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Classifying Web 2.0 Supported Applications By Pattern Of Usage: Functional & Technical ISSUES

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CLASSIFYING WEB 2.0 SUPPORTED APPLICATIONS BY PATTERN OF USAGE: FUNCTIONAL & TECHNICAL ISSUES

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Abstract

The rapid evolution of Internet technologies have witnessed new Web elements, such as blogs, wikis, social networking, social bookmarking, and other related applications referred to as Web 2.0. Web 1.0 paradigm was related with passive, just receptive users, whereas Web 2.0 paradigm relies mainly on user participation and user-generated content. In Web 2.0 applications users are invited to comment, share, edit, classify, as well as remix data from multiple sources. Although there are several Web 2.0 applications in the market there is still lack of a profound approach guiding the analysis, design and development of such applications. This paper suggests classifying Web 2.0 tools by "Pattern of Usage" or in other words the functionalities that characterize their specific features. By reviewing several literatures we extracted multiple attributes related to functionalities of Web 2.0 tools. These have been crystallised into 7 patterns of usage that include; Inter-connectivity, Content authoring, Content tagging & rating, Content aggregation & syndication, Content remixing, Content streaming and File sharing. By interlinking functionality/ usage with underlying technologies, techniques and architecture we provided insight into design and technical requirements for Web 2.0 supported applications. Furthermore we broke down the patterns into basic, elementary to include Inter-connectivity, File sharing and Content remixing, and secondary, supportive to include the other four patterns. This would provide the technical core for any development methodology targeted at Web 2.0 applications.

Keywords: Web 2.0, Pattern, Usage, Design, Architecture

1   INTRODUCTION

The concept of "Web 2.0" began during a conference brainstorming session between Tim O'Reilly and MediaLive International, where O'Reilly referred to Web 2.0 as the "second generation" of Web-based applications that emphasize online collaboration, participative computing and so called editable Web (O'Reilly, 2005, Levy, 2007). According to O'Reilly (2005) Web 2.0 tools include blogs, wikis, file-sharing services (e.g. podcasts), mashups, web/ RSS feeds, social networking and social bookmarking. For example, blogs engage users to post comments and share opinions, whereas wikis allow users to edit and co-create content. Examples of file sharing services include Flickr and YouTube that allow users to upload and share multimedia files, even more users can provide comments and rate the files they share (Chawner, 2008).

Several contributions argue about the meaning of Web 2.0, their specific features, their possible applications and value creation in various fields, such as e-commerce, e-learning and content publishing. For, example Web 2.0 tools when integrated as part of the delivery of in particular MIS courses, they will enable an experience-based, participative-rich delivery model instead of the traditional instructional

techniques (Huang & Behara, 2007). Web 2.0 tools also offer a rich-participatory, network-centric learning environment that would enhance the teaching experience putting forth a participative, independent and experience-based pedagogical model (Eijkman, 2003). Additionally, Majchrzak et al. (2008) show a case of a so-called exploratory learning during a conference paper presentation using a Wiki. Attendees collaborated by giving their feedback on the paper and shared their reactions simultaneously during the presentation which resulted in better learning and idea generation about the topic of the presentation. Ganesh & Padmanabhuni (2007) emphasize the significance of Web 2.0 tools to e-commerce applications, as they argue that Web 2.0 tools would leverage customer purchase behaviour through better participation and negotiation, customer reviews and rating, comparison shopping, etc.

Although there are several Web 2.0 applications in the market there is still lack of a profound approach guiding the analysis, design and development of such applications? A major determinant of a development approach directed to Web 2.0 supported applications is to identify whether Web 2.0 tools are different from traditional Web elements, or not? If they are different what are implications on analysis, design and development?

This requires investigating the following research questions:

What are the specific characteristics of Web 2.0 tools?

Can we identify features related to functionality or in other words patterns of usage that characterize Web 2.0 tools?

Do the various Web 2.0 tools, e.g. blogs, wikis, file sharing services, etc. differ from one other in terms of the functionality/pattern of usage they support?

Is each pattern of usage interlinked with certain architecture, technologies and techniques?

In order to find answers to these questions this position paper presents a survey of Web 2.0 tools and their characteristics/features reviewed from several literatures. After collating multiple features and Web 2.0 types we then started to classify them by removing redundancy and crystallizing the different attributes under generic features. It is argued that the outline of different patterns of usage would indicate the specific functionality of a Web 2.0 tool. Then we will bundle each pattern of usage with the underlying technologies, techniques and architecture required to implement its specific feature. In doing so, we interlink specific Web 2.0 functionality with technical requirements. This resulted in identifying seven Web 2.0 patterns of usage. This paper provides preliminary analysis of Web 2.0 tools surveyed from literature and an exploratory study by applying identified patterns to four diverse real case Web 2.0 supported applications; e-Bay, HousingMaps, GoogleDocs and Twitter. Subsequent publications will concentrate on applying identified patterns on case studies in order to measure their significance and outline implications to Web development methodologies.

