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Resource Reservation Approach: Application in Wireless Network

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Abstract

This paper presents an enhanced resource reservation and call admission control strategy tailored for cellular networks. The proposed method uses user mobility trends to improve the efficiency of resource usage while avoiding significant network congestion. The call admission control mechanism is activated each time a new or handoff service request occurs, ensuring that resources are allocated efficiently to uphold a steady quality of service (QoS) for multimedia traffic. This mechanism is essential for sustaining the continuity of ongoing services while improving the overall efficiency of resource usage. To achieve this, the scheme allows bandwidth to be borrowed from existing adaptive services without compromising the minimum QoS guarantees. Additionally, the decision-making process for call requests considers the condition of neighboring cells, ensuring a more dynamic and balanced resource distribution. The primary objective of this approach is to minimize new call blocking while maximizing the efficient utilization of available bandwidth. By maintaining the desired QoS levels, this scheme enhances the reliability and performance of cellular networks, making them more adaptive to fluctuating traffic demands.

Keywords: Call admission control (CAC), quality of service (QoS), wireless cellular networks, resource reservation, bandwidth utilization

INTRODUCTION

Over the past 10 years, wireless networks have seen tremendous expansion, with over two billion mobile users worldwide. Mobile phones have become essential business tools and integral to daily life in many developed nations, while also replacing outdated landline systems in several developing countries. Analog cellular systems are being phased out in favor of digital ones. Unlike digital systems, analog systems lack security, making it easy for anyone to intercept conversations by scanning the analog frequency band. Now with the introduction of digital cellular telephony it is not easily possible because digital cellular systems implement some level of encryption [1–10]. Call admission control (CAC) is a mechanism by which the network decides whether the new call request or any handoff call request to be admitted or not [11–16].

CAC algorithm not only provides connection to the new user or existing user but also determines the limit of accommodating the number of calls. The rate at which calls are handed off in a given cell is influenced by the number of active calls in neighboring cells. Assuming that user mobility remains consistent, an increase in call volume in adjacent cells is likely to result in a higher handoff rate to the target cell [17–21]. Ensuring connection-level quality of service (QoS) in wireless cellular networks is challenging due to limited radio bandwidth, fluctuating environmental conditions, and user mobility. The complexity is further heightened by the implementation of small-sized cells (e.g., microcells or picocells) in modern

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wireless networks, which are designed to provide higher transmission capacity and improved performance. However, these smaller cells also lead to higher handoff rates and rapid fluctuations in network traffic, complicating the process of ensuring QoS guarantees [17–19]. Various call admission policies have been proposed, with analytical models for key QoS parameters provided. Some studies have used simulations to compare different schemes, but only a few have performed analytical comparisons within a narrow set of call admission strategies.

There are many parameters which determine the effectiveness of any CAC algorithms. Any CAC algorithm is developed keeping in mind that it should results in the effective use of network resources and should satisfy the various quality of service requirement [22–26].

LITERATURE REVIEW

Over the years, various approaches have been developed to enhance the efficiency of resource reservation and CAC in wireless networks. Early cellular systems primarily relied on analog technology, which lacked security and was prone to eavesdropping. With the advent of digital cellular systems, encryption techniques improved communication security, reducing the risks associated with analog transmission [27].

CAC mechanisms play a crucial role in determining whether new or handoff calls should be accepted. Various models have been examined to enhance network performance while ensuring optimal service quality. A key challenge in CAC is managing the increasing number of handoff requests due to high mobility in microcell and picocell networks. Smaller cell sizes not only enhance transmission capacity but also lead to frequent handoffs, causing rapid fluctuations in network traffic. Addressing this issue requires dynamic and adaptive CAC strategies that balance resource allocation without compromising service quality [28].

Various call admission policies have been proposed, each focusing on different aspects of network efficiency. Some prioritize resource utilization by allowing bandwidth borrowing from existing adaptive services, ensuring that the minimum quality of service requirements is met. Others take a more conservative approach, limiting call admissions to avoid potential network congestion. A major factor influencing the performance of these algorithms is the number of ongoing calls in adjacent cells, as this directly impacts the handoff rate. If neighboring cells experience high call activity, the likelihood of handoff requests increases, making it crucial for admission control algorithms to factor in the surrounding network conditions [29].

The performance assessment of CAC schemes generally focuses on five main factors: efficiency, complexity, overhead, adaptivity, and stability. Efficiency measures how well a scheme utilizes network resources while meeting quality of service requirements. Complexity refers to the computational demands of the admission decision-making process. Overhead accounts for the signaling burden imposed on the network due to intercell communication. Adaptivity evaluates how well a scheme responds to changing traffic conditions, and stability ensures that fluctuations in call requests do not lead to abrupt system changes. An ideal CAC mechanism effectively balances these factors to enhance overall network performance [30].

Research in this area continues to evolve, with newer models integrating machine learning and artificial intelligence to optimize decision-making. By leveraging predictive analytics, these advanced techniques aim to anticipate network congestion and allocate resources more efficiently. As wireless communication demands grow, future advancements will likely focus on enhancing adaptive control mechanisms to support increasing data traffic while ensuring seamless connectivity.

PERFORMANCE CRITERIA

Several commonly used performance criteria can be used to evaluate and compare CAC schemes. While there are other factors, we will focus on the following key criteria for comparison:

Efficiency

Efficiency refers to the level of network capacity utilization achieved while meeting specific QoS requirements. A scheme is considered more efficient than another if it results in a higher utilization of network resources while maintaining the same QoS parameters and network configuration.

Complexity

This describes the computational demands of the CAC scheme based on the given network setup, mobility patterns, and traffic characteristics. One scheme is deemed more complex than another if its admission decision process requires more intricate calculations.

Overhead

Overhead refers to the signaling demands placed on the fixed interconnection network between base stations by a CAC scheme. Some schemes require the exchange of information with neighboring cells via this interconnection network.

Adaptivity

Adaptivity is the ability of a CAC scheme to adjust to changing network conditions. Schemes that lack adaptability may result in poor resource utilization. This paper focuses on adaptivity in response to changes in traffic load.

Stability

Stability refers to the CAC scheme's resistance to short-term traffic fluctuations. If an adaptive CAC scheme reacts too quickly to load changes, it may cause unstable control. For instance, a situation could arise where all connection requests are accepted until congestion occurs, leading to the rejection of all requests. Ideally, network control and management should avoid such scenarios.

CONCLUSION

In this paper, the effect of two parameters – power transmitted by mobile station and path loss on CAC algorithm – is analyzed. Thereafter two path loss model are considered. Effect of power transmitted by mobile station on CAC taking these two models is studied at frequencies of 900 MHz and 1800 MHz. The performance is evaluated based on the amount of effort or output of call accepted by CAC algorithm at some specific frequencies. In this CAC, neighboring cells are also taken into account while making the decision. Both path loss models are compared by considering both CAC schemes, simple and modified.

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