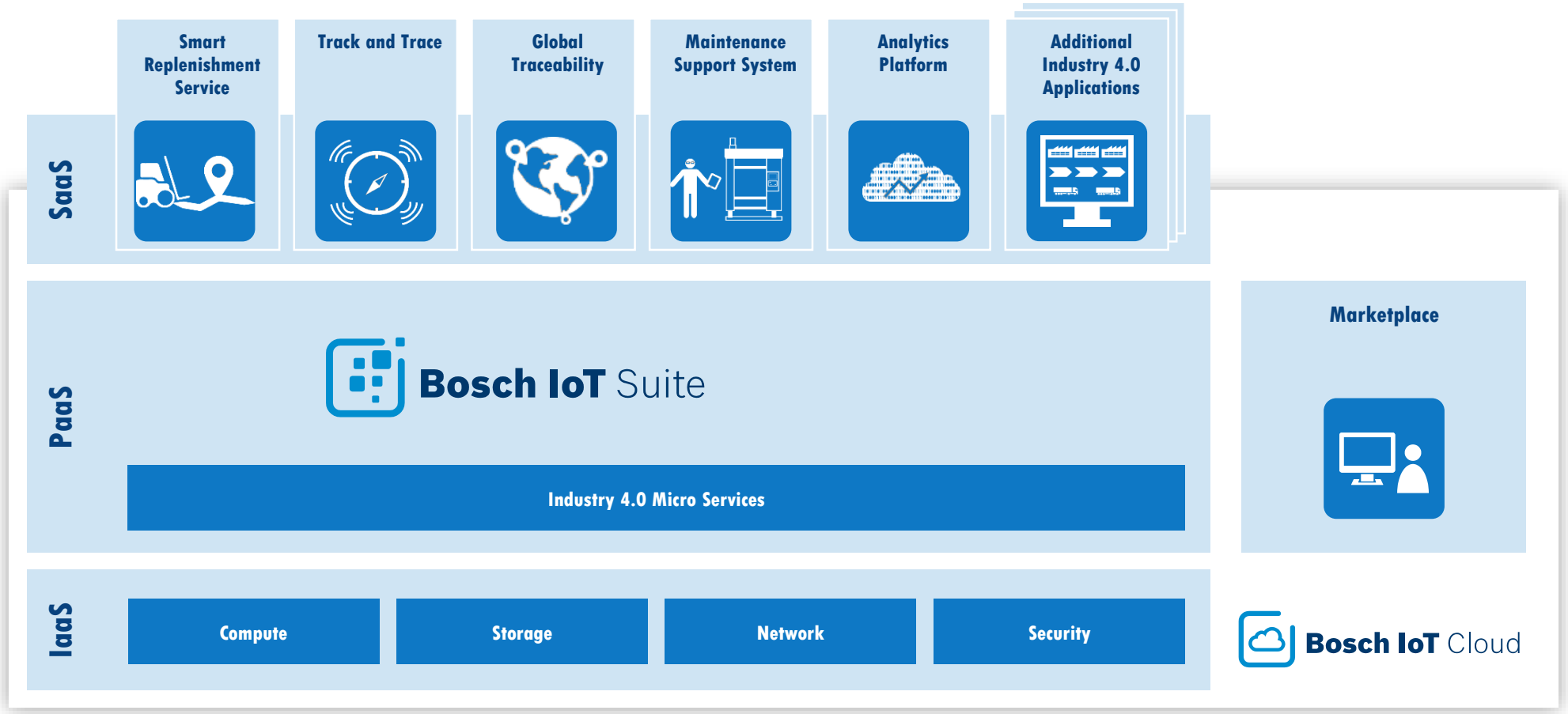
Bosch IoT Cloud & IoT Suite as Foundation for Industry 4.0



