MASHUPS IN WEB 3.0

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Keywords: Mashups, Web 3.0.

Abstract: Web has developed into a platform where applications live as services. This is referred to as Web 2.0. The next version, Web 3.0, refers to using the Web in a new way in new domains. In addition to realizing semantic web, Web 3.0 includes other advantageous concepts too. This paper discusses about mashups in Web 3.0 and describes how mashups will be an integral part of it. Moreover, we will point out some remarkable technical solutions that enable new kind of mashups and speculate about the time when these mashups can be fully implemented and realized.

1 INTRODUCTION

The way the Web is used has gone through significant changes. The Web 1.0 was a simple platform for browsing static documents that were connected with hyperlinks. Next version, Web 2.0, introduced user created content in a significant degree as well as collaboration between users. Communities and social networks as well as different services that enabled sharing videos, images and texts became popular. Mashups, web applications that integrate resources — i.e. the content created by users and enterprises — over the web were developed into a new breed of software that is widely utilized in different domains including mobile and desktop platforms. Currently, we are experiencing a paradigm shift towards web-based software (Taivalsaari, Mikkonen, Anttonen and Salminen, 2011), which consists of resources that can be located anywhere in the world and require no installation or manual updates. This has had a great effect not only on how software is used but also on development and deployment of software (Taivalsaari et al., 2011). In other words, what used to be a document browsing platform has become a means of communication with short messages and live audio, a place for music and video entertainment as well as a platform for full fledged applications such as text and spreadsheet editors and games. However, the evolution of the Web has not ceased, and as technical and other barriers are overcome it turns into version 3.0.

There is no clear definition for Web 3.0. Some use the term as a synonym for semantic web (Hendler, 2009). Others, however, think that Web 3.0 refers to new ways to use the web, and using it in new domains (Silva, Saleh, Rahman and El Saddik, 2008). Our perception of Web 3.0 is the latter. Similarly to Silva et al. (2008), we define Web 3.0 as "tomorrows web" that is ubiquitous and pervasive, which, in addition to semantic web, utilizes also other concepts such as ambient intelligence, smart interfaces and intelligent agents. In addition to these, in our view the Web 3.0 includes the concept of mashware, software created as a mashup as described in a technical report by Taivalsaari (2009). Mashware enables personalization and on-fly customization of web applications; ideally automatically or by the users.

As already pointed out, mashups combine content from more than one source into an integrated experience. This ability to aggregate content leverages the power of the Web to support worldwide sharing, accessing and reusing resources from different locations or in different contexts. Consequently, mashups, as well as mashware, demonstrate the capability of the Web to act as global-scale distribution channel for arbitrary distributed applications.

In this paper we discuss about mashups utilizing Web 3.0 concepts and technologies and present our view on what will happen in the future in the domain of mashups. In addition we describe forthcoming issues that are related to software mashupping using new web technologies. To gain better understanding about how Web 3.0 will benefit mashup developer, we start with a brief background study about the

Salminen A..
MASHUPS IN WEB 3.0.
DOI: 10.5220/0003953901890194
In *Proceedings of the 8th International Conference on Web Information Systems and Technologies* (WEBIST-2012), pages 189-194
ISBN: 978-989-8565-08-2

concept.

This paper is structured as follows. In Section 2, we present the concepts that are included and discussed about under term “Web 3.0”. In Section 3, we describe mashups that are enabled by Web 3.0 technologies and present examples of applications available today. Finally, in Section 4, we conclude the paper.

2 WEB 3.0 CONCEPT

We do not use term “Web 3.0” as a synonym for semantic web. Our perception of Web 3.0 contains not only the ideas introduced as “semantic web” but a lot more. Term “semantic web” refers to extending web documents so that information in them has clear meaning understandable for machines (Berners-Lee, Hendler and Lassila, 2001; Shadbolt, Berners-Lee and Hall, 2006). It can be used to create interoperable websites that make information exchange effortless. For example, semantic web has been successful in the domain of scientific publications (Das, Goetz, Girard and Clark, 2009). In our view, semantic web is an enabler for Web 3.0 applications but there are other aspects as well.

In the Web 3.0, the connection with the rest of the world via Internet is pervasive. It is available at everywhere for everyone at anytime. This has been achieved already as mobile terminals — that have become inexpensive enough for everyone to purchase — enable us to be online at all times, without interruption. However, as new web-enabled devices have been introduced, web applications can reach new fields of everyday devices. Game consoles, televisions and set top boxes already contain web applications and similar capabilities are spreading into cars, book reading devices and picture frames, for instance. Furthermore, progress of ubiquitous technologies (Weiser, 1991) makes everyday artefacts connected to the Internet, thus transforming their data into resources for applications.

