

## Survey on Mobile Ad Hoc Networks (MANETs) – Evolution, Social Networking, Application Use Cases and Future Considerations

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**ABSTRACT:** The increase in the use of mobile devices has sparked a corresponding increase in the number of mobile applications particularly in the social space. In this paper, we present a concise survey of the evolution of Mobile Adhoc Networks (MANETS) considering a variety of application-specific areas and research projects. In particular, the problems faced by the application of MANETs in social space are confronted from several architectural specific domains such as the Peer2Peer (P2P), Client-Server, and Decentralized modes. Suggestions for future improvements are equally provided in this short discourse.

**KEYWORDS:** Adhoc, mobile device, networks, P2P, social network

### 1. INTRODUCTION

Mobile adhoc networks (MANETS) refer to a collection of mobile devices or gadgets but unlike mobile phones do not rely on the GSM or the UMTS systems which depend on heavy and expensive physical infrastructures (Hoebeke et al., 2006). Although these mode of data transmission has its own advantages but it becomes quite expensive and failure prone due to it centralized topology. Since no infrastructure is required, the network can be deployed spontaneously when needed anywhere. In a wired network, the topology is determined by the cables that connect the nodes to each other but In an MANET, the network is created as soon as two nodes are within each other's PAN. This means that the network is continuously reconfigured as mobile devices enters and exits each other's PANs. Also since there are no infrastructures, the mobile devices cannot fail because of a base station, which is the case in networks that rely on GSM communication. The only way a MANET can fail is if one node fails, but since the network is based on P2P communication, the network can easily be self reconfigured. The system architecture of an ad hoc network is depicted in Figure 1.

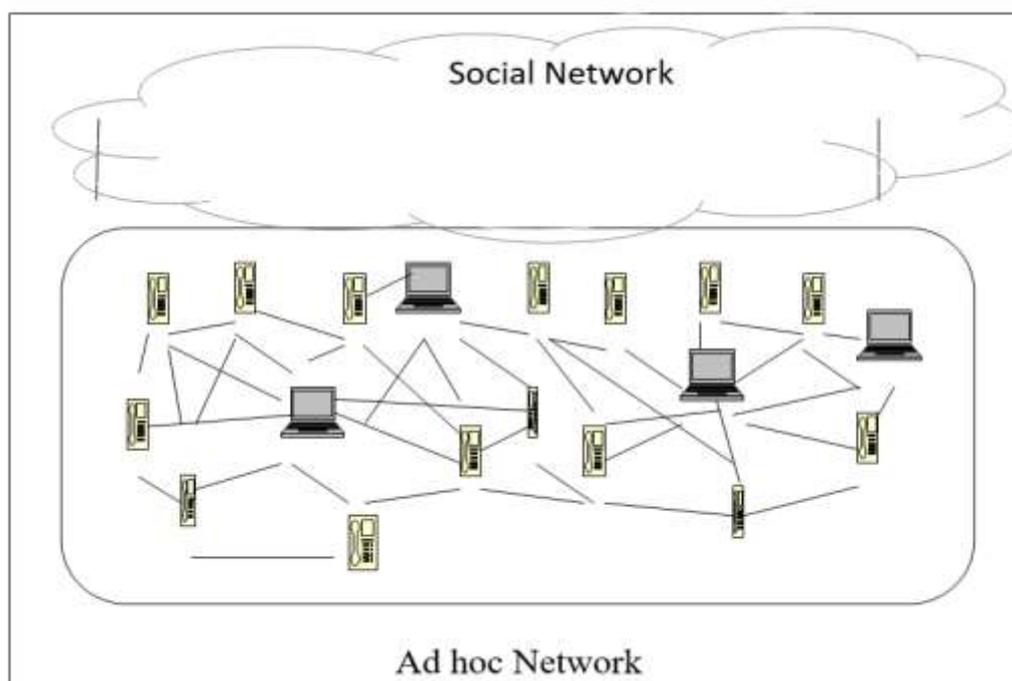


Fig.1 An ad hoc network



The network consists of two layers:

- (a) A physical ad hoc network layer and
- (b) A virtual social network layer.

Devices in the ad hoc network layer are assumed to be equipped with wireless interfaces (e.g., WiFi, Bluetooth) that must support ad hoc communication mode. Nodes in the (virtual) social network layer are connected by virtual links. Each virtual link corresponds to a communication path that may be composed of several physical hops. Nodes connected via virtual links are referred to as *friends*. Once friendship relations are established, friends can perform social operations, such as sharing resources, sending messages, and browsing profiles of each other.

