# Chapter 9
# Semantic Web–Linked Data and Libraries

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## ABSTRACT

*The present society is considered an information society. A society where the creation, distribution, use, integration, and manipulation of digital information have become the most significant activity in all aspects. Information is producing from every sector of any society, which has resulted in an information explosion. Modern technologies are also having a huge impact. So managing this voluminous information is really a tough job. Again WWW has opened the door to connect anyone or anything within a fraction of a second. This study discussed the Semantic Web and linked data technologies and their effect and application to libraries for the handling of various types of resources.*

## INTRODUCTION

The modern world is the information-centric world. The central development of a society is based on how much information it has.This is no new concept. Since the ancient period, the upper-class people used to keep the information very secret to them only. But after developing new technologies, getting information is very easy job now. Presently people have become accustomed to digital information. In the beginning, digital resources are available through computers only. The WWW has opened the doors towards anything or to reach anybody with just a single click. The revolution brings new channels such as tabs, mobile apps as well as various new web technologies like; markup languages, programming languages, web servers, databases, web versions etc. are giving more opportunity to access more resources. Again, the interlinking between the similar concepts and presenting it through the AI (artificial intelligence) technique is making the web world more dynamic.

Libraries are becoming the information centres where resources are not limited inside the library only. These technologies have affected to overall housekeeping works in libraries, especially the procurement of document types has extended to electronic and digitised materials. Managing these materials is also

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becoming more challenging day by day. These technologies are the perfect solution to those challenges. MARC, ISBD, WebOPAC, Dublin Core, Union Catalogue, OAI-PMH etc. are the common technologies libraries are using for storing, managing, retrieval and disseminating the various resources to serve its users.

## OBJECTIVES OF THE STUDY

The followings are the core objectives of this study to aware of

- The semantic web and linked data in brief.
- Why, when and how the web and linked data became the semantic web and linked open data.
- Components of the semantic web and linked data; its framework, standards, languages etc.
- The architecture of the web of stack of the semantic web.
- The advantages and disadvantages of the semantic web and linked data.
- The application of semantic web and linked data in the LIS field.

## COVERAGE OF THE STUDY

The semantic web and linked data technology are completely a part of the WWW which belongs to the computer science and communication engineering discipline. Library professionals got a huge benefit as the traditional libraries are moving towards digital environments. This study is limited to the concept, architecture, required standards, required languages, and some related concepts, advantages & disadvantages and applications of semantic web and linked data only in the field of library & information science and library professionals to impede the lengthiness and expansion.

## LITERATURE REVIEW

A lot of studies were done on the semantic web, linked data and its application in libraries. Some of them are highlighted here. Bakshi and Karger (2005) illustrated the tools built into the Haystack information management from the semantic web. Horrocks (2008) stated the process of RDF and OWL as the standard format for sharing and integration of information and knowledge. The general introduction to some ontology languages and its role in the semantic web (Antoniou et al., 2005). Bizer et al. (2009) refer to the concepts and principles of linked data and situate these within the broader context of related technological developments. Bizer et al. (2008) outlined the technical context in which linked data is situated and the development in the past years through initiatives. The possibilities of representing the most prevalent form of MARC, MARC21 as RDF for the Semantic web (Styles & Ayers, n.d.). Macgregor (2009) illustrated the application of semantic web and related technology to discover a variety of e-resources.

Gonzales (2014) stated the possible framework that will connect the library resources to the web and make them accessible to the mass readers. Halla (2013) elaborated the linked data based cataloguing as well as to overcome the drawback of MARC-based cataloguing. Baker (2012) described the issues

around the Dublin Core and to ensure that library data meet traditional standards for quality consistency and interoperable to other data sources in the linked data environment. Yadagiri and Ramesh (2013) discussed the concept of the semantic web and its related components and its benefits to library functions for providing effective library services. Hallo et al. (2014) pointed out the process to publish library metadata on the web using linked data technologies. Schilling (2011) expressed the relation and future of the library metadata and linked data.

## METHODOLOGY

Descriptive methods of research have been followed here. Starting with a concept followed by the objectives and the scope of the study were demarcated. A review of the related literature has been done then. A brief discussion, need for these technologies so far with a history of these concepts, technology requirement, standards, languages, syntax, semantics etc., the advantages and disadvantages, some related concepts and the application of these technologies in the field of LIS was discussed. The conclusion was drawn based on the cases studied here.

