UNIVERSITY OF BEIRA INTERIOR
Engineering

A New Model of Web-based Application to Social Networking Management Systems

Diogo João Pinto Ribeiro

Dissertation Submitted in Partial Fulfillment of the Requirement for the
Degree of Master of Science in
Computer Science and Engineering
(2nd Cycle Studies)

Supervised by Prof. Dr. Joel José Puga Coelho Rodrigues

Covilhã, October 2014

To my beloved family,
especially to my parents and my grandparents.

Acknowledgements

This dissertation marks the end of another academic stage in my life. A dissertation for obtaining the degree of Master of Science represents a long and demanding path. The support of very particular persons has encouraged me to continue my work, day after day. I would like to thank all persons who directly or indirectly contributed to my work throughout the last year.

I would like to start by thanking to my mother and my father, to whom I am mostly grateful, to doing everything to provide me the best and for helping me to achieve my goals in different areas, but particularly on academic life. I also would like to thank my sister Márcia, for her immeasurable friendship and support, and my uncles and grandparents, for always demonstrating their love, their support and will to live.

I am also grateful to my friends for their strength over the past few months and to encourage me to continue. Foremost, I would like to express my gratitude to Patrícia, who always knew where and how to be present in the most important moments of my life. Her support, patience and help during difficult times, was crucial for me to finish this stage in my life.

Last, but not least, I express my gratitude to my supervisor, Prof. Dr. Joel Rodrigues, for agreeing to suppervise my dissertation, for his friendship, availability, comprehension and for giving me the opportunity to gain some experience in the Computer and Software Engineering area. I also acknowledge the Next Generation Networks and Applications Group at the *Instituto de Telecomunicações* to hosted the final project of my 3-year Bachelor of Science and this dissertation research.

Thank you all,

Diogo João Pinto Ribeiro

Resumo

O aparecimento da Web, nos anos 90, contribuiu para a criação de um novo conceito de partilha e interconectividade. Considerada por muitos a maior invenção do Século XX, a Internet, e em especial a Web, rapidamente se tornou uma ferramenta de trabalho indispensável em muitos aspectos da vida quotidiana da população mundial, mudando o pensamento das pessoas, desde a forma como se compra através da Internet à forma como se comunica de uma maneira completamente inovadora e sem precedentes. Graças ao aparecimento da Web 2.0, a segunda fase na história da sua evolução, a Web tornou-se numa ferramenta muito mais interactiva e colaborativa facilitando assim a partilha online de diversos contúdos multimédia. Esta tecnologia é considerada como uma colecção de novas tecnologias, estratégias de negócio e de tendências sociais, permitindo que os programadores, de uma forma fácil e intuitiva, criem aplicações inimagináveis até aqui.

A ascensão dos blogs, em 1997, desencadeou uma nova maneira de comunicar e partilhar informação entre utilizadores sob a Web. De facto, os blogs aumentaram exponencialmente em poucos anos, levando mesmo a acreditar que uma nova tendência social estava para nascer. Posteriormente, com o aparecimento das primeiras redes sociais, essa tendência social acabou mesmo por se confirmar. Nos dias que correm, as redes sociais fazem parte do dia-a-dia de biliões de pessoas em todo o Mundo sendo, por esse motivo, consideradas como um novo meio de inovação baseado na Web. É através de redes socias que as pessoas recebem a maior parte das notícias pela manhã, gerem os seus negócios, conhecem e mantêm contacto com outras pessoas. Nos últimos anos, redes sociais como o *Facebook*, o *LinkedIn*, o *Google+*, o *Twitter*, o *Foursquare* ou o *YouTube* tornaram-se extremamente populares. Algumas destas redes sociais, como é o caso do *Facebook*, possuem mais pessoas que grandes países. Em 2012, o *Facebook* possuia cerca de 1.01 biliões de utilizadores activos. As redes sociais são uma reflexão do que acontece no Mundo real, onde as pessoas podem partilhar informação e comunicar à distância de um click.

Os blogs surgem perante a necessidade dos utilizadores pretenderem criar e gerir conteúdos, de partilhar interesses e pontos de vista com outras pessoas. Para responder a estas necessidades, foram criados sistemas como o *Blogger* ou o *WordPress* que permitem criar e gerir blogs permitindo assim que utilizadores assumam o papel de administradores e que tenham a capacidade de gerir conteúdos multimédia. Com o aparecimento das redes sociais, tornou-se comum que os utilizadores pretendam criar e gerir as suas próprias redes sociais, as suas próprias comunidades sociais, de acordo com determinados interesses.

Esta dissertação foca-se na criação de uma aplicação/plataforma Web que permita que utilizadores possam criar e gerir as suas próprias redes/comunidades sociais. Através desta plataforma, os utilizadores assumem o papel de administradores podendo criar e gerir conteúdos de uma forma completamente inovadora, fácil e bastante intuitiva. Como administradores, poderão criar uma diversidade de comunidades sociais de acordo com interesses distintos, disponibilizando-as assim a outros utilizadores. Por sua vez, esses utilizadores terão a capacidade de usufruir de todas as funcionalidades da rede social, podendo partilhar conteúdos, editar perfis e informações pessoais, fazer amigos e interagir com eles. Para investigar este tema, o trabalho apresentado nesta dissertação estruturou-se em duas partes. Primeiro, elaborou-se um estudo

aprofundado dos conceitos relacionados com redes sociais. O fluxo de discussão passa depois para o tópico relacionado com sistemas gestores de conteúdos online, nomeadamente para os sistemas gestores de blogs e para softwares que incluem características de redes sociais. Fazendo uma comparação entre diferentes sistemas, elabora-se uma nova solução e procede-se à implementação da mesma. Comparativamente com o software existente que permite a criação ou integração de características de redes sociais, esta nova solução não requer qualquer tipo de processo de instalação, uma vez que é uma solução completamente integrada na Web. Do mesmo modo, esta plataforma distingue-se da maioria do software existente, visto que é uma solução completamente gratuíta. No que diz respeito às características sociais, esta plataforma distingue-se pelo facto de as características implementadas estarem integradas e também não requererem qualquer tipo de intalação, como por exemplo via plugins ou módulos.

Palavras-chave

Redes Sociais, Comunidades Sociais, Sistemas de Gestão de Redes Sociais, Multimédia, Computação na Núvem, Web 2.0

Abstract

The emergence of the Web, in the 90's, has brought a new concept of information sharing and interconnectivity. Being considered the greatest invention of the 20th Century, the Internet, and especially the Web, quickly became indispensable in many aspects of modern human life, changing the mindset of people ranging from how they go shopping through the Web to how they communicate in a completely innovative and unprecedented ways. With the advent of the Web 2.0, the second phase on the evolution of the Web technology, the Web became a much more interactive and collaborative tool, becoming easier to share online content. This technology is based on two distinct paradigms: usability and technology. It is considered a collection of new technologies, business strategies and social trends that let developers, easily and quickly, create new Web applications that were unimaginable until now.

The rise of the blogs, in 1997, triggered a new way to communicate and share information among users over the Web. In fact, blogs increased exponentially in few years, which led to believe that a new online social trend was emerging. Later, with the emergence of online social networks, that social trend was confirmed. Nowadays, online social networks are part of everyday life for billions of people all over the globe, being considered as a new venue of innovation over the Web. It is through social networks that people get news in the morning, do business, meet and maintain contact with other persons. In the past few years, social networks such as *Facebook*, *LinkedIn*, *Google+*, *Twitter*, *Foursquare* or *YouTube* became extremely popular. Some of these social networks, like *Facebook*, have more people than large countries. In 2012, *Facebook* had 1.01 billions of active users. Online social networks are a reflection of what happens in the real world, where people can share information and communicate just a mouse click away.

Blogs came to bring the facility that users needed to create and maintain content, share interests and different points of view with other persons. To meet this needs, were created systems like *Blogger* or *WordPress* that let users create and manage blogs assuming the role of administrators and have the capability to manage online contents. With the advent of social networks, became common the desire of some users to create and maintain their own social networks, their own social communities, according to a different type of interests.

This dissertation focuses on the creation of a Web-based application/platform which let users to create and maintain their own social communities. Through this platform, users assume the role of administrators where they can create and manage online content in a completely innovative, easy and very intuitive manner. Like administrators, they can create a diversity of social communities according to distinct interests, providing that communities to other users. On the other hand, that users have the capability to explore the entire community and can share comments or multimedia content, edit profiles and personal info, make friends and interact with them. To investigate this topic, the work presented in this dissertation was structured in two parts. First, a depth study about the concepts related with social networks was prepared. The discussion flow then passes to the topic related to online content management systems namely to the blogs management systems and software that include social networking features. Making a comparison between this type of systems, a new solution was presented and implemented. Compared with existing software that make possible create or integrate social networking features, this new solution don't need any kind of installation process as well as technical knowledge once it

is a fully integrated solution on the Web. Similarly, this platform is distinguished from most of the existing software because is a free solution. Relatively to social features, this platform is distinguished because the social features implemented are integrated without need any kind of installation support, via plugins or modules.

Keywords

Contents

List of Figures

List of Tables

Acronyms

OSN	Online Social Network
SNS	Social Networking Site
CMS	Content Management System
API	Application Programming Interface
MVC	Model-View-Controller
DBMS	Database Management System
HTTP	Hypertext Transfer Protocol
TCP	Transmission Control Protocol
IP	Internet Protocol
UBI	University of Beira Interior
IT	Instituto de Telecomunicações
NetGNA	Next Generation Networks and Applications Group

Abbreviations

Please consider the following abbreviations with the respective meaning with later invoked in the text:

e.g.   originates from the Latin expression *exampli gratia* which means "for example."

i.e.   originates from the Latin expression *id est* which means "that is." or "in other words."

Chapter 1

Introduction

This dissertation constitutes a partial requirement to obtain the degree of Master of Science in Computer Science and Engineering at University of Beira Interior, Covilhã, Portugal, and describes a research work on the subject of social networking management systems. The focus and scope of the dissertation are firstly described in this chapter, followed by the problem statement and objectives. The adopted approach to solve the problem, the main contributions, and the dissertation overview are discussed in the three last sections.

1.1   Focus and Scope

The emergence of The Web, in the 90's, has brought a new concept of information sharing and interconnectivity, which became a plus for the people's daily life. Being considered the greatest invention of the 20th Century, the Internet has quickly become indispensable and today is an essential resource for the daily work of users and enterprises being used for almost activities like entertainment and business, among many others. Through its evolution, the Internet, together with the information services, mainly the Web, changed the mindset of people ranging from how they go shopping to how they communicate with their friends in unprecedented ways. In the past few years, the volume of user-generated online content has skyrocketed exponentially. The Web 2.0 made easier to share online content, transforming the Web in a much more interactive and collaborative tool based on two distinct paradigms: usability and technology itself. It is considered a collection of new technologies, business strategies, social trends that let developers, easily and quickly, create new applications that were unimaginable until now.

The rise of the blogs triggered a new way to communicate and share information among users over the Web. The emergence and growth of blogs in the late 1990's coinced with the advent of Web publishing tools, like Content Management systems, which facilitated the posting of content by non-technical users (previously, a knowledge of such technologies as HTML and FTP had been required to publish content on the Web). A Content Management System (Web CMS) is a bundled or stand-alone computer application to create, deploy, manage and store content on Web pages. The main feature of content management systems is to store and organize files, and provide version-controlled access to their data. A blog software, or simply *blogware*, act as a content management system and was designed for creating and managing blogs. Over the years, it has been found a wide variety of systems that respond to this type of necessities. Different software provides different features, although all of them provide the basic elements needed by casual bloggers. They allow users to create a variety of blogs, assuming the function of administrators by letting them manage contents, themes and other features. The majority of blogs provide commentary on a particular subject; others function as personal online diaries; and others function more as online branding advertising of a particular individual or company. In fact, blogs increased exponentially in few years, which led to believe that a new online social trend was to born. Later, that social trend was confirmed.

Nowadays, Online Social Networks are part of everyday life for billions of people all over the globe, being considered as a new venue of innovation based on the Web technology. The concept of the first existing social networks was to use profiles to give information about a user and his or her interests. Now social networking involves sharing stories, photos, and involves the use of apps as well as messaging to communicate with others. It is through social networks that people get news in the morning, do business, meet and maintain contact with other persons and users are revealed and become influential. The field of social networking studies how people are connected as well as their relationships with a specific community. This type of social networking did not become popular until the year 2003 when *MySpace* and *Friendster* were launched but, in the past few years, social networks like *Facebook*, *LinkedIn*, *Google+*, *Twitter* or even *YouTube* became extremely popular. Some of these social networks have more people than large countries and are continuing to advance to provide better features for users, and their popular sites will continue to grow up in size. In 2012, *Facebook* had 1.01 billions of active users using the site each month. Online social networks are a reflection of what happens in the real world, where people can share information and communicate just a mouse click away. Due to this fact, sometimes is necessary to explore some of the pros and cons of social media and its effects on our society. Statistics show that 70% of adults have used social media sites to connect with relatives in other states, and 57% of teens have reported making new friendships on social media sites. Likewise, students with Internet access at a rate of 50% have reported using social networking sites to discuss school works, and another 59% talk about instructive topics. Members of groups on social networking sites discuss their health, share important information and resources relevant to their conditions while creating strong support network which led to believe that they can have a better quality of life. Social networking sites also are a important source of employment. Specific sites such as *LinkedIn* are a major resource that 89% of jobs recruiters take advantage of when looking to hire potential employees. On the other hand, social networking platforms are a direct cause for identity theft, cyber bulling and lost productivity at the workplace. For many people, social networking was the biggest waste of time in comparison to activities like shopping, watching television among many others, being the cause for less face to face communication once many people assume that spending less time with others. Social networking sites vary greatly with the features they have to offer, and is what makes each site different from the other. Now social networking is becoming mobile and can be accessed through the use of a smartphone. It is thought to be a great idea and would increase the use of social networking since a lot of people carry smartphones with them at all time. People can use mobile phones to update their status, post comments, upload photos, send messages and update profiles from anywhere. This allows people to be able to get things done as well as take some time to log onto social networks. Making social networks accessible through smartphones is also expected to increase the number of users by a significant amount.

Social networking has its advantages and disadvantages like everything else does. The sites are continuously advancing, and changing to fix the negative problems. Most users have stated that they have had only positive experiences with social networking, and very few people experience cyber bullying. There are still problems that need to be fixed, but it seems that the positive effects outweigh the negative effects. Social networking is a very valuable tool that can be used to meet new people, and allow people to remain in contact with friends. Even though it can waste time, social networking positively affects the world by allowing people to communicate, and remain in contact with friends in an easy and convenient way.

2

1.2 Problem Statement and Objectives

Social networks are now one of the most widely used aspects of the Web and have really taken off over the past few years. Many business, organizations, communities and families are using social networks to promote themselves, to communicate better with others, and to engage with their audience. Social networks allow users to connect with others and build a contact network. They provide a community with collaboration and contribution features as well. This allows the content and information within the social network to be grown by the users themselves. Leading users to create their own social networks or social network tools gives them a dedicated customer area, where feedback on products and services can be obtained. Areas that allow customers to share tips, resources, and product care tips help promote those products or services. There are a wide variety of popular and successful social networking websites and social networking products out there, so what is the need that takes users to want to create their own social networks, managing their own social communities? Creating their own social networks, their social communities, users can take a more active role on it, leading them to assume the role of administrators where they can manage users and their content. Many users have interest in a specific topic, wishing to share it with other people that have the same interest. Existing social networks are not the best vehicle to share specific contents. In *Facebook*, for example, are shared thousands of stories related to different topics by thousand of people which doesn't facilitate the search and selection task for those interested in a specific topic. On the other hand, the creation of groups in this type of systems seeks to fill this gap. However, most of these groups are restricted by a certain number of users, being hidden.

The main objective of this dissertation is the development of a platform, fully integrated on the Web, that enables the creation of social networks subject to a specific topic or theme. It is intended that this platform has intuitive and easy to access by the all type of users, without any kind of technical knowledge. Users can register and create their own social networking communities assuming the role of administrators and making a full management of the contents of the respective social community. Each user can create multiple social social networking communities, referring to different topics, not being defined any limit on the number of social communities by administrator. Subsequently, those social networking communities are available so that all people can register and enjoy the same. As critical factor for the development of this platform points up the fact that for a given topic may be exist more than one social community, making the selection of news more complicated.

1.3 Adopted Approach for Solving the Problem

To achieve the objectives described in the previous section, the research work of this master program was divided into the following tasks:

1. The first task consists in reviewing this area of knowledge, so as understand the basic concepts related with the problem and, therefore, prepare for the subsequent tasks. It should start by exploring the social networking paradigm and the software in the computational context.

2. The second task consists of surveying the academic and industry publications to elaborate a concise perspective over social networking management systems.

3. The third task is focused on find open issues in the state-of-the-art work. This task is considered the most important since its the one that defines how this dissertation will add value to the existing scientific work.

4. The fourth task consists in studying social networking features and choose the appropriate technologies that will allow the implementation of the new proposed solution along this dissertation.

5. The fifth task should be build on the knowledge obtained in the previous tasks to implement a innovative, intuitive and consistent platform to help users to create their own social networks and make a full management of contents, using a fully integrated web application, and without need any kind of technical knowledge.

6. The last task is focused on the system evaluation, showing its feasibility and highlighting the best characteristics of the proposal. The prototype should be an example of a social networking management system to use.

1.4   Main Contributions

This section briefly describes the scientific contributions resulting from the research work represented by this dissertation. The main contributions may be structured and described as follows:

1. The first main contribution of the work presented in this dissertation comprises a comprehensive study, in a complete perspective, of the basic concepts related with the field of development of online social networking platforms. Within the scope of this dissertation, the contribution particularly focuses on the topic of the present features in this type of platforms/software. Such study consisted in reviewing the literature thoroughly, compiling and organizing significant amount of references related to the addressed issue, and proposing a new approach, that is, a new model to online social networking platforms. This research work was on the basis of one publication: a paper accepted for publication and presentation in the 9th International Conference on Communications and Networking in China (Chinacom) [RRHN14], held in Maoming, People's Republic of China, China, between the 14th and 16th of August, 2014, being presented with the Best Paper Award on the Multimedia Communications & Smart Networking Symposium (see Appendix A.1).