In the middle 2000s, mobile social software has been given the acronym, MoSoSo (Counts & Fisher, 2008; Lugano, 2016). They are considered as the mobile equivalents of online social networks like Friendster and Facebook MySpace. They help users find old friends, or potential new ones, on the go (Terdiman, 2005). In the following section (Section 2) a summary of some previous, existing and emerging mobile Adhoc networks (MANETS) useful in social networking applications are presented. This is then followed by some futuristic research ideas to assist in the enhancement of the existing and emerging MANETS.

## 2. MOBILE ADHOC NETWORKS (MANETS): RESEARCH STUDIES AND USE CASES

### 2.1. Mobile Web Server

Historically, the Mobile Web Server (MWS) was developed by Nokia for the Symbian S60 platform (Hammershøj et al., 2009; Yu et al., 2010). It consists of a port of the Apache web server to Symbian along with a solution that provides a mobile device with a global URL and HTTP access to it. This solution is implemented to circumvent the firewalls that many mobile operator employ to prevent access from the Internet to mobile devices in their network. The solution consists of a gateway that runs on a computer on the Internet and an application that runs on the mobile device. Together with an appropriate DNS configuration they provide a mobile device with a URL in the operator networks of today. MWS enables users to set up a web server on their mobile device and access resources on this device via the Web. Its purpose was to provide new ways to publish and access information on the web. For example, a user is able to access the device's contact list, add calendar entries, and send SMS messages, etc. from a personal computer or another mobile device (Mohamed & Wijesekera, 2012). Example applications include accessing your friends and co-worker's calendars as well as mash up applications that use multiple data sources when creating mobile Web sites.

### 2.2. Kirkhus and Sveen's Research

Lars Kirkhus and Anders R. Sveen (Kirkhus & Sveen, 2003) at the Norwegian University of Science and Technology (NTNU) embarked on a study with the aim of finding out how mobile devices can be used for continues collaboration amongst users. They started with the testing of Java's new API for Bluetooth, and the JSR82 API; this gave rise to the initiation of the Peer2Me framework. Since no mobile devices were readily available as at the time, they started the test with just the use of computers and where focused basically on evaluating transfer rates and discovery time.

### 2.3. Lund and Norum Research Studies

When Kirkhus and Sveen finished their master thesis, they left NTNU leaving the Mobile Work Across Heterogeneous Projects (MOWAHS) project behind. The project was now undertaken by Carl-Henrik Wolf Lund and Michael Sars Norum as a part of their depth study after which they developed the Peer2Me framework (Lund & Norum, 2005). They also explored the domain of collaborative applications using mobile devices, and presented a set of requirements for a new improved framework focusing on network independency. Along with the actual plans of the new framework, they described technologies and theoretical principles behind peer-to-peer computing (Hestnes and Vatn, 2006).

### 2.4. Super-Peer Architecture for P2P Networks

Some major deficiencies associated with unstructured P2P networks were identified in existing frameworks such as Peer2Me. This includes: limited scalability and inefficient search mechanisms. To overcome this deficiency, an Efficient Clustered Super-Peer (ECSP) P2P model (Li & Vuong, 2004) was developed. In this model, peers are grouped into clusters according to their topological proximity. Super-peers are selected from regular peers to act as cluster leaders, responsible for locating content and maintaining the network structure for client peers. Super-peers also connect to each other, to construct a backbone overlay network.



To scale the routing on overlay networks connecting super-peer nodes, application-level broadcasting protocol, called Efa (Li & Vuong, 2004) was designed. Efa's application is not only useful to the system analyzed in the current study, but rather it is also applicable to all large, unstructured, P2P networks on the Internet. Utilizing just a small amount of topology info, Efa is almost as simple as flooding, but it can be much more efficient. To further verify the effectiveness of the mechanism, an experiment was carried out to implement and evaluate the architecture.

In summary, addressing the problem of unstructured P2P networks, the following procedure was proposed:

- A cluster based super-peer system that groups peers according to their topological proximity. The introduction of a new level of hierarchy results in greater scales of query lookup and forwarding functionality, and increases stability, scalability and performance.
- Utilization of a novel method to find the nearest neighbors, whereby we can generate networks according to topology metrics.
- Designing an efficient application level broadcasting protocol, Efa, to perform routing on the super-peer backbone network. Efa is much more efficient than flooding.
- Introducing a novel super-peer redundancy to improve reliability and to decrease the possibility of single-point failure.
- Implementing the mechanism and evaluating it, both with a real network environment and with simulation tools.

These procedures helped in improving the effectiveness of an unstructured P2P network.

## 2.5. JXTA

JXTA is short for Juxtapose that means side by side. It draws a parallel between peer-to-peer and client/server, web based computing - the two are juxtapose.

