# RDF and OWL

**Gian Piero Zarri**
*University of Paris IV/Sorbonne, France*

## INTRODUCTION

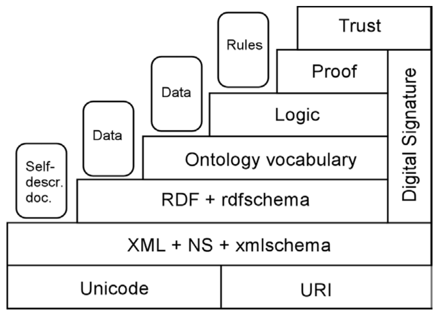
As Web-based content becomes an increasingly important knowledge management resource, Web-based technologies are developing to help harness that resource in a more effective way.

The current state of these Web-based technology—the "first generation" or "syntactic" Web—gives rise to well-known, serious problems when trying to accomplish in a non-trivial way essential management tasks like indexing, searching, extracting, maintaining, and generating information. These tasks would, in fact, require some sort of "deep understanding" of the information dealt with: In a "syntactic" Web context, on the contrary, computers are only used as tools for posting and rendering information by brute force. Faced with this situation, Berners-Lee first proposed a sort of "Semantic Web" where the access to information is based mainly on the processing of the *semantic properties* of this information: "… the Semantic Web is an extension of the current Web in which information is given well-defined *meaning* [emphasis added], better enabling computers and people to work in co-operation" (Berners-Lee, Hendler, & Lassila, 2001, p. 35). The Semantic Web's challenge consists then in being able to manage information on the Web by "understanding" its proper semantic content (its meaning), and not simply by matching some keywords.

## BACKGROUND

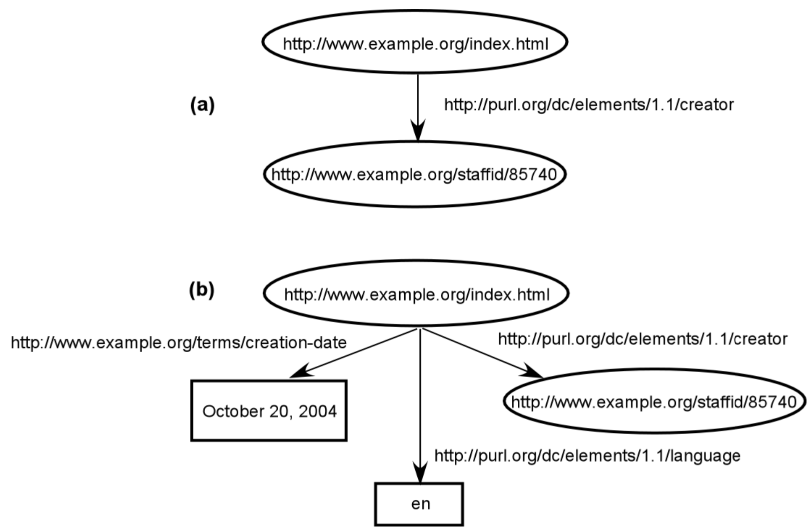
The architecture proposed by Berners-Lee for the Semantic Web is reproduced in Figure 1. "Unicode" and "URI" make up the basis of this hierarchy. The Unicode Standard provides a unique numerical code for every character that can be found in documents produced according to any possible language, no matter what the hardware and software used to deal with such documents. Uniform Resource Identifier (URI) represents a generalization of the well-known Uniform Resource Locator (URL) that is used to identify a "Web resource" (e.g., a particular page) by denoting its primary access mechanism (essentially, its "location" on the network). URI has been created to allow recording information about all those "notions" that, unlike Web pages, do not have network locations or URLs, but that need to be referred to in an RDF statement. These notions include network-accessible things, such as an electronic document or an image, things that are not network-accessible, such as human beings, corporations, and bound books in a library, or abstract concepts like the concept of a "creator."

