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Power Control Based Call Admission Control Method of the CDMA PCS System*

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■ Abstract ■

This paper proposes a new call admission control method to enhance the reverse link capacity of a cell with heavy traffic in the CDMA PCS system under the uneven traffic load between cells. Since the capacity of a cell in the CDMA system is restricted by the total interference caused by terminals in the own cell and the adjacent cells, we can enhance the capacity of a cell by reducing the interference from other cells if possible. Our power control method allows that the signal powers received in base stations with heavy traffic be larger than those received in base stations with light traffic in order to make the interference due to other cells in the cells with heavy traffic relatively small. In the previous study, it was assumed that the signal power received by each base station in the CDMA PCS system is same when the call admission control algorithm is implemented. We could show that the reverse link capacity of a cell in the CDMA PCS system can be increased about 20% under our call admission control method.

1. Introduction

The demand for mobile communications is increasing very rapidly. In order to meet the demand, the PCS(Personal Communication System) should make an efficient use of the scarce radio resources. In the TDMA PCS system, various DCA(Dynamic Channel Allocation)[1-5] and reuse partitioning[6-7] techniques have been proposed to enhance the capacity of a cell with heavy traffic when the traffic loads between cells are uneven. In the CDMA PCS system, however, these techniques cannot be applied since mobile terminals in every cell use the same frequency band. This paper focuses on the method which can enhance the capacity of a reverse link of cells with heavy traffic in the CDMA PCS system when the traffic loads between cells are uneven.

In the CDMA PCS system, power control is

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very important to ensure adequate grade of services to each mobile terminal in the system. That is, the signal power received by the base station from every terminal in the same cell is controlled to be the same in order not to make a terminal cause severe interference to other terminals(to solve near-far problem).

In this paper, we propose a new power control method to enhance the reverse link capacity of a cell in the CDMA PCS system under the uneven traffic load between cells. The proposed method does not need the measurement of the propagation gain as done in [12, 13]. However, we construct LP model using the average gain value obtained by computer simulation results of [9]. After determining initial power value, the received powers in base stations are adjusted to guarantee certain level of the link communication quality. Based on the proposed power control method, a new call admission control algorithm is developed.

In the previous study, it is assumed that the signal power received by each base station in the CDMA PCS system is same when the capacity of a cell is calculated [8-10]. Since the capacity of a cell in the CDMA system are restricted by the total interference from the own cell and the adjacent cells, we can enhance the capacity of a cell by reducing the interference from other cells if possible. Our power control method allows that the signal powers received in base stations with heavy traffic be larger than those received in base stations with light traffic. This method can make the interference due to other cells in the cells with heavy traffic relatively small satisfying the grade of services of terminals in each cell. We could show that the capacity of the CDMA PCS system can be increased about 20% under our call admission control method. In this study, we assume the power is perfectly controlled and only voice traffic is considered. Our method can be extended without difficulty when the power control is not perfect and multimedia traffics are considered. In this study, we do not consider the voice activity factor. However, it can be readily added.

System description and model are presented in Section 2. In Section 3, we describe how the values of the desired initial received signal power at the base stations are calculated. In Section 4, after determining initial power value, we show how the received powers in base stations can be modified to satisfy the desired link communication quality and propose the new call admission control algorithm. Some numerical examples are provided in Section 5 and conclusions and future research directions are discussed in Section 6.

2. System Description and Model

We consider the uplink of a multiple cell CDMA system. Let N_i be the number of users in the cell i. The chip rate for all users is fixed and the total bandwidth, W, is used by all users. Let P_i be the power level received at the base station i, which is determined based on the traffic load of cell i. Transmission rate for all users is given as R and p_i represents the power limit constraint. Each user specifies a minimum tolerable QoS. Usually, this is in the form of bit error rate (BER) or frame error rate (FER). It is assumed here that BER/FER requirement can be mapped into an equivalent E_b/N_0 requirement. Let the required E_b/N_0 value be denoted by γ. For a multiple cell system, the expression for the E_b/N_0 of each user in cell i is given by

$$(E_b/N_0)_i = \frac{W}{R} \cdot \frac{P_i}{(N_i - 1)P_i + \sum_{j \neq i} N_j \cdot f_{ij} \cdot P_j + \eta_0 W} \tag{1}$$

where f_{ij} denotes the average interference caused at cell site i when user in cell site j is received at its fixed target base station with one unit signal power. Background additive white Gaussian noise with one-sided power spectral density η_0 is assumed.

