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Mobile Social Networking

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Abstract

With the huge prevalence of mobile devices and social networks in recent years, Mobile Social Networks (MSNs) have been rapidly gaining popularity. Mobile social networking is social networking where users who have similar interests connect with others through their mobile devices. This paper presents a survey on the MSNs. It introduces MSNs by going through their features that distinguish them from conventional social networks. Then, the paper covers the most popular MSN application classifications. Furthermore, it provides a review about MSNs with regard to system architectures, and the most common current challenges. Finally, several important opportunities and future research directions are outlined.

Introduction

With the growing interest in social networks and mobile technology, a new trend called MSN (Mobile Social Network) was born. The MSN can be defined as a system that provides a variety of data delivery services involving the social relationship between mobile devices' users [1]. MSNs contain the main functions of typical web-based social networking services, such as sharing pictures, chatting, searching for new friends with the same interests, and so on. In addition, it creates the advantage of wireless communications for mobile networking by allowing users to share information and stay in touch with their friends anytime and anywhere [2]. MSNs and their applications have recently acquired huge popularity. As of January 2016, 52 percent of users in North America used their mobile devices in accessing social media, while the global mobile social penetration rate was 27 percent [3]. People find that mobile devices are very well suited for creating social communities due to many aspects. Theses aspects include not only the mobility feature, but also some additional features such as contextual information. The mobile context can be produced by information such as the location of the mobile device, the time of day, tags that describe the environment, information from other devices around it, velocity, and some other capabilities that the device has and some options preferred by the user [4]. The rapid growth in popularity of social networks has enabled huge numbers of users to communicate over their mobile devices, however at the same time, it has opened new challenging issues. A considerable amount of effort has been devoted to finding appropriate solutions for problems such as security, privacy, data management, data mining, and so on.

Although this topic has huge revolution and wide-ranging of research areas, there is a lack of surveys that provide well organized and comprehensive review. The aim of this paper is to cover most relevant aspects of MSNs. It presents an overview of MSNs by beginning with a brief background and their main features. Then, it goes through the most popular MSN application classifications, types of architecture, main challenges, and finally opportunities and future directions.

Background

A. Social Networks

The beginnings of social networks were in the nineties of the twentieth century where people were able to exchange ideas over the Internet through chat rooms. After the evolution of Internet technologies and social sites, a newer generation of social networking was born with more features. People started to have profiles, share content and search for other users with similar interests. This evolution was from within Web 2.0, which had the sharing of data as its major concept. Then, because of the spread of mobile devices, the research community turned to transfer those current trends in social networking to mobile devices. Mobile 2.0, refers to the generation of mobile internet services that leverage all the current trends of Web 2.0 on mobile devices. Mobile social networking means transferring all current trends in social networking to mobile devices, in addition to new properties that are provided by mobile devices and networking that will be discussed in the next section.

B. MSNs Features

In order to understand the MSNs new features, we need to take a look at what capabilities that mobile devices may have. MSNs can take advantage of capabilities of contemporary mobile devices such as Global Positioning System (GPS) receivers and sensing modules (i.e. camera, microphone, gravity sensors, accelerometer, etc) to furnish a lot of contextual information about the users. For example, they can show information like their current location, what they are doing in current moment, what song they are currently listening to, which photos they are taking, when and where, could be produced and extract. In addition to the centralized network (e.g. Wi-Fi and cellular networks), the multiple radios in mobile devices provide opportunistic networks,

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where contact is being made among mobile nodes, without complete end-to-end message routing paths. It consists of nodes where each intermediate node can be a host or a router and connect with other nodes [1]. Thus, MSNs enhance conventional social networks with additional features that are summarized by:

- **Location-awareness.** This feature means delivering information about a device's physical location to another user or application [8]. That makes the MSN applications able to provide many interesting advantages. For example, the best location of the user can be determined by gathering information from the mobile device technologies about the most visited locations. Furthermore, mapping the photos that are taken by the user with their exact location can be shown. Another interesting feature is that the user can search and find nearby people who share their interests or live nearby.