*Figure 1. Semantic Web architecture according to Tim Berners-Lee*




XML (eXtensible markup language) (see Bray, Paoli, Sperberg-McQueen, Maler, & Yergeau, 2004) has been created to overcome some difficulties proper to hypertext markup language (HTML); this last suffers from a number of limitations, from its lack of efficiency in handling the complex client/server communication of today's applications to the impossibility of defining new tags to customize exactly the user's needs. XML is called "extensible" because, at the difference of HTML, it is not characterized by a fixed format, but it lets the user design its own customized markup languages (a specific DTD, document type description) for limitless different types of documents; XML is a "content-oriented" markup tool. Basically, the syntactic structure of XML is very simple. Its markup elements are normally identified by an opening and a closing tag, like <**employees**> and </**employees**>, and may contain other elements or text; the elements must be properly nested and every XML document must have exactly one root element. Markup elements can be specialized by adding attribute/value pairs inside the opening tag of the element, like <**person name**="**Jane**">; taking into account the nesting constraint, a very simple fragment of XML document could then be represented as: "<**employees**> <**person name**="**Jane**"> <**id**>99276</**id**> </**person**> </**employees**>". To allow a computer inter-

*Figure 2. RDF statements represented in graph format*




preting correctly a fragment like this, it is necessary, however, to specify the semantics of the markup elements and tags used to make it; a simple way of doing this is to make use of a DTD. A DTD is a formal description in XML Declaration Syntax of a particular type of document: for example, a DTD may specify that every **person** markup element must have a **name** attribute, and that it can have an offspring element called **id** whose content must be text. There are many sorts of DTDs ready to be used in all kinds of areas (e.g., www.w3.org/QA/2002/04/valid-dtd-list.html#full) that can be downloaded and used freely: some of them are MathML (for mathematical expressions), Sync Multimedia Integration Language (SMIL), Chemical Markup Language (CML), Open Software Description (OSD), Electronic Data Interchange (EDI) , Platform for Internet Content Selection (PICS), and so forth. A more complete way of specifying the semantics of a set of XML markup elements is to make use of XML Schema (as mentioned in Figure 1): XML Schema (Thompson, Beech, Maloney, & Mendelsohn, 2001; Biron & Malhotra, 2001) supplies a more complete grammar for specifying the structure of the elements allowing, for example, to define the cardinality of the offspring elements, default values, and so forth.

## MAIN FOCUS OF THE ARTICLE: RDF AND OWL

Moving up in the structure of Figure 1, we find now Resource Description Framework (RDF), an example of "metadata" language (metadata = data about data) used to describe generic "things" ("resources," according to the RDF jargon) on the Web. An RDF document is basically a list of statements under the form of triples having the classical format: <**object, property, value**>, where the elements of the triples can be Universal Resource Identifiers (URIs), literals (mainly, free text), and variables. To follow a well-known RDF example (Manola & Miller, 2004), let us suppose we want to represent a situation where someone named John Smith has created a particular Web page. We will then make use of the RDF triple: <**http://www.example.org/index.html** (*object*), **creator** (*property*), **john_smith** (*value*)**>**. Adding additional information about the situation, by stating, for example, that the Web page was created October 20, 2004, and that the language in which the page is written is English, amounts to add two additional statements: <**http://www.example.org/index.html** (*object*), **creation_date** (*property*), **October 20, 2004** (*value*)> and **<http://www.example.org/index.html** (*object*), **language** (*property*), **English** (*value*)**>**. Note that RDF uses a particular terminology for denoting the three elements of the triples, calling then "subject," "predicate," and "object," respectively, the "object," "property," and "value" elements of the triples; this decision is really questionable because it introduces an undue confusion with well-defined and totally different linguistic categories.

RDF triples can be represented as directed labeled graphs, by denoting resources as ovals, properties (predicates) as arrows, and literal values like **October 20, 2004** or **English** within boxes. Figure 2a represents under graph form the original statement: "John Smith has created a Web page"; the addition of information about date and