IaaS / PaaS / SaaS = Infrastructure / Platform / Software as a Service

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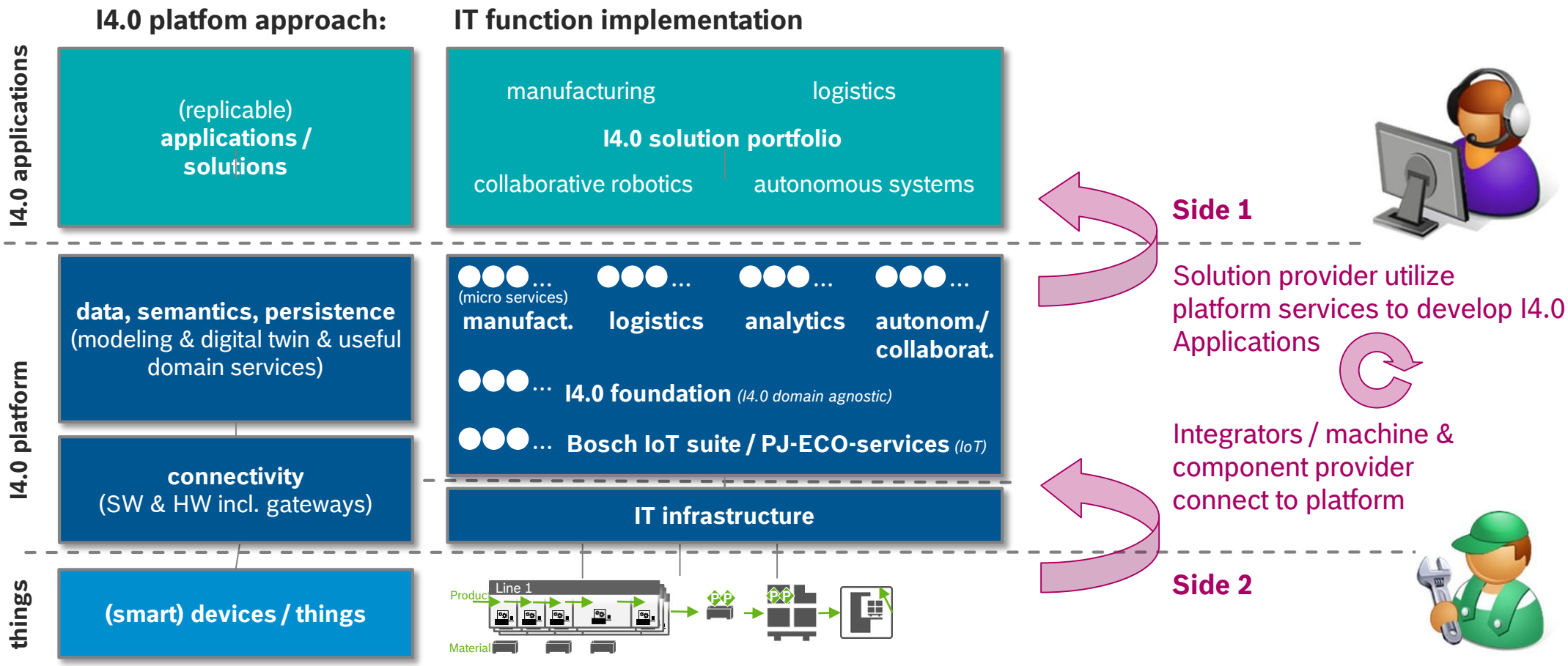
I4.0 Platform: Two-Sided Platform



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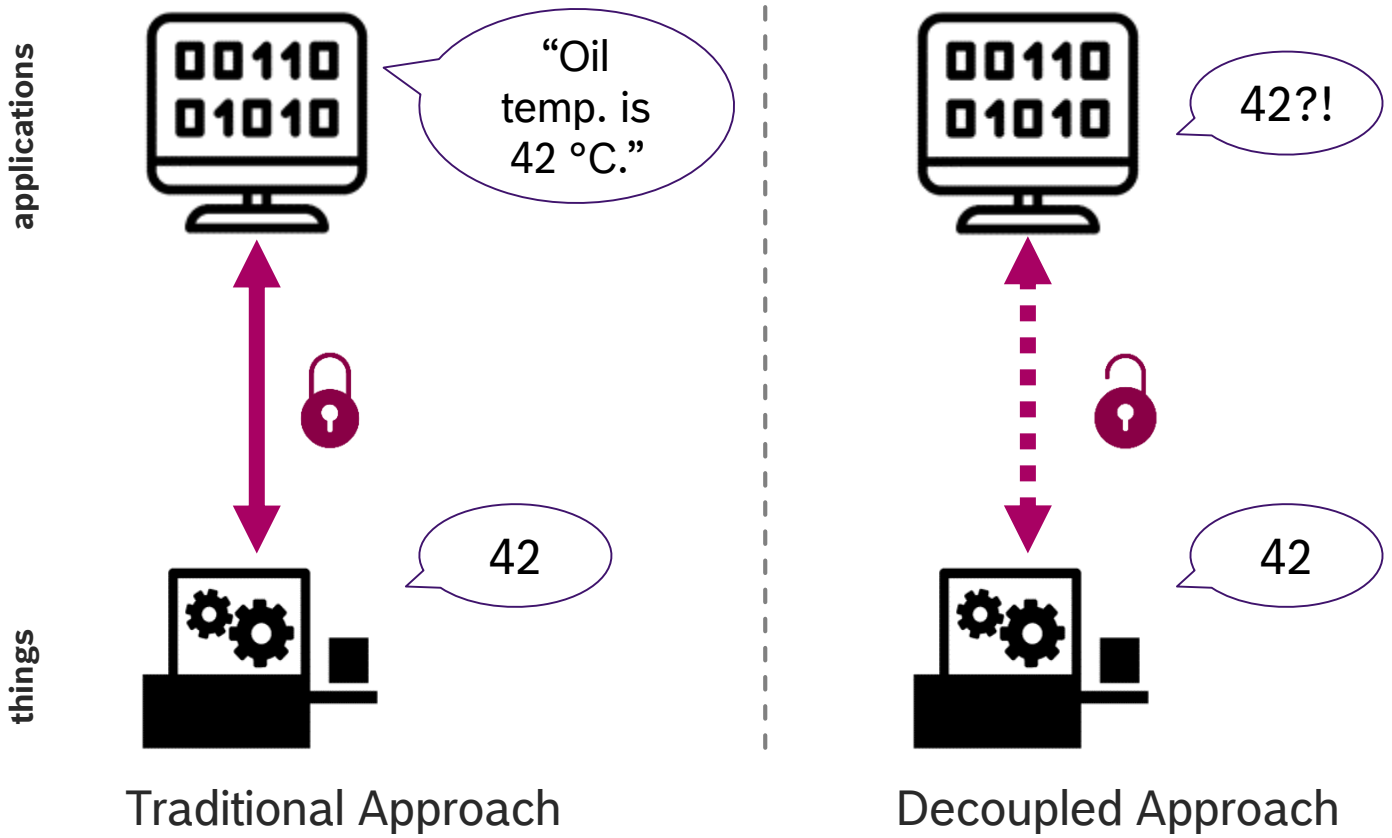
Excursus: Semantic Technologies



