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A QoS Guaranteed Call Admission Control (QOG-CAC) Algorithm for Broadband Networks

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ABSTRACT

Call admission control (CAC) is one of the techniques deployed in managing network resources. Recently, the dynamic QoSaware CAC (DQA-CAC) algorithm was proposed to reduce the new connection blocking rate and improve resource utilization. However, the algorithm admits new connections and degrades existing ones without recourse to delay requirements of delay-intolerant extended real-time polling service (ertPS) and real-time polling service (rtPS) connections—which may incur additional delay, leading to an increase in packet drop rate and, consequently, reduced throughput. In this article, a QoS-guaranteed call admission control (QOG-CAC) algorithm is proposed to ensure QoS and consequently increase the throughput of all class of connections. The proposed QOG-CAC is simulated using a Java-based discrete event simulator. The results of the extensive simulation experiments conducted show that the proposed algorithm outperforms the compared scheme with regard to average system throughput, new connection blocking rate, and per-flow throughput of real-time as well as non-real-time connections

KEYWORDS

Delay, Dynamic QoS-Aware CAC, Mobile Broadband Network, Pre-Check Mechanism, QoS Guaranteed CAC, QoS-Guaranteed CAC, Radio Resource Management (RRM)

INTRODUCTION

The widespread use of mobile devices such as laptops, tablets, and smartphones has led to a growing demand for multimedia applications and data transmission. Consequently, there has been an explosive global increase in demand for high-speed data, which is expected to grow at a compound annual growth rate (CAGR) of 57% from 2014 to 2019 (CISCO, 2018). To meet this growing demand, mobile broadband technologies such as Long-Term Evolution and Worldwide Interoperability for Microwave Access (WiMAX), also referred to as the IEEE 802.16 standard, have been developed. The WiMAX standard ensures high data rate, provides wide area coverage, and improves spectral efficiency (Prasad and Velez, 2010. Furthermore, the standard has witnessed tremendous growth due to its low cost of deployment and maintenance.

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However, managing the growth and assuring the quality of service (QoS) of all users within this standard has become a matter of great concern for both researchers and network operators due to the scarce nature of wireless resources. Thus, to ensure efficient management of resources and QoS, radio resource management (RRM) techniques such as call admission control (CAC) are required.

As one of the fundamental RMM techniques, CAC, which admits or rejects a call depending on whether the required QoS of the requesting connection will be fulfilled while ensuring the required QoS of the existing calls (Saidu et al., 2015), plays a key role in maintaining QoS and ensuring efficient resource utilization. Several CAC schemes (Saidu et al., 2015; Wang et al., 2007; and Shúaibu et al.,2010 and Shu'aibu et al., 2011) have been proposed to guarantee efficient resource utilization and QoS for admitted connections. However, the schemes in (Wang et al., 2007; and Shúaibu et al.,2010 and Shu'aibu et al., 2011) waste resources due to the reservation and/or degradation policies deployed and that in (Saidu et al., 2015) improve resource utilization while guaranteeing QoS but only check the bandwidth requirements of the existing and requesting connections before degradation, without recourse to the delay requirements of delay-intolerant ertPS and rtPS connections. This may significantly reduce as well as underestimate the resources allocated to these connections. This can cause some of the ertPS and rtPS connections to miss their delay deadlines, hence leading to their drop and consequently reducing their throughput.

In this paper, a QoS-guaranteed CAC algorithm is proposed to further boost resource utilization and increase throughput of delay-sensitive ertPS and rtPS connections. The QOGCAC scheme, in addition to employing the pre-check mechanism and dynamic bandwidth degradation mechanism, also deploys a delay-check token bucket-based mechanism to ensure that the delay guarantee of ertPS and rtPS connections will be guaranteed. The performance of the proposed algorithm (QOG-CAC) is evaluated against that of the DQACAC and the QoS-aware CAC scheme with BR and BD algorithms (QA-CAC) using a discrete event simulator.

The rest of the sections of this paper are organized in the following order: the next section presents a background of the study followed by the proposed scheme; Section IV presents the performance evaluation, discussion of results; and the last session presents the conclusion.

BACKGROUND

This section provides a review of some of the CAC schemes that have been proposed to manage network resources in WiMAX networks.

A CAC algorithm was proposed in (Wang et al., 2005) to ensure QoS and improve resource utilization. The scheme prioritizes handoff connections over new connections through the use of guard channels. It also borrows bandwidth from existing low priority connections when bandwidth is not sufficient to admit new calls. The scheme improves bandwidth utilization and reduces call blocking probability (CBP) as well as handoff call dropping probability (HCDP). However, bandwidth may be wasted due to the guard channels and is unfair to low-priority connections because of its borrowing policy.

In (Ganesh & Bhuvaneswari, 2011), an enhanced call admission control scheme was proposed to ensure fairness for lower-priority classes during busy hours. The scheme admits calls based on available bandwidth and reserves bandwidth for UGS calls instantaneously based on connection arrival rate until the CBP of non-UGS calls exceeds a set threshold. The scheme is fair to non-UGS calls at low arrival rates but increases their blocking rates due to the high threshold set and the reservation policy used.

A dual partition CAC scheme (DP-CAC) is proposed in (Shúaibu et al.,2010) to improve resource utilization. The DP-CAC partitions the system bandwidth into two, with one partition (P_v) used for variable bit rate (VBR) traffic and the other (P_c) for constant bit rate (CBR) traffic. The scheme admits CBR traffic based on maximum data rate if the total bandwidth of admitted connections is less than the bandwidth of P_c and admits VBR traffic based on sustainable data rate if the available bandwidth