

Chapter IX

Opportunistic Networks

Andreas Heinemann

Technical University of Darmstadt, Germany

ABSTRACT

This chapter introduces opportunistic networks. Such networks support spontaneous interaction between mobile users carrying mobile devices with them. After having been presented with the motivation for this new type of network, the reader will learn the underlying concepts, including an opportunistic network definition. Next, this chapter discusses what makes opportunistic networks different to mobile peer-to-peer networks and mobile ad hoc networks; two network types that are closely related. We present a number of applications with a focus on data dissemination. As a sequel to that, the chapter discusses human factors that are important for opportunistic networks, namely privacy preserving techniques and an incentive scheme. The chapter concludes with an overview of future research issues by naming a number of open and unsolved problems.

INTRODUCTION AND MOTIVATION

A predominant concern in ubiquitous computing (UC) is the natural and effortless interaction of humans with a *smart* environment in order to carry out a certain task or simply to make life easier. Often, interaction is bootstrapped with a user's personal, mobile device. Such a device may carry a digital representation in form of a user profile and a key pair that serves as a digital identity. Examples of devices are personal digital assistants (PDAs) or mobile phones. Especially the mobile phone plays a prominent role since it

has conquered our everyday life and is basically *ubiquitously* available for the user.

More and more mobile phones and PDAs are equipped with short range wireless communication capabilities. In most cases, either Bluetooth (Bluetooth SIG Inc., 2003-2005) or 802.11b WiFi technology (IEEE, 1999) is integrated. The prevalent use of wireless connectivity is to synchronize personal data between a mobile device and a desktop computer (via Bluetooth) or have easy access to an institution's network (via a 802.11 WiFi Wireless Access Point) and further to the Internet. But in addition, with the integration of

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short-range wireless communication technology into these devices a new network type called *opportunistic network* and its corresponding applications based on *spontaneous* interaction and collaboration among devices and users is emerging.

Opportunistic networks are closely related to two other network types: mobile peer-to-peer networks and mobile ad hoc networks (MANETs). The latter operate mainly on the networking layer and provide novel types of infrastructure for all kinds of applications. Some underlying principles of the two types of networks can be found in the chapters “Wireless and Mobile Communication” and “Peer-to-Peer Networks” of this book, respectively. Later in this chapter, we will compare the two network types to opportunistic networks, which we concentrate on in the remainder. Opportunistic networks may be considered the least emphasized of the three in the literature, but as the chapter will show, they offer unique and promising opportunities for the dawning ubiquitous computing era.

Opportunistic network applications take advantage of the fact that mobile, personal devices are able to discover and communicate with each other whenever they are nearby. We motivate opportunistic networks with a concrete application example.

Example: *At a computer science conference site, researchers from all around the world stay together for 2-3 days to discuss recent advances in their fields. Due to the limited time, each attendee tries to make his stay as beneficial as possible, for example, by talking to colleagues during coffee breaks. For novices in research there might be the question “Who should I talk to?” or “Which other attendees are working on similar research problems?” By carrying a Bluetooth enabled mobile phone, the device is able to communicate with nearby devices carried by others in order to look for interesting conversational partners. Once the devices have discovered a match in research*

interests, the devices notify their owners and the owners are able to switch to a face-to-face communication due to the short communication range.

The devices might also exchange information, for example, paper reading lists, without user notification. By this, each attendee would learn about what other researchers are currently working on.

After the conference is over, this information is carried back home and the attendee might share this information with colleagues at his research institute, again, by using his mobile phone and without notice.

The example emphasizes two things. First, opportunistic networks help to make people physically aware of each other and second, opportunistic networks support data dissemination very similar to *word of mouth* communication among humans.

The remainder of this chapter is organized as follows. In the next section the reader will learn the underlying ideas and concepts of opportunistic networks. After that, a comparison to mobile peer-to-peer and MANETs is done. The section “Opportunistic Network Applications” presents typical applications for this network type with a focus on data dissemination mechanisms. As seen in the previous example, an opportunistic network node consists of a human with a personal device. Thus human factors need to be considered in opportunistic network application design. This is addressed in the penultimate section. The final section summarizes this chapter and, being a fairly new topic in UC, gives directions for possible future issues and challenges. The chapter closes with a list of pointers to literature for those who want to dig deeper into opportunistic networks.

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