- **The ability to Interact Asynchronously.** MSNs offer asynchronous interaction by allowing the users to send many kinds of messages. Users can send to other users in the network text messages (such as SMS), multimedia messaging (MMS), email services or any other types of interaction in asynchronous manner [4]. That could be done in very suitable way for the users. They can decide to not receive messages in a specific time. In addition, many options could be serve with this service such as setting a reminder to the missed messages or receiving messages just from certain persons.

- **The Ability to Capture and Tag Media.** Capturing media from mobile devices is the ability of using contextual information to tag places and users in MSNs [4] In social networks, user can choose from suggested commonly used tags based on his current location. Also, he can tag other users automatically with his mobile device based on their proximity. For instance, in Path social network the user can tag places based on his current location, and can also take photos or change his status and tag his friends who are with him.

- **Automatic Processing of Sensed Data.** Multiple sensing modules (e.g. GPS, cameras, microphone, accelerometer, gravity sensor etc.) and other capabilities in the mobile devices allow MSN's users to share real time activities with friends and keep track of each other [8]. In addition, with mobile device contextual information, their status could be automatically updated (such as at school, at home, sleeping or busy).

- **Keeping in Touch.** The multiple radios in mobile devices allow MSNs to work over both infrastructure based networks and opportunistic networks. MSNs can use Wi-Fi, Bluetooth, cellular, or wireless mobile ad-hoc networks (MANETs) etc. This is one of the most important aspects why MSNs are far more engaging and gaining increasing momentum in communities.

C. MSN Applications

Many MSN applications are widely used nowadays, and many different applications are expected to appear in the near future. This section focuses on MSN applications in the field of their prevalence and types.

1. Some Recent Statistics. The number of social network users around the world is expected to grow from 0.97 billion in 2010 to around 2.5 billion in 2018 [3]. In other words, it is expected that around a third of Earth's entire population will use social networks by 2018[3]. In fact, we cannot overlook the role of the proliferation of mobile devices in the increased usage of social networks. For instance, according to Facebook (2015), there are 1.04 billion daily active users on average for December 2015, and 934 million of them are mobile daily active users [5]. With such a large turnout on the mobile social networks, rivalry has become very intense among application develop companies. Thus, many applications have been produced in the last few years. Nevertheless, some MSN applications are more popular than others. Many statistics are published annually to monitor changes that may occur in the number of users of some popular applications. Globally, Facebook is number one of social networks, with almost 1.6 billion monthly active users around the world as of January 2016 [3]. Furthermore, other studies show that, in the United States, in 2014, the second ranked social network after Facebook was Instagram based on usage [6]. The other most famous mobile social networks LinkedIn, Snapchat, Pinterest, Tumblr, Vine, Twitter, Kakaotalk while the most popular mobile chat applications are Whatsapp, WeChat and LINE [3].

2. Classifications of MSN Applications. The recent research papers propose various classifications of MSN applications. The most popular and most appropriate classifications from the literature are listed below.

A. Uses

Applications are usually designed for specific application domain. Thus, some research papers classify MSN applications based on their purposes/use. Some classes and examples are shown in Table 1. The weakness of this classification system is that, it is kind of loose and some applications may be included under more than one category as they may have more than one purpose. However, this way of catego-

rizing might be used on the app stores (or app marketplace) in many systems (i.e. videos, health, weather, social, games, etc.)

B. Device Discovery

According to Pietilainen (2010), the MSN applications have three classes:

Proximity Sensing Based Applications. This class contains the applications that use geo-proximity as the main filter in determining who is discoverable on the social network. Some of these applications use Bluetooth to discover the devices nearby. That enables users to meet new people and interact with them. Most of the dating applications are proximity sensing based applications. This kind of applications differs from check- in based applications (some papers call this location-based applications), which is the second class.

