

Architectural Model for Wireless Peer-to-Peer (WP2P) File Sharing for Ubiquitous Mobile Devices

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Abstract—This paper presents an architectural model for Wireless Peer-to-Peer (WP2P) file sharing system for ubiquitous mobile devices. File sharing is one of the rationales for computer networks with increasing demand for file sharing applications and technologies in small and large enterprise networks and on the Internet. With the popularity of mobile phones in day-to-day activities, P2P file sharing in mobile phones is highly desirable, especially in 2/2.5G mobile networks. The proposed model is based on a hybrid or semi centralized architecture with the central database server acting as an interface between the mobile devices. The P2P communication model employs the Short Messaging Service (SMS) and Multimedia Messaging Service (MMS) as the messaging medium. The mobile phone initiates a search for a particular file on the mobile P2P network using a General Packet Radio Service (GPRS) connection. The database replies the “searcher” mobile phone with a list of all the available files and the details of the mobile phones that have them. Using this information, the requesting mobile phone makes a SMS connection to any of the phones provided by the database server. The mobile phone with the file then sends it to the requesting mobile phone using the MMS. We present an architectural model using mobile proxy, SMS and MMS, for a mobile P2P network for 2/2.5G networks despite operator constraints.

Index Terms— File sharing, mobile P2P, mobile phone, mobile proxy

I. INTRODUCTION

PEER-TO-PEER (P2P) FILE SHARING is relatively new in the growing list of mobile-based technologies, making it the focus of interest in the world of information technology in the last couple of years. In a P2P networking model, each of the computers on the network could act as both servers and clients thus distributing the network load and overhead across all the devices on the network, forming a network of

individual peers with ability to search the network for shared resources. The characteristics of P2P architecture, such as reliability, easy one-to-one communication, and extensible distribution of resources, make it one of the most suitable networking technologies for mobile system [1] – [3].

In the past, mobile devices were just cell-phones that had conversation and message functions, but the gradual process of time led to smart phones, Personal Digital Assistant (PDA), lap-tops etc. Nowadays, anyone can have these mobile devices for business or amusement [4]. The P2P network has emerged as an efficient system, being typically used for sharing content files containing audio, video, data or any digital-format files and distributing services over fixed networks. After the introduction of Napster in 1999, the popularity of P2P networks has been increasing among the internet communities. Recently, P2P applications are considered to be generating most of the internet traffic [5].

In recent times, mobile phones are one of the most popular communications tools in use. With their increasing popularity as a necessity in day to day activities, bringing P2P file sharing to mobile phones is the next big challenge in peer-to-peer networking. This is in recognition of the fact that these phones have limited processing power, limited memory capacity, intermittent connectivity to the Internet, limited screen and keyboard size and operator constraints [6]. Recently, the P2P technology has extended its scope to address relevant problems of mobile systems in cellular networks, which has attracted very little interest in the academia.

In this paper we considered P2P applications in cellular networks, in particular (2/2.5G) networks given their inherent constraint. This paper thus presents an architectural model for a file sharing system for use on mobile devices – a mobile P2P network. Furthermore, the paper also considered the best way to trim down the generic P2P file sharing on the Internet for mobile phones, especially (2/2.5G) Global System for Mobile Communications (GSM) networks that have their own inherent constraints. Figure 1 shows the generic P2P network on the Internet that allows participating computers to act as

both servers and clients for file sharing, while figure 2 shows the virtual representation of a mobile P2P network described in this paper. The most important characteristics that make P2P file sharing attractive to large scale content distribution, especially in mobile networks are efficient bandwidth utilization, scalability and adaptability, reliability and cost effectiveness. The focus of this work is on 2/2.5G systems. 3G+ systems operate on IP-based networks and would pretty much overcome the limitations of GPRS in this regard.

The rest of the paper is organized as follows. In section II we examine related work and in section III we discuss our methodology. In section IV we present the system design and finally, the paper concludes in section V.

