Software Architectures for Social Influence: Analysis of Facebook, Twitter, Yammer and FourSquare

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Abstract

Social media systems like Facebook and Twitter have experienced exponential growth in their user base as they fulfil basic human desires of communication, sharing of opinions, thoughts and intentions. Plus they also act as source of news and a place to network and meet interesting people who would otherwise be unreachable. Social media systems have thus become important tools for dissemination of information and addressing peoples’ information needs and as they are user driven and interactions are mainly over user-generated content, they provide useful features for supporting conversations which are the essence of such systems.

This research is a conceptual analysis of how social media systems have been modeled to influence. The aim is to discern how the design choices made during development have enabled the growth of such systems and their prevalent influence on user interactions. The theoretical basis of the research is a persuasive context which describes how interactive computing systems have an impact on users’ thoughts and consequently lead to a change in their behavior. The study focuses on the architectures of Facebook, Twitter, Yammer and Foursquare to date among the most common social media systems serving different user needs while essentially encouraging conversations in a collaborative environment. The architectures of these systems mainly developed using open source software have undergone numerous changes in order to be able handle enormous amounts of user-generated data in real time and at the same time also be secure and respond to the user’s needs.

Taking these factors into consideration, this research through review of literature, provides further insights into the use of social media systems and how their inherent design choices provide a platform to influence both user actions and interactions by: (i) contrasting between various social media systems, (ii) detailing the features that facilitate influence, (iii) analyzing the architectures of four social media systems, and (iv) analyzing the persuasion context and the resultant effects.

The research is limited by the choice of the four systems for analysis and its conceptual nature which could not provide adequate opportunities for discerning key contextual issues like location, category and knowledge of users and so forth. This could be extended by empirical studies that are longitudinal in nature and use of data mining and/or social network analysis to discern the relationships and discussions within the respective systems.

Keywords: social media, architecture, social influence, persuasion, social web platform
Foreword

This thesis was written for my Master of Science degree majoring in Information Processing Science at the University of Oulu.

I would like to extend my gratitude to a few people whose help, insight and belief in me have proved invaluable in both my life and study experiences. First, I would like to show my gratitude to my supervisor Professor Harri Oinas-Kukkonen for his wise guidance and advice throughout the thesis process and providing an opportunity to develop my research skills. Secondly, I would like to thank the reviewer of the thesis Agnis Stibe for his critical analysis, useful and insightful comments. Thirdly, I would like to express my gratitude to Peter Hagstrom a dear friend who has always encouraged and believed in me and who helped me out of a difficult situation during my initial studies at the university. Fourthly, is the Department of Information Processing Science for providing me with an enabling environment and an opportunity to further my studies.

Finally, I would like to thank the Almighty whose Grace has gotten me this far, my mother and other family members for their constant support and all the friends I have met along the journey who have made the learning experience to be even more worthwhile.

Michael Oduor

Oulu, February 20, 2012
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1 INTRODUCTION

Social networking (henceforth SN) taken at face value has always been present in one form or the other and it is only with the advent of the Internet and the world seemingly becoming “smaller” has the concept become more relevant (Weaver & Morrison, 2008). People by nature are social creatures and we require constant interaction and collaboration in whatever tasks we undertake. The ability to create value from working together in groups that is more than the sum of the individual parts is our most admirable resource Weaver & Morrison (2008) further add. Earlier it used to be the six degrees of separation which stated that we were all potentially six steps away from every other person on earth and recent research (Barnett, 2011) indicates, especially now with the advent of social networking sites (SNSs) that the average number of connections between people has reduced to just four friends-of-friends-of-friends-of-friends (Boyd & Ellison, 2007).

SN on the web includes everyone who has access and this has enhanced a bottom-up creation, sharing and distribution of information that give users power to influence their interactions. The essence of SN is participation and user-generated content in a collaborative and open environment. SN encompasses any medium where users are able to participate, create and share content and there are currently a lot of available technologies that focus on online collaboration and user-generation of content (van Zyl, 2009).

The growth of SN has been greatly enhanced with the advent of Web 2.0. A term made famous by O'Reilly (2005) which emphasized the shift of the web from being a hub of just information retrieval to a place where users are both the “generators and controllers” of the information that exists on the Web. This also enhances the connection between various individuals who share similar interests. Table 1 below illustrates this shift to Web 2.0 which is termed as a new way of working as compared to Web 1.0 which was somehow restrictive in the sense that it was more a top-down approach to creation of information and interaction (Weaver & Morrison, 2008). To have the Web as a platform means that it provides services rather than traditional packaged software, it facilitates and enables user participation, it is less costly, and also highly scalable (O’Reilly, 2005).

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Technological advancement coupled with an increasing number of differing users across the globe has led to improvement in communication channels and enabled easier and quicker information exchange and provided a variety of options to reach both people and resources. This as we will later discuss, has further provided opportunities to influence and consequently have an effect on the choices people make. The present research thus examines how users interact via social media systems (henceforth SMS) generally and goes more in depth with analysis of four SMS. In addition, it explores the underlying techniques through which SMS’ features influence users.

The research is conceptual by its nature and adopts a dual approach in the analysis of literature in order to make appropriate inferences. The first one is front-end (external) view; concerned with how an information system is used and the consequences of this use. The second is the back-end (internal) view and this consists of methods used in constructing the architecture and the architectural composition in order to attain the required functionality. Following the discussion of these two aspects, a basis for analysis of the persuasion context is established.

1.1 Purpose of the study

The purpose of this research is to carry out an analysis of how SMS architecture has been modeled to influence and the inherent features that are embedded into these technologies that facilitate this influence–duality in analysis. That is, the architecture and the features resulting from design and development of the architecture. There are many kinds of SMS available that have been developed for different purposes with their focus being on online collaboration and sharing of user-generated content (O’Reilly, 2005); these systems mostly share similar features such as creation of user profiles that disclose whom the user is in contact with, access to others contacts lists, customization of user profiles, private messaging, discussion forums, media uploading, integration with other applications (Boyd & Ellison, 2007; Fogg & Iizawa, 2008) amongst others.

After discussion on the general SMS features and architecture, the research concentrates on the following social media systems: Facebook – to date the social networking site (SNS) with the most number of registered users, Twitter – a microblogging and (SNS), Yammer – an enterprise microblogging and social collaboration tool and FourSquare – a location-based application that enables users to post their location (commonly referred to as “check-ins”) to friends. An inherent feature in social media is its appeal to humans need for interaction as alluded to in the introduction. Influence requires one to understand fundamental aspects of human behavior and these systems seem to embody this understanding as can be attested to by their growing user base and the plethora of available applications with active users.

1.2 Related and Supporting Work

Persuasive technology is a relatively new research field pioneered by BJ Fogg that views computers as persuasive technologies (captology) that can motivate and influence the user. In his seminal book Fogg (2003), persuasive technology is defined “as any interactive computing system designed to change people’s attitudes and behaviors” (Fogg, 2003). Although not directly related to social media; the underlying features such
as, simplicity of use, wide reach and easy accessibility provide SMS with an ideal context for influence. Plus many of the persuasive techniques applied in other computing systems are equally applicable in SMS. Fogg (2003, p. 23-28), further introduced the functional triad which describes the various persuasive roles computers play from the users perspective, together with several persuasive criteria. The triad shows that interactive technology can operate: as a tool that increases capability; as a medium that provides interactive experiences; and as a social actor that creates relationships (Fogg, 2003).

Building on from Fogg’s (2003) is Oinas-Kukkonen and Harjumaa’s (2009) Persuasive Systems Design (PSD) model for designing and evaluating persuasive systems which categorizes persuasion techniques according to:

1) Primary task that support the carrying out of a user’s real-world activity and is comprised of reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal.

2) Dialogue support – degree of feedback and features which support interaction between the users and the system. Dialogues support is comprised of praise, rewards, reminders, suggestion, similarity, liking, and social role.

3) System credibility support – designing more credible and subsequently more persuasive systems. Credibility support comprises of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability.

4) Social support – designing systems that motivate uses by leveraging social influence. This includes social facilitation, social comparison, normative influence, social learning, cooperation, competition and recognition (Oinas-Kukkonen & Harjumaa, 2009).

The PSD model (Oinas-Kukkonen, & Harjumaa, 2009) further present’s seven essential postulates behind persuasive systems that relate to accessibility and reach, ease of use, making and enforcing g of commitments, attitudes and persuasion strategies, sequential nature of persuasion, the ideal moments for initiating persuasive features and openness.

As SN involves user interaction, it is important to understand how the growth of mass media channels and the Internet have expanded the frame of communication–from the physical to the virtual. The same basic principles that apply in human-to-human interaction can also be applied to computer-mediated communication and human-computer interaction (which is more significant for influence as will later be discussed).

Inherent in the above postulates and the PSD model are social psychological theories on attitude change, influence, learning and so forth that help to explain human behavior in different circumstances. Therefore, it is relevant to consider the applicable theories such as the elaboration likelihood model (ELM; Petty & Cacioppo, 1986) which is a theory on attitude change that describes two distinct–direct and indirect–routes to information processing and persuasion; Bandura’s (1969 & 1989) social learning and social cognitive theories which provide a framework for understanding, predicting and changing human behavior and state that people learn new behaviors by studying (the consequences), observing and then replicating the actions of others; and Cialdini’s (2003, 2007a, 2007b) studies on influence which show how formulating requests in certain ways can trigger automatic compliance response from individuals.
Additionally, the present research is an analysis of different SMS and as these have grown in use and popularity more research has been directed towards the field. Therefore, relevant scholarly literature involving the application and use of SMS will be utilized to build on the present research. Such works will include the role of social computing (Wang, Zeng, Carley & Mao, 2007), its constituents one of which is the various types of SMS (Kaplan & Haenlein, 2010; Boyd & Ellison, 2007; Weaver & Morrison, 2008), the impact of SN on organizations (van Zyl, 2008; Mangold & Faulds, 2009; Kaplan & Haenlein, 2010; Zhang, Qu, Cody & Wu, 2010; Hoong, Tong, Leow, Aun, 2012) and the effect this has on the users and their interactions with one another (Sakamoto, Ma & Nickerson, 2009; Fogg & Eckles, 2007; Fogg & Iizawa, 2008; Fogg, 2008; Sakamoto, 2012; Duffy, 2011; Brubaker & Hayes, 2011.)

There have also been numerous scholarly articles on architecture, but most of these have focused on the security and architectural constraints exhibited by SMS and ways in which the situation can be remedied. For example, (Xu et al. 2010; Eyers et al. 2012; Greschbach et al. 2012) highlight how the centralized architecture (referred to as storage-centric architecture by Eyers et al.) of online social networks suffer from performance bottlenecks and central points of failure as a result of the structure. Besner, Lipford, Shehab & Cheek (2009) look at the privacy issues that arise when third-party applications and their developers are given access to users’ information. Yang et al. (2011) compare the architectures of Facebook and Google although they do not go into much detail about the actual system implementation in these.

1.3 Motivation

As implied in the title of the research work although not explicitly mentioned, this study is essentially about social media and an analysis of how the continued growth and popularity of social media use has an influence on how people interact and are affected by their interactions with and via the SMS. There has been an increasing interest in the field which has led to increased scholarly works as mentioned in the preceding section.

In the scholarly studies that have so far been done, a majority have focused on the SMS beneficial use and how these can be used as marketing tools to benefit firms—an online search for social media architecture mainly resulted in articles focusing on organizational implementation and not the actual architectural composition of these systems. There has also been an increase towards scholarly articles that focus on online social behavior, social influence and comparative analyses—not dealing with the architecture—of the various SMS such as Facebook and Twitter.

So far there has not been much research done on the architectural features of these tools and an analysis and comparison of the differences in architecture and how these have been modeled. In this research, the author thus attempts to address this gap by studying how four SMS are constructed and designed, how this enables these systems to influence human interactions and the choices that are made as a result of the interaction.

1.4 Research Contribution

The overall contribution of the research is to show how SMS are modeled to influence
(via their design choices) and how these impact on the users. The study is progressive in nature, building on the current and on-going studies on social computing systems and it provides further opportunities for exploring the social web and new understanding on social interaction and influence online. A key contribution of the present research is an analysis on the persuasive context through an architectural route. This is done by comparing the underlying architectures of Facebook, Twitter, Yammer and Foursquare and relating these to the persuasive goals and target behaviors present in the respective systems. Comparison of these can be said to be new as previous studies have not specifically dealt with an analysis of the four (or any four SMS for that matter). Most have focused on general use of SMS in a particular context or have analyzed only one of the systems in use, but there is a shortage of literature analyzing multiple systems.

1.5 Structure of the study

The rest of the paper is structured as follows. Chapter 2 introduces the research methodology and provides an overall summary of the research. Chapter 3 outlines the theoretical framework with a discussion on social influence, SMS and how the former is prevalent in the latter. Chapter 4 is a discussion on social media architecture that serves an introduction to Chapter 5 that discusses and compares the architectures of Facebook, Twitter, Yammer and Foursquare. Chapter 6 analyzes the persuasion context focusing on the intent, the event and the strategy. This is then followed by a discussion that provides a synthesis of the main topics in the research and the concluding thoughts, limitations and avenues for further research.
2 RESEARCH SETTING AND PROCESS

This research study addresses social influence in software architecture by analyzing the architecture of the chosen SMS and also defining the persuasion context associated with these. Social media has become a prevalent research area due to the evolution of the web from a top-down communication channel to its current state where it has become more social and user driven—many-to-many.