2   TYPES OF WEB 2.0 TOOLS & UNDERLYING TECHNOLOGIES

O'Reilly (2005) identifies eight major Web 2.0 types that include blogs, wikis, podcasts, mashups, web feed/RSS, social networking and social bookmarking. Similarly, Anderson (2007) mentions six Web 2.0 tools that cover blogs, wikis, tagging and social bookmarking, multimedia sharing, audio blogging and podcasting and RSS feeds and syndication. Ganesh & Padmanabhuni (2007) add to previously mentioned Web 2.0 tools Office 2.0 applications, and additionally Laudon & Travor (2007) consider virtual reality applications and streaming as Web 2.0 tools. Based on this we identify the following ten Web 2.0 tools (Table 1).

Web 2.0 Tool	Brief Description
Blogs	Blogs are easy to create and maintain web sites that enable users to publish content instantly in the form of posts (Richardson, 2006, Franklin *et al.,* 2007). The published posts may take various forms, for example, text and images, and even audio and video content (Hill, 2005). A major important feature that became possible by blogs is commenting where multiple participants can add and share their comments, which leverage social interaction (Väljataga, 2008).
Wikis	Wikis are web-based systems that allow end-users to co-create and accumulate knowledge through a set of interlinked web pages (Franklin *et al.,* 2007). These web pages can be edited by members who have authorization for that (Ebersbach *et al*., 2006). A wiki is a very good example of democracy in a way that it is opened to everyone to add or edit information. But they are monitored by knowledgeable members in order to ensure information quality. In this way it provides efficient and timely collaborative content co-creation and publishing (Long, 2006).
Social networking	Social networking refers to online community websites that interconnect users and enhance sharing of common interests and activities (Kroski, 2007). Social networks support a very wide range of activities; starting from chatting, group mailing, collaborative commenting on related blogs and the support for feedback which allows a group to rate the contributions of others (Franklin et al., 2007). Social networking sites collect data about members and store them as user profiles that can be shared among members of the site (Barsky et al., 2006, Boulos & Wheeler, 2007).
Social bookmarking	Social bookmarking is a service that aims to let users store and share their favourite bookmarks in a format accessible via other Internet users instead of the traditional technique of search engines (Owen et al., 2006). Bookmarks have assigned tags that would be rated by other end users. Tagging is the act of classifying knowledge by enabling users to describe the content using their own keywords or in other words tags (Boulos & Wheeler, 2007). Benefits include enabling users to share bookmarks and classification schemes/tags that other users created, as well as rating of such resources (Barasky E. et al., 2006 and Boulos & Wheeler, 2007).
Web feeds & content Syndication	There refer to a technique for notifying users about updates or new content published on the Internet (Chavan, 2005). This provides users with a summary of recently updated content that might cover a blog, news headlines, video or audio contents. These notifications are retrieved by special software called feed aggregator (Boulos & Wheeler, 2007). Web feeds improve the experience of Internet users, as they get the updated content delivered automatically to them instead of the traditional way of browsing several web pages seeking for the updates (Tseng and Ng, 2007). The syndicated content is supplied to the aggregator in the form of RSS format (Sharp, 2006), or another web feed standard called Atom (Ganesh & Padmanabhuni, 2007).
Mashups	This is a web application that integrates data from more than one source into a single application (Craig, 2007, Mödritscher et al., 2008). This is realised through open APIs, shared data sources and Web services (Anderson, 2007). The Programmable web highlights that there are hundreds of open APIs available that can act as a foundation for the development of mashups. Most widely used APIs are found at Google, Yahoo, Microsoft MSN, Amazon.com and e-Bay (ProgrammableWeb, last accessed 19-04-2009). The use of Service Oriented Architecture (SOA) allows developers to incorporate different pieces of information in creating innovative value-added mashups (Fox, 2008). It also could use techniques like AJAX that can fasten synchronous requests to web servers, as well as RSS feeds in order to share updated alerts keeping mashups up to date (Kulathuramaiyer, 2007).
File & multi-media sharing	These occur when users upload photos, videos or other file resources to Web sites and share them with others. Examples include YouTube (videos), Flickr (photographs), Odeo (podcasts), etc. Podcasts are digital media files that can run on i-pods, these are shared over the Internet and made available to syndicated download through RSS feeds. Users can subscribe to regular podcast feeds (audio/video RSS feeds), download them automatically, and transfer them to a portable device or computers (Chowdhury et al., 2006 and Boulos & Wheeler, 2007). Other