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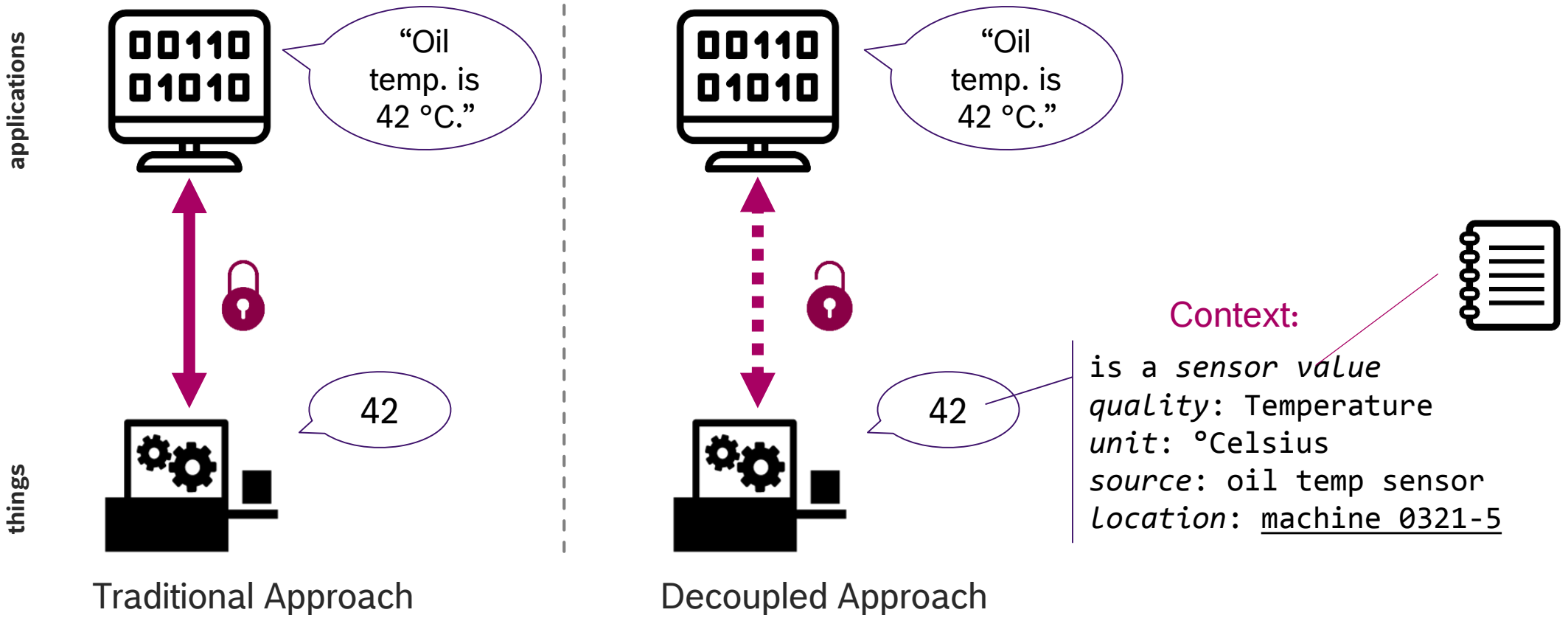
Excursus: Semantic Technologies



