ISBN: 978-989-8533-20-3 © 2013 IADIS

A MIDDLEWARE ARCHITECTURE FOR MOBILE SOCIAL NETWORK INDEPENDENT OF ACCESS INFRASTRUCTURE

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ABSTRACT

In recent years, middleware for mobile social network has attracted the attention of academia, causing the design and development of various approaches by researchers. This type of middleware facilitates and makes more efficient the development process of mobile social networking applications. Furthermore, middleware solutions also abstract the communication process with others applications, allowing the acquisition, persistence and reuse of social context information and location of users, besides providing API so that developers can access this information quickly and build new social applications. With a view to supporting this new trend of research, in this paper we propose a middleware architecture for mobile social networking called My-Direct which will make use of Wi-Fi Direct as a solution to improve the connectivity between the nodes of the social network. Along with My-Direct also will be created a mechanism for user privacy, since the mobile device should allow social activities only among friends.

KEYWORDS

Social Network, Mobile Social Network, Middleware, Mobile Devices, Wi-Fi Direct.

1. INTRODUCTION

The growing interest in social networks and smartphones has resulted in a new trend called MSN (Mobile Social Network). The goal of these social networks is to contribute to human interactions, allowing users who are socially related to use their mobile devices to perform activities of common interest (Nyugen, 2010).

In recent years, the introduction of a middleware on the development of MSN has attracted the attention of academia, leading the design and development of various approaches of researchers. In Karam and Mohamed (2012) it is possible to find some of these solutions, already in Holanda et al. (2012) describe a solution developed by brazilian researchers.

Middleware for MSN (MMSN) should consider the limitations of mobile devices such as limited power, low memory capacity, limited processing power, scalability and heterogeneity (Gupta et al., 2009). Furthermore, MMSN should provide a layer that provides common services needed by different MSN applications and separate social network management concerns from application requirements (Bottazzi et al., 2007). The middleware should enable efficient operations of MSN application by being self-configuring, self-adapting, self-optimizing and self-protecting.

Being middleware for MSN a topic of recent research, many of the problems mentioned above don't yet have an ideal solution. Thus, current middleware solutions are incomplete, and doesn't exist middleware infrastructure that solves all problems (Karam and Mohamed, 2012).

In order to contribute to this new trend of research, in this paper we propose a middleware architecture for MSN called My-Direct that will make use of Wi-Fi Direct (Wi-Fi Alliance, 2010) as a solution to improve the connectivity between the nodes of social network. This work also aims to create a mechanism for user privacy, since the mobile device should allow only social activities among friends.

2. REQUIREMENTS FOR A MIDDLEWARE FOR MSN

The introduction of a middleware facilitates and makes more efficient MSN application development process. Furthermore, the middleware also eases access to data, so that heterogeneous applications have access to them. However, developing a middleware layer for mobile social applications is not an easy task, because it presents a number of issues and challenges that need to be taken into consideration, which, according to Karam and Mohamed (2012), are as follows:

- **Simplifying the development process:** A MMSN should be responsible for simplifying the process of developing an application MSN. The simplification of this process can be obtained by providing high-level abstractions with lightweight interfaces to mobile application developers. Facilitate application integration and reuse must also be functions of the middleware.
- **Energy Efficiency:** A MMSN should provide mechanisms to efficiently use the resources of the battery and ensure that the application performs well on mobile devices with limited resources.
- **Privacy:** A MMSN should provide a simple technique that consumes fewer resources to implement appropriate control policies on the exchange of social data, to ensure user privacy.
- **Scalability:** MSN applications suffer increased number of users constantly. This number of nodes should not affect application performance. Thus, a MMSN must be flexible, so that it can manage the increasing number of nodes without compromising system performance.
- **Fully distributed architecture:** A MMSN should be designed to be fully distributed without centralized control. Specifically, it should be built to be used in ad hoc networks without assuming centralized servers.
- **Heterogeneity and dynamic nature of mobile devices:** A MMSN should be designed in a fully distributed, considering the heterogeneous and dynamic nature of mobile devices, as well as privacy concerns. A MMSN should hide the heterogeneity of applications and allow adaptation to dynamic environments.

3. THE MIDDLEWARE ARCHITECTURE MY-DIRECT

The construction of mobile social networks is a complex task. The introduction of middleware in the field of mobile social networking aims to facilitate the development of this type of network by providing features that help developers manage the users, the maintenance of social relationships between users, in data privacy and social communication between network devices.

With the emergence of new technologies for communication between devices such as Wi-Fi Direct, becomes interesting introduction and evaluation of these new solutions in the middleware environment for MSN.

