CDMA2000 1x 시스템을 위한 송신전력기반 전송률 제어방안

Transmitted power based dynamic rate control for CDMA2000 1x system

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Abstract

In a CDMA system, the capacity is variable and mainly depends on multiple access interference. The multiple access interference has a deep relationship with transmitted or received power. The capacity of CDMA2000 1x system is considered to be limited by the forward link capacity. Different rate data traffic requires different transmitted powr and rate controlling enables the system utilize radio resource more efficiently. A very simple rate control algorithm for data calls in CDMA2000 1x system is proposed. In the proposed algorithm, by monitoring the total transmit power, we cansimply adjust data rate to channel conditions and efficiently use radio resources. The proposed algorithm is easy to implement in power controlled CDMA systems.

Key Words : rate control, CDMA2000 1x, power control, cell load

I. Introduction

It is generally accepted in industry that the capacity of IS-95 CDMA systems are reverse link limited. While CDMA2000 1x improves reverselink with pilot aided coherent demodulation and emerging data services are likely to require higher data rates in forward link than the reverse link. Hence, the capacity of CDMA 2000 1x system is limited by the forward link and load control mechanism for forward link becomes important issue. A small fraction of the data users are assigned a large fraction of the transmitted power budget in the forward link. Hence, the capacity of the cell is limited if the higher-data-rate user is closer to the boundary, while very large capacities are available if the high-data-rate user is in the interior of the cell. System resources such as transmitted power and data rate need to be efficiently controlled to maintain overall system feasibility and optimize network performance.

In the radio channel, transmission rates are closely related to signal-to-interference ratios (SIRs), and the SIRs can be efficiently controlled by power control. For forward link, specific SIR and rate control issues can be found in [1] where some complex computation is required at the base station. For optimum resource allocation, joint power and rate control is studied [2], [3]. However above methods requires accurate channel estimation or prediction and complex algorithm such as Lagrangian relaxation technique which requires lots of iterationsand increase system load, and those techniques are difficult to be implemented in real system. In this paper, we propose simple rate control algorithm for the power controlled CDMA system. By using this algorithm, we can enhance system throughput performance.

II. Cell load of CDMA2000 1x System

The capacity of CDMA2000 1x system is determined by the interference and the system has power control mechanism. And so, the total transmitted power at the base station can represent the total cell load. The maximum transmitted power should be chosen such that users can have sufficient transmitted power to achieve their quality requirements when the system reaches the allowable system load. The maximum load function is obtained when the transmitted power reaches maximum power. The Call load of CDMA2000 1x system can be measured by total transmitted power at the base station[4][5].

In this paper, we consider the variable data rate but the feasible transmission rates are limited to a small number of discrete values. For the radio configuration 3 of IS-2000, the feasible data rates are 19.2Kbps 38.4Kbps, 76.8Kbps and 153.6Kbps [6]. Since the high rate data has small spreading gain, the assigned power should increase as the data rate increase to guarantee the required QoS. We assume equal bit energy for the data traffic and the allocated power increases in proportion to the data rate

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and the required E_b/N_0 of data call is identical regardless of data rate. It enables the system to handle the cell load by controlling data rate. A large fraction of transmitted power is assigned to a small fraction of data users. Hence, the capacity of the cell is limited if the higher data user is closer to the boundary. In that case, by reducing the data rate of the data user in the cell boundary, the system can have redundant resources and reduce blocking probability.

III. Proposed Rate Control Strategy

In the CDMA2000 1x system, the feasible transmission rates are limited to a small number of discrete values. In this paper, we consider radio configuration 3 of IS-2000 and the data rates are 19.2Kbps 38.4Kbps, 76.8Kbps and 153.6Kbps. CDMA2000 1x system should support voice and data simultaneously in a cell. If the data call is near cell boundary, data call requires strong transmitted power via power control. It induces high interference to the other calls. In that case, in spite of just one data user, lower rate than 153.6kbps should be allocated to protect voice calls. To solve this problem, transmitted power based rate control scheme is necessary.

The basic concept is as follows. Total transmitted power is periodically monitored for every load control period. Load condition is divided into three states such as overload, stable and under load state. The load states are shown in Fig. 1 where P_{over} and P_{under} are thresholds for overload and under load state respectively.

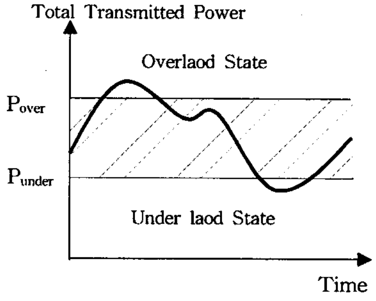

Fig. 1 Load state based on transmitted power

Fig. 2 shows rate control scheme according to load states. In the over load state, the system starts to reduce the data rate of which data call has highest transmitted channel power compared to its data rate. The reason why reduce the data rate of which highest power data call is that the user suffering worse channel condition requires more transmitted power by power control algorithm. The reduction of data rate means the reduction of required transmitted power. If there is no data call to reduce data rate, the system drops in-service call to reduce transmitted power. The users in the cell can enjoy their specified quality of service (QoS)by reducing data rate or dropping call. In the under load state, there are enough resources and the system can raises data rate. When the system raise data rate, the system chooses data call having lowest $S_{k,i}/R_{k,i}$ value. To raise data rate of data call having lowest $S_{k,i}/R_{k,i}$ requires smaller transmitted power than the other data calls in the cell. The system tries to maximize data rate and gives each user best throughput as possible.