2. The second main contribution relates to the creation of a new concept about creating social networks related with specific themes, where people who share the same interests can connect to each other, sharing experiences and content creating small and large social communities. Through this contribution, is addressed one of the main objectives of this masters program.

3. One last contribution consists in adapting the concept of blog management systems for the field of social networks, where different users can create an amount of social networks assuming the capacity to administer and manage all contents. The prototype of the presented model also results of the inherent work to this contribution. Firstly, different features of different software was revised. Later, an analysis of the same features is included in order to answer to some kind of problems. The model is described, along with the presentation of the prototype.

1.5 Dissertation Overview

This dissertation is organized in five main chapters. The body of the dissertation is constituted by three chapters, preceded and succeeded by the Introduction and the Conclusions and Future Work chapters, respectively. The contents and organization of the main chapters of this dissertation can be summarized as follows:

– **Chapter 1** contextualizes the problem addressed in this dissertation by introducing the subject, focus and scope of the research work. The adopted approach for solving the problem is also outlined in this chapter, along with main contributions of the underlying research work. Last, the organization and structure of the dissertation is described.

– **Chapter 2** first explains the basics of content management systems, so as to better understand the remaining part of the dissertation. It also provides a detailed perspective over existing blog and social networking software, identifying the main gaps in the state-of-the-art. From the identifying gaps, this chapter also clearly identifies the problem to be studied in this dissertation.

– **Chapter 3** outlines the method taken to address the problem described in the section 1.2. Firstly, a brief description of the used technologies was given to explain the fact that the sames have been chosen. It also explained the implementation of the solution presented in this dissertation and how it is structured.

– **Chapter 4** starts from the presentation of some results of the proposed solution when compared with other existing solutions, such as the web user interface, the installation process and the social networking features available.

– **Chapter 5** includes some final remarks regarding the problem addressed in this dissertation, and then presents the main conclusions of this dissertation as well as possible directions for future work.

In order to maintain consistency along the dissertation, the long form of an acronym is repeted in the initial chapters, such as Resumo and Abstract, and only once more from the Introduction chapter onward.

Chapter 2

State-of-the-Art on Social Networking Software

This chapter elaborates a depth study on the existing social networking systems, software or platforms. Throughout this chapter, some important and related concepts are discussed and is made a review of the main features that make this type of systems the most used and desired systems on the Web.

2.1 Introduction

Nowadays, File-Sharing Systems and Social Networking Systems are the most sought systems by Internet Users. Together, they represent more than half of the total traffic generated by the Internet. SNS's are present in everyday life for the vast majority of the world population, as well as in daily life for many companies, brands, organizations or small businesses. With regard to the people's daily life, they are primarily responsible for (i) the acquisition of knowledge, once that news come to social networking first and later for other media; (ii) the ability that people have to share personal information as well as personal stories, in real time, with their contacts network; (iii) the development of social character, which in turn leads to an increase in personal satisfaction. Relatively to brands, companies and other business structures, they are the primary means of publication, where that is possible give an overview about products and services with the intent of influencing people to purchase them, this being a critical factor for the success of any business structure. Online Social Networks allow hundreds of millions of Internet users worldwide to produce and consume content. They provide access to a vast source of information and they have proved to be very powerful in specific situations (*e.g.,* during the 2010 Arab Spring or the 2008 U.S. Presidential elections) [HDF$^+$11, HP10]. An Online Social Network results from the use of a dedicated web-service, often referred to as Social Networking System or just Social Network Site (SNS), that allows users to (i) create a profile page and publish messages, and (ii) explicitly connect to other users thus creating social relationships. In fact, an OSN can be described as a user-generated content system that allows its users to communicate and share information. An OSN is formally represented by a graph, where nodes are users and edges are relationships. Posts and comments are the main vehicle to share various kinds of information such as product recommendations, personal opinions, ideas, stories, etc. [GHFZ13]. The benefits of this paradigm and associated technologies attracted worldwide attentions, with several scientific and industry conferences gathering professionals and researchers from all over the globe. Nowadays, given the impact of OSN's on society, is important to study the influence that SNS's have on people's choices in the real world. In order to support such discussion, section 2.2 explains the influence and impact of social media on people's choices. Some studies about the presence of companies and brands on social networks are presented, as well as how social platforms influence the decision-making process of users. Following this line of thought, section 2.3 and section 2.4 discusses existing social media software. Finally, in section 2.5 are presented and described some important features which must be taken into account when it comes to social media software, namely in social networking systems.

2.2 The Influence of Social Media

In modern times, the vast majority of the world's population spend too much time surfing the web, particularly on social networking and blog sites [LICP12]. Everyday, Web users are faced with the emergence of new products or services by major brands. Similarly, many users tend to share personal information about a specific product or service. All this contributes to influence people's choice for a product or a brand, compared to other existing products or brands in the market. Thus, more and more people look for this type of social media systems to formulate opinions and thus facilitate decision-making processes, becoming important that business structures introduce themselves and had some space on social media systems.

According to the 2013 Digital Influence Report presented by Technorati Media, [Med], for the year 2013 sixty percent of brand marketers predict an average increase of 40% in social spend. Actually, the bulk of brands' digital spend goes to advertising, search and producing video. Spending on social, including influencer outreach, making up only 10% of their total digital marketing spend. More than half of the social budget (about 89%) goes to Facebook, followed by YouTube and Twitter, which the remaining 11% of their social spend going to blogs and influencers. However, contrary around these statistics, Technorati affirm that blogs and retail sites rank high with consumer for trust, popularity and influence. When making overall purchase decisions, for consumers, blogs trail only behind retail and brand sites, being in the top 5 "most trustworthy" sources and assuming a more important role than Facebook when it comes to affecting purchase decisions. Thus, it appears that brands spend much of the social budget where consumers do not see value, or are not as influenced. More than 90% of brands surveyed for Technorati Media Digital Influence Report stated they have a presence on Facebook, followed by Twitter and YouTube. Lastly, Google+ appears with only 26% of brand managers reporting a presence on that service.
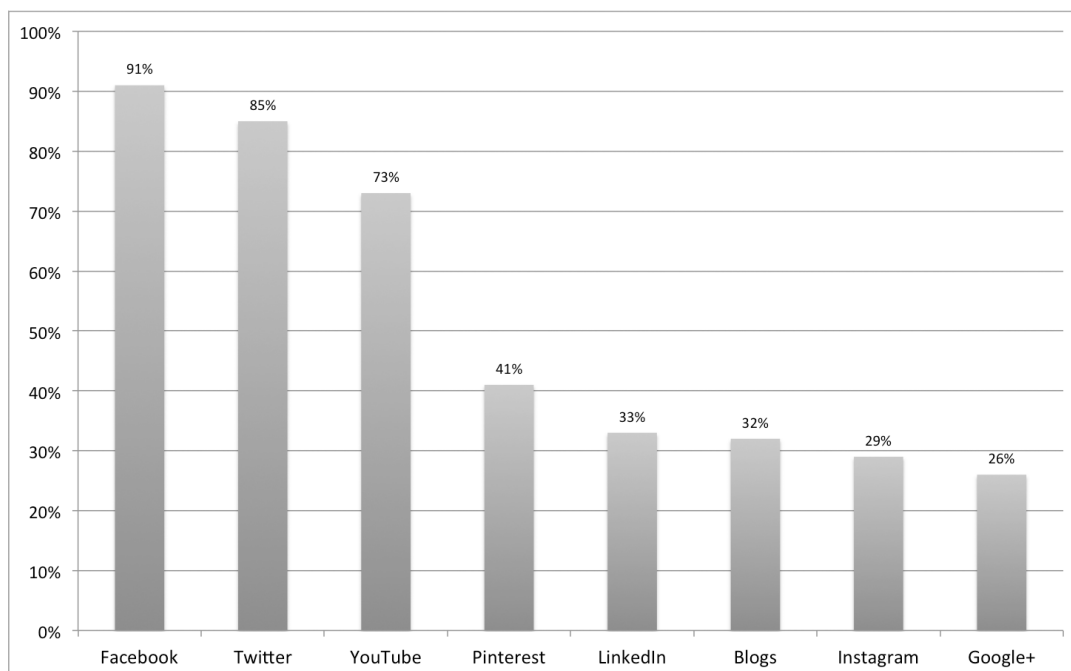

Figure 2.1: The presence of Brands in different Social Networking Sites. This figure is an adaption of figure 1 of the Technorati Media 2013 Digital Influence Report [Med].

There are many reasons why consumers follow brands and their latest news: Keep up with activities, learn about products and services, sweepstakes and promotions, provide helpful feedback, join community of brand fans, make purchases, among many others. With the big investments brands are making on the social media platforms, consumers said keeping up with a company's activities and learning about products and services were the top reasons for following brands on Facebook, Twitter, YouTube, Pinterest and Instagram but, the survey mentioned above, also indicates that many of those consumers are turning to retail and brand sites or even blogs when looking to make a purchase. Blogs were found to be the third-most influential resource when it comes to making overall purchases (31.1%), only behind retail sites (56%) and brand sites (34%), but still above Facebook (30.8%), that is one of the online services most used. As a matter of fact, consumers agree that, when it comes to community size, the smaller the community the greater the influence.
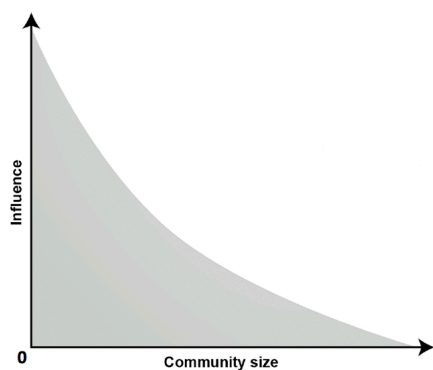
(a) Community size influence when making overall purchases
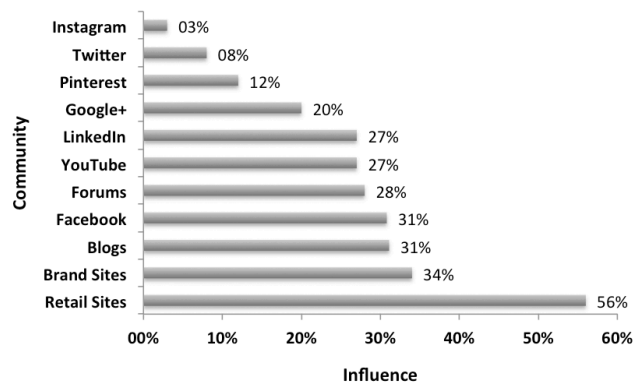
(b) Online Social Media Services most likely to influence a purchase

Figure 2.2: The influence of Social Media in overall purchases. This figure is an adaption of a study present in Technorati Media 2013 Digital Influence Report [Med].

It can be stated that most small communities have the capacity to influence more people because they possess greater knowledge of issues, products or services, which in turn leads to an increased confidence by the people who visit the community. As can be seen in figure 2.2(b), retail sites and brand sites are those that influence more people because the degree of knowledge they have about the product/service is greater, which facilitate decision-making process in overall purchases. With regard to the creation of influence by brands and influencers, blogging is the primary publishing tool, and about a third of influencers say they have been blogging for five or more years. Most bloggers (about 52%) operate 2 to 5 blogs, while 43% operate just one. Only 5% of bloggers operate 6 or more blogs. The primary method for bloggers is text, but photos and microblogging (*e.g.*, Twitter) come in at 38% and 31%, respectively. Video and audio are the least used methods. Bloggers also say that other bloggers are very influential when it comes to choosing their own content to publish. When it comes to measuring their own success, blog/website page view rank highest but social following (*e.g.*, Facebook Likes, Twitter followers) and user interactions (*e.g.*, comments) also rate high.

From a different point of view, people constantly face uncertainties in life, where they have to make choices with real time and limited information. In situations of uncertainty, the hu-

man being is wired to base its decisions on what other people do. Cialdini refers to this as a "social proof" [Cia01]. In the context of mobility [JCW$^+$13], people constantly seek out information and short cuts to support their decisions. Mobile devices have the ability to assist them in just-in-time information gathering, becoming indispensable in many aspects of modern life (*e.g.*, shopping, eating, meeting people or traveling). Mobile devices not only allow people to connect with other people at varying scales at anytime, from everywhere, but also allow people to capture and share activities in real time and meet any kind of need of its consumers. For example, *Yelp* app is a mobile application that help users to find places where they can go dinner. This mobile application is based on the social navigation provided by ratings and reviews by other users that help to choose a place/restaurant. The star rating provides a mental short cut and the one with the most number of stars probably is the chosen one. Lee, Lippman, Pentland and Dugundji [LLPD11], investigated the impacts of social proof and the mental shortcuts due to mobile social information by instrumenting people engaging in real decisions in the real world. Their goal was understand the impacts of virtually mediated social influences on people's decisions and how it relates to time, taste, prince and the physical social environment. They approached this problem by creating a digital menu mobile application that was used directly during people's economic decisions at a local restaurant. People were informed to participate in the Digital Menu trial to evaluate the user experience of digital menus. They were randomly assigned to different groups that showed different social information when they logged in to the digital menu at the restaurant. Lee *et al.* observe people in different social networks in the real world in a microscopic manner with large groups of people. They captured behavioral traces through the categories and dishes participants browsed, ordered, and captured the social network information that participants saw and the time they took to making their choices. The results show:

1. Diversion of choices: about 56 percent of people chose as the main dish, a dish that was not on the list of their favorite dishes from the online pre-survey menu. This implies that people's choices can be changed by the actual context and therefore, mobile guided just-in-time decision systems could have significant influence on people's choices.

2. Second degree friends have experienced as many common dishes as the first degree friends, indicating that friends of two degrees of separation can provide people with reinforcement in their choices.

3. Scale of influence: Information from social networks affect 2 to 10 times more people when people consider their choices compared to co-present physical social influence.

4. Time of engagement: friend's names on the menu made people spend longer time to decide, showing that visibility of friend's choices encouraged one to spend more time to evaluate choices before making a decision.

5. Price factor: Average price comparison between different experimental groups showed that anonymous group of friends had strongest influence in pulling people to choosing cheaper items.

6. Summary:

   – Individual friends increased engagement.

   – Group of friends affected price choice.

   – Dishes popularity served as shortcuts to decision making.

It is known that many times people's choices are impacted by the social group they belong to. People may be influenced by who they know, who they are with, who they are watching or who they are thinking about. They tend to vote similarly to people whom they are close to and regularly meet [Wal11]. More importantly, peer impacts and normative influences that are similar can affect the outcome of people's decisions. According to the above study, when people are seated together at a table and are sequentially choosing their dishes, the sequential order creates social influences that make people choose different dishes from preceding dish choices made by others. Most recently, influence of social networks on SNS's have revealed the effects of status in purchase behavior and the resulting unpredictability and inequality when social influence was introduced. A study made using Cyworld (most popular SNS in Korea), [IHG09], showed that there are three different group of users with very different purchase behavior:

- Low status group: about 50% were not affected by social influence. The main given reason that support this fact is related to the way this type of users are included in the network and show limited interactions.

- Middle status group: about 40% of users are moderately connected, show reasonable non-purchase activity on the site and have a strong and positive effect due to friends' purchases.

- The high status group: about 12% of users are well connected and very active on the site. This group of users shows a significant negative effect due to friends' purchases, *i.e.*, this group differentiates itself from others by lowering their purchase and strongly pursuing non-purchase related activities. This social influence leads to almost 14% drop in the revenue of this group. Individuals with high level of interaction are more likely to have a strong social identity in their community, which in turn leads to an increase in personal satisfaction, *i.e.*, increases the welfare of the individual and thus leads to encourage, promote and facilitate the knowledge sharing and organizational learning [MLJS06, DYK11].

As people are more connected, real-time information is constantly generated by the social connections they have. Until the emergence of the Internet, explicit connections were required for people to influence each other. However, the recent proliferation of social networking and mobile communications show that people are willing to publish openly and consume continuously in real time, which can lead to behavioral changes (*e.g.*, certain type of behavior in the same direction can be encouraged).

2.3   Blogging Software

With the advent and the exponential growth of blogs, in the 90's, emerged a new social trend over the web. The spontaneous growth of blogs is directly proportional to the increase of online digital contents. Thus, blogs came to bring the facility that users needed to create, share and maintain content, sharing its points of view, suggestions and comments according to a distinct universe of topics. David Sifry and Technorati presented a study about the state of the blogosphere, in 2006 and 2010, respectively [Sif, Tec]. In 2006, more than 50 million of blogs were counted and every 5.5 months that number has doubled, being 60 times bigger than it was in 2003, only 3 years ago. About 75,000 blogs were created each day, which meant that, on average, every second a new blog was created and 3 months after, their bloggers were still posting. In 2010, Technorati took a deeper dive into the entire blogosphere, including a study

about traditional media against social media. The 2010 edition of State of the Blogosphere found blogs in transition. Bloggers use of and engagement with various social media tools was expanding, and the lines between blogs, micro-blogs, and social networks were disappearing. As the blogosphere converges with social media, sharing of blog posts was increasingly done through social networks.

2.3.1 Content Management Systems

In the last two decades user friendly web development tools and programming languages were invented. Web marketing has become crucial in today's world and widely accepted in commercial market in last few years. Previously, creating and maintaining websites was not an easy task [Pat] but with the help of CMS people can make this task so easy that even novice can handle their site. According to Patel *et al.* [PRP13] and a CMS is a "system that lets people apply management principles to content". Generally, all CMS's fulfill common tasks of content like create, edit and publish [ECA12]. All blogging software is based on the concept of CMS's, where it is possible for users create, manage and publish digital contents, assuming administration roles. Table 2.1 makes a comparison of the three most popular open source CMS's [Net], indicating its main features [PRP11]. Choosing a CMS is not straightforward and requires an analysis about what is intended, technical expertise, budget and what users need their site do [XY10].