## SEMANTIC WEB

Before getting in touch with the semantic web, it is required to know well about the web. The semantic web is the extension of the web. It is a space, where any information can be shared worldwide. The English scientist Tim Berners-Lee invented this in 1990 to share information all over the world. Initially, it is written in HTML and published text information only through the internet by providing a unique locator ID for retrieval. Later it also started sharing images, videos and other file formats with various hyperlinks for connecting and go through the related information. It works via a data transfer protocol like HTTP through which data were transmitted to the end-user. As technology grows, the web has been grown to the semantic web to provide better access and reuse to the resources.The semantic web is a technology that represents information about some data which is interlinked to some related concepts in respect to the data (Bakshi & Karger, 2005).

## LINKED DATA

Linked data is a method, by which some data are interlinked to each other in the web for providing a better answer to the search queries through browsers. This technology builds with the help of web technologies. In the beginning, the web provides the document search. One can retrieve the documents on the web according to the person's query. But after developing the linking technology, users can retrieve related data from the query instead of documents and with the search results, some interlinks also appeared by which users can look over some related concepts to their area of interests (Campbell, Lorna & MacNeill, 2010).

## NEED FOR THESE TECHNOLOGIES

HTML facilitates the hyperlink method of connecting other pages on the web, it is necessary to develop a method through which users can retrieve the relevant data/information instead of relevant documents. According to the user's demand, the concept of 'web of documents' and the 'web of data' came out. The web of document method is the result of the traditional web search which can retrieve related documents from a particular search query. But the web of data is the result of modern hyperlink data structure method which can retrieve the particular data/ information with some hyperlinks to some other data/ information related to the query.

*Figure 1. Web of document*
*(Adapted from. [Sabou, 2016])*

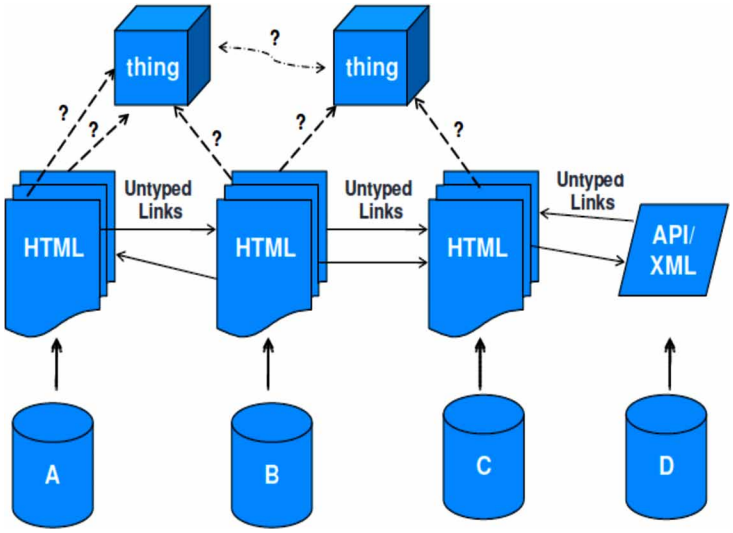
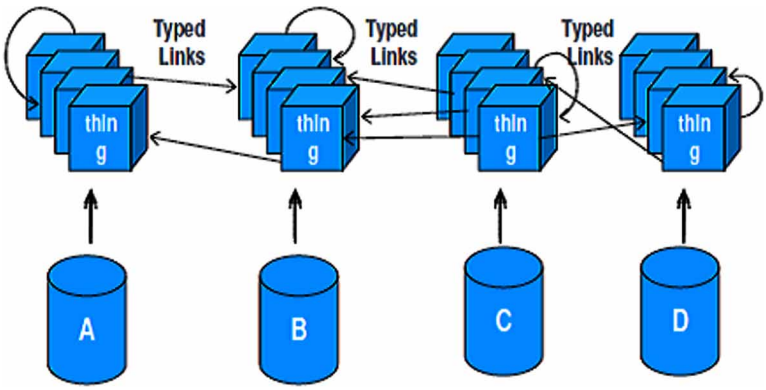



*Figure 2. Web of data*
*(Adapted from. [Sabou, 2016])*



As figure 1&2 show the differences, the web of document can access a particular content through two or more context. The context(s) are connected to some other context(s) so, it might possible that some irrelevant documents may retrieve. But in the web of data, the contents are connected to the related contents. So users can have a look at the related contents only when they want to, without any irrelevant interrupt.

## BACKGROUND OF SEMANTIC WEB AND LINKED DATA

In 1990 the WWW was developed by Tim Berners-Lee, for sharing resources through the Internet (Berners-Lee, Handler& Lassila, 2001). The semantic network model was formed in far back in the 1960s by one scientist Allan M. Collins, one linguist M. Ross Quillian and one psychologist Elizabeth F. Loftus to represent the relationships between concepts. After four decades, Tim Berners-Lee applied this concept to the modern Internet and coined the term World Wide Web where interlinks between the related concepts through metadata has built up to create, upload and share of resources.

