QoS-Guaranteed Spectrum Handover Algorithm for Heterogeneous Wireless Networks

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Abstract. In this paper, we present a new QoS-guaranteed handover algorithm by applying a cognitive radio concept. Existing research on handovers in heterogeneous wireless networks focuses on cell selection. We present a handover that is sensitive to user requirements by expanding cell to spectrum.

Keywords: QoS guarantee, Spectrum handover, Cognitive radio, Heterogeneous wireless network

1 Introduction

Smart devices that can be supported by a variety of access networks have been rapidly entering the market in recent years [1]. As mobile communication networks are increasing, maintaining network performance becomes an important issue. An efficient handover that meet user quality of service (QoS) requirements can solve performance problems related to this issue [2].

Handover decision-making schemes that consider users’ requirements according to the services are needed. Cognitive radio technology can meet the QoS more sensitively by changing its communication parameters in response to network and user demands. This paper provides a QoS-guaranteed spectrum handover algorithm in heterogeneous wireless networks.

2 Cognitive Radio

Cognitive radio (CR) is a communication technology first proposed by Mitola [3] for improving the use of spectrum utilization. The cognitive cycle is composed spectrum sensing, spectrum analysis, and decision making as shown in Figure 1. A CR monitors which spectrum bands are available and detects the spectrum holes. In spectrum analysis, the characteristics of the spectrum holes are determined using the information captured during spectrum sensing. The CR then determines information such as the data rate, transmission mode, and bandwidth following which it chooses the appropriate spectrum band [5].
An important application of CR is dynamic spectrum access [4]. We will apply spectrum access techniques to our algorithm for meeting required QoS.

3 QoS-Guaranteed Spectrum Handover Algorithm

We propose a new handover decision-making algorithm that consists of two steps. In the first step, all spectrums based on QoS are analyzed, and spectrums that meet the QoS requirements are identified. There may be more than one classified spectrums. In the second step, load balance is taken into consideration. The details of these two steps are given below.

3.1 Spectrum Analysis Based on QoS

All application have QoS requirements to provide proper service level. In this paper, delay, delay jitter, packet loss, and bandwidth are considered as QoS requirements. Table 1 explains weights for performance requirements with corresponding application types [2]. \( w = (w_1, w_2, w_3, w_4), w_1 > 0, \sum_{i=1}^{4} w_i = 1 \)

<table>
<thead>
<tr>
<th>Application</th>
<th>Delay</th>
<th>Delay jitter</th>
<th>Packet loss rate</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice</td>
<td>0.35</td>
<td>0.35</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td>Streaming</td>
<td>0.25</td>
<td>0.35</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>Download</td>
<td>0.02</td>
<td>0.02</td>
<td>0.56</td>
<td>0.4</td>
</tr>
<tr>
<td>Browsing</td>
<td>0.15</td>
<td>0.03</td>
<td>0.32</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Existing researches have applied QoS weight methodologies to cell-based networks. We use weight method to spectrum-based network on the part of cognitive radio. We can get condition of a network i. The greater the value of A, the better.
3.2 Load Balancing

Considering network conditions alone is not efficient, because specific cell concentrations can occur. Load balancing can lead to decrease a number of handovers and unnecessary network performance. Cell concentration is defined in equation (2).

\[ L_i = \frac{\text{Allocated bandwidth of spectrum}}{\text{Total bandwidth of spectrum}} \]  

3.2 Joint Function

We provide a simple joint function for composing spectrum analyzing and load balancing results.

\[ J(\bar{i}) = A_i \times (1 - L_i) \]  

The network with the largest value of J will be chosen. This value acts as a threshold for next coming handover. If next J is greater than present J, a handover will occur. Conversely, the handover will be rejected if the next J value is less than the present J value.

4 Experiments

We made MATLAB simulations for verifying performance of proposed QoS-guaranteed spectrum handover algorithm.

In order to compare a random handover algorithms with the proposed algorithm, we allocated numerous mobile nodes. A random handover algorithm changes cells when accessed cells encounter load problems.

Figure 2. Shows the results of the average number of handovers that occurred using random and proposed algorithms. The average number of handovers was fewer with the proposed algorithm when compared to the random algorithm.

5 Conclusion

In this paper, we presented a new spectrum handover algorithm for supporting QoS that consider load balancing. In order to meet user requirements more sensitively, we divided the cell into several spectrums using concepts from cognitive radio
technology. The proposed spectrum handover algorithm eliminated redundant handovers. However, the requirements used in the algorithm were limited. In future works, we intend to investigate more variables and verification methods.

![Graph showing comparison of average number of handovers between random and proposed QoS guaranteed spectrum handover.](image)

**Fig. 2.** Comparison of Average Number of Handover.

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**References**