Given number of users in each cell, the system is said to be feasible if there exists non-negative $P_1, P_2, \cdots$ which satisfy

$$\frac{W}{R} \cdot \frac{P_i}{(N_i - 1)P_i + \sum_{j \neq i} N_j f_{ij} P_j + \eta_0 W} \geq \gamma$$

and

$$0 < P_i \leq p_i \tag{2}$$

In the CDMA system, using the concept of C/I balancing, the power control mechanism is adopted to maintain the link E_b/N_0 value in each cell at the almost same level in order to make the other cell interference as low as possible.

If there exists more than one feasible vector, it follows that we need some optimization criterion. In a multiple cell system, we want to use the lowest total transmitted power, so that the interference to other cells is minimized. For this criterion we can also find the maximum number of users of each cell that can be simultaneously supported while meeting their QoS constraints.

3. Generalized Optimization Model

The model for determining optimal power value of each cell is developed under the following assumptions.

- For the outercell interference, real data (number of users in each cell) up to the second tier cells are used.
- The cells out of the second tier are assumed to have maximum power value, which is set as 1. The maximum number of users, N_{max}, of cell K in these cells are determined by the following QoS constraint.

$$\frac{W}{R} \cdot \frac{1}{\{(N_{max} - 1) \cdot 1 + \sum_{j \in I_K} f_{Kj} \cdot N_{max} \cdot 1 + \sum_{j \in J_K} f_{Kj} \cdot N_{max} \cdot 1 + \eta_0 w\}} \geq \gamma \tag{3}$$

where I_K and J_K represent index sets of cell number in the first and the second tiers surrounding cell K. We assume that the cells with N_{max} users, whose received power is equal to 1, generate the worst traffic environment.

- f_{ij}'s are assumed to have some constant values. First moments of simulation results [9] are used. Assuming the propagation path loss exponent is 4 and the standard deviation of the shadow fading in dB is 10, they are 0.0637 for $j \in I_i$ and 0.0241 for $j \in J_i$. (The second moments are 0.0276 for $j \in I_i$ and 0.0087 for $j \in J_i$)

- Traffic is assumed to be uniformly distributed over the service area within each cell.
- Voice activity detection is not modeled.

First consider the cell 1. Number of users up to the second tier cells are given as $N_1, N_2, N_3, \cdots, N_{19}$ as shown in Figure 1. N_{max} is assumed in those cells out of the second tier.

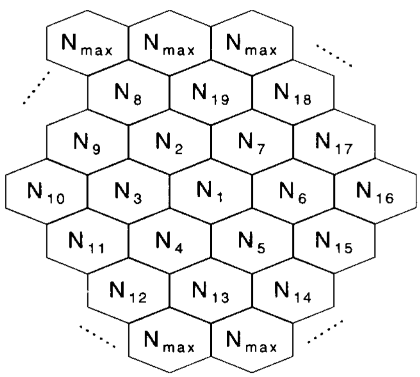


Figure 1. Data for LP 1

Now we try to determine optimal power of cell 1, $\widehat{P_1^*}$. It should be determined by minimizing total received power while meeting the QoS constraints in each cell. That is, LP 1 can be formulated as

$$\textit{Minimize} \quad P_1 + \sum_{i \in I_1} P_i + \sum_{j \in J_1} P_j$$

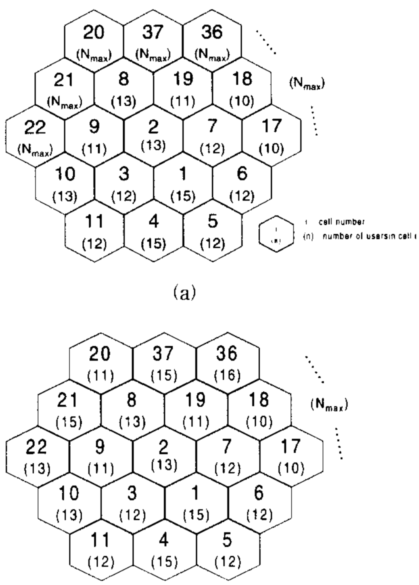
Subject to

$$\frac{W}{R} \cdot \frac{P_l}{(N_l - 1)P_l + \sum_{i \in I_l} N_i P_i f_{li} + \sum_{j \in J_l} N_j P_j f_{lj} + \eta_0 w} \geq r$$

