Toward Measurement and Analysis of Virtualized Infrastructure: Scaffolding from an Ontological Perspective

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Measurement and analysis of virtualized infrastructure

- Context: cloud computing
  - Virtualized infrastructure
  - Sheer scale and extensive use of virtualization will make it almost intractable
- Measurement and analysis are important here too:
  - Dependency as another topology graph
  - Analysis of availability / impact / security
- An initial attempt in the WIDE cloud:
  - VRDF (Virtual Resource Description Framework)

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VRDF project objective

- Develop a framework to describe and analyze complex dependency of services, virtual machines, virtual routers and VLANs
  - … in order to improve the availability of Data Centers and maintain their security level

- Describe dependency of VM to physical machine
- Describe dependency of virtual nets to networking devices

- Assess the impact of failure
- Analyze dependency

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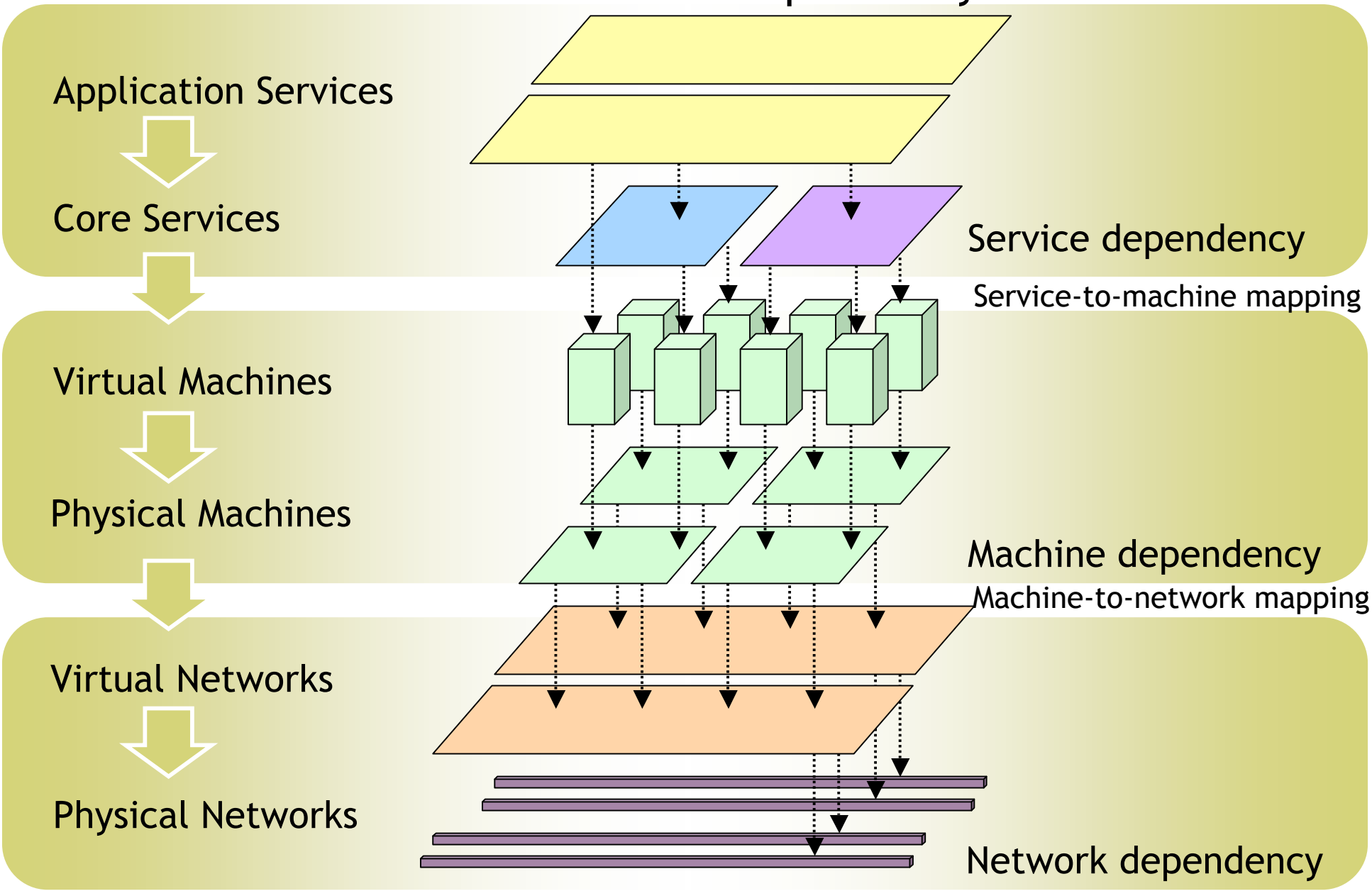
VRDF: 3 tiers of dependency



