

An Overview and Differentiation of the Evolutionary Steps of the Web X.Y Movement: The Web Before and Beyond 2.0

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ABSTRACT

Web 2.0 is a popular term used to describe a class of Web applications that offers mostly free services to its users. However, an exact definition of the concepts, features, and technologies that argue for a Web 2.0 service is still missing. Similarly, terms such as Web 3.0, Web 4.0, or Web 2.5 also have no clear and unambiguous definitions. This chapter reports the results of a Web and literature survey about Web X.Y concepts. Based on several definitions, we synthesized new definitions for Web X.Y, which provide an overview and can be used for differentiation, and we classified contemporary Web services (e.g., Flickr) according to these definitions.

KEYWORDS

Web X.Y evolutionary stages, Web 0.5, Web 1.0, Web 1.5, Web 2.0, Web 2.5, Web 3.0, Web 3.5, Web 4.0, Web X.Y definitions, Web X.Y services classification

INTRODUCTION

The World Wide Web (WWW) has been through many changes since its beginnings and has become the largest information platform worldwide. When Tim Berners-Lee published his ideas for hypertext in 1989, he could not have guessed how he would change our lives. Due to technical progress made since then, its use has become more and more intuitive and users can provide their own content for public use more and more easily. Similarly, when O'Reilly Media coined the term "Web 2.0" in 2004, they combined a set of concepts under one notion. In addition, version numbers can be used to differentiate evolutionary steps of the Web, as it is common practice with software systems.

The term "Web 2.0" – and it seems that the same will happen with "Web 3.0" – has often been abused as a marketing term over the years. Many people used it as a buzzword without knowing that it does not only constitute a particular technology, e.g., AJAX, but refers to other concepts and features. Therefore, there exist a lot of different perceptions of Web 2.0 (or Web X.Y in general).

This chapter aims at clarifying what Web 2.0 (Web X.Y) is, and what it is not. It goes into detail regarding the concepts (e.g., collaboration or mashups), features (e.g., tagging or microformats), technologies (e.g., AJAX or Flex), tools (e.g., Wikis or blogs) and services (e.g., Flickr¹ or MySpace²) of Web 2.0. Based on a literature and Web survey, we present an overview of the evolution of the Web before and beyond it. We summarize existing Web X.Y definitions and derive new comprehensive definitions from these findings. However, the main focus lies on the classification of Web X.Y, including definitions with differentiating and common factors.

In summary, this chapter provides a categorization of evolutionary Web steps that makes it possible to assign Web applications and services, as well as principles and concepts, to a particular Web step.

DESIGN OF THE SURVEY

Today, the term Web 2.0 is omnipresent. In March 2008, Google Blog Search³ delivered over 10 million blog entries, Del.icio.us⁴ listed over 400,000 tagged bookmarks, and Amazon⁵ stocked over 1,700 related books. However, the ACM Digital Library⁶ returned only 337 scientific publications dealing with Web 2.0, which indicates that there exists only little research in this area. Furthermore, because many user groups have gotten in touch with Web 2.0 in many different ways, there exist many diverse perceptions of what Web 2.0 is all about. The disagreement is even greater regarding the meaning of Web 2.5, 3.0, 3.5, or 4.0.

Thus, our main research objective was to identify the commonalities and variabilities of definitions for Web X.Y. Based on the available body of knowledge in the form of blog entries, scientific publications, and books, we elicited which concepts, definitions, technologies, and services are used.

Research Method

In order to systematically conduct the review, we roughly based the research method on the systematic literature review process synthesized by Kitchenham (2004). The following phases were conducted to realize this literature review. Besides identifying the need for a systematic literature review, the following steps were performed:

- *Background research*: Initial scoping survey to identify search terms for Web X.Y. While this is not a step defined by Kitchenham (2004), we performed it to retrieve as many search terms as possible within a short period of time (approx. 2 weeks).
- *Review planning*: Specification of the research question, required data, and search terms, as well as identification of search engines (i.e., data sources).
- *Identification of literature*: Search for literature in the search engines and retrieval of titles, abstracts, and reference material.
- *Selection of literature*: Reading of literature abstracts, including (i.e., selecting) and excluding literature, and obtaining full-text versions of the selected literature. Analysis of the references in the obtained literature in order to identify further literature (i.e., repeating this phase with the new list of literature).
- *Quality assessment*: Reading the full papers or Web resources, evaluating their appropriateness, and identifying bias.
- *Data extraction*: Extraction of relevant data (e.g., definitions, keywords, etc.) from the literature.
- *Data synthesis*: Structuring and systematization (descriptive / non-quantitative) of the quality defects and quality defect diagnosis techniques found.

The systematic literature review was conducted between October 2007 and March 2008 using the techniques described in the following subsections.

Data Sources and Search Terms

In order to get a relatively objective picture of Web X.Y, we utilized many different data sources found via the search engines of Google⁷, ACM Digital Library, IEEE Xplore⁸, and Del.icio.us. Search terms used included “Web 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5 / 4.0” in conjunction with “definition”, “concepts”, “examples”, etc.

Furthermore, we used data sources concerning Web X.Y topics, such as Read/Write Web⁹, O’Reilly Radar¹⁰, TechCrunch¹¹, or Mashable¹². They all had valuable information, which represented the broad spectrum of people’s opinions about Web X.Y steps.

In order to identify representative services for the particular Web X.Y steps, we utilized websites providing rankings of successful Web applications. We selected different websites with diverse criteria, such as

the most famous services associated with a particular Web X.Y step (e.g., top 100 of best Web 2.0 applications in 2007), services compiled by a jury, or a list of successful websites in terms of traffic rankings¹³. In addition, we utilized Google Trends¹⁴, McKinsley (2007a; 2007b), and Gartner (2007a; 2007b) to infer trends beyond Web 2.0.

Literature Selection and Literature Quality Assessment

Our goal was to get an insight into which kinds of definitions exist for Web X.Y steps and which concepts and features constitute a particular step. Thus, we collected documents, images, and video, which included descriptions, examples, and definitions about Web X.Y. Search requests were limited to English-language queries only. In most cases, our Del.icio.us bookmarks refer to English-language documents, too. Concept descriptions or definitions in scientific papers or books are regarded as sources with higher quality and thus priority in contrast to, for example, blog entries. In our own definitions, we considered sources with higher priority to have a higher value.