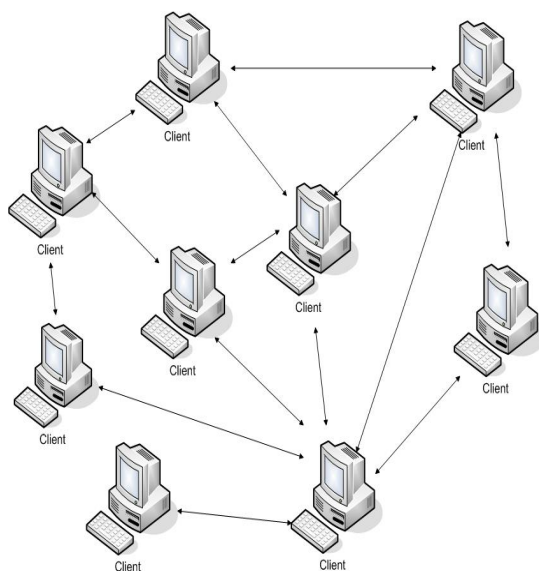


Fig. 1: A Generic P2P Network on the Internet

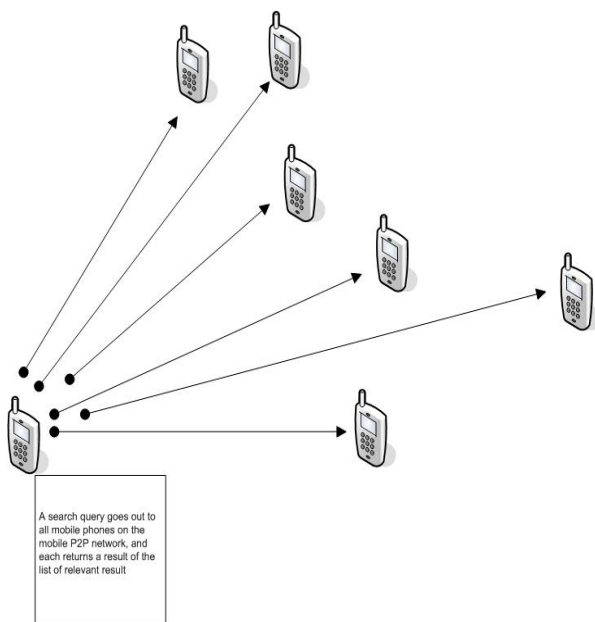


Fig. 2: A Virtual Mobile P2P Network

II. RELATED WORK

As the mobile environment brings new challenges to P2P networking, mobile P2P must offer appropriate techniques for coping with them. There are three main traditional P2P architectures for mobile P2P networks: centralized P2P, decentralized P2P and hybrid or semi-centralized P2P [5], [6]. The centralized P2P architectures consisted of peers and a dedicated server or several central index servers to control the whole network and maintain an index of the connected peers and their resources. The decentralized P2P architecture lacks central servers or entities to control the network; every peer in this architecture has equal functionality. All information, including meta information is maintained by peers, peer discovery and query delivery functions are distributed among peers. The hybrid P2P architecture is a mixture of centralized and decentralized architecture, combining the efficiency and resilience of both architectures.

Some studies use the Session Initiation Protocol (SIP) as the underlying signaling protocol for mobile peer-to-peer [5], [7], [8]. SIP is an application-layer control protocol that allows a host attached to a network to establish, modify, and terminate multimedia sessions such as Internet telephony, Internet conferencing, event notification and instant messaging. SIP is signaling protocol and does not provide any mechanism for the actual transport of information between peers; once the resources are located the transfer is established directly between peers. The basic SIP is only responsible for the session management between the peers. If other functionalities are to be provided, then SIP needs to be modified by adding new extensions to SIP or by adding new header fields to SIP messages [8]. These modifications will only support basic functionalities of P2P file sharing application on mobile phone. In the future, we will design new mechanism and add more header fields to support extra features, like friend list, black list, download priority, file segmentation and multiple downloading, etc. [8]. Similarly, a study in [6] described a novel Plug-and-Play Application Platform (PnPAP) to enable dynamic selection between diverse P2P and session management while preserving the best network connectivity through Holistic Connectivity (HCon). The concept enables flexible and seamless communications for mobile devices in P2P network. However, there is the need for an additional Protocol, the State Machine (SM) to coordinate PnPAP and HCon. This overhead could affect performance especially if the only available connection is slow, e.g. GPRS [6]. Similarly, PnPAP is meant to be running all the time that the mobile device is on, this again set challenging requirement for optimizing the consumption of memory and CPU power.

III. METHODOLOGY

The mobile P2P file sharing proposed in this paper lies within the context of a Second Generation (2/2.5G) GSM mobile network. There are constraints in trying to replicate a generic Internet P2P application for a mobile phone network. These constraints revolve around the issue of operators preventing mobile terminals from acting as independent terminals with an IP address [9]. Operators also control data traffic including ports suitable for them; most times too, the 3G mobile network does not offer any way to sustain active GPRS

connection. In some other networks, voice and data can not be transferred simultaneously [10].

With these constraints in mind and coupled with the limited resources of mobile phones, it would be difficult or impractical to build the virtual mobile P2P network as shown in figure 2 where phones connect to phones directly to share files. An alternative way to physically represent the mobile P2P network is to find a way around these constraints. Hence, this work developed a mobile P2P network by introducing a web server to act as a mobile proxy. An architecture that is a variant of the hybrid or semi centralized architecture will be used because previous authors have acknowledged it as a good alternative for efficient and scalable mobile P2P application. The server hosts a database that keeps meta information of files and phones that have them. As the file sharing component, the Short and Multimedia messaging service, SMS and MMS were adopted.