The concept of linked data came in 2006 by Tim Berners-Lee as to interlink data between different sources. The term linked data is also coined by Lee. Later on, the web of data concept came in 2007 from the linked open data project, supported by the W3C working group for aiming to make available and interlink the datasets on the web under an open license.

## THE SEMANTIC WEB TECHNOLOGY

The semantic web is the collaborative movement by which structured and semi-structured data are converted into a structured web data. In the beginning, the internet is used to hyperlink the documents in academic and industry both for interconnect more and more pages for accessing from multiple points. The user interaction in websites through content management system expands the web into a dynamic level. It works through some standards to organise and make the semantic web possible.

- **Components of the SemanticWeb:** The followings are the components (Yadagiri & Ramesh, 2013) of the semantic web, by applying these the goals of the semantic web will be achieved-
  - **World Wide Web Consortium-** the W3C is the organisation of maintaining the standards for the web founded by Tim Berners-Lee after 1994 at the MIT lab in support with the European Commission and DARPA. It is the open web platform for interacting with the users through any device. It enables the users to create data stores on the web, build vocabularies and write rules for handling data.
  - **Resource Description Framework-** the RDF is a graph-shaped metadata data model belongs from the W3C family and is designed on the base of the entity-relationship concept. This is a descriptive model of information applied to describe the web resources to express the subject-predicate-object concept. It came to light in 2004 under the recommendation of W3C.
  - **Resource Description Framework Schema-** RDFS is a language that used to describe the vocabulary in the RDF graph. It is also used to define the resource type or classes through

some properties. It is a type of ontology definition language. This language was first released in 2004 by W3C recommendations.

- **Simple Knowledge Organisation System-** SKOS is a data model which represents the knowledge organisation system like classification scheme, subject heading list, thesauri or any other type of structured controlled vocabulary in a machine-readable format. This model type is defined in ontology language and expressed and encoded through RDF syntax. It is supported by W3C recommendations and was first appeared during 2004-05.
- **Standard Protocol and RDF Query Language-**it is a graph matching or semantic query language that used to retrieve and manipulate data stored in RDF structure on the web. The W3C recognised as a standard language and the key technology for the semantic web in 2008.
- **Web Ontology Language-** OWL is a standard for encoding and exchanging ontologies and is designed to support the semantic web. OWL came to light in 2004 by margins of DAML and OIL. It is built upon RDF standard and is the concept of providing information in explicit meaning for better understanding and process of information on the web.
- **Notation3-** N3 is a non-XML serialisation of RDF model developed by Tim Berners-Lee in 2008. It is more compact than RDF notation.
- **N-triples-** N-triples is a format for RDF graphs for storing and transmitting data in a line-based plain text serialisation format. It is the subset of Turtle and developed by Dave Beckett under W3C.
- **Turtle-**it is an RDF model format for presenting data with a SPARQL syntax. It is the subset of N3 and superset of N-triples and developed by Dave Beckett under W3C.

- **Semantic Web Stack:** The semantic web stack illustrates the layered architecture of the semantic web. The stack was created by Lee (figure 3). It is based on the hierarchy of languages and each language exploiting the features and extending the capabilities of the layers.