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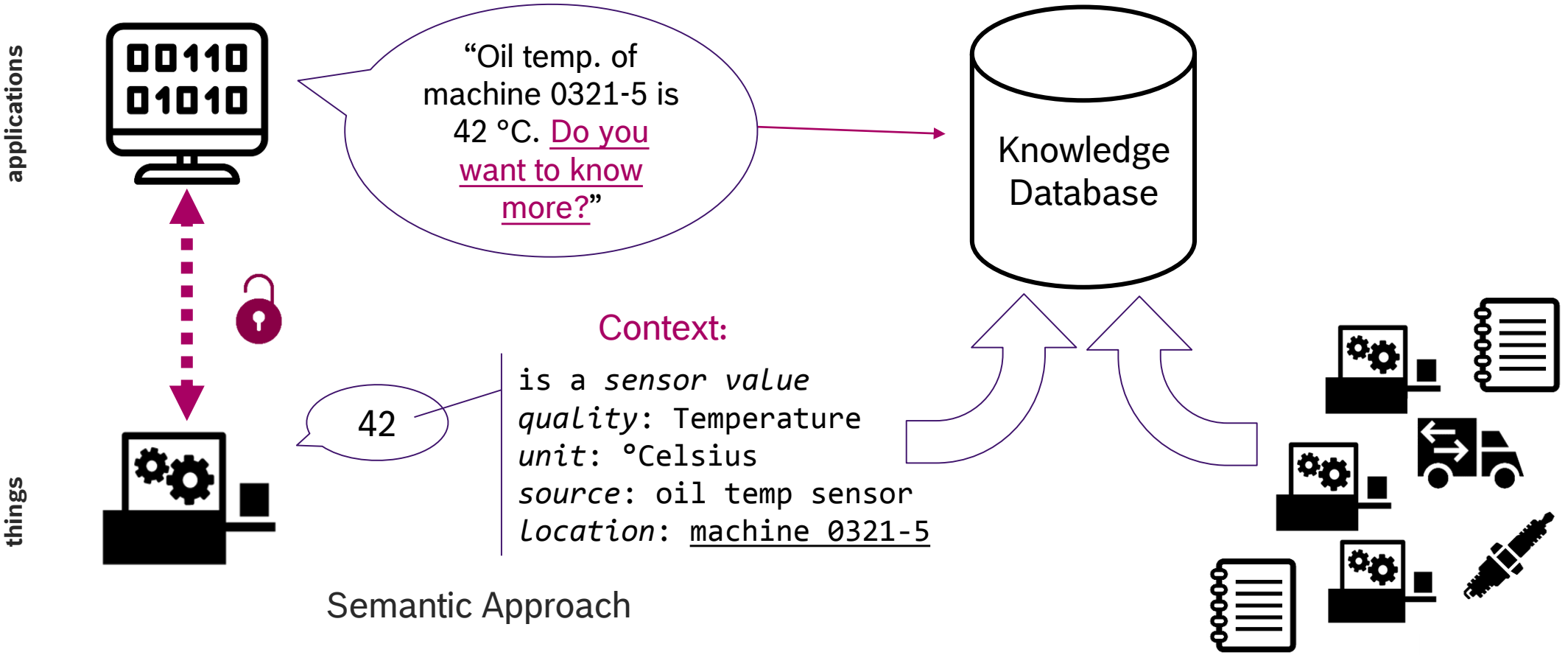
Excursus: Semantic Technologies



Semantic Approach

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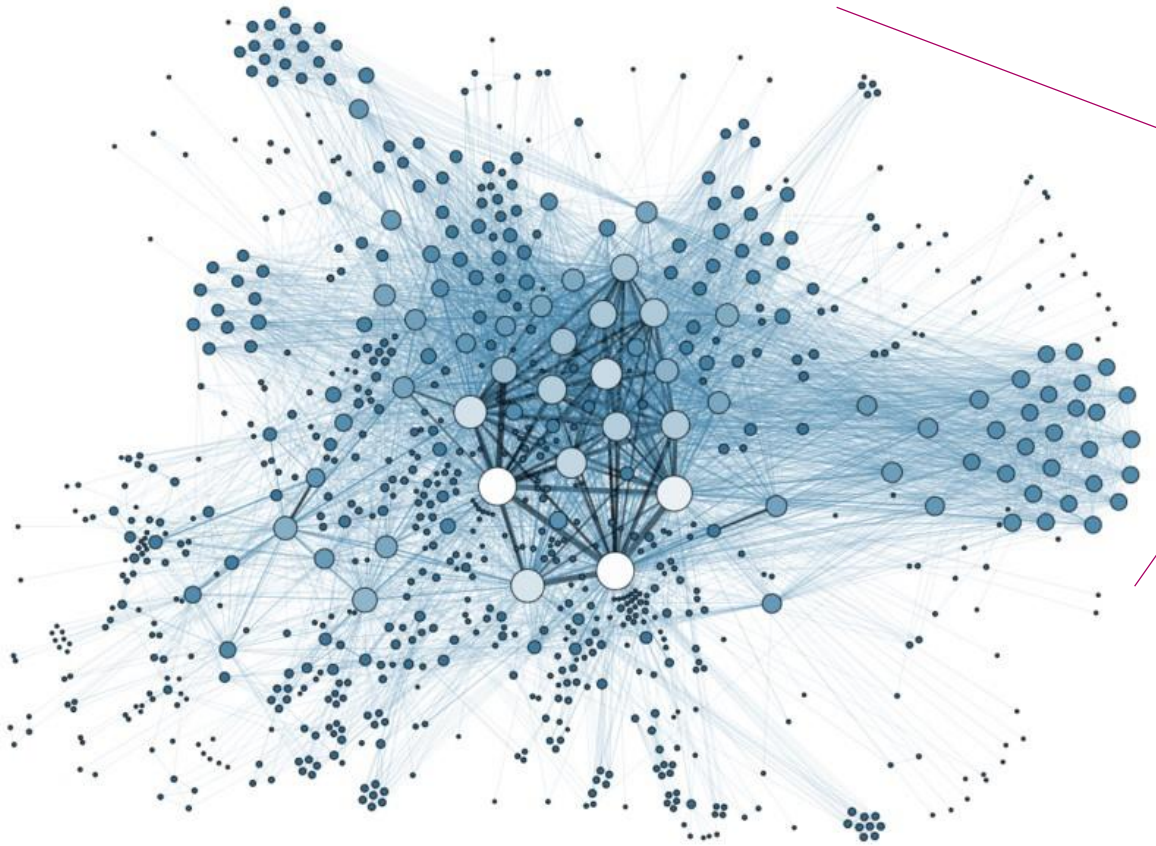
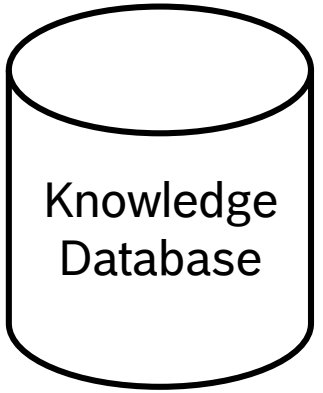
Excursus: Semantic Technologies