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Project deliverables

- Information model and RDF schema definitions for virtual asset enumeration and dependency analysis
- Initial set of SWRL rules for such analysis
- Initial proof of concept that works with Protégé
- Delivered to METI in March 2010

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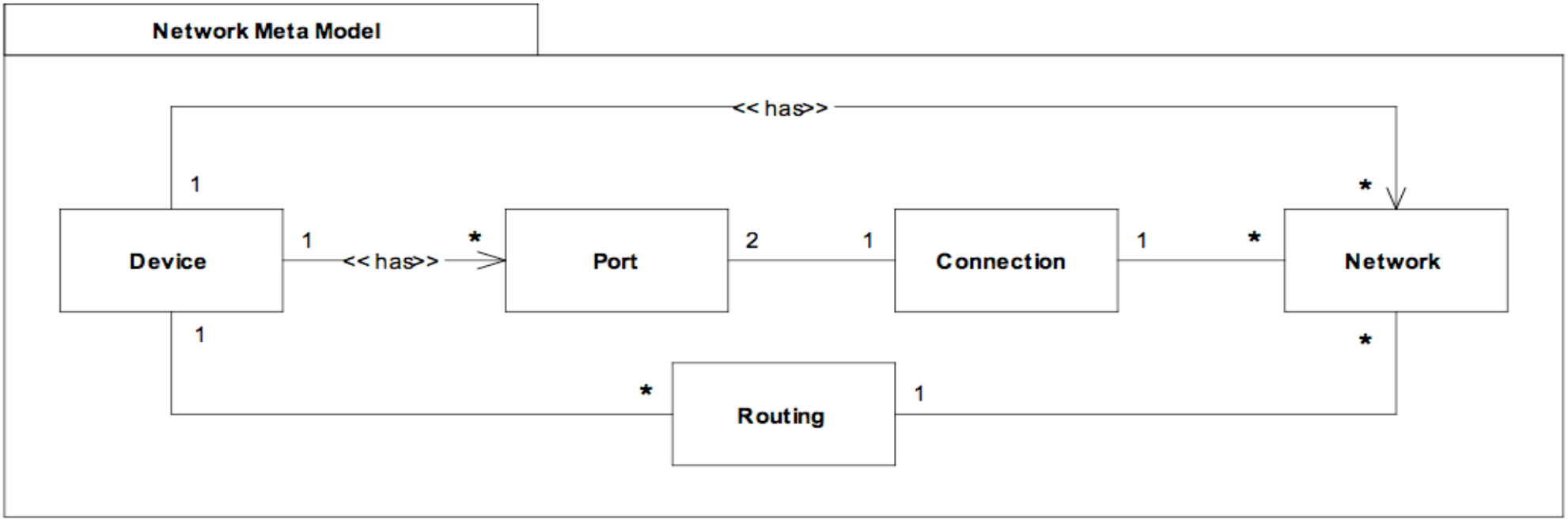
Network layer meta-model