Thus, this work aims to develop the My-Direct, a middleware for MSN that will make use of Wi-Fi Direct, aiming to bring independence of access infrastructure and improvements in the coverage of the social network and in the transmission rate of data between nodes.

The Wi-Fi Direct specification was developed by the Wi-Fi Alliance and operates in 802.11 devices, but is not linked to any specific standard 802.11. This specification introduces the ability to direct connection to millions of devices already have Wi-Fi deployed (WI-FI Alliance, 2010).

According to Wi-Fi Alliance (2010), the introduction of Wi-Fi Direct devices extends the Wi-Fi in order to provide a new connectivity experience. This technology increases the portability of content and applications across all devices of the user through a single and common specification, allowing users to access movies, music and photos point-to-point.

The Wi-Fi Direct is also based on the strengths of Wi-Fi such as performance, security, ease of use and ubiquity, and it adds features such as no need for access to a network infrastructure (Wi-Fi Alliance, 2010). Instead of first connect to a network infrastructure and then connect to another device on the network, users can connect directly to devices that offer the services they need. This allows, for example, a user show the photos on your smartphone to your friends by connecting to a television and viewing the images, regardless of the presence of a network infrastructure that is available for both devices.The My-Direct despite having already specified, its architecture is still in the initial stage of implementation. In this section, we will only describe its layers and main features and leave to display the completion of coding on another occasion.

3.1 Architecture

The middleware My-Direct will be implemented in a P2P architecture targeted the Android platform. The fact that it targeted the Android platform implies the choice of a minimum version of operating system support. For this, we chose to develop the My-Direct to version 4.0 of Android, since the manipulation of resources and support Wi-Fi Direct are present in their SDK (Software Development Kit).

The Figure 1 shows the My-Direct architecture. Here, we can see that the architecture is composed of four layers: (i) interface, where will stay the set of classes responsible for building the GUI (Graphic User Interface), (ii) communication, where it will be located the API that will assist in linking devices, (iii) privacy, that will serve to identify users and verify their degree of friendship and (iv) modules, which will serve to extend the middleware.

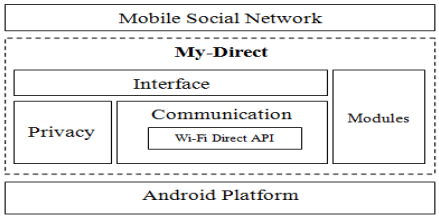

Figure 1. The My-Direct architecture.

3.1.1 Interface Layer

As mentioned earlier, the My-Direct will run on the Android platform. This implies that all classes of the interface will have to follow the pattern of this platform. Thus, the interface layer will contain the implementation of classes that extend the Activity class of the Android SDK. These classes will be responsible for the interaction between the user and My-Direct. Thus, all functions of the My-Direct will be available on the screen and the user only has to select one of them and see the result.

It is important to remember that in the Android platform the design of classes is defined in XML (eXtensible Markup Language). These XML also serves to construct menus, the definition of strings and assigning images to display an Android application. Therefore, in the My-Direct interface layer will be stored implementations of the GUI classes and their respective XML.

3.1.2 Communication Layer

The communication layer consists of the classes responsible for the association and effective communication between devices. To perform these actions, classes of this layer will make use of Wi-Fi Direct API, which is provided by the Android SDK. This layer will possess key features like detection of mobile devices with Wi-Fi Direct, the association between them, extracting information (name, IP and MAC) of these devices and effective data exchange.

When occurs the proximity between two devices, the communication layer will check if they are with Wi-Fi Direct enabled. If so, will allow the devices to perform the association and begin the process of information exchange. This whole process will be controlled and monitored by users via interface layer.

3.1.3 Privacy Layer

There are several works in the literature such as Castelli et al. (2012) and Endler et al. (2011) that address the issue of how to infer social relationships in mobile environment. In the case of My-Direct, the independence with respect to the access infrastructure does not allow access to online social networks for information extraction, for example. Thus, it would be wiser to evaluate the affinity between users through information already contained in the mobile device. For this, we chose to identify users using a tuple containing the MAC address of the device, the name that identifies the device during connection and the bond between users. The schema of the tuple can be seen below:

(*MAC, DEVICE NAME, BOND*)

The MAC address was chosen because it is a unique identifier, which will avoid repetition of information associated with a particular mobile device. As the MAC address is not simple information to the user decorating, we also chose to store and use it along with the device name as information to be displayed on the screen of middleware.