Check-in-Based Applications. This is mostly based on the geo-community structure of MSNs. The users inform the system of their current location. In these types of applications, the mobile devices are just to update and consume information presented by the service since the data and logic are on the centralized servers. Foursquare application is an example of this class.

Participatory Sensing Applications. Basically, in these systems, mobile devices cooperate to gather sensor data (camera, GPS, accelerometer, microphone, gravity sensors, etc.) stored on central servers. The servers provide reports of the data via a web- based interface.

C. Pure and Hybrid

At the beginning of social networks, they could only be accessed through websites. Then, with the increasing spread of mobile devices, it has become necessary to develop mobile device applications. Thus, hybrid (online and mobile) co munities have emerged allowing users to access social networks through both websites or by their mobile devices. Many hybrid applications were first designed and developed as web-based, and then extended to mobile platforms. For instance, Facebook started out as web-based and then extended to be accessed through mobile browsers and applications. On the other hand, purely mobile systems initially have been designed for mobile devices. Path is one of those MSNs. It is also worth mentioning that some networks, were initially mobile platform and then developed to web-based such as Instagram. The majority of the research papers adopt this classification. In fact it is elaborate and simple, however, it does not pay attention to other factors, like how the application works or what is the purpose of it, in any consideration.

3. Where, Who, and What. Hu et al. (2015) proposed another classifications of MSN applications as: where, who and what [8]. These three classes are defined below:

Where. The MSN applications make responses depending on location changes. Foursquare is an example of such an application.

Who. The MSN applications make responses depending on the changes of objects' proximities. The responsibility of collecting and processing information collected from individual users is on the central server, so as to hand out proximity results to the user's' social groups as needed.

What. The MSN applications make responses depending on the area of applications. Usually the applications have specific objectives such as entertainment, education, etc. However, this division is not accurate because it would be a repetition of some of the applications into more than one class.

Area class	Examples
Health Care	LactMed, REMM
Educational	Blackboard Mobile Learn, iTeach, ClassDoJo
Cloud Storage & File Sharing	Evernote, Dropbox
Social interaction	Facebook, MySpace, Twitter, LinkedIn
Multimedia Sharing	YouTube, Vimeo
Information & Recommendation	Yelp, Flixster

Table 1. Classifying MSN applications according to their uses

Mobile Social Networks Architectures

Architecture Types. Three major types of architectures can be identified in this context to serve different data exchange, sharing, and delivery approaches. This section is the identification and discussion of these three different MSN architectures: centralized, peer-to-peer and hybrid.

A. Centralized architecture. In centralized architectures,

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clients or users can access multiple services by connecting to the server via the Internet. The content from the content provider is delivered to the mobile users via the server. Also, any user's updating or sharing of content with other users in the MSN occur via the centralized server. Therefore, this MSN architecture consists of three major components, i.e., server side/content provider, client side/mobile user and network infrastructure. Such architecture is the most widely used in MSN.

B. Peer-to-Peer Architecture. Peer-to-peer (P2P) architecture, or what some papers call decentralized architecture, depends on opportunistic network connections, in which the users are able to exchange information by using wireless technologies such as Bluetooth or Wi-Fi. Without connecting to a centralized server, users share data among each other as long as every user carries wireless technologies, and the appropriate software on their mobile devices. In an opportunistic network, for most of the time, there is no complete path from source to destination, which may cause one of the shortcomings of this architecture as what will be discussed in the comparisons section.

C. Hybrid architecture. Hybrid architecture integrates centralized and peer-to-peer architectures in a form that combines the traditional architecture and opportunistic networks architecture. In other words, in such architecture, users can contact each other with or without infrastructure. So, the usefulness is manifested in that the users can contact the content provider by a centralized network structure if it is available or, if not, they still can contact each other. Not only can news, weather, or social media be collected from the Internet, but also messages, photos, and videos can be shared through opportunistic networks among mobile devices.