The research setting, research question and the method used in answering the research question is discussed in the following sections.

2.1 Research setting and research question

The focus of this research will be to provide an analysis of the stated SMS and the inherent features that enable the influence. Social media can be said to influence people by using the power of pictures, video and narratives interactively to generate content which is consistent with the users’ values. As technology always influences peoples’ attitudes in one way or another (never neutral, “always on”), it is therefore important to consider persuasion (which is a form of influence) as a process rather than a single act (Oinas-Kukkonen & Harjumaa, 2009), because continuous engagement with technology especially for a particular purpose is more likely to lead to reinforcement of attitudes which can be said to be the ultimate aim of persuasive technology.

The following research question will help to expound on the issues highlighted above: How are software architectures modeled to influence?

Integration—rather than individuality—of complementary disciplines leads to effectiveness and one of the vital elements in systems management is the integration of separate but related products and processes (Schiesser, 2002). Integration in this case refers to that of the human aspect (social influence) and technology that creates an environment (social web platform) that enables persuasion to thrive. The answer to this question will involve analysis of the four SMS and their inherent features, how these are differentiated and whether there are any commonalities that define their level of influence.

To further expound on the research question above and in relation to the platform, the research also aims to determine whether there is an ideal context for persuasion. This will consist of an analysis and discussion on the various persuasive techniques employed in technology especially those suited to SMS. Since the research also focuses on social influence it is also important to consider the appropriate and/or inappropriate moments for delivery of messages which in SMS seems not be very clear due to the high level of freedom and interactivity exhibited. Context in the case of social web platforms also consists of peoples view about their surroundings and the need for
consistency and as stated in Oinas-Kukkonen & Harjumaa (2009), “if systems support the making of commitments, users will more likely be persuaded”.

2.2 Research method

The research was mainly conceptual-analytical in nature combined with a detailed review of literature which enabled the researcher to get a better understanding of the topic and to also discover new patterns and themes (Figure 1) that were used to provide suitable analysis that aided in finding answers to the research question. Its conceptual basis meant that it was built from previous research concerning the user and how they are influenced by their interactions with technology and by making inferences from the previous studies conducted to draw rational conclusions and provide practical alternatives based on issues derived from the literature (Järvinen, 2001). Detailed review of the literature leads to a focused approach to collection of significant articles.

Detailed reviews provided a means of identifying and categorizing most of the existing literature concerned with the research question. Among the reasons for conducting a review are to summarize the existing facts about use of technology, identify gaps in current works in order to suggest areas for further analysis and to provide a framework for suitably positioning new research interests (Kitchenham, 2004). As theories represent conceptual systems as a structure, they gather, integrate and systematize previous research results (Järvinen, 2001).

Kitchenham (2004) describes a set of review guidelines a modification of which was used to help in defining the problem, analyzing the data and coming up with a concise conclusion. The steps include 1) identification of the need for a review, 2) formulation of the research questions, 3) searching for relevant articles, 4) classification of data needed to answer the research question, and 5) data synthesis and summary of the results (Kitchenham, 2004). Thus the process of developing the theory consisted of topic specification, application area addressed by the theory—what is known about the topic, identification of the major themes of the research and the relationship among them, and drawing conclusions based on the relationship between the research themes as will be explicated in the next session on the review process.

![Figure 1. Review themes](image)
2.2.1 Literature review process

Gathering and analyzing literature based on the main themes of the research was very essential in the review process, hence the need to define the themes prior to analysis so as to provide a basis for searching the relevant literature. Data collection involved a broad review and classification of relevant literature. These included conference papers, handbooks, journals, and articles on the Web which helped to gain theoretical and practical relevance. The reviewed literature included information based around the themes mentioned in the previous section—effectiveness (with a social psychology underpinning and related to technology), SMS, and their architectures (with a particular focus on the four forming the basis of the research). These were further supplemented with literature on persuasive technology, behavior change support systems and theories on influence and human development which helped to gain theoretical understanding of fundamental principles involved in learning.

The review process (Figure 2) was based on a mapping of Ulrich & Eppinger’s (1999) five-step concept generation method in the concept development phase of product development and Kitchenham’s (2004) systematic review guidelines. The steps included a clarification of the problem, searching for relevant literature, systematic exploration and a reflection of the review process and solutions. These steps are in ascending order starting with clarification of the problem and ending with analysis and conclusion.

1. Clarification of the problem
   – Identification of the need for review i.e. the motivation and research objectives

2. Formulating the research question
   – this defined the search criteria


4. Explore systematically
   – Classification of data and synthesis

5. Reflection on the process and solution
   – Analysis and conclusion

Figure 2. Review process
Clarifying the problem consists of having a general grasp of the problem and then breaking it down into manageable steps. The first step is based on the motivation and the identification of a need for the review. The research question that was to direct the search for solutions was then defined which was followed by an external and internal search for relevant information. External search was conducted on online databases search as the ACM Digital Library, IEEE Xplore and SpringerLink; and internal search means using own knowledge to create general solution concepts—making inferences from the studied literature. For example, retrieving information from memory and adapting the information to help in answering the research question.

The external search focused around the main themes guiding the research and the main aim was to establish a theoretical basis from prior work on social psychological theories and theories on human development and relate these to their interaction with technology. The second search stream involved searching for literature on social media systems’ architectural composition; which was literature on the systems that comprise the technology stack of the social web platforms that form the basis of the research. Systematic explorations are steps involved in classifying the data from the search results by organizing and synthesizing the literature. Finally, reflection on the process and solution entails the analysis of the context, discussion and concluding the research.

2.2.2 Synthesis of review themes

The main topics that directed the flow of the research—Influence, SMS and systems architecture—were combined in the analysis and discussion which provided a coherent reflection of the literature that had been previously reviewed. Quite a number of articles were used in the review and these mainly concerned the topics above. Some were not entirely related to the stated themes, but provided relevant background information that complemented the topics. The key points for selection of the literature were:

- Objective of the research – research question
- Relevance to the current study’s theme(s)
- Results of the studies

A mapping of the articles to the related research topics is presented (Table 2) preceded with a discussion on the findings. Some of the articles are applicable to the different themes and are also interchangeable; meaning, there are some such as Lindqvist et al. (2011) that describe how people interact with Foursquare according to the inherent design choices in a social setting whilst at the same time explaining what they actually use it for.

Our thoughts and actions are usually aimed at openness and having a meaningful connection with one another and advances in technology affords ways in which this could easily be done. As technology influences people in one way or the other as a result of the designer choices, the theoretical basis for the influence should be appreciated. Social computing is a multidisciplinary field that draws from technical, social and other practices and is driven by a need to model aspects of human society and explain the cause and effect relationship between people’s social practices, their use of technology and the resultant influence. SMS primarily use similar standards and protocols and their longevity is dependent on the rules and policies that are implemented in addition to supporting the social interaction they were designed to support and the representational data they contain. The standards and protocols that
enable different systems and data to be integrated (underlying infrastructure), lead to functionalities and features (user-facing applications), that facilitate influence. There are certain key dimensions which help to categorize SMS and their use and these to some extent also help to determine the persuasion context.

Table 2. Main topics and related articles

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<th>Main Topics and Related Articles</th>
<th>Social Systems</th>
<th>Systems Architecture</th>
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3 SOCIAL INFLUENCE AND SOCIAL MEDIA

The continued advancements in technology and the web becoming more social have led to more “intimate” interactions with technology whereby human actions are directed by their use of technology. This section therefore discusses social influence, social media and how the former is prevalent in the latter and has enhanced its growth due to the human need for cooperation and interaction.

3.1 Social influence

There has been a wide array of research done on social circles, importance of patterns in networks that connect individuals with one another, influence and how environmental (external) factors impact on our thinking and in trying to limit the scope of the material to be reviewed, the researcher mainly focused on literature that dealt with the organization of social ties (Granovetter, 1973 & 1983; Feld, Scott L., 1981), how group interactions and involvement lead to compliance (Fehr & Fischbacher, 2004; Cialdini, Robert, 2007a), influence strategies (Kelman, 1961; Cialdini, Robert, 2007b), social interactions in technology (Donath and Boyd, 2004; Park, Lee & Han, 2007; Sakamoto et al., 2009; Idler, 2011; Fischer & Reuber, 2011; Sakamoto, 2012) amongst others that are discussed herein.

In 1955, Simmels (as referenced in Feld, 1981) described modern society as consisting of loosely connected social circles of relationships. The relationships in social networks and the degree of interconnectedness often has an influence on both individual and group action and people ignore or underestimate the extent to which their actions in a situation are determined by the similar actions of others (Cialdini, 2007a). We are all influenced—either consciously or unconsciously—by the actions of others and our decisions in most cases are usually as a result of the choices of many. And we act in a certain way because of various reasons—other people are doing the same, recommendation from experts, we may not get another opportunity and so forth. Despite the end result of our actions, we have a lot of reasons—either internal (dispositions) or external (environmental influences)—for acting the way we do (Bandura, 2002; Kaptein, 2011) which all influence our development. “The greater the number of people who find any idea correct, the more the idea will be correct” (Cialdini, 2007b, p. 128).

The more the frequency of interaction among individuals, the higher their feelings of friendship for one another (Granovetter, 1973) and with increased levels of interaction especially in a socially connected setting the more likely it is for the members to have an influence on one another. Social influence is usually not explicitly processed, rather it just occurs (one cannot say with certainty why they acted in a particular manner) as one of those “unwritten rules” people follow (unconsciously) in order to get rewards, form a favourable self-image or because ones’ own beliefs are congruent with the induced behaviour (Sakamoto et. al. 2009). What Kelman (1961), categorizes as the three processes of social influence: compliance, identification and internalization.

There are some instances, for example, when one joins a new club, moves into a new apartment and so forth that have laid down rules which need to be followed, failure to which there will be repercussions; conformance to these can be classified as obedience
to a higher authority—coercive form of influence, rather than persuasive form which occurs more “discreetly” and emphasizes internalization (Kelman, 1961). The behaviour displayed by individuals is usually acquired through observation of response patterns as depicted by various socializing agents; especially those resulting from decisions made by others (and the resulting consequences) that influence one’s own decision making (Bandura, 1969).

Social influence is an interaction of human behaviour, individuality—mainly factors personal to an individual—and the environment and describes how real or perceived expectations of others influences ones beliefs and values (Idler, 2011). Deutsch & Gerard (1955), distinguished between two types of social influence: normative and informational—also referred to as social proof (Cialdini, 2007b)—influence. The former refers to the psychological need to belong and occurs when individuals conform with the beliefs, values, behaviours and positive expectations (whose fulfillment reinforces positive feelings) of others typically within a group; whereas the latter refers to acceptance of information obtained from another as evidence about reality—the need to be right—Deustch & Gerard (1955) add. Informational social influence posits that individuals determine what is correct by looking at what others view as or think is correct especially when deciding what constitutes correct behaviour (Cialdini, 2007b, p. 116). One typically relies on social proof (information quantity) when they are not sure of themselves or how a particular situation should be handled—peripheral route to persuasion (Petty & Cacioppo, 1986; Cialdini, 2007b).

As social networks grow individuals begin to form themselves around particular focus groups (foci), mostly exclusively (strong ties) and have minimal relations with individuals from other foci which Feld 1981 defines as: “social, psyhological, legal, or physical entity around which joint activities are organized”. These foci define and organize their social relations, are good sources of social support and consequently lead to the development of social norms. Social norms are standards of behaviour based on widely shared beliefs (Fehr & Fischbacher, 2004) that efficiently and accurately help to guide and influence the interactions within the group. It is the ability to establish and enforce social norms that distinguishes human cooperation from the animal world and individuals obey norms voluntarily if their individuals goals match the normatively required behaviour—internalization—or they may be forced to obey if their goals differ from the normatively required behaviour—compliance—Fehr and Fischbacher (2004), further add.

Cialdini (2003) distinguishes between two types of social norms descriptive norms—what is typically done, and injunctive norms—what is typically approved or disapproved of and for these to be persuasive, their alignment should be in tandem rather than in competition with each another. To show the effectiveness of the two norms when applied correctly, Cialdini (2003) gives examples of how a restatement of warning signs in a national park and combination of the descriptive and injunctive norms in a recycling campaign influenced the desired intentions. In the former example, warning signs focusing on the prevalent behavior, that is, the descriptive norm—theft of wood—led to more theft, whereas those focusing on social disapproval—the injunctive norm—of environmental theft resulted to fewer thefts over the duration of the experiment.

If the prevalent behaviour is beneficial and approved by the majority then both norms can be incorporated as indicated in the recycling campaign where more participants after viewing the advertisements believed that recycling was both widely approved of and prevalent and they planned to recycle in the future (Cialdini) 2003 further states.
For the two norms to be persuasive the timing of the delivery of the message is essential and the message must be present when the desired behaviour is to take place and also as can be seen from the two examples above, how communication is framed determines whether or not the communication will be effective (Cialdini 2003).

Even though people are generally poor at recognizing why they behave as they do and fail to appreciate the role of especially descriptive norms in estimating the causes of their conduct (Cialdini, 2007a), individuals usually have to model their behaviour in a certain way and meet the expectations of their group members in order to maintain their self-definition as a member of that particular group (Kelman, 1961). Conveying facts on the preferred behaviour of the majority often leads to acts of compliance and majority opinion on any issue subsequently leads to the desired action (Cialdini, 2007a).