The bond is nothing more than the degree of affinity between two individuals. It works the same way as the concept of circles used in the social network Google Plus (http://plus.google.com). We decided to use this trick because we noticed that the middleware solutions for MSN there were no reference to a management mechanism affinity allowing the user to classify a person according to the degree of affinity. Thus, the user can specify whether a person belongs to the family circle, circle of friends, circle of colleagues or circle of acquaintances. Based on this classification, the user can, for example, share data only with individuals of a given circle.

The information contained in the tuple will be persisted on mobile device through files. The use of files justifies our choice to keep only three pieces of information, since we know the restrictions of mobile storage. It is also important to note that in the act of communication these files will not be transmitted. The data contained therein will be obtained from your own Wi-Fi Direct. Thus, with these data, the privacy mechanism determines, for example, if a device found in the neighborhood belongs to a friend of the user.

3.1.4 Modules Layer

Another goal of My-Direct is to facilitate the development of MSN. For this, the layer modules can be used by developers to introduce new features to the My-Direct. This will allow developers to create different types of MSN.

3.2 Example of Use

When the My-Direct is ready, developers will be able to build social P2P applications such as chat and photo sharing, in addition to can extend it through modules. Thus, in a simple chat application developed with My-Direct, for example, the user will be able to use the GUI (interface layer) to see your list of partners, the bond with them, and which theirs is available to connect. If some partner has not yet been classified, the user will have the option to add the bond (privacy layer). When choosing the partner, the communication layer, through Wi-Fi Direct, will go to associate the mobile devices of users. Thereafter, the chat can be performed.

4. RELATED WORKS

Although middleware for MSN is a new area of study, there are several works in order to resolve issues related to this topic. Each approached the problem from a point of view, however, some of them has similar characteristics.

In Karam and Mohamed (2012) it is possible to find some of these solutions. Among them, the most common type of architecture is P2P as in Kern et al. (2006), Bottazzi et al. (2007) and Kalofonos et al. (2008), but there are also those that use centralized architecture as Gupta et al. (2009) or hybrid as Kalofonos and Antoniou (2008). With regard to network technology used for communication between nodes, the most cited is the Bluetooth. However, there are also works that make use of Wi-Fi.

In mobile environment the user wants to access information anytime and anywhere. Thus, the construction of middleware with a centralized architecture like Gupta et al. (2009) is not appropriate. The best option for middleware architecture aimed at mobile environment is P2P (Karam and Mohamed, 2012), where there is not centralized control and communication is done directly between devices.

The decentralized architecture requires network technologies that support interaction P2P. Most of the aforementioned studies, with the exception of Gupta et al. (2009), make use of Bluetooth for communication between nodes of mobile social networking. However, the use of Bluetooth requires that the devices are relatively close so that the communication occurs. Furthermore, transmission rate of this technology is limited, which influences the performance of the middleware.

Middlewares for MSN also deal with sensitive data such as social relationships, activities and user preferences, which can be used to infer other confidential information about the user over time. Thus, as in Kalofonos et al. (2008), Basuga et al. (2009), Kalofonos and Antoniou (2008) and Holanda et al. (2012), a middleware for MSN must manage user data and have adequate control policies on the exchange of such information to ensure the privacy of users. However, none of these works allows the user to have the option to sort the people with whom he wants to relate according to the degree of affinity.

From the analysis of these works, we can see that the mobile environment requires a decentralized architecture. Therefore, to connect network nodes is needed to use a type of wireless network, independent of central infrastructure, which enables a fast and efficient communication between nodes in the social network. Furthermore, it becomes clear also that a user may want to classify one or more persons that relates to him differently, as a friend or coworker, for example.

Therefore, to correct these deficiencies, this paper proposes the My-Direct, a middleware architecture for MSN that will make use of Wi-Fi Direct as network solution for the relationship between us and a privacy mechanism that will allow the user to sort their peers according to the degree of affinity.

5. CONCLUSION

The middleware solutions in the literature show that there isn't an approach which satisfies all the requirements that the development of a MSN requires. Furthermore, within this set of approaches each author tries to solve one or more problems, present in a mobile social network environment, using various techniques, methods and tools. Given this middleware solutions heterogeneity, this paper proposed a new architecture called My-Direct. This solution aims to bring new resources to the area middleware for MSN as the introduction of the use of Wi-Fi Direct for P2P communication between mobile devices and a privacy mechanism that will help users to establish social relationships with people of interest.

At the end of the design and implementation of the My-Direct, we plan to provide a tool to assist developers in the process of building social networks P2P.

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