	different kinds of resources can be also shared, such as "Slide Share" that allows users to share PowerPoint presentations (Secker, 2008). File sharing and podcasts are based mainly on P2P networks Ganesh & Padmanabhuni (2007).
Web casts & streaming	Webcasting or in other words Web streaming is a service that enables users to receive live media files in real time (Lorance, 2003). Podcasts and webcasts share a common feature that they cover both audio and video content (Keliher, 2005). Webcasts are streamed live and require the user to be connected to the Internet while playing or viewing the webcast (Shim et al., 2007), whereas podcasts are downloadable through the Internet and capable of being played or viewed asynchronously by a portable multimedia device, such as i-pods (Holtjana et al., 2004). Moreover, Videoconferencing provides the opportunity for group meetings to be held over the Internet where users may use special software to communicate via online chats with audio and video support (Raunik, 2006).
Virtual Reality	Virtual world is an application that enable users to interact with a computer-simulated environment, a real or imagined one, where users can 'make home' and interact via avatars (Internet users' representations of themselves), like Second Life (http://slife.com/). The simulated environment can be similar to the real world, for example, simulations for pilot, combat training or health care education (Thalmann, 1999 and Boulos & Wheeler, 2007) or for entertainment pusposes. Online games are based on virtual reality technologies where markup languages like VRML allow creating "virtual worlds" hyperlinked through the World Wide Web. According to Hu et al. (2006) massive capacity and responsiveness make client server architecture limited for virtual reality applications and therefore imply a scalable peer-peer network architecture.
Office 2.0	Sometimes called online productivity tools (Chawner, 2008). It provides web-based office-like functionality that cover shared documents and spreadsheets (Kroski, 2007). Users can co-create, edit, store and share content over the Internet while maintaining revision histories (Craig, 2007). It also provides online task lists, calendar sharing, reminders, planners, etc. (Ganesh et al., 2007). Examples include services such as Google Docs, mainly based on AJAX technologies that provide web-based applications with same responsiveness like desktop applications. This enables for Rich user experiences or so called Rich Internet Application (RIA) (see Appendix for more details).

Table 1: Summary of Web 2.0 Tools

3   CLASSIFYING WEB 2.0 PATTERNS OF USAGE

O'Reilly describes several design concepts that underlie Web 2.0 applications as part of an interview carried out by Baumann (2006) in Information Today Newsletter. He specifies the *'network effect'* as a major cornerstone of Web 2.0 applications, which implies the importance of modern communications networks and exploitation of the massive pool of networked users. He also points to *'information sharing'*, *'user participation,* and *'knowledge'* as major characteristics of Web 2.0 applications. In particular he puts emphasis on so called '*collective intelligence'*, which means analysing reviews and tags written, edited, and published by Internet users to obtain a collective pool of knowledge.

Similarly, Ganesh & Padmanabhuni (2007) explain that Web 2.0 applications mainly rely on leveraging the *'network effect'* by attracting a large number of participants and enabling interactions between them. They conceptualise Web 2.0 as a mechanism to enhance a rich user experience by facilitating speedy *'collaborative participation'*, *'co-creation of content'*, *'collaborative information exchange'* and *'file sharing',* e.g. podcasts over peer-to-peer networks and exploiting users' *'collective intelligence'*. They also elaborate that in Web 2.0 applications content can be *'aggregated'* from several resources via RSS feeds or Atom feeds as an alternative to RSS. Furthermore, they specify modularity as a key concept for realising Web 2.0 applications. This implies the usage of small, modular technological constituents, for example availability of lightweight APIs (Application Programming Interfaces), RSS feeds and Web

services have made Mashups easy to implement. We note that modularity is a characteristic relevant to Web 2.0 architecture rather than the pattern of usage.

There have been other several contributions aiming at classifying Web 2.0 applications based on several criteria. For example, Anderson (2007) suggests that Web 2.0 applications can be classified in terms of the activity/task they attempt to fulfil. This resulted in identifying the following Web 2.0 activity types; '*networking*', '*aggregation*', '*data mashups'*, '*tracking and filtering'*, '*collaboration*', '*office-style software'*. By tracking and filtering he means searching and processing Web 2.0 content extracted from blogs, multimedia sharing services, bookmarking tags and user reviews. Whereas office-style software includes applications like Office 2.0 that implements online task lists, calendars, reminders, planners, etc. through a responsive, rich user experience desktop-like Web application.