Another norm that can also help in determining ones actions and that was initially introduced in the “theory of planned behaviour” (TPB) which postulates three independent determinants of intention (Ajzen, 1991) is the subjective norm. The subjective norm refers to the perceived social pressure (from important others) to perform or not perform a behaviour. For example, my friends say jogging early in the day → preferably in the morning, is better. Subjective norms are also prevalent in social interactions and define what is expected from people. The other two postulates in the TPB are: attitude toward behaviour - how one views the behaviour in question, and perceived behavioural control - perceived ease or difficulty of performing the intended behaviour (Azjen, 1991).

Social norms create conformity within groups and heterogeneity across groups (Fehr & Fischbacher, 2004) and groups can and should demand of their members that they have self-respect, value their own experience and be independent in their own judgment in order to foster group consensus (Deutsch & Gerard, 1955). In addition, a greater degree of attitude and behaviour change can be achieved by people working in unison rather than alone and that is the power of social influence (Fogg, 2003, p. 197).

Summarily, a sense of belonging–greatly enhanced by adhering to group (social) norms–is essential in human cooperation and facilitates the spread of information and ideas and leads to the growth of communities of shared interest whilst enhancing group cohesion. Social influence basically refers to the choices one makes (or does not) as a result of external factors, the most prominent being the action of others.

3.2 Social media

According to Friedman, there are three world “flatteners”: First are new technologies and what these have enabled. Secondly, are new ways of working and a new and dynamic environment for business and finally, the emergence of a new breed of people on the field who are technically adept and are willing to work (as cited in Solomon & Schrum, 2008, p. 9). What social media has enabled (and continues to) and the opportunity it avails to both individuals and businesses can be considered as an important factor in enhancing information reach as will be expounded on herein.

SMS fall under the realm of social computing (Wang et al., 2007), a multidisciplinary field spanning both technological and social sciences and relying on several other fields to support social interaction and communication. These include but are not limited to human computer interaction, social psychology, economic theories and social network
analysis (Table 3). As ICT and society influence each other, social computing underlines technological development for the society whilst incorporating social theories and practices into systems development (Wang et al., 2007).

Social computing systems facilitate social interaction among groups of people (or between people and computer systems), are driven by a need to computerize aspects of human society and a need to predict the consequences of changing technologies and guidelines on peoples behavior. Within these social computing systems, there is a complicated relationship between social practices and the underlying architectures taking place that influences both social interaction and how people use information systems (Wang et al., 2007; Hansen et al., 2011.)

Table 3. Social Computing Composition

<table>
<thead>
<tr>
<th>Application Domains</th>
<th>Technological Infrastructure</th>
<th>Theoretical Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Online Communities</strong> – blogs, wikis, social networks etc.</td>
<td>Web technology</td>
<td>Social Psychology</td>
</tr>
<tr>
<td><strong>Business and Public Sector</strong> – recommendations, forecasting, feedback, e-government, decision analysis etc.</td>
<td>Database technology</td>
<td>Communication and HCI theories</td>
</tr>
<tr>
<td><strong>Interactive entertainment</strong> – training, gaming, storytelling etc.</td>
<td>Multimedia technology</td>
<td>Social network analysis,</td>
</tr>
<tr>
<td></td>
<td>Wireless technology</td>
<td>Organizational theories</td>
</tr>
<tr>
<td></td>
<td>Agent technology</td>
<td>Sociology</td>
</tr>
<tr>
<td></td>
<td>Software engineering</td>
<td>Computing theories</td>
</tr>
</tbody>
</table>

3.2.1 Characteristics of social media

Technological developments which have changed the way that information is managed and the connectedness of the modern society have led to a rapid increase in the creation and use of SMS such as blogs, wikis, discussion forums, photo and video sharing sites and so forth. The rapid growth in information technology (IT)–for example, the convergence of handheld devices, wireless Internet and satellite communication has additionally eased communication globally and hastened the spread of news and information to all corners of modern society. This has consisted of networks, incentives and the aggregate behavior of groups of interlinked communities—that are communicating from different settings and environments–and the ways in which their decisions can or do have implications for others (Easely & Kleinberg, 2010; Fischer & Reuber, 2011).

Digital technology’s effects do not only transform our sense of place; it also links us more closely with the immediate environment and our sense of place is more and more being augmented by information wired from the World Wide Web (Schwarzer, 2010). More so from SMS which generate an enormous amount of social data that can be used
to better understand the organization of a community (or a set of communities) and its inhabitants Hansen, Shneiderman & Smith (2011, p. 12) add.

The ubiquity of IT enables easy access to information; such as carrying with us wherever we are encyclopedic libraries and archives, thus possessing a knowledge-screen that can be overlaid on our visual field to deepen its appearance along the course of our changing predispositions (Schwarzer, 2010). In this regard, it can be said that social media enhances a sense of community with minimal obligation and the choices of society are made better by an in-your-pocket means of recognition. As the Internet has now become an interactive platform that enables users to form online communities based on their specific interests, this evolution has greatly enhanced the merging of the real and virtual worlds Schwarzer (2010) adds.

Social media is thus an evolution back to the Internet’s roots and it is re-transforming the World Wide Web (WWW) to what it was initially created for: “a platform to facilitate information exchange between users” (Kaplan & Haenlein, 2010). Users are now turning into producers and consumers of information—in contrast to traditional forms of media such as television that deliver content to mass populations but do not facilitate or allow for user engagement—as most real world activities migrate online and in any particular location; the network is extending reality as we know it. Unlike traditional media which is essentially a monologue (one-to-many), social media communication is based on a dialogue (many-to-many) (Kaplan & Haenlein, 2010; Hansen et. al., 2011, p. 12).

Social media encourages and fosters communication, facilitates the expression and spread of (new) ideas, connections and provides an environment where people can discuss just about anything; the power lies with the users who produce, review and distribute the information. Social media provides new ways to interact with information and shows possibilities of collecting independent activities of interconnected users to personalize information evaluation and to assess the preferences of a large number of people which may be more informative than the opinions of a few editors or experts (Lerman & Jones, 2007; Sakamoto, 2012). Furthermore, the openness has given users more input in shaping the communication and how information is to be delivered.

With increase in adoption of social media more scholarly works have been directed to the field and in these studies, there are elements of subjectivity involved when it comes to description of social media—and analysis of the content quality of material produced (Chai, Potdar & Dillon, 2009). Due to this, there has not been a common definition of the term. Although different authors have applied varying definitions depending on the context and use such as: a) in the business setting to engage with customers and shape consumer discussions in order for organizations to benefit (Mangold & Faulds, 2009; van Zyl, 2009; Kaplan & Haenlein, 2010); b) in user experiences and usability in mobile devices (Multisilta & Milrad 2009); c) in how interaction in social media channels can affect thinking and behaviour (in Fischer & Reuber, 2011 for example); and d) allowing the creation of public profiles, connection of users, displaying these connections, and viewing and going through the list of (one’s own and others) connections—social browsing (Donath & Boyd, 2004; Lerman & Jones, 2007; Boyd & Ellison, 2007), in all these definitions there has been people interacting with technology to create new content and share experiences. Therefore, social media can be defined as:
“Scalable Internet and mobile-based technologies (Table 4) which mostly arose with the advent of Web 2.0 that afford social interaction, creation, sharing and exchange of user experiences–user generated content (UGC)–through use of rich digital content that facilitates construction of a shared meaning among communities”

SMS facilitate both online and face-to-face interaction and have presented an unparalleled opportunity for people to interact on a much wider scale and in a way that was not possible prior to its popularity and growth (Fischer & Reuber, 2011).

3.2.2 Social media systems

The view of the Web as a platform that provides tools and documentation to enable creation of applications that can be embedded within the environment has enabled the growth of SMS some of which are discussed below (Boyd & Ellison, 2007; Mayfield, 2008; van Zyl, 2009; Kaplan & Haenlein, 2010; Hansen et. al., 2011, pp. 17 - 28).

Social networking sites (SNS) allow people to build personal profiles, share their personal information with friends and colleagues and send e-mails and instant messages to one another. SNS have mainly been common amongst the younger generation, but there has been a pronounced increase in use of SNS among the over 35 generation (Hampton, Goulet, Rainie & Purcell, 2011). Prime examples of these are: 1) MySpace and Facebook which are mainly for social purposes, 2) LinkedIn and XING for professional networking, and 3) Ning and Ravelry which are niche networks targeting a specific segment within a community who share similar interests such as knitting, former classmates who would like to keep in touch and so forth (Boyd & Ellison, 2007; Mayfield, 2008.)

Collaborative authoring and/or projects enable users (small groups and even communities of thousands) to create, edit and share content and information about specific subjects of interest. The underlying thought being, the joint effort of many produces better results than that of one actor. Collaborative projects include: Wikis - Wikipedia being the most popular in this category, social bookmarking sites such as Del.icio.us, StumbleUpon, Xmarks which allow the storing and sharing of web bookmarks, shared documents which involves sharing and editing of documents online and facilitated by services such as Google Docs, DropBox and Syncplicity (Hansen et. al., 2011; Kaplan & Haenlein, 2010.)

Blogs are online journals where users can post messages and viewers can comment, subscribe and link to the particular blog. The topics consist of the authors personal stories concerning their life and summaries of relevant information in topics of their interests. Blogs have also gained prevalence among companies such as General Motors which use it to interact with their customers–through addition of comments–and to enhance transparency (Mayfield, 2008; Kaplan & Haenlein, 2010.) The most common Blogs are Wordpress and Blogger from Google. Additionally, Microblogs–where users can post mini blog-like posts to announce what they are doing or where they are–are similar to blogs in the focus on recent posts which are known as tweets and are limited
to 140 characters. Twitter and Yammer\textsuperscript{1} are good examples of such presence applications. (van Zyl, 2009; Hansen et. al., 2011.)

Content communities comprise of a variety of media types consisting of video sharing (YouTube, Vimeo, Hulu), photo sharing (Flickr, PhotoBucket) and PowerPoint presentation sharing (Slideshare, DocStoc) between users (Mayfield, 2008; van Zyl, 2009.) News aggregation where the latest news published from different websites is listed based on users subscriptions who also receive updates automatically. Real simple syndication (RSS) and Digg are among the common tools in this category (Mayfield, 2008).

Virtual worlds that have become very common as they attempt to model physical places as well as face-to-face interaction and lead to creation of rich collection of networks. They are divided into: Virtual social worlds and Virtual game worlds. The former allows participants to live in a three-dimensional (3D) virtual environment similar to their real life in the form of avatars. The prominent examples here are Second Life and The Sims which are designed mainly for adults, but there are also others available for the younger generation such as Webkinz and Habbo (Kaplan & Haenlein, 2010; Hansen et. al., 2011.) The latter includes games that are usually community-based video games that allow simultaneous interaction in a virtual world where you may find people from different areas globally playing together. Also known as massively multiplayer online games (MMO), they utilize the Internet–or may be played in game consoles such Xbox 360 and PlayStation 3–and include role-playing games such as World of Warcraft and Everquest and strategy games such as Mankind and War of Legends (Kaplan & Haenlein, 2010; Hansen et. al., 2011.)

Finally, are location-based services (from the virtual to the physical) which integrate hardware and software tools to enable annotation of physical locations. This is primarily through the use of smart phones that are integrated with Global Positioning Systems (GPS), cell tower location services, compasses, still and video cameras, audio and motion sensors and so forth that locate and orient a user in space and these lead to the creation of more content as they can be captured at anytime and as the events unfold. As they are location-based, they also provide contextual information about the world immediately around users. These are divided into location sharing, annotation and games and include applications such as Google Latitude, Foursquare, Facebook Places, Gowalla, Geocaching and Letterboxing (Hansen et. al., 2011).

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
Social Media Type & Examples \\
\hline
Social Networking Sites & MySpace, Facebook, LinkedIn, Ning \\
\hline
Collaborative authoring & Wikipidea \\
\hline
Blogs & Microblogs & Wordpress, Blogger, Twitter, Yammer \\
\hline
Content communities & YouTube, Flickr, Slideshare \\
\hline
News aggregation & RSS, Digg \\
\hline
Virtual worlds & Second Life, The Sims, World of Warcraft \\
\hline
Mobile-based services & Foursquare, Gowalla \\
\hline
\end{tabular}
\caption{Summary of Social media systems}
\end{table}

\textsuperscript{1} Yammer which started initially as a microblog has evolved and is now more of an enterprise communication tool with more features than Twitter and its graphical user interface (GUI) progressively resembling that of Facebook.
3.3 Social influence in social media

In looking at how technology influences, it is relevant to consider whether one is interacting with or through the technology (Fogg, 2003, p. 16). When interacting through–computer-mediated communication (CMC), then technology is a channel that enables humans to communicate, for example, IM for people in different locations. Whereas interacting with–human computer interaction–implies that a technological product is a participant in the interaction and can proactively seek to motivate and influence users Fogg (2003) continues.

Peoples’ interaction in an online environment is dependent on the type of medium used which also frames and defines the message. According to the social presence theory, communication media differ according to the degree of “social presence”–state of being present–between two communicators using a social medium (Lowenthal, 2010). Some communication media have a higher degree of social presence (for example, the characters in virtual environments), whereas others have a lower degree of social presence (for example, e-mail, audio). The higher the degree of social presence the more a communication medium is viewed as sociable, warm and personal and the larger the social influence that communicators–people interacting with the media–have on one another (Kaplan & Haenlein, 2010; Lowenthal, 2010).

