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Investigation on directional interference based DCA scheme in TDD-CDMA

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Abstract: Dynamic channel allocation, abbreviating for DCA, is a unique portion of radio resource management (RRM) schemes in TDD-CDMA systems, an important branch of 3rd Generation mobile communication standards adopted by 3GPP. The paper investigates the basic characteristic of DCA including slow DCA and fast DCA in TDD-CDMA systems with smart antennas and presents a whole resolution scheme including an improved slow DCA, a directional-interference-based resource assignment and slot reallocation algorithm. A dynamic system level simulator programmed on OPNET based on Monte-Carlo method is modeled, established and optimized to investigate the effect of smart antennas on DCA schemes and prove the performance gain of improved DCA algorithms. The results show that the improved slow DCA and direction-interference-based fast DCA schemes are help to increase system capacity and reduce dropping rate.

Keywords: 3G, TDD-CDMA, RRM, DCA

1. INTRODUCTION

TDD-CDMA, combining time division duplex (TDD), time division and code division multiple access (TDMA/CDMA), is an important branch of third generation wireless communication systems. For the third-generation mobile systems, two TDD-CDMA standards have already been adopted by 3GPP: TD-CDMA and Time-Division Synchronous CDMA 1. The TDD systems are appearing in the low-power end, be apt at the low-cost and simplifying of hardware realization. Besides, their more effective frequency band utilization resulted from that both uplink and downlink operated in the same frequency. 2. Furthermore, TDD-CDMA is increasingly the focus of research and is being experimented with in combination with multi-carrier CDMA for fourth-generation standards.

The paper pays more attention to the unique radio resource management of TDD-CDMA: dynamic channel allocation (it is commonly abbreviated as DCA). For a physical channel of TDD-CDMA, it is characterized by frequency, slot, spreading code, even spatial angle (if smart antenna is employed). DCA is utilized to allocate those RUs (radio resource units) 3. It is divided as slow DCA for the resource allocation to each cell and fast DCA for the resource

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allocation for bearer services. There are some wonderful published papers focused on this topic 4-6, but most of which regards a part of DCA in TDMA or TDD-CDMA. The paper has a strong eye for DCA scheme in a LCR TDD system with smart antennas including both slow and fast DCA part. The DCA investigation in smart antenna system is seldom touched beforetime. Theoretical analysis and simulation results are both presented.

The rest contents are organized as: Chapter 2 introduces some traditional DCA for TDD-CDMA systems and investigates the effect of smart antennas (SA) on them; a dynamic system-level simulator based on Monte-Carlo method and OPNET is established to validate the results of theoretical analysis in the Chapter 4. A conclusion is served at the end.

2. THE EFFECTS OF SMART ANTENNAS ON DCA SCHEMES FOR TDD-CDMA AND IMPROVED SCHEMES FOR BOTH SLOW DCA AND FAST DCA

DCA denotes dynamic allocating the available radio resource to all radio bearers. Its purposes are on one side the limitation of the interference (keeping required QoS) and on the other side to maximize system capacity 3. So, its functions cover dealing with multiple access interference (MAI) and inter-cell interference. It should require whole information beyond the scope of a single cell, so its logical entities commonly located at radio network controller (RNC) in network architecture.

DCA is divided as slow DCA and fast DCA. The functionalities of slow DCA is in charge of assigning and adjusting the available radio resource to each cell according to the varying cell load. It is utilized to reduce mainly inter-cell interference. And that of fast DCA is aim to avoid MAI in the own cell. In fact, the resource priority assignment plays an important role in the slow DCA implement, consisting of frequency priority and time slot priority. The latter one segregates all RUs to slot with different location area such as a cell or a smaller region based on the measurements and negotiation between adjacent cells during network planning firstly. The assignment results stored at RNC is a preference lists for fast DCA.

The traditional slow DCA schemes have two kinds of criteria: cell-based and distance-based. The former one is just assigning different slot priority to different cell. But this kind of slow DCA not only wastes expensive resource but it should result in severe intercell interference at cell margin. The latter one is improved by differentiating the different region of a cell in the slot priority setting and changing as Fig 1. For this criterion, the slot priority setting for the centric area is arbitrary but cautious for the marginal area.