Data Extraction

We extracted relevant passages (e.g., Web 2.0 concept or Web 3.0 definition) from the retrieved resources. After that, we aggregated the extracted information into the following topics:

- Web 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5 / 4.0 definitions
- Web 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5 / 4.0 descriptions of concepts, technologies, tools, and services
- Comparisons of Web X.Y evolutionary steps (e.g., Web 1.0 vs. Web 2.0)
- Web X.Y services and companies (if possible, we attached the context (i.e., the concept of which the mentioned service is an example))

Data Synthesis Activities

For every group of collected definitions, we extracted statements, respectively concepts, features, and technologies, and summarized them into defined terms (e.g., collective intelligence, social networking, or sharing), and therewith created lists of concepts ordered by occurrences. We utilized the extracted lists of concepts to infer our own definitions.

In order to classify services to a specific Web X.Y step, we extracted a list of concepts that constitute a Web X.Y step and assigned them to the selected Web services. Of course, the degree of uncertainty increases after Web 2.0.

Search Result Documentation

Relevant resources were stored as Del.icio.us bookmarks and relevant passages within these findings, such as concept descriptions, definitions, or examples, were annotated and commented by us using the Web service Diigo¹⁵. We used the same vocabulary (i.e., tags) for both services. The aggregated groups of definitions and concepts are documented in a spreadsheet to extract our list of concepts for every group.

THE WEB X.Y

Before O'Reilly Media coined the term Web 2.0 in 2004 and thereby created a new way of thinking about the Web, the Web had experienced continuous development. The initial idea of the Web arose in the early 1980s, but it was a long journey until the Web kicked off a revolution in information distribution in the early 1990s. In the following, we describe the evolutionary steps of the Web, from its beginnings, when Tim Berners-Lee developed the technological fundamentals (i.e., Web 0.5 – establishing the architecture of the Web), via the rise of the Web (Web 1.0) and its rapid commercialization (Web 1.5), up to the current Web (Web 2.0). While new stages of the Web supersede older ones, concepts and technologies from new stages do not completely replace older ones but co-exist with them (e.g., email, FTP, blogs, etc.). As

an example, the Web 1.0 era was characterized by Web services whose content was created by the carrier and not by the users. While the content of Web 2.0 services mainly comes from their users, even in this Web 2.0 era, there still exist services that only let their users consume pre-built content (e.g., news services, such as BBC).

In order to better understand the definitions of Web X.Y services presented in the following sections, it might be helpful to first read the dimensions of the synthesized classification in the next part.

Web 0.5 – The Rise of Tim Berners-Lee’s Vision

In the late 1980s and early 1990s, Tim Berners-Lee cleared the way for one of the biggest and most influential inventions of humanity – the World Wide Web (WWW or, in short, Web), which owes its name to Berners-Lee’s first homonymous browser called WorldWideWeb. Very early, he had a vision of a barrier-free Web, where machines of all types are connected to the Internet and a universal information space is established where everything is based on hypertext. The Web should become the central medium where people all over the world would be connected with each other and where data would always be up to date (Berners-Lee, 2000). In this era, the technical infrastructure with its fundamental technologies, such as HTML, URI, HTTP, Web server, and the concept of linking Web pages, were developed. During this phase, the Web emerged as a winner against competitive products, such as Gopher.

Definition 1 *Web 0.5 services are distributed and content-offering precursors to Web pages using non-standard technologies, protocols, and tools. Examples are systems such as Gopher, FTP, or Usenet.*

Web 1.0 – Growth of the Web: The First Mainstream Websites

Web 1.0 (1990 – 2000) was the phase during which the general public embraced the Web. It was also the time when standardization of the underlying technologies began, e.g., HTML or the HTTP protocol. This initial phase peaked from about 1993 until 1996, and represents an information space designed to help people all over the world exchange information. However, this was a one-way publishing medium, because only website authors exclusively provided the content – the “read-only Web”.

Definition 2 *Web 1.0 services are presentation-oriented content viewing services based on technologies supporting static Web pages (mainly hard-coded HTML pages) without much interaction, used to display information. Typical examples were simple homepages or directory services, such as Altavista¹⁶, Yahoo¹⁷, or Netscape¹⁸, as well as basic supportive tools such as Web development tools (e.g., HTML editors) and basic search engines, such as AliWeb¹⁹.*

Web 1.5 – The Web of Experts

People often label the time from about 1996 onwards as Web 1.5, with a dramatic growth in users gaining access to the Web. The Web as a platform experienced increasing commercialization when big Internet players, such as eBay²⁰, Amazon, or Microsoft with its Internet Explorer browser, emerged. This time brought many technical revolutions, such as more dynamic Web pages created on the fly from an ever-changing database and content management systems (CMS). In contrast to Web 1.0, Web developers needed a lot more skills to create business websites – not only HTML, but also client-side scripting (e.g., JavaScript or Java Applets) and server-side programming (i.e., Common Gateway Interface (CGI)).

Definition 3 *Web 1.5 services are commerce-oriented content-viewing services based on technologies supporting dynamic pages (e.g., DHTML) and form-based interaction that often had closed APIs and closed IDs for presenting company-generated content. Typical examples are Google, Amazon, or eBay, as well as basic supportive tools such as Content Management Systems or WYSIWYG Web development tools.*

Web 2.0 – The Social Web

In 2004, O'Reilly Media first recognized that services such as Del.icio.us, Wikipedia²¹, or MySpace are representatives of a new Web era, which constitutes a shift away from a one-way medium towards a bidirectional read/write Web. In O'Reilly's (2005) famous essay, they described Web 2.0 (2000 – 2010) as a new stage in the evolution of the Web. In the spirit of Web 2.0, Web-based applications make the most of the intrinsic advantages of the Internet as a platform. They get better as more people use them by capturing network effects; they enable collaborative work; they deliver rich user experiences via desktop-like interfaces; and they combine data from multiple sources into new services. The power of consumers is a lot stronger than in the time of Web 1.0, because the amount of Web users has exploded dramatically in the last ten years. This has opened new possibilities for users as well as for website operators.

Blogs have replaced ordinary homepages and enable users to reach many people in an easy way. Social networking is a phenomenon especially with younger Web users. Facebook²², a popular social networking platform for students, is gaining about 100,000 new users every day, and 45% of registered users come back to the site every day (in March 2008²³). The most successful Web 2.0 services all have social networking capabilities. The distribution of Flex or AJAX suddenly has enabled Web developers to create desktop-like user interfaces. Public Web APIs are an important component of so-called mashups. Mashups combine data from different sources to create a new service with more value. An RSS feed is a syndication concept that enables people to keep up to date with websites without the need to explicitly visit these websites. Web desktops, such as Netvibes²⁴ or Pageflakes²⁵, bring back the original idea of Web portals and reduce information overload. Tagging and folksonomies are two major concepts of Web 2.0 that go hand in hand and are integral parts of many community-based services. Tagging is a quick and easy technique that enables people to describe resources to be discovered by others. Del.icio.us, for example, enables its users to share and find bookmarks by providing description tags for the resources, whereas Flickr users tag photos and YouTube²⁶ users tag videos.