Social media thrives on user engagement as can be deduced from the preceding section(s). Social influence is prevalent in the social media scene because of the fact that people are primarily interacting with individuals they already know, can identify with (especially in social networking sites like Facebook) and/or interacting and connecting to people involved in issues that one cares about (Boyd & Elison, 2007). There is sharing of information, providing meaning to the information shared through joint feedback, understanding other’s thoughts and subsequently, influencing one another (Bandura, 2002) “en masse”. This is further cultivated by the inherent feature of the SMS that encourage continued user interaction and contribution via a web of interconnected links (nodes) enabled by rich graphical content that is integrated with e-mail, live chat, audio (in some instances like MMO games), video, animation and hyperlinked content. This refers to the modality of information. That is, how information is presented could be more of an influence than the information itself (Fogg, 2003).

Furthermore, a sense of belonging enhances cooperation; and with the technology transcending physical boundaries and having “humanistic and persuasive features”, physical presence is no longer a prerequisite to establish relationships and encourage action. An example of encouraging action is the Arab Spring Revolutions where social media (more specifically Twitter) played a crucial role in mobilizing citizens–giving the marginalized groups a voice to say how they felt–and disseminating information to the outside world especially when the communication channels were disrupted by the oppressive regimes. Tapscott (2012) in his talk on TED (www.ted.com) about the principles of the open world and in reference to the uprisings states: “You think that social media is about hooking up online? For these kids [in the Tunisian Revolution], it was a military tool to defend unarmed people from murderers.” This underlines the important role social media had in the revolutions and how it has generally had an impact on people’s lives.

Our modes of perception in terms of how we use and interact with technology have also been greatly enhanced with continued technological advancement. Plus the pervasive
nature of technology further affords opportunities for persuasive interaction, because users can be easily reached and technology–the Web and other Internet-based systems–combines the positive attributes of interpersonal and mass communication (Oinas-Kukkonen & Harjumaa, 2008; Cassell, Jackson & Cheuvront, 1998.) What Fogg (2008), refers to as “Mass Interpersonal Persuasion” (MIP). MIP is comprised of six components–Persuasive Experience, Automated Structure, Social Distribution, Rapid Cycle, Huge Social Graph, Measured Impact, which all existed independently (in technology) and described the nature of distributed and interactive forms of computing, but were bundled together after the launch of the Facebook platform Fogg (2008) adds.

Some components of MIP (Fogg 2008), Oinas-Kukkonen & Harjumaa’s (2009) postulates to be considered in the design and evaluation of persuasive systems and mainly the social support category in the PSD model and Cialdini’s (2007b) weapon’s of influence–Reciprocity, Commitment and Consistency, Social Proof, Liking, Authority and Scarcity, will now be used to exemplify how social influence has been applied in social media. All these are primarily derived from similar psychological and sociological principles.

Former CEO and co-founder of Ning in an interview with the BBC (2009) stated, regardless of whether one thinks social technology or the Internet is good or bad, “it is”. Meaning technology is never neutral rather it is “always on” and intended to change people’s thoughts and behaviors and this is epitomized in MIP by utilizing social influence dynamics (Oinas & Harjumaa, 2009; Fogg, 2008a). For example, in Facebook or any other social networking site one usually feels obliged to respond in kind–reciprocate, when an invitation to join a group or to join a cause or for friendship is received. Liking could also apply here as we prefer to say yes to the requests of people we know and like (Cialdini, 2007b, p. 167).

Secondly, Sakamoto et al. (2009) in their experiments on other’s influence on ones decision making carried out on Digg, found that the major determinant of people liking a story was not based on the “interestingness” of the story, but rather those that were liked by many others which also affected peoples judgments of their own preferences. As many SMS allow people to share their opinions and learn from others (Sakamoto et. al, 2009), information about the number of likes for a comment or a story, the trending topics (information quantity) and so forth is easily accessible thus people find it easy to rely on social proof (many people like it or are doing it so it must be good) to make their judgment. This also corresponds to the sixth principle of MIP (Fogg, 2008a)–measured impact which refers to facts that are actually reported and are visible by both the users and creators. For example, two hundred people like this, fifty members recently joined the group and so forth.

Thirdly, creation of groups in Facebook, lists on Twitter or collaborative teams in virtual worlds leverages normative influence by providing a means for people with shared interests to gather together thus forming norms that direct the interactions of the group. This works by making peoples behaviour visible to other members of the group so that whenever one comments or sends a message, it has to meet the standards set upon by the group norms. The persuasive experience is credible because it is enclosed within the high-trust culture of a social media group (Fogg, 2008).

Fourthly, is the social facilitation principal under social support in the PSD model (Oinas-Kukkonen & Harjumaa, 2008) which states that people perform better when other people are present or are watching (Fogg 2003, p. 197). This works best in
synchronous communications like live chat and the interactions in a virtual world which take place in real time and requires all participants to be active at the same time (Hansen et. al., 2011, p. 27) thus leveraging the principle of social facilitation and enhancing the communication and the possibility for influence through interaction, presence and observation.

Closely related to facilitation is the principle of social learning which is based on the power of modeling (Fogg, 2003, p. 201, Oinas-Kukkonen & Harjumaa, 2008) which states that people learn by observing others’ actions and noting the consequences of those actions. Many websites today come with accompanying blogs and forums where users can interact and in these any achievement is celebrated by the community—which brings the power of social support (Fogg, 2003).

Finally, under social support are the principles of competition–where there should be a means for people to compete with each other, and recognition–systems should provide public recognition for the achievers. A good example of these two principles comes from Foursquare where users compete to have the most days with check-ins over a predefined period (usually 60 days) and the one with the most check-ins is rewarded by becoming the ‘Mayor’ of that particular place they have been frequenting.

SMS can be augmented together or with other websites by for example, posting messages to your Facebook page from Twitter and adding the like button to ones website or blog. This ability to connect different technologies provides better information and leverages social support principles discussed above and thus can be more persuasive (Fischer & Reuber, 2011; Fogg 2003, pp. 195-201). In addition to their simplicity (in use) the success of SMS lies in their ability to encourage users to adopt specific target behaviours: registration, uploading photos, connecting and sharing content with friends and so on which ultimately influences their interaction (Fogg & Iizawa, 2008) as will be discussed later in analysis of the persuasion context. The continued use of SMS is motivated by enjoying to talk about oneself, interest in other’s actions and the “experience of interacting with shared content” which allegedly creates the demand for a social norm (Fogg & Iizawa, 2008; Fehr & Fischbacher, 2004.)

To sum up, social media has grown in importance and is a mainstay in our lives because it enables users to dictate how and when they will interact and many of the tools available are also easily adaptable to the users’ needs due their simplicity in use, reach and accessibility.
The previous chapter dealt with social media in its basic sense and how the inherent nature of SMS enable, facilitate and enhance social influence. The issues covered in the previous section thus provide a platform for the enhancement of the discussion through a focus on the underlying architectures of the four chosen systems. The social influence aspect is prevalent–as can be deduced from the preceding section–in the chosen channels and it is through analysis of their respective architecture that a comprehension and linkage between the two dimensions can be attained. Architecture represents the structure of a system and deals with the interaction between system components, thus the present chapter discusses SMS architecture.

The growth of social media–both in terms of applications and usage–has accelerated because (as alluded to in the previous section on the launch of the Facebook Platform) of the provision by the various SMS of platforms which have provided a means for third parties to create and distribute interactive web (and nowadays mobile) applications to the millions of people linked in an online social network (Fogg, 2008). These (social) applications are built on top of users’ profiles and they enhance the functionality and user experience of the various SMS by adding content to the respective sites and also providing new social activities. Such activities include: allowing users to share photos, play games, share books that one has read and also recommend these to others, share location, dynamic posting of content–for example from Twitter to Facebook amongst others (Besner, Lipford, Shehab & Cheek, 2009; Fischer & Reuber, 2011). This has resulted to developers, content and service providers having access to a large social network to popularize their applications and services hosted outside the social network provider’s infrastructure (Sharara, Westphal, Radosavac & Kozat, 2011).

A platform consists of an application programming interface (API) and the related tools which enable developers to utilize the huge amount of information on the social sites to develop interesting applications that allow a combination of multiple services. These applications can access the user profile attributes and provide services to users and interact with them by integrating attributes from multiple target profiles (Besner et al. 2009). APIs have transformed mobile carriers, SMS amongst others sites into interactive sites that communicate with a host of other applications, across personal computers (PCs) as well as mobile phones. APIs facilitate the exposure of data and other businesses processes in ways that others (developers, researchers) can make use of (Metz, 2012).

Most of the systems APIs are based on Representational State Transfer (REST) principles involving client-server relationships. REST basically refers to navigation across a website by clicking links–state transition–which leads one to the following webpage(s). Conformance to REST principles is being RESTful and to be RESTful an API should: a) separate the client from the server; b) have all details needed to respond to a request within each request; and, c) use Hypertext Transfer Protocol (HTTP) and its methods. The commonly used HTTP methods include GET, POST and DELETE. These retrieve information from a specified target such as a website, send information to a defined target for example updating a blog or website and remove information from the specified target (deleting a post or tweet) respectively.
Social web platforms—(henceforth SWP)—(Facebook, Twitter, Yammer, Foursquare in this case) require high scalability, performance standards, availability, disaster recovery—this is especially important when upgrading the software, adding hardware/capacity and during failure of hardware components—should provide the ability to increase capacity to storage systems with minimal overhead and no downtime, should operate in real time, be fault tolerant and so forth (Borthakur, Sarma, Gray, Spiegelberg, Gray, Molkov, Aiyer et al, 2011; Eyer, Freudenreich, Margara, Frischbier, Pietzuch, Eugster, 2012.) These architectural features are important because as these SMS and networking services become more common and attract a greater number of users who consume the applications, services and content offered, there is a strain on the utilization of CPU cycles, cache spaces and network bandwidth provided (Sharara et al., 2011).

For this reason, the infrastructure of most SWP have evolved with time going through frequent changes, redesign, re-implementation and reorganization to their architectures some of which were originally built around a traditional relationship database management system (RDBMS) that has had performance and scalability limitations (Eyers et al., 2012, Borthakur et al., 2011). Additionally and for the most part, these platforms have had a logically centralized architecture (Greschbach, Kreitz & Buchegger, 2012; Eyers et al. 2012; Xu, Chen, Zhao & Fu, 2011) with the relevant agents being the site providers and the users of these sites. All the communications between the users have also been relayed by the central providers Greschbach et al. (2012) add. A centralized system suffers from performance bottlenecks and performance failure (for example, Twitter’s over capacity and database maintenance errors), because the user clients repeatedly requests centralized servers for newest content regardless of whether there is a new update or not (Xu et al., 2011).

These issues have led to the transition to a somewhat layered architecture (Figure 3) consisting of: Presentation or front tier (HTML, CSS, Flash)—deals with expressiveness, information rendering, user interaction, Services or application business logic (Ruby on Rails, Scala)—coordinates data between the two layers, responsible for data management and resource abstraction, and Data or back-end (RDBMS and NoSQL clusters, such as MySQL and Couch DB)—stores and retrieves data from the database which is then passed on to the application logic for processing before being displayed to the user. These interact through asynchronous message passing and each layer consists of number of systems dedicated to performing their respective tasks (Yang, Tsai, Chen & Ramandeep, 2011). In between the application logic and the back-end is a Caching layer (Memcache, SQL query caching) to help in handling requests and also aid in the server’s and database’s processing requirements Yang et al. (2011) add. The above—especially the application logic, caching and the back-end, are typically the layers involved when working with data and having them layered ensures that they are isolated and independent.
The frequent changes undertaken on the architectures of the SMS could also be explained by the fact that all the requirements for systems of such massive scale could not be known prior to their development and additional requirements were learnt during implementation and real-world system usage by end users. Eyers et al. (2012) further add that SWP offer disparate services which share information, reading and modification of common data sets using different technologies. These technologies are mostly based on open source software (OSS) which can be customized to suit the internal needs of the respective entities concerned and also help in running their operations. Additionally, some of the OSS are built in-house or are modifications of the software already available to meet their architectures demands. Some of these organizations also contribute back to the open source community by open sourcing their own internal projects (Pingdom, 2010) thus providing an opportunity for their work to be improved on and also benefit others who may want to utilize these systems.