*Figure 3. Lee's web stack*
*(Adapted from [Horrocks, 2008])*

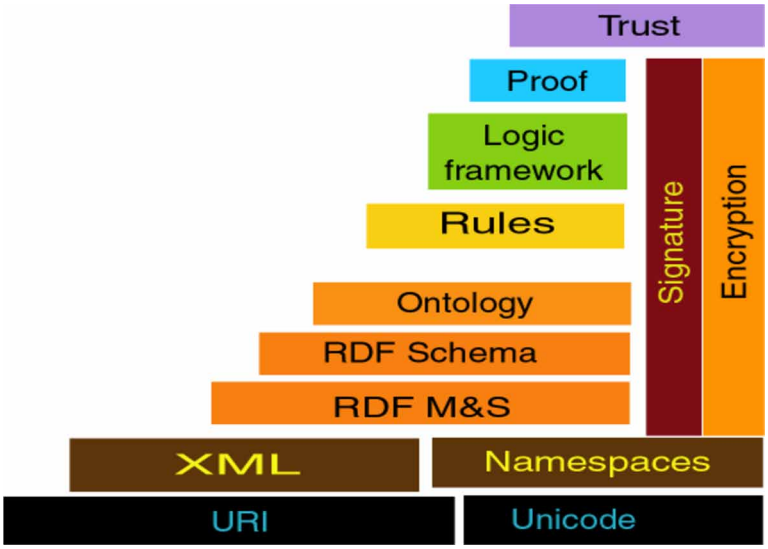
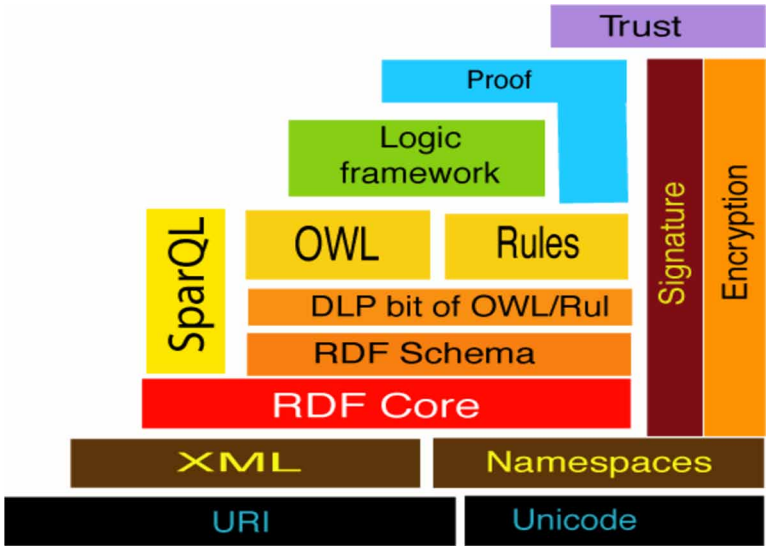


*Figure 4. Modern web stack*
*(Adapted from [Horrocks, 2008])*




The modern web stack (figure 4) layer unstained with OWL and attention has turned towards the rules layer and language.

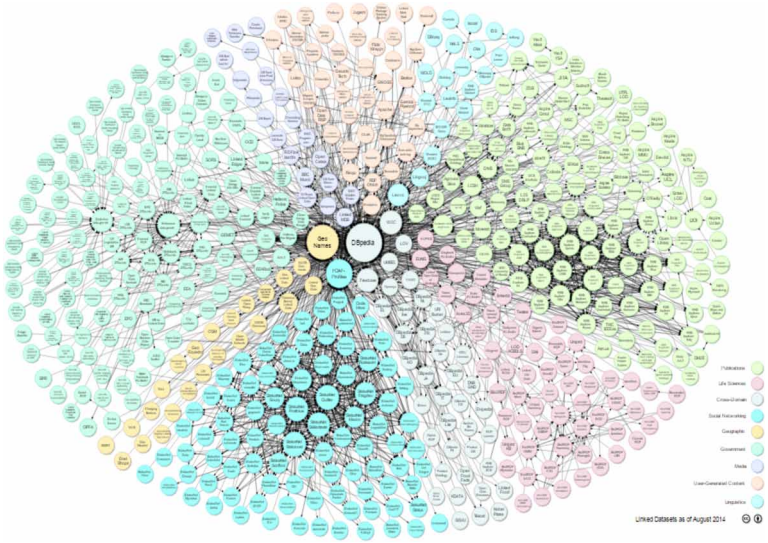
- **Advantages of the SemanticWeb:** The followings are some advantages of the semantic web-
  - It would understand users need and interest and organise every type of file format.
  - Search engines will ask questions about the user's query.
  - It wants feedback about users to search results and can calculate users past, present and potential future interest.
  - Users can publish classified ads for any products and the web will index it in their database.
  - If users publish any data, the web will integrate the data with their existing data.
  - Users can merge different data sources and create a new database without touching the original database.
  - Even in shopping and marketplace users can search any product with any specification in anywhere in the web.
- **Disadvantages of the SemanticWeb:** The followings are some disadvantages of the semantic web-
  - The WWW and the semantic web are not compatible with each other. The WWW is written in HTML and the semantic web is written in RDF.
  - The semantic web tools don't generally support the large-scale application and is vary from application to application.
  - The common ontologies are not easy to describe.

## THE LINKED DATA TECHNOLOGY

To make the semantic web a reality, voluminous data is to be presented in a manageable format to make available it. It is also needed to connect the related data. This interconnects of the data structure is called Linked Data. These links represent information through a web browser, after indexing the documents by the search engines and according to the search queries. In the conventional hyperlinks, the relationship of two documents wasn't able to describe an individual entity of the documents. As a limitation of the HTML, the global information system has evolved from the links of documents to the links of data.

