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Configuration Workshop 2014 Novi Sad/Нови Сад

Integrating Distributed Configurations with RDFS and SPARQL

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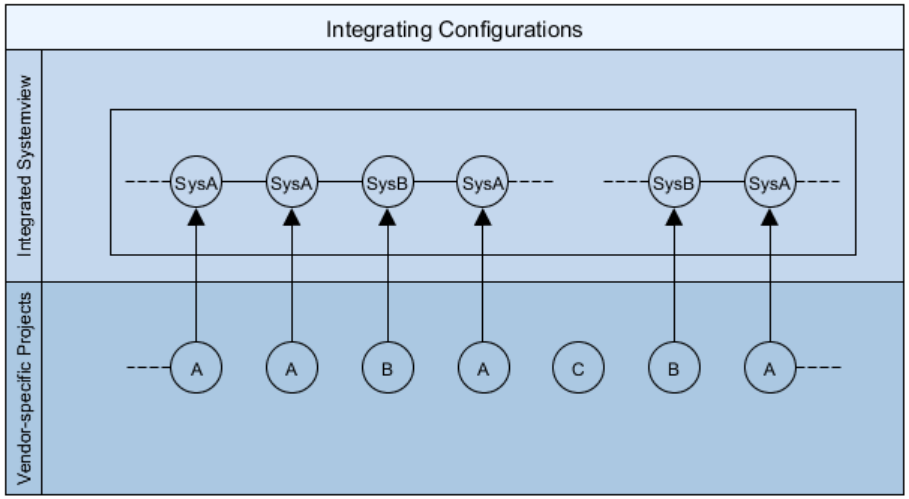
Integrating Distributed Configurations with RDFS and SPARQL
Use Case

Large technical systems are sometimes configured with multiple product configurators
These configurators use their own ontologies
Knowledge engineers would rather share a toothbrush than share a concept name

Example Railway Line:

- Individual stations are configured by different vendors
- These configurators store their configurations in separate databases (projects)
- How can the infrastructure owner (i.e. railway company) write queries about the whole system in a vendor independent manner?



Integrating Distributed Configurations with RDFS and SPARQL Using Semantic Web Technologies

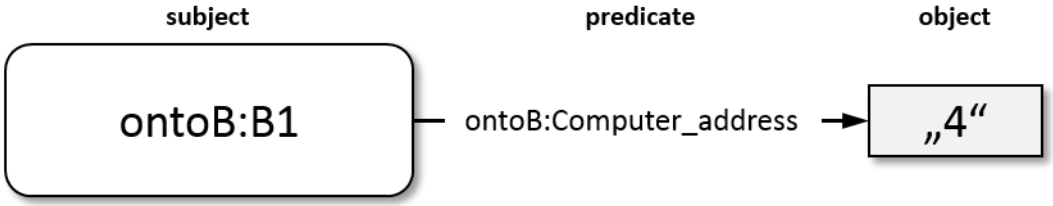
Looking for a “lightweight” non-proprietary approach using only standard Semantic Web technologies

Our approach uses:

- RDF(S) to represent configurations and knowledge bases (ontologies)
- SPARQL (standard RDF query language) to create linked system view
- A little bit of OWL

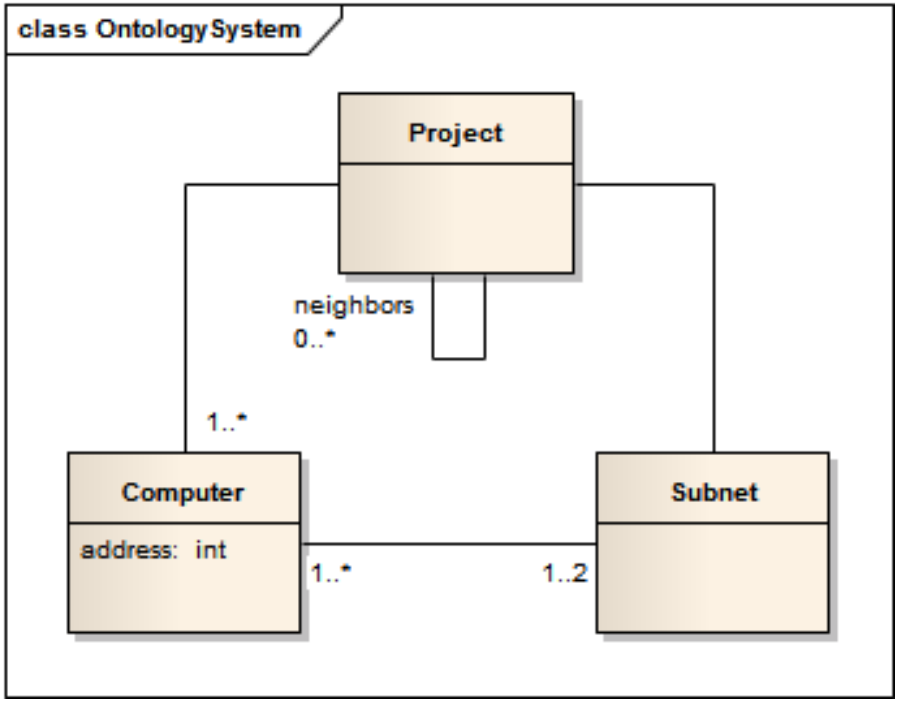
Example:

RDF-graph consists of triple: subject (URI) predicate(URI) object(URI or Literal)

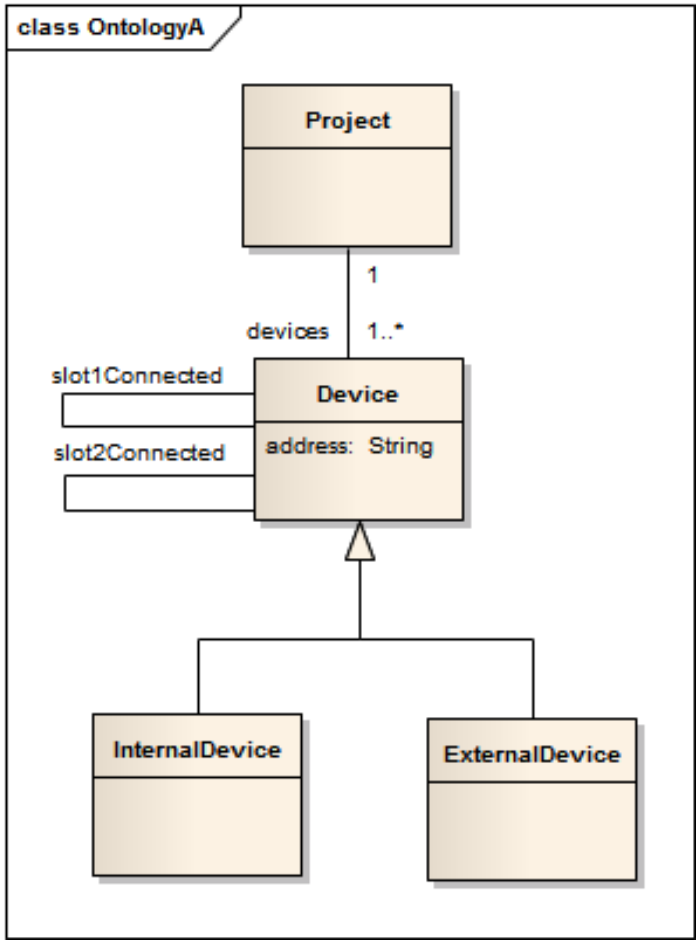


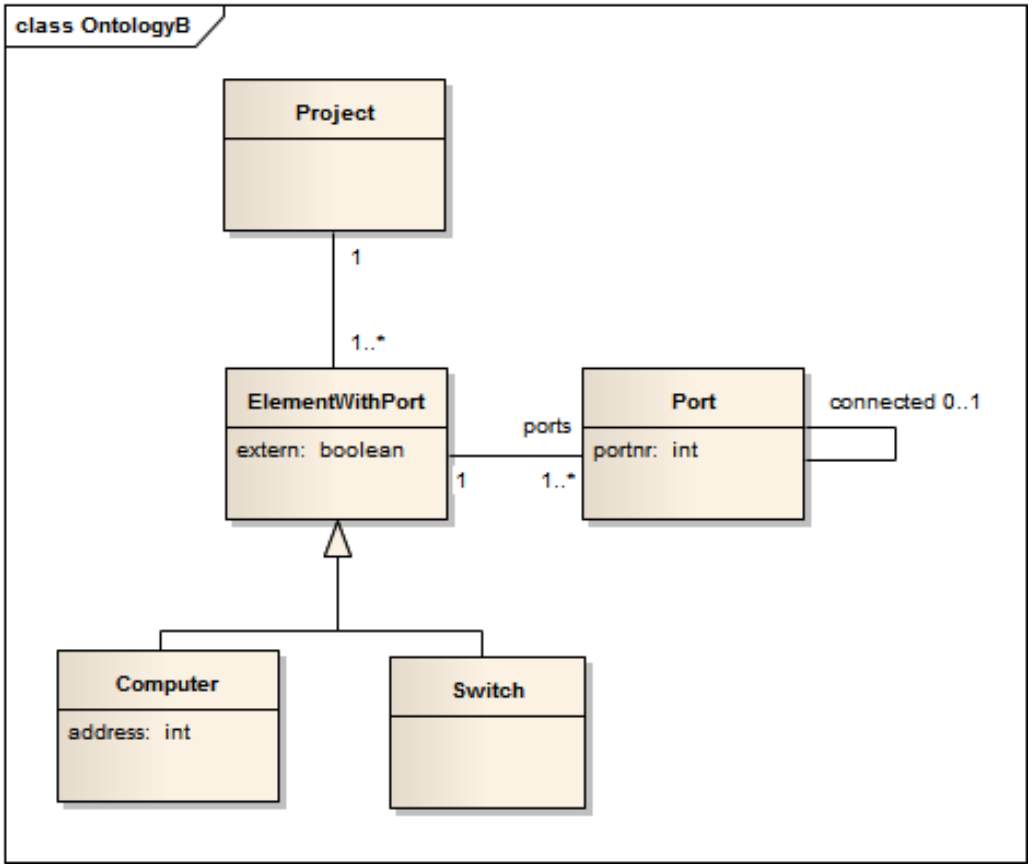
Integrating Distributed Configurations with RDFS and SPARQL
Working Example – System Ontology

- Fictitious computer network
  - Every computer has an unique address
