Chapter 6
Buffer Management in Cellular IP Network using PSO

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ABSTRACT

Cellular IP networks deal with the concepts of micro-mobility. Buffer management in Cellular IP networks is very crucial as its proper usage not only increases the throughput of the network but also results in the reduction of the call drops. This article proposes a model for buffer management in Cellular IP network using Particle Swarm Optimization (PSO), an evolutionary computational method often used to solve hard problems. The model considers two kinds of buffers; Gateway buffer and Base Station buffer. In the proposed two-tier model, the first tier applies a prioritization algorithm for prioritizing real-time packets in the buffer. In the second tier PSO algorithm is used on a swarm of cells in the network. PSO is applied for a given time slot, called window. In each window period the swarm can store number of packets depending on the window size and the total number of packets. The effect of various parameters e.g. number of packets, size of packets, window size, and a threshold value on buffer utilization has been studied by conducting the simulation experiments.

INTRODUCTION

Cellular IP protocol is a solution for mobility management at micro level, where it intends to provide handoff support besides the micro mobility management. Being designed for micro level of mobility, Cellular IP supports frequently moving mobile hosts. It can also efficiently serve rarely moving or even stationary mobile hosts. A Cellular IP network consists of interconnected nodes. These nodes accomplice two tasks. They route IP packets inside the Cellular IP network, on the other hand they communicate with mobile hosts via wireless interface. Components of Cellular

IP network are Cellular IP Base Station which controls and is responsible for nodes in a cell, Cellular IP Gateway that connects Cellular IP network to Internet and stores the packets intended to be sent through Internet in its buffer, and the Cellular IP Mobile Node which implements the Cellular IP protocol. Many operations take place in Cellular IP network such as routing, paging, and handoff etc. Quality of Service (QoS) in Cellular IP network depends on many factors and is provided according to the resources available in the network. Buffer, as an example, is one of the important resources in Cellular IP networks which must be managed and utilized in an effective manner so that a Cellular IP network gives better performance.

Considering two types of traffic, real-time and non real-time, there should be good schemes for buffer management by which least packets loss is guaranteed. In wireless communications packets are prone to be dropped, lost, or delayed which results in connection disturbance. Proposed schemes for buffer management in wireless communication networks especially in Cellular IP networks must be as robust as possible, and give good results in terms of QoS.

One of the tools that can be used to optimize the performance of the buffer is Particle Swarm Optimization (PSO) algorithm. PSO is a swarm intelligence based algorithm and is often used to find solution to an optimization problem in a search space. This algorithm is based on the sociological behavior associated with birds flocking (Nedjah & Mourelle, 2006). PSO has been applied in many optimization applications and has given good results so far. As an example PSO algorithm is used for bandwidth allocation in cellular networks (Huang, Chuang, Lai, Sun, & Guan, 2007). PSO algorithm can be summarized as follows (Seo, Im, Heo, Kim, Jung, & Lee, 2006).

```
PSO ()
{   Initialize random swarm location
and velocity.
```

```
   Repeat until the optimum value is
obtained
   {    Update velocity.
        Update positions.
        Update Pbest, (best position
for each particle)
        Update Gbest (the best posi-
tion for the swarm so far)
   }
```

For the buffer management problem of Cellular IP network, a two tier model is being proposed. In the first part it prioritizes the real-time packets in the buffer and arranges them in the front portion of the buffer. It uses an algorithm to search and sort these packets. After that the packets are served from the front end of the buffer till a specified threshold is met. Rest of the packets will not be dropped straightforward but they will be transferred back to the swarm consisting of seven cells in the Cellular IP network. The swarm will search for the best solution to store all the returned packets from the Gateway buffer. Eventually, the packets will be transferred to the Gateway buffer with higher priority. Most of the returned packets to the swarm are normally (most probably) non real-time packets. It is due to keeping the real-time packets in the front side of the buffer and serving them. Therefore the non real-time packets, considered to be less important, might be delayed.

The rest of the article is organized as follows. In the next section related models have been described. In section 3 Particle Swarm Optimization (PSO) is explained step by step. Section 4 briefly explains buffer types in Cellular IP networks. In section 5, the proposed model is elaborated. Section 6 contains the simulation experiments for the performance of the model and its comparison with the buffer management for Intelligent Gateway Gadget. Some observations have been made on the results obtained and the comparison between the two models in section 7. Section 8 concludes the proposed work.

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