Whereas, McAfee (2006) was more concerned with investigating 'Enterprise 2.0' applications, focusing only on those Web 2.0 applications an enterprise will adopt in order to harness organization tacit knowledge. He classifies Enterprise 2.0 in terms of what he refers to as SLATES. *'S'* refers to *'search'* that implies the ease of retrieving information using keywords, *'L'* refers to *'link'* marking the advantage of links between web pages that provide structure to online content, where search engines make use of such networked content linking to the most relevant piece of information of concern to the user in a certain context, *'A'* stands for *'authoring'* characterizing the ability to co-create and update content and keeping track of versions like in wikis, *'T'* refers to *'tags'* aiming to classify and categorize content using informal user participation through assigning tags, ratings and reviews, *'E'* refers to *'extensions'* such as recommendation pattern techniques that extend content beside what has been requested by the user like Amazon.com's recommendation list and *'S'* stands for *'signals'* a kind of notification alerts or notes such as RSS feeds to notify users whenever a certain content has been updated.

Additionally, Chawner (2008) elaborate that Web 2.0 applications encourage interactivity through for example blogs and wikis, as well as content sharing and rating services. In that regard she identifies several roles people may take while using Web 2.0 tools, these include '*content consumer',* '*content commenter',* '*content creator*' and '*content collector'.* With Content consumers she means users acting passively just to read published content, whereas content commenters act reactively by commenting on other users' contributions, content creators are users who act proactively to published content by generating content, for example in wikis or content sharing services, such as sharing audio files, whereas content collectors are users who keep themselves notified or updated with advancements in websites, such as joining bookmarking websites or subscribing to various web feeds from Websites of interest.

It is apparent that Web 2.0 features that have been suggested above overlap and share similarities. In order to crystallize them and remove redundancy we develop the following table (Table2) where we collate similar attributes and try to bundle them under a generic feature characteristic. In that way we identify seven pattern of usage; inter-connectivity, content authoring, content tagging & rating, file sharing, content aggregation, content remixing and content streaming as follows:

	O'Reilly (Baumann, 2006)	Ganesh & Padmanabhuni (2007)	Anderson (2007)	McAfee (2006)	Chawner (2008)
Inter-connectivity	User participation Network Effect	Collaboration Participation Network effect	Collaboration Networking	Link	Content consumer Content commenter

Content authoring		Content co- creation	Office-style software	Authoring	Content creator
Content tagging & rating	Knowledge Collective intelligence	Collective intelligence	Tracking and filtering	Tag Search Extension	Content creator
File sharing	Information sharing	Information exchange File sharing	Office-style software		
Content aggregation		Aggregation	Aggregation	Signal	Content collector
Content remixing		Mashups	Data mashups		
Content streaming		Podcasts			

Table 2: Classifying Patterns of Usage of Web 2.0 Applications

4   MAPPING PATTERS OF USAGE TO WEB 2.0 TOOLS

i   **Inter-connectivity:** Web 2.0 types share a common feature which is an architecture that encourages interactions, collaboration and participation. For example, blogs let Internet users to participate through posting comments (Chawner, 2008, Cosh, 2008). Similarly, social networking sites allow rich inter-connectivity between participants, such as chat, post notes, as well as sharing data, or user profiles among the members (Barsky et al., 2006). Web 2.0 also enhances content collaborative editing, where several users can collaborate in editing the same content and share it among several others at the same time. For example with wikis or Office 2.0 users can interact and collaborate in editing each others' contributions (Franklin et al., 2007). Connecting people and enhancing interactions and participation among them are major goals of Web 2.0 (Barsky et al., 2006).

ii   **Content authoring:** This is another important characteristic of Web 2.0 referring to authorization to co-create content and publish it over the Internet. This would facilitate and fasten content creation and publishing as usually people need to contribute to a certain topic, for example work information, facts, hobbies, etc. In that regard, blogs give the blog creator individual authority to generate his/her own blog, whereas wikis and Office 2.0 enable group authorizations; i.e. several participants can edit each others' work (McAfee, 2006). Content quality is a major concern in content authoring as according to Anderson (2007).

iii   **Content tagging & rating:** One of the challenges appeared with Web 2.0 applications that involves mainly user generated content is classification. Traditionally to classify a content taxonomy was used, however it becomes more difficult to apply with the huge diverse background of participating users with different languages, etc. This gave rise to a classification technique called folksonomy; in which the responsibility of classifying content is given to the community along with the responsibility to create and maintain that content. The community decides where this content belongs to by the use of "tags" (Mathes, 2004; Gruber, 2007). Tagging enhances social search as applied in social networking websites. Furthermore, tagging can rely on a technique called content clouds which is a visual representation of the frequently

used tags (Jones, 2006), if a certain tag is frequently used to classify a website this means that this website is concerned most with the subject of that tag (Cosh, 2008).

iv **File sharing:** With the advancements in P2P networks and the relatively low cost of digital media devices, such as digital cameras several Internet users can now upload and share media files over the Internet (Anderson, 2007). P2P networks fasten the exchange of files by opening direct sessions between the users without the need to stream content or files through the server, like in social networking chat rooms, file sharing services websites, Skype, online games, etc.