  - A computer can be part of 1-2 subnets
  - A computer is part of exactly one project
  - A project is some arbitrary subdivision of the whole network

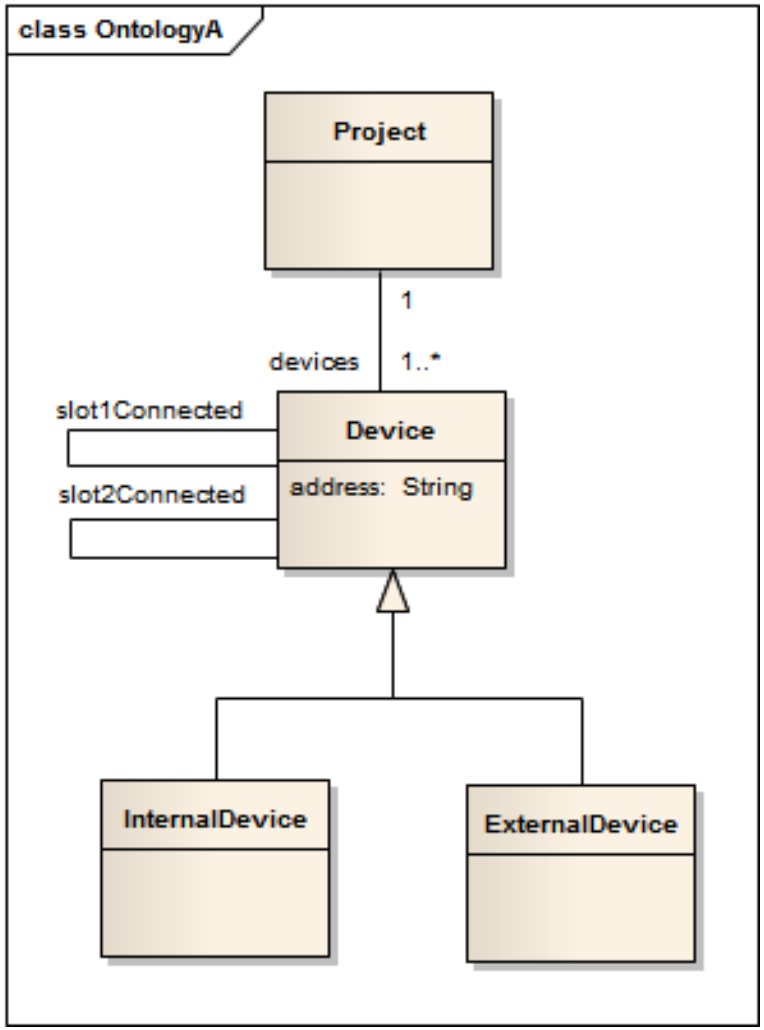


Integrating Distributed Configurations with RDFS and SPARQL
Working Example – Configurator-specific Ontologies