On the other hand fast DCA refers to the process of allocating available resources in preference list, generated by slow DCA, to bearer services. It is close to the quality of service (QoS) of those bearer services and is generally divided as two stages: the resource allocation at the beginning of radio connection establishment and the resource reallocation during communication according to the measurement on the cell load situation and bearer’s QoS requirements. Hence, fast DCA should be distinct to the services with different QoS requirements such as real-time (RT) service and non real-time (NRT) one. DCA should prior serve the service with stringent QoS requirement. Besides, an effective scheme, at the same time, does well to keep system stability and increase capacity. There are many kinds of fast DCA algorithms, in which the most rational one in CDMA system is the interference based one because CDMA is interference limited. And the resource reallocation should be realized by slot reallocation in TDD-CDMA.

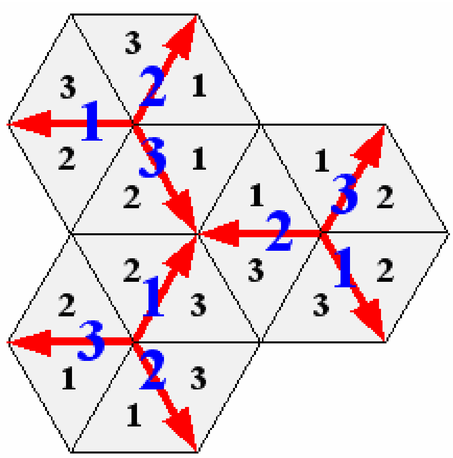

Fig 3 an improved slow DCA scheme with smart antennas

According to those shortcomings, we present an improved slow DCA scheme as shown as Fig 3. In the picture, the number on thick red line is the prior slot, which should be allocated firstly and cover a 120-degrees sector. And the other number in each 120-degrees sector is the slots whose priority just inferior to the prior slot. All slot distribution rule is designed as arrayed with clockwise and there is 60-degrees phase distinction between slots. The improved scheme takes all kinds of slot collision not only prior slot but other slots into account and is more suited for the user mobility. Consequently, the novel scheme should weaken the contradiction between slow DCA and fast DCA operating. But it is impossible to banish this conflict completely. It is because the fast DCA in TDD-CDMA with smart antennas should assign or reallocate radio resource following the rule of insulating location-neighboring users into different slots, but they should be allotted crossly in same slot for slow DCA.

The dominating effect of smart antennas on fast DCA algorithm makes traditional SINR computation model invalid. The desired signal power, intracell and intercell interference are changed due of the various antenna gain and interference reducing of smart antennas. As a result, the SINR computation modeling in TDD-CDMA with smart antennas has to establish based on each beam in a slot. For uplink and downlink, its modeling should be as following formula separately.

$$\frac{S}{I+N}=\frac{P_{jr}}{\upsilon\cdot[(1-\beta)(I_{own}-P_{jr})+I_{oth}]+P_N} \tag{1}$$

$$\frac{S}{I+N}=\frac{P_{jt}\cdot G(\phi_j,\phi_{bm})}{\upsilon\cdot(1-\alpha+i_j)[P_{own}-P_{jt}\cdot G(\phi_j,\phi_{bm})]+P_N} \tag{2}$$

where S means the desired signal power, I denotes the whole interference come from both intra-cell and inter-cell, N is the background thermal noise, P_{jr} stands for the signal power of desired user received at Node-B, P_{jt} is the transmission power of Node-B to user j, v is the active factor of speech traffic (as 1 for data traffic), β is the multiple user detection factor, α is the orthogonal factor among spreading codes, I_{own} and I_{oth} is the intra-cell and inter-cell interference, i_j is the ratio of I_{oth} to I_{own} for user j or UEj, P_{own} is the total transmission power of in the own cell of desired user, $G(\phi_j,\phi_{bm})$ is the antenna gain of UEj in its serving beam m, and P_N is the background thermal noise.