Table 2.1: Comparison between the three most popular open source Content Management Systems.

	Drupal	Joomla	WordPress
About	Drupal is a powerful tool for building complex sites and requires some expertise and experience to operate.	Joomla offers middle ground between the developer-oriented, extensive capabilities of Drupal and user-friendly but more complex site development options than WordPress offers.	WordPress began as an innovative, easy-to-use blogging platform. With an increasing number of themes, plugins and widgets this CMS is widely used.
Installation	Drupal Installation Forum	Joomla Installation Forum	WordPress Installation Forum
Ease of Use	Requires the most technical expertise of the three CMS's. However, is capable of producing the most advanced sites. With each release, it is becoming easier to use. If people are unable to commit to learning the software or cannot hire someone who knows it, it may not be the best choice.	Less complex than Drupal, more complex than WordPress. Relatively uncomplicated installation and setup. With a relatively small investment of effort into understanding Joomla's structure and terminology, people have the ability to create fairly complex sites.	Technical experience is not necessary; it is intuitive and easy to get a simple site set up quickly. It is easy to paste text from a Microsoft Word document into a WordPress site, but not into Joomla and Drupal sites.
Features	Known for its powerful taxonomy and ability to tag, categorize and organize complex content.	Designed to perform as a community platform, with strong social networking features.	It's powerful enough for web developers or designers to efficiently build sites for clients; then, with minimal instruction, clients can take over the site management.

2.3.2 Existing Blogging Software

The blogging software, or just "blogware", was designed for help to create and manage blogs. Over the years, it has been found a wide variety of blogging management systems. Indeed, different software provides different features to users. Although, all of them provides the basics elements needed by casual bloggers: they allows to bloggers create a variety of blogs, assume the function of administrators leaving them to manage contents, themes and many other features. Some of these systems are freely available while others are paid. Some of them require a installation process while others not. TopTenReviews, [Rev], provides a detailed comparison between some blogging software. There are many blogs software but for the purpose of exemplifying, the author refers only the followings:

1. **Blogger:** is the great, widely used blog software. Was developed independently but in 2002 was purchased by Google [Dev]. Is free, easy to use, well organized and intuitive. Having a blog through Google makes it really easy to monetize. Blogger also provides plenty of challenge for more advanced users who want to customize their blog.

2. **TypePad:** is a beautifully thorough proprietary blog software program with hosting included for more storage and bandwidth. It costs fewer than $5 per month for a basic membership. Advanced tools and features include stats, word banning, text file uploads and static pages. TypePad is an ideal tool for bloggers looking for an audience and submits their blog entries to Google, Technorati and more.

3. **Squarespace:** it's an easy way to set up a blog, or even a full website that can all be managed remotely. Squarespace has one of the finest interfaces for designing, customizing and personalizing blogs without knowing programming language or finding third party templates. Squarespace is also easy to use and great blog software for someone just starting out.

4. **LiveJournal:** is free to join, but the features, storage and image upload capabilities are limited unless bloggers upgrade to the paid account. This program is ideal for writers and artists with enough technical know-how to figure out how things work and how to make LiveJournal's features work for them.

5. **Open Salon:** is an emerging community powered by capable blog software and writers who are looking for an audience. It's a simple, plain service focused on great content rather than design and features. The blogging interface is clean and very organized.

2.4 Social Networking Software

Social Networks are now one of the most widely used aspects of the Web and have really taken off over the past few years. Many business, organizations, communities and families are using social networking to promote themselves, for communicate better with others, and to engage with their audience. Social networking relies upon users building up their own network of contacts on the site. This, in turn introduces them to new contacts and allows them to find and be found more easily. Also, this allows news contacts to be recommended or introduced, helping to grow the user's network.

2.4.1 Existing Social Networks

There are a wide variety of social networking sites available. Some of which are already very popular and have excellent social features. The next sections take a look at the most prominent features of some of more popular sites [Pea10].

2.4.1.1 Facebook

Facebook (`www.facebook.com`) is the most popular SNS for everyone over the age of 13. It is started out for Mark Zuckerberg, a student at Harvard University, branching out to all the Universities, and now available for everyone. The main features available in Facebook are:

- A customizable profile
- Users can update their statuses
- Users can connect with other users by adding them as "friends"
- Statuses of friends can be commented upon and users can indicate that they like particular statuses
- Friends can post messages to each others profiles
- Photos can be posted and shared
- Events can be posted and shared
- Groups can be created and joined, promoting specific activities or interests
- Topics can be discussed
- Third-party developers can create their own applications for Facebook, to add more to the platform.

2.4.1.2 LinkedIn

LinkedIn (`www.linkedin.com`) is a SNS for business contacts, colleagues, and classmates, which primarily encourages business contacts to connect. Features available on LinkedIn include allowing the users to:

- Customize their profile
- Connect with colleagues
- See how users are connected to other
- Recommend other users with respect to a job
- Integrate Twitter with their account profiles
- Create and view business profiles
- Third-party developers can create their own applications too

2.4.1.3 MySpace

MySpace (`www.myspace.com`) is a SNS used primarily by a younger audience. It is very popular with bands, particularly because of how much profiles can be customized with Hypertext Markup Language (HTML) and how music can be embedded within profiles. Features of MySpace include:

- Customizable profiles, complete with:
  - HTML customization: allowing users to customize the colors, look and feel of MySpace
  - Music integration
  - The user's current mood
  - Comments

- Groups: small subjects of users
- MySpace TV: video sharing
- Integration and development of thrid-party applications via an API
- Forums for discussions
- Polls to get user opinion

2.4.1.4 Twitter

Twitter (`www.twitter.com`) is a micro-blogging SNS, which primarily deals with very short messages of 140 characters or less. Despite this, it has a large number of prominent features, that include:

- Profiles can be customized, both in terms of colors and background image
- Users can update their status
- Users can reply to each other's status updates
- Users can repost another user's status update, using the ReTweet function
- Powerful searching based on users replying to each other and tagging of tweets with hashtags

The ease of use and small set of core features have made Twitter very popular.

2.4.1.5 Netropolitan

Netropolitan (`www.netropolitan.info`) was launched on September 16th, 2014, and bills itself as "the online country club for people with more money than time" [CNN]. To join, users have to pay up $9,000 for dues and a membership fee, then another $3,000 per year after that. Members must be at least 21 years old and must register using their real names. Once registered, they may form groups around common interests, and have access to posts and status updates by all other users. There are no ads, the site is not indexed by search engines, and moderators are active at all times to police bad behavior (*e.g.*, spamming ads). Clicking an ever-present button will call up a "Member Service Associate" to provide help with the site at any time.

2.4.2 Existing Social Networking Software

There are a number of very fantastic and successful social networking websites and social networking software available out there. Social Networking Software can be used to develop unique social networking sites, *i.e.*, users can turn their "normal" websites into a complex website integrating amazing social features. Wikipedia made a detailed comparison of some of existing social networking software [Wikb] that users can view in order to choose the software that suits most of your needs. Next, proceeded to the analysis and comparison of social networking software where, once again, are only described some of the most popular.

2.4.2.1 Drupal

Drupal is a popular, free available and open source CMS that can be used to create easy-to-use and easy-to-update websites. By extending this to through the thousands of modules that the communities have developed, users can create almost any type of website they want, ranging from e-commerce to SNS's [Dru]. Consuming those modules, users have the capability to add some social features to their websites. The main social modules available on Drupal are: Activity Log, Comment Notifications, News Feed, User Relationships and Friend Lists among others.

2.4.2.2 Elgg

Elgg is an open source social networking platform, complete with functionality for setting up profiles, sharing files, adding friends, blogging, aggregating RSS, content tagging, and social graphs, *i.e.*, is a rapid development framework with built-in social features. It is a great fit for building any app where users log in and share information. Elgg also has an API, allowing developers to extend Elgg by adding additional functionality as well as a RESTful API to allow other applications to interact with the platform. It has been used to build all kinds of social apps like open networks (similar to Facebook), topical (like the Elgg Community), private intranets, dating, educational, company, etc [Elg].

2.4.2.3 Joomla

Joomla is another open source CMS, with a range of built-in social networking features. Through its commercial add-on JomSocial, Joomla has the ability to become a truly real social network. With JomSocial members can update statuses, manage and customize profiles, share and comment on photos, upload videos from YouTube, Vimeo or others hosts, create their own events or join existing events and share their ideas on a dedicated stream. Members can create groups around their favorite topics and invite others, add friends and accept or decline friend requests. They can also restrict their posts so that they are only seen by the people they choose. With real-time alerts on new comments, likes, friends requests and messages, JomSocial keep your members engaged and interested all the time [Jom]. The price of this software varies according to the number of features and may range from $99 to $299.

2.4.2.4 BuddyPress

BuddyPress is a powerful plugin that takes WordPress powered sites beyond the blog with social-network features. BuddyPress lets users sign-up and start creating profiles, posting messages, making connections, creating and interacting in groups, and much more. A social network in a box, BuddyPress lets users easily build a community for companies, schools, sports team, or other niche community [Bud].

2.4.2.5 Oxwall

Oxwall, [Oxw], is a free, open source MVC software, flexible and easy-to-use PHP/MySQL social networking software platform. Its flexibility is an extremely easy way to change the way it works using Oxwall plugins. These plugins are complete units of functionality that can be used for various purposes. Oxwall offers unseen level of efficiency when users need a full-featured, working site. Oxwall social features available are: photo and video sharing, groups, events and friends management, comment and tagging, privacy and profile customization, file-sharing and video-conference.

2.4.2.6 PHPFox

PHPFox, [PHP], is a social network software that gives users the ability to create a unique community and includes many of the features found on SNS's like Facebook or MySpace. There are numerous addons, themes and various other integration's for the system that make it an excellent choice for those in the market. The interface is simple but functional and once populated with content and users, the system has a nice clean flow to it. Probably, this software is one of

the most complete on the market and its price starting at $299. The full version of this software costs $499.

2.4.2.7 SocialEngine

SocialEngine is another paid solution of social networking software and another one of the most complete on the market like PHPFox. This software have three different versions: Starter which costs $299, Professional which costs $449 and Advanced which costs $699. The price varies according to the number of social features presented on each version. SocialEngine gives users a simple, unbranded network that they can customize in any way, *i.e.*, makes diverse styles of social networking possible. Users will have the freedom to maintain fine-grained control over all aspects of their site and content with absolutely no "powered by" links or "SocialEngine" branding presented to members [Soc].

2.4.2.8 Hybrid Approaches

Hybrid approaches facilitate the integration of some social aspects on user's website including (i) Facebook applications that are accessed via Facebook's main site, providing additional features to users; (ii) Facebook connect that allows websites to interact with Facebook, using it as an authentication protocol, pulling friend data from it, as well as pushing and pulling status updates to and from Facebook; (iii) Out-of-the-box hosted solutions, such as Ning that allow users to create and maintain a social network community direct from their web browser; and (iv) Google OpenSocial that are a set of common API's that make applications for social networks inter-operable with supporting SNS's.

The vast majority of social networking software as described above requires an installation process but sometimes users don't have the technical knowledge to do that. For example, users must grant write privileges to a variety of folders, or even must create database users and grant them access to their respective databases.

2.5 Social Networking Main Features

In social networks there are numerous characteristics that distinguishes them from each other and that can provide users with a huge set of features. However, some features are common to several social networks and therefore should be taken into special consideration. Thus, in the following sections, the author wishes to highlight three of the key features present in the vast majority of existing social networks.

2.5.1 Profile Costumization

The Internet supports social interaction that is scalable from the micro level (two way conversation) to the macro level (creating a global online social network). Internet users indicate an increasing willingness to create a persistent digital identity that enables long term social interactions. The internet can function as a continuously open channel for social contact and connectivity. An integrated solution with persistent identities for conversation partners and multiple communication modes increases the ability to maintain continuous social connectivity. This functionality is delivered by social networking sites, which simplify communication

and publishing. Social networking sites support an individual's construction of their persistent digital identity. Each member of a SNS creates a personal profile, displaying identifying information (*e.g.*, a photo) and contact information (*e.g.*, an email address). In Friendster SNS, Boyd, [BH06], report that members create profiles with the intention of communicating news about themselves to others. Dwyer [Dwy07] found that people use SNS's to maintain existing relationships and develop new ones. Members described an increase in their social productivity and reported the use of SNS's to re-establish connections with lost friends and view friends through their profile.

In fact, the profile plays a important role in the use of social networking sites. Profiles are the cause of much public concern with respect to the use of SNS's, due their exposure of private information to unknown audiences. Members are willing to disclose information in the face of privacy concerns because of two factors:

– interaction is often initiated by collecting information from a new communications partner. If the interaction is the main goal, then for SNS's a good profile is the key for success, *i.e.*, if Alice wants to begin a conversation with Bob, she has to tell him who she is. So, Alice use her profile to do that. Without her profile, Bob won't know who is trying to send him a message, and may ignore it.

– A profile includes a representation of users personal social network, those individuals whom they have identified as "frinds". In the context of SNS's, a friend is anyone users authorize as a communication partner. This status is binary and can be terminated by each of them.

The profile is one of the three most important features because serves as a mechanism for digital self presentation and serves as a portal to all friends. Since users network of friends is a public component of their profiles, then how many friends they have and who they are is a visible and easily captured status metric which in turn encourages users to expand their own network of contacts and to regularly update their profiles [DHW08].

2.5.2   Friend Relationships

The first major SNS that attracted worldwide attention was Friendster. It popularized the features that define contemporary SNS such as profiles, public testimonials or comments, and public lists of friends. While most sites focus on introducing people to strangers with similar interests, Friendster was designed to help friends-of-friends meet [BE07]. In [APES09] *et al.* present a system that establishes friendship links among peers under dynamic conditions of peer availability. The possible peers which may become friends are discovered in a gossip fashion. Their system is self administrated and does not depend upon any central entity, which means that all of the social network is handled by the peers themselves. In their SNS, the peer who initiates a friendship request to another peer is known as the source peer and the peer whom this request is intended is know as the target peer. The functionalities provided to the users are the following:

– Adding new friends in order to build a social circle: a peer can request other peers discovered by the underlying peer sample service (PSS), which are potential candidates of friends, to become their friends. The source peer requests the target peer to become its friend. The target peer has to reply to this request, and if the reply is positive, the peers become friends.

– Removing friends: the source peer removes the target peer to remove it from its list.

– Maintaining status of friends: the system must keep peers up-to-date about the online status of their friends.

The implementation of the proposed SNS has been done in Tribler, which is a Bittorrent based file-sharing client. In Tribler, peers have a permanent identifier - *PermID* - which is based upon public-private key pairs. A peer, the challenger, can challenge another peer, the challengee, for its identify by generating a large random number. The challengee encrypts it with its private key, and then the challenger decrypts the result with the public key of the challengee. If the result of this decryption is the same as the random number generated, the authentication succeeds. For establishing a friendship link, the mechanism follows the request-reply notion. The source peer initiates it by sending a friendship request to the target peer. Target peer then takes its decision over it by accepting or denying the request. Finally, target peer reply is sent back to the source peer. If the reply is positive, both peers become friends.

In order to deal with the unavailability of the both peers, the authors have designed two types of mechanism, which works for friendship requests and friendship replies. These two mechanisms are:

1. Retry: if the target peer is not online, the source peer will retry to connect to it after every 5 minutes, until the target peer comes online. Similarly for receiving replies from the target peer, if the source peer is unconnectable for some reason, the same retry mechanism is adopted. The initial retry time interval of 5 minutes is increased to 24 hours after one day has passed since the friendship process was initiated. After a week all pending friendship messages are dropped from the source and the target peers.

2. Helpers: helpers are online friends of both the source and the target peer. When the source peer is unable to connect to the target peer for requesting friendship link establishment, it dispatches its friendship request to these helpers. Helpers then try to contact the target peer every 5 minutes. These helpers are also used by the target peer for forwarding its friendship reply to the source peer, in ca it is unable to contact it.

Depending upon the availability of the both peers, different scenarios for establishing friendship links between them was distinguished:

– Case 1 - Both peers are online: source peer directly sends the friend request to the target peer. Depending upon the target peer response, it is added or deleted from the source peer friends list.

– Case 2 - The source peer is online, but the target peer is not: source peer after a failed attempt to connect to the target peer would try to retry the mechanism.

– Case 3 - The source peer has gone offline after initiating the friendship request, but the target peer is online: since the source peer cannot connect to the target peer, it dispatches the friendship request to its helpers. The helpers the connect to the target peer and forward the friendship request to it.

2.5.3 Comment and Post

Social networking sites mostly consist on the publishing and sharing of resources among registered users. The registered users of a OSN are enable to create and protect a digital representation of themselves on the platform, to define connections with other registered users, to publish resources and make them available to other users, and to browse the resulting pool of content by connectivity. In [MSE12], the authors propose a conceptual model of the workings of a typical OSN platform as experienced by its users, putting a distinct emphasis on the resources published through such platforms. Each OSN platform is portrayed as a vertex-labeled directed graph, the vertices of that graph standing either for identities registered by users on the platform (*i.e.*, identity nodes, also thereafter referred to as ID nodes), or for published resources (*i.e.*, resource nodes, also thereafter referred to as RS nodes). As for the arcs of the graph, they are associated with different semantic meanings depending on the label of their editing nodes, namely:

– (ID, ID) arc: transcribes the existence of a trust kind of relationship between the identities mapped on its ending nodes, *i.e.* an arc pulled from ID node a to ID node b implies that a is trusted by b.

– (ID, RS) arc: transcribes the existence of an ownership kind of relationship between the identity and the resource mapped on its ending nodes, *i.e.* an arc pulled from ID node a to RS node x implies that a owns x.

