Lightpath provisioning: XML schema or RDF schema?

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Problem statement:

When trying to find and provision inter-domain lightpaths in optical hybrid network[1] one of the main obstacles of control plane interoperability is the lack of a common model for the description of the network.

Within the research community there is now consensus that a common schema is (a first step to) the solution to this problem. The newly started NML-WG (Network Markup Language Working Group)[2] within OGF (Open Grid Forum) should provide this common schema.

An open question is whether to use an XML-based schema, such as the one in use by the Network Measurement Working Group (NM-WG)[3] in OGF, or an RDF-based schema, such as the one provided by Network Description Language (NDL) at the Universiteit van Amsterdam (UvA).

These notes describe our motivations for using RDF as the syntax for NDL[4], and offer some reasons for the adoption of RDF as the language for a common schema.

Model versus Syntax

The most important task of a working group is, in our opinion, creating a consistent and useful ("lightweight yet powerful") model. The mapping of a model into a schema is a secondary task. Creating an ontology in RDF is not very different from defining an XML schema, or database design. There you also must describe your model in a schema using classes and relations.

Below we describe four features of RDF, and in particular RDF/XML, which in our view make it a preferred choice over plain XML.

[1] Optical hybrid networks in this document are networks that provide both IP paths, and dedicated circuit switched paths, i.e. *lightpaths*. These networks are currently being built by national research and education networks (NRENs) to meet the ever-growing need for bandwidth of researchers.

[2] https://forge.gridforum.org/sf/projects/nml-wg

[3] https://forge.gridforum.org/sf/projects/nm-wg

[4] http://www.science.uva.nl/research/sne/ndl/

RDF and RDF/XML

According to the W3C (World Wide Web Consortium) website[5]:

- RDF is a framework for representing information on the Web.
- RDF integrates a variety of applications […] using XML as interchange syntax. The RDF specifications provide a lightweight ontology system to support the exchange of knowledge on the Web.

RDF/XML is an XML syntax for RDF defined in terms of Namespaces in XML, the XML Information Set, and XML Base.

Strengths of RDF

We believe the following are the main strengths of RDF:

1. **Ontology**: When defining a schema for RDF, you have to define a complete ontology, which means that every element must be given a well-defined meaning. This is both an advantage to the schema author, who is forced to clearly define context and meaning for every single element, as well as for users, who may use the meaning to leverage the information on the semantic web.
2. **Use of URIs**: Every element described in RDF is automatically given a unique URI[6]. These identifiers are usually based on the location of the publish document.
3. **Internal references**: RDF provides a very easy way to reference other objects defined in the same document.
4. **Pointers to other documents**: When you want to reference a resource described elsewhere, you can explicitly point to another RDF file. This allows for a structured way of maintaining distributed information
5. **Extensibility**: A user can mix two ontologies in his application, even when neither ontology author was aware of the other schema.
6. **Toolset**: Because RDF is meant as a generic way of describing information, there are several tools which can automatically "make sense" of your data.

Beside the above advantages, we are only aware of one disadvantage of RDF:

1. **Verbosity**: In our experience, RDF/XML is about 1 to 2 times as verbose as XML. It should be noted that RDF models can also be described using other syntaxes, such as N3, which are can easily be optimized for fast parsing.

Because RDF/XML is a XML syntax, one could argue that XML can always be used to achieve all of the above strengths. However, in that case it is better to use an existing standard, than to develop a custom solution, both for compatibility reasons, as well as being able to leverage existing tools

[5] http://www.w3.org/2001/sw/
[6] URI: Uniform Resource Identifier. A web address or URL is a form of a URI.

Requirements for a Network Schema

In the previous section we explained several features that RDF has over plain XML. Below we describe why we feel these features are important when developing a network schema:

1. The use of URIs as generic identifiers is an advantage in multi-domain environments, since it makes it easy to express a request like “a path from A to B” with “A” and “B” clearly and uniquely defined.
2. The relations between network elements can lead to cycles in the relation-graph (e.g. when combining multiplexing and inverse multiplexing adaptation functions). RDF extends the tree structure of XML with reference pointers to deal with cycles.
3. We want to describe the interrelation of different (administrative) network domains. Each domain must be able to publish its own network information and point to other network domains.
4. We want to allow for easy extensibility with the network schema. That is, allow the users to not only publish the information they care about, but also allow them to mix it with other schemas, both current (e.g. geographic information or organizational information in geo and vcard), but also future schemas, either direct extensions to NML or non-directly related schemas.

RDF and Semantic Web

RDF is intrinsically linked to Semantic Web. Again from the W3C website:

> *RDF emphasizes facilities to enable automated processing of Web resources and as such provides the basic building blocks for supporting the Semantic Web.*
>
> *The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.*

If we adopt RDF for our common schema we are allowing distinct applications consume the information across community boundaries.

For example, we already use schemas developed by other parties, like the *geo* and *vCards* schemas. This is an advantage to us as schema developers since we don’t have to re-invent the wheel each time. XML namespaces have the same advantage. In addition, other applications can re-use the information published. While a geographic or address book applications will not “understand” our network descriptions, it will be able to extract the relevant geographic or address information embedded in the schema. This is actually intrinsic to RDF: applications should extract the information they need, and ignore the rest.

There is a third advantage, since all information has the same structure, and is defined by machine readable schemas: as a consequence, parsers can parse all data, even if they don’t understand the full details, and can still reason about it. For example, it will become possible to define logical rules, like: an “interface” “connected to” another “interface”, which is “switched to” another “interface” “connected to” a fourth “interface” means that the first “interface” is also “connected to” the last “interface”. Even if a parser does not understand the meaning, of “interface” and “connected to”, it can still apply rules like this.

Usage of RDF schemas

Information described with RDF in NDL is not bound to reside on the web. We envision two major service types:

- Semi-static data, generated out of an internal database, or directly polled from devices,
- Short lived data, for example when using a web service, where you can get a view of the data, or simply a yes/no answer for a request.

References

Why RDF model is different from the XML model
Tim Berners-Lee
http://www.w3.org/DesignIssues/RDF-XML
An article containing some reasons to use RDF instead of XML:

> *You can parse the semantic tree, which end up giving you a set of (possibly mutually referential) triples and then you can use the ones you want ignoring the ones you don't understand.*

RDF W3C page
http://www.w3.org/RDF

Semantic Web W3Cpage
http://www.w3.org/2001/sw/