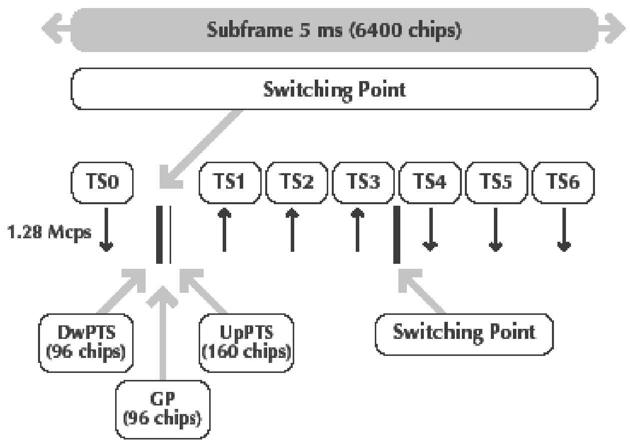

Fig 4 the sub frame structure of LCR TDD system

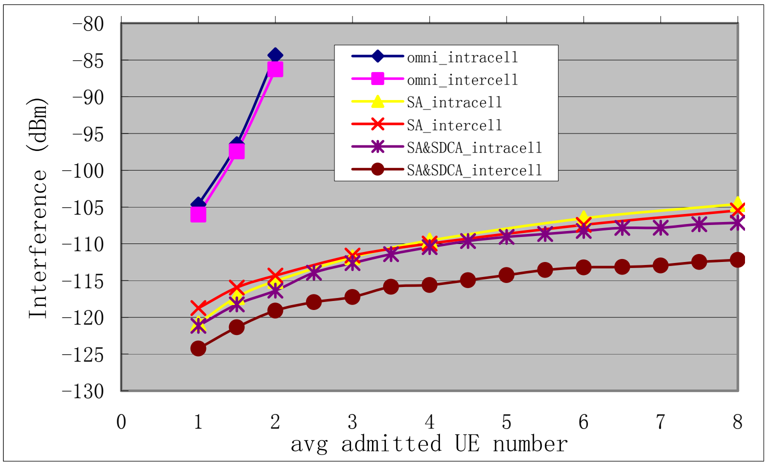

Fig 5 the interference reducing of improved S-DCA scheme in a LCR TDD system with smart antennas