$$0 < P_l \leq 1, \quad l = 1, 2, \cdots, 19 \qquad (4)$$

where I_l and J_l represent index sets of cell numbers in the first tier and the second tier surrounding cell l. For the cell m in the outside of second tier, P_m is set as 1 and N_m is assumed to have N_{max}. It can be easily seen that at the optimal solution $(P_1^*, P_2^*, \cdots, P_{19}^*)$ of LP 1 all QoS constraints are met with equality. (This tells us that the optimal power vector can be also obtained by solving the QoS equations only. This is a system of linear equations in the powers.) From the optimal solution $(P_1^*, P_2^*, \cdots, P_{19}^*)$ of LP 1, the optimum value of cell 1 is determined as $\widehat{P_1^*} = P_1^*$. The optimal power of cell 2, $\widehat{P_2^*}$ can be determined similarly. By making cell 2 the center cell, LP 2 is constructed by the same procedure as in cell 1. And the optimal power of cell 2 is determined as $\widehat{P_2^*} = P_1^*$. By solving 19 LP problems successfully we can obtain $(\widehat{P_1^*}, \widehat{P_2^*}, \cdots, \widehat{P_{19}^*})$. We can see that $(\widehat{P_1^*}, \widehat{P_2^*}, \cdots, \widehat{P_{19}^*})$ makes the QoS constraints satisfied for the users in each cell and E_b/N_0 value in each cell is greater than 5. Suppose $(P_1^*, P_2^*, \cdots, P_{19}^*)$ is the optimal solution of LP 1. Then P_i^* has greater value than $\widehat{P_i^*}$ except P_1^*, which is equal to $\widehat{P_1^*}$. Because $P_i^*(i = 2, 3, \cdots 19)$ is obtained by assuming the worst traffic environment in some of the first and/or the second tier cells, while $\widehat{P_i^*}$ is determined based on the real data unto the second tier cells.

For example, P_2^* of LP 1 and $\widehat{P_2^*}$ are determined to satisfy QoS constraint for the users in each cell based on the Figure 2.a and 2.b respectively. (Figure 2 is constructed from Figure 3 of numerical example). So it is natural that P_2^* has greater value than $\widehat{P_2^*}$.



(a)

(b)

Figure 2. Data Used to Determine P_2^* of LP 1(a) and $\widehat{P_2^*}$(b)

4. Power Control-Based CAC Algorithm

In our model, the power value in each cell is supposed to vary depending on the traffic load. The new power vector should be determined whenever the traffic load changes, such as new call arrival. Therefore, our power control method should be tied together with the call admission control procedure. The proposed power control-based CAC algorithm consists of following 3 steps. In the first step we estimate the received signal power in each base station by solving LP models successfully. In LP model f_{ij} is assumed to have some constant value. The second step is to check if the link E_b/N_0 requirement is satisfied in each cell based on the calculated received signal power value. In this step f_{ij} is assumed to be random variable. The first and second moment of simulation results [9] are used. In the third step the power value is modified for each link to satisfy E_b/N_0 requirement in each cell. In this algorithm perfect power control is assumed.

① Determination of powers in each cell
If a new call arrives in cell i, set $N_i = N_i + 1$. Let cell i be a center cell and solve 19 LPs successfully as explained in section 3. If there exists feasible power vector ($\widehat{P_1^*}$, $\widehat{P_2^*}$, $\cdots$, $\widehat{P_{19}^*}$), go to step 2. Otherwise the new call is blocked and set $N_i = N_i - 1$.

② Using the power vector obtained in step 1, we check the QoS(E_b/N_0) requirement of cell i and cells of the first and second tiers surrounding cell i. That is, for each cell l ($l = i$, $l \in I_i$, $l \in J_i$), we check if the following condition is satisfied.

$$P_r[\,(E_b/N_0)_l \geq r\,] \geq 0.99 \tag{5}$$

From equation (1), (5), if

$$P_r[\,\sum_{j\neq l} f_{lj} N_j \widehat{P_j^*} \leq \frac{\widehat{P_l^*}}{r}\frac{W}{R} - (N_l - 1)\widehat{P_l^*} - \eta_0 w\,] \geq 0.99\,, \tag{6}$$

the new call is accepted.