A summary (Table 5) of the systems, the characterizing features and programming languages used in ensuring that they meet real-time generation of content, are scalable, fault-tolerant and other characteristics required of highly distributed architectures is discussed below. To provide a complete list of all the software utilized within the respective platforms would take some effort and the following chapter that details the system composition and architecture represents some of the main software used to run the various platforms.
Table 5. Comparison of Platform Architecture

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Yammer</th>
<th>Foursquare</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Languages</strong></td>
<td>PHP (Primary), Java, Erlang, C++, Python</td>
<td>Ruby, Scala, Java, Javascript, C</td>
<td>Scala, Java, Erlang, C, Objective-C</td>
<td>Scala (Primary), Java, Javascript</td>
</tr>
<tr>
<td><strong>Scaling</strong></td>
<td>Horizontal</td>
<td>Horizontal</td>
<td>Horizontal</td>
<td>Horizontal</td>
</tr>
<tr>
<td><strong>Caching</strong></td>
<td>Yes (Memcache)</td>
<td>Yes (Twemcache)</td>
<td>Yes (In-memory cache)</td>
<td>Yes (Memcache)</td>
</tr>
<tr>
<td><strong>Database</strong></td>
<td>HBase/MySQL</td>
<td>Cassandra/MySQL</td>
<td>Berkeley DB Java Edition</td>
<td>MongoDB</td>
</tr>
<tr>
<td><strong>Query method</strong></td>
<td>MapReduce</td>
<td>MapReduce</td>
<td>MapReduce</td>
<td>MapReduce</td>
</tr>
<tr>
<td><strong>Authentication</strong></td>
<td>OAuth protocol</td>
<td>OAuth protocol</td>
<td>OAuth protocol</td>
<td>OAuth protocol</td>
</tr>
</tbody>
</table>

Facebook and Twitter both rely on MySQL, for the former it is mainly used for persistent connections and in the latter, for storage—of smaller datasets—in addition to Cassandra. All the platforms utilize a flavor of NoSQL—“not only SQL” (http://nosql-database.org/) databases which do not use the relation model of SQL database management systems (DBMs) and are more suited to handling Big Data which the platforms essentially deal with. Other than Yammer the details of which could not be found, the other three utilize the MapReduce framework (http://research.google.com/archive/mapreduce.html)—a programming model for processing large data sets across a cluster of computers. For these Hadoop is used in both Facebook and Twitter and MongoDB is used in Foursquare. Yammer probably has some sort of MapReduce jobs, but it was not discernable from the available material on their architecture.

There are common technologies used in Facebook, Twitter and Foursquare. These include Hadoop, Hive, Thrift, Kestrel (Twitter and Foursquare), for caching they use Memcache (in Twitter a customized version forked from Memcache) in the case of Yammer, the Berkeley DB Java edition they use comes with in-memory caching. Additionally, all the platforms scale horizontally which is an advantage of using NoSQL databases as these enable scaling through the addition of more machines onto your resource base (scaling out) thus joining the strength of many machines into a single virtual resource with the combined strength of all the machines put together (Nati Shalom's Blog, 2010). This ensures: there is continuous availability; there is performance flexibility; there is continuous upgrades; and that an application can be easily geographically distributed for disaster recovery purposes or to reduce geographical latency (Nati Shalom's Blog, 2010).

The rapid growth experienced by the SWP and the fast pace of technological advancement, has increased their (creators) dynamism and led to out-of-the-box creativity in order to meet the demands of the increase in users and rapid cycle of technology production and invention.
5 SOCIAL WEB PLATFORMS

The present chapter continues with the discussion on architecture by focusing on the high-level system components in Facebook, Twitter, FourSquare and Yammer and the relationships between these components. The discussion on the respective platforms will be categorized according to the conceptual diagram (Figure 4) in the previous chapter and will explain the system composition of each layer. Each of the platforms has an engineering blog/webpage(s) on their Websites where the changes to their architectures and systems are stated and for one to understand and be updated on the system composition one needs to follow the updates to their respective blog/webpage(s). Although, information about updates to the respective systems architectures are also usually available on other websites across the Web, but these are usually fragmented and difficult to find.

5.1 Facebook

Facebook–among the first to publish its API– is currently the most popular SWP with more than a billion users responsible for over one trillion “likes”, over two hundred billion photos and seventeen billion location check-ins. Out of these billion users, six hundred million access the site via a mobile device (BBC, 2012).

5.1.1 Facebook API

Facebook provides a platform: to enable making websites more social via the use of Social Plugins such as the like button; to support integration and incorporation of Facebook functionality into mobile applications—for iPhone, iPad and Android—with the use of their tools and software development kits (SDKs); and to develop applications within Facebook itself.

To access the Facebook API, a valid user account is required. Facebook is based on the Graph API which presents people and the connections they have to all they care about and the API also lets one to read and write data to and from Facebook. The Graph API presents consistency in viewing of the Facebook social graph systematically representing the objects–user profiles, people, photos, events, pages, groups, photos, videos, notes, checkins—in the graph and the connections–friendship relations, shared content, photo tags–between them. The use of objects is more consistent simplifies the task of writing data to and from Facebook (Facebook Developers, 2012; IBM, 2010).

Every object has a unique ID (identifier) by which it can be accessed or people and pages with usernames can alternatively be accessed with their usernames all in the same way. For example, users, pages and events can be accessed by pointing to a specific URL (uniform resource locator). All objects are connected to each other via relationships. For example, Michael is a Fan of the Arsenal page and Michael and Lucy are friends. These relationships are also referred to as connections and different connection types for different objects are supported (Facebook Developers, 2012)

All publicly available information is easily accessible via the Graph API, but to access
private data a user’s permission is required which is done using Facebook Login. This authenticates and asks them to authorize the application. Facebook uses OAuth 2.0 an open protocol which enables the Graph API to be securely authorized in a standard method from web, desktop and mobile applications. The Graph API enables 1) object retrieval/selection when a query is made and fields–id name, picture of someone–can be returned by choosing the “fields” query parameter; 2) deletion through issuing HTTP DELETE requests to the objects URLs. For example, DELETE https://graph.facebook.com/ID?access_token=... HTTP/1.1 for clients that support HTTP methods; and, 3) publishing by issuing HTTP POST requests to the appropriate connection URLs, using an access token. Additionally, it is also possible to search and update objects, filter results and discover the connections of an object (Facebook Developers, 2012).

5.1.2 System architecture

Facebook uses a variety of technology for different sections of infrastructure which are mostly based on open source technologies some of which have been developed internally. Using Figure 3 above, the various technologies employed at Facebook will be discussed below.

Facebook represents a set of interconnected information that takes pieces of data from different infrastructure and combines it together to provide a consistent experience to the user (Sobel, 2011). Facebook’s architecture (Figure 4) is designed to be stateless and distributed–users sessions are not tied to a particular server and page requests are handled by any of the servers in its infrastructure (Paul, 2012). Furthermore, Facebook consists of a set of federated services (Eyers et al., 2012) which combine data from disparate sources that are used to meet the user needs and for data analysis purposes for example. To begin with, the presentation layer (front-end) is primarily implemented in PHP and behind this there is a load balancer–that splits the traffic, sitting in front of the Web server which looks at the request initiated by the user, figures out the pieces of data needed and combines them in HTML (HyperText Markup Language) and renders these to the user (Pingdom, 2010; Sobel, 2011.)

Many of the back end processes at Facebook are largely realized as services–to borrow from SOA’s (Software Oriented Architecture) description, services can be invoked, are loosely coupled, and are independent of solution and product–which are never implemented in PHP, rather in a number of languages such as C++, Java, Erlang, Python amongst others (Rothschild, 2009). For this, HipHop for PHP was built to convert PHP to C++ on its web servers, which is then compiled for improved performance (Pingdom, 2010). Services are needed because there are functions that need to encapsulate their own data such as the search service where it is the only effective way to deliver that particular functionality and it is more efficient trying to distribute those across a single tier of servers running a scripted language Rothschild (2009) adds. In order to support different services, a software framework–Thrift, was built to facilitate communication between all the backend services and for easily building and deploying these services. Thrift is also used for cross-language development making it easier for the different languages to communicate together. Scribe which is built on top of Thrift is a server for aggregating log data that’s streamed in real time from clients and it is designed to be scalable and reliable. Scribe moves data from the server to a central repository (Rothschild, 2009; Pingdom, 2010). Thrift and Scribe amongst others, provide a
common framework to enable easier creation of services.

Facebook leverages caching to limit the load on the database and reduce the time spent on requests to the database. Memcached which is mainly run from memory speeds up the database by caching data in RAM (Random Access Memory) to reduce reading time and is where all the indexing is done as the database cannot be used for distributed indexing. Memcached (http://memcached.org/) is a distributed memory object caching system for speeding up dynamic web applications and it is now an essential feature in distributed systems that help to address performance and scalability issues. Memcached stores hot data from MySQL into the cache and supports get\incr\decr and multiget\multiset operations and it is used as a caching layer between the web servers and the MySQL servers; it is also primarily used in most of the scaling operations (Pingdom, 2010; Sobel, 2011).

MySQL has played a key role from the beginning of Facebook and there are thousands of MySQL servers in multiple data centers. Facebook’s architecture is a shared nothing (SN) architecture which keeps everything independent and limits the failure domain to a very minimal portion of the data. Persistence is done using MySQL, Memcached and HBase and if there is a missing cache, the front end cluster makes a call out to the backend cluster to answer the query (Rothschild, 2009; Sobel, 2011; Eyers et al., 2012). MySQL is used because it is simple, fast and reliable and meets the storage needs, although at Facebook it is not used as a relational database, but rather for its very good data integrity moving joins and logic to the web servers where optimizations are easier to perform (Sobel, 2011; Pingdom, 2010; Rothschild 2009) add.

To support the disparate set of services offered to users, Facebook utilizes different technologies to implement them. Some of these services include publishing photo albums and photo management, messaging, insights, metrics and so forth. For photos, they developed Haystack high-performance storage and photo recovery system which implements a HTTP-based photo server that stores photos in a generic object store (Vajgel, 2009). Messages–chat, SMS, email, and messages–insights which provide real-time analytics related to Facebook, and a metrics system for collecting statistics use their own architecture that allows for automatic scaling in a cluster of servers (Eyers et al., 2012; Borthakur et al., 2011). These are built on the Apache Hadoop platform– which provides a distributed file system and a framework for analyzing large data sets– and utilize Apache HBase; a database-like layer built on top of Hadoop whose HDFS (Hadoop Distributed File System) provides a mechanism for reliably storing and organizing large amounts of data Borthakur et al. (2011) adds. HBase is highly scalable, splits the storage and processing requirements, enables greater horizontal distribution and easier data replication and integrates easily with Hadoop.

The above although not representing all the technologies employed at Facebook, provide an overview of the main ones. Even though the services offered at Facebook are implemented using different technologies, they work in tandem to meet scalability, availability and reliability requirements to ensure the ecosystem meets the users’ needs.
5.2 Twitter

Twitter as of the mid of 2012 has over half a billion users with about a third of these coming from the United States. The entire backend of Twitter was initially managed using MySQL, but over the years it has undergone several changes and system optimization to meet the drastic increase in load (Eyers et al., 2012) as will be discussed on the sub section on architecture.

5.2.1 Twitter API

Twitter also provides services to enhance automation of Twitter functionality, ways to interact with it and to enable making websites more social via the use of Social Plugins such as Twitter cards which enable the attaching of media experiences to Tweets that link to one’s content; Embedded Timelines and Tweets enable the display of public timelines on one’s website and also websites to generate code which easily renders Tweets on any website (Developers, 2012). Additionally, there is the Twitter button which one can use to distribute content, communicate with followers or discuss topics that are currently trending; and Twitter Mobile Platform provide means for enhancing one’s mobile application (Developers, 2012).

The most commonly accessed platform objects in Twitter are Tweets (also known as Status Updates), Users, Entities and Places. Tweets are text-based messages of 140 characters which users can send, Users can be anyone or anything that interacts with the system and they can, for example, tweet, “Entities provide metadata and additional information about content provided on Twitter” and are most often within Tweets, and finally “Places are specific named locations with corresponding geo coordinates which can be attached to Tweets by specifying a place_id when tweeting” (Developers, 2012).

Twitter API is based on REST architecture consisting of client-server like interactions where requests to the server are initiated by the client. These requests are processed and then given back as a “collection of network design principles that define resources and ways to address and access the data” Bhat et al., (2012). REST allows access to information through use of an HTTP invocation. Twitter’s API is HTTP-based having GET, POST and DELETE requests that can be used to access data and consists of the
Streaming API, REST API and the Search API (Bhat et al, (2012); Developers, 2012)

As of the current version (1.1) of the REST API, the Streaming and Search APIs are included in it. Streaming API provides low latency access to Twitter’s Tweet data categorized according to: 1) streams of public data flowing through Twitter; 2) user streams having most of the data matching with a user’s view of Twitter; and 3) multi-user or site streams meant for servers that have to connect to Twitter on behalf of many users. The Search API runs searches against real-time index of the most recent tweets (6-9 days of Tweets) and is implemented on a separate stuck with a separate database thus causing the returned objects to have different structure and IDs (Bhat et al., 2012).

Twitter provides authentication methods with different authentication styles and before settling on a particular method, one should understand how it will affect the users experience and the way applications are written. The authentication method depends on the API chosen; The REST API requires one to either send unauthenticated or OAuth signed requests in which applications need to obtain access tokens depending on use cases on behalf of a Twitter user; The Search API does not require authentication; and with the Streaming PI one can either set OAuth signed or HTTP Basic authenticated—where a user name and password are required when making a request–requests.

5.2.2 System architecture

Over the years the number of Tweets received by Twitter has been gradually increasing and this increase in traffic has led to a mismatch between the growth rate and the ability of Twitter’s system to handle the increasing load. Whenever there had been a surge in traffic during certain events which lead to many people tweeting, Twitter experienced periods of downtime usually represented by the fail whale error message (Figure 5). The whale usually appeared on the site when there were numerous requests above the number Twitter supports and it was a light-mannered way of reporting the error and apologizing to users for the inconvenience (Wikipedia, 2012).

