Chapter 4
A Service for Improving the User Experience in WLANs and WPANs

Ricardo Augusto Rabelo Oliveira
Universidade Federal de Minas Gerais, Brasil

Antonio Alfredo F. Loureiro
Universidade Federal de Minas Gerais, Brasil

ABSTRACT
In this chapter is presented a framework to a service that acts as a middleware to the applications, providing the information about the wireless network context. The increasing use of wireless communications in mobile devices calls for a new level of resource management. Users with mobile devices accessing wireless hot spots are a commonplace, and, thus, their management is becoming more important.

1 INTRODUCTION
Quality of communication in wireless systems is heavily dependent on several factors including interference on the radio signal and mobility of the communicating devices. However, it is very difficult to assess the transmitted signal and predict when a bad quality signal is being caused by interference or mobility. The information about the network context is very important to achieve a better application performance. In a wireless network there is a huge variety of devices and communication protocols that demands a different programming approach than in a wired network. Also, mobile devices with multiple radio interfaces are becoming commonplace, as a way to provide not only flexibility to select and access different wireless networks, but also to maintain the mobile user connectivity over wider areas of coverage. Currently, the most common radio technologies are Bluetooth, GPRS, UMTS, CDMA2000, IEEE 802.16, for metropolitan area networks, and IEEE 802.11 for local area coverage. A typical case of multiple radio use is a user with a mobile device who initially gets connected to the Internet via a 802.11b access network and, later on, switches the access network to a metropolitan area technology such as CDMA2000. Furthermore, over areas covered with multiple wireless networks, the user may switch, along the time, to the best access network based on different criteria such as connection cost, network state (e.g., channel quality,
available bandwidth, network load), and application requirements.

The goal of this work is to design a service that communicates directly with the device drivers for monitoring and controlling resources using the information available at the wireless interface. The objective is to have a cross-layer solution for a middleware and applications that use the context information to improve the management and the user experience. The functionality of this service can be separated in two groups. The first one contains the information about the wireless card, such as the basic configuration and statistics about the link. The second one uses the measures done at the energy level of the received signal to describe the events that are happening at the wireless environment. The application uses a communication interface with this service, allowing an adaptation at the current network context.

Given a set of events at the wireless environment, we are interested in identifying mobility and interference, which cause a greater impact at the wireless communications. Over an estimated time interval, a statistical analysis of the energy level of the transmitted signal allows to identify these events associated with both the device mobility and the interference that happen at the communication. The distinction between mobility and interference is possible due to a several types of effects that affect the signal energy level wcp.

The first step in this process is the definition of the metrics to measure the communication quality and what type of impact is caused by these events. These metrics describe the relation between the energy level of the received signal and the integrity of the transmitted data. Considering the communication frame as the basic unit of the data communication, the irradiated frame is identified at the receiver if the energy level of the signal is above a threshold that allows its correct reception at the wireless interface.

Variations of the communication quality have different impacts on the application performance. The wireless interfaces have different strategies to deal with the damaged frames. For example, apply the ARQ mechanism for an automatic retransmission. But when the number of retransmissions increases, the energy consumption and the delay experienced for the upper communication layers also increase, making it prohibitive for some types of devices or applications.

The total loss of communication is an extreme case, but there are effects of the communication quality that affects the application performance. The following metrics identify these effects:

- The maximum speed capacity of the wireless interface, due to the channel conditions. Depending on the environment conditions, the wireless interface changes the rate by selecting another modem;
- The effective throughput seen by the application during the communication. It takes into account the overhead caused by the excessive number of retransmissions and by the control information from the network protocols;
- Measures the impact along the time caused by the successive retransmissions and the changes at the wireless interfaces;
- The variation of the delay, which has the impact maximized when the wireless channel is affected by a great variability of the communication quality.

These metrics are parameterized by the communication quality of the wireless channel, so even they are the same of the wired network, the influence of the wireless channel has a greater impact over them.

To measure the impact of the communication quality, the receiver signal strength indicator (RSSI) is used. This information is collected at the time of the frame reception. The fluctuations of this value are modeled as a stochastic process with a superimposition of the signal fading effects (Suzuki, 1997). In this work, we apply the
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