The definition of this umbrella term has suddenly enabled the Internet community to talk about the concepts and technologies of a new evolutionary Web stage. To some extent, Web 2.0 has become a buzzword, because it is used by people for everything that gets popular on the Web.

Definition 4 *Web 2.0 services are user-oriented, content-sharing (upload, edit, and download), social networking (personal data), or static mashup services based on technologies supporting dynamic micropages that harness collective intelligence. They may support an open API with closed data and closed ID in order to use the Web as a distributed file system (user-generated content) or collaboration system (networking effects). Typical examples are YouTube, Flickr, Digg, Del.icio.us, LinkedIn, or MySpace, as well as basic supportive tools, such as Wikis or blogs.*

Web 2.5 – The Mobile Web

Users of Web 2.5 (2005 – 2015) will be “always-on”, carrying along their mobile devices connected to the Internet. Services such as Twitter²⁷ indicate the way people in Web 2.5 use the Web. There is a shift away from “desktops” as unique Internet access towards an increased usage of mobile devices – off-site reading (e.g., with RSS feeds and Web desktops) and publishing (e.g., Twitter as a microblogging service or Diigo as a social annotation service) will be integral parts of Web 2.5.

Although Web 3.0 will be the first Web stage to have semantic technologies as an integral part, first Semantic Web applications will exist already in Web 2.5, e.g., Twine²⁸ or Freebase²⁹. In Web 2.5, social

networks will go beyond “ego surfing”. Semantic annotations will be a key concept of Web 2.5 social networks, with people describing themselves and their input so that they can connect automatically.

Currently, many start-ups and research institutes are working on so-called social search engines that will go beyond keyword-only approaches and leverage semantic information within social networks (Breslin and Decker, 2007), e.g., PeerSpective³⁰, Eurekster³¹, Yahoo! Answers³², Google Co-op³³, or Wikia Search³⁴.

Yihong Ding (2008) describes the data portability dilemma as “the next great frontier for the Web”. A DataPortability³⁵ workgroup has already been founded to address the problem of supporting the portability of user identities, photos, videos, and other forms of personal data of social networks.

Blogger Luke Gedeon (2006) sees 3D Web as a technology for creating virtual worlds (Second Life³⁶ was one of the first services of this kind), rather a feature of Web 2.5 than Web 3.0.

Web 2.5 is the first stage in the evolution of the Web that may bring the Internet infrastructure to its boundaries. In 2007, the video sharing service YouTube consumed as much bandwidth as the entire Internet did in 2000 (Lohr, 2008). The New York Times wrote in February 2008 that a research firm projected that user demand for the Internet could outpace network capacity by 2011. However, this rather implies challenges in terms of the modernization of the infrastructure than causing an Internet blackout in the future (Lohr, 2008).

Definition 5 *Web 2.5 services will be (mobile) device-oriented, user-, link-, or time-sensitive, cross-site, content-moving, virtual-reality-based, or dynamic mashup services based on technologies supporting rich user interfaces and user-sensitive interfaces that might support an Open ID and Open Data in order to support RUE (Rich User Experiences) and personal data portability. Examples are Second Life, Diigo, or Yahoo pipes.*

Web 3.0 – The Semantic Web

A common opinion is that Web 3.0 (2010 – 2020) is equivalent to the Semantic Web (Lassila and Hendler, 2007; Ayers, 2006; Hendler, 2008). Market analyst Mills Davis (2007) expects that semantic technologies will embrace all semantic techniques and open standards that can be applied on top of Web 2.0 (e.g., knowledge representation, basic reasoning, pattern detection, or ontology- and model-based inferencing). Intelligent agents will be working hand in hand with Web users to connect knowledge in real time using automated and semi-automated methods (first applications in early states exist, e.g., Twine or Freebase). According to Davis, further trends of Web 3.0 are intelligent user interfaces (that know about the user and are able to tailor system behavior and communication) and end-user development.

Jim Hendler, professor of computer science, sees Web 3.0 as a combination of Web 2.0 technologies plus a subset of the Semantic Web (Borland, 2007). AdaptiveBlue founder Alex Iskold believes that the initial idea of the Semantic Web is not realizable: “Its ultimate goal is to deliver perfect answers, which are unattainable. It is technologically impractical to achieve” (Zaino, 2007). Maria Azua, vice-president of technology and innovation at IBM, shares the opinion that not all facets of the Semantic Web are mainstream capable because using the Semantic Web in its entirety involves massive effort (Borland, 2007). However, Eric Miller, MIT, believes that Web 3.0 will indeed harness semantic technologies, but will be a hybrid, spun from a number of technological threads (Borland, 2007).

Blogger Steve Rubel (2008) expects that websites will be obsolete by 2012. According to him, the future are Web Services and not websites. Leading Web 2.0 players, such as Amazon, still continue to expand their offers of Web Services and APIs. The trend is towards Software as a Service (SaaS), where third-party users can leverage APIs free or for a fee. Alex Iskold (2007) has the same vision of Web 3.0, where

the old perception of protecting one's own data at all costs is displaced by a new way of thinking that open data is a competitive advantage.

For San Murugesan (2007), Web 3.0 will be an entry-level Semantic Web that will be visualized by virtual worlds, accessed through diverse devices. Furthermore, cross-site ID recognition and cross-site identification of information will be an integral part. According to him, Web 3.0 will make use of already matured Web 2.0 features, such as RSS, tagging, folksonomies, and widgets, but also of technologies evolving in Web 2.5 (e.g., micro-blogging, 3D Web, SaaS, and mashups).

Nova Spivack (2006) defines key emerging technology trends for Web 3.0, such as ubiquitous connectivity (everybody is online – everywhere), network computing (e.g., distributed computing, SaaS), open technologies (e.g., open APIs, protocols, or open data), open identity (e.g., OpenID), and the intelligent Web (e.g., Semantic Web technologies, natural language searching³⁷, or machine learning).