Although, Twitter may have now said goodbye to the whale following the recent US elections where it experienced a record number of Tweets – peaking at 327, 452 Tweets per minute (TPM) – without it experiencing any downtime. This demonstrated that Twitter’s architecture (Figure 6) which is somewhat similar to Facebook’s, can remain resilient with the change in usage patterns and that the optimizations to their infrastructure has led to systems that can withstand an ever-increasing load albeit with still more work to be done to enhance its resiliency, scalability amongst others (Engineering Blog, 2012).

![Twitter error message](image)

Figure 5. Twitter error message
The Twitter front-end uses the Ruby on Rails framework which works well with the user facing applications and as of late 2009 was deployed on a Ruby Enterprise Edition (Engineering Blog, 2011) running on Unicorn behind Apache (Engineering Blog, 2010). This was again replaced in 2011 when they launched Blender, a Java server to replace the Ruby-on-Rails front-end of which together with Lucene a search engine library written also in Java led their search being three times faster (Engineering Blog, 2011a). Twitter primarily utilizes Javascript, Ruby, Scala and Java; C is also supported, but rarely used to write new services (Humble, 2011). To assist in the challenges of building a stable distributed system with disparate services speaking different protocols, Twitter developed Finagle a system that simplifies building of robust client and servers in Java, Scala or any JVM-hosted language and provides a rich set of protocol independent tools (Engineering Blog, 2011c).

Although it has undergone some changes with the slow phasing out of Ruby–especially in the middle tier in favour of Scala–which it was built on, Twitter primarily remains a Ruby application with Ruby daemons doing asynchronous processing on the background (Venners, 2009). Load balancing is employed to optimize activities between servers by equally distributing process execution amongst multiple servers. Ruby has performance limitations when handling backend processing in comparison to Scala which has advanced features, enables quick production and is good for long-running process (Venners, 2009; REDFIN Developers’ Blog, 2010.) It is for this reason that most of Twitter’s stack has been moved to the Java Virtual Machine (JVM) which provides better scalability and performance and better encapsulation of services and Scala integrates well with and can borrow from Java libraries as well (REDFIN Developers’ Blog, 2010; Humble, 2011)

Most of the services that run on the background are Scala-powered, for example, Hawkwind a bunch of user objects dumped out by Hadoop and is used for people search, Hosebird for streaming of public tweets to search engines (Streaming API) using low-latency HTTP-based persistent connection (REDFIN Developer’s Blog, 2010). There is also Thrift that is used as the remote procedure call (RPC) mechanism for transferring data and communication between the front-end and back-end services and JSON (Javascript Object Notation) over REST is used as the public RPC (Humble 2011). Then there others such as Snowflake for generating unique ID numbers for each Tweet that can be more evenly sharded across a cluster and T-bird and T-flock for storing and indexing Tweets (High Scalability, 2011).

Everything is kept in cache which leaves the database for mainly backup and storage and this relieves the burden from the database and accelerates page loading. To meet the needs of their large-scale production environment, they built Twemcache a robust and more manageable version of Memcached which improved maintainability and helped to better monitor their caching servers (Engineering Blog, 2012b).

Twitter still uses MySQL for smaller datasets and it is mainly used because it is fast, has a robust data storage layer, replication that works and it is easy to use and also run. To extend MySQL features that are missing are usually built on top of it. T-bird and T-flock mentioned earlier are built on top of Gizzard, a distributed data storage framework that handles sharding of data, replication and job scheduling and is built on top of MySQL (High Scalability, 2011). Gizzard is used as a building block for other storage systems in MySQL such as FlockDB–a distributed database used for edge storage. Other storage systems include: Cassandra used for high velocity writes and lower velocity reads;
Hadoop to provide horizontal scalability and redundancy and to process unstructured and large datasets; and Vertica for analytics and large aggregations and joins (High Scalability, 2011).

Figure 6. Twitter Architecture

5.3 Yammer

Yammer established in the third quarter of 2008 is an enterprise social network that links employees to content, conversations and business data. It provides a secure and private social network to companies and increases employees’ productivity by enabling easier collaboration, faster decision making and self organization into teams to handle business challenges. As networks are private, signing up for a Yammer account requires a valid company e-mail account. Unlike the other SNSs covered here which are free for all users, Yammer is based on a freemium business model; this means it is provided free of charge, but for advanced features a premium is charged (Wikipedia, 2012).

5.3.1 Yammer API

Like Facebook, the social graph—people and their connections to all they are dealing with—albeit a corporate one is at the heart of Yammer. The social graph has further been extended by open graph (an integration protocol) that can be used by developers to create a presence for their applications inside Yammer networks. The building blocks of the open graph are the actor, actions and objects. The actor is the one who initiates an activity story within the Yammer network; an action which notifies the user what has happened to an object (liked, created, etc.), must be specified when a third-party application sends an activity story; and an object is created (if it does not already exist) when a third-party application sends an activity story to a Yammer network (Yammer Developers, 2012).

Yammer Connect which leverages the Yammer Javascript API embeds features and actions into websites. These features include a Login button and an Embed widget.
which connects people, conversations and data across different business applications with Yammer. Yammer also enables generation of access tokens for users and networks and uses OAuth 2.0 for authentication of users and application identification. The Realtime API (JSON HTTP API) uses the Bayeux protocol (http://svn.cometd.com/trunk/bayeux/bayeux.html) to deliver realtime “push messages. Yammer like Twitter is also based on a REST API, all resources support JSON and all API calls are subject to rate limiting (Yammer Developers, 2012).

5.3.2 System architecture

The primary languages used at Yammer are Java and Scala. In addition to these, they also use Ruby, C, Javascript-for the front-end, C, Objective-C and Erlang. Yammer’s main application is Ruby on Rails, but they have over twenty Java services written using Dropwizard (http://dropwizard.codahale.com). All of Yammer’s services are RESTful web services—meaning they conform to the REST principles. Dropwizard is used to power Yammer’s JVM-backend and it pulls together libraries from the Java ecosystem into a simple package that reduces the workload and production time in developing a HTTP+JSON web service.

Yammer do not have a lot of public information about their general architecture and from the available information, it is stated that they use Berkeley DB Java Edition—which they have had to make a few alterations on—as their backend data store (Yammer Engineering, 2012). Scala has been the primary back-end language for Yammer in which they built a number of services. Some of which are, a real-time message delivery service, a distributed data store for message feeds, their search system—built on top of Lucene and Zoie real time search, a specialized server for integrating with Active Directory that streams staff changes from companies, a service—Streamie, (built in Riak) for handling thousands of Yammer notifications a second with low latency (Yammer Engineering, 2011; Basho Blog, 2011; Dzone, 2011). Due to the complexity of using Scala in terms of productivity gains and reduction of maintenance load they decided to move to Java (Yammer Engineering, 2011).

5.4 Foursquare

Foursquare—a social positioning service—(www.foursquare.com) was launched in the first quarter of 2009 and is an application for sharing and saving the places one visits and it provides personalized recommendations and deals (in the case of company offerings) based on where others have visited if they share similarities. Foursquare has over 25 million members who have made over 3 billion check-ins with millions being registered daily (About foursquare, 2012).

5.4.1 Foursquare API

Foursquare’s API features let third-party applications integrate into the core foursquare
experience, making it easier for users to discover and use the applications – Connected Apps Platform. The Core API manages the interactions on the mobile application and on the website. These include check-ins, viewing history, locating friends, creating tips and lists, searching for and learning more about venues, and accessing specials and recommendations. Methods for accessing resources – venue, tip, user – at a canonical URL (Uniform Resource Locator) are provided. There are also Merchant and Venue Platforms that enable developers to collaborate with venue managers to manage venue information and interact and create an experience with customers responding to check-ins and to construct location information into applications without requiring deeper foursquare integration and authentication. Consumers with their own location database can also connect with Foursquare’s (Foursquare Developers, 2012).

The Merchant and Venues Platform are implemented using the Real-time API. The Real-time API provides an opportunity for managers to know when users check in to their venues (venue push API) and also developers are notified when their users check in from anywhere (user push API). The user push API pushes to an application every time a user who has authorized the OAuth consumer checks in. A POST request with a checkin parameter containing a normal check-in response from the user’s point of view will be received by the server. The venue push API is designed for applications used by venue managers to provide a real-time view of traffic into the venues (Foursquare Developers, 2012).

5.4.2 System architecture

Unlike the other platforms, Foursquare has details of the technology they use in their about page (About foursquare, 2012) which gives a brief but informative overview of the systems that it is built on. Almost the entire code for the front-end is written in Scala and the web and API are built on top of the Lift web framework – a secure, scalable, modular, easy to use and maintain web framework. Lift applications are written in Scala – a JVM language – therefore, Java libraries can still be used and deployed to a servlet container and application server. Python and Bash scripting are also used for automation of tasks and dynamic content is written in Javascript and Soy for templating.

Foursquare’s live site data is stored in MongoDB – a scalable, high-performance open source database written in C++ and caching of a set of expensive calculation is done using Memcache. Offline and distributed data processing, building recommendations and powering of internal reporting is done in Hadoop. Hive an SQL layer built on top of Hadoop facilitates easy summarization of data and analysis of large datasets. Recently a set of new components was introduced to the Hadoop stack. These include Oozie to aid in workflow management, Thrift for data serialization, Pig for adhoc analysis and Scoobi for the writing of MapReduce jobs in Scala (About foursquare, 2012; Foursquare Engineering, 2012).

Searching for venues, tips, users, and events search is powered by Solr and Elasticsearch which are both built on top Apache Lucene. The former is mainly used for users and to-dos and the latter as their main search system. Geo-indexing of searches uses

3 An email sent to their contact address on 23 October 2012 indicated on their Website directed me to their about foursquare webpage (https://foursquare.com/about) and also advised me for the most up-to-date news on foursquare, to regularly follow their blog (http://blog.foursquare.com).
Google’s s2 library and PostGIS is used to transform addresses into coordinates which enables the placement of venues on maps making them available for location-based search. Amazon Simple Storage Service (Amazon S3) is used to store user-generated photos and content delivery is through Akamai. Foursquare’s hosting is within Amazon Elastic Compute Cloud (Amazon EC2) service. NGINX—a HTTP, reverse and mail proxy server, is used for routing requests and serving static content, and HAProxy for load balancing across requests across many machines (About foursquare, 2012).
5. ANALYSIS OF THE PERSUASION CONTEXT

Technical design choices in relation to system architecture determine the content that can be seen, the mode of interaction with the content (request and response), visibility span of the content and the linkages between people and content. These choices consequently influence the social interactions that they enable and mediate. Additionally, social media use is dependent on social practices and individual personalities (Hansen et al., 2011).

Computing technologies can take on functional roles as was stated in the introduction section and these roles define the persuasion context with the ultimate result being to change one's attitudes and behaviors or lead to compliance—which is not long-lasting. Embedded into persuasive systems are nuances/triggers; which, depending on how one interacts with an information system (IS) and their purpose for the interaction, may lead to the behavior change process via persuasive strategies resulting from the architectural design.

The context assists in learning and reasoning about user behavior and analysis of the persuasion context requires and understanding of the occurrences in information processing, specifically, understanding the roles of persuader, persuade, message, channel and the larger context. The persuasion context consists of the intent, the event and the strategy which are expounded on in the following sections (Oinas-Kukkonen & Harjumaa, 2008).

5.1 The intent

In analysis of the intent, it is important to determine the persuader (as computers do not have intentions of their own) and the change type. That is, whether the persuasion aims at an act of compliance, attitude and/or behavior change (Oinas-Kukkonen & Harjumaa, 2009; Oinas-Kukkonen, 2012). Intentions could arise from the creators of the social platforms, those who give access of the platforms to others and the individual using the platforms (in the case of the current study). These are collectively referred as endogenous, exogenous and autogenous respectively (Fogg, 1998; Oinas-Kukkonen, & Harjumaa, 2009.) SWP can be categorized as both endogenous and exogenous technologies as they have been created with the intention to persuade in some way and user participation is mainly caused by external factors such as receiving an invite from friends. Although in the case of an invite, the one inviting may not have a conscious intention of persuading the invitee. Table 6 gives examples of the persuasion intent for both the persuader (creators of the respective systems) and the persuadee (users of the systems). Fogg (1998) in categorizing the persuasion intent acknowledged that the categories in the classification may not always be precise and mutually exclusive thus leading to potential ambiguities.
Table 6. Persuasion Intent of the social web platforms

<table>
<thead>
<tr>
<th>Persuader</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Yammer</th>
<th>Foursquare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persuadee</td>
<td>Build social relations</td>
<td>Call for action</td>
<td>Sharing with colleagues</td>
<td>Discover places, things and deals</td>
</tr>
<tr>
<td>Interaction</td>
<td>with social ties</td>
<td>Stay informed</td>
<td>Enhance productivity</td>
<td>Competition and exploration</td>
</tr>
<tr>
<td>Interaction</td>
<td>in a ‘walled garden’</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For systems to be persuasive they should aim at changing users’ attitudes or behaviors, they should assist users in determining goals and remind them of achieving these over time and users objectives should be supported by communicating relevant experiences from others within their social network (Mukhtar, Ali, Belaid & Lee, 2012). Interpersonal interactions with technology are essential for persuading individuals to adopt behavior changing activities. Persuasion can enable continuous change in individuals’ attitudes; therefore, it has the capacity to effect behavior change. The essence of persuasive technology is that the onus lies with the receiver (persuadee) on whether or not to participate in the process of persuasion initiated by the persuader. According to the social cognitive theory, to enable behavior change an understanding of individuals’ attitudes concerning behavior is required then the creation of messages directed at these attitudes (Bandura, 1989).