– (RS, RS) arc: transcribes the existence of a referral kind of relationship between the resources mapped on its ending nodes, i.e. an arc pulled from RS node x to RS node y implies that x refers to y.

– (RS, ID) arc: As for (RS, RS) arcs, such arc transcribes the existence of a referral kind of relationship between the resource and the identity mapped on its ending nodes, *i.e.* an arc pulled from RS node x to ID node a implies that x refers to a.

It ensues that the social graph of a given OSN platform is, in the presented model, materialized by the induced subgraph formed by the ID nodes of its operational graph. After, the authors consider important take care of the entities that interact with that structure. They refer to those entities as the consumers of an OSN platform, and model them as active graph crawlers. Then, they propose the following set of operations available to consumers, first relatively to "management":

– accessAs(Identity i): That operation specifies the root ID node i from which a consumer is to start crawling the operational graph, and by extension, the identity i under which subsequent operations are to be realized.

– register(Identity i): That operation enables a consumer to append the ID node i to the operational graph provided such node does not already exist; that ID node is initially disconnected (*i.e.* no edge to any other node).

– unregister(Identity i): That operation enables a consumer to remove the ID node i from the operational graph. It is to succeed if and only if that ID node is the root ID node for the identity currently assumed by the consumer.

– publish(Resource r): That operation enables a consumer to append the RS node r to the operational graph, r is to be connected to the consumer's current root ID node through an (ID, RS) arc.

- unpublish(Resource r): That operation enables a consumer to remove the RS node r from the operational graph. It is to succeed if and only if there exists an (ID, RS) arc from the consumer's current root ID node to r.

- ink(Node n1 , Node n2): That operation enables a consumer to create an arc from node n1 to node n2, subject to the following conditions depending on their respective labels:

  - (ID, ID) arc: If and only if n2 is the consumer's current root ID node.
  - (ID, RS) arc: Unavailable.
  - RS, RS) arc: If and only if n1 is owned by the identity currently assumed by the consumer.
  - (RS, ID) arc: If and only if n1 is owned by the identity currently assumed by the consumer.

An additional condition is that the node linked from/to is to be known to the consumer.

- unlink(Node n1, Node n2): That operation enables a consumer to delete an existing arc from node n1 to node n2, it is subject to the same conditions as the link operation as per the nature of the arc.

And second, relatively to "crawling":

- followArc(Arc a): That operation enables a consumer to crawl the arc a and learn about the node at its end, that node is then considered as known to the consumer.

- getArcs(Node n): That operation enables a consumer to retrieve the set of outgoing arcs from known node n.

Online Social Networking platforms also increasingly integrate the possibility for their users to leave "comments" on published content. What distinguishes those comments from "classic" resources is essentially the fact that a comment is automatically referred back to by the resource it refers to, allowing bidirectional navigation between the two. Such behavior can be extended by incorporating the following tie operation:

- tie(Resource r1, Resource r2): That operation en- ables a consumer to create an arc from owned RS node r1 to known RS node r2, a second arc from r2 to r1 being reciprocally created.

A user wishing to leave a comment on a resource would then just have to publish that comment and tie it to its target.

2.6 More Related Concepts

The characteristics mentioned above are undoubtedly the most important, that allow social networking stand out from each other. However, many other related concepts are equally important. The two described concepts bellow can not be directly perceptible to users, but deep down, they often ensure the success of social networks and are responsible for processing, storage and analysis of data generated. In sections 2.6.1 and 2.6.2 the themes of cloud computing and big data are briefly discussed.

2.6.1 Cloud Computing

The structure of a Social Network is essentially a virtual organization whith trust relationships between friends. Cloud environments typically provide low level abstractions of computation or storage. In fact, computation and storage clouds are complementary and act as building blocks from which high level service clouds can be created. Storing large ammount of data is challenging as it requires large reliable storage space [PTXK13]. Stora clouds are often used to extend the capabilities of storage-limited devices such as phones and desktops providing transparent access to data from anywhere. The are a wide variety of cloud providers such as Amazon EC2/S3, Google App Engine, Microsoft Azure and also many smaller open clouds like Nimbus, Eucalyptus or Hadoop [CCRB10]. For example, Hadoop is the most popular open source cloud computing platform that supports mass data storage with good fault tolerance design [JPD$^+$12]. Hadoop can provide a significant improvement to any system. It is designed to scale up from single servers to thousands of machines, each one offering local computation and storage [Whi10]. There are many instances of cloud computing and social networking integration. However, most examples use cloud platforms to host social networks or create scalable applications within the social network, *e.g.*, Facebook users can build scalable cloud based applications hosted by Amazon Web Services.

2.6.2 Big Data and Data Mining

Big Data is a popular term used to describe the exponential growth and availability of data [Ana14]. As information systems are becoming sophisticated and mobile, cloud computing, social networking devices are now very popular, the amount of data is rapidly increasing every year (about 60%). Big data is data which should be analyzed by a company or an organization, but has not been tried to be analyzed or could not have been processed by technologies [CML14]. It contains various concepts of information ranging from simple numerical data to voice, video, or daily texts at Internet blogs or SNS's. It includes not only collecting and analyzing information but also the sequence of decision making based on it [HTYL12]. For example, Facebook and Twitter along with many other companies, have high valuations due to data assets they are committed to capturing or creating. In fact, more data may lead to more accurate analysis.

Chapter 3

SNetGNA Communities,
A New Social Networking Platform

Chapter 3 presents a new solution for social networking management systems. Throughout this chapter it will be presented the various stages in the development process of the new solution, being explained the system modeling and the used technologies as well as the implementation of some important features.

3.1   Introduction

Create a new social networking platform is not an easy task. First of all, because nowadays there is a wide variety of social networking sites that are already part of everyday life for many people and many companies and organizations around the world. Secondly, because creating a complete social networking platform involves the integration of many social features and sometimes it becomes difficult to know which ones will actually make a difference to users [Xf13]. Thus, this dissertation proposes a new solution for social networking management system. That solution is fully integrated on the Web and does not need any kind of installation process and support, unlike what happens with other software/platforms presented in section 2.4.2. Table 3.1 presents a general comparison between state-of-the-art social networking software and the proposed solution in this dissertation.

Table 3.1: General comparison of Social Networking Platforms. This table is an adaption of Table I from the scientific contribution [RRHN14] of this dissertation.

		Price	Installation	Codebase
State-of-the-art Solutions	Drupal	Free	Out of the box	PHP/MySql
	BuddyPress	Free	Out of the box	PHP/MySQL
	Elgg	Free	Out of the box	PHP/MySQL
	Oxwall	Free	Out of the box	PHP/MySQL
	JomSocial	starting at $99	Out of the box	PHP/MySQL
	PHPFox	starting at $299	Out of the box	PHP/MySQL
	SocialEngine PHP	starting at $299	Out of the box	PHP/MySQL
Proposed Solution	**SNetGNA Communities**	**Free**	**Fully integrated**	**PHP/MySQL**

The name of the platform - *SNetGNA Communities* - arises from the junction between social networking communities and the NetGNA Lab. Similarly to what happens with blog management systems, *e.g.* Blogger (also a fully integrated Web solution), the SNetGNA Communities platform, proposed in this dissertation, will allow users to create and make a full management of their own social networking communities. Users can create an unlimited number of social communities according to their personal interests, where can share ideas and opinions with other users with

the same interests. As already stated in section 2.2, smaller communities have more influence for people's choices which in turn leads to an increased confidence by the people who visit the community. So, letting users create those communities gives them the possibility of being able to create discussions about certain topics that may have some influence on people's choices, contrary to what happens with large communities like Facebook or Twitter, where millions of stories about different topics are shared every day. On the other hand, and as can be seen again in section 2.2, small communities like blogs rank high with consumers for trust, popularity and influence but lack many of the social features present in social networks like user profiles, friendship requests, personal messaging, etc. There already exist plugins, *i.e.* social networking components that help users to turn blogs into flexible and robust communities (*e.g.*, BuddyPress is a plugin for WordPress). Later, the first social networking platforms has appeared which allow users to build small communities with all social aspects available. However, and as can be seen in table 3.1, many of those social networking platforms requires a process installation out of the box, *i.e.*, users have to download the software, unzip the file, copy files to server and grant read/write privileges to some folders. During the installation process, users have to create databases and make them available on the server. Figure 3.1 exemplifies the six steps (described on the left side panel) of the installation process for the open source software Elgg.

Figure 3.1: Illustration of the installation process for the Elgg social networking platform

Still, most of these social networking platforms do not bring with all the social features installed by default. For example, if users want to create and share events, depending of the software, user may have to install that module. However, not all users have the technical knowledge to perform such operations. Thus, in this chapter the authors present a new model of social networking platform, fully integrated on the Web, where users can create and manage their communities without need any kind of technical knowledge to perform any kind of operation.

3.2 System Modeling

In the next three sections (3.2.1 to 3.2.3) is made an overview on the system modeling, including its structure, requirements and architecture, *i.e.*, it is explained how the system is designed and engineered and also how the system allows the interaction of its users. Finally, the authors make a brief description of the used technologies and why the importance of your choice.

3.2.1 System Structure and Requirement Analysis

For the SNetGNA Communities platform, three classes of users are considered: general users, general administrator and community's administrators. The system administrator or general administrator is a person who have access to everything in the system. It is the responsible to maintain the system functionality. Entering back in the administration module through the portal site, the general administrator can manage all registered users and all registered communities. The community's administrators also can register and login in the portal site and manage his own communities space, including releasing and deleting his own new communities, invite users to a specific community, validate users or even see who is online. General users are the users who are registered in a specific community and can explore all the features on it, including the right to read friends posts, send and receive friendship requests to/from other users and manage personal profiles. Figure 3.2 illustrates the function structure of the proposed solution.
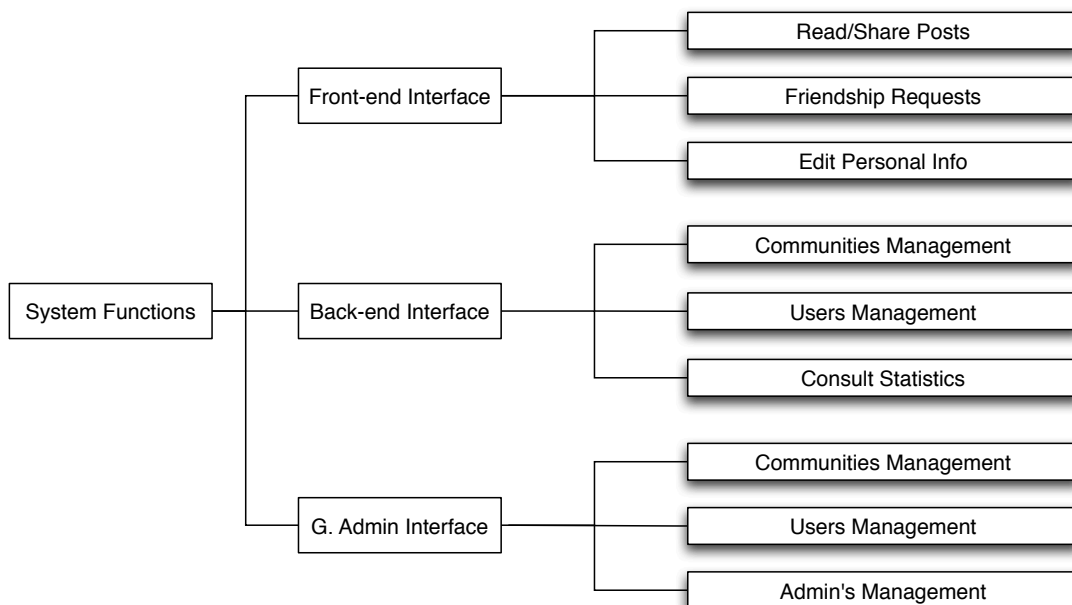

Figure 3.2: Illustration of the function structure for the SNetGNA Communities Platform.

All system functions can be divided into three classes: one belongs to system Front-end interface, *i.e.* the general users interface, the second belongs to Back-end interface, *i.e.* the community's administrators interface and the last one belong to General Administrator interface. Using each one of the system interface, specific type of users can operate only the specific functions available for each type of users.

The requirement analysis is the basis of success of any software. A good requirement analysis leads developers to understand what users will really need. The SNetGNA Communities platform assume three types of users: a general administrator, community's administrators and general users, as described above. According to figure 3.2, each type of users can perform specific operations using the respective web interface. In this section, the authors intend to demonstrate the relation between users and such operations using the use case diagrams.

To perform any kind of operation, general users must be logged-in in the specific web user interface. After the authentication process, if succeeded, general users can explore the community where they are registered, performing operations such as manage profiles, editing and updating personal information, make friends, *i.e.* send and receive friendship requests, read friends posts and share posts. The use cases diagram for general users is shown in figure 3.3:
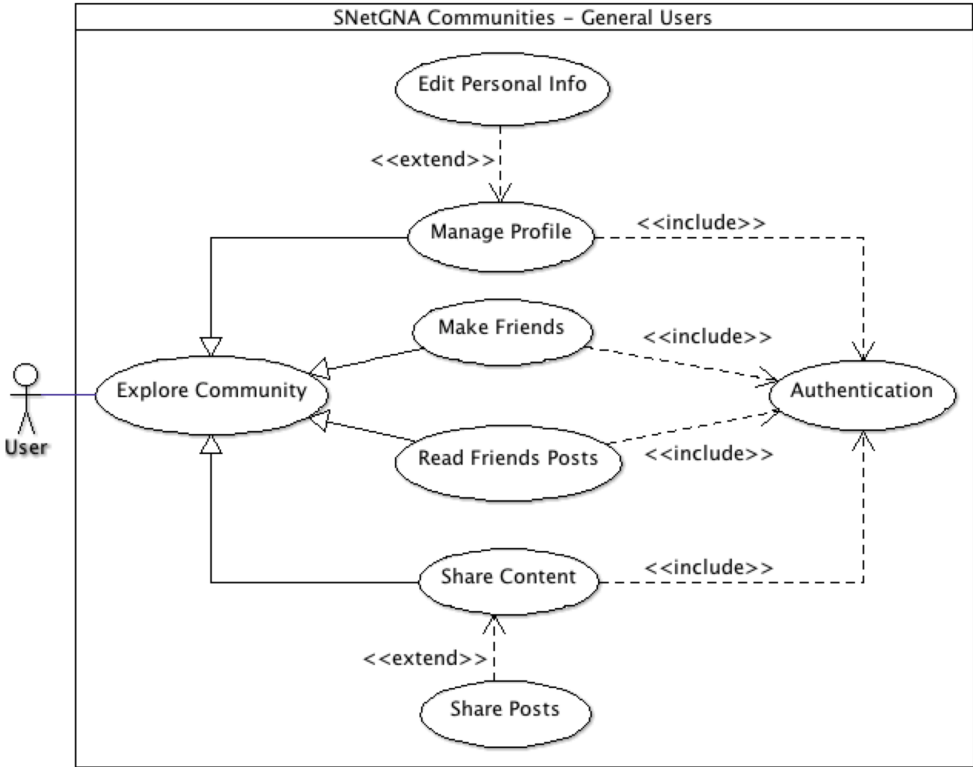

Figure 3.3: Representation of use cases diagram for general users.

As well as general users, also the community's administrators must be logged-in in the specific web user interface to perform any kind of operation. After the authentication process, if succeeded, community's administrators can manage their communities, including create and delete existing communities, or even edit communities information. To create a new community, the administrator must set the community information, including the name and description. To delete or manage existing communities, the administrator must select a specific community. The community's administrator also have the capability to manage users, performing operation such as search and delete, validate or invite new users from/to a specific community. The use cases diagram for community's administrators is shown in figure 3.4:
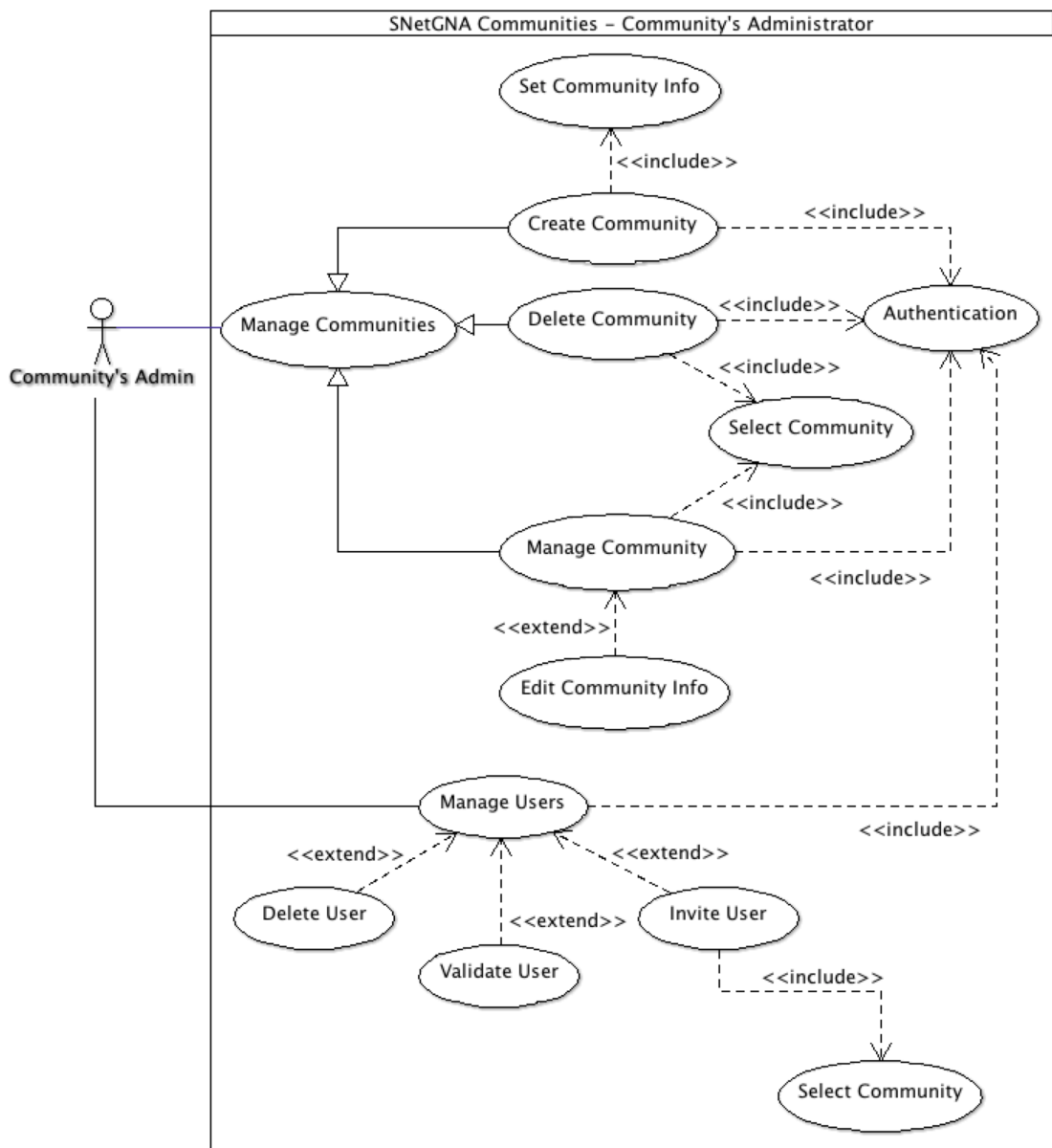

Figure 3.4: Representation of use cases diagram for community's administrators.