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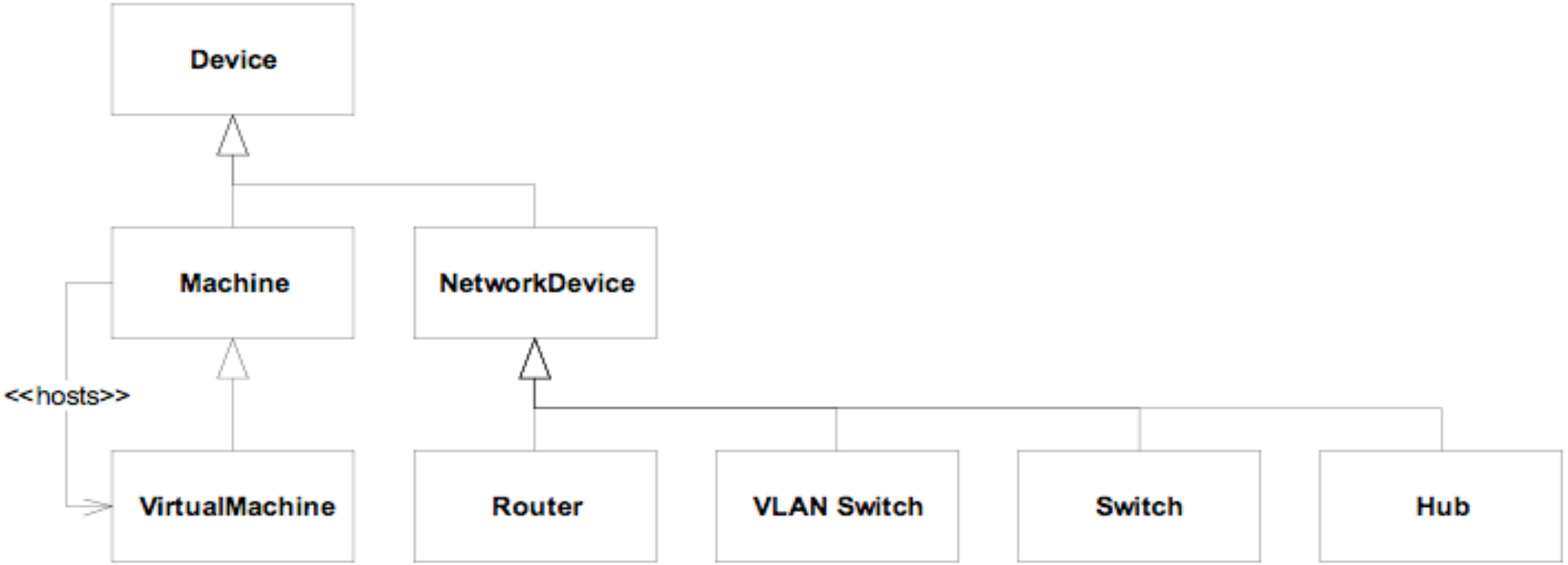
Device classes

- Subject to extension



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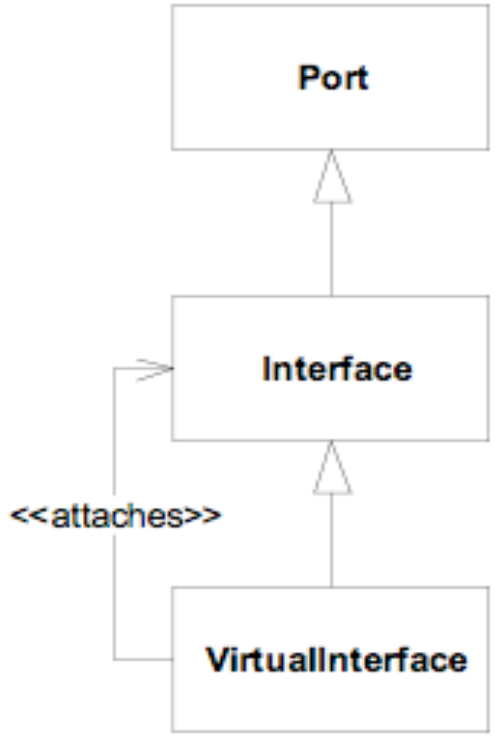
Virtual Interfaces in VRDF