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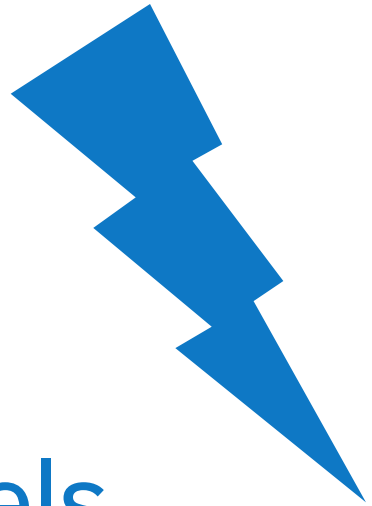
Three Issues:



1 – Usability
2 – Access Control
3 – Lack of common models

USABILITY

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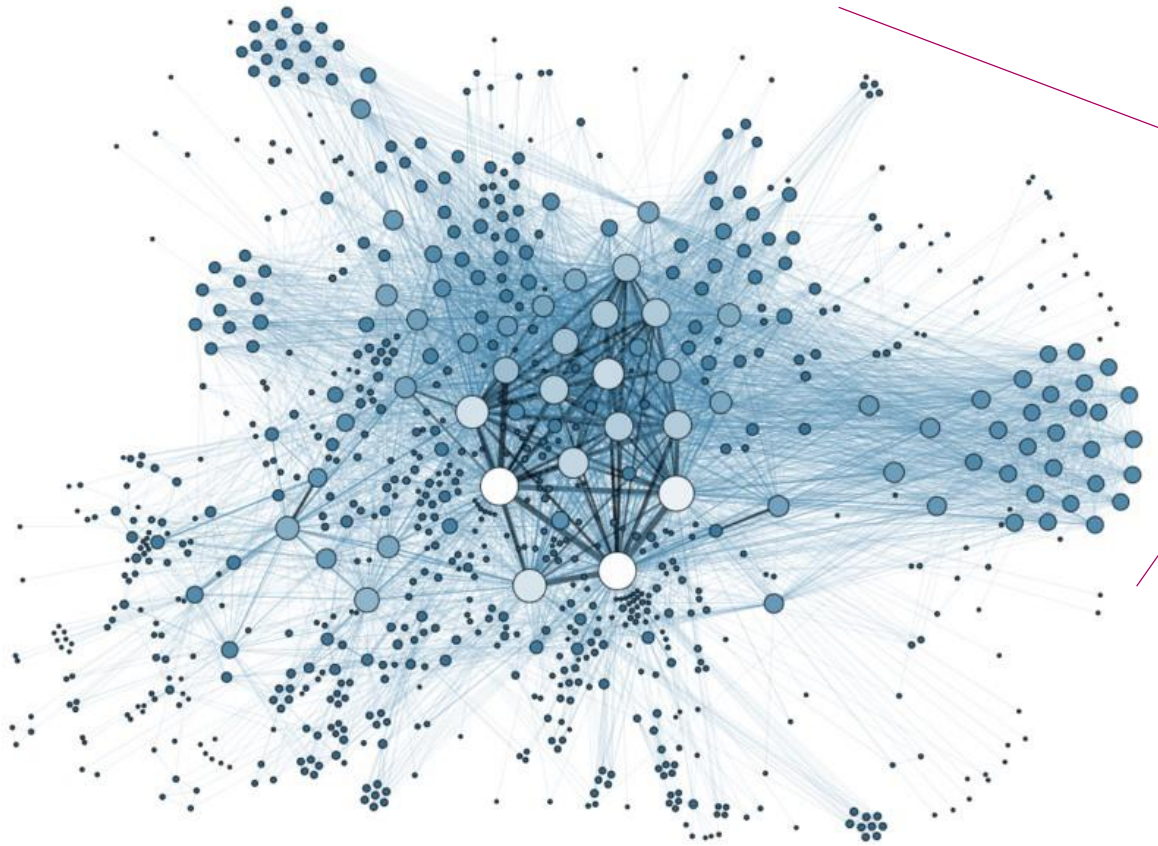
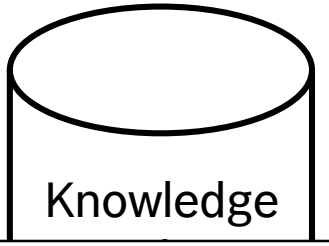
Issue usability
Semantic Technologies – expert technology, expert tools