Lastly, figure 3.5 shows the representation of use cases diagram for the general administrator. The general administrator of the SNetGNA Communities platform have access to everything in the system. He can perform operations such as view communities, delete a specific community, manage community's administrators or general users including delete or validate them. To perform any kind of operation, the general admin must be logged-in in the specific web user interface.
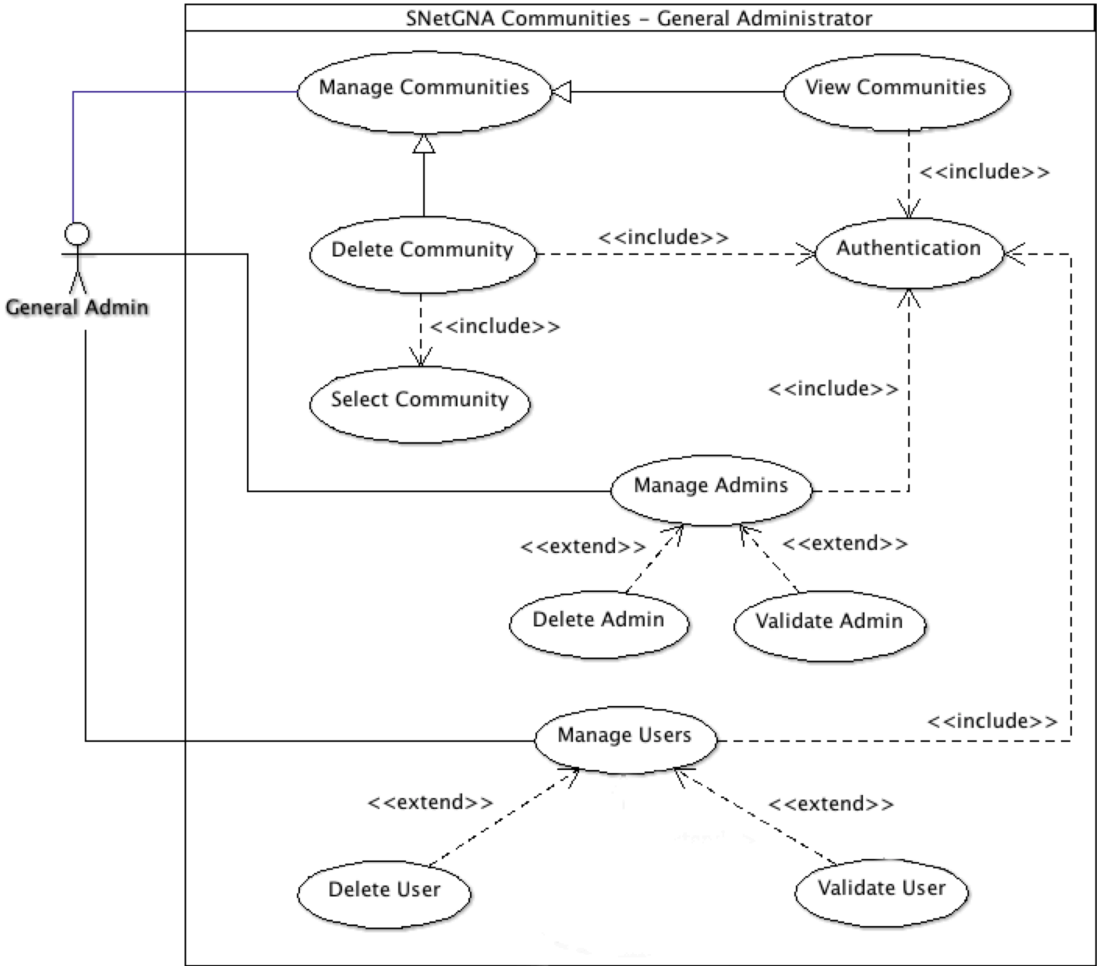

Figure 3.5: Representation of use cases diagram for the general administrator.

Figure 3.6 describes the working principle of the SNetGNA Communities platform. In general, the diagram is a representation of the work-flow of functions and operations for the general users and community's administrators. Only the work-flow for these two types of users is presented, because the authors of this dissertation assumes that the operating principle for the general administrator is similar, at all, with the operating principle of the community's administrators.
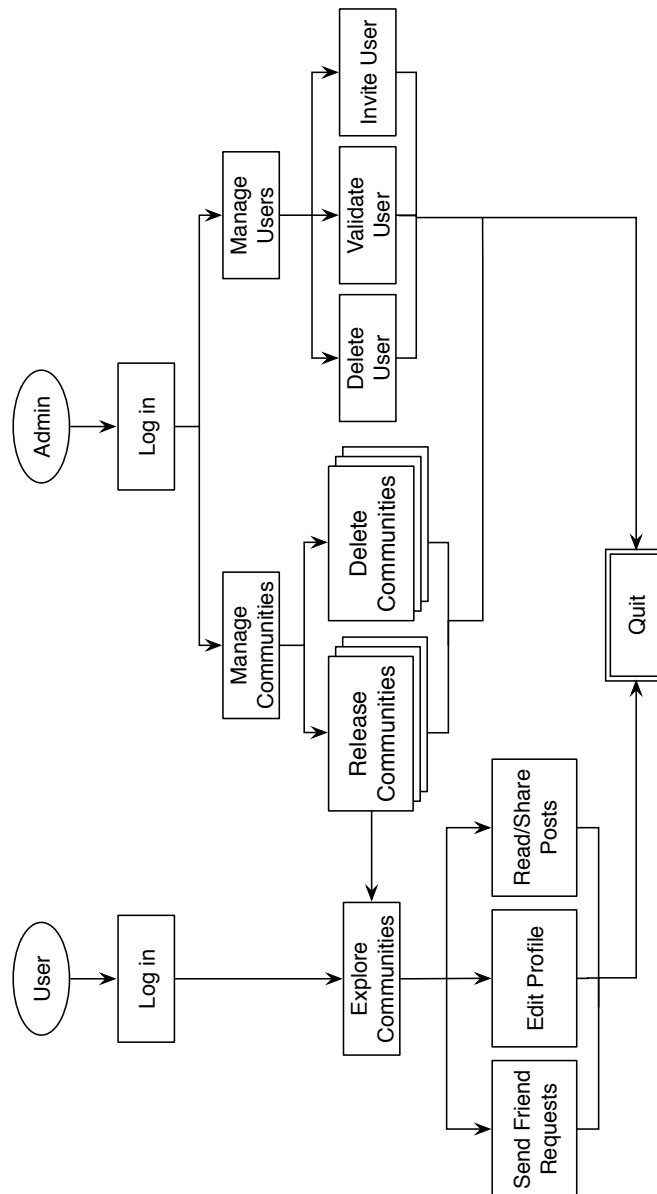
Figure 3.6: Illustration of the working principle of the SNetGNA Communities platform.

To complete the requirement analysis is required proceed for the database modeling process. A logical data model contains all the needed logical design choices and all the physical storage parameters needed to generate a design in a data definition language, which can then be used to create a database. A fully attributed data model contains detailed attributes for each entity. Figure 3.7 represents the relational model of the SNetGNA Communities database, describing, in a comprehensive way, how the entire entities are related to each other, showing which are their specific attributes.
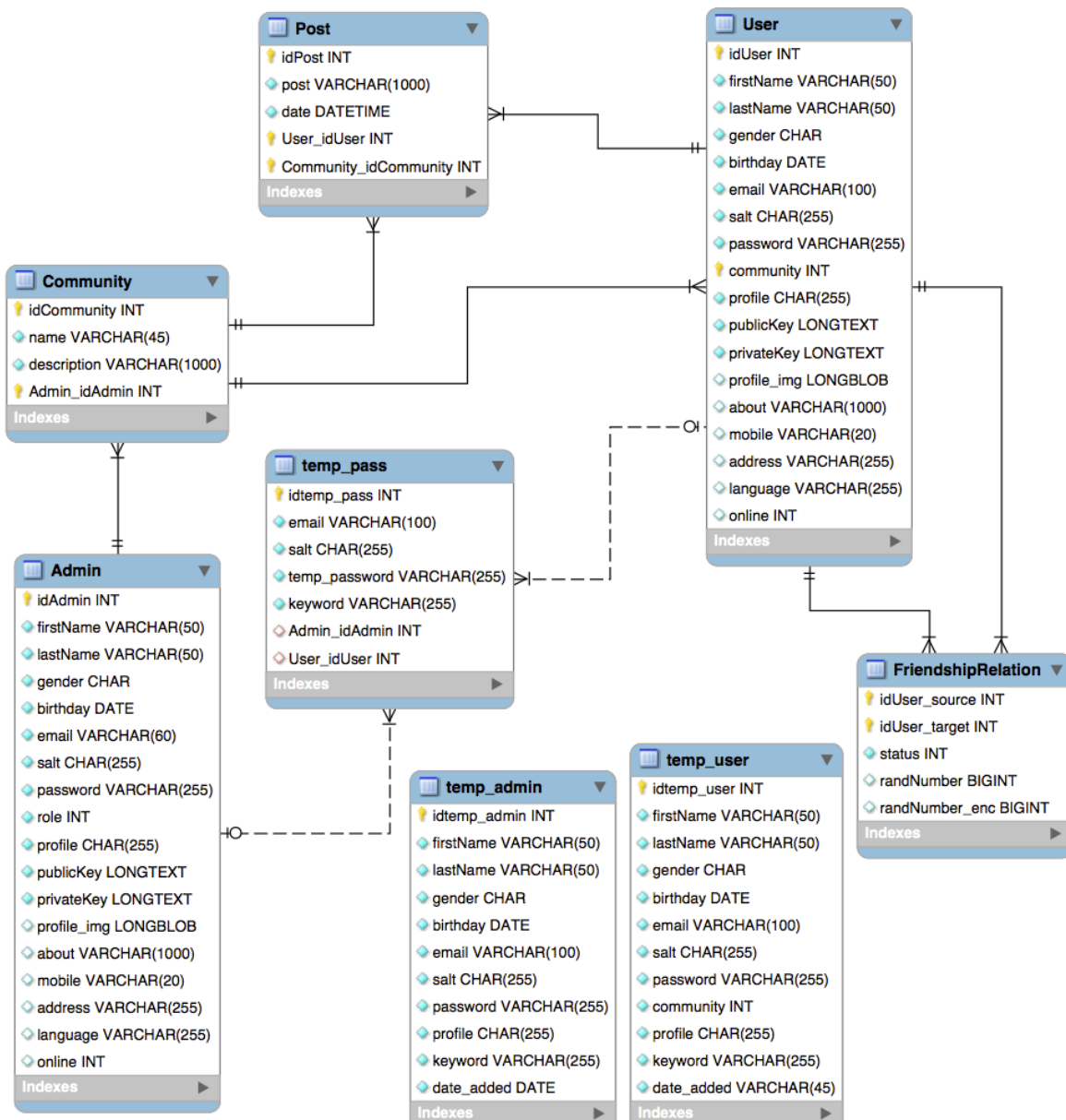
Figure 3.7: Representation of the Relational Model of the SNetGNA Communities database.

3.2.2   System Architecture

According to Huang, [Hua10], there are two models used by blog management systems. The first one is the B/S model (Browser/Server) and the second is the Web based service. Browser/Server architecture actually is a kind of improvement from Client/Server structure with the development of Internet technologies. In this structure, the Web user interface is completed by WWW browser. A few business logics are made by browser and major business logics are made by server, formed what is called 3-tier structure [fTfG11]. Such type of structure allows users to operate in any place, without need to install any special software. A computer with Internet access, through its browser, send a request to server and the server returns a response.

Figure 3.8 illustrates the architecture for the proposed solution in this dissertation - the SNetGNA Communities platform. The respective architecture is based on the model presented above, the B/S model. Through the Internet, using a browser running over any type of operating system, users can access to each web user interface and request input and output operations. The web user interface is simple and intuitive developed in PHP under the CodeIgniter framework. All the content generated from the platform is registered in a database located at the server, using the MySQL DBMS. Through the Web user interface, users also have the ability to consume/install third-party services. The platform access to those services via specific services API's.
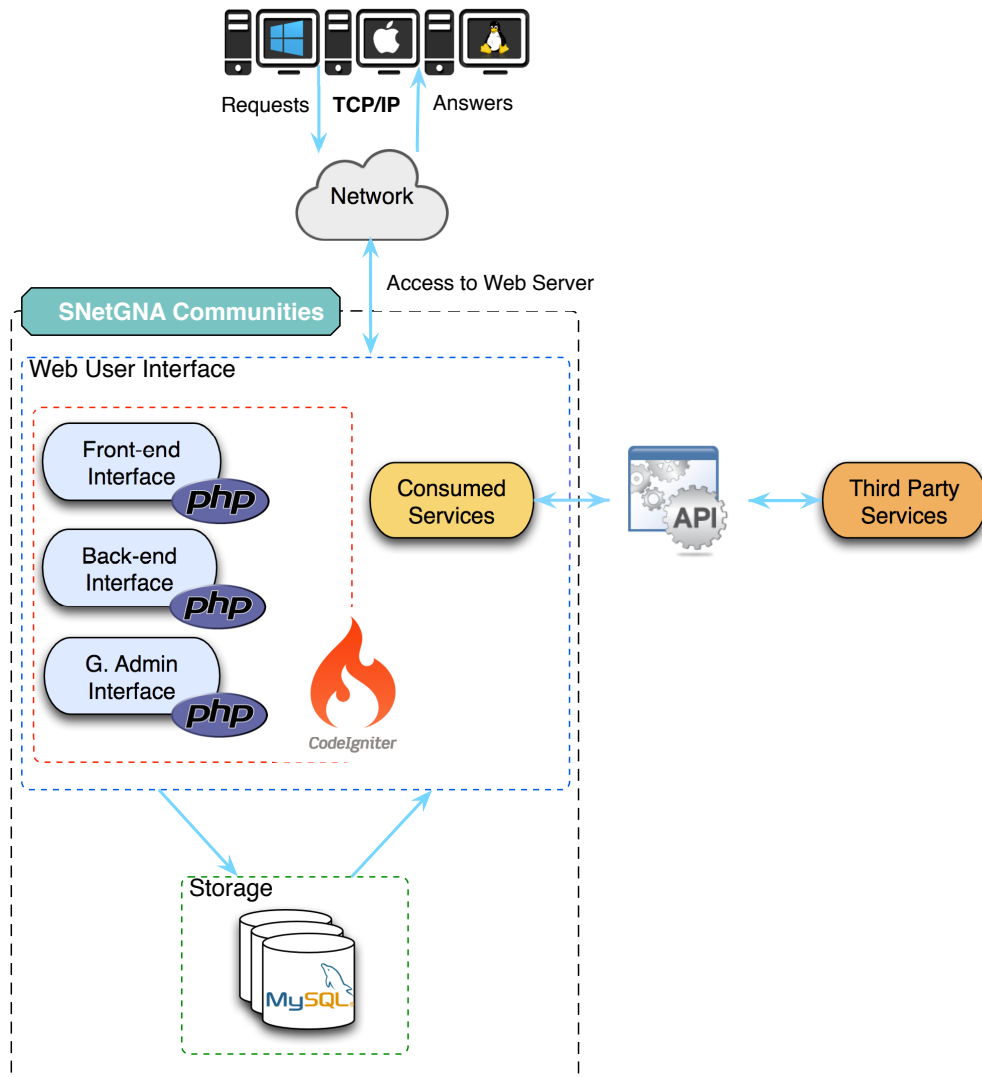

Figure 3.8: Illustration of the SNetGNA Communities platform architecture.

3.2.3   Used Technologies

SNetGNA Communities is a platform designed in PHP, under the CodeIgniter framework which is built by PHP coders to create full-featured Web applications. It goals is to enable programmers to develop their projects much faster, providing a rich set of libraries for commonly needed tasks, as well as a simple interface and logical structure to access these libraries [Inc].