A. Network Architecture

Our proposed architecture is based on the generic P2P network after careful analysis of the needs of mobile P2P file sharing application on mobile phones for the following reasons:

1) Reliability of Mobile Networks

Mobile network is expected to be more reliable than wireless network or the Internet, since mobile services are required to be available 24 hours a day.

2) Limited Resources

Mobile phones have limited battery life, insufficient processing power, limited storage capacity, limited screen size and keyboard.

3) Operators Constraints

Most operators prevent mobile terminals from acting as independent terminal with Internet Protocol (IP) addresses and also control data traffic and ports used by these mobile devices.

B. Application Architecture

The applications consist of the client application and the server application. The client application is made up of three modules namely: User interface, message handler and file download. The message handler is responsible for registering, processing HTTP request/response messages and interaction with central index server. The server application is responsible for registering mobile nodes and processing HTTP request/response messages.

C. Module Interactions

The mobile phone, through the developed phone application initiates a search for a particular file on the mobile P2P network. The phone connects to the web and database server using GPRS connection. The database replies the 'searcher' mobile phone with a list of all the available files and the details of the mobile phones that have them. With this information, the requesting phone makes a SMS connection to any of the phones provided by the database server. The phone keeping the file in question will then send the file to the requesting phone using the MMS. This model is shown in figure 3.

IV. SYSTEM DESIGN

A mobile P2P application that would run on the phones participating in a mobile P2P network should take the constraints of the phone into consideration. The application should be as simple as possible requiring a minimal text input from the users. As such, the user should be required to supply the most basic information about the file to be submitted or to be searched for. The reason is obvious; mobile phones have small keypads, small screen sizes and limited memory capacity.

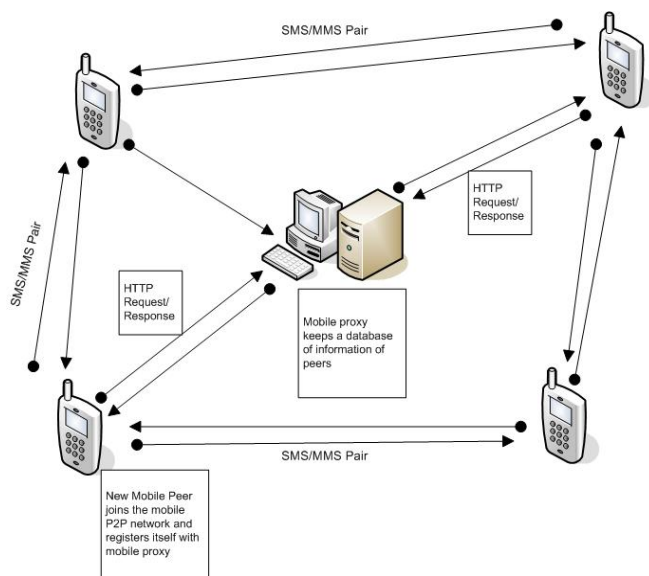


Fig. 3: Proposed Mobile P2P

A. Phone User Interface

Figure 4 shows the two main interfaces of the mobile P2P application running on the Sun wireless Mobile Toolkit Phone Emulator. The application was developed using the Java programming language for mobile devices (J2ME). Java was selected as the choice language of implementation because of its high security features and the wide spread availability of its runtime environment on modern mobile (smart) phones. Most smart phones that are manufactured today come embedded with the Java Runtime Environment (JRE).

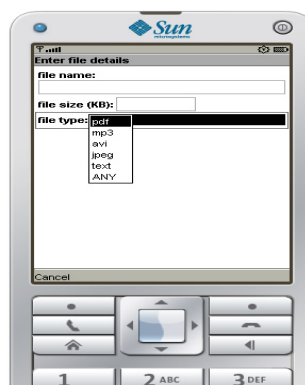


Fig. 4a: File Submission Interface

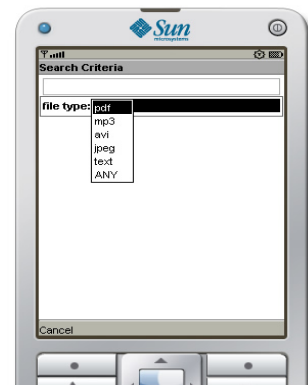
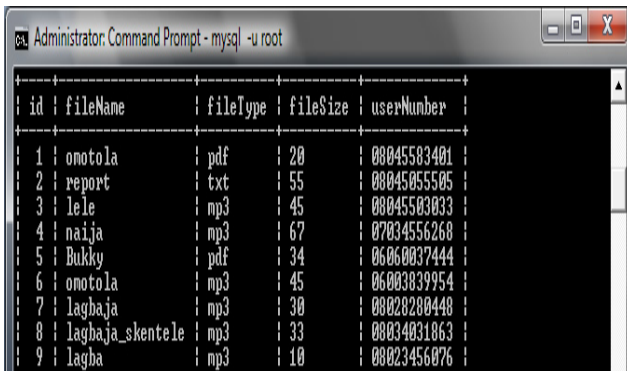