Definition 6 *Web 3.0 services will be content-oriented, semantic-based, context-sensitive services based on technologies supporting semantically enriched websites that might support portable IDs in order to use the Web as a database and an operating system. Examples are Eureka, AskWiki, Twine, or Freebase.*

Web 3.5 – The Ubiquitous Web

Web 3.5 (2015 – 2025) is the transition towards the “Intelligent Web” many people expect as Web 4.0. Summarizing the thoughts of blogger Harshal Hayatnagarkar (2007), in Web 3.5, we will see fully pervasive services based on matured and embraced semantic techniques from Web 3.0. We expect key technologies of Web 3.0, such as 3D Web or semantic technologies, to be upgraded to the next level of sophistication. Advancements in Web 3.0 technologies will evolve within Web 3.5 and will be fully matured within Web 4.0. As an example, we believe that established virtual worlds of Web 3.0 will evolve into more advanced 3D worlds, where people will use upcoming technologies, such as holograms (Kanakaracus, 2008) or augmented reality, which will bring the virtual world (e.g., 3D-enhanced social networks) and the real world closer together. Jack Domme, Hitachi Data Systems' chief operation officer, believes that we will have ubiquity of the Web. For example, today's RFID technology will be part of nearly everything (e.g., every paper or device) around us and will enable the environment to become interactive (Kanakaracus, 2008).

Definition 7 *Web 3.5 services will be fully pervasive, interactive, and autonomous agents considering the personal context based on advanced semantic technologies supporting reasoning and basic AI that might bring the virtual and the real world closer together. Examples might be 3D-enhanced virtual social networks, natural language services, or fully interactive real-life environments (e.g., RFID, ambient sensors).*

Web 4.0 – The Intelligent Web

Since the Web has not even reached the third stage, the Web community can only speculate as to what we can expect from Web 4.0 (2020 – 2030). San Murugesan (2007) believes that in Web 4.0, sophisticated artificial intelligence technologies will come into play. Intelligent proactive agents will interact with each other and work hand in hand with the users within a Ubiquitous Web (Davis, 2007; Murugesan, 2007). According to Nils Müller, the line between human beings and devices will blur and even disappear (Kanakaracus, 2008).

In Web 4.0, we will not only be the ones that input information into a device (e.g., a computer in Web 1.0, a mobile phone in Web 2.0, our intelligent house connected to the Internet in Web 3.0); rather, we ourselves will be the information sources directly connected to the Internet. Chips implanted for restoring the sight of blind people or sensors on the motor cortex of the brain for controlling a computer with thoughts (possibly an avatar within a 3D world) are scenarios that could be a reality in the future, since research is in progress (Kanakaracus, 2008).

Dean Kamen's "Luke Arm" is an artificial arm (advanced prosthesis) that has the same capabilities as a normal human arm and has been ready for clinical trial tests since the beginning of 2008 (Adee, 2008). Such a technological revolution foretells what we can expect from Web 4.0 – the Web will pervade all parts of our lives. Ambient Assistant Living is one application where elderly people will wear artificial legs and arms equipped with sensors connected to the Internet that proactively interact with relatives and caregivers.

If we believe Nova Spivack, WebOS is the next logical step from Web 3.0 (Farber, 2007). According to him, the Internet will become the planetary computer, where all IP-capable devices (e.g., computers, mobile phones, or implanted sensors) will compose one unit, i.e., one big parallel world.

Definition 8 *Web 4.0 services will be autonomous, proactive, content-exploring, self-learning, collaborative, and content-generating agents based on fully matured semantic and reasoning technologies as well as AI. They will support adaptive content presentation that will use the Web database via an intelligent agent. Examples might be services interacting with sensors and implants, natural language services, or virtual reality services.*

CLASSIFICATION OF WEB X.Y SERVICES

In order to classify services according to our synthesized definitions, we collected diverse sources containing rankings of Web applications and websites – for example, the 100 most popular Web 2.0 services in 2007 or the top 100 most popular websites on the Web. We counted the number of times Web services were mentioned within these rankings and extracted a new list ordered by frequency. If the source containing the ranking provides tags, categories, or descriptions for websites, we utilized this information to collect the concepts that people (individuals, juries) associated with them. Finally, we derived a table of the most popular websites with their associated features.

The set of Web X.Y features is a result of an intense analysis of definitions and descriptions regarding the meaning of Web X.Y. We collected special keywords about concepts (e.g., collaboration or mashups), features (e.g., tagging or microformats), technologies (e.g., AJAX or Flex), tools (e.g., Wikis or blogs) and services (e.g., Flickr or MySpace).