The JXTA project (Maibaum & Mundt, 2002) was started by some researchers at Sun Microsystems. Its goal is to explore a vision of distributed network computing using peer-to-peer topology, and to develop basic building blocks and services that would enable innovative applications for peer groups. It is now an open source project under the Apache Software License and has the following three objectives:

- Interoperability - across different peer-to-peer systems and communities.
- Platform independence - multiple/diverse languages, systems, and networks.
- Ubiquity - every device with a digital heartbeat.

JXTA is defined to be independent of programming languages, so that it can be implemented in C/C++, Java, Perl, and numerous other languages. The Java binding, JXTA2SE, is the most mature of these. The protocol is specified as a set of XML messages. This means heterogeneous devices with completely different software stacks can interoperate with the JXTA protocols. The Peers in a JXTA based network can advertise and discover other resources, communicate with each other via "pipes" and cooperate dynamically to form peer groups (Amron, 2017; Xhafa et al., 2010).

Many of these features resemble those of the Peer2Me framework, but there are some differences:

The Java binding of JXTA, JXTA Java-SE requires Java 2 Standard Edition (J2SE) to run. This makes it unsuited for most mobile devices on the market.

There is no support for Bluetooth as a network medium, which also makes it unsuited for mobile devices since Bluetooth is the most common means of communication on such devices.

## 2.6. JXTA-J2ME (JXME)

To overcome the limitations of JXTA, a side project called JXTA-J2ME (JXME) is started (Käppeli, 2003; Espiritu & Yu, 2006). The purpose of JXTA-J2ME is to provide JXTA compatible functionalities on devices using the Connected Limited Device Configuration (CLDC) and the Mobile Information Device Profile 2.0 (MIDP), typically a mobile phone or a PDA.

The JXME was first designed as a proxy based peer-to-peer solution, relying on a central device acting as a proxy between the peers. This prevents real peer-to-peer operated ad hoc networks. In the newest version however, this proxy is removed. The main disadvantage with both solutions is the lack of Bluetooth support.



### 3. CONCLUSIONS AND FUTURE CONSIDERATIONS

#### 3.1. P2P networks

The shared provision of distributed resources and services, decentralization and autonomy are characteristic of P2P networks (Tsai, *et al*, 2009). In a P2P network, each node can function as a client and server at the same time, that is, it can provide and consume services or resources. There is no central node for the organization of the network or the communication between the peers in the network; thus, communication between peers takes place directly. There are two main types of P2P network architectures: pure and hybrid (Yang *et al.*, 2001; Lin *et al.*, 2014; Han 2015). Pure P2P is fully decentralized as there are no central coordinating nodes present in the network. Hybrid P2P, on the other hand, allocates selected tasks like indexing or authentication to a small group of nodes, which assume the role of a controlling unit as a result. This type of network architecture combines P2P and client/server principles. How each node in a P2P network can separately determine when and how it makes its resources available to other entities becomes a core priority for application developers. Optimization plans are ideal but they have to be implemented with resource-constrained considerations particularly for memory/energy conserving device requirements.

#### 3.2. Client/server architecture

A server is a computer that serves specific requests from other computers, called clients (Morkved, 2005). Each instance of the client software can send data requests to one or more connected servers. In turn, the servers can accept these requests, process them, and return the requested information to the client. The most basic type of client-server architecture has only two types of nodes, namely the clients and servers. This type of architecture is sometimes referred to as two-tier. However, how best to implement such architecture is limited by its single-point of operation problem making it vulnerable to fail under heavy loading situations.

#### 3.3. Centralized P2P network architecture

A centralized indexed server (Morkved, 2005) is used in the centralized network architecture to maintain a database of its users at any time as well as the content shared. The database is updated whenever a peer logs on to the network. Query requests from peers are sent to the index server and the database will be queried. If matches are found, the server returns the result to the initiator with information of the nodes with the file. Transfer can then be initiated with this information. Example of application developed using this architecture is Napster. The same challenge of the client/server architecture naturally applies to this type of architecture due to the single-point of operation problem. Fundamentally, this system will most likely fail when a fault occurs on any part of the system.

#### 3.4. Decentralized P2P network architecture

Instead of central servers, each peer acts as an index server, searches and holds its local resources (Morkved, 2005). It also acts as something like a router, relaying queries between peers. A node will send a query message to the peers it is directly connected to. If there is a match in their list of resources, the query will be forwarded to the peers they are connected to on the network. This process continues across the whole network. However, there would be a lot of network chatter due to the amount of querying done. Example of application developed using this architecture is Gnutella. Blockchains can be very useful in this regard but which blockchain is best and whether it should be open or closed remains to be seen.

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