We may assume $\sum_{j\neq l} f_{lj} N_j \widehat{P_j^*}$ follows normal distribution with mean $\beta_1(l)$ and variance $\beta_2(l)$, where

$$\begin{aligned}\beta_1(l) &= E[\sum_{j\neq l} f_{lj}N_j\widehat{P_j^*}] \\ &= \sum_{j\neq l} N_j\widehat{P_j^*}E[f_{lj}]\end{aligned} \tag{7}$$

$$\begin{aligned}\beta_2(l) &= V[\sum_{j\neq l} f_{lj}N_j\widehat{P_j^*}] \\ &= \sum_{j\neq l} N_j^2\ \widehat{P_j^*}^2\ V[f_{lj}]\end{aligned} \tag{8}$$

Let

$$C_l = \frac{(\frac{\widehat{P_l^*}}{r}\cdot\frac{W}{R} - (N_l-1)\widehat{P_l^*} - \eta_0 w) - \beta_1(l)}{\sqrt{\beta_2(l)}} \tag{9}$$

Then, if $\min_{l=i,\, l\in I_i,\, l\in J_i} C_l \geq Z_{0.99}$, we accept the call. And the optimal power vector is updated as $(\widehat{P_1^*}, \widehat{P_2^*}, \cdots, \widehat{P_{19}^*})$ determined in step 1. Otherwise, we go to step 3.

③ First we start with the target cell i. The powers of cell $l(l=i,\ l\in I_i,\ l\in J_i)$ is changed as $K_i\cdot\widehat{P_l^*}$. The K_i is determined to satisfy the following equation.

$$\frac{\frac{K_i\cdot\widehat{P_i^*}}{r}\cdot\frac{W}{R} - (N_i-1)K_i\cdot\widehat{P_i^*} - \beta_1(i)}{\sqrt{\beta_2(i)}} = Z_{0.99} \tag{10}$$

$$\beta_1(i) = \sum_{j\neq i} N_j\cdot K_i\cdot\ \widehat{P_j^*}^2 * E[f_{ij}] \tag{11}$$

and

$$\beta_2(i) = \sum_{j\neq i} N_j^2\cdot K_i^2\cdot\ \widehat{P_j^*}^2 * V[f_{ij}] \tag{12}$$

Now the cell i' in I_i and J_i becomes target cell. And by the same procedure described above $K_{i'}$ is also determined. Finally each cell l can have its own K_l value. Based on these K_l values, the power of each cell is successively determined using following steps.

a. $K_p = \underset{(l=i,\ l\in I_i, \text{ and } l\in J_i)}{Max} K_l$. Set the power of cell p as $K_p\cdot\widehat{P_p^*}$. If $K_p\cdot\widehat{P_p^*}$, ≥ 1 the call is blocked and set $N_i = N_i - 1$. Otherwise, go to step b.

b. Fixing the power of cell p as $K_p\cdot\widehat{P_p^*}$, we go to the cell q with the next highest K_l value. And K_q is modified to satisfy the following equation.

$$\frac{\frac{K_q\cdot\widehat{P_q^*}}{r}\cdot\frac{W}{R} - (N_q-1)\cdot K_q\cdot\widehat{P_q^*} - \eta_0 W - \beta_1(q)}{\sqrt{\beta_2(q)}} = Z_{0.99} \tag{13}$$

where

$$\begin{aligned}\beta_1(q) &= N_p\cdot K_p\cdot\widehat{P_p^*}E[f_{qp}] \\ &+ \sum_{j\neq q,p} N_j\cdot K_q\cdot\widehat{P_j^*}E[f_{qj}]\end{aligned} \tag{14}$$

and

$$\begin{aligned}\beta_2(q) &= N_p^2\cdot K_p^2\cdot\ \widehat{P_p^*}^2\ V[f_{qp}] \\ &+ \sum_{j\neq q,p} N_j^2\cdot K_q^2\cdot\ \widehat{P_j^*}^2\ V[f_{qj}]\end{aligned} \tag{15}$$

Set the power of cell q as $K_q\cdot\widehat{P_q^*}$. If $K_q\cdot\widehat{P_q^*}\geq 1$, the call is blocked and set $N_i = N_i - 1$. Otherwise, step b is repeated until we get the power for all cells.