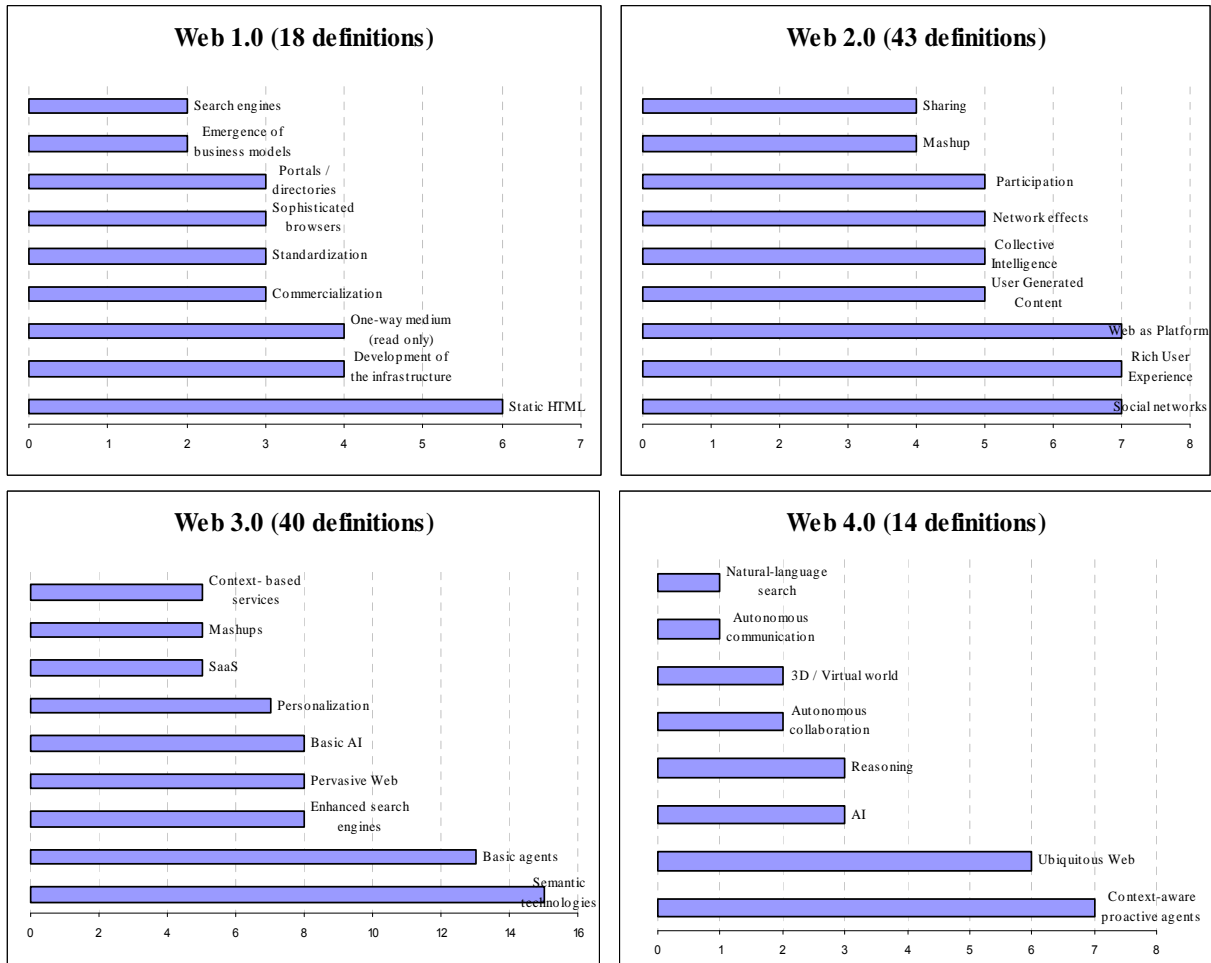


Figure 1 Most often mentioned Features of Web X.0 Stages

In order to systematize the characterization of a Web X.Y era, we clustered similar keywords and identified the six different dimensions “Frontend”, “Content”, “Backend”, “Ads”, “Services”, and “Search”, which differentiate services in the Web X.Y versions. In addition, we synthesized a list of concepts and features ordered by number of times mentioned in Web X.0 definitions that indicates what people see as the main characteristics of Web stages (see Figure 1). The described evaluation resulted in Table 1, where we classified several existing services using this classification system.

Table 1 Classification of Web X.Y Services

Dimension																	
		Craigslist	BBC	Amazon	eBay	Wikipedia	YouTube	Flickr	Del.icio.us	Digg	LinkedIn	Technorati	MySpace	Netvibes	StumbleUpon	Buzzword	Freebase
Web 1.0	Ads	On-site Ads															
	Ads	Plain Ads															
	Content	Content Viewing															
	Frontend	Static Pages															
	Frontend	No Interaction															
	Frontend	Insensitive Interface															

Dimension		Craigslist	BBC	• Amazon	eBay	Wikipedia	YouTube	Flickr	Del.icio.us	Digg	LinkedIn	Technorati	MySpace	Netvibes	• StumbleUpon	Buzzword	Freebase
Services	Experience-based Services																

Frontend

Presentation

- *Static Pages* refers to HTML-based Web pages that do not change and are only rarely changed to reflect new information or news about the site.
- *Dynamic Pages* refers to Web pages that can dynamically change their content based on the selection of a menu item or tab (e.g., using Dynamic HTML). All information is stored in the page (i.e., only parts are shown) or the whole page is (re-)loaded on demand.
- *Dynamic Micropages* refers to Web pages that (almost continuously) reload information (or ads) based on a triggering event (e.g., time or the user) from the server. In addition, the server can trigger a server push (e.g., BlazeDS, Comet). In contrast to dynamic pages, only parts of the whole page are reloaded or exchanged (e.g., by using AJAX, JSON, or Flex HTTPService).

Interaction

- *No Interaction* refers to pages that do not support any interaction besides providing content, providing metadata, commenting, or searching.
- *Form-based Interaction* refers to pages that allow interaction in the form of forms that are used to deposit contact or shipping data.
- *RIA* refers to “Rich Internet Applications”, which are perceived as true desktop applications but do not need to be installed. They offer (almost) all the functionality of local desktop applications (e.g., drag & drop, menus, etc.). RIA services go beyond the classic website paradigm (e.g., Buzzword).

Interface

- *Preset (Insensitive)* interfaces refer to frontends that are fixed and do not change in any case.
- *User-Sensitive* (personalized, adaptive) interfaces refer to frontends that automatically or manually adapt to the preferences of the user or a group of users.
- *Device-Sensitive* interfaces refer to frontends that adapt to the device the user uses to view the service and content (e.g., a mobile phone, iPhone, PDA, tablet PC, etc.).
- *Location-Sensitive* interfaces refer to frontends that are sensitive to the location in the physical world (e.g., using GPS).
- *Content-Sensitive* interfaces refer to frontends that are sensitive to the content they present (e.g., by getting darker if a dark movie is shown).
- *Time-Sensitive* interfaces refer to frontends that are sensitive to the time they are used, such as darker street maps at night in a navigational system.

Content

Commenting

- *On-Site* commenting refers to comments or recommendations made by the users to the actual content. The comments are stored on the same website where the content is stored.
- *Off-Site* commenting refers to comments or recommendations made by people to the actual content (and potentially to on-site comments). However, the comments are stored on another (probably independent) website (e.g., Diigo as social annotation service).

Classification

- *Tagging* refers to free classifications of content by people using their own words that best describe the content in their eyes.
- *Strict Classification* refers to grouping content into predefined classes that cannot be changed by the user.

Flow

- *Upload* refers to content that can be uploaded and stored on a server.
- *Download* refers to content that can be downloaded from a server by users other than the original author(s).
- *Move* refers to content that can be moved between servers (i.e., cross-site).

Handling

- *Viewing* refers to content that can be also viewed on a server/website by users other than the original author(s).
- *Editing* refers to content (and not metadata) that can be viewed and edited on a server by users other than the original author(s).

Backend

API

- *Closed API* refers to an application programming Web interface that cannot be used freely (maybe via a fee).
- *Open API* refers to an application programming Web interface that can be used freely by external (third) parties.

ID (Identity)

- *Closed ID* refers to a personal account on a server/website (or partner websites of the same operator/organization (e.g., Yahoo Pipes and Flickr)) that identifies a person and is used to store personal data.
- *Open ID* refers to a personal account that can be used by different servers (i.e., a decentralized single sign-on service) in order to identify people, eliminating the need for multiple usernames across different websites.
- *Portable ID* (avatar) refers to a personal account that can be used at servers to unambiguously identify oneself (e.g., like an electronic passport), including the identification of one's role in a network of people (e.g., if they are using different nicknames or email addresses).