Integrating Distributed Configurations with RDFS and SPARQL
From UML to RDF




```
ontoA:InternalDevice
  rdf:type owl:Class ;
  rdfs:subClassOf ontoA:Device .

ontoA:Device_address
  rdf:type owl:DatatypeProperty;
  rdfs:domain ontoA:Device ;
  rdfs:range xsd:string .

ontoA:Device_slot1Connected
  rdf:type owl:ObjectProperty ;
  rdfs:range ontoA:Device ;
  rdfs:domain ontoA:Device .

# instance data
ontoA:A1
  rdf:type ontoA:InternalDevice ;
  ontoA:Device_address "1";
  ontoA:Device_slot1Connected
           ontoA:A2 , ontoA:A3 .
```

Integrating Distributed Configurations with RDFS and SPARQL
Open World Assumption & Unique Name Assumption

Semantic Web Technologies usually use Open World Assumption and don't use Unique Name Assumption

Open (OWA) vs. Closed World Assumption (CWA)

```
# How many times was Elvis married? (OWA)
:Elvis :isMarriedTo :Priscilla .
# How many connections does A1 have? (CWA)
:A1 :Device_slot1Connected :A2 , :A3 .
```

Unique Name Assumption (UNA)

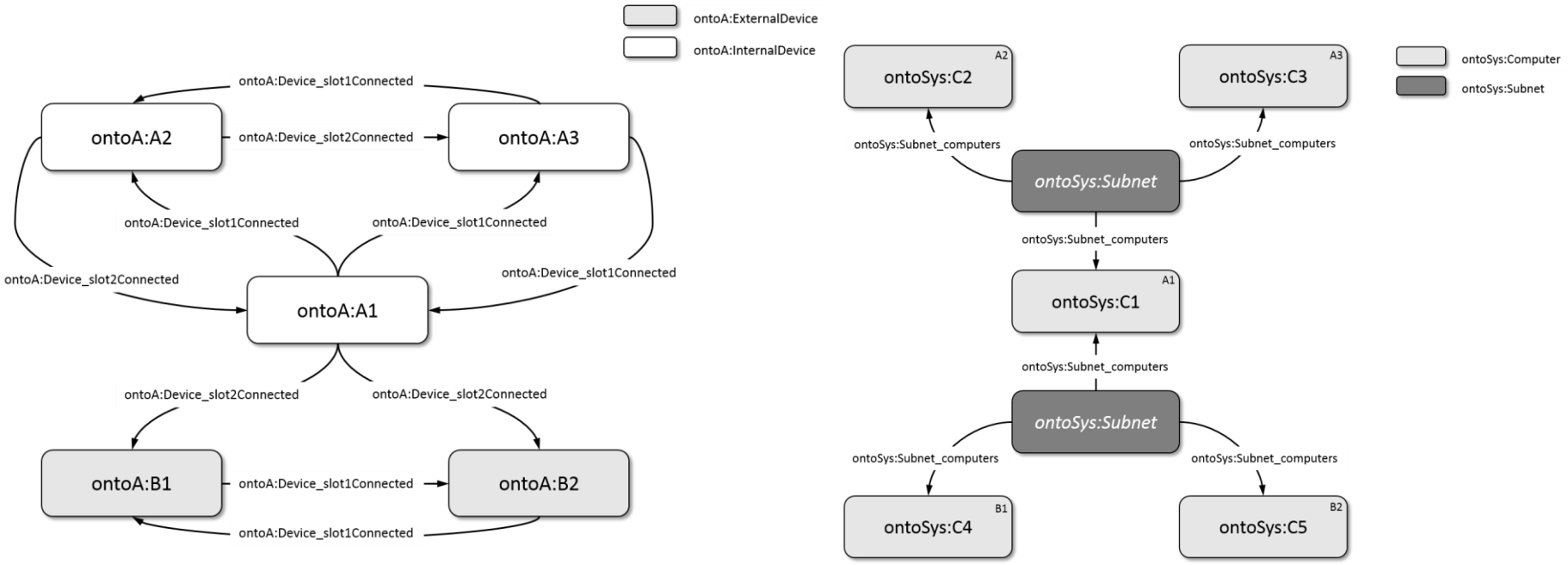
```
:TheKing :loves :PeanutbutterBananaSandwich . (Without UNA)
:Elvis owl:sameAs :TheKing .
:A1 :Device_slot1Connected :A2 , :A3 . (UNA)
```