If we can get the all the $K_l(l=i,$

$l = I_i, l = J_i$) values and corresponding power vector, we accept the call.

5. Numerical Examples

Based on the data given in Figure 3, the optimal power is determined in each cell.

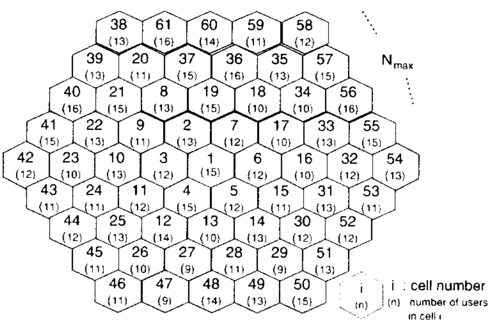


Figure 3. Number of Users in Each Cell for Numerical Example

LP i is solved to derive $\widehat{P_i^*}$. For example, $\widehat{P_1^*}$ is determined based on the first tier data set (cell 2~7), the second tier data set (cell 8~19), and the worst traffic assumption on the outercells. On the while, $\widehat{P_2^*}$ is determined on the first tier data set (cell 1, 3, 7, 8, 9, 19), the second tier data set (cell 2, 4, 5, 6, 10, 11, 17, 18, 20, 22, 36, 37), and the worst traffic assumption on the outercells, and so on.

The second column table 1 shows the optimal solution of LP 1. We can see relatively high power in some of the first and the second tier cells because of the worst traffic assumption on the cells out of the second tier. Since all QoS constraints are met with equality at the optimal solution of LP 1, E_b/N_0 value in each cell is equal to 5. P_1^* is used as the optimal power value of cell 1, $\widehat{P_1^*}$. Now LP 2 is solved to derive the optimal power value in cell 2, $\widehat{P_2^*}$, and so on. The third column of Table 1 summarizes the optimal power ($\widehat{P_1^*}$, $\widehat{P_2^*}, \cdots$, $\widehat{P_{19}^*}$) derived from LP 1~LP 19. Comparing with the P_i^* it can be seen that $\widehat{P_i^*}$ decreases in cell 2 ~19. E_b/N_0 value in cell 1 turns out to be 5.36. We can also see that E_b/N_0 values in other cells are greater than 5. As we will see, if more real data (number of users in the third or the fourth tier cells) are used, it can be expected that $\widehat{P_i^*}$ decreases further and E_b/N_0 value becomes closer to 5 in each cell.

<Table 1> Power Determination Results

Cell	Optimal Solution of LP 1 (P_i^*) Power	Optimal Power Value ($\widehat{P_i^*}$) Power	Optimal Solution of the Extended LP 1 Problem Power
1	0.3603	0.3603	0.2534
2	0.3629	0.3314	0.2386
3	0.3620	0.3134	0.2216
4	0.4411	0.3598	0.2547
5	0.3459	0.2854	0.2026
6	0.3172	0.2698	0.1961
7	0.3202	0.2888	0.2093
8	0.5441	0.3723	0.3015
9	0.4461	0.3144	0.2459
10	0.5553	0.3271	0.2539
11	0.4915	0.2906	0.2293
12	0.6055	0.3126	0.2431
13	0.4309	0.2487	0.1923
14	0.5406	0.2868	0.2269
15	0.4244	0.2525	0.1971
16	0.4363	0.2472	0.2034
17	0.3849	0.2526	0.2031
18	0.4370	0.2729	0.2247
19	0.4263	0.3104	0.2472

Our generalized optimization model uses the number of users in each cell of the first and the second tiers. The outer cell is assumed to have the worst traffic. Now, suppose we can also use the data of the third and the fourth tier cells. That is, number of users in all the 61 cells including target cell are available. Thus, our extended LP problem has 61 variables and 61 QoS constraints. Let $\overline{P_i^*}$ be the optimal power in cell i. To determine optimal power value in each cell we also must solve the LP 1~LP 19. Fourth column of Table 1 shows the result for the extended LP 1 problem. Now $\overline{P_1^*}$ becomes 0.2534. $\overline{P_2^*}$ can be obtained from the extended LP 2 problem, and so on. We can see that the power value in each cell of the fourth column of Table 1 decreases compared to the value of corresponding cell of the second column. $\overline{P_1^*}$ also has smaller value than $\widehat{P_1^*}$. Likewise, it can be expected that $\overline{P_i^*}$ also decreases compared to $\widehat{P_i^*}$ $(i = 2, 3, \cdots, 19)$.