Comparisons

The main advantages of using servers providing most of the MSN services via the Internet are: reducing the processing operations and hardware requirements in mobile devices; simplicity in implementation; and efficiency in control. However, this architecture requires high stability and reliability in servers. In addition, one of the main issues is that in some conditions, the servers have traffic overloads. In decentralized architecture, data could be shared between direct neighbors or by multi-hop communications in opportunistic networks or MANET. Usually, as we mentioned above, in opportunistic networks there is no complete path from source to destination. Therefore, routing between intermediate nodes is the main challenge. Another concern is that the routing between nodes consumes resources such as energy and storage. In addition, in such architecture, systems should be able to deal with intermittent connectivity and expect content distribution and some delays. In this architecture and the hybrid one, if the traditional communication network is not available in some special cases, such as disaster cases, services can be provided over opportunistic networks between users. Furthermore, between direct neighbors, short-range communications such as Wi-Fi Direct and Bluetooth could be used and that would help to reduce cost and overloads over the wide-area network infrastructures. In hybrid architecture, the issue in transferring data is the network selection from centralized to distributed or vice versa [1]. Otherwise, with the integration of the traditional centralized network and decentralized network, features and services of both architectures could be gained, and many issues could be avoided. Therefore, future MSNs will tend to have hybrid architecture.

Solutions for MSNs

Recently, many researchers have focused their efforts in developing solutions supporting MSNs such as new languages, new frameworks or middleware. Some of their main aims are to support application development, and opportunistic social connection allowing MSN applications to work in decentralized and centralized architectures. In literature, there are Middleware for Mobile Social Networking (MMSN) that provide an Application Programming Interface (API) that helps developers to access social context information (such as a user's' location) and build new social applications. Furthermore, some MMSN provides a caching mechanism to increase scalability and availability in decentralized and hybrid architecture where opportunistic contacts may have the issue of many simultaneous user requests. So, the caching mechanism helps to guarantee smooth delivery of the data and many requests can be served. These solutions are supporting MSNs architectures in various ways. The motivation of many MMSN solutions is assisting mobile distributed networks to take advantage of MANETs that function without connections the Internet. MobiClique middleware is an example of these solutions. Pietiläinen, Oliver, Varghese, Diot, and Lebrun (2009) developed this middleware for MSNs that combine social networks and opportunistic contacts with supporting ad-hoc networks. MobiClique does not depend on a central server or network infrastructure; however, it enables neighboring mobile devices to communicate directly through Bluetooth technology [9]. Furthermore, it presents an open API to allow developers to develop new services and applications based on it [9]. All these are considerable advantages, however their approach needs improvement in resource management and security. In addition, the use of Bluetooth as network technology in their work may have a negative impact on the middleware efficiency because it has very limited transmission rate. Other example, Luiz, Maria, and Admilson (2013) proposed middleware architecture for MSN and they called it My-Direct.

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My-Direct aims to use Wi-Fi Direct technology to connect between the nodes of a social network [10]. From the authors' perspective, a middleware for MSN should also pay attention to the limitations of mobile devices such as limited energy power, low memory capacity, limited processing power, and scalability. Therefore, their work's also proposed an intelligent mechanism for the management of mobile device resources to provide a reduction in power consumption. However, My-Direct should have a mechanism for privacy. Indeed, there are many similar presented MMSN architectures in the literature. It could be noted that, currently, most of these solutions are supporting P2P architecture. In particular, Bluetooth is the most used network technology, then WiFi. In addition, some are combining WIFi Dirct and Bluetooth technologies to avoid loss of connectivity. However, that MMSN should be modified to provide solutions for more than one problem. Some designs pay attention to the networking between commuters driving to provide them an opportunity to form virtual mobile communities. Recently, MMSN solutions have appeared for vehicular social networks (VSN), which is a branch of MSN to facilitate communication between commuters driving on roadways. RoadSpeak, which was provided, by Smaldone, Han, Shankar, and Iftode (2009) is the first design that introduced this idea. It proposed for vehicular mobile social networks, which aims to assist communication between users who are physically in the vicinity, but cannot be contacted directly, by voice chatting service [11]. The drawback of this model is that it completely relies on centralized servers. In addition, according to the authors, it experiences some problems in delay. For improving opportunistic networks, many new cross-layer design frameworks focus on data communication and network performance. Cross-layer design is an architectural design that allows different layers such as network and application layers to exchange information to improve the network performance. Cross-layer design optimization is a part of Cross-layer design, which uses exchange information to provide network improvement in many faces, such as opportunistic scheduling and routing. Indeed, such information exchanging could be used to optimize the design of protocols in different layers. For example, the protocols could be optimized to reduce energy consumption by using routing information in routing protocols in determining the route with the least amount of energy [12]. In the literature, there are many new advantages assisting MSNs that have been gained with the large amount of researches on cross-layer optimizations.

