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A capacity acquisition protocol for channel reservation in CDMA networks

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Abstract

In this paper, a capacity acquisition protocol is proposed for channel reservation in CDMA networks. Under this protocol, a cell is virtually divided into three regions (i.e., inner region, forced handoff region, and active handoff region). A new call in the active handoff region works in soft handoff mode upon its admission, while a new call in the inner and forced handoff regions works in single mode. However, in the forced handoff region, calls working in single mode can be forced into soft handoff mode, when extra capacity is needed by soft handoff calls. As a result, no explicit channel reservation is required before a call enters soft handoff. By adjusting the size of the forced handoff region, the capacity acquisition can adapt to traffic load and guarantee a desired call dropping probability. To evaluate the capacity acquisition protocol, an analytical model is derived and is also validated through computer simulations. Numeric results illustrate that the capacity acquisition protocol significantly reduces the call dropping probability.

Keywords: Capacity acquisition; Soft handoff; CDMA; Channel reservation

1. Introduction

Dropping an on-going call is more disturbing than blocking a new call. To resolve this problem, channel reservation for handoff calls can be used in a call admission control (CAC) algorithm to prioritize handoff calls over new arrival calls. However, channel reservation in CDMA networks is non-trivial because of the special features of soft handoff. It is well known that soft handoff of CDMA networks reduces interference and increases the interference-sensitive capacity [1]. This feature must be taken into account by the channel reservation scheme in a CAC algorithm. In addition, two other important features found in this paper need to be considered. One is that soft handoff and the

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need of channel reservation occur at different times. The other is that a call working in single mode releases a certain amount of capacity when it is forced into soft handoff mode. Based on these features, a novel channel reservation scheme called capacity acquisition protocol is proposed in this paper for soft handoff calls in CDMA networks. This protocol focuses on uplink operation of a CDMA network.

In the capacity acquisition protocol, three regions, i.e., inner region, forced handoff region, and active handoff region, are introduced for each cell. When an admitted call moves into or a new call arrives at the active handoff region, it works in soft handoff mode. In the forced handoff region, an admitted new call works in single mode and thus only communicates with one base station. Since a call in soft handoff mode consumes less capacity than it does in single mode, some capacity is implicitly reserved by a new admitted call in the forced handoff region. When more capacity is needed by soft handoff calls, it can be acquired from new admitted calls in the forced handoff region by forcing them into soft handoff mode. Thus, before a call enters soft handoff, no explicit channel reservation is required to reserve capacity.

The size of forced handoff region in the capacity acquisition protocol can be adjusted according to the traffic load in the network. As long as traffic load is lower than an upper bound, a target call dropping probability is guaranteed by the load-adaptive protocol.

To date, many algorithms have been proposed for call admission in CDMA networks [2–7]. Neither the signal-to-interference ratio (SIR)-based CAC algorithm in [2] nor the interference level-based CAC algorithm in [3] considers interference reduction by soft handoff. The interference reduction brought by soft handoff is not considered either in [4], although a call in the soft handoff region can access two base stations. Compared to the schemes in [2–4], the CAC analytical model proposed in [5] achieves better performance, because it takes into account the capacity increase factor introduced by soft handoff. According to this model, the larger is the size of soft handoff region in a cell, the smaller is the call blocking probability of a CDMA network. No differentiation is performed between soft handoff and new arrival calls in [5]. Algorithms reserving fixed channels [4] for soft handoff calls waste resources. In [6], a "look around" CAC algorithm is proposed to reduce dropped calls. Soft guard channels are exclusively used for handoff calls, which also results in low resource utilization. In [7], an adaptive channel reservation scheme is proposed for soft handoff calls in a CDMA network. When a user with an on-going call moves into a reservation region, it starts a channel reservation procedure, so channels are reserved individually for each handoff call. Thus, each handoff call does not have fixed reservation of capacity and the utilization is improved. However, this method still wastes a large amount of capacity, because the reserved capacity for a soft handoff call are held useless during the period from the approval of reservation request to the initiation of a soft handoff call. In addition, when traffic load (i.e., new call arrival rate) is high, the resource utilization of the adaptive reservation scheme is not guaranteed to be more efficient than that of a fixed reservation scheme, because many users need to have reserved channels. In other words, this scheme is not actually adaptive to traffic load.

The rest of this paper is organized as follows. The capacity acquisition protocol is proposed in Section 2, and is analyzed in Section 3. The analytical model is justified by simulations in Section 4 where analytical results are used to compare the new scheme with other channel reservation schemes for CDMA networks. In Section 5, a load-adaptive capacity acquisition protocol and its performance are presented. Practical issues of the capacity acquisition protocol is discussed in Section 6. The paper is concluded in Section 7.

2. Capacity acquisition based on soft handoff

The capacity acquisition protocol is motivated by the features of soft handoff.

2.1. Features of soft handoff

As shown in Fig. 1, a mobile terminal in soft handoff is able to communicate with base stations