EVOLUTION OF THE WORLD WIDE WEB: FROM WEB 1.0 TO WEB 4.0

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ABSTRACT

The World Wide Web as the largest information construct has had much progress since its advent. This paper provides a background of the evolution of the web from web 1.0 to web 4.0. Web 1.0 as a web of information connections, Web 2.0 as a web of people connections, Web 3.0 as a web of knowledge connections and web 4.0 as a web of intelligence connections are described as four generations of the web in the paper.

KEYWORDS

Web 1.0, Web 2.0, Web 3.0, Web 4.0.

1. INTRODUCTION

The World Wide Web (commonly known as the web) is not synonymous with the internet but is the most prominent part of the internet that can be defined as a techno-social system to interact humans based on technological networks. The notion of the techno-social system refers to a system that enhances human cognition, communication, and co-operation; Cognition is the necessary prerequisite to communicate and the precondition to co-operate. In other words, co-operation needs communication and communication needs cognition [8].

Web is the largest transformable-information construct that its idea was introduced by Tim Burners-Lee in 1989 at first [1, 9]. Much progress has been made about the web and related technologies in the past two decades. Web 1.0 as a web of cognition, web 2.0 as a web of communication, web 3.0 as a web of co-operation and web 4.0 as a web of integration are introduced such as four generation of the web since the advent of the web.

Web 1.0 is the first generation of the web which according to Berners-Lee, could be considered the read-only web and also as a system of cognition [1]. Web 1.0 began as an information place for businesses to broadcast their information to people. The early web provided a limited user interactions or content contributions and only allowed to search the information and read it.

Web 2.0 was defined by Dale Dougherty in 2004 as a read-write web [7]. The technologies of web 2.0 allow assembling and managing large global crowds with common interests in social interactions. The differences between web 1.0 and web 2.0 are numerous that are described in the reminder of the paper.

Web 3.0 or semantic web desires to decrease human's tasks and decisions and leave them to machines by providing machine-readable contents on the web [12]. In General, web 3.0 is included two main platforms, semantic technologies and social computing environment. The semantic technologies represent open standards that can be applied on the top of the web. The social computing environment allows human-machine co-operations and organizing a large number of the social web communities [6].

Web 4.0 will be as a read-write-execution-concurrency web with intelligent interactions, but there is still no exact definition of it. Web 4.0 is also known as symbiotic web in which human mind and machines can interact in symbiosis.

1.1. Related Works

There is not any specific research about the web generations from the web advent in formal. Fuchs et al. in [8] outlined three qualities of the web based on an analytical distinction. Web 1.0 was introduced as a tool for thought, web 2.0 as a medium for communication between humans and web 3.0 as networked digital technology to support co-operation of humans. San Murugesan described web 2.0 as the second phase in the web's evolution in [10] in which technologies, services, development approaches and tools of web 2.0 were introduced in detail.

The main contribution of this paper is to provide a comprehensive overview of the evolution of the World Wide Web from web 1.0 to web 4.0. It compares characteristics and technologies of the web generations and tries to show progress of the web during past two decades.

1.2. Outline of the Paper

The paper is organized as follows: section 2 provides an overview of Web 1.0. Web 2.0 is described in section 3. Section 4 is about Web 3.0. Web 4.0 is described in Section 5. Finally section 6 provides conclusions.

2. WEB 1.0

In 1989, Tim Burners-Lee suggested creating a global hypertext space in which any network-accessible information would be referred to by a single Universal Document Identifier (UDI). The dream behind of the web was to create a common information space in which people communicate by sharing information [7].

Web 1.0 was mainly a read-only web. Web 1.0 was static and somewhat mono-directional. Businesses could provide catalogs or brochures to present their productions using the web and people could read them and contacted with the businesses. Actually, the catalogs and the brochures were similarly advertisements in newspapers and magazines and most owners of ecommerce websites employed shopping cart applications in different shapes and forms [6]. The websites included static HTML pages that updated infrequently. The main goal of the websites was to publish the information for anyone at any time and establish an online presence. The websites were not interactive and indeed were as brochure-ware. Users and visitors of the

websites could only visit the sites without any impacts or contributions and linking structure was too weak. Core protocols of web 1.0 were HTTP, HTML and URI.