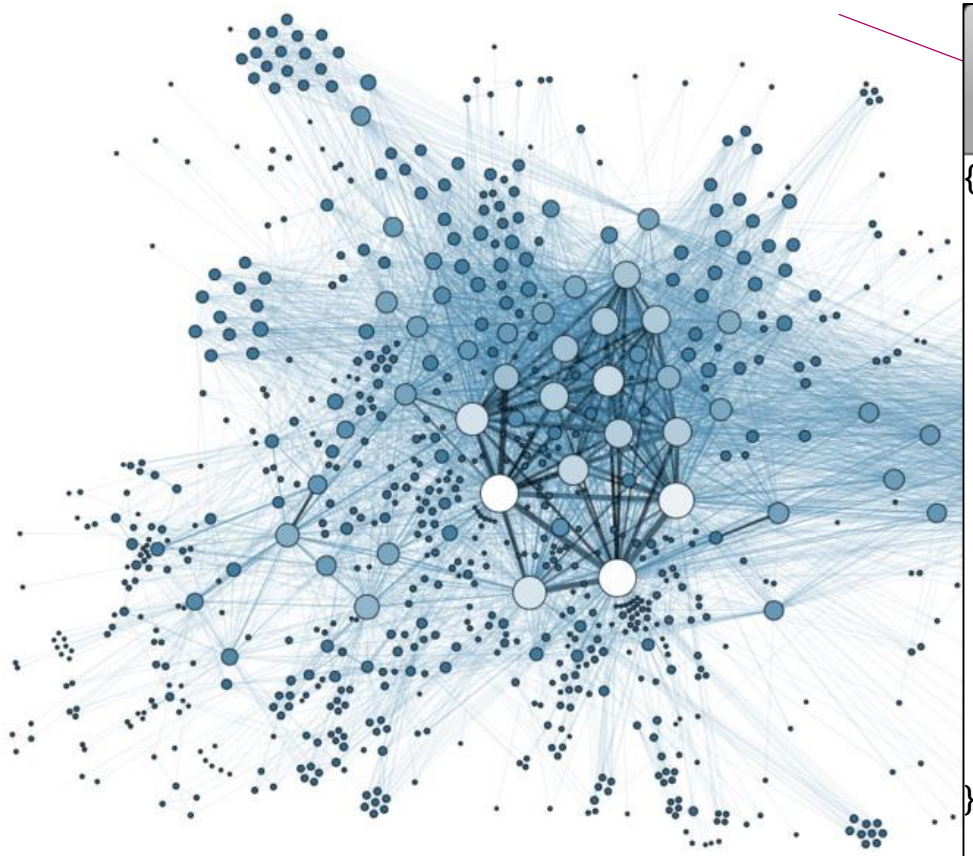





```
i4c  rdf:type  :Machine
i4c  b40:hasSensor  XDK_light
i4c  b40:hasGUID  "117B52C3-56D8-4F07-BD21-F74728B599FC"
XDK_light  rdf:type  :Sensor
XDK_light  b40:hasObservation  XDK_light_obs
XDK_light  b40:isAttachedTo  i4c
XDK_light_obs  rdf:type  ssn:Observation
XDK_light_obs  b40:hasBaseUnit  qui:Candela
```

```
> SELECT ?sensor ?machine
  WHERE {
    ?sensor rdf:type ssn:Sensor ;
            b40:hasObservation ?x ;
            b40:isAttachedTo ?machine .
    ?machine b40:hasGUID "117B52C3-56D8-4F07-BD21-F74728B599FC“ .
    ?x b40:hasBaseUnit qui:Candela .
  }
```