CodeIgniter lets developers creatively focus on their projects by minimizing the amount of code needed for a given task. Is based on the MVC development pattern. The MVC pattern is an architectural design pattern created to separate the user interface from the business logic of an application. The user interface, also called "view", uses the controller to interact with the logic data of the application (model). Figure 3.9 shows the components of the MVC architectural design pattern and the way they interact with each other. The MVC pattern represents data structures. Typically, model classes contain functions that help retrieve, insert and update information in a database. The view contains the information that is being presented to an user. Normally, a view can also be a Web page, but in CodeIgniter a view can be a page fragment, like a header or footer. Finally, the controller serves as a intermediary between the model, the view and any other resource needed to process the HTTP requests and generate a Web page. The whole content generated by the platform is registered in a database. That database is designed using the MySQL DBMS. MySQL is free, open source and a widely used technology that works perfectly with PHP.
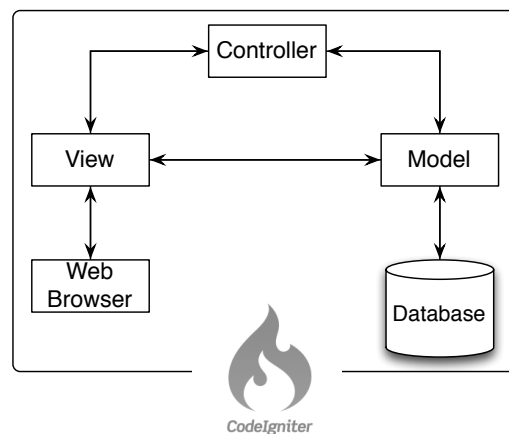

Figure 3.9: Illustration of the Model-View Controller pattern diagram.

3.3 System Implementation

In the next four sections, the authors of this dissertation explains how SNetGNA Communities platform was implemented describing some main mechanisms created to help users in their functions. Those methods are explained according to the three web user interfaces: back-end interface, front-end interface and general admin interface. The registration and authentication process, described in section 3.3.1, is explained independently since it is similar for all interfaces.

3.3.1 Registration and Authentication

One of the major concerns around the development of social networking systems is related to the concept of security, often associated with the users data, including the security of their own passwords. For example, in 2012, the SNS LinkedIn was hacked and nearly 6,5 millions user passwords were stolen by a group of Russian cyber criminals. Owners of the hacked accounts were no longer able to access their accounts, and the website repeatedly encouraged its users to change their passwords after the incident [Wika, Ppl]. With the intention of preventing this

type of incident, a safety mechanism, that allow users to register and authenticate without revealing their true passwords, was implemented.

3.3.1.1 Registration

During the registration process, general users and community's administrators must fill some fields (*e.g.*, name, gender, birthday, e-Mail address and password). The general admin don't need to register itself once that he have access to the entire system and this is responsible to add him automatically. When general users and community's administrators click to submit the registration, they are automatically added to the `tem_user` and `temp_admin` table in the database, respectively. At this time, users are not yet validated. To validate the registration process the both type of users must access to their e-Mail accounts and click on a validation link that will verify if the request is valid. If the request is really valid, the data on `temp_user` and `temp_admin` tables in the database are copied to the `User` and `Admin` tables, respectively, and both type of users are forward to the respective web user interface. This mechanism allows to verify if indeed the registration request came from a real person. The safety question related to this mechanism is the fact that the `password` field is not stored in clean text in the database. The `password` field is filled using an encrypted concatenation of the encrypted password (SHA1) with a encrypted salt (SHA1) automatically generated during the registration process. Figure 3.10 allows to understand better the described mechanism.
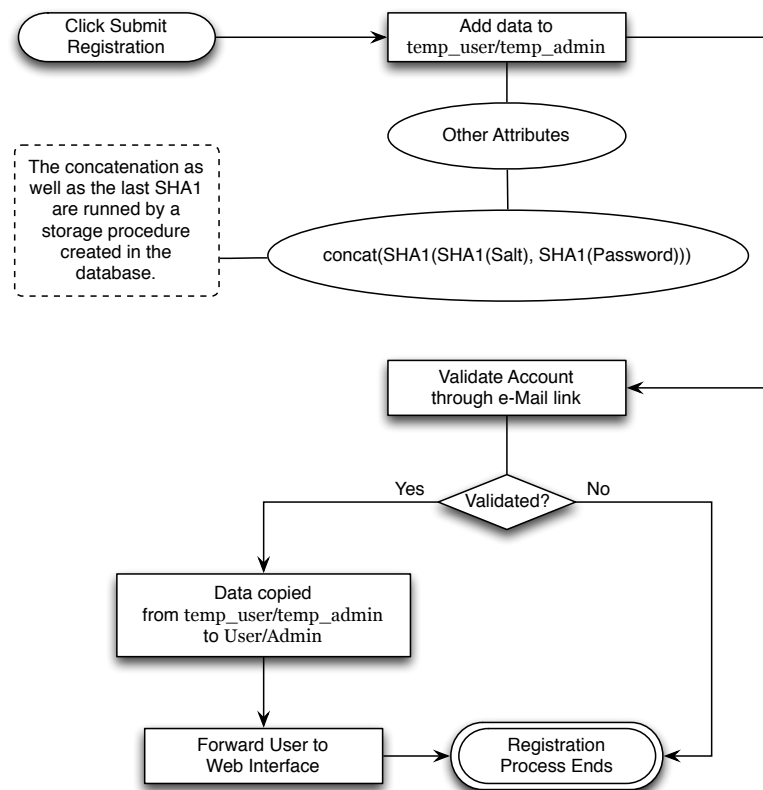

Figure 3.10: Illustration of the registration process.

If the registration process was not immediately validated, the users data remains in `temp_admin`/`temp_user` tables for more two days. After these two days has passed, the validation link is no longer valid, the data are removed from the `temp_admin`/`temp_user` in the database

and the user must make the registration process again. This mechanism is made by running an event in the database:

```
1 CREATE DEFINER='root'@'localhost' EVENT 'deleteTemp_Admin'
2 ON SCHEDULE EVERY 1 DAY STARTS '2014-01-01 00:00:00'
3 ON COMPLETION PRESERVE ENABLE
4 DO DELETE FROM temp_admin where date < (CURDATE() - INTERVAL 2 DAY);
```

3.3.1.2 Authentication

Once registered, general users and community's administrators can log-in into their accounts. Each user must be in their respective web user interface to perform the log-in. Firstly, they must fill the log-in form with their respective access credentials - e-Mail address and password. When they click on the log-in button, the system will verify those credentials. In fact, when the log-in button is clicked, the passed attributes to the system are the e-Mail address and the encrypted password (SHA1). After, the system will get the user associated `salt` (encrypted with SHA1) from the `User/Admin` table in the database and verify if the pair of credentials [e-Mail address, concat(SHA1(SHA1(salt), SHA1(Password)))] is equal to the pair [`email`, `password`] got from the `User/Admin` table in the database. If the result is true, the authentication process is valid and users can log-in into their accounts. To help understand the described mechanism, figure 3.11 illustrates the authentication process. The authentication process is exactly the same for the general administrator. The only difference is that the field `role` from the `Admin` table also must be verified and its value must be "1".
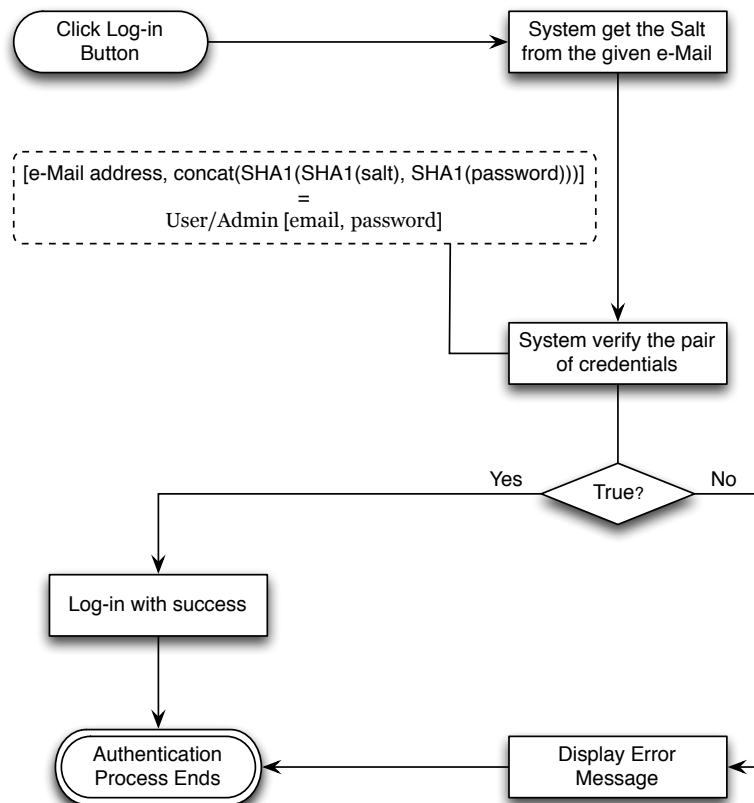

Figure 3.11: Illustration of the authentication process.

3.3.2 Back-End Interface

When logged-in, community's administrators are redirected to their respective account spaces (figure 3.12). The dashboard which is shown in the center allows to the community's administrator to have an overview of their social communities (*e.g.*, the 5 newest social communities and users as well as online users). In the right panel, its shown a welcome message to administrators where it is explained how the administrator can interact with the interface. On the other hand, in the left panel the administrator can navigate through the interface performing all the operations described in figure 3.4, namely manage communities and manage users.
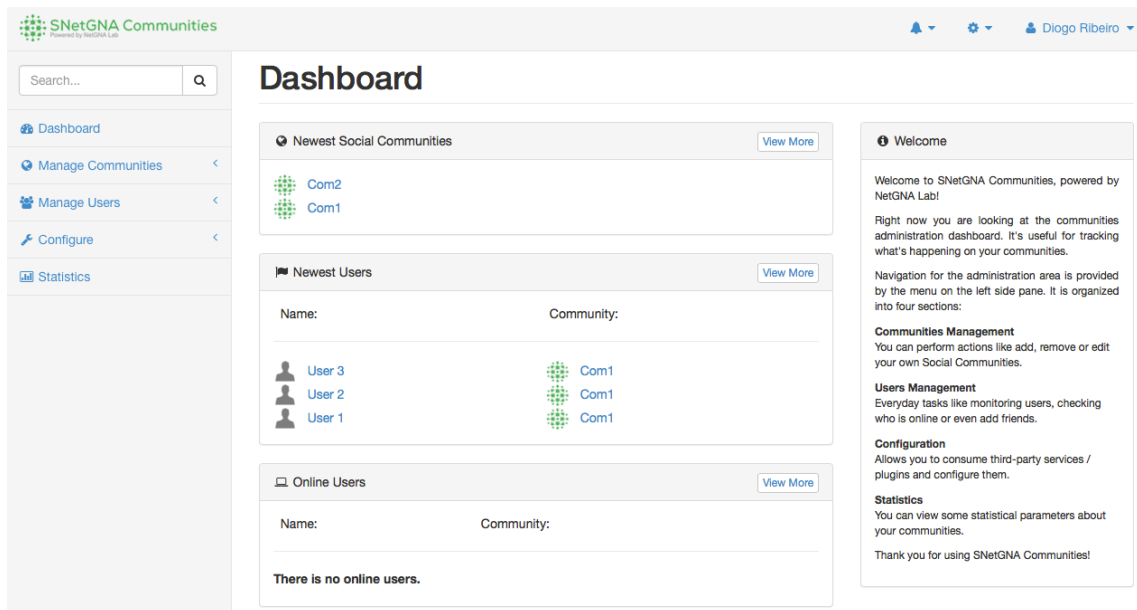

Figure 3.12: The Back-end web user interface. This interface is specific for community's administrators.

Relatively to the communities management, the administrator can create, delete or edit a community information. To create a new social community, the administrator only needs to set the community information such as name and description. Then, the system will verify if exists any community with the given name. If the result is true an error message is displayed. If does not exist any community with the given name, the system will populate the fields from the `Community` table in the database. On the other hand, when an administrator wants to delete communities, the system will get all the communities associated to the administrator `id` and shows up the the entire list with the option to delete each one. After the user click on the delete option for a specific community, the system will verify if exists any registered user on the community. If the result is true, the system will prompt the administrator giving them the option to continue or cancel the process. If the administrator want to continue, the system will delete first all users and all content related to the community and then remove the community fields from the `Community` table. If the community don't have any registered users, the system will delete automatically the community fields from the `Community` table in the database. Lastly, to edit a community information the administrator only needs to fill the name and description fields an then the system will update the information in the `Community` table in the database.

Relatively to the users management, the community's administrator can invite, delete or validate users. To invite users, the administrator only needs to select the specific community for which he want invite an user, and indicate the user e-Mail address. The system automati-

cally send an email to the user with a link which redirects to the sign-up page on the indicated community. After the invite user fill all the registration fields and click sign-up button, the registration process described above is executed. The administrator can also search for an user by his e-Mail address and removes him from the social community were belongs. When performing this operation, the system removes first all the content associated with the respective user, like its posts, and then remove then remove the user from the `User` table in the database and so the system itself. The community's administrator still has the possibility to validate users. However this operation will only shows the users that has registered in the last two days and yet not validate their accounts through the e-Mail link validation, as described in section 3.3.1.1. When the administrator validates an user, the system will automatically copy the data from the `temp_user` table to the `User` table in the database.

3.3.3 Front-End Interface

After the authentication succeeded, general users are redirect to their personal account spaces, the news feed page. Here, they can read all the friends posts. The system will get the recent posts from the `Post` table associated to their friends, *i.e.*, if the user is friend of another user the pair of `id`'s is present in the `FriendshipRelation` table in the database. So, getting the friend's `id` the system will get their posts and shows them on the news feed. The posts are ordered in a decreasing way by the `date` attribute of the `Post` table. The system will calculate the time between the current time and the value obtained from the `data` attribute and the post with the lowest result is shown first. General users can share posts with their friends. To perform such operation, the user must fill the post field in the top of the news feed as described in figure 3.13. Then, the system will insert the shared post into the `Post` table in the database. Automatically, that post is shown on the news feed as well as all the friends posts.
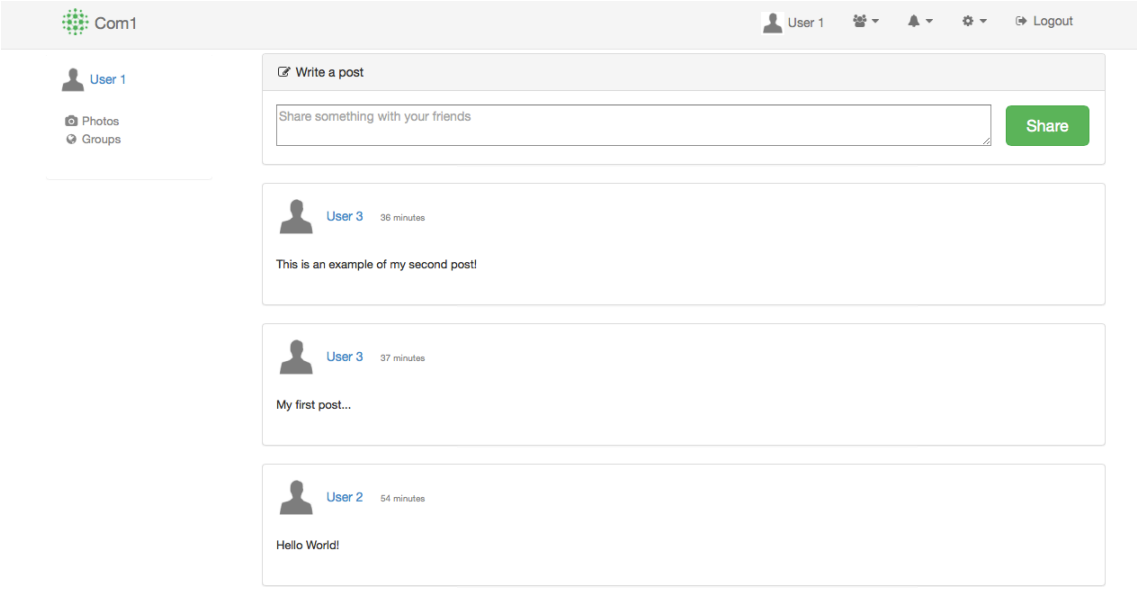

Figure 3.13: The Front-end web user interface. This interface is specific for general users.

Relatively to the profile management, users can edit their personal information through the profile. They have the capability to change their profile pictures, or update some fields such as basic information, contact information or details about them. The system will get the personal

information inserted by the users and will update the respective values in the `User` table.

