2012 4th International Conference on Computer Modeling and Simulation (ICCMS 2012)

IPCSIT vol.22 (2012) © (2012) IACSIT Press, Singapore

An Improved Region Division Allocation of Orthogonal Variable Spreading Factor Code in the Forward Link of WCDMA Network

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Abstract. Unrestricted access to the Wideband Code Division Multiple Access (WCDMA) network depends on availability of and unrestricted access to Orthogonal Variable Spreading Code Factor (OVSF) codes. The OVSF codes, if not carefully assigned to users are easily exhausted. Here we propose an improvement to an existing algorithm; Region division Allocation and tagged it as Improved Region Division Allocation (IRDA) of OVSF codes. According to our algorithm, not only that a user uses codes within its allotted region but would be able to borrow channelization codes from other code regions. In situations where it borrows from other regions, our algorithm enables the user to return to its home code region as soon as it finds an available code. The simulation result indicates optimum and fair usage of the available code.

Keywords :WCDMA, Code Blocking, Spreading Factor, OVSF Code, Defragmentation

1. Introduction

WCDMA is adopted and implemented as the 3rd generation wireless network's multiple access technology by UMTS. This technology gives User Element UE the ability to have full duplex access either through frequency division duplex FDD or time division duplex TDD. In the FDD mode, separate 5 MHz carrier frequencies are used for the uplink and downlink respectively, whereas in TDD only one 5 MHz band is timeshared between the uplink and downlink. The 3rd generation networks answer the needs for increasing demand for high and variable data rate services such as video, web surfing, image and data communication. In the downlink of WCDMA, variable data rate is supported by using orthogonal variable spreading factor OVSF codes. The codes have different spreading factors or chip rates in that higher user data rates are spread using low Spreading Factor SF and lower user data rates are spread using high SF. In either case the user data rate is spread to attain the bandwidth of 5MHz. Apart from spreading, the OVSF codes also maintain orthoganality between different users in the sense that the product of two different channels will result to zero

$$\left\{f(x)|g(x)\right\} \equiv \int_a^b f(x)g(x)\,dx = 0,\ a \le x \le b \tag{1}$$

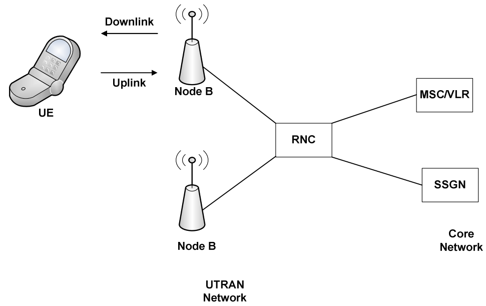

Fig. 1 UMTS Network

This result explains the fact that the interference between two or more channels of the same cell is zero. Another important issue in code assignment is code blocking, a phenomenon where an incoming call is blocked not due to lack of transmission channel but due to lack of OVSF code caused mostly by fragmentation in the code tree. Code assignment schemes should fairly [5] assign codes to Low data rate sessions and High data rates session while considering existing interference before assignment. The rest of the paper is organized as follows. Section two discusses related work, section for IRDA, section four deals with simulation and result while section five is for conclusion.

2. Related Work

In the downlink of WCDMA network, several channels of variable data rates are transmitted at the same time. The variable data rates are supported by using a single orthogonal variable spreading factor code to spread and maintain an interference free communication. A great deal of research is done to ensure an efficient use of the available codes in order to accommodate the highest number of channels possible at the same time, also to reduce fragmentation within the code tree. The code assignment can largely be grouped among other as conventional allocation, dynamic allocation, region division/partitioning (dynamic partitioning) allocation, Hybrid code allocation and genetic Algorithm allocation.

2.1. Conventional Code Allocation Scheme

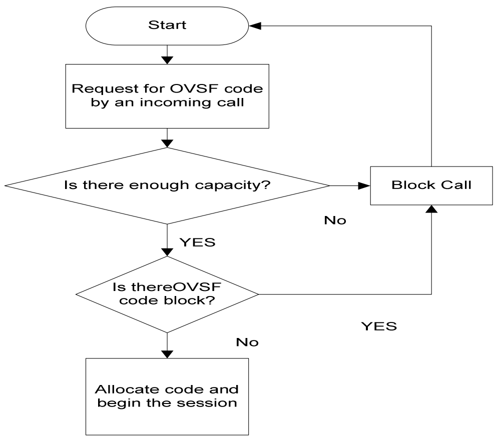

Fig. 2 CCA Flow Chart

In this code assignment scheme the code allocation is simple and straight forward. It is a system in which in-coming calls or sessions are allowed to transmit if their requested codes are available and assignable if no assignable code available, the call is instantly blocked. This assignment scheme is very simple to implement but has greater probability of code block

2.2. Dynamic Code Allocation Scheme DCA

As the name suggest, the allocated codes are dynamic in nature in the sense that a particular session may start transmitting with a particular OVSF code and end its session with a different code [1]. As earlier stated, if the available assignable codes satisfy the Kraft's inequality it implies that the call can be supported by the channelization code. In the event where there is no single code available to support this particular call session as explained in example 2.1 above, a reassignment of codes takes place to create room to accommodate this call. The spreading code of one or more calls are interchanged with new codes so that an assignable code that meet the spreading and orthogonality requirements of the new call is created thereby. The DCA [1] ensures efficient use of the channel resources with more throughput and little blocking but comes with it an additional signaling and delay.