Issue usability
Approach: REST API for simplified use



http://10.49.0.164/class/b40:Machine

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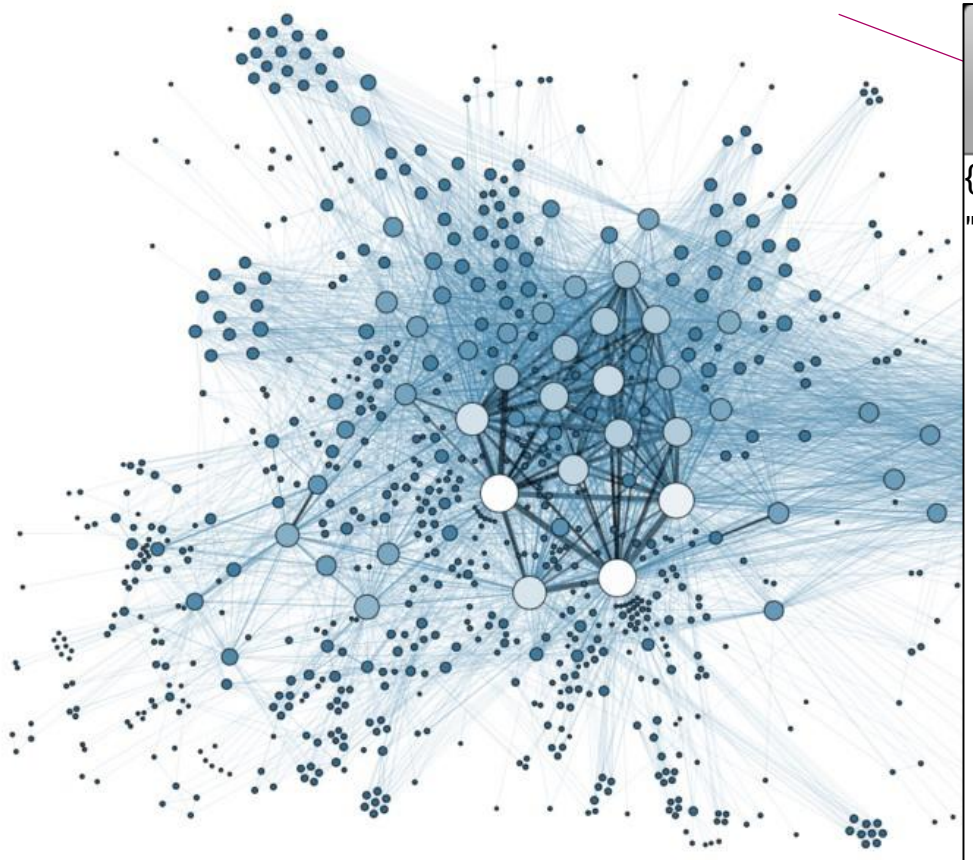
```
{
 "ids": [ "b40:Machine14", "b40:I4C", "hts:HoP2_HTS", dcpi:DC_DemoCase",
   "dcpi:RPI" ],

 "_links": {
   "hts:HoP2_HTS": {"href": "http://10.49.0.164/res/hts:HoP2_HTS"},
   "b40:I4C": {"href": "http://10.49.0.164/res/b40:I4C"},
   "b40:Machine14": {"href": "http://10.49.0.164/res/b40:Machine14"},
   "dcpi:RPI": {"href": "http://10.49.0.164/res/dcpi:RPI"},
   "dcpi:DC_DemoCase": {"href": "http://10.49.0.164/res/dcpi:DC_DemoCase"},
   "self": {"href": "http://10.49.0.164/class/b40:Machine"}
 }
}
```

Issue Usability
Approach: REST API for simplified use



http://10.49.0.164/res/b40:Machine14

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```
{
"id-map": {
  "b40:hasGUID":  "27ae2d92-bce3-4558-8542-1d3996c1ab71",
  "rdfs:label": “Milling Cutter",
  "rdf:type": "b40:Machine",
  "b40:hasSensor": “b40:OilTempSensor"
 },
 "_links": {
  "b40:Machine": {"href": "http://10.49.0.164/res/b40:Machine"},
  "b40:hasGUID": {"href": "http://10.49.0.164/res/b40:hasGUID"},
  "self": {"href": "http://10.49.0.164/res/b40:Machine14"},
  "b40:OilTempSensor": {"href": "http://10.49.0.164/res/b40:OilTempSensor"},

