Doctoral Dissertation

Analysis of Forward Link Capacity in CDMA Systems Supporting Two Traffic Classes

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Abstract

During the last decade, code division multiple access (CDMA) has become one of the most promising technology today and will continue to be in future cellular mobile communication systems. In the early stage of deployment of CDMA systems, voice traffic prevailed over data traffic. At this stage, the reverse link was considered as a capacity limiting link since mobiles were identified with non-orthogonal code and the mobile transmission power was low. The soft handoff has been widely adopted in CDMA systems due to its advantage of higher capacity compared to that of hard handoff in the reverse link. Furthermore, soft handoff also provides lower call dropping rate and increased cell coverage area in the reverse link. Thus, the research on the capacity analysis has been mostly focused on the reverse link with soft handoff.

In the recent mobile communication systems, due to the increasing mobile data traffic such as traffic from mobile Internet services, the traffic load imposed on the forward link has become heavier than that on the reverse link and the forward link capacity has been attracting more attention. In future mobile systems, provision for sufficient forward link capacity will be very important since the forward link load will be much heavier than the reverse link load in mobile multimedia services such as Internet access.

In CDMA systems supporting multiple traffic classes such as voice and data, some works have been done showing that the soft handoff reduces forward link capacity. This is because, in the forward link, other cell interference can be increased by soft handoff. But, other handoff methods have not been actively studied. There has only been a few capacity analysis conducted on the hard handoff in the forward link supporting multiple traffic classes. This is because the hard handoff is not practical for voice traffic. Moreover, the capacity of a combined handoff, which combines soft and hard handoffs, has not yet been analyzed.

Here, we consider a combined handoff strategy in which voice services are provided with soft handoff whereas data services are supported with hard handoff. In this dissertation, the forward link capacity of CDMA systems supporting two traffic classes is analyzed with hard, soft, and combined handoffs. From the results of analysis, we suggest that the combined handoff is a practical candidate for handoff method in CDMA systems supporting two traffic classes in the forward link.

We analyze the effect of handoff methods on the forward link performance based on the two system models. The difference between the two models are performance measure and power allocation method. In the first model, the performance measures are the average value of the bit energy to noise density ratio and power allocation method depends on the distance between a mobile and a base. In the second model, the performance measures are the outage probability of the bit energy to noise density ratio and power allocation method depends on the required bit energy to noise density ratio.

With the numerical results, this dissertation discusses how to determine system parameters in CDMA systems supporting voice and data services. This dissertation can provide some guidelines in designing, implementing, and operating CDMA cellular networks supporting multimedia services. In terms of capacity, the hard handoff is the best method. On the other hand, the soft handoff provides lower call dropping rate than any other handoff strategies. The combined handoff is a compromise between the soft and hard handoff strategies. The improvement of the combined method over the soft handoff is the increased capacity while maintaining the Quality of service (QoS) for voice traffic comparable to that of the soft handoff. The combined handoff can be very useful in CDMA cellular networks supporting both voice and data services simultaneously.

Keywords: CDMA, forward link capacity, soft handoff, hard handoff, multimedia traffic