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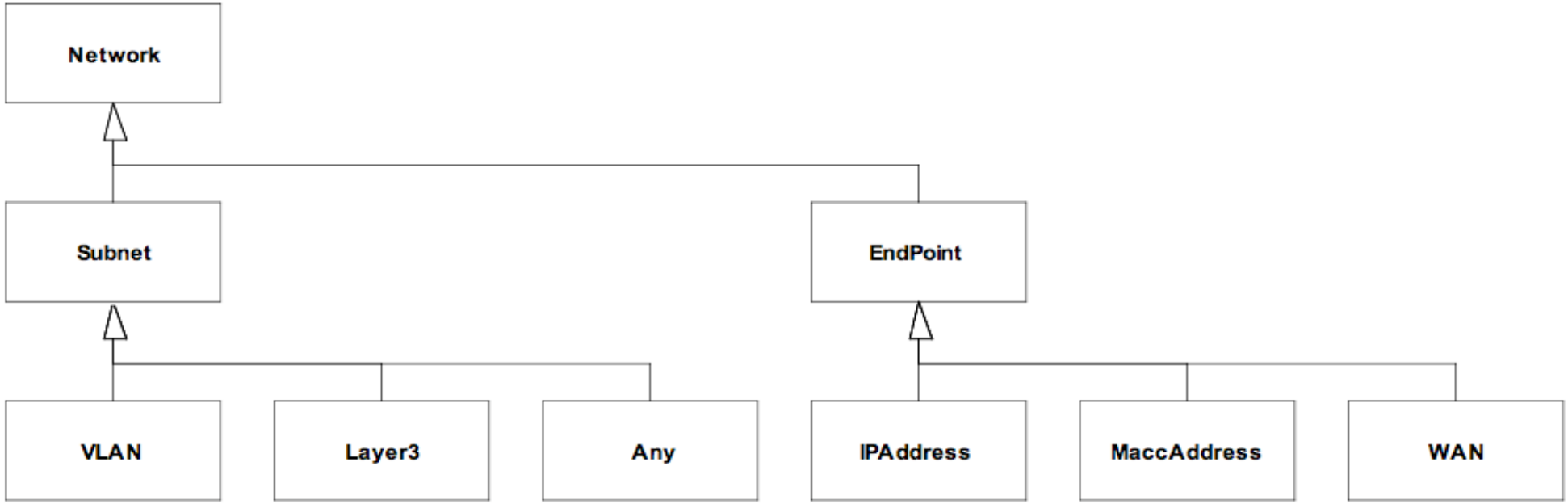
Network resources



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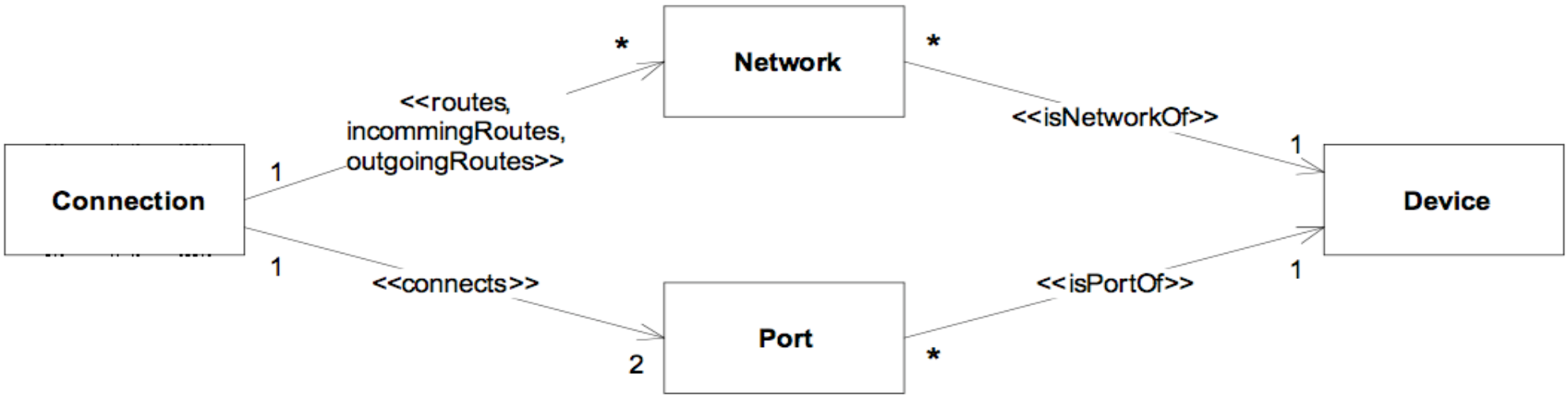
Connection