- **Components of the Linked Data:** Berners-Lee has figured out four components (Coyle, 2012) of linked data, they are-
  - **Uniform Resource Identifier-** the URI is used to identify a document on the web, came into use in 1990. The uniform describes the unique identity of any resources on the web. The resource describes the various types of resources and the identifier distinguishes what to identify from a container. The syntax and semantics of URI are derived from the WWW concept which is designed to layout in Functional Recommendations for Uniform Resource Locator and Functional Requirments for Uniform Resource Names.
  - **Hypertext Transfer Protocol-** it is a TCP/IP-based application-level protocol used to deliver data on the web founded in 1990. It is a standardised method to communicate with each other through the computer system. It specifies and construct the search query from the end-user to the servers and returned according to the demand of the user. It is also can be used to the extension of its request methods, error codes and headers.
  - **Standards and Control Vocabulary-**it is the process of finding information using some standards of indexing the matter on the web using some control vocabularies as index terms and standards for running the web technologies like RDF, SPARQL, SKOS, OWL, N3, N-triples, Turtle etc.
  - **Include Link-**the links are made to other resources from one document for interlinking the same types of concepts and for discovering and use most of the related materials. This is the reuse of information value added by the web.
  - **Linked Open Data-** LOD is the latest addition to the components in linked data. LOD is a data which is available as a whole under open license and users can read, download, print or use it in any circumstances. Berners-Lee, the inventor of LOD specified it as the 5$^{th}$component of linked data. The LOD Project started in 2007, aiming to identify datasets which are available in open license and to republish the data in the RDF framework. From then the datasets has grown to huge amount RDF triples and links (figure 5).
- **Advantages of the Linked Data:** The followings are some of the advantages of linked data-
  - It is sharable, extensible and easily reusable according to need.
  - It supports multilingual functionality for data and user services.
  - Getting information with a variety of related links is available quickly.
  - Publishing and promoting information or products is just got easier.
  - It supports the retrieval and remixing the data to consistent access to all metadata providers.
  - No longer to input data in a manual format, it identifies the fields and input automatically.

*Figure 5. DB pedia datasets up to August 2014*
*(Adopted from. [http://lod-cloud.net])*




- **Disadvantages of Linked Data:** Several challenges may have to face both the users as well as developers while using linked data, these are-
  - Required regular update due to the information revolution as a huge amount of information is generating and changing regularly. Failed to which the links may not work properly.
  - Sometimes it may difficult to understand the concept. People may get confused about URL/ URI, open-world assumption, HTTP, syntax etc.
  - Keep the license agreement in mind and the terms of use of the materials at the time of reuse or publish it.

## SOME SIMILAR CONCEPTS RELATED TO SEMANTIC WEB & LINKED DATA

To make understand about the semantic web and linked data some closely related concepts needed to know about (Yadagiri & Ramesh, 2013), these are-

- **Hypertext Markup Language-** HTML is a rigid markup language which is used for displaying contents on the web through the browsers. Any materials or contents are written in a document editor in between the angle tags (<>), will be displayed in the browser. HTML first appeared in 1990 from the SGML as a standard stated by W3C.
- **eXtensible Markup Language-**XML is the extensible form of HTML. It provides fundamental structure and syntax for the contents of the web materials. It also has the capabilities of simplified data storage and sharing mechanism and was developed in 2009.
- **Microformats-**it processes the data of markup in the web page within HTML tagging. It may be written in a natural language or formatted displays of product information.

- **Web Ontology-** ontology describes the identity of anything in general terms. Web ontology is the structural framework for representing knowledge within a specific domain on the web. It uses machine-readable semantics to communicate between human and machine.
- **A Friend of a Friend-** it is an application initiated by RDF in 2000 for connecting people of the same interest level or group through links. It provides a rich vocabulary to describe the personal relationship. In another way, it may call the social semantic web within a network.

## APPLICATION OF SEMANTIC WEB AND LINKED DATA IN LIBRARIES

Nowadays libraries are turning mainly, one is in the form of anautomated library system and the second one is in the form of a digital library system due to the various applications of emerging technologies. In the automated system, library operations are set automatically through ILM software. The most important part of an ILMS is managing the library records or the databases. To manage this database or metadata especially in the form of a catalogue, a library uses various schemes from the early period. After the 1960s when different MARC formats were started using tags to describe the metadata of the documents, the storage and retrieval of information got easier and much faster. The syntax may fix here but the semantics of the tags vary from item to item and represent the full bibliographic details of any documents.