Fig. 4b: File Search Interface

B. The Database Server

This is the part of the implementation that resides on the server. These components communicate with the mobile peers using the GPRS connection of the mobile phone network provider. The server and database modules handle all data submission and data requests on the mobile P2P network. The module also handles all the high traffic jobs on the network such that the phone, with limited resources does little or no work. In essence, all bandwidth and resource demanding processes are moved away from the mobile phones onto the server what has more computing power and bandwidth. The database of choice was the MySQL database because of its lightweight and high scalability. Figure 5 shows a part of MySQL database showing details of files and phones on which they are stored.



id	fileName	fileType	fileSize	userNumber
1	omotola	pdf	20	00045583401
2	report	txt	55	00045055505
3	lele	mp3	45	00045583033
4	naija	mp3	67	07034556268
5	Bukky	pdf	34	06060037444
6	omotola	mp3	45	06003839954
7	lagbaja	mp3	30	00020200440
8	lagbaja_skenetele	mp3	33	00034031863
9	lagba	mp3	10	00023456076

Fig. 5: MYSQL Database

C. The Search Results

A user of the mobile P2P network receives a search result after having searched through the network for a particular file. Figure 6 shows the result of a file search displayed to the user.



Fig. 6: The Search Results of the Web/database Server

D. The Peering and File Sharing Module

In the final stage of the file sharing, the application depends on SMS and MMS messaging to facilitate the sharing of files among the participating phones. While an automatic request is made for a specific content through SMS, the owner of the content replies with a multimedia message containing the requested file. Figure 7 shows a representation of the final process of file sharing. After a user has received meta information from the database server, a request for the file is initiated using a background process that sends an SMS message to the owner of the file. The owner of the file receives the SMS and replies the sender of the message with a Multimedia Message containing the requested file. The file type and file size that could be sent using the MMS is dependent on phone type, capability and operators settings.

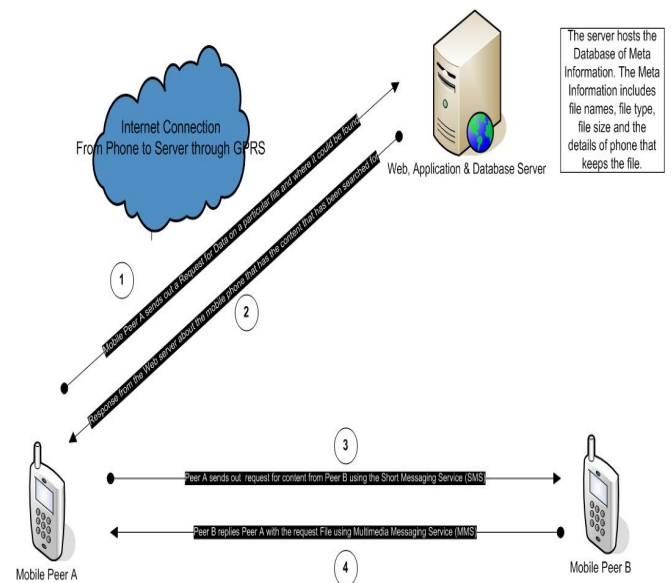


Fig. 7: The Mobile P2P Process

V. CONCLUSION

This paper presents a work that developed a P2P file sharing application for use on mobile devices that have a connection to the Internet through the GPRS network. To achieve this, the various existing P2P architectures were appraised. At the end of the review and having taken into consideration the peculiarities of mobile devices with their limited resources, the hybrid or semi centralized architecture was proposed for a feasible mobile P2P file sharing system. The focus of this paper is on 2/2.5G systems. 3G+ systems operate on IP-based networks and would pretty much overcome the limitations of GPRS in this regard.

The work has thus made it possible to create a working solution to the problem of file sharing irrespective of the location of the mobile peers. Furthermore, the work if properly optimized is a viable option for mobile file sharing in second generation (2/2.5G) mobile networks with GPRS capability. It has been shown that the major units of the system that network operators need to focus on for the success of the P2P file sharing are the GPRS connection, SMS and MMS.

Future research work on Mobile P2P would involve further designing of control mechanism for future features and to address the issue of trust, reputation, accountability, security, and interoperability with different mobile peer-to-peer networks thus creating a system that would allow different mobile P2P networks to compare databases and exchange contents.

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