Lastly, general users can search other users and create friendship relations with them. Possibly, this is the most important feature for general users: having the ability to relate with other users and share stories and ideas. To help understand this process, the user who makes the request for friendship will be referred as the source user, and the user who receives the request will be referred as the target user.
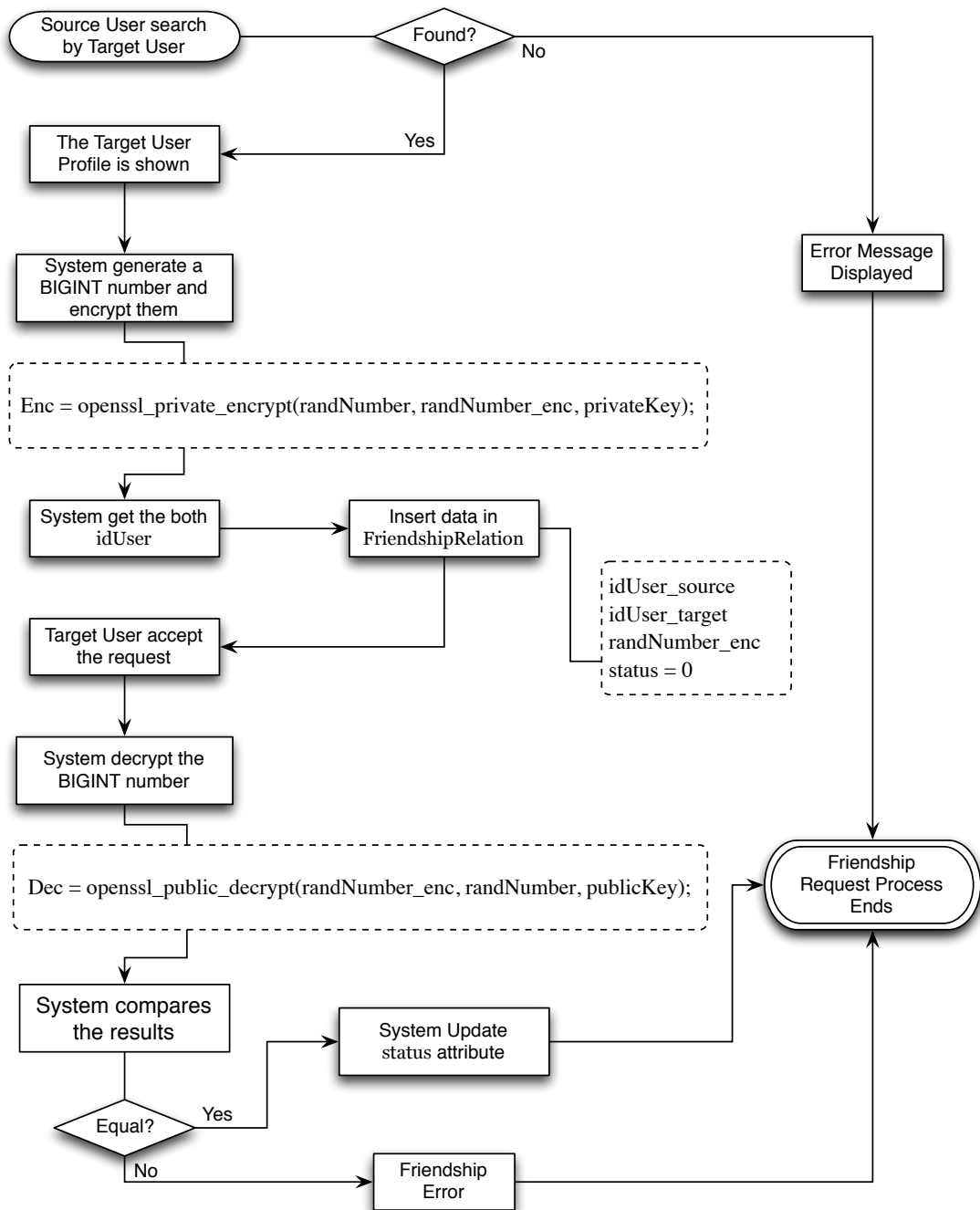

Figure 3.14: Illustration of the friendship relation process.

To perform this operation, the source user must search the target user by his name or e-Mail address. The system will search in the `User` table if exists any user with the given name or the

given e-Mail address. If the search result is true, the system will show the target user profile to the source user giving him the possibility to add the target user as a friend. Then, the process is similar to the process described in section 2.5.2, *i.e.*, the system will generate a random large number, get the `privateKey` from the source user and encrypt the generated number with it. After the system will get the `idUser` for both users and insert all this content into the `FriendshipRelation` with the `status` attribute set to 0 (zero). At this point, the both users are not yet friends. First, is necessary that the target user accept the request. So, the target user receives a notification with the friendship request on the notifications center and when he click on the accept button the system will get the `publicKey` from the source user and decrypt the large random number with it. In the end, if the result of the encryption and decryption operation is the same, the `status` attribute is set to 1, which means that the friendship request was succeeded and both users are now friends. This process is illustrated in figure 3.14.

3.3.4   General Admin Interface

All the general administrator web interface is similar to the back-end interface. The general administrator can manage general users as well as community's administrators, and can manage all communities. The general administrator web interface is shown in figure 3.15.
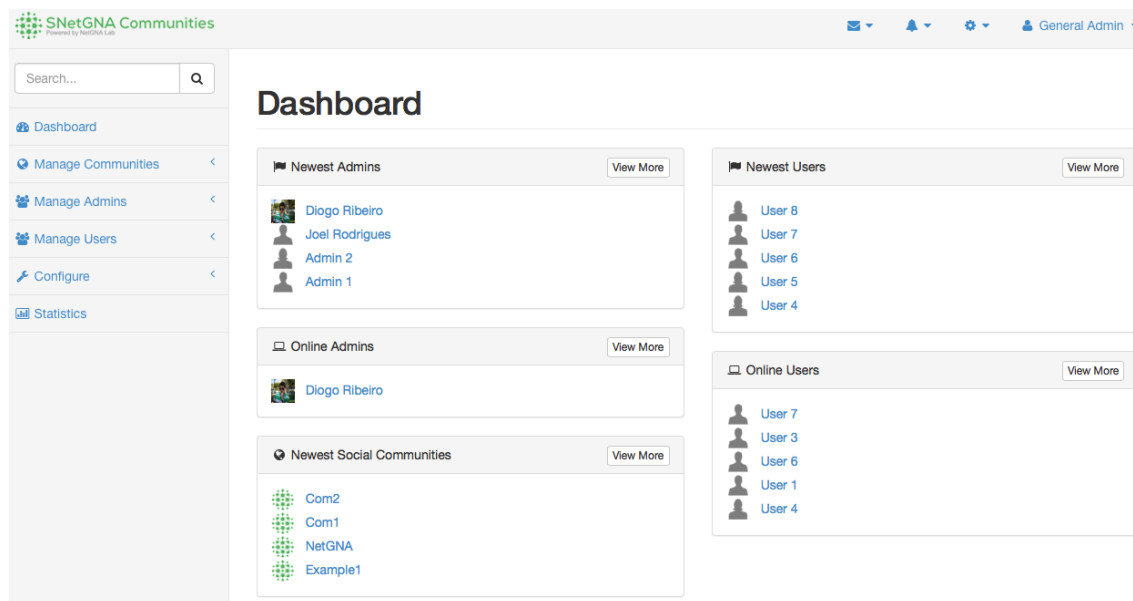

Figure 3.15: The General Admin web user interface. This interface is specific for the general administrator.

The general administrator can search and delete communities. As described above, this process is exactly the same as for the community's administrators. First, the system will delete all community users and respective content and then the community. Likewise, the process that allows to manage users is exactly the same as that implemented for the community's administrators, although the general administrator cannot invite users to explore a specific community. The main difference in terms of operations that can be performed between the back-end interface and the general admin interface is that the general administrator also can manage community's administrators and only not the users. However, the process is the same, varying only the local where the system get and insert the data, particularly in the `temp_admin` and `Admin` tables in the database.

Chapter 4

System Evaluation and Results

Chapter 4 provides an evaluation of the new solution for social networking management systems, over the web. Throughout the chapter some comparisons between the new solution and the state-of-the-art social networking systems are made and the results of such comparisons are revealed.

4.1 The Web Interface

Each one of the web user interface of SNetGNA Communities platform is simple, clean, organized and very intuitive comparatively to the interfaces of other existing platforms in the market. In this section, is made a comparison between the front-end and back-end web user interfaces of SNetGNA Communities platform and the Elgg platform (an award-winning open source social networking platform). Figure 4.1 shows the news feed page from the front-end web user interface of the SNetGNA Communities and the Elgg platforms, respectively:
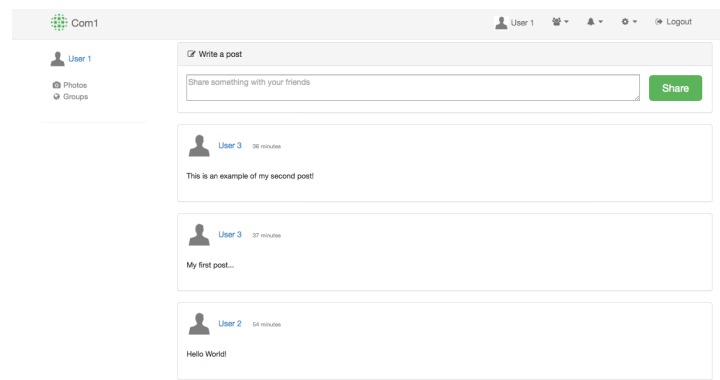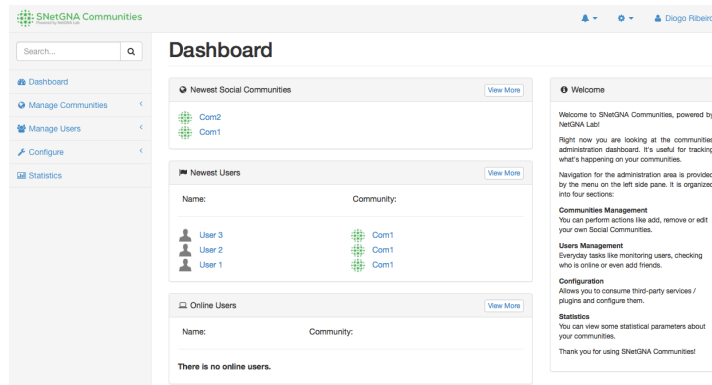

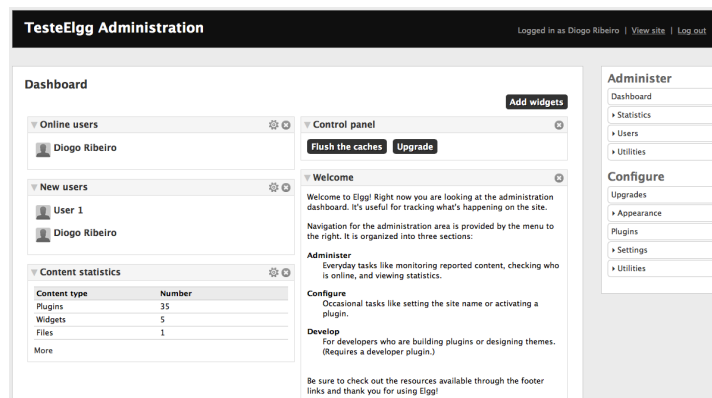(a) The SNetGNA Communities front-end web user interface.
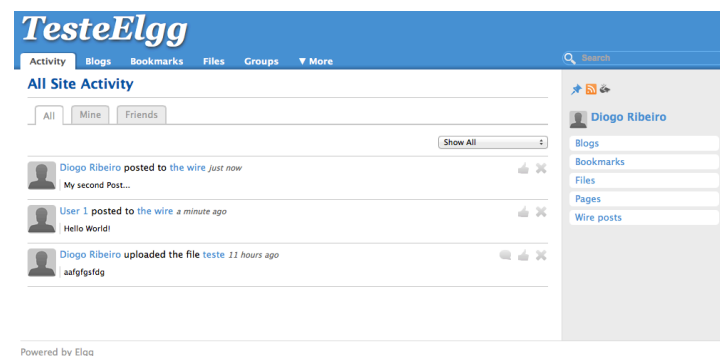
(b) The Elgg front-end web user interface.

Figure 4.1: Comparison between the SNetGNA Communities front-end interface and the Elgg front-end interface.

As can be seen, the layout of figure 4.1(a) is more smoother and more intuitive than the layout of figure 4.1(b). Here, users can focus more on what is shared, improving their personal experiences in the community where they belong. Next, figure 4.2 shows the different between the dashboard page of the back-end web user interface for the two platforms.

(a) The SNetGNA Communities back-end web user interface.

(b) The Elgg back-end web user interface.

Figure 4.2: Comparison between the SNetGNA Communities and the Elgg back-end interfaces.

Again, the layout of figure 4.2(a) is better organized than the layout of figure 4.2(b). Thus, the administrators of the SNetGNA Communities platform can have a better overview about their communities than the administrators of the Elgg platform.

In short, the SNetGNA Communities platform was designed to provide users a great experience of management and interaction. Only giving the users a optimal personal experience of sharing ideas and connecting with others, this platform can become competitive compared with the existing solutions.

4.2 Installation Process

Table 3.1 makes a brief comparison between some of the social networking platforms available in the market. As can be seen, the majority of those social networking platforms requires a process installation out of the box and that process takes some time to users, depending on the technical knowledge of each one. Figure 3.1 shows the steps that must be overcome to complete the installation of Elgg social networking platform. Similarly to Elgg, the installation process for

the other platforms, such as BuddyPress, Drupal and Oxwall is the same. The described platforms are free and are available for download in the respective websites. After to download them, users must have to unzip the file, copy the entire directory to the server and grant read and write privileges to some folders and files. During this process, users also must be capable to create databases and make them available in the server. Figure 4.3 shows the average time it takes each platform to be fully installed, from the point that the user proceeds to download it to the point where he can take advantage of the whole platform, without restrictions.
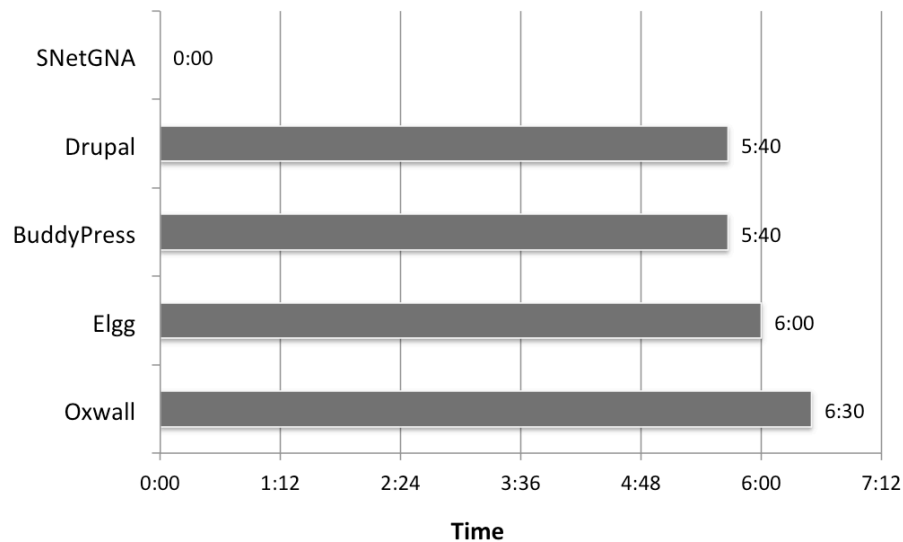

Figure 4.3: Illustration of the average time of the installation process between different social networking platforms.

In this case, the SNetGNA Communities platform stands out completely from all the others once is a fully integrated web solution and does not need to install any kind of support software. This new solution provides user a new experience because they do not need to have any technical knowledge to perform any task. This can be assumed as one of the main critical points that can not influence the use of such systems. The installation process may depend from the technical knowledge of the user, for example, to create databases, import them to the server and grand different privileges for some files and folders. In this case is assumed that the different times present in figure 4.3 are lower than the usual, since the authors of this dissertation have knowledge in the area and thus the process becomes easier. Therefore, the time of the installation process can vary from user to user according to his experience.

4.3 Social Networking Features

This section made a comparison between the social networking features present in the SNetGNA Communities platform as well as in the other state-of-the-art platforms.

Social networking features are the most important components in this type of systems. They provide a fully integrated experience to the user. As described before in section 2.5 there are three features that are considered the main features: profile customization, friendship relations and posts and comments. However, there are many other features that also play an important role

such as instant or private messaging, media sharing (*e.g.* photos and videos), events calendars, groups among many others. Together, all those features make the social networking platforms much more complex and ready to respond to any need from users. Nowadays already exists a set of very complex plugins for blog systems with the intend to make them more interactive. Based on the social networking features described above, a comparison between the available software was performed. For each feature, and according to its integration in the respective software was given the following value of evaluation:

– 0: Not available for the software

– 1: Not integrated. However it is possible to integrate them via plugins or modules

– 2: Already integrated in the software

As can be seen in figure 4.4, the three paid softwares were considered the best among the others. However, it is important make a comparison between the SNetGNA Communities platform and free solutions like Elgg, Drupal, BuddyPress or Oxwall. The comparison is made and presented in table 4.1.
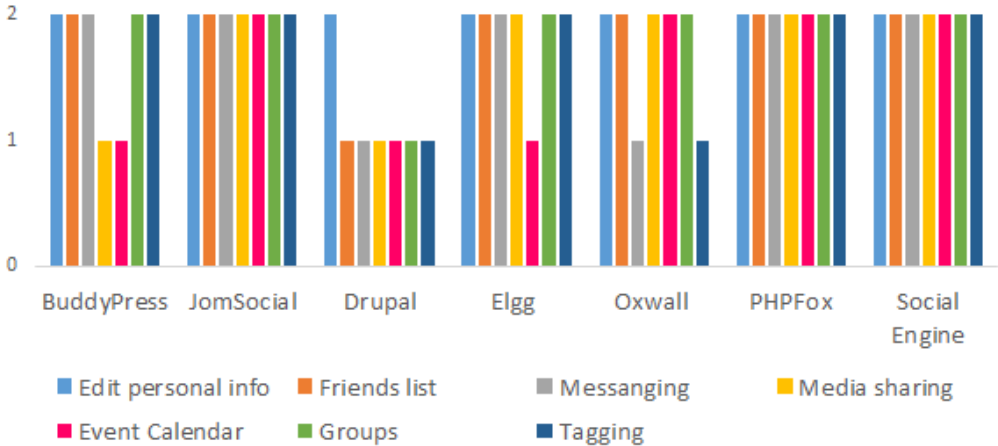
Figure 4.4: Comparison of the social networking features presented in different platforms.

Table 4.1: Brief comparison between SNetGNA Communities and state-of-the-art free solutions.

	SNetGNA	Elgg	Oxwall	BuddyPress	Drupal
Edit Personal Info	Yes	Yes	Yes	Yes	Yes
Friends List	Yes	Yes	Yes	Yes	No
Messaging	No	Yes	No	Yes	No
Posts	Yes	Yes	Yes	Yes	Yes
Media Sharing	No	Yes	Yes	No	No
Event Calendar	No	No	Yes	No	No
Groups	No	Yes	Yes	Yes	No
Tagging	No	Yes	Yes	Yes	No

As can be seen in table 4.1, the SNetGNA Communities platform don't have yet all the social features available. However it is important to refer that all those features must be included in the future.