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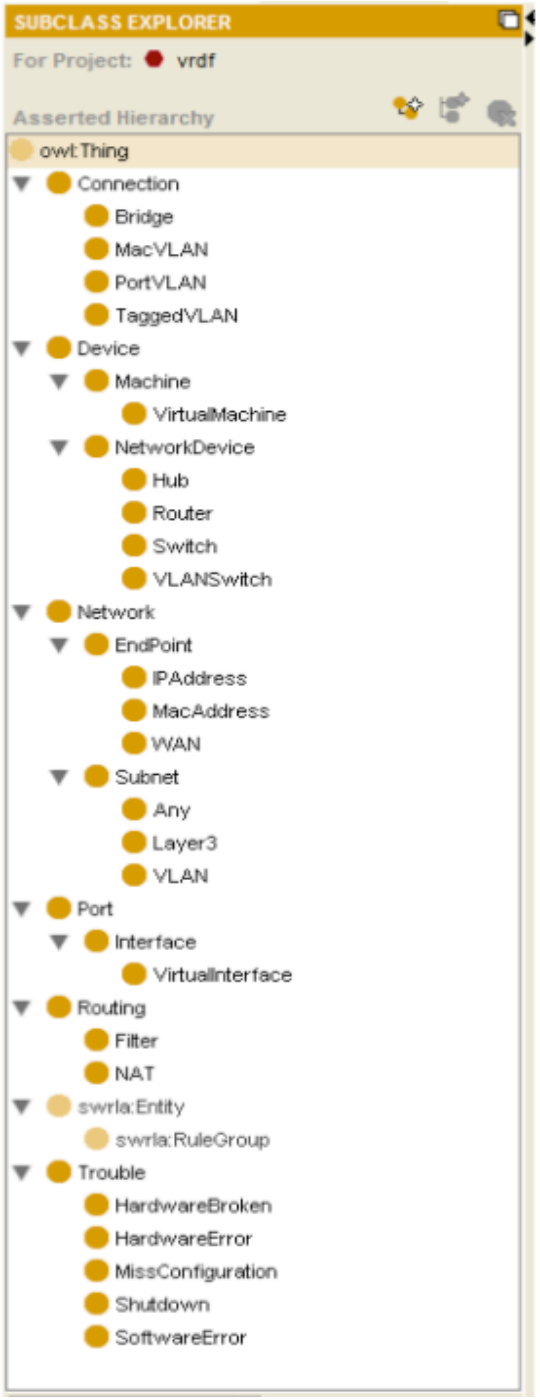
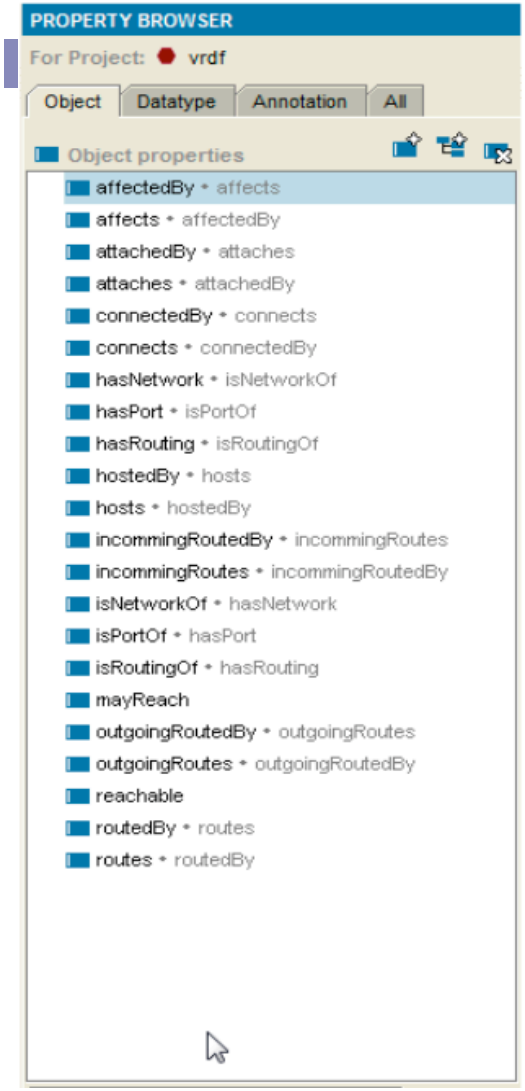
RDF schema

```
<owl:Class rdf:ID="Routing">
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:cardinality rdf:datatype="http://www.w3.org/2001/XMLSchema#
      >1</owl:cardinality>
      <owl:onProperty>
        <owl:ObjectProperty rdf:ID="isRoutingOf"/>
      </owl:onProperty>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:ID="Switch">
  <rdfs:subClassOf>
    <owl:Class rdf:ID="NetworkDevice"/>
  </rdfs:subClassOf>
  <owl:disjointWith>
    <owl:Class rdf:ID="VLANSwitch"/>
  </owl:disjointWith>
  <owl:disjointWith>
    <owl:Class rdf:ID="Router"/>
  </owl:disjointWith>
  <owl:disjointWith>
    <owl:Class rdf:ID="Hub"/>
  </owl:disjointWith>
</owl:Class>
<owl:Class rdf:ID="VirtualMachine">
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty>
        <owl:ObjectProperty rdf:ID="hostedBy"/>
      </owl:onProperty>
      <owl:cardinality rdf:datatype="http://www.w3.org/2001/XMLSchema#
      >1</owl:cardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class rdf:ID="Machine"/>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:about="#VLAN">
  <owl:disjointWith>
    <owl:Class rdf:about="#Layer3"/>
```