As time passes, the web becomes semantic. The MARC tags were also becoming backdated. Though at present, almost every library uses MARC formats as standard for describing the metadata but in modern society, with new technologies it's becoming difficult to describe everything through MARC due to the rising of various file formats. Sometimes MARC failed to express the digital content details as local variation changes the consistency (Halla, 2013). It can't specify the relationship between entities or the hierarchical relationship of entities as it is a document-centric format for description.

So, as a drawback of MARC families, a new concept came alternatively i.e. FRBR then RDA and BIBFRAME (Gonzales, 2014). This technology changes the presentation architecture of data. FRBR is the entity-relationship model which represents the core relationship and navigates the hierarchical relationship of entities and provides also links to other materials. RDA is the guideline to formulate the bibliographic data. The BIBFRAME is the new data model concept replaced to MARC. It is designed to describe bibliographic information using linked data to integrate with the wider web of data. So far the web becomes semantic by representing data from HTML to XML; likewise, libraries represent the resource elements through Dublin Core metadata schema. The modern web OPAC not only retrieves the particular metadata but also retrieve the related data by the help of DC elements. Various web-based services like documentation, bibliographic, reference, referral etc. were given very easily.

Again the digital library architecture is not limited to the metadata only. It is an archive which provides the document itself for use and reuse of the resource(s). The linked open data facilitates full access to the resource(s) so far. Consortia are the best and popular example for open data. Import-export of data is another great example. OAI-PMH facilitates to handle the data migration for both LMS and digital archive. It is needed to establish ontologies for describing the specific objects. It also should be interoperable for easy access constantly and coherently. SEKT project has guided that a digital interface should redirect to other archives for accessing different type of resources for the same purpose (Sure, & Studer, 2005). It can be understood better with some of the worldwide case studies of the application of these technologies.

1. **Case Study:** 1
    a. **The OCLC**- OCLC is using linked data for several years and for several purposes. The first example is WorldCat service. It is a global cooperative catalogue service, which collects bibliographic details from libraries, incorporates into their database, and shares publically. The different objects that represent the different entities like the author, subject, work, place, publisher etc. are presented through standard ontologies and linked through other/ similar data in the database.

The Dewey service is another example. It provides the full bibliographic details of the document. The search entities are ISBN, title, author and subject heading. The links are mainly created by the author and the subject headings and recorded as virtual authority links, which also retrieve the other/ similar works.

Virtual International Authority File (VIAF) is the authority file deals with the various library authority files and combines and linked together for a single interface. It mainly deals with 'see' and 'see also' records and directed to the original records.

The Faceted Application of Subject Terminology (FAST) is another example. It is derived from Library of Congress Subject Headings (LCSH) and used both in WorldCat and Dewey services of OCLC. It uses very rich vocabulary for creating headings to control and maintain the uniformity/ standard and headings are interlinked to each other (OCLC, n. d.).

    b. **The LC**- Likewise the OCLC datasets, LC (Library of Congress) has also several datasets. The LC subject headings used by the co-operative libraries around the United States for sharing and linking up their database to others. The authority file (Name Authority File) provides several authoritative data of several entities like the place, person, title etc. Names are maintained through controlled forms. The LC classification scheme is also adopted for used in other libraries and most widely used classification in the world. The MARC relator codes through vocabularies and serves the identifier (The Library of Congress, n. d.).
    c. **The Wikipedia-** A tremendous example of both semantic web and linked data is Wikipedia. It is the largest and most popular in general reference work on the internet. It consists of more than 40 million articles in more than 250 different languages (as on Feb 2014) and almost all articles are editable and usable in any manner. The inter-links between the articles make it more dynamic and one of the top ten most usable website in the world (Wikipedia, 2017).

2. **Case Study:** 2
    a. **The NDL, India**- The National Digital Library under the Ministry of Human Resource Development, Govt. of India is an excellent example. It is the national archive in a single interface full of interlinks to the various repository sites in India. NDL harvest the metadata from those sites and create the links, and by clicking on those links it redirected to the particular sites/ resource(s) (Rahaman, Jana & Roy, 2017). They have also followed certain vocabularies for indexing and search-retrieval.
    b. **The West Bengal Public Library Network**- It is a library network of West Bengal state in India which contains full of resource(s)/ interlinks to all types of user and necessary for the public for fully open. It provides links to various types of libraries in Web Bengal, library circulars, the library acts, digital rare books, the library catalogue, community information services etc. (The West Bengal Public Library Network, n. d.).