v **Content aggregation:** The growth of Web 2.0 applications has given rise to tools that perform a notification or syndication functionality aiming to keep users updated with their favorite sites (Boulos & Wheeler, 2007). While having continuously added and updated content over the Internet it is important to keep up with changes regarding this content, especially when users are interested in multiple sources of information scattered over multiple Web sites. An aggregator or feed reader can be used to centralize all the recent changes in the sources of interest, and a user can easily visit the reader/aggregator to view recent additions and changes (Chowdhury et al., , 2006). The feed aggregator can syndicate several Web content, such as news headlines, blogs, file sharing resources, etc. This can be also coupled with mashups; re-mixing aggregated content like in Yahoo Pipes.

vi **Content remixing:** This involves mashup-based services that refer to Web applications combining data from more than one source into a single integrated tool. This is implemented by accessing open APIs and available data sources to produce another meaningful application (Craig, 2007). Thus, mashups are Web-based applications that inter-mix content from multiple online sources (McConchie, 2008). For example, Paul Rademacher's housingmaps.com combines Google Maps with Craigslist apartment rental and home purchase data sources to create a richer housing search tool (O'Reilly, 2005).

vii **Content streaming:** Audio or video files can be transmitted as live or archived files. Streaming techniques imply content to be streamed directly to users, not downloaded from or a single server computer, thus it uses P2P networks. This makes access feasible for slower connections. Applications that use streaming include satellite channel webcasts and virtual reality games. Videoconferencing applications are also a kind of streaming that uses certain software to share screens via online chat, audio and video resources (Raunik, 2005).

By reflection on Web 2.0 tools and their underlying technologies as discussed in section 2 , we can conclude architecture, technologies and techniques required for different Web 2.0 tools classified by patterns of usage (Table 3).

	Pattern of use							Architecture	Technologies	Techniques
	Inter-connectivity	Content authoring	Tagging & rating	File sharing	Content aggregation	Content remixing	Content streaming			
Blogs								Client-server	Web scripting tools	
Wikis								Client-server	Web scripting tools	Content quality
Social networking								Client-server RIA P2P	Web scripting tools & RSS	Rating Pattern matching
Social bookmarking								Client-server	Various scripting tools	Folksonomy Content cloud Rating Pattern matching
Web feeds								Client-server	RSS	Syndication
Mashups								SOA	Open API, Web services	
Webcasts & Streaming								P2P	Multimedia protocols & languages	Multimedia Streaming Techniques
Multimedia file sharing								P2P	RSS	Folksonomy
Virtual reality								Client-server P2P RIA	VRML	Multimedia Streaming Techniques
Office 2.0								Client-server RIA	AJAX	

Web 2.0 types (row label along left side)

Table 3: Mapping Web 2.0 Tools to Patterns of Usage & Underlying Technologies, Techniques & Architecture

5 REFLECTION ON REAL CASE WEB 2.0 SUPPORTED APPLICATIONS

e-Bay is an example of an e-commerce application that adopts multiple Web 2.0 features. Based on exploring e-Bay website we identify for example a section called "community" that includes facilities of a *discussion forum* where users can discuss eBay-related topics, such as their shopping experience, share their opinion about a certain product, etc. There is also a blog where users can post comments about products they have purchased through e-Bay. Chat rooms are also available where users can socialise to build intimacy with the e-Bay application. There is also the option of creating virtual community groups of various interests like in Facebook, where users can share common interests publicly or in person. Thus eBay supports the **interconnectivity** feature of Web 2.0 that enhances participation, collaboration and interactivity. This enables sellers to become highly responsive to buyers which enhance customer service and help sellers to better understand customers providing them products that best suit them as supported by Lee and Lin (2005). Another Web 2.0 feature applied in e-Bay is **content rating** that enables users to rate and provide reviews about different products and sellers. This leverages online trust and helps sellers establish a profound reputation that will lead to customer loyalty (Walla and Zahedi, 2008). **Content syndication** is also a Web 2.0 feature applied in eBay where sellers can use feeds to inform buyers about new products or availabilities of products in store inventories, as well as notify about running auctions or so called "buy it" now listings that refer to promotions for products of interest. In this way buyers will not need to surf constantly the application to check for updates which will definitely enrich the customer shopping experience (McAfee, 2006).