Another interesting development related to pervasive computing is ambient intelligence, which is a slightly different concept. Ambient media or intelligence refers to systems that are unobtrusive, context aware, personalized, adaptive and anticipatory (Zelkha, Epstein, Birrell and Dodsworth, 1998). It emphasizes the ability of devices to communicate and make decisions independently without user interaction. Ambient media has been included in Web 3.0 concept by Silva et al. (2008). This provides another view to web as a pervasive platform used for making daily tasks easier.

Our view to Web 3.0 includes the concept of mashware (Taivalsaari, 2009) as well. In mashware, the idea of mashups has been expanded into software. Mashware is created from software components that are retrieved from all over the web and composed together without static linking or preprocessing. Realizing mashware in the full extend would allow really large-scale collaboration between developers as application components could be shared and reused without restrictions. Similarly, what has been achieved with current mashup tools (see a detailed summary in (Taivalsaari, 2009)), mashware applications could be developed possibly by the end-users themselves. Mashware, naturally, requires well-defined interfaces and we believe that a lot can be learnt from the work already done in the domain of semantic web.

Interestingly, Google’s CEO Eric Schmidt described ideas similar to mashware when he gave his definition for Web 3.0 at Seoul Digital Forum in 2007. Schmidt’s definition remarked that Web 3.0 applications will be pieced together, relatively small, able to be run on any device, fast and customizable, distributed via social networks and using data stored in the cloud. Certain characteristics, i.e. “pieced together”, “fast and customizable” and “using data stored in the cloud”, are features of mashware as well. However, according to Taivalsaari (2009), mashware is not limited to small applications, and distribution through social connections. Furthermore, mashware does not require universal-scale cross-platform compatibility even though this can be achieved with certain technologies.

Mashups rely on web services that are accessed through APIs. Therefore, mashups benefit greatly from recent developments called Open Web and Open API. The term Open Web refers to development promoted by Open Web Foundation, which is founded by major web organizations and aimed at promoting specifications that are royalty free and compatible with open licenses. This makes using different interfaces in co-operation easier. An interface following Open Web recommendations and available to be used by different parties is referred to as an Open API.

2.1 Enabling Technologies

Web 3.0 is driven by technological challenges that include implementing semantic web, expanding web browser capabilities, having reliable high bandwidth network connections, and linking physical world with the Web.

Semantic Web. Giving semantics for data refers to turning it into information that can be processed independently by machines. In the domain of the Web this means giving well-defined structure and meaning for data stored currently within unstructured and meaningless web documents. Languages and frameworks that can be used to achieve this already exist. RDF (Resource Description Framework), for instance, can be used with OWL (Web Ontology Language) or XML (eXtensible Markup Language) to describe the meaning of data within structured web documents.

In addition, there are solutions that can be used with the HTML, language currently used to describe most documents available in the Web. Microformats and microdata, the former described by the microformats community (*http://www.microformats.org*) and the latter introduced as part of HTML5 specification (Hickson, 2011), can be used to annotate the content with machine-readable labels. These solutions are lightweight, simple and evolutionary, in contrast to RDF used with OWL or XML, which can be described as revolutionary, but more complex and difficult to understand as well.

Web Browser Capabilities. Web browser performance has been increasing at unforeseen pace during last few years. Performance in JavaScript execution has skyrocketed thanks to development of powerful engines during ongoing JavaScript engine race started in 2008 between major browser vendors. In addition to code execution performance, also document rendering speed has evolved.

Two developments, HTML5 and WebGL, have significantly improved capabilities of web browser as a next generation application platform. HTML5 specification (originally named Web Applications 1.0) determines features that are typical for desktop applications and makes them available in browsers implemented as native features. These features include support for drag and drop, local data storage (offline functionality), drawing surface available for direct access by graphics hardware as well as video and audio playing capabilities. Even though HTML5 specification is still at the draft stage many features have already been implemented by browser vendors and included in stable versions of web browsers.

WebGL is a technology that enables hardware accelerated 3D graphics in a web browser. This is remarkable because it allows visually attractive games and other applications to be created without browser plug-ins. WebGL can be used for 2D graphics as well, and this enables developers to create graphics in procedural style without web browsers document object model (DOM), which is aimed at presenting static documents. WebGL specification has reached its first stable version number 1.0. Because of WebGL is a very low level interface, numerous higher level frameworks and libraries have been developed to make it easier and faster to create WebGL applications.

Cross-origin Resource Sharing. One of the significant problems in composing mashups has been web browsers poor capability to communicate across domains. Because of restricting security model of web browsers, also known as the Same Origin Policy, to be able to communicate directly with different web services one has need to use some cumbersome workarounds, such as dynamically inserted script elements and JSON with padding (JSONP). These workarounds are typically prone to security threats. Thanks to a recent specification called CORS (Cross-origin resource sharing) by W3C, mashup developers will be able to make cross-domain requests in similar fashion as the same domain requests. However, CORS needs to be implemented by service providers and it is currently supported by only a few services.