Data

- *Closed Data* refers to content that is stored on one server and cannot be exported to other services.
- *Open Data* refers to (one's contributed) content that can be transferred to another service (e.g., transferring one's images from Flickr to another service), deleted, or otherwise changed.

Ads

Type

- *Plain Text / Pictures* refers to ads purely based on text or images.
- *Animated* refers to animated ads (e.g., animated GIFs, Flash, etc.) without other media (i.e., sound).
- *Multi-Media* refers to animated ads (e.g., videos, animated slides, or interactive feedback ads) including sound and other media.

Source

- *On-Site* refers to ads from the website operator.
- *Off-Site / Mixed-in* refers to ads that are dynamically mixed into a website.

Sensitivity

- *Content-Sensitive* refers to ads that are sensitive to the content presented to the user.
- *User-Sensitive* (personalized) refers to ads sensitive to an individual person (e.g., using information on the person and his (search) history).
- *Device-Sensitive* refers to ads tailored to the characteristics of the device the content (and ad) is viewed on.
- *Location-Sensitive* refers to ads that depend on the physical location in the real world where the content is presented (e.g., advertisements for food on the parking lot of a mart).
- *Time-Sensitive* refers to ads that are sensitive to the time they are presented.

Services

Sensitivity

- *Preset (Insensitive)* refers to services that are insensitive to external events.
- *Content-Sensitive* refers to services that are sensitive to the content processed by the service.
- *User-Sensitive* (personalized) refers to services sensitive to the user (e.g., using information on the person and his (search) history).
- *Device-Sensitive* refers to services tailored to the characteristics of the device the content is processed on (or for, by the service).
- *Location-Sensitive* refers to services that depend on the physical location in the real world where the service is executed or for which the content is processed (e.g., Semapedia³⁸).
- *Time-Sensitive* refers to services that are sensitive to the time they are executed (e.g., darkening the display of navigational devices at night).

Activity

- *Inactive* refers to services that produce their service or content independently of their users.
- *Reactive* refers to services that have to be triggered and guided by the user and react by executing their process.

Mobility

- *Immobile-Distant / Hosted* refers to services that are executed on one server (e.g., Buzzword³⁹).
- *Mobile* refers to services that are executed on a server but can change the server and distribute themselves.

Intelligence

- *No* refers to services with hard-coded processes.
- *Rule-based* refers to services based on (static/predefined) rules or processes.
- *Experience-based* (learning, adaptive) refers to services that can learn and adapt their rules (e.g., Amazon's personalized suggestions).
- *Exploring* (looking for new information, services, etc.) refers to services that learn and optimize their service (i.e., goal) and explore their environment to further optimize their service (e.g., by exploring new websites and collecting new information (news) relevant to the user).

Mashup

- *No Mashup* (one source) refers to services that use only one source of content.
- *Content Mashup* refers to data mashups mixing different data streams / blocks from different providers into a completely new service.
- *Software Mashup* refers to mashups using multiple services (reusable functionality) that are applied on a single stream / block of content.
- *Static Mashup* refers to mashups that are programmed by developers and cannot be changed easily.

- *Dynamic Mashup* refers to mashups that are developed using a mashup development tool and that can be changed by the end-user (or a technically experienced user).

Search

Power / Complexity

- *Plain Search* refers to simple search based on indexed words.
- *Boolean Search* refers to a simple querying language for tailoring a specific search.
- *Advanced Search* refers to more complex search forms that can exploit specific types or formats of content preset by the user (e.g., “filetype” in Google Search).
- *Natural Language Search* refers to a search language that is based on natural language (e.g., “when was Wikipedia founded?”).

Activity

- *Reactive* refers to search services that are triggered by the user.
- *Proactive* refers to search services that are executed pro-actively.
- *Syndication* (e.g., RSS or Atom feeds) refers to search services that can be subscribed to and consist of machine-readable data.

Location

- *Off-Site* refers to search services that index information on other websites (e.g., Google).
- *Cross-Site* refers to meta-search services that query multiple websites (or other search engines) (e.g., Clusty.com).
- *On-Site* refers to search services that index information on one’s own website.

Sensitivity

- *Preset (insensitive)* refers to search services that are insensitive to external information.
- *User-Sensitive* (personalized) refers to search services personalized to the user (e.g., using information on the person and his (search) history).
- *Device-Sensitive* refers to search services tailored to the characteristics of the device the index is searched on (or for/ by the service).
- *Location-Sensitive* refers to search services that depend on the physical location in the real world where the service is executed or for which the content is processed.
- *Time-Sensitive* refers to search services that are sensitive to the time they are executed.

CONCLUSION

Chronologically, the terms Web 0.5, Web 1.0, and Web 1.5 originated after the term Web 2.0 was coined by O’Reilly in 2004. According to the Sapir-Whorf Hypothesis, defining a term for a set of concepts enables people to talk about them (Hardman and Pemberton, 2008). Consequently, the naming of Web X.Y steps enabled people to talk about a specific Web era, which subsumes concepts, features, patterns, and technologies. However, even with versioning numbers to differentiate groups of Web services, many people still use them as buzzwords without knowing the core commonalities of these services.

This chapter described prospective trends and visions for the “Web X.Y”, such as Web 2.5, 3.0, or 4.0. We collected concepts (e.g., collaboration or mashups), features (e.g., tagging or microformats), technologies (e.g., AJAX or Flex), tools (e.g., Wikis or blogs), and services (e.g., Flickr or MySpace) of Web X.Y in order to develop a new classification system for Web services. In addition, this helped us to synthesize new, more precise definitions for Web X.Y.

Figure 2 depicts the steps of the Web on a timeline. We extracted the time spans from the discovered references. However, the steps are very fuzzy and no exact start or end times can be given (illustrated by the

gradients). However, while new stages of the Web supersede older ones, concepts and technologies from older stages still exist in the newer stages. The horizontal lines indicate concepts or features (e.g., OWL) and the corresponding Web step (e.g., Web 3.0). For example, OWL emerged in 2004 but is the first integral part of a later Web step (Web 3.0). Additionally, while Web 2.0 was defined in 2004, the summarization of services under this version of the Web started earlier. Wikipedia was founded in 2001, blogs were coined in 1997, and the first Wiki was developed in 1995. Similarly, if Web 3.0 represents the “Semantic Web“, its rise started in 1999 with the vision of Tim Berners-Lee, or in 1993 with Gruber’s definition of ontologies in computer science. This reveals that assigning concepts or features to one particular Web step is not always clear, because virtually every concept needs a very long preliminary lead-time, or else the concept may have existed in the “real world” for a long time (e.g., the concept of social networks).