3. WEB 2.0

The term web 2.0 was officially defined in 2004 by Dale Dougherty, vice-president of O'Reilly Media, in a conference brainstorming session between O'Reilly and MediaLive International [7]. Tim O'Reilly defines web 2.0 on his website[1] as follows:

"Web 2.0 is the business revolution in the computer industry caused by the move to the internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them."

Web 2.0 is also known the wisdom web, people-centric web, participative web, and read-write web. With reading as well as writing, the web could become bi-directional. Web 2.0 is a web as a platform where users can leave many of the controls they have be used to in web 1.0. In other words, the users of web 2.0 have more interaction with less control. Web 2.0 is not only a new version of web 1.0; Flexible web design, creative reuse, updates, collaborative content creation and modification were facilitated through web 2.0. One of outstanding features of web 2.0 is to support collaboration and to help gather collective intelligence rather web 1.0 [10]. Table 1 compare web 1.0 and web 2.0 in some features simplicity.

Table 1. A Comparison of web 1.0 and web 2.0

Web 1.0	Web 2.0
Reading	Reading/Writing
Companies	Communities
Client-Server	Peer to Peer
HTML, Portals	XML, RSS
Taxonomy	Tags
Owning	Sharing
IPOs	Trade sales
Netscape	Google
Web forms	Web applications
Screen scraping	APIs
Dialup	Broadband
Hardware costs	Bandwidth costs
Lectures	Conversation
Advertising	Word of mouth
Services sold over the web	Web services
Information portals	Platforms

The main technologies and services of web 2.0 are included blogs, really simple syndication (RSS), wikis, mashups, tags, folksonomy, and tag clouds that some of them described as follows in briefly:

- Blogs- The term weblog (or blog) was proposed by Jorn Barger in 1997. The blog is included the web pages called posts which published chronologically with the most

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[1] http://radar.oreilly.com/archives/2006/12/web-20-compact-definition-tryi.html

recent first, in journal style. Visitors of the blogs can add a comment below a blog entry. Most blogs are textual and but there are other sorts such as photoblogs or photologs, videoblogs or vlogs and podcasts [9, 10].

Posts of blogs can be tagged with keywords in order to categorize the subjects of the posts. For instance when the post becomes old, it can be filed into a standard, theme-based menu system. Linking is another important aspect of blogging. Linking deepens on the conversational nature of the blogosphere and its sense of immediacy and helps to facilitate retrieval and to reference information on different blogs [9].

- Really Simple Syndication - RSS is a family of web feed formats used for syndicating content from blogs or web pages. RSS is an XML file that summarizes information items and links to the information sources. Using RSS, users are informed of updates of the blogs or web sites which they're interested in. Atom is another syndication specification aimed at resolving issues of multiple incompatible RSS versions [10].

- Wikis- A wiki is a web page (or set of web pages) that can be easily edited by anyone who is allowed access. Unlike blogs, previous versions of wikis can be examined by a history function and can be restored by a rollback function. Wiki features are included: wiki markup language, simple site structure and navigation, simple template, supporting of multiple users, built-in search feature and simple workflow [9, 10].

- Mashups- Web mashup is a web page (or web site) that combines information and services from multiple sources on the web. Mashups can be grouped into seven categories: mapping, search, mobile, messaging, sports, shopping, and movies. More than 40 percent of mashups are mapping mashups. It is easier and quicker to create mashups than to code applications from scratch in traditional ways; this capability is one of most valuable features of web 2.0. Mashups are generally created using application programming interfaces [29].

Several development tools are available to create blogs, wikis, mashups, and social networks. These tools, such as mashup tools, wiki engines, blog software, make adoption of web 2.0 easier, quicker, and cheaper. Developers use three basic development approaches to create applications of web 2.0: Asynchronous JavaScript and XML (AJAX), Flex, and the Google Web Toolkit [10].

- Asynchronous JavaScript and XML- AJAX is a web development approach that used for development of most interactive websites by retrieving small amount of data from web server and display it on the web application without reloading the whole page [13]. AJAX is included several technologies: XHTML or HTML, cascading style sheets (CSS), JavaScript and XML [10].

- Flex- Adobe Flex is a software development kit (SDK) to create and deliver cross-platform rich internet applications (RIAs) on the web [10]. Flex is based on Flash and supports common design patterns by providing a programming language.