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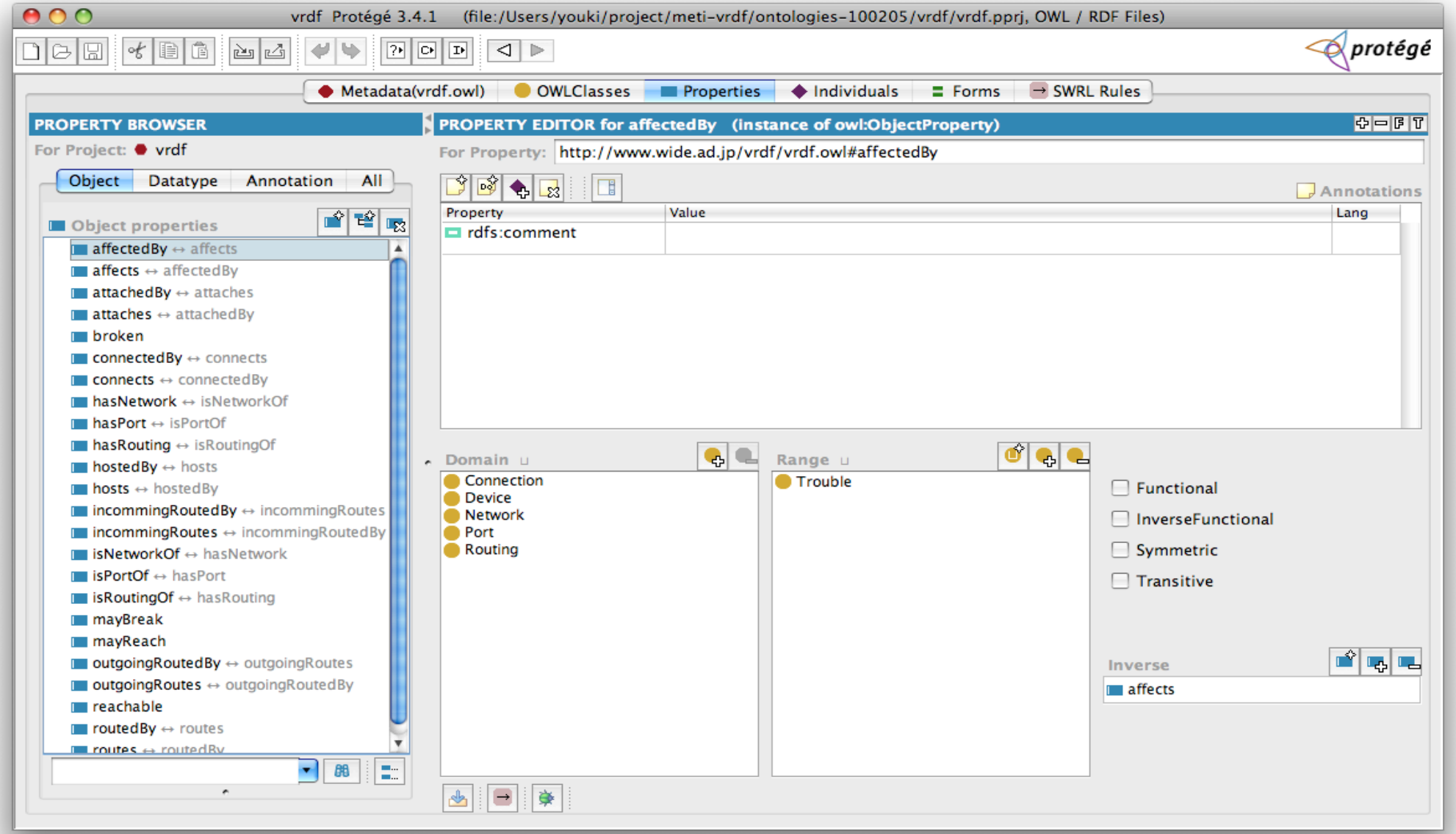
RDF schema viewed in Protégé