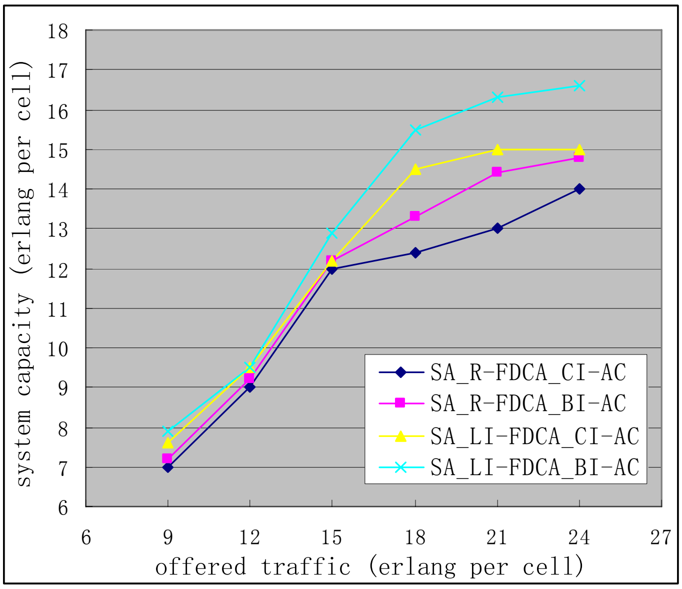

Fig 6 the comparison of Random and Least-directional-Interference fast DCA

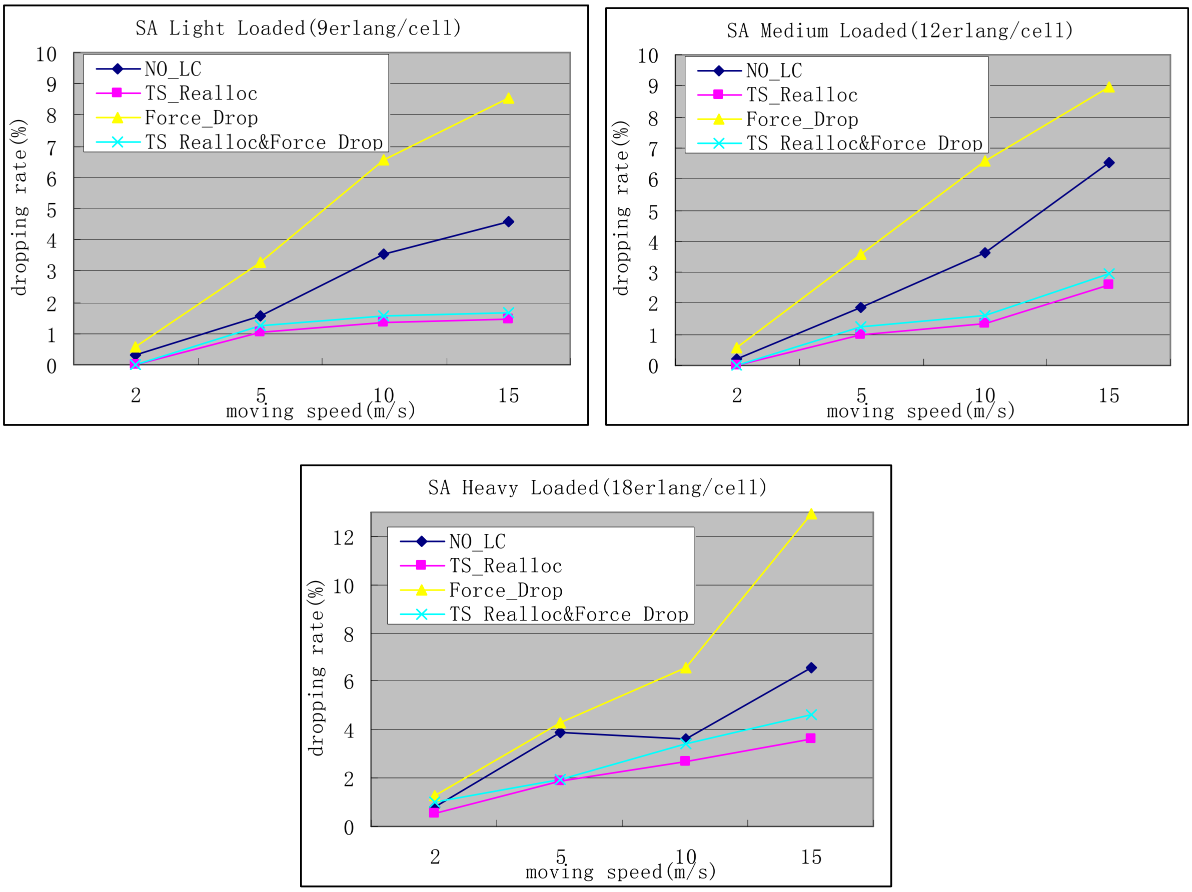

Fig 8 the dropping rate comparison for different LC scheme under different load conditions

4. CONCLUSION

The paper analyzes the basic characteristic of DCA including slow DCA and fast DCA in TDD-CDMA systems with smart antennas. Based on traditional schemes, two improved slow DCA schemes and a directional-interference-based radio resource assignment and reallocation algorithms are presented. Some simulations have been done to investigate and prove the effect of smart antennas on RRM schemes and the performance of improved DCA algorithms.

The simulation results show us that slow DCA has a well behave on intercell interference restraining. The direction-interference-based resource assigning and slot allocating are able to increase system capacity and reducing dropping rate under heavy load conditions.

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REFERENCE

1. http://www.3gpp.org