Depending on the functional role taken, the SWP change peoples’ attitudes and behaviors using influence strategies found in the social studies. Even though user involvement in current SWP is structured in a variety of ways, there are identifiable patterns because of existence of similar behavioral goals (for example, registration for the service, getting others to join, content generation) and due to success of the tactics in attaining the behavioral goals, new platforms are patterned after these (Fogg & Eckles, 2007). As persuasion is sequential in nature and utilizes multiple strategies, each strategy should help the persuader in meeting both behavioral and attitudinal goals from which additional strategies can be employed. What Fogg and Eckles (2007) refer to as the behavior chain that consists of Phases with multiple goals known as Target Behaviors.

As computers do not have intentions of their own, it is important to determine the persuader (their design bias should also be clear), the change type required—compliance, attitude and/or behavior change—and the means of achieving voluntary influence(Oinas-Kukkonen & Harjumaa, 2009; Oinas-Kukkonen, 2012.) SWP have been created with the intention to persuade through emphasis on behavioural goals—registration to the service, getting others to join, content creation and sharing—and their success in creation of the persuasive experience is hinged on user collaboration and constant engagement through facilitation (and encouragement) of regular visits to the respective systems. This is done by encouraging the persuadee (user) to participate in the persuasion process by creation of messages enabling the behavior change. That is, persuasive goals and their matching target behaviours realized via the strategy.

5.2 The event

The event category in context analysis consists of the use, user and technology contexts (Table 7). The use context defines the problem domain and the purpose for using
interactive technologies and focuses on what information may be relevant for a user in a given situation (Oinas-Kukkonen & Harjumaa, 2009). In the case of the platforms some of the uses have already been covered in the social media section in an earlier chapter and as mentioned in the previous section, all SWP essentially have similar behavioral goals and are all aimed at facilitating and enhancing user engagement within their environments. Facebook is used primarily in a social context for airing personal thoughts, sharing news—personal or otherwise, playing games, keeping in touch and reconnecting with friends, sharing information about events, locations and so forth. In the case of businesses it can be used for engaging with customers through requesting for their opinions on products, or certain topics, sharing event schedules and targeted advertising.

Twitter on the other hand is used more for news aggregation and connects users to the latest stories, opinions and what they find interesting. Yammer is used within enterprises to enhance communication and information dissemination amongst colleagues through announcements, sharing of conversations, working together in groups, syncing user additions, deletions, profile information, content collaboration, connecting people to thought leaders and so forth. Foursquare helps in exploration of cities (discovering new places and keeping track of visits), connecting with friends, for creation and sharing of location data, getting tips and deals and earning points and badges by having the most visits to a particular location and as a game where one get both virtual and tangible rewards for check-ins (Lindqvist, Cranshaw, Wiese, Hong, & Zimmerman, 2011.)

Table 7. Persuasion Event and its example features in the social web platforms.

<table>
<thead>
<tr>
<th>Event</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Yammer</th>
<th>Foursquare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social context</td>
<td>News aggregation</td>
<td>Enterprise setting</td>
<td>Sharing location data</td>
<td></td>
</tr>
<tr>
<td>Example features</td>
<td>Reciprocity – acquaintances and friends</td>
<td>Directional – consumption and dissemination</td>
<td>Productivity via connection of more employees – information seekers and information sources</td>
<td>Voluntary check-in, competition and rewards enhanced via the gaming aspect</td>
</tr>
</tbody>
</table>

The user context is more concerned with the differences in individuals and their intention to use a particular interactive technology. For example, de Moor’s (2010) socio-technical framework for studying social media and based on an analysis of Twitter, found that different type of users can be distinguished based on their usage patterns. These include a) broadcasters who have more followers than they follow themselves; b) acquaintances who show reciprocity in their relationships; and c) evangelists who follow more than the number of their followers and are often spammers. Another distinction was between information sources (focal point with numerous followers), friends with various kinds of mainly reciprocal relationships and information seekers who post rarely, but follow others regularly (de Moor, 2010; Zhang et al., 2010.) This distinction between users can be found in Facebook for example where there are some users who primarily consume others’ news without giving in return or they interact with very few people. The User context for Yammer and
Foursquare can be derived from the classification of user types, their reason for using the services and how they use the particular service. The user goals for use of Yammer are to enhance organizational productivity through sharing of answers to frequent questions asked by colleagues and for Foursquare, the goals are to interact with others (the social aspect) through sharing of information of the visited places and the gaming aspect where there is competition and rewarding for the frequency of visits.

Still on the users, some are comfortable with the open nature of communication exhibited in SMS whereas others are not and this difference in view leads to different ways of interacting with the system. Vodanovich, Sundaram, & Myers (2010) contrast between digital natives and digital immigrants in their paper on the use of information systems (ISs). They define digital natives as those who grew up in a digital world, have grown up in a world where use of ICT is pervasive and ubiquitous, their lives are shaped by technology differently and are more comfortable with peer-to-peer collaboration and the disclosure of personal information. Digital immigrants on the other hand, were not born into the digital world; rather they have learnt to use ISs in their adult lives. Natives, for example, prefer synchronous modes of communication–IM, whereas immigrants prefer asynchronous such as e-mail (Vodanovich, Sundaram, & Myers, 2010). The difference between the natives and immigrant could help explain the difference among users as explained in de Moor’s (2010) study and how they use interactive technologies.

The technology context defines the characteristics of the technologies being employed in computer-human and computer-mediated persuasion and the strengths, weaknesses, opportunities and risks associated with the use of these should be understood (Oinas-Kukkonen & Harjumaa, 2009). Failure and success of ISs depends on fluent navigation and interaction rather than just the design. In view of the technology, a consideration of the underlying infrastructure as aforementioned (chapter 4) that enables efficient delivery of the required features needs to be taken into account.

Characteristics of technology could also be likened to the components of MIP (Fogg, 2008) which were earlier introduced. The components describes how: a) technology creates a persuasive experience (designed to change attitudes and/or behaviors)–for example, how a message is framed when one receives an invitation to use an application; b) digital technology automates the persuasive experience and enables people to share their experiences with others; c) the persuasive experience could be shared from one friend to another via technology; d) how technology quickly distributes the persuasive experience–shortest possible cycle time for getting involved and involving others; e) the persuasive experience can reach a network of millions of people connected to one another through social ties; and finally f) people (users and creators) via technology can observe the effects of the persuasive experience (Fogg, 2008). It is these issues that make the creation and delivery of target behaviors and persuasive goals easier and much faster and that form the subject of the discussion in the next section.

5.3 The strategy

Direct and indirect routes–dependent on ones motivation and ability–to persuasion need to be considered, but simplicity is also important in persuasion. If a task is simple to do or mostly automated then we are more likely to do it sooner; whereas if a task is
complex and/or has multiple steps then we are likely to either avoid it or procrastinate (Fogg, 2008). Hence, there is a need to simplify the persuasive experience which relies on symbolic strategies that trigger the emotions and often trying to convince the persuadee to take action (Oinas-Kukkonen & Harjumaa, 2009).

The phases of the behavior chain identified by Fogg and Eckles (2007) include Discovery, Superficial Involvement and True Commitment. Discovery and Superficial Involvement are concerned with becoming aware of a Web service by learning about it from friends for example and deciding to try it and getting started by setting up an account. As the covered platforms are already well known and have a combined total of over one and half billion users, comparing the persuasiveness of the platforms will be based on the third phase of the behavior chain—True Commitment (Figure 7). The target behaviors of the third phase include: creating value and content that others can consume, staying active and loyal through repeated visits to the site and involving others to use the service by inviting others to be friends, sharing information via links (Fogg & Eckles, 2007) and so forth.

The success witnessed by the growth of SMS has hinged on persuading users to perform certain behaviors failure to which most would not have witnessed the growth in their users now occurring. There are many uses and goals (matched with their target behaviors for the phase 3 of the chain) for SMS, but the main persuasion goals according to Fogg (2008) can be broken down to:

1. Encourage users to create a personal profile – create value and content;
2. Invite and connect with friends – involve others;
3. Respond to others’ contributions – create value and content; and
4. Regularly access the site – stay active and loyal

Phase 3
True Commitment

*Figure 7. Third phase of the Behavior Chain*

**5.3.1 Creating the profile page**

Creation of profile pages—in line with the target behavior of creating value and content—is required when registering to the four platforms although the level of detail varies. In Facebook and Yammer more and highly revealing personal information is requested from the user in the profile section than in Twitter and Foursquare which for example, do not request birthdays, religious information, family information, work and educational information. Although other than name and birthday (in the case of Facebook) and Job Title and Department (in Yammer’s case), filling in the other details
is not necessary for one to set up an account.

Yammer though tries to ensure that users give as much detail as possible on their profiles by tracking their progress on a progress bar strategically located next to their details. The “Update info” and “Edit Profile” tabs are always present on Facebook and Yammer’s user profile page to reduce the barrier for adding profile information and to imply that a profile page should frequently be updated (Fogg & Iizawa, 2008). All the four have a Bio section—where one can briefly tell about themselves—under the profile section and the length and size of the required information is indicated by the size of the input field and this influences users towards pleasant and brief self-introductions (Fogg & Iizawa, 2008).

The profile page and its subsequent editing is not as prominent in Twitter as it is in Facebook and Yammer because Twitter is primarily used as a news aggregator and disseminator and people are rarely concerned with editing or looking through their profile other than when setting up an account and updating their information. In the case of Foursquare, since it is location-based and primarily a mobile application that is based on recognition and competition, the profile page (accessible via the Web) displays the number of check-ins, days out, photos, tips, badges won, “mayorships” (based on the most days with check-ins over the preceding 60 days), number of friends and other information that lets one know what their friends have been up to.

The common factor in updating the profile in the four cases is that it is made as simple possible and in a way that encourages one to frequently review their information. Although as has been noted, updating the profile is not consistently done on the four and level of detail required differs. Some users fill in just the bare minimum required (name, date of birth—which does not have to be displayed on the profile, and e-mail address) in order to be able to access the service.

5.3.2 Invite and connect with friends

The possibility to connect with friends and like-minded individuals is what makes interactions in social media valuable and being able to invite friends is an important behavior for the success of the sites and inviting friends has been made to be as simple as possible. The second persuasive goal links with the target behavior of involving others.

Facebook, Twitter, Yammer and Foursquare persuade people towards the achievement of this result by providing opportunities to easily find and add friends or people they may be interested in. For example, in Facebook, Foursquare and Yammer, there is an ever present input field with placeholder text that nudges one to try to find their friends. The text requests one to search for people, places, things (Facebook), people, groups and conversations (Yammer) and invite friends to their service (Foursquare). In addition to the input field, Facebook and Foursquare also offer suggestions of people one may know based on their own friends; Twitter suggests who to follow based on the people one is already following; and as Yammer requires a company URL to sign up for an account, the author did not have a considerable number of friends to view whether the

4 Twitter and Yammer do not use the concept of friending, rather they use follow; and one can follow a friend or a complete stranger who does not have to reciprocate. That is, the relationship can be unidirectional.
same principles are applied, but a look at the notification settings indicated that one could enable receipt of follow suggestions by email. Yammer is also within a closed organizational environment, thus it is believed that follow suggestions have to be within the same organization or if from an outside network, then those that have been given access to the organization’s network.

The four also display the number of friends (followers in the case of Yammer and Twitter) thus motivating users to connect to more friends. Facebook for example, publicizes the number of mutual connections between users and reduces the task of finding friends by providing options that limit the scope of the search. One can for example search according to their hometown, their current location, secondary school, mutual friends, college or university and employer. Twitter when displaying follow suggestions also shows “followed by” which is often a mutual connection.

5.3.3 Respond to others’ contributions

As people primarily utilize SMS to share their thoughts, views, successes and/or failures, interaction (over user-generated content) and their responses form the core of such services. People are especially more satisfied when they see others responding positively to their posts or updates (Fogg & Iizawa, 2008). User behavior makes the service more valuable by creating content that others can consume (e.g. videos, polls, breaking news/news features, photos, and links) and form discussions around (Fogg & Eckles, 2007).

All four services notify users about new content posted which serves as first step in response initiation. Notification of new content is conducted in two ways. The first one is via a news feed (the first point of contact when one logs in to the respective sites) and is located on each user’s Home page showing all the recent activities and posted content. The posted content is just a click away thus increasing the motivation by simplifying the process of accessing the user information.

The second method of notification is via an email to a user’s e-mail address whenever there are any updates to their account. Although one can choose the frequency of update – either daily or a weekly digest, the updates one would prefer or not be notified at all of any new updates. This could be updates on posts to ones timeline, for friend requests or confirmations, photos or any other content one is tagged in, has commented on or has been mentioned, check-ins, new followers, invitations to groups or events, suggestions for people to follow and so forth. This expands the reach of the respective sites beyond their own domain and is a call for people to engage.

Commenting is also encouraged by placing a comment box below every posted content (signifying simplicity) which becomes a sought of dialogue with any additional comments. All the participants in the conversation are also able to view one another’s comments as they contribute themselves. The persuasion goal of responding to others’ can be said to fulfill all the three target behaviors, but mainly creates additional value and content.
5.3.4 Regularly access the site

Regular access to the site matches with the target behavior of staying active and loyal. Persuading users to access the site often is one of the main goals of SMS and such services benefit by having frequent return visitors which makes it more engaging for others (Fogg & Eckles, 2007; Fogg & Iizawa, 2008.) Users are persuaded to visit the respective services often via a) e-mail updates as has been noted in the previous section which update one on what is happening and the changes that have taken place (from their last visit), b) The News feed which describes what has been posted and by whom, and c) users presence in each others’ online spaces (Fogg & Iizawa, 2008).