Challenges

With the development of mobile social networks applications, and the way they are being deployed and widely used in our daily lives, many concerns and challenges have involved MSNs. In this section, the main challenges are presented with some suggested solutions from the literature.

1. Securities and Privacy. There is a consensus among researchers that the security and privacy are the urgent challenges in MSNs. Mobile device applications can access social network information where the users permanently share their locations, preferences and other details. The current models for the exchange of this information are the main impulses why security and privacy are the major issues that remain and need to be addressed. In the design of MSN applications, designers should consider trust relations, private information leakage, and malicious behavior. [13]. Users disclose some information that is considered private information in many MSN applications, such as identities, locations, phone numbers and profiles in one way or another. Indeed, location privacy is one of the main issues. Mobile applications can easily trace users or know their daily routines and behavior. Many popular social networks provide privacy setting options, while many others are not paying these properties sufficient attention. That problem paves the way for some third parties to access users information and use it for their purposes. Profile matching protocols such as that used in FindU application is a useful solution to reduce the risk of privacy violation. The idea behind this application is to allow the users to find from a group of users whose profiles best match with their own. Thus, that would contribute to limiting the exchanged information. Also, many MSNs applications now offer a special privacy policy choice to grant more protection by blocking some other users from viewing all the personal information or part of it. To adapt mobile social application, users must have trust in other components such as the Internet Service Provider (ISP), Local Service Providers (LSP), and other users. Users provide private information to ISPs to use mobile applications maintained by the ISPs. In addition, users who use short-range wireless technology such as Wi-Fi/Bluetooth for opportunistic networking, reveal some personal information to share their social network identifiers between devices. In other forms, in MSN centralized architecture, servers have information about locations of users. Users send queries to servers by their mobile devices to find nearby users and some information about them. With all this amount of unbounded social information, trust is crucial. MSN's providers and other service providers have to offer a secure system for users' personal information privacy protection to acquire the users' confidence. The social networking information used in nodes cooperation in mobile opportunistic networks should be performed in trusted mechanisms such as trust-based filters to establish trustworthy communications over mobile opportunistic networks [14]. Furthermore, authentication and access control are highly challenging issues in security in MSNs. Thus, the need for strong authorization and access control mechanisms has become imperative. Facebook is one of the first who are interested in this aspect and provides

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sophisticated access control mechanism. Fong, Anwar and Zhao (2009) provided a formalized model of a Facebook access control mechanism. Their constructed model captures the access control paradigm of Facebook and can be instantiated into any Facebook-style MSNs, each with a recognizably access control mechanism. [15]. Even if this model needs generalization and more improvement, it is a valuable contribution in this field.