High Bandwidth Connections. High bandwidth Internet connections are already available for households and the price of subscribing for a high bandwidth connection in western countries has decreased. However, numerous areas exist where the prices are still relatively high. In addition to fixed Internet connections, mobile connections with fixed rate data plans have rapidly become common in western countries. According to the OECD's latest statistics (December 2011) there are 309 million fixed and 590 million mobile broadband subscriptions. Number of wireless subscriptions rose 26 % during last year whereas the number of fixed subscriptions was increased only by 5.8 %.

In spite of the increase in mobile subscriptions, mobile Internet is still often unreliable, and it suffers from different kinds of defects. For instance, mobile connections typically suffer from long latency times and issues on handover situations, which can be major shortcomings with certain types of applications. Luckily, new cellular broadband technologies are providing solutions for these and other technical issues.

Linking Physical World with the Web. Linking the physical world with web capable applications such as mashups can add a new dimension to the user experience of a mashup. Location-awareness has already been proven successful in mobile games, in which it has been found to be a very attractive feature (Korhonen, Saarenpää and Paavilainen, 2008). In addition to player location, physical artefacts have been incorporated into games as well (Reid, 2008). Similar idea would benefit mashups as well. However, linking not only location but also physical items into the mashup requires some infrastructure to be built. The infrastructure, however, does not need to be high-end technology, but simple 2D bar codes containing small amount of necessary information of the linkage may be enough.

3 MASHUPS IN WEB 3.0

Mashups will take advantage on developing web technologies and concepts introduced along Web 3.0. In the following, we discuss about how mashups benefit from Web 3.0 technologies today, in near and in distant future.

3.1 Mashups Today

Mobile Mashups. Most successful mobile mashups today are those used for communication with multiple instant messaging services. These are available for all mobile operating systems and used quite widely. Reasons behind this success of instant messaging mashups are, first the obvious need for applications of this kind caused by rivalling instant messaging service providers, and second the fact that mobile devices suit particularly well for communicating with other people. Another type of a successful mobile mashup is map-based mashups. Typically, these mashups show some additional location-related information on top of a map, for instance some mashups show other user locations on a map.

Pervasive Mashups. Mashups can be found in everyday devices as well. Some televisions, for instance, include media front-end applications that have capabilities to present videos from multiple web services. Furthermore, mashup for presenting weather information is another popular application in this kind of device.

HTML5 Mashups. Utilizing HTML5 in mashups is already possible. With HTML5 creating mashups is more straightforward. It enables using video and audio elements in mashups without the need for plug-ins. With HTML5's WebSockets it is possible to create real-time collaborative mashups, as they can be used for low latency bi-directional communication without the overhead caused by HTTP, which is used before for applications of this kind.

Using W3C's Geolocation API it is possible to create location-aware mashups. This enables some context-awareness such as location dependent searches and filtering. However, location accuracy gained with this technology is sometimes very poor. For instance, when travelling with a train and connecting to the web with the internal WLAN of the train, Geolocation usually points to one of the stations that may be on the other side of the country.

As HTML5 specification and other new APIs are relatively new and still at draft stage, it is necessary to create fallback mechanisms if it is desired to be sure that mashups relying on these techniques work for all users. This adds complexity of mashup architectures and implementations.

3.2 Mashups in Near Future

Some Web 3.0 technologies are already available outside research laboratories in commercial devices. We anticipate that mashups relying on such technologies will be available in the near future. In the following, we discuss about mashups that are built on these technologies.

WebGL Mashups. WebGL specification enables hardware accelerated 3D graphics in a web browser. This technology has not been yet utilized in mashups. 3D graphics could be well fitted into social mashups which would be used to communicate with other users in virtual spaces. Another way to use WebGL in mashups could be creating new visualizations for services, for instance video and picture services. Furthermore, 3D enables new ways to present complex data. For instance, a stock mashup that tries to compress enormous amount of information in one screen could benefit from using WebGL graphics to make the information easier to interpret.

Mashups Accessing Arbitrary Mobile Peripherals. Mashups with access to mobile device peripherals will become common in the near future. One domain of such mashups is augmented reality. Augmented reality mashup could access the camera of the device and add information related to the context of the user on top of the real time video. The information would be retrieved from web services, for instance a mashup could use a visual search service to provide photos and details of an unidentified plant or access Wikipedia to provide additional information about sights located around the user. Mashups of this kind would rely on accurate information about user location as well as device orientation.

Ambient Mashups. With ambient media, there are possibilities for even more advanced mashups. Using a mobile terminal to have effortless access to content relevant to the user context, and combining this context with the resources of the Web, can be very valuable for the user, especially if the mashup could work autonomously without explicit user input. Furthermore, if the mashup allows user collaboration, even richer user experiences can be provided.