HousingMaps is an example for mashup applications that put forth an important feature of Web 2.0 which is **content remixing**. Housing Maps offers a combined source that gets rental listings from two open services available on the web; Craigslist, a famous classifieds free service, and Google maps, a free interactive mapping service that enables direct access to maps or satellite images taken for any part of the globe. The application interprets listings from Craigslist and displays them on Google Maps using Google Maps' API (Christopher, 2007, Yee, 2008). The result is a visual map of who is renting apartments and where are these apartments. According to Yee (2008) Craigslist provide RSS feeds with news about, for example the best of Craigslist postings or apartments for rent in a certain city, however these RSS feeds do not provide enough information about listing positions and other important details. As a result HousingMaps.com uses **web crawling** technique in order to search Craigslist for real-time detailed information about listings. As stated before in previous sections mashup applications are usually based on RSS feeds and open APIs in order to integrate data from more than one source into a single one. Moreover, as shown in HousingMaps.com example web crawling technique can be also used in order to retrieve real-time data not found on open APIs or RSS feeds.

GoogleDocs is an example of a Web 2.0 enabled application that falls under the category of Office 2.0. This application offers a web-based functionality that resembles Word applications with a desktop like responsiveness facilitated by AJAX engine (Craig, 2007). GoogleDocs enhances features like **inter-connectivity** by enabling users to collaborate and edit the same document simultaneously with no need to reload the edited document every time to see the alterations, which as a result improves **content authoring** and find means for **content sharing**. The application also offers mobile access, in which users can browse their documents and follow updates on their mobile phones, this accessibility enhances even more the effect of social networking and enables for more inter-connected users who can be always involved. Additionally, GoogleDocs covers an important feature of Web 2.0 which is **content syndication;** where users can instantly receive RSS feeds regarding a certain document of interest whenever updates happen to the document.

Twitter is an example of Web 2.0 application that facilitates social networking through micro blogging. This application enables users to send and receive updates, called tweets that are posts limited to 140 characters. Senders deliver tweets to other users, called followers, who have previously subscribed to the sender's page. This can be done either through twitter web site or via SMS. The ease of use, speed, and accessibility encouraged the wide spread of twitter in several disciplines aiming to enhance **inter-connectivity** among users and again help to create a tighter network of friends sharing the same interests. Examples of twitter applications include 2008 US presidential elections that relied on twitter as a publicity method, e.g. President Barack Obama used it to send real time updates to followers. The same way happened with the Iran 2009 elections where twitter enabled electors to become updated with news about their candidates. Another interesting phenomenon of how social networking can help increase awareness in crisis management is applied by the American Red Cross that uses Twitter to warn users about local disasters. Twitter also can be used as an online marketing tool where businesses can promote their products and form a network of followers who are constantly updated with any new offerings. Another major Web 2.0 feature offered by Twitter is **content syndication** that enables users to be synchronously updated with followers' posts and feeds. Twitter also offers open APIs that enable integration with other services and applications such as Facebook.

In that way we can conclude how the different cases applied different Web2.0 patterns of usage as shown in Table 4.

		Pattern of usage					
		Inter-connectivity	**Content authoring**	**Content tagging & rating**	**File sharing**	**Content aggregation & syndication**	**Content remixing**
Web 2.0 Enabled Examples	**e-Bay**	Discussion boards, blogs, chat rooms, virtual community group		Enable users to rate and provide reviews on products and sellers		Syndicate updates on user favorite products and sellers	
	Housing Maps						Combine data from Craigslist and Google Maps
	Google Docs	Collaborate on same document	Co-create content		Share content directly with users with no need actually to stream or download content	Syndicate updates happening to a document of interest	
	Twitter	Send user's tweets almost				Syndicate other user's tweets	

			instantly, accessibility				

Table 4: Mapping Web 2.0 Real Cases to Web 2.0 Patterns of Usage

6   CONCLUSION

By mapping various Web 2.0 tools (blogs, wikis, social networking, etc.) to their specific patterns of usage, their underlying technologies, techniques and architecture as indicated in Table 3 (see section 4) we can match Web 2.0 patterns of usage along with their required technologies, techniques and architecture. We also investigated four different Web 2.0 enabled examples with the aim to apply the proposed Web 2.0 patterns of usage on real case applications (see section 5). By doing so we found out that minor alterations could be done to our classified patterns of usage for further accuracy and better clearness. These include changing the pattern of content aggregation to include syndication as well, as for twitter the application acts as a syndicated forum rather than just a news aggregator. Techniques like web crawling and web semantics technologies should be also added to the classification of Table 3 as web intelligence is an important part of Web 2.0 applications, these are included in search engines, mashup based services or using user profiles and personalisation for e-commerce applications, as well as wiki-based applications. Device-independence or in other words platform independence became also apparent as an important technical feature for Web 2.0 when investigating cases like twitter and e-bay. Moreover, security has been found out as another important feature for Web 2.0 applications. We can thus summarize the different Web 2.0 patterns of usage and related architecture, technologies and techniques as in the following table (Table 5).