- Google Web Toolkit- GWT is an open source Java development framework that makes creating AJAX applications easy. It allows to web developers debug AJAX applications in the Java language using the Java development tools of their choice. GMT provides a complier and a special web browser that help developers to debug the GWT applications [10].

4. WEB 3.0

John Markoff of the New York Times suggested web 3.0 as third generation of the web in 2006 [14]. The basic idea of web 3.0 is to define structure data and link them in order to more effective discovery, automation, integration, and reuse across various applications [5].Web 3.0 tries to link, integrate, and analyze data from various data sets to obtain new information stream; It is able to improve data management, support accessibility of mobile internet, simulate creativity and innovation, encourage factor of globalization phenomena, enhance customers' satisfaction and help to organize collaboration in social web.

Web 3.0 is also known as semantic web. Semantic web was thought up by Tim Berners-Lee, inventor of the World Wide Web. There is a dedicated team at the World Wide Web consortium (W3C) working to improve, extend and standardize the system, languages, publications and tools have already been developed [4]. Semantic web is a web that can demonstrate things in the approach which computer can understand. The main important purpose of semantic web is to make the web readable by machines and not only by humans.

The current web is a web of documents, in some ways like a global file system that the most important problems about it are included: The web of documents was designed for human consumption in which primary objects are documents and links are between documents (or parts of them). Semantics of content and links are implicit and the degree of structure between objects is fairly low [2, 15, 16]. Figure 1 represents the structure of web of documents in simple [15].
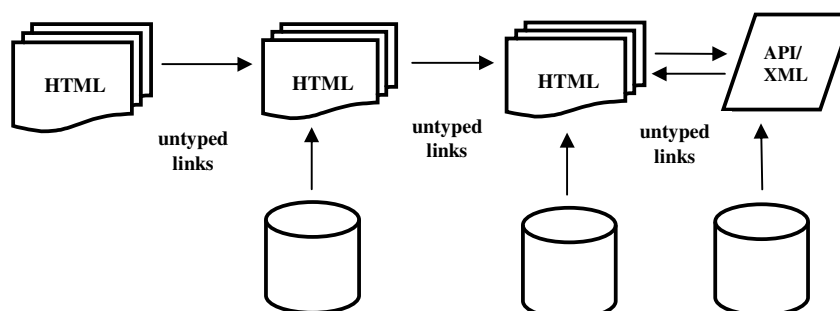

Figure 1. Web of Documents

Semantic web is being to be developed to overcome the problems of current web. Semantic Web can be defined a web of data, in some ways like a global database that most its features are included: The aim of design web of data is machines first, humans later. Primary objects are things so links are between things. Semantics of content and links are explicit and the degree of structure between objects is high based on RDF model [2, 15, 16]. In Figure 2, the structure of web of data is shown simplicity [15].
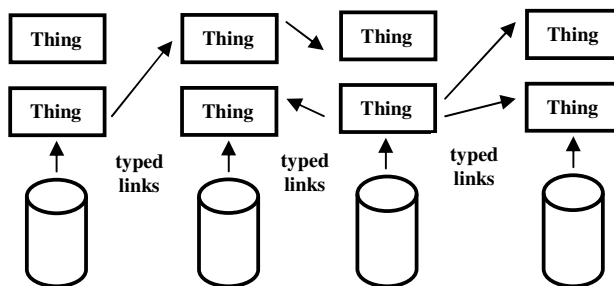
Figure 2. Web of Data

The main difference between web 2.0 and web 3.0 is that web 2.0 targets on content creativity of users and producers while web 3.0 targets on linked data sets. Table 2 compares some differences between web 2.0 and web 3.0.

Table 2. A Comparison of web 2.0 and web 3.0

Web 2.0	Web 3.0
Read/Write Web	Portable Personal Web
Communities	Individuals
Sharing Content	Consolidating Dynamic Content
Blogs	Lifestream
AJAX	RDF
Wikipedia, google	Dbpedia, igoogle
Tagging	User engagement