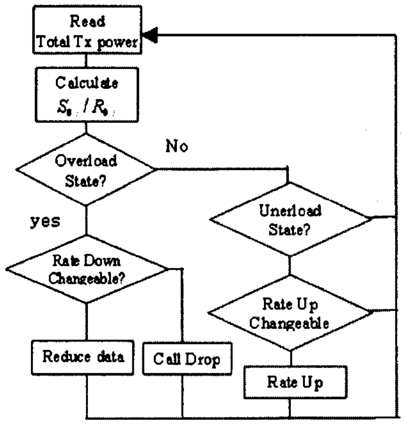

Fig. 2 Rate control based load control scheme

IV. Simulation results

To evaluate the performance of the proposed rate control strategy, system level simulation is performed.

Table 1 Simulation parameters

Parameter	Value
Cell radius	1Km
Mean of voice service rate	1/90(1/sec)
Mean of data service rate	1/200(1/sec)
Maximum Power of base station	20W
Target $(E_b/N_o)_v$	5dB
Target $(E_b/N_o)_d$	4dB
Activity Factor	0.4 (voice), 1 (data)
Standard deviation of shadowing	8dB
The power ratio of over head channel	30%

The cellular layout consists of 2 tiers of surrounding cells of radius R (= 1km). The call arrival process is modeled as an independent Poission process and call duration has the exponential distribution with mead call duration 90 and 200 sec for voice and data respectively. It is assumed that thevelocity of mobiles is uniformly distributed over 0~100km/h andthe required Eb/No for voice and data traffic is 5dB and 4dB respectively. The overload threshold and under load threshold are 90% and 60% of maximum transmit power, respectively. The simulation parameters used in simulations are listed in table 1.

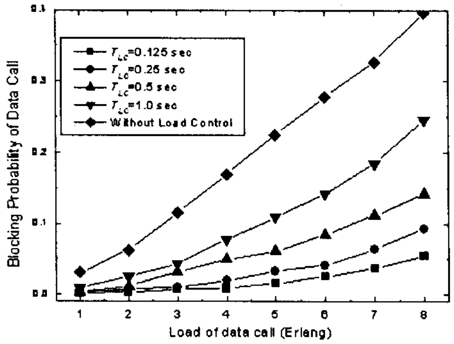

Fig. 3 Blocking probability of data call with varying data load.

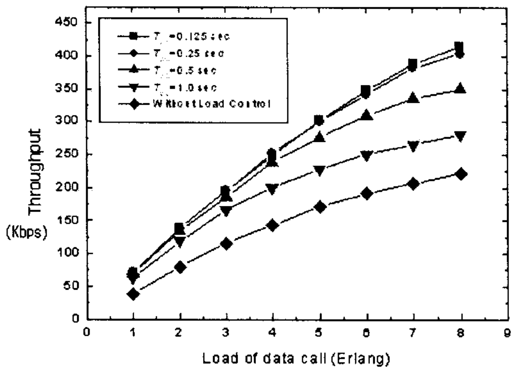

Fig. 4 Throughput with varying data call load and load control period

Fig. 3 shows blocking probability when the system has load control mechanism. T_{LC} is load control period. At every load control period, the system monitors total transmitted power and calculates P_i/R_i value, and performs rate control in case of overload or under load state. As the load of data call increases, blocking probability of voice and data call increase. If load control scheme is not adopted, blocking probability is much higher than the case of load control scheme. As shown in Fig.4, the proposed rate control algorithm enhances the throughput performance. As the load control period comes smaller, the throughput becomes higher. If the system has not load control algorithm, blocking probability increase due to overload condition and it induce decrease of system throughput. As shown in the simulation results, Smaller load control period can reduce blocking probability and increase system throughput. However, smaller load control period can induce higher system load and it is important to find an optimal load control period.

VI. Conclusion

In this paper, rate control algorithm for CDMA2000 1x system using the total transmitted power and rate control algorithm. CDMA system has a flexible radio resource since the CDMA system is the interference limited system. By adopting the rate control algorithm, we can reduce the call blocking probability and it means the enhancement of system quality of service. This rate control also enhances the system throughput. Enhancement of System throughput has a deep relationship with the cost of data service. We also shows the effect of rate control period on the with system performance. As shown in this paper, the proposed rate control scheme can be applied to the CDMA2000 1x system and it is very practical scheme to be applied to CMDA2000 1x system.

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