2. Data Mining. People use mobile social media for communication and networking. Actually, their vital participation in various applications' activities generates vast amounts of social media data. Mining this huge behavior data of mobile users can be used to significantly improve several aspects. For example, this information that has been obtained about social behavior could be used to improve the MSN application itself. In addition, it can provide better user experience, such as mobile search. Also, it provides many services to society such as the road traffic situation. [16] Nevertheless, big data could bring real new challenges to data mining. Data mining software needs to be able to access the data stored on the users' mobile devices in addition to the online social data. Once data has been fetched, it needs to be combined, represented, analyzed and extract meaningful patterns from it using machine learning algorithms or manually offline to be analyzed. There are some approaches in using data mining to support MSNs. First, the server uses the data collected from the mobile devices and that are in the local database to provides some data mining services. After analyzing, the result of data mining processing is sent to the mobile device. Cloud computing can play an influential role here. By recent designs, network analysis software is on the Internet, information from the social networks can be extracted directly, benefiting from the resources and power of the cloud servers in data processing operations. Data generated locally in a mobile context could be also gathered through the mobile device, combined with the online social data on the Internet and sent to a remote server to be stored into a local database. Then, by using data mining algorithms, data are analyzed to earn useful results. Another approach is performing data mining on the distributed mobile devices. Data mining software should access and analyze the data stored on the mobile devices of users. However, performing the whole data mining operations on a small device is currently a real challenge with the given computing power and poor resources. Indeed, social media mining confronts massive challenges. In addition to performing complex and large amounts of mining tasks in an efficient way, there are some other obstacles. For example, data mining software needs to mine information from different types of data from different mobile devices and online social data with preserving the privacy. Another duty is handling noise and incomplete data because the data on websites are not always available to the browsers [17].

3. Different Devices and Different Platforms. Today people use various devices to communicate and access applications and they expect a seamless experience across all their devices. However, there are certain requirements each application should have to be compatible with a certain device. For example, for the most famous platforms, the iOS platform devices have screen resolution measured differently than Android platform devices. Also, iOS devices use a virtual keyboard while some Android devices use a hard keyboard and some others have both. In addition, every platform has its own design standards that guarantee desired quality and performance. These standards include, for instance, Graphical User Interface (GUI), User Experience (UX), and the platform Software Development Kit (SDK). Therefore, MSN applications need to handle the different hardware and software platforms and different OS versions, as well as different features in each device type. However, it is clear that this is a major challenge for developers. As attempts to facilitate their work increase, there are different approaches in to the diversity in mobile application platforms. The easy way is the web-based approach, which allows any user with whatever smart device to access the application. By using different web tools like Cascading Style Sheets (CSS) and JavaScript, developers can make the web site in the Internet compatible with different mobile browsers. The downside of building a mobile website for a mobile application is that the mobile browser does not posses all the functionality of a desktop browser. Moreover, this approach is limited due to the poor ability of mobile browsers to access and use all device resources and features, such as the camera. The most costly approach is to create native applications for each platform. Which means, each different platform needs different environment, tools, language, compiler, and may need different developers to develop an application. On the other side, because the native application is built specially for each platform, it can achieve the highest quality, optimal performance, and full access to all the device's capabilities. The developers' dream of "write once, run anywhere" still has many hindrances. Recently, cross-platform environments have been appeared to help developers to develop their applications and reuse the code across multiple platforms. There are some approaches that could be followed in this area. In the Cross-compiler approach, a Cross- platform compiler can convert the source code to native binaries [18]. Another possible approach is Virtual Machine in which a virtual machine or interpreter executes the code at runtime [18]. However, the challenge with cross-platform tools is to make the application built by it to look like a native application when it runs on each device. Because it's not customized to each specific device, the application that's created may have poor native user interface, less performance relatively, and inferior access to all the features of its runtime environment. Many developers and application companies currently use cross- platforms to get benefits from the lower cost. In

this area, a very recent product by Facebook to support cross-platform development has been produced. It lets developers work with JavaScript but still use native interface components such as UITabBar on iOS and Drawer on Android [19]. According to Facebook (2016), as a result of using asynchronous communications between the app and the device, all operations can be completed without blocking the UI, which provides a smoother user experience.