Tim Berners-Lee proposed a layered architecture for semantic web that often represented using a diagram, with many variations since. Figure 3 gives a typical representation of this diagram [11].
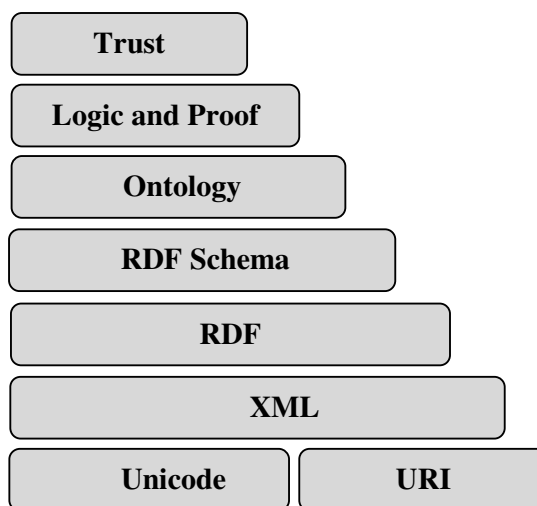

Figure 3. Semantic Web layered architecture

The layers of the semantic web architecture are briefly described as follows:

- Unicode and URI: Unicode is used to represent of any character uniquely whatever this character was written by any language and Uniform Resource Identifier (URI) are unique identifiers for resources of all types [17, 18, 22]. The functionality of Unicode and URI could be described as the provision of a unique identification mechanism within the language stack for the semantic web [19].

- Extensible Markup Language: XML and its related standards, such as namespaces (NS), and schemas are used to form a common means to structure data on the web without any communication between the meanings of the data. XML is used as a base syntax for other technologies developed for the upper layers of the semantic web. NS is used to identify and distinguish different XML elements of different vocabularies. It supports mixing of different elements from various vocabularies to do a specific function. XML schema assures that the received information is according to the sent information when two applications at this level exchange information with together [22].

- Resource Description Framework: RDF is a simple data model that uses URIs to identify web-based resources and describes relationships between the resources in terms of named properties and values. Generally, the RDF family supports interoperability at the semantic level. RDF developments consist of the base web language, so that agents are able to make logical inferences to perform functions based on metadata.

- RDF Schema: provides a predefined, basic type system for RDF models. It describes classes and properties of the resources in the basic RDF model. RDF Schema provides a simple reasoning framework to infer types of resources.

- Ontology: The ontology layer described properties and the relation between properties and different. Ontology can be defined as a collection of terms used to describe a specific domain with the ability of inference.

- Logic and Proof: This layer is on top of the ontology structure to make new inferences by an automatic reasoning system. The agents are able to make deductions as to whether particular resources satisfy their requirements by using such the reasoning systems [11].

- Trust: The last layer of the stack addresses trust in order to provide an assurance of quality of the information on the web and a degree of confidence in the resource providing this information.

Semantic web is not limited to publish data on the web; it is about making links to connect related data. Berners-Lee introduced a set of rules have become known as the Linked Data principles to publish and connect data on the web in 2007 [2]:

1. Use URIs as names for things

2. Use HTTP URIs to look up those names

3. Provide useful information, using the standards (RDF, SPARQL) by look up a URI

4. Include links to other URIs to discover more things

Data providers can add their data to a single global data space by publishing data on the web according to the Linked Data principles.

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5. WEB 4.0

Web 4.0 is still an underground idea in progress and there is no exact definition of how it would be. Web 4.0 is also known as symbiotic web. The dream behind of the symbiotic web is interaction between humans and machines in symbiosis. It will be possible to build more powerful interfaces such as mind controlled interfaces using web 4.0. In simple words, machines would be clever on reading the contents of the web, and react in the form of executing and deciding what to execute first to load the websites fast with superior quality and performance and build more commanding interfaces [21].

Web 4.0 will be the read-write-execution-concurrency web. It achieves a critical mass of participation in online networks that deliver global transparency, governance, distribution, participation, collaboration into key communities such as industry, political, social and other communities [27]. Web 4.0 or webOS will be such as a middleware in which will start functioning like an operating system [23]. The webOS will be parallel to the human brain and implies a massive web of highly intelligent interactions [25].

Although there is no exact idea about web 4.0 and its technologies, but it is obvious that the web is moving toward using artificial intelligence to become as an intelligent web.

6. CONCLUSIONS

This paper provided an overview from the evolution of the web. Web 1.0, web 2.0, web 3.0 and web 4.0 were described as four generations of the web. The characteristics of the generations are introduced and compared. It is concluded web as an information space has had much progress since 1989 and it is moving toward using artificial intelligent techniques to be as a massive web of highly intelligent interactions in close future. Future work on this paper will focus on the deeper and broader research about the semantic web and its issues.

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