Mashware. Another development in the near future will be the first fully mashware applications. Mashware will be combined from multiple components according to user's needs. For instance, a mashware video player could be constructed from components that are added according to which services the user would like to access, what types of videos are played and what type of device the player is executed on. If, for instance, YouTube (*http://www.youtube.com/*) and Vimeo (*http://vimeo.com/*) services were used, the application would include interfaces only for those services and exclude interfacing components for Qik (*http://qik.com/*) and Yahoo Video (*http://screen.yahoo.com/*). The player could add the rendering component according to the video types so that opening a video in Ogg Theora, H.264 and Adobe Flash format would result in adding a corresponding component to the application. Furthermore, the user interface of the player would be added as a component so that a living room media centre would have different look and feel than a mobile version of the same application. These application components could be downloaded over the web from different services following a common interface specification. Naturally it is possible to provide a closed repository of components as well.

High-bandwidth Mashups. As mobile network connections get faster it will be possible to develop mashup applications that combine resources that require a lot of bandwidth. This can be for instance a high quality real time mobile television combined with related web content.

Mashups Embedded in Everyday Devices. In addition to televisions, other devices will have mashup applications as well. Mashups will be included in devices such as vehicles and game consoles. For instance a car navigator with a web connection could show live weather information and web camera images in addition to driving instructions. Furthermore, games can use mashups to add changing content into the game worlds. These mashups embedded in everyday devices will turn more advanced as well when the full potential of these specialized platforms is combined with web resources in imaginative ways.

Mashups in Games. In the future, mashups will be implemented within games as well. Web content from different sources can elaborate games in numerous ways. Dynamic content has already proven to be successful in games (Vanhatupa, 2009). For instance, game character's presence could be added with images and messages from players account on social networking services. Game worlds could include content from the real world, for example news casts could be played and real weather conditions could be reflected. Furthermore, games that are relying on user context, such as location-aware and augmented reality games, could naturally include some web content that would complement the experience.

Mashups Utilizing Microformats. Microformats, i.e. small details of information embedded in existing HTML documents, will be used in mashups as well. These lightweight semantics are already widely available, and using them in mashups is only a matter of time. Microformats are currently used by search engines to annotate search results. In mashups microformats could be used as an input when requesting relevant content. Another option where microformats are useful is content filtering.

3.3 Mashups in Distant Future

Some Web 3.0 technologies are not yet deployed in public, or they have some technical issues that need to be overcome before using them more widely. We anticipate that it will take some time for mashups relying on such technologies to emerge. In the following, we discuss about mashups that will be available in distant future as technical barriers are broken.

3D Mashware. As 3D web technologies have just reached somewhat stable stage, it will take a while for the first 3D mashware applications to become existence. Adding third dimension to graphics requires a new approach to user interface development and therefore existing user interface frameworks cannot be used. Furthermore, as the WebGL is a rather low level interface, creating mashware demands much attention to details. However, it is likely that existing higher level libraries and frameworks build for WebGL can be used as a stepping stone. Yet another technical restriction is the inability to use canvas element to render content formatted in HTML. This makes it hard to reuse the existing visual elements of the web that rely on Document Object Model (DOM).

Mashups Relying on Semantic Web. The full-fledged semantic web is still around the corner. Utilizing semantic web's full power in mashware will result in mashups that are capable of including new services and content types automatically. Mashups could benefit from semantic web's knowledge about relations of artefacts (and users) in the web and use it to provide information that is most relevant to the user.

Mashups Utilizing Large-scale Physical Infrastructure. Mashups that take advantage of physical infrastructure build in everyday devices will eventually be available, but because of required installations of hardware, this is not possible in the near future. However, mashups utilizing such physical connection can be really innovative and useful. For instance, Near-Field Communication (NFC) tags installed into a retail store could be used as an input for mashup providing price comparison information as well as other information about products such as possible use scenarios.

4 CONCLUSIONS

In this paper, we argued that mashups and mashware are at the core of what is known as Web 3.0, the next version of the web. Some mashups that utilize Web 3.0 technologies are already available and in wide use. In addition to describing some examples of today's Web 3.0 mashups we pointed out mashups and mashware applications that will likely be available in the near future. Furthermore, we discussed some more advantageous ideas that will take somewhat longer to appear.

From software engineering point of view mashups set an interesting challenge. Mashup design has been previously considered as ad hoc activity with minimal relation to software engineering practices, architecting or disciplined development (Hartmann, Doorley and Klemmer, 2008). However, our research has been focused on describing disciplined guidelines for mashup development (Salminen, Nyrhinen, Mikkonen and Taivalsaari, 2010) as well as general architecture for mashups (Mikkonen and Salminen, 2011).

As technical issues are being solved in accelerating pace, our position is that mashups and mashware will play an important role in how we will be using the Internet in Web 3.0 era.

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