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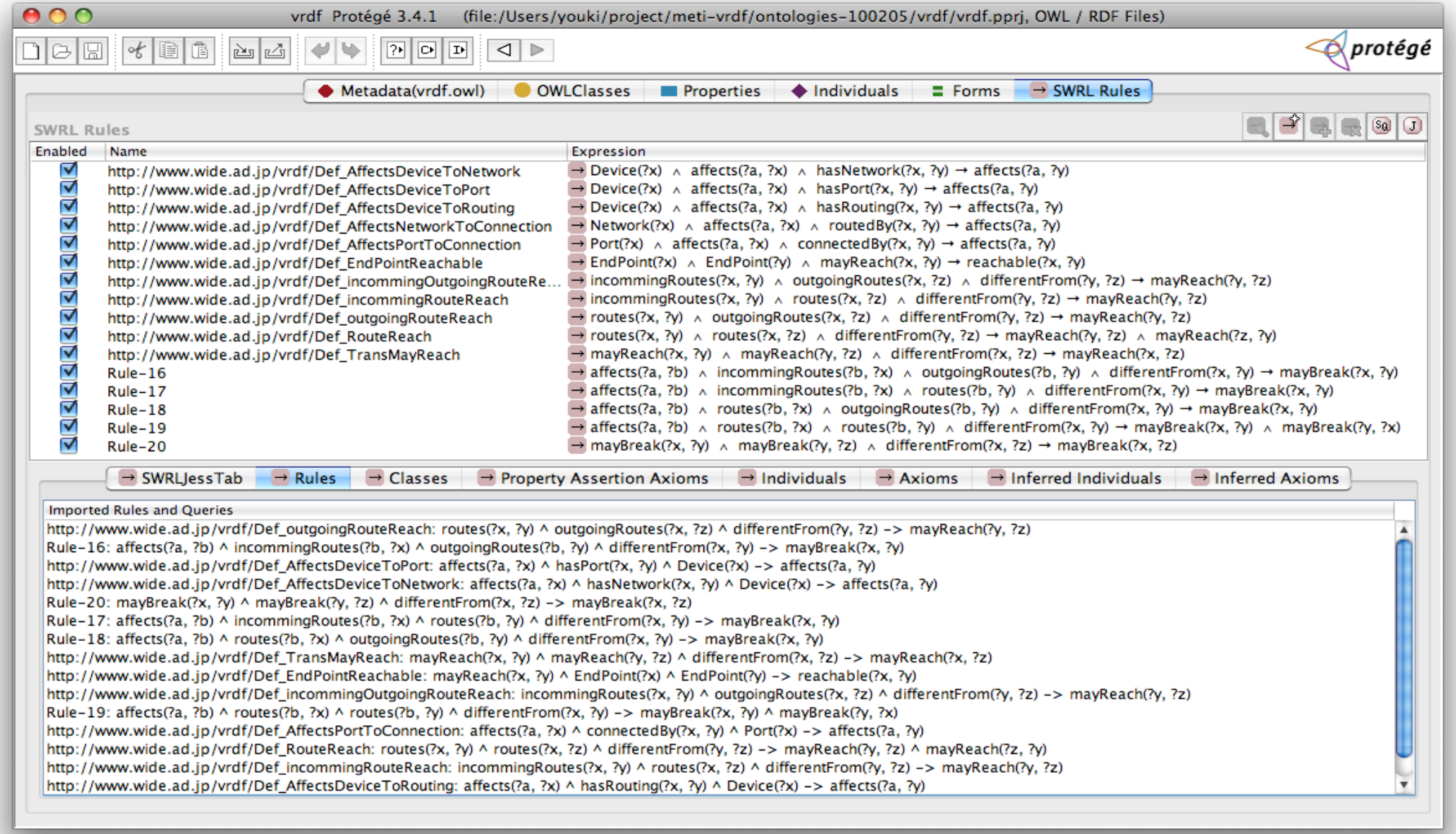
SWRL rules in Protégé



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Summary

- Measurement of Virtualized Infrastructure
  - Dependency as another topology graph
  - Analysis of availability / impact / security
- Scaffolding from an Ontological Perspective:
  - Enumeration of virtual & physical resources
  - Description of dependency
  - RDF schema
  - Initial attempt to use rule engines e.g., SWRL
- Remaining tasks:
  - Service dependency
  - Data extraction tools
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