3. **Case Study:** 3
    a. **The Library Services**- In the present day, libraries are providing various types of new services. Web-based services are one of the important of them (Rahaman, Jana & Roy, 2017). Through the second and third generation of web (web 2.0 and 3.0) libraries are providing services like- Union catalogue (which represents a combined interface for retrieving resources from two or more libraries), Resource sharing/ Interlibrary loan (a loan facility of resources by a patron from other libraries if it is not available in the present library or vice versa), Discovery services (a single interface of retrieving any resources acquired by the library holding in any medium), Blogs (it is a service for providing the latest updates about the library with both side interaction), RSS (a feed for tracking of new contents from any site), Social sharing (by sharing options one can share/ recommend resources to individual/ group/ organisation), Tagging (tag a term in a search result for using later), Creating list (a list of reading materials for use in future both for staff and user and also can be shared with others), Useful links to other resources/ organisation (may be open/ closed), Ratings (it is a method of like or dislike any resource(s) and can also be used as a review for the same) etc.

These services are using various standards for storing-retrieving, fetching-harvesting, indexing, folksonomy, interlinks for making those resources usable worldwide. The semantics and linking technologies are used not only to retrieve the required resources but the similar resources also related to the searched item.

## CONCLUSION

The goals of a library and these technologies are almost the same, to store and manage information in a well-structured meaning and provide it to the mass, through quick retrieval mechanics and relevant as fast as possible.These technologies are not limited to online but offline also. Library in-house operation tools are also providing search history facilities. Discovery tools are providing search facilities from all content holders over a single interface. Just like union catalogue online bibliographies, thesaurus, encyclopaedias are also using web ontologies. Now the web 2.0 technologies are used in and as library 2.0 which facilitates regular updated and evaluated multidimensional library services by using the same mechanism. It focuses on the user need and not limited to one-way service but also provide a facility for feedback and interaction. The next generation of web and library 3.0 is nearby and based on the concept of man-machine interaction and open protocols.

Library professionals come in handy to semantic web and linked data to provide effective library services. As the professionals stand between the user and information as a gatekeeper, they should bring them together. The implementation of library portals through semantic web and interlinks with various resources will fulfil the vision of the libraries. The semantic library portal should have automated interaction with a search engine combined with web ontologies, and the content is tagged with information. The adoption and implementation of technologies will enable ontology-facilitated sharing and reuse of learning resources. Such a portal will allow the library to provide the best services.

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## REFERENCES

Antoniou, G., Franconi, E. & Harmelen, F. V. (2005). Introduction to semantic web ontology languages. *Reasoning Web*, 1–21. doi:10.1007/11526988_1

Baker, T. (2012). Libraries, languages of description, and linked data: A Dublin Core perspective. *Library Hi Tech*, *30*(1), 116–133. doi:10.1108/07378831211213256

Bakshi, K., & Karger, D. R. (2005). *Semantic web applications*. doi:10.1186/1471-2105-10-S10-S1

Berners-Lee, T., Handler, J. & Lassila, O. (2001). The semantic web. *Scientific American Magazine.*

Bizer, C. (2008). Linked data on the web. *WWW 2008 Workshop on Linked Data on the Web*, 1265–1266. 10.1145/1367497.1367760

Bizer, C., Heath, T., & Berners-Lee, T. (2009). Linked data: The story so far. *International Journal on Semantic Web and Information Systems*, *5*(3), 1–22. doi:10.4018/jswis.2009081901

Campbell, L. M., & MacNeill, S. (2010). The semantic web, linked and open data: a briefing paper. *World Wide Web Internet and Web Information System 6*. Retrieved from http://wiki.cetis.ac.uk/images/1/la/The_Semantic_Web.pdf

Coyle, K. (2012). Semantic web and linked data. *Library Technology Reports*, *48*(4), 10–14.

Gonzales, B. M. (2014). Linking libraries to the web : Linked data and the future of the bibliographic record. *Information Technology and Libraries*, *33*(4), 10–22. doi:10.6017/ital.v33i4.5631

Halla, M. L. (2013). Linked data in libraries: Library of Congress' Bibliographic Framework Transition Initiative. *Library Philosophy and Practice*, 1–23. Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2454&context=libphilprac

Hallo, M., Lujan-Mora, S., & Trujillo, J. (2014). Transforming library catalogs into linked data. *Proceedings of the 7th International Conference of Education Research Innovation*, 1845-1853.

Horrocks, I. (2008). Ontologies and the semantic web. *Communications of the ACM*, *51*(12), 58. doi:10.1145/1409360.1409377

Macgregor, G. (2009). E-resource management and the semantic web: applications of RDF for e-resource discovery. In The E-Resources Management Handbook, (1). doi:10.1629/9552448-0-3.20.1

OCLC. (n.d.). Linked Data . *OCLC.*

Rahaman, W., Jana, S., & Roy, S. (2017). Web-based library services in academic perspective: knowledge management with special reference to institutional repositories. In *UGC Sponcored National Seminar 2017: Towards knowledge society: problems and prospects.* Academic Press.

