Chapter 10
Packet Scheduling in Home and Business Femtocell Networks

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ABSTRACT

This chapter presents the performance of the existing macrocell schedulers in the home femtocell environment and provides a scheduling solution for the traffic differentiation problem in the business femtocell environment. The traffic classification concept is applied to Best Effort (BE) traffic in the femtocell network, and a Grade of Service (GoS) metric is used as a scheduler parameter to classify the traffic in terms of total delivered throughput. CDMA2000 1xEVDO Rev, a femtocell product, is used to conduct two different throughput experiments in order to collect real Data Rate Request (DRC) values. For both existing and proposed scheduling methods, the first experiment consists of 4 BE users, and the second experiment consists of 4 BE and 2 Voice over IP (VoIP) users. Collected DRC values are used in computer simulations to assess the performance of both the existing and the proposed scheduling methods. Average delivered throughput, throughput fairness, BE traffic differentiation error, and VoIP packet delay bound error are used as key indicators to show the performances of both scheduling techniques.

INTRODUCTION

Femtocell is a solution to indoor data capacity and indoor coverage problems of 3G/4G wireless communication systems. In this chapter, CDMA2000 1xEVDO based femtocell is considered for performance investigation of existing macrocell packet scheduling methods in home femtocell environment (Yavuz, 2006; Black, 2002; Bhushan, 2006; Ching, 2003; Parry, 2002). This chapter also proposes new scheduling methods for BE traffic differentiation for business femtocell environment. Scheduler is an essential part of the wireless radio resource management module in femtocell product.

The task of scheduler is to dedicate required amount of resources to users based on their network related parameters. The most commonly used conventional scheduling methods are Round Robin (RR), maximum data rate request (maxDRC), proportional fairness (PF), average DRC (aveDRC), exponent DRC (expDRC), and maxDRC-PF. The performances of these schedulers were investigated under two different traffic environments.
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scenarios which are 4 BE only and 4 BE + 2 VoIP. Average delivered throughput, throughput fairness, and VoIP delay bound error are key performance indicators (KPIs) to assess and compare the schedulers’ performances.

Scheduler is also used to provide differentiated services to users in the network. BE traffic is the most common type traffic created by applications such as web surfing, file download/upload, and email access. These traffic types will cause disproportional traffic creation and network resource usage among users. Hence, resource usage level of different BE users will be different from each other although all BE users have the same subscription level and payment. Therefore, network operators wanted to classify BE users into different traffic groups in order to control their network usage and charge them accordingly. In order to achieve traffic classification at scheduler level, we have introduced GoS parameter into scheduler’s decision metric (DM), which is used to make packet scheduling decisions. New scheduling methods are classified as GoS based schedulers and named as GoS-RR, GoS-maxDRC, GoS-PF, GoS-aveDRC, GoS-expDRC, and GoS-maxDRC-PF.

In order to assess and compare the performances of proposed GoS schedulers in business femtocell environment, average delivered throughput, BE traffic differentiation error, and VoIP delay bound error values are used as KPIs. As a result of real femtocell experiments and simulations, the appropriate scheduling methods are recommended for home and business femtocell environment.

**BACKGROUND**

Femtocell is a miniature base station providing 3G/4G wireless broad connection to users at home or office. Femtocells are mainly used to provide coverage and high quality data connection to users at indoor locations using existing broadband internet connections. The basic characteristics of femtocells will be:

- **Low-power:** Femtocell will only transmit 10-100 miliwatts, or lower power levels than Wi-Fi access points
- **Low-cost:** Mobile operators will be offering femtocells as a part of subscription package
- **User-installed:** Femtocell will be installed by users without any configuration
- **Compatible with existing mobile devices:** Femtocell will be supporting both existing and next generation mobile devices and handsets.
- **Broadband Connection:** Femtocells will connect to operators’ networks using wired broadband internet connection such as DSL, cable or fiber optics.
- **Based on cellular network standards:** Femtocells will be built using existing UMTS and CDMA standards. And they will also support LTE, WiMAX, and UMB.
- **Deployed in operator-owned spectrum:** Femtocells will operate in licensed frequency spectrum owned by network operators. They can also share spectrum with the macro cell network.

The main advantages of femtocells for users are:

- **Increase indoor coverage:** Femtocells will provide coverage up to 200 meters. In most home and office environments, this means five bars of coverage.
- **High performance data:** Femtocells will support 4-6 concurrent active data or voice calls, which means that users will be experiencing high data rates than they do in macrocell environment.
- **Improved multimedia experience:** Femtocell will deliver high quality of multimedia experience with high rate data connection.
- **High voice quality:** Femtocells will support a new generation of voice quality, which is called High Definition Voice (HDVo).