As mentioned in the original model example, under these power value $\overline{P_i^*}$ the E_b/N_0 in each cell has the value of greater than 5. However, we can also expect that E_b/N_0 value under the power $\overline{P_i^*}$ becomes closer to 5 than that under the power value $\widehat{P_i^*}$ in each cell.

For our power control-based CAC algorithm, the maximum number of users in cell 1 can be obtained by iterating 3 steps proposed in section 4. In the previous study, it was assumed that the signal power received by each base station in the CDMA PCS system is same when the capacity of a cell is calculated. If we assume equal power in all the cells, some modifications are required in the power control based CAC algorithm.

- In step 1,

  The power of cell i becomes

  $P^* = \max\{\widehat{P_1^*}, \cdots \widehat{P_{19}^*}\}$

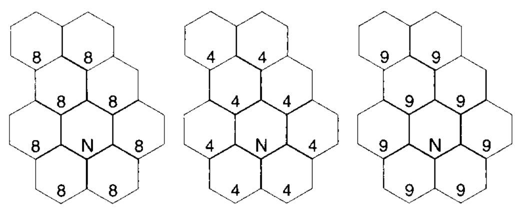
- In step 3,

  After determining each cell's K_l value, the power of each cell is determined as

$$\max\{K_l \cdot P^*\} \text{ if } K_l P^* \leq 1 \text{ for } all\, l,\ l = i,\ l \in I_i,\ l \in J_i.$$

  Otherwise, the call is blocked.

For the numerical example, three different data sets are used as shown in Figure 4.



(a) data set 1 (b) data set 2 (c)data set 3

Figure 4. Three Different Data Sets

Now let's consider the problem obtaining the maximum number of users accommodated in the center cell given that number of users in other cells are fixed. First assume equal received power in each cell, that is, $P_i = P$. Then, the maximum number of active users in the center cell can be obtained by the procedure suggested above. For our power control-based CAC algorithm, the maximum number of users in cell 1 can be obtained by iterating 3 steps proposed in section 4. Table 2 summarizes the results. They also show the optimal power value in each cell.

From the above results we can see following facts.

1) If there is light traffic around the target cell, power control-based CAC and equal power CAC give same maximum number of active users, 18, in the center cell. The reason is that small power values in adjacent cells make other cell interference relatively small. Therefore, we can gain little benefit by power control-based CAC

2) If there is heavy traffic around the target cell, power control based-CAC can accomodate more number of users than equal power CAC. This is because large power values in the adjacent cells make other cell interference relatively large. By making other cell interference (or power) small, we can increase the capacity of the center cell.

3) Compared to data set (3), data set (1) shows more difference in maximum number of users accommodated in center cell. Adjacent cell of data set (3) itself needs relatively large power compared to that of data set (1). Therefore, the adjacent cell of (3) does not have enough room to spare power for the center cell.

As we have seen in previous example, the power control-based CAC algorithm requires