4. Energy Constraints. Power conservation is an important aspect, which has to be taken into account for designers of applications for MSNs. Most of the power consumption in mobile devices comes from sensing devices and radio interface. Therefore, MSN applications cause much battery consumption and it is challenging to develop applications for MSN's that can reach the user's satisfaction and in the same time save the battery life. In order to contribute to this trend of research, many researchers have proposed solutions that could help in saving energy through better utilization of mobile devices resources and consumption. middleware could provide mechanisms for efficient use of energy resources. For example, As mentioned previously, My-Direct, proposed by (Luiz, Maria, & Admilson 2013) is middleware architecture for MSN which create an intelligent mechanism for the management of mobile device resources to provide a reduction in power consumption. As another example of contributions in this field, Han and Srinivasan (2012) suggested an energy efficient device discovery protocol, eDiscovery, which discovers more peers and consumes less energy [20]. This protocol performs relatively better than other protocols in the domain of consuming less energy, however, it needs to be expanded for different mobile platforms.

Opportunities and Future Research Directions

All the issues and challenges involving MSNs we previously discussed, remain to be mightily addressed and open wide doors for future research. In addition, there are many opportunities to improve the efficiency, functionality, intelligence, and ubiquity of the applications and services for MSNs, which can contribute importantly in human's lives and the future. In this section, some of trending researches with huge growth potential are debated.

1. Business and Marketing. Lately, businesses have realized that traditional communication methods are often less effective than current mobile social networking. MSNs and their techniques could contribute crucially to the development of business in many aspects especially in marketing, improving communications and social behavior analysis. Businesses can fetch direct feedback from their customers via various MSNs services since they can be a very interactive way for companies to relate to their customers. In addition, businesses can use activities and the social behavior of MSN users to understand and analyze human interactions and relationship and exploit the resulting information to improve their marketing and the experience of users. Now, this domain is a current trend in research and many commercial tools recently have been produced in marketing strategies. This tools use and analyze the data coming from MSNs such as the profiles of the users and their dynamic locations and activities. Moreover in the field of behavioral analysis and marketing, using MSNs in advertising is a new area for the large and small companies, which have started to create new departments in this. Interactive advertisements are one kind of advertisement in MSNs that ask users for involvement and feedback in a direct and easy way. On the other hand, viral marketing such as Native ads has taken an essential role in the marketing works of many companies. The idea is that a product advertisement is directed to a particular persons who the company thinks, depending on their profiles, locations or other information, they may be interested in this product. It may pass also to the persons who are famous or have an important social position on the social networks so this advertisement would probably be passed to the largest possible number of people. Often, these advertisements are shown in a way to be like regular content in the MSNs service.

2. Human-Computer Interaction (HCI). Human-Computer Interaction (HCI) is the study of the interaction between people and computers [21]. Since mobile devices are becoming increasingly popular, and may comparatively replace the desktop computers as the hardware for HCI, they are also coming in the scope of research on HCI [22]. Therefore, mobile interaction is a branch of HCI, which aims to understand the requirements and needs of mobile users. Such interaction is at most done at the user interface. Thus for Software Engineering and Design aspects, providing software tools to develop the interfaces that users need to interact with is one of the major concerns. Due to the limited screen size in mobile devices, this is a crucial area of mobile HCI research to guarantee efficiently presented information. Now and in the near future, voice, virtual reality (VR) and wearables (such as Apple watch) are new types of interactions that are on spreading. Having these new technologies as interfaces in mobile devices makes huge shifts emerge in HCI. Therefore, it is extremely important for UI and UX designers and application developers to become familiar with all these amazing technologies and stay relevant with HCI's new directions.