Pragmatic solution: Use SPARQL (CWA) and use UNA by Default, i.e. treat identifiers as different objects unless stated otherwise with owl:sameAs

Integrating Distributed Configurations with RDFS and SPARQL
Creating System View

How do we get from instance data of ontology A (left) to System View (right)?

- Create System View from vendor-specific view with SPARQL CONSTRUCT queries



Integrating Distributed Configurations with RDFS and SPARQL
Creating Instances

New instances can be created either by creating a new URI or by using blank nodes.

Example new URI:

```
CONSTRUCT {
  ?computeruri rdf:type ontoSys:Computer.
  ?computeruri ontoSys:Computer_address ?address.
}
WHERE{
  ?device ontoA:Device_address ?address.
  BIND(URI(CONCAT(URISYS,STR(?address)))
      AS ?computeruri)
}
```

Example blank node:

```
CONSTRUCT {
    _:blanknodeForProject rdf:type ontoSys:Project .
    _:blanknodeForProject ontoSys:origin ?project .
}
WHERE{
    ?project rdf:type ontoA:Project .
}
```

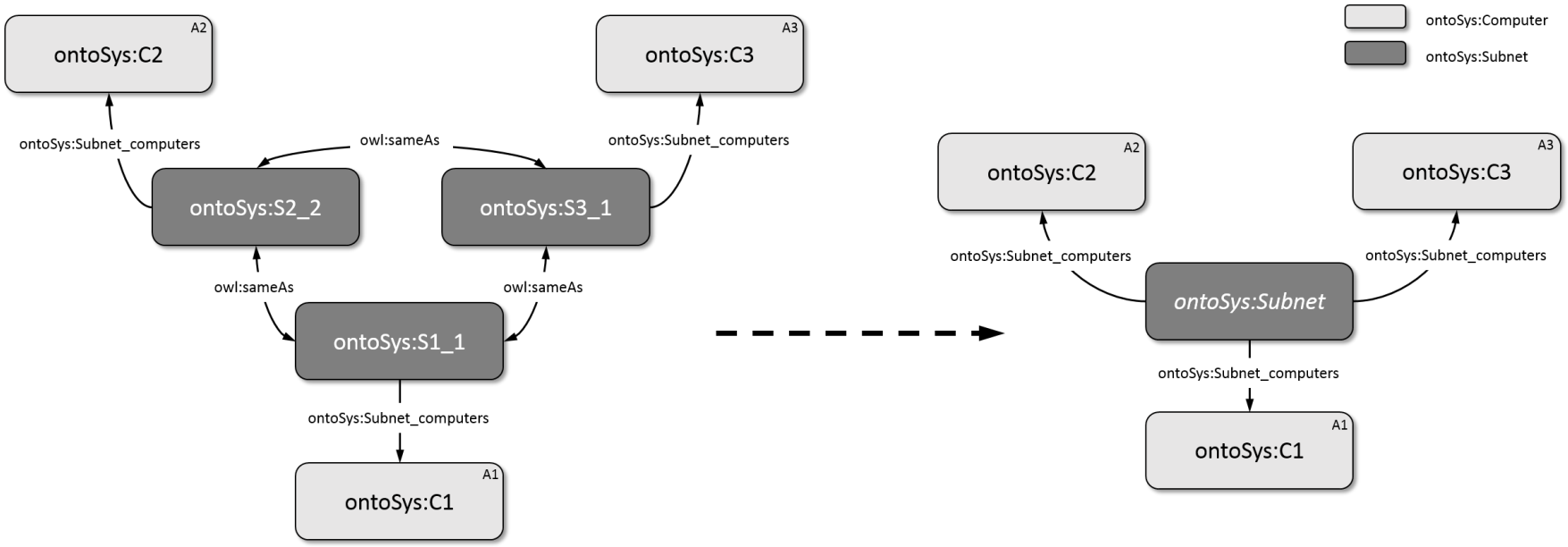
Integrating Distributed Configurations with RDFS and SPARQL Complex Mappings with owl:SameAs