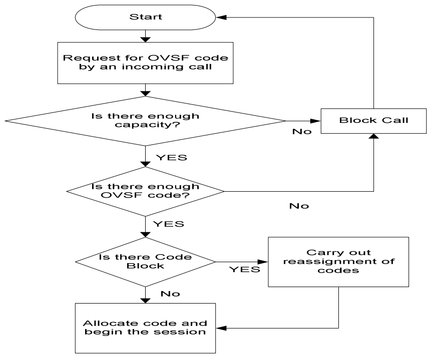

Fig. 3 DCA Flow Chart

2.3. Region Division Allocation RDA

RDA [2] is a proactive code allocation scheme which divides the whole channelization code tree into regions before any call arrives. The code region is defined by the probability of requests for each data rate based on priori knowledge of the network's call distribution. Under RDA scheme, for all incoming calls, first the channel capacity is checked after which the call seeks for spreading code directly from its code region. If assignable code is available it is allocated and the call session begins if not then if the probability to borrow spreading code from other regions is less than its blocking probability then a code is borrowed from other regions otherwise the call is blocked

3. Improved Region Division Allocation IRDA

In our algorithm Fig. 7, we introduce a notations call home code C_h and visiting code C_v. By home code C_h, we mean a class of code reserved for certain group of call rates. A code becomes a visiting code C_v when utilized by a call or session which initially is not meant for that code group. Therefore all visiting codes are engaged codes. As the algorithm shows, the first task of the base station is to check for available resources. Radio resource management RRM carry out the task of managing the effect of incoming calls on the overall interference level of the network and the quality of service requirement of the incoming call. If this requirements are met then the call checks for idle assignable spreading code in its C_h, if found it allocate it, if not then other code class is checked. If it ultimately finds an assignable code in any of the other code groups, code allocation takes place and session starts.

Meanwhile at the beginning of each frame all call sessions utilizing C_v would look back at their home codes weather a code is free for use. If free, code reassignment takes place from visiting code to home code. If assignable (orthogonal) code is not found in all the regions, the call is blocked. In this work the reassignment is limited because for a particular session only a single code reassignment can take place which is the one taking place between its home and visiting code region.

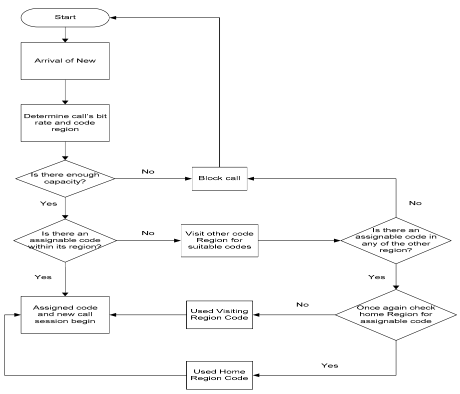

Fig. 4 IRDA Flow Chart

4. Simulation and Result

In our model, we considered four sets of call group (R, 2R, 4R and 8R). Each of the rates is allotted equal number of OVSF code regions. The calls follow the poison's distribution. The incoming call is random and queue is first in first out (FIFO). As shown in the flow chart above, an incoming call is directed first to its code region to pick a code after verifying that there is enough capacity to accommodate the call. If the region have extra or remaining codes to allocate to the call, a new call session begins, if on the other hand there is no extra code, an assignable code is searched for in the other code regions. If available the call takes the code and the session begins. In a nutshell, our algorithm as clearly shown by our flow chart, allows a caller using a code in other regions not its allotted home region code to returns to its home immediately it find out that there is free code available.

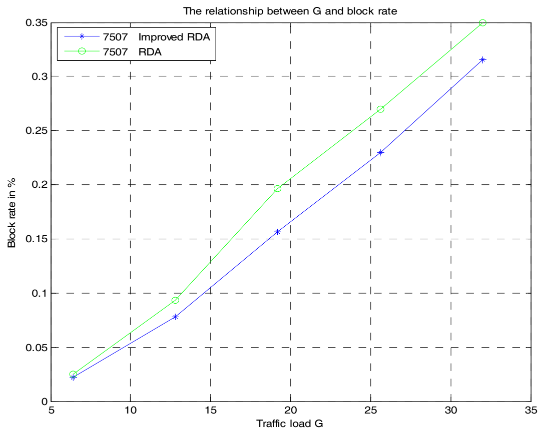

Fig. 5 The relationship between traffic and block rate for IRDA

This idea also answers the need for fair allocation of codes between higher bit rate calls and lower bit rate calls. By changing the simulation time we can vary the amounts of calls. The simulation results for two different time duration is given, we observe that the higher the number of callers the higher the number of session accepted. We also observe that in either of the cases Improved RDA has lesser call drops compared to RDA

Considering the results of the simulation contained in the Fig 5, Improved RDA has a better performance with respect to RDA. The BLUE curve represents IMPROVED RDA and GREEN curve represents RDA. In both of the figures, RDA exhibit higher call drop for the same amount of traffic when compared to Improved RDA

5. Conclusion

Orthogonal Variable Spreading Factor (OVSF) code management and selection in the downlink of WCDMA is a very important issue in the 3rd generation CDMA network. If appropriate code selection algorithm is not followed, the huge capacities and capabilities of the network are underutilized. In this research, we particularly selected RDA and made some improvement to it for better performance. As we have seen in the simulation results contained in the graph, our humble contribution helped in reducing code blocking, ensuring fair allocations amongst low bit rate callers and high bit callers and allowing more user elements UE to participate at the same time. Future work could dwell on a new OVSF code assignment which would be able to combined fair allocation, considering each call's QoS requirements, interference level of the system and unlimited call admission.

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