In addition to mobile HCI research about the mobile device itself, researchers must take into account the larger social and contextual factors surrounding mobile device use. With the growing influence of the social networking via mobile devices, people are not just interacting with devices; they are interacting with other people through mobile devices. A lot of research nowadays aims to supporting collective activity and all relative tools and applications to analyze groups or organizations goals, behavior and how they use technologies to support their goals. This area of HCI, called social computing, now is one of the most rapidly developing. Social computing refers to the support of social behavior through computational systems [23]. It is a field of HCI that has emerged from the intersection of social science, computer science, and design. Social computing overlaps with other research areas connected with HCI, such as Computer-Supported Cooperative Work (CSCW), computational social science, social informatics, and crowdsourcing. To conclude, HCI is one of the key trends in the research on MSNs.

3. Mobile Cloud Computing (MCC)

Mobile Cloud Computing (MCC) is a combination of mobile computing, cloud computing and mobile Internet [24]. MCC is a new model where both the data storage and the data processing happen outside of the mobile device, in a centralized computing platforms located on the clouds. Mobile users can send requests through the internet to access these platforms. In general, cloud computing architecture consists of three layers: the lowest layer, Infrastructure as a Service (IAAS) layer, which is contains physical devices and hardware such as servers and storage. The second layer is Platform as a Service (PaaS) that has a parallel programming environment, distributed storage, management system, and distributed file systems. Software as a Service (SaaS) is the end user layer, which provides the user software and applications. Social contents and web services that are linking to the cloud can leverage in this parallel and distributed computing techniques. Thus, in our scope, MSNs could take advantage of a cloud computing platform in the improvement of data storage capacity and processing power, improvement of synchronization of data, universal accessibility, improvement of reliability and scalability, and deployment of social services of MSNs

7. Related Works

Several surveys on MSNs can be found in the literature. Each focuses on some aspects. In the field of MSN software systems, a survey by Olive (2008) is about platforms for mobile networks research [25]. This survey paper discusses the desirable characteristics of mobile platforms necessary for mobile network research and assesses some popular mobile platforms. In the MSN network architecture domain, Karam and Mohammed (2012) presented a survey on middleware platforms for MSN which cover the main middleware challenges for MSN, the state of the art middleware platforms for MSN and discuss their advantages and disadvantages; and conduct an exhaustive comparative study of these middleware platforms [27]. In addition, a valuable survey of context data distribution for mobile ubiquitous systems has provided by Bellavista (2012) [28]. It proposes a unified architectural model for context data distribution, an overall comparison of infrastructures for context data distribution and the main issues and future research in the field [28]. Furthermore, Wang, Vasilakos, Jin, and Ma, (2013) have an appreciated survey on Mobile Social Networking in Proximity (MSNP) [2]. They provide a complete definition of MSNP, and opportunistically nodes network and geo-proximity as a filter in MSNP. Their paper also proposes a networking technologies and platform independent architecture for developing MSNP applications based on WiFi direct. [2]. It could be said that there is a lack of surveys addressing the MSN subject in an overall perspective. However, there are some few comprehensive surveys, which are covers MSN topic in a holistic manner relatively, such as what Kayastha, Niyato, Wang, and Hossain (2013) have written. Their paper presents a comprehensive survey on the MSN specifically from the perspectives of applications, network architectures, and protocol design challenges [1]. Hu et al. (2015) also propose a useful comprehensive survey

Conclusion

In the last few years, the increasing of MSNs has become a vital link between social sciences and mobile technologies. MSN services are being widely produced, deployed and used which would change the way people communicate and exchange data. The properties of the mobile device add to the MSNs many unique features that have been discussed in this paper. Thus, with using various mobile devices technologies, new applications with new services and diverse purposes have evolved rapidly. The Classification of MSN applications have been provided in this paper based on many papers' perspectives. In addition, overall architectural approaches of MSN over mobile networks, a brief comparison between them, and present related designs have been discussed. However, there are issues that taint the advantages of the MSN services and cause concern to researchers who are interested in this area. Therefore, the major issues and challenges, which still have to be further studied, also have been explored in this paper. Finally, this paper presents the actual opportunities and future research directions that can help improve the efficiency and intelligence of MSNs services to enjoy our lives more and more.

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