Using multiple URIs for the same object makes complex mappings easier

Example Creating Subnets:

```
# Whenever 2 Devices are directly connected in OntologyA, they are
part of the same Subnet in OntologySys
CONSTRUCT {
  ?sub1 ontoSys:Subnet_computers ?c1 .
  ?sub2 ontoSys:Subnet_computers ?c2 .
  ?sub1 rdf:type ontoSys:Subnet .
  ?sub2 rdf:type ontoSys:Subnet .
  ?sub1 owl:sameAs ?sub2 .
} WHERE {
?d1 ontoA:Device_slot1Connected ?d2
…}
```

Integrating Distributed Configurations with RDFS and SPARQL
Complex Mappings with owl:SameAs (cont.)

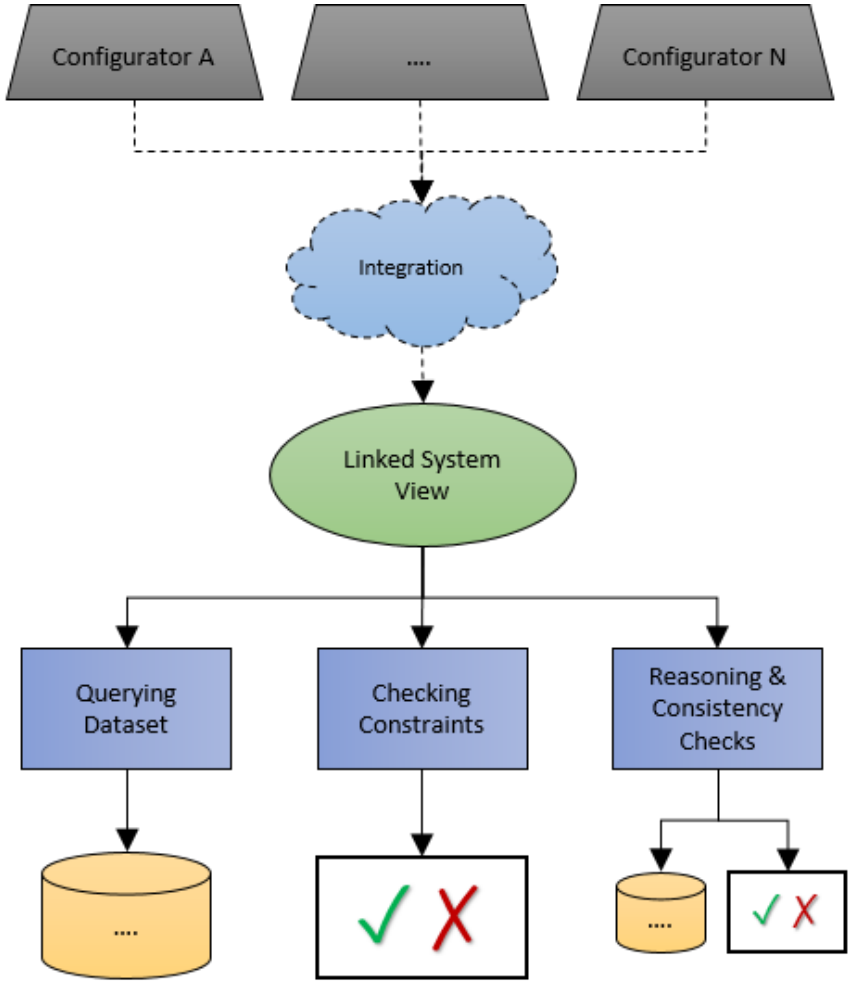


Integrating Distributed Configurations with RDFS and SPARQL
Result of Data Integration