As depicted, we assume that every decade consumes one full version number (e.g., Web 2.0 encompasses 2000-2009) (as specified by Radar Networks (Farber, 2007)) and half versions arise between the full versions (e.g., Web 1.5 arose in 1995-2005). Nevertheless, some sporadic services do occur before these time spans and announce the Web step to come (e.g., research on the Semantic Web started around 2001 and first services for Web 3.0 do exist).

Table 2 lists a collection of metaphors for Web X.0 steps, which emphasize the theme of a particular Web step. The table also emphasizes that there exist diverse point of views on Web X.Y steps, especially for future steps. As with the “Intelligent Web”, which is assigned to Web 3.0 and Web 4.0, some people define evolutionary Web steps earlier than others.

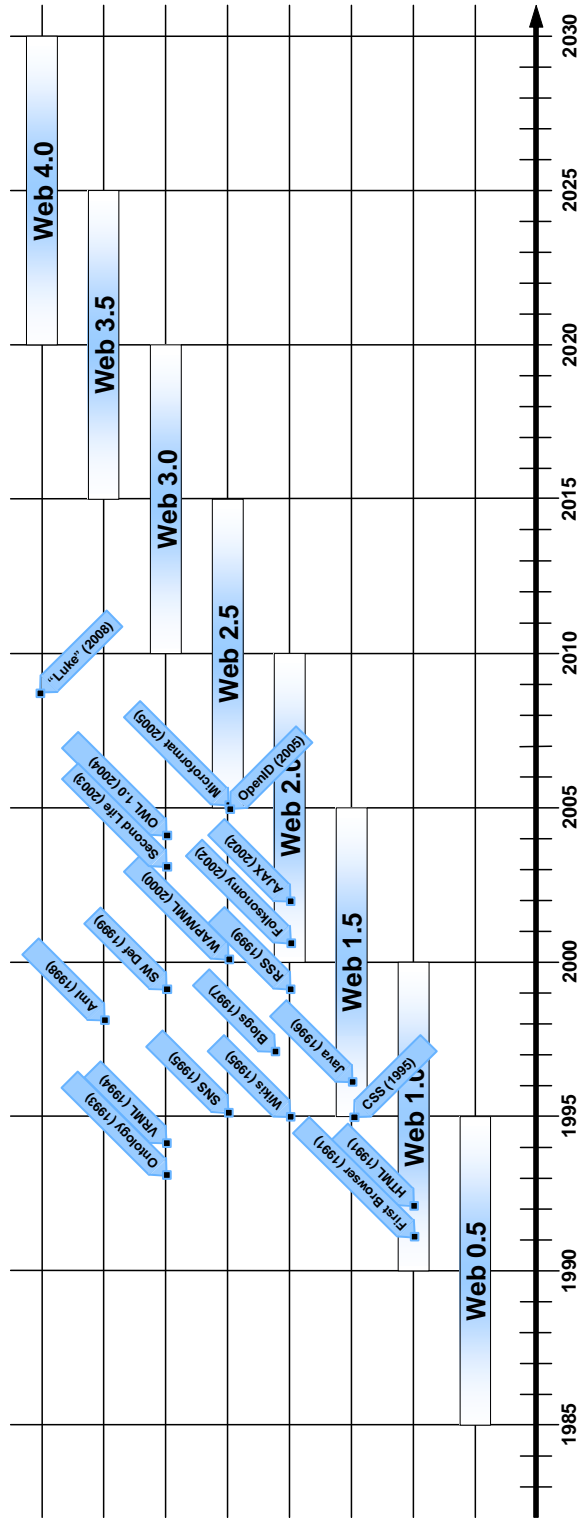


Figure 2 Web X.Y Timeline

Table 2 Collection of Catchphrases and Metaphors of Web X.0 Steps

Web 1.0	Web 2.0	Web 3.0	Web 4.0
Connects information (Davis, 2007)	Connects people (Davis, 2007)	Connects knowledge (Davis, 2007)	Connects intelligence (Davis, 2007)
Info-centric (Murugesan, 2007)	People-centric (Murugesan, 2007)	Machine-centric (Murugesan, 2007)	Agent-centric (Murugesan, 2007)
	Social Web (MacManus, 2007a)	Intelligent Web (MacManus, 2007a; Spivack, 2007)	AI Web (MacManus, 2007a)
		The Semantic Web (Farber, 2007)	The Web OS (Farber, 2007)
			Intelligent Web (Davis, 2007; Murugesan, 2007)
			Smart Web (Murugesan, 2007)
Allows individuals to create and share ideas (Krupp, 2007)	Allows groups to create and share ideas (Krupp, 2007)	Allows societies to create and share ideas (Krupp, 2007)	Is the singularity (Krupp, 2007)
		Gives the Internet itself a brain (Richards, 2007)	
	Interaction (Kiss, 2008)	Recommendation and personalization (Kiss, 2008)	
	The document Web (MacManus, 2007b)	The Data Web (MacManus, 2007b)	
Back-end (Richards, 2007)	Front-end (Richards, 2007)	Back-end (Richards, 2007)	Front-end (Richards, 2007)
First time to show the value of standards (MacManus, 2007b)	Teaches us how liberating standards can be (MacManus, 2007b)	Reflects on what worked in Web 2.0 (MacManus, 2007b)	
Centralized "them" (O'Brien, 2007)	Distributed "us" (O'Brien, 2007)	Decentralized "me" (O'Brien, 2007)	

As one can see, these catchphrases all capture different aspects of a Web X.0 step. However, they focus on a more or less similar theme. Web 1.0 focuses mainly on information presentation and could be named "Information Web", whereas Web 2.0 focuses mainly on the participation and collaboration of users and therefore could be named "Users' Web" or "Social Web". Consequently, Web 3.0 will probably focus on semantic technologies to unlock the wealth of information and could be named the "Semantic Web", whereas Web 4.0 will probably focus on agents, intelligent assistance, as well as smart, proactive, and learning services that might be circumscribed as the "Intelligent Web". However, for Web 3.0 and Web 4.0, we can only imagine what will become reality.

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KEY TERMS & DEFINITIONS

Web 0.5: Web 0.5 services are distributed and content-offering precursors to Web pages using non-standard technologies, protocols, and tools. Examples are systems such as Gopher, FTP, or Usenet.

