Chapter 11
Peer-to-Peer over Mobile Ad-Hoc Networks

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ABSTRACT
In this chapter we review various approaches for the convergence of Peer-to-Peer (P2P) and Mobile Ad hoc Networks (MANETs), identifying strengths and weaknesses, and putting things in perspective. P2P and MANETs are among the most active research topics in pervasive computing. The convergence of P2P networks and MANETs would allow existing P2P applications such as P2P file sharing and P2P streaming to benefit from the ubiquitous connectivity of ad-hoc. A P2P network over an ad-hoc infrastructure is a powerful combination that provides users with means to access different kinds of information anytime and anywhere. Realizing such a system is, however, not straightforward.

INTRODUCTION
The goal of mobile computing is to provide access to information and resources at anytime, anywhere. The traditional client-server architecture is insufficient to provide these needs, due to various issues like scalability (as the number of nodes grows the server can be overloaded) and link failure (which may lead to server unreachable). To cope with these issues there is a need for an architecture which allows both decentralized and spontaneous connectivity. Peer-to-Peer (P2P) systems offer the means to realize decentralized networks, which can be used to share resources over the internet. On the other hand, a Mobile Ad-hoc Network (MANETs) is a spontaneous network made of mobile nodes connected wirelessly but without relying on a specific infrastructure network. A P2P network over an ad-hoc infrastructure is a powerful combination that provides users with means to access different kinds of information anytime and anywhere. P2P systems and MANETs have been developed by different communities in order to address entirely different requirements. Despite being fundamentally different, MANETs and P2P networks share the common vision of

load distribution based on the user’s willingness to share resources in a dynamic and decentralized manner.

The P2P network concept has drawn increasing attention, and has been widely deployed on the Internet for various purposes, including distributed data storage, file sharing, collaborative computing, and Internet telephony (Wu, 2006). The P2P system is popular for being scalable, fault-tolerant, and self-organized. Nowadays P2P has turned out to be one the most active research areas of distributed computing and networking. P2P was originally used to describe the communication between two peers. Recently, it refers to a system that enables two or more peers to share resources (based on peer’s willingness) by using some appropriate communication system, without relying on central coordination. P2P applications offer a way to take advantage of different computer resources on the internet.

The term P2P became popular in 1999 with the emergence of Napster (Napster, 1999). Napster changed the way files were shared on the internet because it let peers download digital materials from each other, rather than from dedicated servers, increasing the system capacity and scalability. Napster, though, was still a centralized P2P application since it used a centralized indexing server.

By contrast, a second generation of P2P applications exemplified by Gnutella (Gnutella, 2000), Freenet (Clarke, 2000), KaZaA (KaZaA, 2002) and BitTorrent (BitTorrent, 2001) provided a truly decentralized architecture.

On the other side, MANET technology also draws great attention of worldwide researchers and scientists. Since the first appearance of wireless ad-hoc networks in the DARPA packet radio networks in the 1970s (Jubin, 1987), it became an interesting research object in the computer industry. In the 1990s, the concept of commercial ad-hoc networks arrived with notebook computers and other viable wireless communications equipment. At the same time, the idea of a collection of mobile nodes was proposed at several research conferences. The IEEE 802.11 subcommittee (IETF-manet) had adopted the term “ad-hoc networks” and the research community had started to look into the possibility of deploying ad-hoc networks in other areas of application. During the last couple of years tremendous improvements have been made in the research of ad hoc networks. Due to their ability to create and organize a network without any central management, MANETs are characterized as the art of networking without a network (Jiang, 2004). A MANET is a special kind of wireless ad-hoc network where there is no fixed backbone infrastructure. Due to this, the MANET can be flexible and rapidly deployed (Goldsmith, 2002).

MANETs and P2P networks are decentralized, autonomous and highly dynamic in a fairly similar way. In both cases, network nodes contribute to the overall system performance intermittently and unpredictably. Both rely on mechanisms to publish, share, index, cache, discover, and reorganize resources dynamically. They both aim at supporting efficient data distribution mechanisms such as multicasting. The strong functional similarities between MANETs and P2P networks, has recently sparked a new research thread based on a fundamental question: is it possible and beneficial to envision a convergence between P2P and MANETs? Such convergence would be appealing as it would allow distributed applications to run over spontaneous, infrastructure-less networks, adding a new dimension to the current Internet.

In this chapter we review MANETs and P2P systems from this new perspective. First we look at each technology independently, considering their commonalities and differences. Then we survey existing literature on the topic of P2P over MANETs. A critical discussion of the state-of-the-art will lead us to the identification of the key areas that require further research.
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