	`	Architecture	Technology	Technique
Web 2.0 Patterns of Usage	Inter-connectivity	Clint-server Device- independent RIA	Web scripting tools AJAX RSS Web semantics	
	Content authoring	Client-Sever Device- independent RIA	Web scripting tools AJAX RSS Web semantics	Content quality User profiles Security
	Tagging & Rating	Mainly client Server Device- independent	Web scripting tools RSS	Rating Pattern matching Reviews Folksonomy
	File sharing	P2P or client-server Device-independent	Web scripting tools AJAX RSS web semantics	File sharing SW Rating Folksonomy Security
	Content aggregation & syndication	Mainly client-server Device-independent	Web scripting tools RSS	Syndication
	Content remixing	SOA	Open API RSS feeds web services web semantics	Web crawling
	Content streaming	P2P Device- independent	VRML	Multimedia streaming techniques

				Security

Table 5: Web 2.0 Patterns of Usage & Related Architectures, Technologies & Techniques
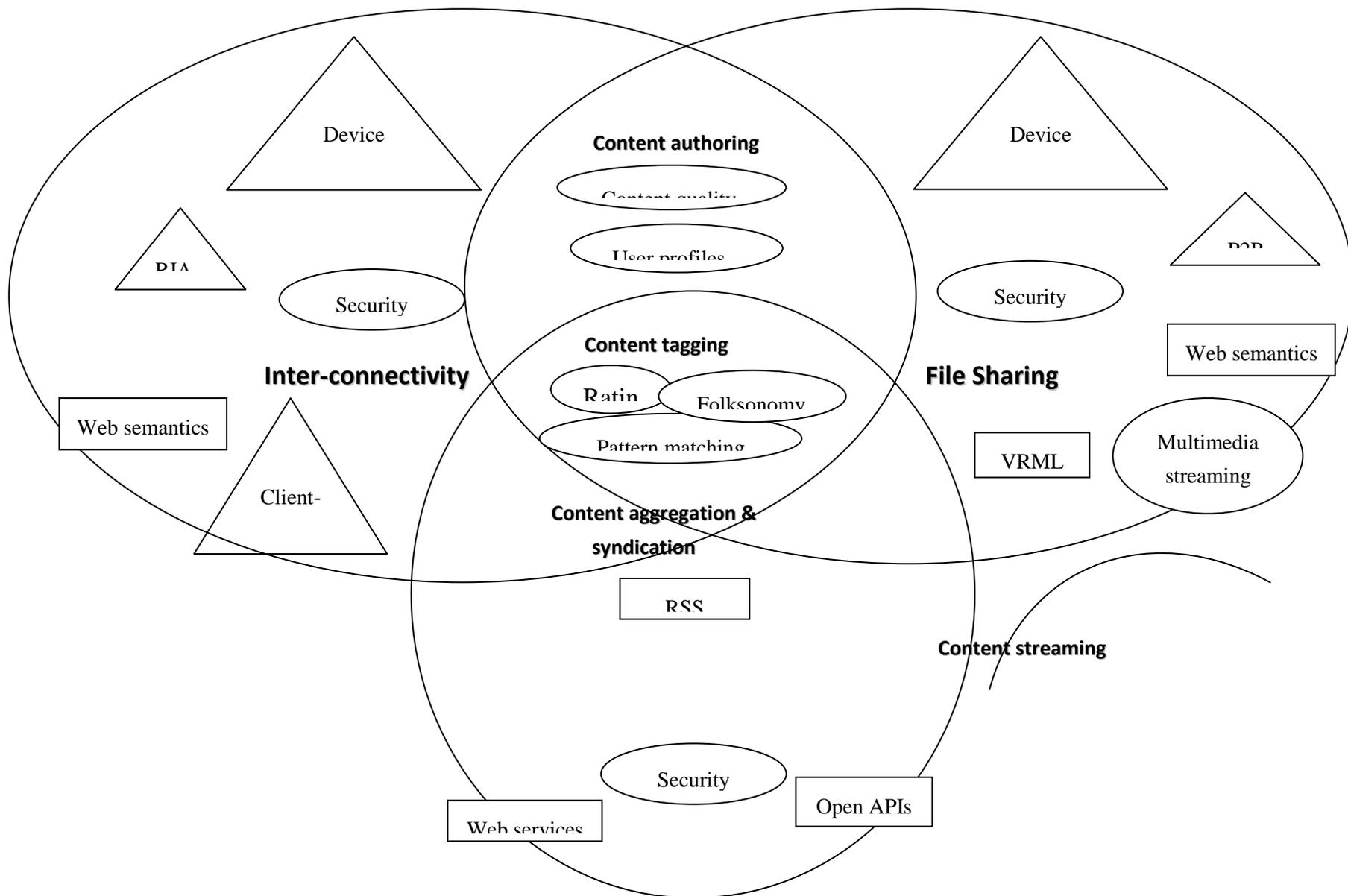
The significance of each classified pattern of usage may vary according to the nature of the Web 2.0 application. For example for e-learning systems we expect the application to depend more on inter-connectivity, content authoring, file sharing and content streaming. On the other hand, for e-commerce applications inter-connectivity, content aggregation and content tagging & rating, in the form of comments and reviews would be the key major items. The introduced classification of Web 2.0 patterns of usage can be also used for assessment purposes, trying to find out missing Web 2.0 elements in current applications. For example, in e-Bay application a **missing** design pattern is tagging that would enable social searching; as users can tag a certain product under an informative tag relevant to the user experience, so that others can search for the same product using tags assigned by other shoppers. Tags may also be further extended to include pattern matching (McAfee, 2006). For example, recommending several links that match or even extend the user's purchased items. Mashups and podcasts may also add value to e-Bay, by for example interlinking related services, e.g. electronic appliances with household services, or sharing podcasts about a certain product, etc.