Web 1.0: Web 1.0 services are presentation-oriented content viewing services based on technologies supporting static Web pages (mainly hard-coded HTML pages) without much interaction, used to display information. Typical examples were simple homepages or directory services, such as Altavista, Yahoo, or Netscape, as well as basic supportive tools such as Web development tools (e.g., HTML editors) and basic search engines, such as AliWeb.

Web 1.5: Web 1.5 services are commerce-oriented content-viewing services based on technologies supporting dynamic pages (e.g., DHTML) and form-based interaction that often had closed APIs and closed IDs for presenting company-generated content. Typical examples are Google, Amazon, or eBay, as well as basic supportive tools such as Content Management Systems or WYSIWYG Web development tools.

Web 2.0: Web 2.0 services are user-oriented, content-sharing (upload, edit, and download), social networking (personal data), or static mashup services based on technologies supporting dynamic micropages that harness collective intelligence. They may support an open API with closed data and closed ID in order to use the Web as a distributed file system (user-generated content) or collaboration system (networking effects). Typical examples are YouTube, Flickr, Digg, Del.icio.us, LinkedIn, or MySpace, as well as basic supportive tools, such as Wikis or blogs.

Web 2.5: Web 2.5 services will be (mobile) device-oriented, user-, link-, or time-sensitive, cross-site, content-moving, virtual-reality-based, or dynamic mashup services based on technologies supporting rich user interfaces and user-sensitive interfaces that might support an Open ID and Open Data in order to support RUE (Rich User Experiences) and personal data portability. Examples are Second Life, Diigo, or Yahoo pipes.

Web 3.0: Web 3.0 services will be content-oriented, semantic-based, context-sensitive services based on technologies supporting semantically enriched websites that might support portable IDs in order to use the Web as a database and an operating system. Examples are Eurekster, AskWiki, Twine, or Freebase.

Web 3.5: Web 3.5 services will be fully pervasive, interactive, and autonomous agents considering the personal context based on advanced semantic technologies supporting reasoning and basic AI that might bring the virtual and the real world closer together. Examples might be 3D-enhanced virtual social networks, natural-language services, or fully interactive real-life environments (e.g., RFID, ambient sensors).

Web 4.0: Web 4.0 services will be autonomous, proactive, content-exploring, self-learning, collaborative, and content-generating agents based on fully matured semantic and reasoning technologies as well as AI. They will support adaptive content presentation that will use the Web database via an intelligent agent. Examples might be services interacting with sensors and implants, natural-language services, or virtual reality services.

Mashup: Mashups refer to an ad-hoc composition of content and services coming from different sources to create entirely new services that were not originally provided by any integrated source.

ENDNOTES

¹ Photo sharing service acquired by Yahoo (<http://www.flickr.com>).

² It is considered to be the first social network. In 2008, it is the best-known one worldwide (<http://www.myspace.com>).

³ Specialized Google search for finding and searching in blogs on the Web (<http://blogsearch.google.com>)

⁴ Social bookmarking service for storing and describing links online (<http://del.icio.us>)

⁵ Largest online store worldwide that sells many products, e.g., books or clothes (<http://www.amazon.com>)

⁶ Full-text search of ACM journals and conference proceedings (<http://portal.acm.org>)

⁷ In 2008, the world's best-known search engine (<http://www.google.com>)

⁸ Full-text access to publications of IEEE and IEE (<http://ieeexplore.ieee.org>)

⁹ Blog that provides daily Web technology news, reviews, and analysis (<http://www.readwriteweb.com>)

¹⁰ O'Reilly Media Blog that watches and reports on interesting technology news (<http://radar.oreilly.com>)

¹¹ Blog that profiles and reviews Internet products and companies (<http://www.techcrunch.com>)

¹² Blog concerned with social networking news and applications (<http://www.mashable.com>)

¹³ Traffic rankings of websites (<http://www.alexa.com>)

¹⁴ Comparison of worldwide interest in a topic by means of search queries over time (<http://www.google.de/trends>)

¹⁵ Social bookmarking and annotation service, which can be used as a research tool (<http://www.diigo.com>)

¹⁶ <http://www.altavista.com>

¹⁷ <http://www.yahoo.com>

¹⁸ In the mid-1990s, Netscape was a leading computer service company best known for its browser. It was acquired by AOL in 1998 (<http://www.netscape.aol.com>)

¹⁹ <http://www.aliweb.com>

²⁰ Is an online auction service launched in 1995 (<http://www.ebay.com>)

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- ²¹ Wikipedia is a multilingual, Web-based, free content encyclopedia project (<http://www.wikipedia.org>)
- ²² <http://www.facebook.com>
- ²³ <http://www.facebook.com/press/info.php?statistics>
- ²⁴ Netvibes is a multi-lingual, AJAX-based personalized start page much like Pageflakes (<http://www.netvibes.com>)
- ²⁵ <http://www.pageflakes.com>
- ²⁶ Video sharing service acquired by Google. Is one of the most used services in 2008 (<http://www.youtube.com>)
- ²⁷ Twitter is a service for people to communicate and stay connected through the exchange of quick, frequent answers to one simple question (<http://www.twitter.com>)
- ²⁸ Semantic Web application by Radar Networks with aspects of social networking, wikis, blogging, and knowledge management systems(<http://www.twine.com>)
- ²⁹ Developed by Metaweb, which describes Freebase as "an open shared database of the world's knowledge" (<http://metaweb.com>)
- ³⁰ Integrating social networks and Web search (<http://peerspective.mpi-sws.mpg.de>)
- ³¹ Eurekster provides "Swickis", which are configurable search engines (<http://www.eurekster.com>)
- ³² A community-driven website, which enables users to ask questions that are answered by other users (<http://answers.yahoo.com>)
- ³³ A platform that allows Web developers to build their custom search engine (<http://www.google.com/coop>)
- ³⁴ Open-source search engine where the users determine the relevance (<http://alpha.search.wikia.com>)
- ³⁵ <http://dataportability.onconfluence.com/display/dpmain/DataPortability+Project+Charter>
- ³⁶ Internet-based virtual world where users interact through avatars (<http://www.secondlife.com>)
- ³⁷ AskWiki is a natural search engine in a very early stage that uses semantic technologies and seeks to provide specific answers to questions using information from Wikipedia articles (<http://www.askwiki.com>)
- ³⁸ Connects Wikipedia knowledge with relevant places in physical space (<http://www.semapedia.org>)
- ³⁹ Web-based word processor (<http://www.buzzword.com>)