Chapter 5

Conclusions and Future Work

This chapter begins with some comments on the evolution of existing social networking systems, and how they influence and affect the daily lives of its users. Then, the authors present the main conclusions of the work developed throughout this dissertation. Finally, the third section presents some suggestions on possible research directions that can be addressed in the future.

5.1 Final Remarks

The Internet is part of everyday life for the majority of the world population, changing routines and habits, connecting individuals and businesses, allowing the sending of a huge set of information in a simple way. Within this digital environment, it was felt the need to find a new way of communication that could facilitate the relationships between users. Social Network Systems arise from this need for individuals to share their states of mind, to create social ties with other individuals and having the ability to communicate with them permanently.

The first digital OSN emerges around 1995 and is called Classmates. The emergence of this system was given by the need to perform a reunion of old friends from school or college, trying to carry for the digital era the existing social ties in the daily lives of users. Such system proved to be a success, even with the disadvantage of being a paid service bucking the trend of social networks that proceeded it. Social networks peaked of usage and popularity between the years 2010 and 2011. Given the exponential growth of users, social networks were presented in the year 2012 as a definite and permanent way for the entire population, leaving aside the idea of being seen as a service of fashion. However, social networks has played a very important role in the development of communication process in real time. Most individuals who have Internet access, seek to join and adapt to social networks. On the other hand, in the recent years, companies and brands also feel the need to make part of these platforms, which help them to promote their services and products. Today, social networks are used by people from 5 to 85 years old around the world, representing thousands of individual users as well as several companies that seek to define its position in the digital environment. The existence and widespread use of social networks reflects a society increasingly connected. Although, these systems differ among themselves. They have the basic features and principles to allowing the sharing of information and common interests between users. To ensure this principle, social networks must have three basic features: the ability of each user customize his own profile, establishing bonds of friendship with other users having the capability to share posts or comments with other users. In fact, users show a growing desire to create digital identities that enables the relationship with other users. Each new member of a social network can create a personal profile, setting up personal information as contact information and personal tastes. The proper definition of a profile enhances the relationships between members, allowing them to reconnect with old friends and meet their current profiles. The ability to interact with other members and to establish friendship relations is one of the most striking features of a SNS. To help maintain these friendship

relations it is important that these systems allow a permanent contact between users letting them to publish resources and comment on another users' posts. It should be noted that there are many solutions of SNS's offered to users. However, they present some limitations such as the price or the installation process. To fill this gaps, a new model for the social networking systems was proposed and presented in this dissertation.

5.2   Main Conclusions

Nowadays there are a unlimited number of SNS's and its adherence grows up day after day. Given this fact, it is possible to understand that everyday millions of shares are made, associated to an unlimited number of subjects. During the study presented in this dissertation was understood that small communities have greater influence on the people's choices. So, this study lead the authors to believe that for users who have the same interests is better to participate on small communities than on big communities like Facebook where millions of users share millions of interests according to a distinct universe of topics. To understood how is possible develop a entire new system that would demonstrate improvements over the existing solutions, a depth study was made and where is tried to understand what open issues can be resolved. Hence, the main motivation of the development of the proposed system lies in the possibility of developing a fully integrated web system, where users don't need any technical knowledge to be able to use the platform. The interface is simple and intuitive, and to access the platform only a computer with Internet access is needed. The main focus of the development of this system is to produce and share content related to a particular topic through a specific social community created with the purpose of integrating users with a common interest. For the proposed solution, three type of users were considered: the general administrator, community's administrators and general users. Each of them have a specific web user interface where can perform different operations. Through the back-end interface, community's administrators have the capability to create social communities related to specific topics, delete them or edit their information such as name and description. They also have the capability to manage users, including invite users, delete registered users or validate users who has not validated yet. When general users create a new community it is available to the general public. Thus, general users have the capability to register on it and after they are logged-in they can explore the entire community. Here they can set up personal information, make friends, read friends posts and share posts with friends. Lastly, the general administrator have full access to the platform.

The results show that the proposed solution fills some open issues related to social networking platforms. The SNetGNA Communities platform is a fully integrated web solution and so does not need to go through any installation process unlike to what happens with other platforms presented in this dissertation. Relatively to the social networking features implemented, the SNetGNA Communities platform is not yet much developed as others mentioned. Although the topic of social networking is quite fashionable, there are not many research works available under the management of social networking platforms and often was only possible to get information about the existing solutions using their websites to try understand their way of operation. Still, this new platform gathered contributions from many other research works. In the end, this dissertation gathers a set of studies related to the field of studies of social networking systems and can be used for depth further studies.

5.3 Directions for Future Work

Given the initial objectives set for this project, the authors conclude that a new system, simple and intuitive for the user, is obtained. In this sense, the system already have some key features implemented. As stated above, the SNetGNA Communities platform is divided into three web user interfaces: the front-end web user interface for general users, the back-end web user interface for community's administrators and the general admin web user interface for the general administrator. Each one of these interfaces possess a set of implemented methods. For the general admin and back-end interfaces has already been implemented the basic functions. On the other hand, for the front-end interface only three main functions were implemented: edit profiles and personal information, make friendship relations and post and share resources with friends. However, it is still important to continuing the development of much more functions for each web user interface in order to make the system increasingly complex.

Features like event calendars, messaging, tagging, groups among others are important and should be part of the SNetGNA Communities platform namely for the front-end web user interface. On the other hand, as described in the architecture of these new platform, it is important develop an interface that can consume third-party services via their respective API's. For example, services like Dropbox will can be associated to the SNetGNA communities platform through its RESTful API. Then users can import or export data for their Dropbox accounts in a transparent way, *i.e.*, running the RESTfull API function in background, without user being aware of them. One another important aspect is related to grant a role more active to the general administrator of the system. Features like analyzing detailed statistics about each community's administrator and each community or even about each user would be important. For example, if the general administrator verify that a particular community isn't having acceptance, not being sought by new users, can get in touch with its administrator informing him or can even remove the specific community from the system.

References

[Ana14]   Revolution Analytics. *Big Data*. Mary Ann Liebert, Inc., 2014. 22

[APES09] S. M. A. Abbas, J. A. Pouwelse, D. H. J. Epema, and H. J. Sips. A gossip-based distributed social networking system. pages 93–98, Groningen, June 2009. 18th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises, IEEE. 18

[BE07]   D. Boyd and N. Ellison. Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication*, 3(1):210-230, October 2007. 18

[BH06]   D. Boyd and J. Heer. Profiles as Conversation: Networked Identity Performance on Friendster. volume 3, page 59c. 2006 Proceedings of the 39th Annual Hawaii International Conference System Sciences (HICSS), IEEE, January 2006. 18

[Bud]   BuddyPress. BuddyPress Documentation - About. Available in `https://buddypress.org/about/`. Accessed Mar. 2014. 16

[CCRB10] Kyle Chard, Simon Caton, Omer Rana, and Kris Bubendorfer. Social cloud: Cloud computing in social networks. pages 99–106, Miami, FL, July 2010. 2010 IEEE 3rd International Conference on Cloud Computing (CLOUD), IEEE. 22

[Cia01]   Robert B. Cialdini. Harnessing the Science of Persuasion. *Harvard Business Review*, pages 72-79, October 2001. 10

[CML14]   Min Chen, Shiwen Mao, and Yunhao Liu. Big Data: A Survey. *Mobile Networks and Applications. Springer*, 19(2):171–209, April 2014. 22

[CNN]   Doug Gross, CNN. Facebook for rich people (for just $9,000). Available in `http://edition.cnn.com/2014/09/16/tech/social-media/netropolitan-social-media/index.html?iref=allsearch`. Accessed Sep. 2014. 15

[Dev]   Google Developers. Blogger API Documentation. Available in `https://developers.google.com/blogger/`. Accessed Mar. 2014. 13

[DHW08]   Catherine Dwyer, Starr R. Hiltz, and George Widmeyer. Understanding Development and Usage of Social Networking Sites: The Social Software Performance Model. page 292, Waikoloa, HI, January 2008. Proceedings of the 41st Hawaii International Conference on System Sciences, IEEE. 18

[Dru]   Drupal. Drupal Community Documentation - Community building and social networking modules. Available in `https://www.drupal.org/node/206724`. Accessed Mar. 2014. 15

[Dwy07]   C. Dwyer. Digital Relationships in the "MySpace" Generation: Results From a Qualitative Study. page 19, Waikoloa, HI, January 2007. 40th Annual Hawaii International Conference on System Sciences 2007 (HICSS), IEEE. 18

[DYK11]   Norriati Din, Saadiah Yahya, and Raja Suzana Raja Kassim. Online Social Networking for Quality of Life. pages 713-718. Asia Pacific Internacional Conference on Environment-Behavior Studies, Elsevier, December 2011. 11

[ECA12]   Michal Ennert, Marek Cajkovsky, and Norbet Adam. Optimization Model of Management and Security of Multimedia Content using Drupal CMS. pages 289-293, Herl'any, January 2012. 2012 IEEE 10th International Symposium on Applied Machine Intelligence and Informatics (SAMI), IEEE. 12

[Elg]   Elgg. Elgg 1.9 Documentation. Available in `http://learn.elgg.org/en/1.9/`. Accessed Mar. 2014. 16

[fTfG11]   Jian fei Tu and Rui feng Guo. The Application Reseach of Mixed Program Structure based on Client-Server, Browser-Server and Web Service. volume 1, pages 193-195, Guangzhou, May 2011. 2011 International Conference on Business Management and Electronic Information (BMEI), IEEE. 30

[GHFZ13]   Adrien Guille, Hakim Hacid, Cecile Favre, and Djamel A. Zighed. Information diffusion in online social networks: a survey. *ACM SIGMOD Record*, 42(2):17–28, May 2013. 7

[HDF$^+$11]   Philip N. Howard, Aiden Duffy, Deen Freelon, Muzammil Hussain, Will Mari, and Marwa Mazaid. Opening Closed Regimes - What Was the Role of Social Media During the Arab Spring? pages 1–30. Project on Information Technology and Political Islam, 2011. 7

[HP10]   Amanda L. Hughes and Leysia Palen. Twitter adoption and use in mass convergence and emergency events. *International Journal of Emergency Management*, pages 248–260, February 2010. 7

[HTYL12]   Xiaoyue Han, Lianhua Tian, Minjoo Yoon, and Minsoo Lee. A Big Data Model Supporting Information Recommendation in Social Networks. pages 810–813, Xiangtan, November 2012. 2012 Second International Conference on Cloud and Green Computing (CGC), IEEE. 22

[Hua10]   Shurong Huang. An Object-Oriented Development Model of Blog Management System. volume 2, pages 310–313, Yichang, November 2010. 2010 International Conference on System Science, Engineering Design and Manufacturing Informatization (ICSEM), IEEE. 30

[IHG09]   Raghuram Iyengar, Sangman Han, and Sunil Gupta. Do Friends influence Purchases in a Social Network? Working Paper, Harvard Business School, February 2009. 11

[Inc]   EllisLab, Inc. A Fully Baked PHP Framework. Available in `https://ellislab.com/codeigniter`. Accessed Nov. 2013. 31

[JCW$^+$13]   Long Jin, Yang Chen, Tianyi Wang, Pan Hui, and Athanasios V. Vasilakos. Understanding User Behavior in Online Social Networks: A Tutorial Survey. *Communications Magazine, IEEE*, 51(9):144-150, September 2013. 10

[Jom]   JomSocial. JomSocial Features - Joomla Community Extention. Available in `http://www.jomsocial.com/features`. Accessed Mar. 2014. 16

[JPD$^+$12]   Jie Jiang, Weiwei Pang, Yule Deng, Kate He, and Zhuyan Gu. A Blog Personality Recommender System Based on Cloud Computing Infrastructure. pages 1–5, Shanghai, May 2012. 2012 International Joint Conference on Service Sciences (IJCSS), IEEE. 22

[LICP12] Cristopher Leberknight, Hazer Inaltekin, Mung Chiang, and H. Vincent Poor. The Evolution of Online Social Networks: A Tutorial Survey. *Signal Processing Magazine, IEEE*, 29(2):41–52, March 2012. 8

[LLPD11] Kwan H. Lee, Andrew Lippman, Alex S. Pentland, and Elenna R. Dugundji. The Imapcts of Just-In.Time Social Networks on People's Choices in the Real World. pages 9–18, 2011. 10

[Med] Technorati Media. 2013 Digital Influence Report. Available in `http://technorati.com/report/2013-dir/`. Accessed Aug. 2014. 8, 9

[MLJS06] Junghoon Moon, Jessica Pu Li, Sooran Jo, and G. Lawrence Sanders. Improving Quality of Life via Blogs and Development of a Virtual Social Identity. *Journal of Information Technology Management*, XVII(3):26-37, 2006. 11

[MSE12] Erwan Le Malécot, Mio Suzuki, and Masashi Eto. Online Social Network Platforms: Toward a Model-Backed Security Evaluation. Number 3, Lyon, France, April 2012. Proceedings of the 1st Workshop on Privacy and Security in Online Social Media, ACM. 20

[Net] Rackspace Support Network. CMS Comparison: Drupal, Joomla and Wordpress. Available in `http://www.rackspace.com/knowledge_center/article/cms-comparison-drupal-joomla-and-wordpress`. Accessed Jun. 2014. 12

[Oxw] Oxwall. Oxwall Software Documentation. Available in `http://docs.oxwall.org/introduction:about_oxwall`. Accessed Mar. 2014. 16

[Pat] Google Patent. Content Management System - US 6356903 B1. Available in `http://www.google.com/patents/US6356903`. Accessed Aug. 2014. 12

[Pea10] Michael Peacock. *PHP 5 Social Networking*. Packt Publishing, October 2010. 14

[PHP] PHPFox. PHPFox - PHP Social Networking Software. Available in `http://moxi9.com/phpfox`. Accessed Mar. 2014. 16

[Ppl] Pplware. LinkedIn atacado e 6 milhões de passwords roubadas. Available in `http://pplware.sapo.pt/informacao/linkedin-atacado-e-6-milhoes-de-passwords-roubadas/`. Accessed Aug. 2014. 32

[PRP11] Savan K. Patel, V. R. Rathod, and Satyen Parikh. Joomla, Drupal and WordPress - A Statistical Comparison of Open Source CMS. pages 182–187, Chennai, December 2011. 2011 3rd International Conference on Trendz in Information Sciences and Computing (TISC), IEEE. 12

[PRP13] Savan K. Patel, V. R. Rathod, and Jigna B. Prajapati. Comparative Analysis of Web Security in Open Source Content Management System. pages 344–349, Gujarat, March 2013. 2013 International Conference on Intelligent Systems and Signal Processing (ISSP), IEEE. 12

[PTXK13] Phani C. Polina, Tuan T. Tran, Bin Xie, and Anup Kumar. SOS: Social network-based distributed data storage. pages 687–690, Sydney, NSW, October 2013. 2013 IEEE 38th Conference on Local Computer Networks (LCN), IEEE. 22

[Rev]   Top Ten Reviews. Blog Software Review 2014 - Best Blogging Software. Available in `http://blog-software-review.toptenreviews.com`. Accessed March. 2014. 13

[RRHN14] Diogo J. P. Ribeiro, Joel J. P. C. Rodrigues, Guangjie Han, and Jianwei Niu. SNet-GNA Communities: A New Proposal of Web Application to Online Social Networking Management Systems. Maoming, People's Republic of China, August 2014. 9th International Conference on Communications and Networking in China (Chinacom), IEEE. 4, 23

[Sif]   David Sifry. State of the Blogosphere, February 2006 Part 1: On Blogosphere Growth. Available in `http://www.sifry.com/alerts/archives/000419.html`. Accessed Apr. 2014. 11

[Soc]   SocialEngine. Features - SocialEngine Community Software. Available in `http://www.socialengine.com/features/php`. Accessed Mar. 2014. 17

[Tec]   Technorati. State of the Blogosphere 2010. Available in `http://technorati.com/state-of-the-blogosphere-2010/`. Accessed Apr. 2014. 11

[Wal11]   Susan K. Walker. Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives. *Journal of Family Theory and Review*, 3(3):220–224, September 2011. 11

[Whi10]   Tom White. *Hadoop The Definitive Guide*. O'Reilly Media, 2 edition, October 2010. 22

[Wika]   Wikipedia. 2012 LinkedIn Hack. Available in `http://en.wikipedia.org/wiki/2012_LinkedIn_hack`. Accessed Aug. 2014. 32

[Wikb]   Wikipedia. Comparison of social networking software. Available in `http://en.wikipedia.org/wiki/Comparison_of_social_networking_software`. Accessed Apr. 2014. 15

[Xf13]   Song Xin-fang. Survey of Model and Techniques for Online Social Networks. pages 1495–1498, Colombo, April 2013. 2013 8th International Conference on Computer Science & Education (ICCSE), IEEE. 23

[XY10]   Cao Xiang and Wenhua Yu. Using Content Management System Joomla! to build a website for research institute needs. pages 1–3, Wuhan, August 2010. 2010 International Conference on Management and Service Science (MASS), IEEE. 12

Appendix A

Attachments

A.1   CHINACOM 2014 Best Paper Award

The 9th International Conference on Communications and Networking in China
August 14-16, 2014 Maoming, People's Republic of China

BEST PAPER AWARD

present to

SNetGNA Communities: A New Proposal of Web Application to Online
Social Networking Management Systems

Diogo Ribeiro, Joel J.P.C. Rodrigues, Guangjie Han,
and Jianwei Niu

Instituto de Telecomunicações, University of Beira Interior, Covilhã, Portugal
University ITMO, St. Petersburg, Russia and
Hohai University, China and Beihang University, China

General Co-chairs

Qinghua Zhang, Vincenzo Piuri, Lei Shu

Technical Program Co-chairs

Yan Zhang, Danny Tseng, Chonggang Wang