〈Table 2〉 Maximum Number of Users and Power Value

		Data Set 1		Data Set 2		Data Set 3	
		Equal Power	Power Control Based CAC	Equal Power	Power Control Based CAC	Equal Power	Power Control Based CAC
Maximum Number of Users Accomodated in Center Cell		12	15	18	18	10	12
Power Value up to the Second Tier	1	0.4885	0.90156440	0.8062	0.47433042	0.4288	0.73883169
	2	0.4885	0.73659610	0.8062	0.48121958	0.4288	0.66091054
	3	0.4885	0.73749546	0.8062	0.48121958	0.4288	0.66091054
	4	0.4885	0.73766575	0.8062	0.48121958	0.4288	0.66091054
	5	0.4885	0.73766575	0.8062	0.48121958	0.4288	0.66091054
	6	0.4885	0.73766575	0.8062	0.48121958	0.4288	0.66091054
	7	0.4885	0.73749546	0.8062	0.48121958	0.4288	0.66091054
	8	0.4885	0.44407751	0.8062	0.14160266	0.4288	0.48250157
	9	0.4885	0.48094563	0.8062	0.15496134	0.4288	0.57796734
	10	0.4885	0.44314233	0.8062	0.14160266	0.4288	0.56109390
	11	0.4885	0.48147488	0.8062	0.15496134	0.4288	0.57796734
	12	0.4885	0.44335671	0.8062	0.14160266	0.4288	0.56109390
	13	0.4885	0.48195059	0.8062	0.15496134	0.4288	0.57796734
	14	0.4885	0.44684513	0.8062	0.14160266	0.4288	0.56109390
	15	0.4885	0.50783331	0.8062	0.15496134	0.4288	0.57796734
	16	0.4885	0.44683553	0.8062	0.14160266	0.4288	0.56109390
	17	0.4885	0.48190130	0.8062	0.15496134	0.4288	0.57796734
	18	0.4885	0.44324755	0.8062	0.14160266	0.4288	0.48250157
	19	0.4885	0.48095245	0.8062	0.15496134	0.4288	0.57796734

much complicated calculations. Therefore, for practical implementation the algorithm might have some limitation. One way to handle this problem is to use simple table for CAC in each base station.

Following Table 3 gives some interesting results. It shows the maximum number of users in the center cell according to the traffic load pattern in the adjacent cell.

〈Table 3〉 Maximum Number of Users in Center Cell According to the Traffic Load Pattern in Adjacent Cell

Traffic Pattern in Adjacent Cells	Maximum Number of Users in Center Cell under Equal Power Assumption
(8 7 8 7 8 7 ···)	13
(8 7 6 8 7 6 8 7 6 ···)	13
(8 7 6 5 8 7 6 5 8 7 6 5 ···)	14
(8 7 6 5 4 8 7 6 5 4 ···)	14
(8 7 6 5 4 3 8 7 6 5 4 3 ···)	16

Fifth row of Table 3 shows that if number of users in adjacent cells are (8, 7, 6, 5, 4, 8, 7, 6, 5, 4 ···), the maximum number of users accommodated in center cell under equal power assumption is 14. As we have seen in Table 2, if we fix the number of users in adjacent cell as 8, which is max {8, 7, 6, 5, 4}, the maximum number of active users in cell 1 becomes 15 under power control-based CAC. Therefore, if number of users in adjacent cells varies in the pattern of (8, 7, 6, 5, 4, 8, 7, 6, 5, 4 ···), we can simplify number of users in adjacent cells as 8. And the number of users threshold for power control based CAC becomes 15, which is still 1 more compared to the 14 of equal power assumption. Above discussion just shows one typical example. To make a whole threshold table for various traffic load condition needs lots of work. It can be a good topic for further study.

6. Conclusion

We proposed a new power control and call admission control method which can increase the reverse link capacity of a cell in the CDMA PCS system when the traffic loads between cells are uneven. In our power control method, the signal powers received in base stations with heavy traffic are made to be larger than those received in base stations with light traffic. This method can make the interference due to other cells in the cells with heavy traffic relatively small satisfying the grade of service of each cell. The proposed method does not use the measurements of the propagation gain, but uses the average gain value obtained by computer simulation. After determining initial power value by LP, the received powers in base stations are controlled to guarantee certain levels of the link communication quality. The new power vector is determined whenever the traffic load changes, such as new call arrival. Based on the proposed power control method, we develop the call admission control algorithm. In the previous study, it was assumed that the signal power received by each base station in the CDMA PCS system is same when the capacity of a cell is calculated. We could show that the capacity of the CDMA PCS system can be increased about 20% under our call admission control method when we assume the power is perfectly controlled and only voice traffic is considered. For practical implementation, however, the CAC algorithm might require too much calculations. One way to handle this problem is to make the threshold table for maximum number of users in a cell under the various traffic load condition. It is a topic for future study. Sampath [11] has proposed a power control method for a multimedia single cell CDMA system, which alters transmitting powers of terminals based on the requesting grade of services to enhance the capacity of the reverse link. Since our method can be extended without difficulty when the power control is not perfect and multimedia traffics are considered, the performance analysis of our power control method under these circumstances will be the future research topic.

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