Referring to Table 5 we can conclude that there are repetitions in architecture, technology and techniques for the various patterns. Therefore, we will collate the common features to come up with only three main patterns of usage: interconnectivity, content sharing and content remixing. These are required to provide basis for the other four patterns. Intersections between the three basic patterns can yield other supportive patterns. For example intersection between interconnectivity and file sharing will provide the basis for content authoring (see Appendix Figure 1). Same for the intersection between interconnectivity, file sharing and content re-mixing will cover patterns like content tagging and content aggregation and syndication. Based on our previous analysis (Table 3 &Table 5) content streaming is part of file sharing. However we still need to investigate case studies that will cover the use of file sharing with content remixing as the four cases we covered before do not involve this mix.
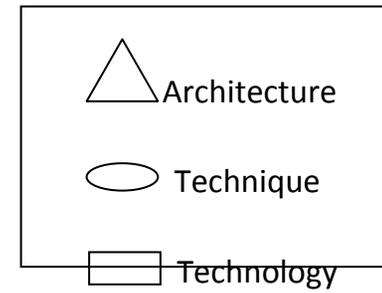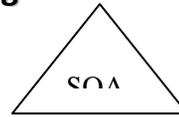
As concepts and principles of Web 2.0 are still evolving, it is proposed that introduced Web 2.0 patterns of usage (Figure 1see Appendix) represent a useful contribution and roadmap guiding the design and development of Web 2.0 supported applications. We suggest that the identified patterns represent a useful classification for both practitioners and researchers. Practitioners will in particular gain a better understanding of Web 2.0 tools' characteristics in terms of their specific functionality/pattern of usage, as well as required technologies, techniques and architectures. This will help them better analyze, design and develop Web 2.0 supported applications. Researchers can make use of the classification to better understand functional and technical requirements for Web 2.0 supported applications that would improve conceptualizing the specific nature of Web 2.0 applications. The research is still in its first stages and future work will cover applying identified patterns of usage on several case studies in order to identify if they match the introduced classification or not? Of particular interest is the validation of breaking down the patterns into elementary, basic (inter-connectivity, file sharing and content remixing) and the supportive, secondary patterns (content streaming, content authoring, content tagging and content aggregation & syndication).

Appendix

Content authoring

Content quality

User profiles

Security

Inter-connectivity

Web semantics

Content tagging

Ratin

Folksonomy

Pattern matching

File Sharing

Web semantics

VRML

Multimedia
streaming

**Content aggregation &
syndication**

RSS

Content streaming

Security

Web services

Open APIs

Device

RIA

Client-

Device

P2P

Content remixing

Web semantics

SOA

Architecture

Technique

Technology

Figure 1: Road map for Web 2.0 Patterns of Usage and Related Technical Requirements

Rich Internet Application (RIA) Web 2.0 technologies allow for a more robust user experience than traditional Web applications. RIA is a combination of GUI -style (Graphical User Interface) applications and Multimedia content (Petrassi, 2008). It aims to build Web-based software that works and gives the user a similar experience like a desktop-based software program. A key technical component that facilitates this type of software is AJAX (Asynchronous Javascript and XML). According to Garett (2005) instead of loading a Webpage at the start of the session, the browser loads an Ajax engine that is responsible for both rendering the interface the user sees and communicating with the server on the user's behalf. The Ajax engine allows the user's interaction with the application to happen asynchronously, i.e. independent of communication with the server and in that way will speed up processing on the client side. AJAX technologies are applied heavily in applications, such as Gmail (Google's email program), Google Docs (online to-do lists, calendars, reminders and planners) and Flickr (a photo organizer and comment sharing application).

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