This feature (presence in each others’ online spaces) is available in Facebook for example, where one can visit a friend’s profile page and poke them and they will be notified either via email if notifications are turned on or it will appear on their Home page when they log in. Poking initiates a response from the receiver which could either be in form of a poke and/or posting a message on the senders Wall or Inbox.

An effective persuasive strategy induces some behavior change in the user and leads them to take some corrective actions (Mukhtar et al., 2012) examples of which have been described above. The persuasion goals and target behaviors leverage aspects such as recognition, reminders, competition, suggestion, rewards and so forth of the PSD model in creation of a persuasive experience that is shared via technology from one person to another. This ultimately influences their interactions both with the system and with others.
6 DISCUSSION

All our thoughts are usually aimed at making our interactions and the world more open and connected to our actions. We want to have a meaningful connection with one another both professionally and at a personal level and advances in modern technology have availed prospects for enabling this in ways and at magnitudes that have not been previously available or even possible. Social media is at the core of peoples’ and businesses’ online presence today and it is witnessing continued growth because it typifies and has a subsequent influence on the current culture of fast information sharing (and processing)–be it of personal thoughts, news, opinions–synchronous communication and global interconnectedness driven by technology. SMS have stimulated new ways of working, sharing information and creating content and meaning, leaving a permanent mark on almost all application domains as has been covered in the preceding chapters.

System and information quality determines how ISs are used and the level of user satisfaction, which ultimately influences the user. Even though the standards and protocols used by SMS have much in common, their sustainability is dependent on the rules, policies and user communities supported and the provision of the particular social interaction for which they were designed (Hendler, Shadbolt, Berners-Lee & Weitzner, 2008). Standards enable interoperability between systems components and features and the subsequent production of large-scale systems such as the platforms covered in this study and as such, these standards result in the representational data contained within these systems (Brubaker & Hayes, 2011). SMS are progressively embodying representations of peoples lived experiences and are shaping social interactions both online and offline (Brubaker & Hayes, 2011). They respond to users technical and social needs, facilitating the interaction required and enabling the creation of individuals' own media spaces (Duffy, 2011).

SMS are representational systems that do more than just represent the physical world; they are profoundly connected with both our social and significant day-to-day practices (Brubaker & Hayes, 2011; Burke & Marlow 2011; Lindqvist et al., 2011.) For example, Brubaker & Hayes (2011) when analyzing how the underlying infrastructure–through comparison of two social networks–of SMS and the user practices on these sites are connected, find that users create online profiles and social networks that somewhat represent their offline lives. Self-representation issues also emerged in Lindqvist et al., (2011) research on the reasons people use Foursquare.

Some people (so as to uphold their reputation) did not check-in to places which they thought to be embarrassing and boring such as fast food restaurants, banks and health centers. In contrast, there were some who were mayors of the fast food restaurants Lindqvist et al. (2011) signifying difference in opinion and use affecting how one would like to be seen and additionally affecting what they say and their actions. Duffy (2011) further states that comfortability with technology leads to adoption of application features and adaptation to meet one’s own needs if these are not already being met.
There are also surprising uses of technology which are not part of the original design goals and which could be designed in future systems or editions of the same systems. Such as in Lindqvist et al. (2011) where some people checked in at locations after they had left due to security concerns or others who checked in when they got home to inform friends of their safe return. There are also some people in Facebook, for example, whose number of friendship connections has remained constant from the time they joined the system (even spanning a number of years) which is contrary to Fogg & Iizawa’s (2008) finding in their analysis of Facebook and Mixi that the main goal of such systems is to have as many friends as possible (more so in Facebook). Confusion about systems design and use can lead to preconceptions as can be seen that limit ones proper utilization of the system.

The varying degrees of system use could also be explained by taking into consideration the context, specifically, the user context under event which classified users according to their usage patterns and familiarity and comfortability with technology. For example, digital natives who are more technically adept and more open and expressive in their use of technology and are not overly concerned about security. In contrast to digital immigrants (may also be technically adept in use of technology) who are more cautious and somewhat inhibited in their use.

De Moor (2010) defines four main conversation purposes in distributed collaborative systems and the communities within them; information exchange, coordination of interactions, collaborative sense making and relationship building which all need to be supported. The extent of which is dependent on the purpose and the medium used. In some communities, the conversations may only be focused on a subset of the purposes (de Moor, 2010). Hansen et al. (2011) further categorize SMS according to a set of key dimensions some of which have recently become blurred due to the addition of features which have extended the functionality of the respective systems; such as, introduction of IM in Facebook, capability to attach documents to messages or discussions in both Facebook and Yammer and so forth. These dimensions include the size of producers and consumers with interchangeable roles who distinguish the services on social media. For example, through broadcast of a personal message (tweeting to followers on Twitter or posting to friends wall on Facebook) or medium-sized groups (one’s friends or those they follow) reaching out through viewing of news feeds on social media’s homepages which create a personalized stream of information for an individual (Hansen et al., 2011).

Secondly, are the users varied expectations about the pace of interaction in the systems which are a combination of both synchronous and asynchronous modes of communication. Tweets can be responded to within minutes of receipt or they can take longer to respond to as is the case for responding to wall posts and one can be chatting while responding to private messages in Facebook for example which blurs the distinction between synchronous and asynchronous. Thirdly, are digital objects (and their relations) which form the basic elements of SMS and can lead to different patterns of interaction. Users at Facebook, tweets at Twitter, check-ins at Foursquare, yams at Yammer and so forth cater for different stages and means of engagement. Location being an extension to SMS has enabled the creation of connections between people, objects and places and formation of ties by being in similar places with others even at varying times (Hansen et al., 2011; Duffy, 2011; Lindqvist et al., 2011.)

Fourthly, are the types of connections which can either be explicitly or implicitly connected. Explicit connections are intentionally created by users—such as friending on
Facebook where the connection must be approved by both parties before it is fulfilled— whereas implicit connections are inferred from online behaviors—reply to a discussion post, poking someone on Facebook, connection by shared interests for example a Facebook group or joining an event (Hansen et. al, 2011).

Another distinction is between directed and undirected connections. A mutual connection—when two people become friends—is an undirected connection. In contrast, a directed connection is where one can follow another without first gaining their approval (as in Twitter); highlighting the importance of the directionality of the tie (that, is who is following whom) and the connection not being reciprocal (Hansen et al., 2011; de Moor, 2010). These connections according to Burke and Marlow (2010) lead to two kinds of social behaviors in SMS. The first one is directed communication with friends consisting of targeted communication and personal exchanges and the second is undirected messages. These form the root of passive consumption of social news (going through others’ updates), and broadcasting (updates that are not targeted to anyone in particular) (Burke & Marlow 2010).

Here can one classify both Facebook and Foursquare as having undirected connections and Twitter and Yammer having directed connections. Exchanging information, posting on friends walls, sharing locations, what one is doing, and sharing ‘pings’ (information about the experience of a venue checked-in to) requires an explicit friendship connection. As Facebook is relationship-based, the focus is on building a continuous relationship. Whereas in Twitter and Yammer (more so in Twitter as Yammer has additional functionality, like sharing and uploading of files, an inbox-collection pool of posts, email for sharing documents etc) social connections are not emphasized rather, interesting topics, people and conversations are more important. Information and the updates are constantly changing and the news is always in real-time with the focus being to stay informed. Twitter (due to its short text-based messaging service) as has been mentioned, played a crucial role in dissemination of news during the Arab uprisings when it was difficult to reach the people.

The relationship is much more detached and one can follow people who have interesting viewpoints and topics that they can learn from without having to worry about the connection being reciprocated before access to the individuals or topics of interest. As one can also reply to another’s tweet by preceding their user name with an @ symbol there is a possibility to communicate with strangers and overtime have a mutual connection/following. Although one can follow and be followed in both Twitter and Yammer, thus creating a mutual following and sending direct messages requires that two parties have a mutual connection. Twitter is also more open as anyone can access the Tweets if they have not been made private, plus the tweets are searchable on the Internet which provides even greater access in contrast to Facebook where the information is within a walled garden.

The fifth dimension in categorizing SMS according to Hansen et al. (2010) is the lifespan of the content or how long the content is retained. In Twitter, most user engagement with Tweets happens within a short time of posting and searches of the Twitter network only pull from the most recent days utmost a fortnight or so. With posts, status updates and comments on Facebook or even Foursquare, the communication can go on for a much longer time and it easier to find this information (Hansen et al. 2010).

Important information flows from distant parts of a network and from people with
whom one has limited connection as posited by the Strength of Weak Ties (Granovetter 1973; Granovetter 1983.) Additionally, weak ties act as bridges that integrate social systems and lead to rapid spread of new information and ideas that would otherwise not be available if one was confined only to their close friends’ connections (Kadushin, 2012). Therefore, it can be argued that a good number of the interactions on SMS are based on weak ties that are an essential factor for their growth as interactions with only one’s strong ties limit the amount of information flow within these networks. Even undirected connections such as those in Facebook can have weak ties through implicit connections like being in the same groups although not explicitly connected (you are connected by having a similar interest). Additionally, there are also people with friends running into the thousands a majority of which can be said to be weak ties as one only maintains constant and direct communication with a small percentage of these who are essentially the strong ties.
7. CONCLUSION

In this research, the use of social media and its implications has been covered plus how advancements in technology, the open and collaborative nature of social media and its bottom-up creation and distribution of information have revolutionized the means of communicating and have made information easily accessible. Additionally, the research has also looked at SMS architecture and has discussed and analyzed the differences between four SMS; Facebook, Twitter, Yammer and Foursquare. The four systems were chosen for analysis because they are among the most common SMS and they all represent different forms of use and each has its own distinct characteristics. Although the essence of such systems is the same, in each you may find people who favor the use of one over the other. For example, there are those who prefer using Twitter to Facebook or vice-versa. In the discussion on the platforms architecture, it was determined that they all have a layered architecture with each layer responsible for fulfilling an aspect of the systems performance. Most of the processing and data analysis occurs in the back-end which is implemented using a variety of applications that render services. The architectures have also been built from the ground-up in most cases using open source software which has been customized to meet the respective platforms internal requirements.

The research began by establishing a theoretical foundation for the analysis of the four social media systems by discussion on theories on learning and social psychology. Theories are useful for analyzing and evaluating persuasive systems and help to, for example, understand the problem and selecting strategies to initiate the required change. These theories also form the background to understanding our interactions with technology and the functional roles interactive technologies can have from a user’s viewpoint. These roles increase the users’ ability, provide interactive experiences via rich media and help to create relationships.

The research question stated in the second chapter–software architectures modeled to influence–has been answered by looking at some of the features of the four systems and an analysis and discussion of the persuasion context. The persuasion context consisting of the intent, the event and the strategy assist in acquiring knowledge about user behavior and a comprehension of the roles and events in information processing. The social media systems utilize elements such as liking, reciprocity, social proof and have certain other persuasive goals and their corresponding target behaviors which persuade users to constantly access them.

The study has had some limitations, one of which has been the choice of the four systems and their subsequent analysis which was somewhat disjointed. Analysis of the four platforms as relevant as it was, proved challenging as it was difficult to define a suitable criteria for discussion. Hence the need to first establish a theoretical framework before discussing their system composition and subsequently detailing the persuasion context. Although, the analysis of the persuasion context and the discussion that followed was a merger of the two preceding chapters on architecture and influence. As Foursquare and Yammer are also relatively newer systems compared to Facebook and Twitter, there has been more scholarly work done on the latter two than on the former which also made objective analysis of the four difficult.

A second limitation also related to the choice of the four for analysis. Even though they are all social media systems and they have similarities, their use also differs. Thus it
could have been easier to compare only two which would have provided a better opportunity to discern and analyze the contextual factors like location, category of users, the knowledge of users and so forth. Empirical studies that are longitudinal in nature could also have aided in discerning these contextual factors and highlighting more clearly the differences among users and the forms of use. Although as stated in the introduction, the research opens the way for more studies comparing multiple social media systems both in terms of their structural differences and the context of use.

Following the limitations are the ways in which the research could be extended. An avenue for further research could be to investigate how the strength of weak ties plays a role in the continued growth of social media. This could be done by using data mining and/or social network analysis tools like UCINET to find out: 1) friends and the ties they have in common 2) the symmetry/asymmetry in communication among certain people (and the frequency) depending on the SMS used, 3) the most influential people in a certain network, 4) the most active/inactive people in a network plus the reasons for this, and 5) what is being discussed and also the trending topics. Social network analysis tools could also be used to discern the level of influence exerted on users within a particular network and the benefits derived by being in the network over a certain timeframe. Extending the research in this way will provide empirical validity to it and other issues not dealt with in previous research might also arise as use of a particular methodology is always context and situation-specific and thus the results cannot be generalized (especially when time is factored in).

In conclusion, the growth of social media systems is redefining how people spend their time online as they meet basic human desires on a much broader scale. The underlying technology and architectural design of the various systems serve as a platform for the provision of functionalities and features that facilitate influence through the proposition of persuasive goals.
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