 }}
```

ACCESS CONTROL

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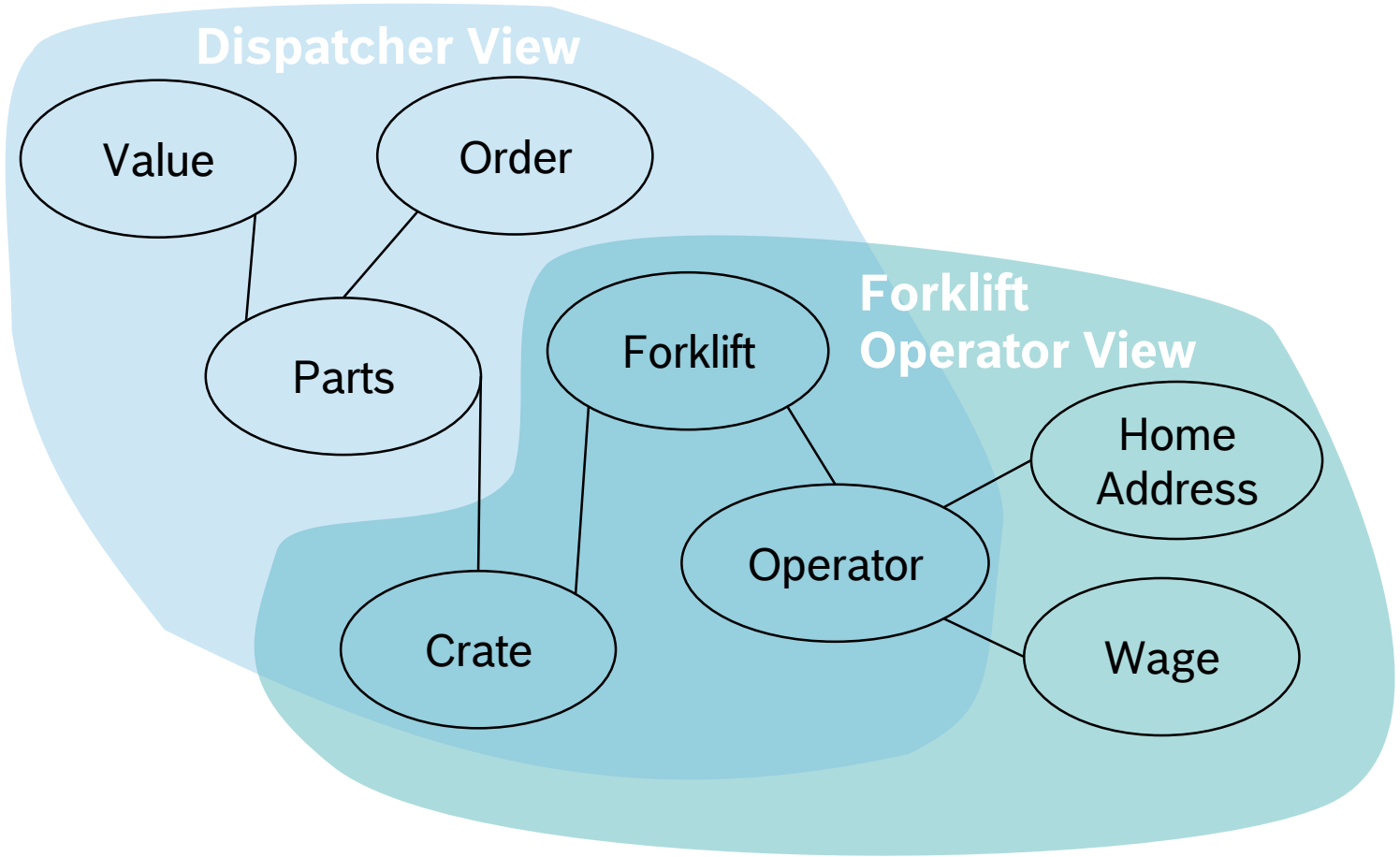
Fine Grained Access Control for Graph-based data

Problem: Interconnected data handled in different contexts



- Data structures not known beforehand (as in SQL)
- Access not decidable on class-level
- Access rights change with current situation

Fine Grained Access Control for Graph-based data

Solution Approach: “TRUSTY”

- Define permission vocabulary
  - User → Role → Domain
  - instanceGrant, classGrant, pathGrant
  - propertyExclusion, hideProp, instanceExclusion, hideInst
  - complexGrant
- Use reasoning to “annotate” data accordingly
  - allowInst, hideInst, hideProp
- Rewrite user queries to only return allowed data

```
# instanceGrant
[] a rule:SPARQLRule ;
  rule:content """
    IF {
      ?user :belongs ?role .
      ?role :access ?domain .
      ?domain :instanceGrant ?inst .
    } THEN {
      ?user :allowInst ?inst .
    }
  """.
```

```
# classGrant
[] a rule:SPARQLRule ;
  rule:content """
    IF {
      ?domain :classGrant ?class .
      ?s a ?class .
    } THEN {
      ?domain :instanceGrant ?s .
    }
  """.
```

LACK OF COMMON MODELS

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Lack of common models for industry

We need ontologies for production, logistics, …!

- Standardization efforts focus on technical interoperability (OPC UA, oneM2M, …)
- Semantic interoperability is mostly ignored

- Existing ontologies focus other domains:
  - Persons/Relations: FOAF
  - Sensors & observations: SSN
  - Quantities, Units, Measurements: QUDT
  - Documents: Dublin Core
  - …

PLATTFORM INDUSTRIE 4.0

industrial internet CONSORTIUM

oneM2M

We need ontologies for production, logistics, …!

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Summary

- Semantic Technologies allow to transport context of data and therefore enable decoupling and reuse
- Currently still to immature for wide-spread use
  - Expert technology, bad tool support
  - Not equipped for industry use cases (e.g. Access control)
  - Lack of common models for manufacturing domain

Current work

- REST API for simplified interaction with knowledge graph
- Approach for Access Control based on permission vocabulary and reasoning

Conclusion

- Semantic Technologies essential for true interoperability and data reuse
- **Help us! Make semantics industry-ready, create common models for manufacturing domain**

THANK YOU

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