Common Cognitive Radio language, a CREW-GENI collaboration

Carolina Fortuna\textsuperscript{1}, Milorad Tosi\textsuperscript{2}, Mikolaj Chwalisz\textsuperscript{3}, Peter de Valck\textsuperscript{4}, Ivan Seskar\textsuperscript{5}

\textsuperscript{1} Jozef Stefan Institute, Jamova 39, SI-1000 Ljubljana, Slovenia
\textsuperscript{2} University of Nis, Serbia
\textsuperscript{3} Technical University Berlin, Germany
\textsuperscript{4} iMinds and University of Gent, Belgium
\textsuperscript{5} Rutgers University, USA.
Outline

• Introduction: CREW CDF and TassOR

• About ontologies and CR use cases

• The Spectrum Sensing Ontology

• Modelling and querying cognitive radio devices: selected examples

• Summary
The CREW federation’s common data format

- 5 testbeds
- Need for harmonizing experiment description
- Need for harmonizing the results from the experiment

common data format that includes a vocabulary based on the IEEE P 1900.1 specifications
Testbed as a Service with Ontology Repository (TaaSOR)

Community focused WEB based tool

- Grounding by team consensus on shared ontologies
- Knowledge reuse by including complementing networking ont. (NOVI, NDL, NDL-OWL)
- Generated ontologies instantly available online and published as Linked Data as well as SPARQL endpoint
CREW-GENI efforts

• Starting from
  • existing standard vocabularies provided by ontologies (NOVI, NDL, NDL-OWL)
  • the existing Testbed as a Service with Ontology Repository (TaaSOR)
  • and the CREW common data format

• create a Spectrum Sensing Ontology capable of describing any device and capability from any cognitive radio testbed

• The final goal is to enable testbed-as-a-service functionality
What is an ontology and why semantic web?

• “an ontology formally represents knowledge as a set of concepts within a domain, using a shared vocabulary to denote the types, properties and interrelationships of those concepts”

• In a way, an ontology is a taxonomy that also has relationships between the concepts

• Ontologies and semantic web technologies enable machine interpretable representations of data thus increasing interoperability

• In semantic web, everything can be described as a triple:

<table>
<thead>
<tr>
<th>Subject (Resource)</th>
<th>Predicate (Property)</th>
<th>Object (Statement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sses:RadioDevice</td>
<td>rdf:hasIndividual</td>
<td>sses:SpectrumAnalyzerTest</td>
</tr>
<tr>
<td>sses:SpectrumAnalyzerTest</td>
<td>sses:supports</td>
<td>sses:SASettings1</td>
</tr>
</tbody>
</table>
Example use case for CR: model relationships between frequency intervals

Situations we would like to be able to represent
Possible semantic rules for expressing the relationships about frequency ranges
The Spectrum Sensing Ontology (1/2)

• The ontology has three orthogonal parts that allow the description of:
  • spectrum related theoretical aspects,
  • device spectrum sensing capabilities and
  • ranges of values for each

• Basic device capability description: base band and RF capabilities described

• Description of the processing for base

• Current version:  
  http://sensorlab.ijs.si/2013/v0/SpectrumSensingExperimentSpecification.owl
The Spectrum Sensing Ontology (2/2)
Modelling a Spectrum Analyzer
Example query: Devices and their sweeping bands

- A set of devices have been added as individuals of the concepts in the ontology
- Their properties were also modelled

- A SPARQL query retrieves all the devices and the frequency ranges they are able to sweep

```
SELECT ?Device1 ?f1 ?f2
WHERE {
}
```
Example query:
Devices with same sweeping bands
Example query: Devices with included sweeping bands

SPARQL query:
```
WHERE {
  FILTER(xsd:integer(?f1) < xsd:integer(?x)).
  FILTER(xsd:integer(?f4) < xsd:integer(?y)).
}
```
Rules to simplify the SPARQL queries and abstract the underlying complexity
Complex SPARQL Query:
Find all spectrum sensing devices capable of sensing frequency X

Execute search

List of device capabilities that cover 2.412 GHz

Frequency Value: 2412
Frequency Unit: MHz

Results:
List of device capabilities that cover 2.412 GHz
Summary

• We have defined and developed a working Spectrum Sensing Ontology that is openly available

• We have modelled several devices and exemplified on use cases how it can be use

• There are several other aspects related to the spectrum sensing device and experiment specification that we have identified but are not yet solved in the current version
• Questions?

• I am happy to provide further explanations and show the running demos locally in Protégé or remotely in TaasOR (today and next days here at FIA)

• Thank you!

• http://sensorlab.ijs.si/2013/v0/SpectrumSensingExperimentSpecification.owl