Sabou, M. (2016). An introduction to semantic web technologies. In *Semantic Web Technologies for Intelligent Engineering Applications,* (pp. 53-81). University of Toronto.

Schiling, V. (2011). *Transformaing library metadata into linked library data*. Retrieved from http://www.ala.org/alcts/resources/org/cat/research/linked-data

Styles, R. & Ayers, D. (n.d.). Semantic MARC. *MARC 21and the Semantic Web.*

Sure, Y., & Studer, R. (2005). Semantic web technologies for digital libraries. *Library Management*, *26*(4-5), 190–195. doi:10.1108/01435120510596044

The Library of Congress. (n.d.). Authorities and vocabularies (Library of Congress). *LC Linked Data Services*.

Yadagiri, N., & Ramesh, P. (2013). Semantic web and the libraries: an overview. *International Journal of Library Science, 7*(1), 80-94. Retrieve from http://www.ceser.in/ceserp/index.php/ijls/article/view/2989

## ADDITIONAL READING

W3C. (2018). *Linked Data*. Retrieved from https://www.w3.org/standards/semanticweb/data

Free File Format Definition. (n.d). Retrieved from http://www.linfo.org/free_file-format.html

Gradmann, S. (2004). Towards an Implementation Model for Library Catalogs Using Semantic Web Technology. *Cataloging & Classification Quarterly*, *39*(3-4), 63–75. doi:10.1300/J104v39n03_05

Group, O. K. (n.d.). Guide to Open Licensing. Retrieved from http://opendefinition.org/guide/

Hypertext Transfer Protocol – HTTP/1010 (n.d). Retrieved from https://tools.ietf.org/html/rfc2616#section-1.1

Kraftt, D. B. (2014). Why Linked Data? Retrieved from https://wiki.duraspace.org/plugins/servlet/mobile?contentld=43910411#content/view/43910411

Lapeyra, L. (2016). Introduction to the Semantic Web and Linked Data. *International Journal of Library Science Lecture in the Department of Library and Information Science and Audiovisual Communication*, University of Becelona. Retrieved from https://www.dlis.hypotheses.org/788

Macgregor, G. (2008). Digital libraries and the Semantic Web: Context, applications and research. *Library Review*, *57*(3), 173–177. doi:10.1108/00242530810865457

UCLA Library. (2018). *Semantic Web and Linked Data*. Retrieved from https://guides.library.ucla.edu/semantic-web/semantic_web_use_cases

## KEY TERMS AND DEFINITIONS

**HTTP:** Hypertext Transfer Protocol is an application based protocol for transforming of information through WWW. Through protocol can interchange information by text or media or can hyperlink to other resources/webpages.

**Linked Data:** It is an interlink technology between two or more documents of related thoughts. Now the links become an open license for most use of thought contents.

**MARC:** Machine Readable Cataloguing (MARC) is an online version of the traditional one. It is presented in the form of the Online Public Access Catalogue (OPAC) from a single library or a group of libraries (union catalogue). The records are presented through particular tags in a standardised format and can be exported/ imported through metadata harvesting say OAI-PMH.

**Markup Language:** It is the process of defining and presenting contents through the web in a syntactically distinguishable format. Hypertext Markup Language (HTML) is the first and basic markup language then eXtensible Markup Language (XML) came into existence as extended version.

**OWL:** Web Ontology Language is a mechanism to process the content of web information. It provides more machine interpretability than XML, RDF and RDF Schema by facilitating additional vocabulary with the existing semantics.

**RDF:** Resource Description Framework is a standard data model for the exchange of data over the internet. Basically, it is a method of describing or modelling the concept of data. A set of classes having certain properties to provide basic elements to describe those data is known as RDF Schema. The set of classes are called as vocabulary or ontology in the web language.

**SKOS:** Simple Knowledge Organisation System is standard to support and use of organising knowledge in a systematic frame like thesauri, classification scheme, subject heading system, taxonomies, etc.

**URI:** Uniform Resource Identifier predefined set of syntax rules which identifies a particular resource in the web. It also maintained extensibility through a separately defined hierarchical naming schema.

**W3C:** The World Wide Web Consortium is a web standard community to lead the web to its full potential and to run and maintain the web from a-z through standards.

**World Wide Web:** The World Wide Web or the web is a network of space where contents are available and accessible from any web-enabled device written in a particular language. The web is now transmitted to semantic web from document centric to data centric.

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