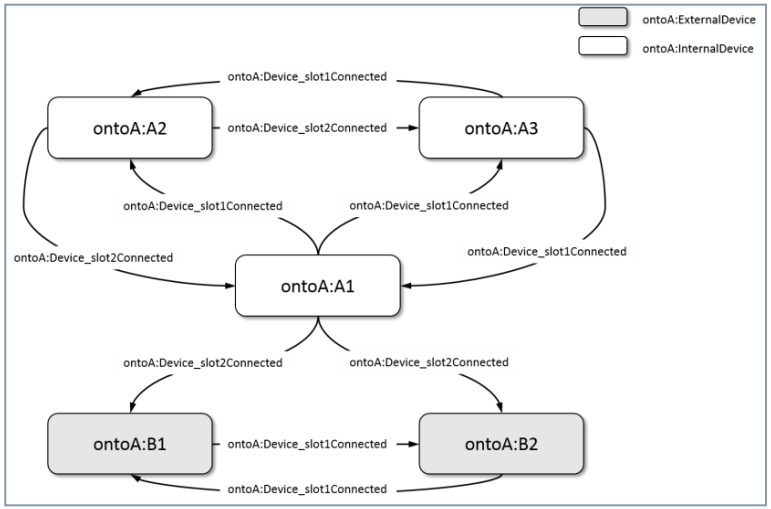
After the data integration we can query the system view, check consistency etc. with SPARQL queries

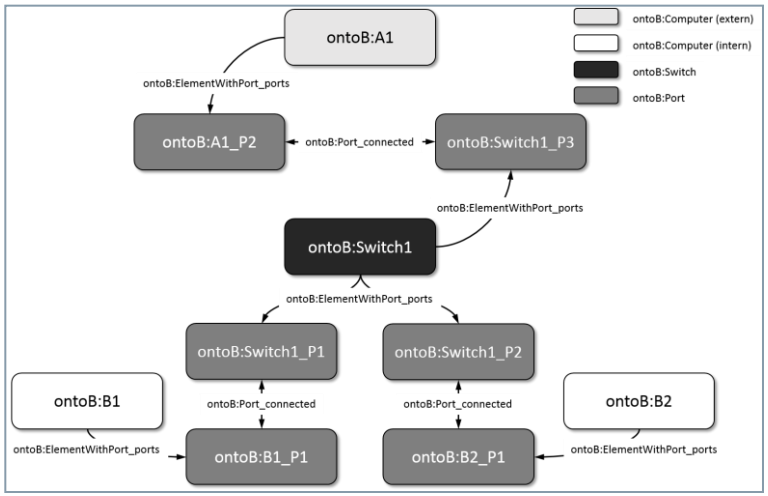
Example:

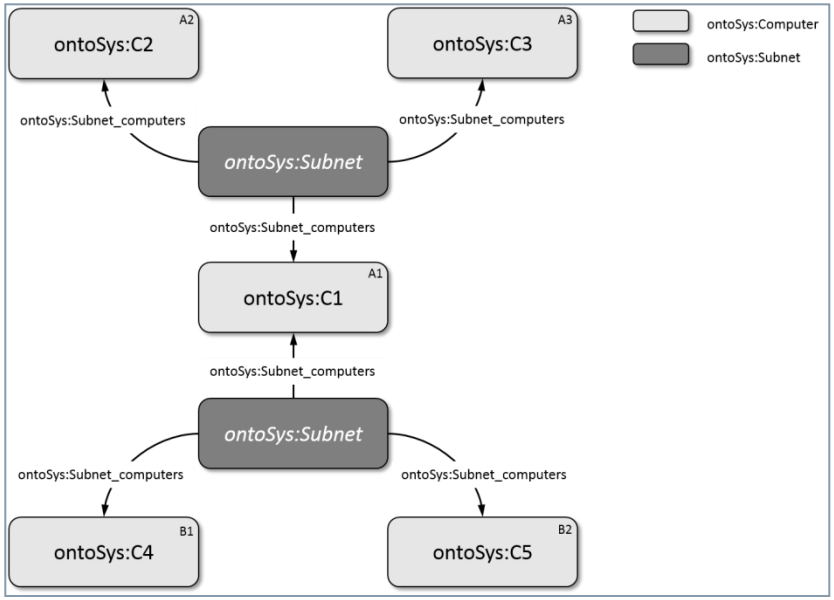
```
# return all the addresses used in all
projects
SELECT ?p ?address
WHERE {
 ?p ontoSys:Project_computers ?c .
 ?c ontoSys:Computer_address ?address .
}
```



Integrating Distributed Configurations with RDFS and SPARQL Recap







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How would you approach the Data Integration scenario?

Semantic Web Technologies and Product Configuration?

How do we share Product Configuration Knowledge Bases?

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Thank you for your attention!

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